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PPL Electric Utilities Annual Report to the Pennsylvania Public Utility Commission

PHASE IV OF ACT 129 PY15 ANNUAL REPORT (JUNE 1, 2023 – MAY 31, 2024) FOR PENNSYLVANIA ACT 129 OF 2008 ENERGY EFFICIENCY AND CONSERVATION PLAN

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Prepared for:
PPL Electric Utilities

September 30, 2024

Table of Contents

Figures

Tables

Acronyms

AHRI	Air Conditioning, Heating, and Refrigeration Institute
AMI	Advanced metering infrastructure
ASHP	Air-source heat pump
C&I	Commercial and industrial
CADR	Clean air delivery rate
CDD	Cooling degree day
CEI	Continuous energy improvement
CF	Coincidence factor
CHP	Combined heat and power
C.L.	Confidence limit
CSP	Conservation service provider or curtailment service provider
CSS	Cross-sector sales
Cv	Coefficient of variation
DLC	DesignLights Consortium
DR	Demand response
DHW	Domestic hot water
DY	Delivery Year
EDC	Electric distribution company
EDT	Eastern Daylight Time
EER	Energy efficiency ratio
EE&C	Energy efficiency and conservation
EFLH	Equivalent fuel load hours
EM&V	Evaluation, measurement, and verification
EISA	Energy Independence and Security Act
EUL	Effective useful life
FCM	Forward Capacity Market
GNE	Government, nonprofit, educational
GPM	Gallons per minute
HDD	Heating degree day
HER	Home energy report
HEW	Home energy worksheet
HIM	High-impact measure
HOU	Hours of use
HP	Horsepower
HPWH	Heat pump water heater
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating, and air conditioning
ICSP	Implementation conservation service provider
IECC	International Energy Conservation Code
IMC	Incremental measure cost
IMP	Interim measure protocol
IPMVP	International Performance Measurement and Verification Protocol
ISR	In-service rate
kW	Kilowatt
kWh	Kilowatt-hour
KPI	Key performance indicator
LED	Light-emitting diode
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and verification
MMMF	Master-metered multifamily
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
P4TD	Phase IV to date
PA PUC	Pennsylvania Public Utility Commission
PAC	Program administrator cost
PIV TD	Phase IV to date
PSA	Phase IV to date preliminary savings achieved; equal to VTD + PYRTD
PSA+CO	PSA savings plus carryover from Phase III
PY	Program Year: for example, PY15, from June 1, 2023, to May 31, 2024
PYRTD	Program year reported to date
PYVTD	Program year verified to date
PYTD	Program year to date
QA/QC	Quality assurance/quality control
REA	Remote energy assessment
RTD	Phase IV to date reported gross savings
SEEE	Student Energy Efficient Education
SEER	Seasonal energy efficiency ratio
SKU	Stock keeping unit

SMI	Secondary market impacts
SWE	Statewide evaluator
T&D	Transmission and distribution
tLED	Tubular LED
TRC	Total resource cost
TRM	Technical reference manual
UEC	Unit energy consumption
VTD	Phase IV to date verified gross savings
VTD+CO	Phase IV to Date Preliminary Savings Achieved + Carryover
WACC	Weighted average cost of capital
ZERH	Zero energy ready homes

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 energy efficiency and conservation (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 IV 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 measurement and verification (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 Technical Reference Manual (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 Total Resource Cost (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. Program Year to Date (PYTD) values for energy efficiency will always be reported gross savings in a semi-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 IV to Date (P4TD): The energy and peak demand savings achieved by an EE&C program or portfolio within Phase IV of Act 129. Reported in several permutations described below.

Phase IV to Date Reported (RTD): The sum of the reported gross savings recorded to date in Phase IV of Act 129 for an EE&C program or portfolio.

Phase IV to Date Verified (VTD): The sum of the verified gross savings recorded to date in Phase IV of Act 129 for an EE&C program or portfolio, as determined by the impact evaluation finding of the independent evaluation contractor.

Phase IV to Date Preliminary Savings Achieved (PSA): The sum of the verified gross savings (VTD) from previous program years in Phase IV where the impact evaluation is complete plus the reported gross savings from the current program year.

Phase IV to Date Preliminary Savings Achieved + Carryover (PSA+CO): The sum of the verified gross savings from previous program years in Phase IV plus the reported gross savings from the current program year plus any verified gross carryover savings from Phase III of Act 129. This is the best estimate of an EDC's progress toward the Phase IV compliance targets.

Phase IV to Date Verified + Carryover (VTD + CO): The sum of the verified gross savings recorded to date in Phase IV plus any verified gross carryover savings from Phase III of Act 129.

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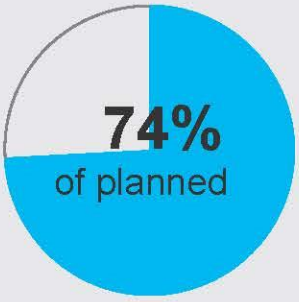
PORTFOLIO COMPLIANCE TARGETS

PPL Electric Utilities offers energy efficiency programs to large and small commercial and industrial, residential, and income-eligible customers.

VERIFIED ENERGY SAVINGS

Phase IV has saved **941,517 MWh/yr***

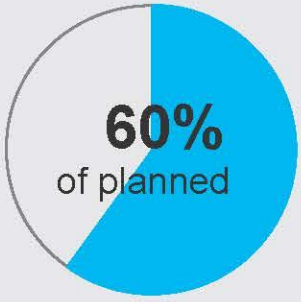


PY15 saved **194,667 MWh/yr**

*Includes Phase III carryover savings

VERIFIED DEMAND REDUCTIONS

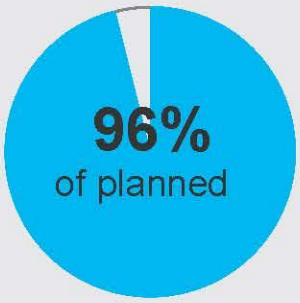
Phase IV has reductions of **103.34 MW/yr**



PY15 has reductions of **31.86 MW/yr**

LOW-INCOME PROGRAM

Phase IV has saved **67,173 MWh/yr***

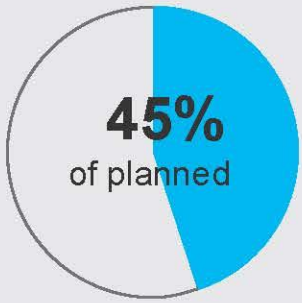


PY15 saved **14,062 MWh/yr**

*Includes Phase III carryover energy savings

EXPENDITURES ($1,000)

Phase IV expenditures **$139,953**



PY15 expenditures **$57,198**

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PORTFOLIO PARTICIPATION AND SATISFACTION

PY15 PARTICIPATION

A total of **221,218** participants

200,217 Residential

16,010 Low-Income

4,991 Non-Residential

PROGRAM SATISFACTION

92% Overall Portfolio Satisfaction

97% satisfied with Non-Residential Program

89% satisfied with Residential Program

88% satisfied with Low-Income Program

PARTICIPANT COMMENTS

"I am very pleased with PPL overall. Customer service is very good and they are your most notable face of PPL."

"My opinion was always high for PPL but having this type of program gives me more comfort."

"This program is extremely valuable to our students! It allows them to actively participate and connects with them, as they are directly responsible for the amount of electricity and water that they use."

"... I was very thankful to receive $400. It certainly helped to lower the overall price of the unit."

"[The program] keeps providing excellent information for low income families and when I call they answer every question with respect."

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 Phases I (2008 through 2013), II (2013 through 2016), and III (2016 through 2021). In late 2020, 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 IV. These plans were updated based on stakeholder input and subsequently approved by the PUC in 2021.

Implementation of Phase IV of the Act 129 programs began on June 1, 2021. This report documents the progress and effectiveness of the Phase IV EE&C accomplishments for PPL Electric Utilities in program year 15 (PY15), as well as the cumulative accomplishments of the Phase IV programs since inception. This report also documents the energy savings carried over from Phase III. The Phase III carryover savings count toward EDC savings compliance targets for Phase IV.

This report details the participation, spending, reported gross, verified gross energy (MWh) and peak demand (MW), and verified net impacts of the energy efficiency programs in PY15. 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 IV 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 performed a process evaluation to examine the design, administration, implementation, and market response to the EE&C plan. This report presents the key findings and recommendations identified by the process evaluation and documents any changes to EE&C plan delivery that were considered based on the recommendations.

1.1. Executive Summary

PPL Electric Utilities continued to successfully implement all energy efficiency programs for Phase IV Act 129 in PY15. Programs are operating effectively and are meeting their program objectives but are slightly behind planned savings for PY15. Each program chapter presents recommendations focused on ways to fine-tune program implementation.

PPL Electric Utilities is on track to meet the portfolio energy savings compliance target and has achieved gross verified energy savings of 941,517 MWh/yr, including Phase III carryover savings (306,275

[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. The 2021 TRC Test Order for Phase IV of Act 129 was adopted by PUC Order at Docket No. M-2019-3006868 on December 19, 2019.

MWh/yr) through PY15, accounting for 75% of the Phase IV overall five-year compliance target of 1,250,157 MWh/yr. In PY15, PPL Electric Utilities achieved 194,667 MWh/yr in verified savings.

Through PY15, PPL Electric Utilities achieved system-level demand reductions of 103.34 MW/yr, which represent 45% of the Phase IV overall five-year compliance target of 229 MW/yr. In PY15, PPL Electric Utilities projected an estimate of 52.80 MW/yr and achieved 31.86 MW/yr in system-level verified energy reductions, or 60% of demand projections.

PPL Electric Utilities is on track to meet the compliance target of 72,509 MWh/yr of verified gross energy savings for the low-income sector for Phase IV. PPL Electric Utilities has achieved 93% of the Phase IV low-income energy-savings compliance target through PY15 (36,084 MWh/yr), including carryover savings from Phase III (31,089 MWh/yr).

PPL Electric Utilities delivered programs for 76% of the Phase IV cumulative projected budget through PY15, estimated in the EE&C plan, expending $139,953,013.[2] The acquisition cost in PY15 is $0.25 per annual kWh and is $0.21 per annual kWh for Phase IV (EDC expenditures/first-year savings). The portfolio-level PY15 total cost of conserved energy (TRC costs/net present value [NPV] lifetime kWh, at generation) is $0.063/kWh. In PY15, the portfolio-level utility cost of conserved energy (program administrator cost [PAC]/NPV lifetime kWh, at generation) is $0.024/kWh. The TRC includes PPL Electric Utilities' and the customers' costs, while the PAC only includes PPL Electric Utilities' costs.

A portfolio is cost-effective when the TRC benefit-cost ratio exceeds 1.0. The PY15 and phase-to-date portfolio is cost-effective with a portfolio-level TRC of 1.19 (PY15) and 1.49 (phase-to-date).

The evaluated net-to-gross (NTG) ratio is 0.70, which includes spillover attributable to the Energy Efficient Homes components of the Residential Program.

In Phase IV, PPL Electric Utilities established a goal to achieve 85% or greater of *very satisfied* and *somewhat satisfied* customers in each program, as shown in Figure 1-1.[3] Respondents to participant satisfaction surveys across all programs reported high levels of satisfaction with the programs, meeting or exceeding the customer satisfaction goal of 85% for each program. In PY15, satisfaction ratings for all three programs and the portfolio overall increased over PY14. With the combined *very satisfied* and *somewhat satisfied* responses, portfolio satisfaction was 92% (n=16,523) in PY15 compared to 86% satisfied in PY14 (n=15,218). The Non-Residential Program achieved 97% satisfaction in PY15 (n=103) compared to 86% in PY14 (n=38), and the Residential Program achieved 89% in PY15 (n=15,981) compared to 85% in PY14 (n=15,063). These increases are all statistically significant.[4]

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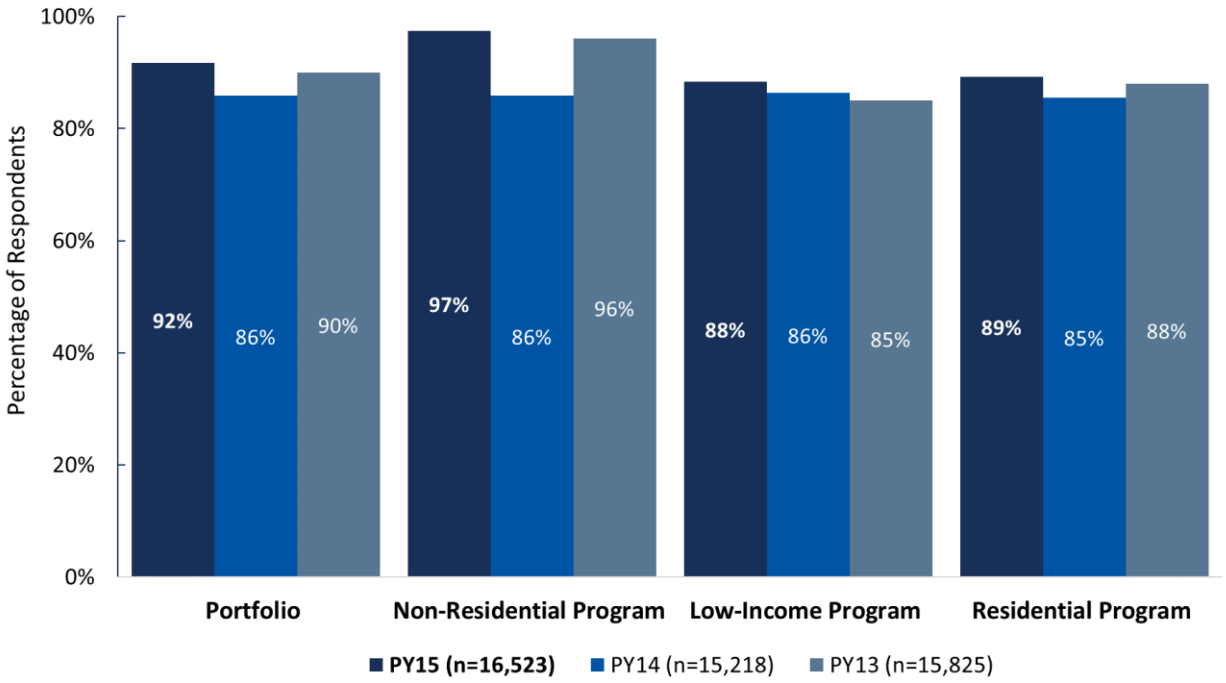
[2] Through PY15, PPL Electric Utilities estimated a budget of $183,488,000.

[3] The customer satisfaction goal is listed in PPL Electric Utilities' EE&C Plan (Docket No. M-2020-3020824) filed February 2024.

[4] Differences between PY15 and PY14 results are statistically different at the 90% confidence level, p-value < 0.10.

Customer satisfaction for the Low-Income Program was slightly higher, though not statistically significant, in PY15, with 88% satisfied (n=439) compared with 86% in PY14 (n=117).

Figure 1-1.Portfolio-Level Program Satisfaction
***Very* and *Somewhat Satisfied* Combined**



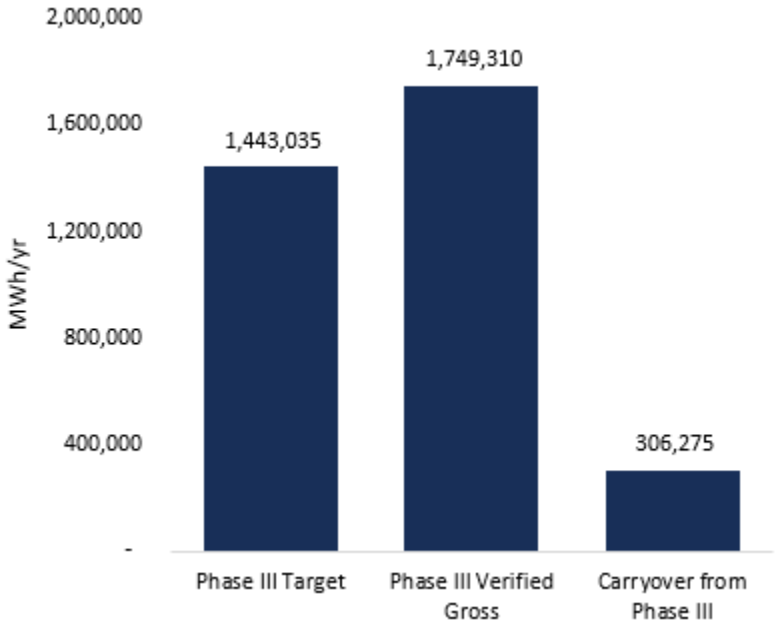
Source: Participant survey question, "Thinking about your overall experience with the PPL Electric Utilities program/component, how would you rate your overall satisfaction?" Program satisfaction results include all responses to the satisfaction question, averaged to compute the portfolio-level satisfaction. These totals may not reflect number of "completed" surveys as reflected in Table 4-4. Non-Residential includes Custom and Efficient Equipment downstream survey respondents, Low-Income includes remote energy assessment and direct install survey respondents, and Residential includes Appliance Recycling, Energy Efficient Homes Equipment, Online Marketplace, Audit and Weatherization, and students and teacher survey respondents.

2. Summary of Achievements

2.1. Carryover Savings from Phase III of Act 129

PPL Electric Utilities has a total of 306,275 MWh/year of portfolio-level carryover savings from Phase III. Figure 2-1 compares PPL Electric Utilities' Phase III verified gross savings total to the Phase III compliance target to illustrate the carryover calculation.

Figure 2-1. Carryover Savings from Phase III of Act 129

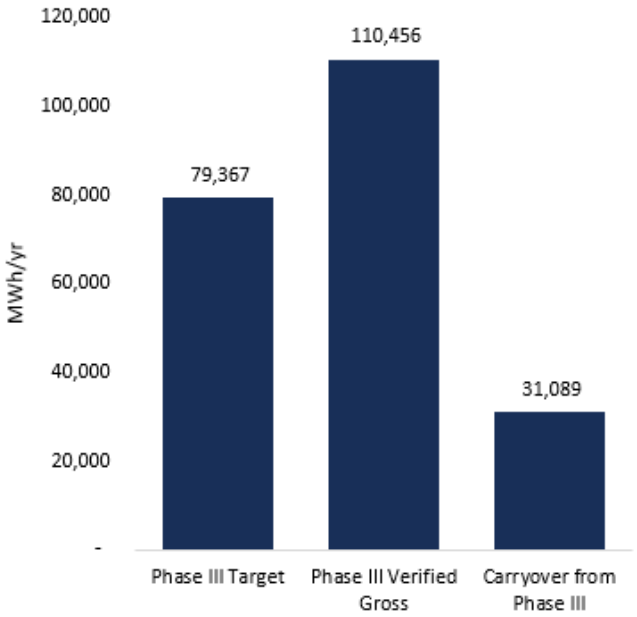


The PA PUC's Phase IV Implementation Order also allows EDCs to carry over savings in excess of the Phase III low-income savings goal.[5,6] Figure 2-2 shows the calculation of carryover savings for the low-income customer segment.

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

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

Figure 2-2. Low-Income Carryover from Phase III



2.2. Phase IV Energy Efficiency Achievements to Date

The Phase IV energy savings targets (MWh) were established at the meter level and peak demand reduction targets (MW) were set at the system level. Accordingly, this report presents MWh totals at the meter level and peak demand savings adjusted for transmission and distribution losses to reflect system-level savings.

Table 2-1 shows the achievements since the beginning of PY15 on June 1, 2023, through the end on May 31, 2024.

Table 2-1. PY15 Energy and Demand Achievements to Date[1]

PYTD	Reported Gross Savings (PYRTD)	Verified Savings (PYVTD)	System-Level Verified Savings (PYVTD)	Unverified (PYRTD)	Realization Rate[2]
Energy Savings (MWh/yr)[3]	258,900[4]	194,667	N/A	52,842	75%
Peak Demand Reductions (MW/yr)[3]	43.32[4][5]	29.78	31.86	10.16	69%[6]

[1]Savings do not include unverified PY14 savings verified in PY15.
[2]Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates include unverified savings. Realization rates in different chapters are calculated by removing unverified reported savings from the denominator.
[3]Savings may not match other tables or figures due to rounding.
[4]Reported savings without unverified savings are 206,058 MWh/yr and 33.16 MW/yr.
[5]Reported savings do not include the application of distribution losses.
[6]Realization rates in this table are applied to verified demand reductions with application of distribution losses.

Table 2-2 shows the Phase IV achievements through end of PY15, including carryover savings. Including carryover savings from Phase III, PPL Electric Utilities has achieved 941,517 MWh/yr of verified savings through the end of PY15. This represents 75% of the Phase IV energy savings compliance target of 1,250,157 MWh/yr. PPL Electric Utilities has achieved 103.34 system-level demand reductions or 45% of the Phase IV demand reduction savings compliance target of 229 MW/yr.

Table 2-2. Phase IV Energy and Demand Achievements to Date

P4TD	Reported Gross Savings (P4RTD)	Verified Savings (P4VTD)	System-Level Verified Savings (P4VTD)	Unverified (P4RTD)	Realization Rate[1]
Energy Savings (MWh/yr)[2]	682,474[3]	941,517[4]	N/A	52,842	93%[5]
Peak Demand Reductions (MW/yr)[2]	110.44[3][6]	96.30	103.34	10.16	87%[7]

[1]Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates include unverified savings. Realization rates in different chapters are calculated by removing unverified reported savings from the denominator.
[2]Savings may not match other tables or figures due to rounding.
[3]Reported savings without unverified savings are 629,632 MWh/yr and 100.28 MW/yr.
[4]Verified energy savings include Phase III carryover of 306,275 MWh/yr.
[5]Realization rate excludes Phase III carryover of 306,275 MWh/yr.
[6]Reported savings do not include the application of distribution losses.
[7]Realization rates are applied to verified demand reductions before application of distribution losses.

Figure 2-3 summarizes PPL Electric Utilities' progress toward the Phase IV MWh portfolio compliance target, and Figure 2-4 summarizes progress toward the Phase IV MW portfolio compliance target. Unverified energy savings total is 52,842 MWh/yr (41,612 MWh/yr for the Non-Residential Program and 11,229 MWh/yr for the Residential Program). The total unverified demand reduction is 10.16 MW/yr (10.08 MW/yr for the Non-Residential Program and 0.08 MW/yr for Residential Program).[7] Cadmus will verify these savings in PY16.

[7] The sum of individual program-level demand reductions does not match total due to rounding.

Figure 2-3. EE&C Plan Performance Toward Phase IV Portfolio Compliance Target (MWh/yr)

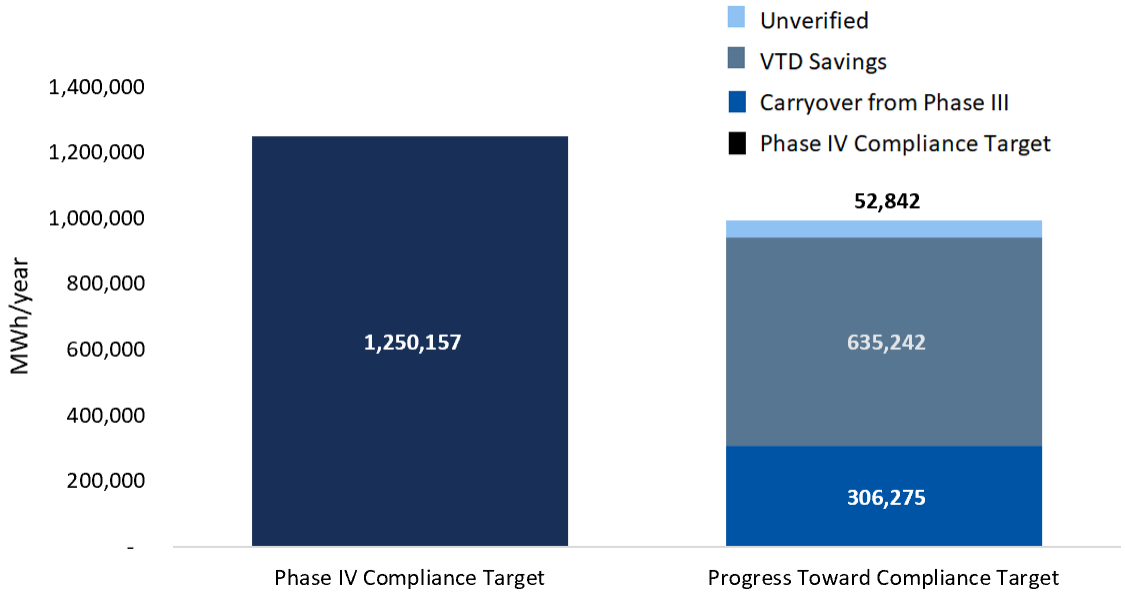
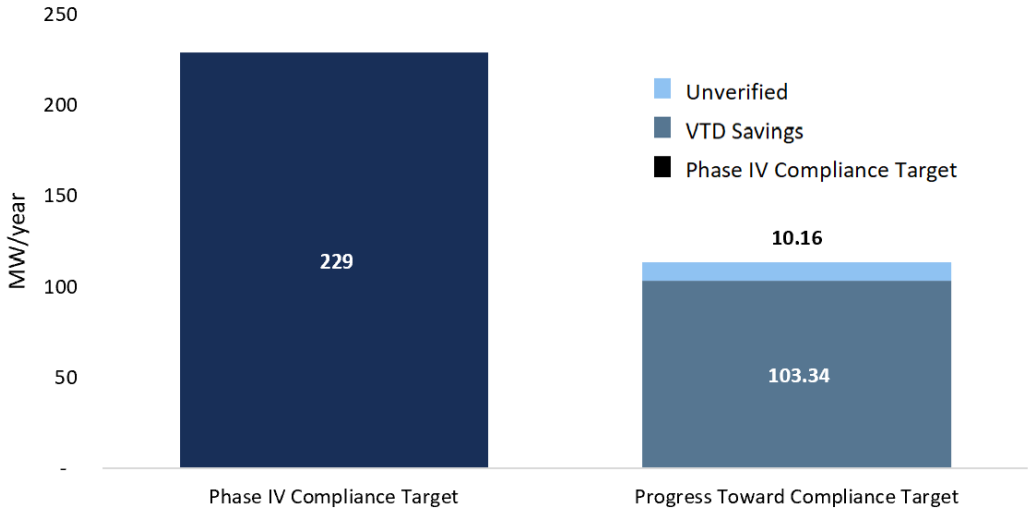


Figure 2-4. EE&C Plan Performance Toward Phase IV Portfolio Compliance Target (MW/yr)

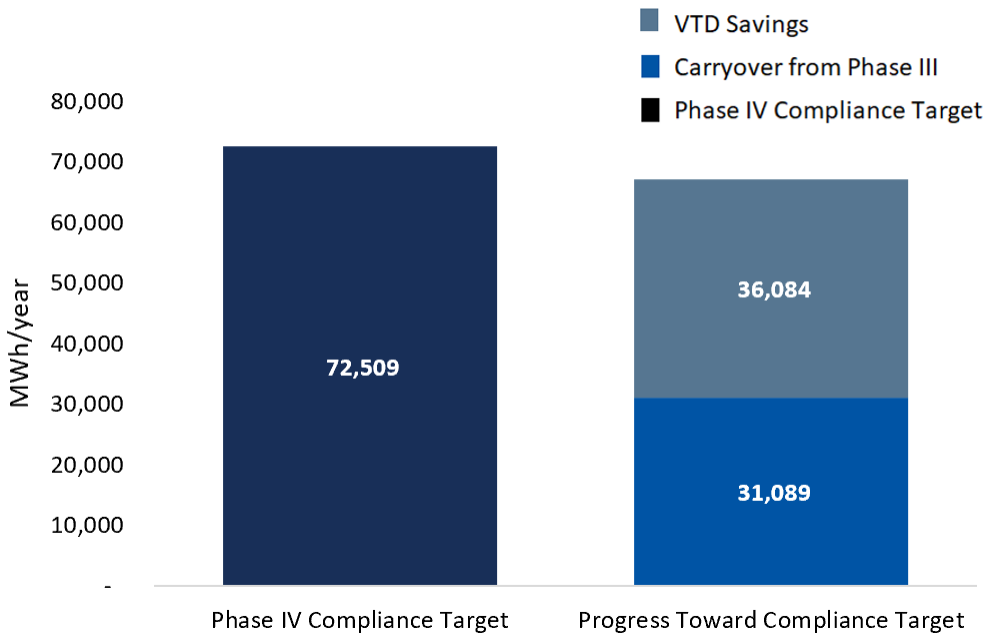


The Phase IV Implementation Order directed EDCs to offer conservation measures to the low-income customer segment based on the proportion of electric sales attributable to low-income households. PPL Electric Utilities' target proportion is 9.95%. PPL Electric Utilities offers a total of 82 EE&C measures to its residential and nonresidential customer classes. There are 18 distinct measures available to the low-income segment at no cost to the customer. This represents 22% of the total measures offered in the EE&C plan and exceeds the proportionate number of the measures target.

The PA PUC also established a low-income energy savings target of 5.8% of the portfolio savings goal. The low-income savings target for PPL Electric Utilities is 72,509 MWh/yr verified gross savings.

Figure 2-5 compares the VTD performance for the low-income customer segment to the Phase IV savings target. Including Phase III Low-Income carryover savings, PPL Electric Utilities has achieved 93% of the Phase IV low-income energy-savings compliance target.

Figure 2-5. EE&C Plan Performance Toward Phase IV Low-Income Compliance Target (MWh/yr)



2.2.1. Phase IV Performance, Multifamily Housing

Table 2-3 lists verified gross electric energy savings (PYVTD) from multifamily housing across all programs, including energy savings from low-income households.

Table 2-3. Multifamily Housing

Program	PYVTD (MWh/yr)	Phase IV VTD (MWh/yr)[1]
Low-Income	4,350	10,316
Portfolio Total	5,485	13,755

[1]Includes PY14 savings left unverified in PY14 and verified in PY15. Because of this, adding the total Phase IV VTD in the PY14 report to the PYVTD savings will not sum to the total Phase IV VTD value.

Master-Metered Multifamily Housing Summary

In compliance with the June 2023 settlement agreement, PPL Electric Utilities agreed to several reporting requirements on its expanded efforts with master-metered multifamily (MMMF) customers. PPL Electric Utilities worked with 10 property managers at 13 MMMF locations throughout its service territory. The Low-Income Program treated 1,648 units at 41 individual buildings (accounts) in PY15. The units (and tenants) received LED lighting, water-saving measures, smart strips, and energy education. Ninety-three customers received comprehensive measures during their appointments. The cost of the direct installation, comprehensive measures, and labor was $410,080.

The Low-Income Program achieved 421 MWh/yr of energy savings and 0.05 MW/yr of demand reductions in PY15 in MMMF housing. PPL Electric Utilities updated marketing collateral and completed outreach to customers in prior phases and non-profit housing authorities to develop MMMF opportunities. Additionally, PPL Electric Utilities' Low-Income ICSP used multiple proprietary software and database resources to locate additional opportunities. These efforts will continue in PY16.

Additionally, the Non-Residential Program treated the common areas of 37 affordable MMMF buildings in PY15. The common areas in these buildings received lighting improvements, HVAC upgrades, ductless mini-split heat pumps, and high-frequency battery chargers. These buildings achieved 207 MWh/yr of verified gross electric energy savings and $10,795.43 in incentives for these projects.

2.3. Phase IV Performance by Customer Segment

Table 2-4 presents participation, savings, and spending by customer sector for PY15. The EDC tariff defines residential, small commercial and industrial (C&I), and large C&I sectors, and statute (66 Pa. C.S. § 2806.1) defines the residential low-income sector and government, nonprofit, educational (GNE) sector. The residential low-income segment is a subset of the residential customer class, and the GNE segment includes customers who are part of the residential, small C&I, or large C&I rate classes. Cadmus removed the savings, spending, and participation values for the low-income and GNE segments from the parent sectors.

Table 2-4. PY15 Summary Statistics by Customer Segment[1]

Parameter	Residential (Non-LI)	Low-Income	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total[2]
Reported Number of Participants[3]	194,952	15,969	8,237	669	1,390	221,218
PYRTD MWh/yr[4]	63,233	12,199	80,122	70,326	33,021	258,900
PYRTD MW/yr[4]	7.24	1.31	16.18	12.01	6.58	43.32
PYVTD MWh/yr[4]	44,095	13,640	51,010	60,566	25,355	194,667[5]
System-Level PYVTD MW/yr[4]	6.44	1.48	8.64	10.58	4.72	31.86[5]
PY15 Incentives ($1000)[4],[6]	$8,217	$4,287	$11,995	$4,702	$4,849	$34,050

[1] This table does not include PY14 unverified savings verified in PY15.
[2] Columns may not sum to totals due to rounding.
[3] Verified participation totals discussed in each chapter and appendix and shown in the infographics may differ from the reported participation in this table.
[4] Savings may not match other tables or figures due to rounding.
[5] Excludes 52,842 MWh/yr and 10.16 MW/yr of unverified savings.
[6] PPL Electric Utilities reports the number of participants and PYRTD using their participant tracking database but uses the incentive amounts from a separate accounting system since they are reported along with the other expenditures.

Table 2-5 shows savings for the GNE sector as defined by statute (66 Pa. C.S. § 2806.1) for residential, small, and large C&I customer sectors defined by the EDC tariff.

Table 2-5. PY15 Energy and Demand Summary of Government, Nonprofit, and Education Sector Customers

Parameter	GNE Customers with Residential Rate Codes	GNE Customers with Small C&I Rate Codes	GNE Customers with Large C&I Rate Codes	GNE Total[1]
PYRTD MWh/yr[2]	0	22,321	10,699	33,021
PYRTD MW/yr[2]	0	4.79	1.78	6.58
PYVTD MWh/yr	0	16,260	9,095	25,355
System-Level PYVTD MW/yr	0	3.17	1.55	4.72

[1] Columns may not sum to totals due to rounding. These totals will not match the values in other tables showing totals by customer sector.
[2] Does not include PY14 unverified savings verified in PY15.

Table 2-6 summarizes plan performance by sector since the beginning of Phase IV.

Table 2-6. Phase IV Summary Statistics by Customer Segment

Parameter	Residential (Non-LI)	Low-Income	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total[1]
Reported Number of Participants[2]	1,701,753	66,538	127,990	2,512	4,873	1,903,666
RTD MWh/yr[3]	141,567	34,735	264,798	176,578	64,796	682,474
RTD MW/yr[3]	18.46	3.80	46.77	29.53	11.88	110.44
VTD MWh/yr[3],[4]	122,316	66,657[4]	247,040	169,561	60,757	941,517[4],[5]
System-Level VTD MW/yr[3]	17.57	4.03	42.53	28.57	10.63	103.34[5]
Phase IV Incentives ($1000)[6]	$19,359	$9,528	$28,975	$11,302	$7,944	$77,109

[1] Columns may not sum to totals due to rounding.
[2] Verified participation totals discussed in each chapter and appendix and shown in the infographics may differ from the reported participation in this table.
[3] Savings may not match other tables or figures due to rounding.
[4] Verified energy savings include Phase III carryover for the low-income sector of 31,089 MWh/yr. The total includes Phase III carryover savings of 306,275 MWh/yr not attributed to individual sectors; therefore, the sum of savings by sector will not match the total.
[5] Includes adjustments to savings made by the statewide evaluator (SWE). Includes PY14 unverified savings that were verified in PY15 and excludes 52,842 MWh/yr and 10.16 MW/yr of PY15 unverified savings.
[6] PPL Electric Utilities reports the number of participants and PYRTD using their participant tracking database but uses the incentive amounts from a separate accounting system since they are reported along with the other expenditures.

2.4. Summary of Participation by Program

Participation is defined differently for some programs and program components depending on the program delivery channel and data tracking practices. Table 2-7 shows the participant definition by program and component, along with the current participation totals for PY15 and Phase IV.

Table 2-7. EE&C Plan Participation by Program

Program/Component	Participant Definition	PYTD Participation	P4TD Participation
Non-Residential Program			
Custom	Unique job number; commercially operable job that received an incentive payment during the reporting period.	235	393
Efficient Equipment (downstream)	Unique job number; corresponds to each unique job that received a rebate.	680	1,977
Efficient Equipment (midstream)	Unique job number; corresponds to each purchase of discounted products.	4,076	14,597
Low-Income Program			
Low-Income Assessment	Unique bill account number; corresponds to an income-eligible household that receives an audit and program services or receives a welcome kit.	16,010	66,581
Residential Program			
Appliance Recycling	Unique job number; corresponds with each unique appliance decommissioned through the program component during the program year.	13,589[1]	37,105
Efficient Lighting	Number of discounted bulbs sold.	67,447	1,588,224
Energy Efficient Homes New Homes	Unique job number; corresponds to a rebated project.	1,427[2]	4,371[2]
Energy Efficient Homes Audit and Weatherization	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	1,776[3]	3,872[3]
Energy Efficient Homes Online Marketplace	Unique job number; corresponds to a rebated project.	5,492	15,420
Energy Efficient Homes Equipment (downstream)	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	9,794[3]	27,712[3]
Energy Efficient Homes Equipment (midstream)	Unique job number; corresponds to each purchase of discounted products.	11	11
Energy Efficient Homes Instant Discount	Unique job number; corresponds to each discounted item purchased.	80,512	83,026
Student Energy Efficient Education	Number of participants is counted as the number of energy conservation kits delivered.	20,169	60,378
Portfolio Total		**221,218**	**1,903,667**

[1] Includes incentive adjustments not included on the Appliance Recycling infographic.
[2] Includes four High-Performance Homes pilot participants.
[3] Includes one Deep Energy Retrofit pilot participant.

2.5. Summary of Impact Evaluation Results

During PY15, Cadmus completed impact evaluations for most program components in the portfolio. Table 2-8 summarizes the realization rates and NTG ratios by program component.

Table 2-8. PY15 Impact Evaluation Results Summary

Program	Component	Energy Realization Rate[1]	Demand Realization Rate[1]	Net-to-Gross Ratio
Non-Residential	Custom	100%	100%	0.74[2]
	Efficient Equipment	92%	80%	0.65[3]
Low-Income	Low-Income	110%	103%	1.00[4]
Residential	Appliance Recycling	93%	95%	0.50[5]
	Efficient Lighting	102%	102%	1.07[6]
	Energy Efficient Homes	87%	92%	0.62[7]
	Student Energy Efficient Education	94%	89%	1.00[4]
Portfolio Total		**94%**	**90%**	**0.70[8]**

[1]Does not include unverified savings in the denominator. Realization rates are applied to verified demand reductions before application of distribution losses.
[2] PY14 evaluated NTG ratio.
[3] PY15 evaluated NTG ratios used for midstream lighting stratum. PY14 NTG ratios used for downstream, direct discount, direct install lighting stratum and downstream, direct discount, direct install non-lighting stratum. PY15 benchmarking NTG ratios used for midstream non-lighting stratum. The NTG ratio for the overall component is the verified gross population energy savings weighted average of the NTG ratios applied to stratum.
[4] No free ridership is expected or measured per the evaluation plan. Therefore, the NTG ratio is 1.00.
[5] PY15 evaluated NTG ratio.
[6] PY13 evaluated NTG ratio.
[7] PY15 evaluated NTG ratios used for all Downstream Equipment and Online Marketplace stratum measures. PY14 evaluated NTG ratios used for Audit and Weatherization stratum. PY13 evaluated NTG ratio used for the New Homes stratum. PY15 evaluated measure-level NTG ratios from Downstream Equipment and Online Marketplace stratums used for PY15 Instant Discount stratum measures that were like PPL program measures, and PY15 benchmarking NTG ratios used where there was not a similar PPL NTG researched value to leverage. For the PY15 high-performance homes strata, a deemed NTG ratio of 1.00 was applied, per the evaluation plan. The NTG ratio for the overall component is the verified gross population energy savings weighted average of the NTG ratios applied to each stratum.
[8] Weighted by PY15 program verified gross energy savings.

2.6. Summary of Energy Impacts by Program

Act 129 compliance targets are based on annualized savings estimates (MWh/year). Each program year, the annual savings achieved by program activity are recorded as incremental annual, or first-year, savings and added to an EDC's progress toward compliance (section *2.6.1 Incremental Annual Energy Savings by Program* presents incremental annual savings estimates). Lifetime energy savings incorporate the effective useful life (EUL) of installed measures and estimate the total energy savings associated with program activity. Cadmus used participant lifetime savings in the TRC test to assess the economics of upgrades by the SWE and calculate the emissions benefits of Act 129 programs. Section *2.6.2 Lifetime Energy Savings by Program* presents the lifetime energy savings by program.

2.6.1. Incremental Annual Energy Savings by Program

Table 2-9 summarizes PY15 PYTD energy savings by program and for Phase IV to date. This report presents energy impacts at the meter level, which do not reflect adjustments for transmission and distribution losses. Cadmus adjusted verified gross savings by the energy realization rate and verified net savings by the realization rate and the NTG ratio.

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

Program	PYRTD (MWh/yr)	PYVTD Gross (MWh/yr)	PYVTD Net (MWh/yr)	RTD (MWh/yr)	VTD Gross (MWh/yr)	VTD Net (MWh/yr)
Non-Residential	185,086[1]	136,239	93,512	507,387	476,478	310,671
Low-Income	12,773	14,062	14,062	35,439	67,173[2]	36,084[3]
Residential	61,040[1]	44,366	28,763	139,649	122,680	81,430
Portfolio Total[4]	**258,900**	**194,667**	**136,337**	**682,474**	**941,517[2]**	**428,185[3]**

[1] Includes 41,612 MWh/yr and 11,229 MWh/yr of unverified savings for Non-Residential and Residential Programs, respectively. Does not include PY14 unverified savings verified in PY15.
[2] Includes 31,089 MWh/yr of carryover savings for the Low-Income Program and a total of 306,275 MWh/yr carryover savings for the Portfolio. The sum of the VTD Gross column will not match the Portfolio total row because carryover savings are not attributed to either the Non-Residential Program or the Residential Program.
[3] VTD Net does not include carryover savings from Phase III of 31,089 MWh/yr for the Low-Income Program or 306,275 MWh/yr for the portfolio.
[4] Total may not match the sum of rows due to rounding.

The previously reported VTD savings from prior years, for the following programs, have changed since the PY14 final annual report was submitted:

- **Non-Residential**
  - **Efficient Equipment Midstream Non-Lighting:** 709 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 98% and a NTGR of 0.94 which yields an additional 695 MWh/yr of gross verified energy savings and an additional 661 MWh/yr of net verified energy savings. These savings are attributed to the Residential (442 MWh/yr) and Small C&I (253 MWh/yr) customer sectors.
- **Residential**
  - **Energy Efficient Homes Instant Discount:** 3,454 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 90% and a NTGR of 0.76, which yields an additional 3,096 MWh/yr of gross verified energy savings and an additional 2,353 MWh/yr of net verified energy savings. These savings are attributed to the Residential customer sector.
  - **Energy Efficient Homes Online Marketplace:** 930 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 115% and a NTGR of 0.88, which yields an additional 1,074 MWh/yr of

gross verified energy savings and an additional 945 MWh/yr of net verified energy savings. These savings are attributed to the Residential customer sector.

- **Student Energy Efficient Education:** 5,434 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 95% and a NTGR of 1.00, which yields an additional 5,152 MWh/yr of gross verified energy savings and an additional 5,152 MWh/yr of net verified energy savings. These savings are attributed to the Residential customer sector.

2.6.2. Lifetime Energy Savings by Program

Table 2-10 summarizes the PYTD and P4TD lifetime energy savings by program. Cadmus adjusted the lifetime savings to account for reduced lighting savings following the 2020 Energy Independence and Security Act (EISA) backstop. Specifically, after the 2020 EISA implementation, Cadmus reduced screw-based LED savings to the difference in energy usage between the efficient bulb and the new baseline. Savings do not include those beyond 15 years for any rebated item, per the Pennsylvania TRC Order.[8]

Table 2-10. Lifetime Energy Savings by Program (MWh)

Program Name	PYVTD Gross Lifetime (MWh)	PYVTD Net Lifetime (MWh)	VTD Gross Lifetime (MWh)	VTD Net Lifetime (MWh)
Non-Residential	2,039,069	1,399,709	7,080,993	4,635,429
Low-Income	95,264	95,264	292,661	292,660
Residential	445,882	283,069	1,216,883	760,447
Portfolio Total(1)	**2,580,215**	**1,778,043**	**8,590,537**	**5,688,537**

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

The previously report VTD lifetime savings from prior years, for the following programs have changed since the PY14 final annual report was submitted:

- **Non-Residential**
  - **Efficient Equipment Midstream Non-Lighting:** 709 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 98% and a NTGR of 0.94 which yields an additional 6,954 MWh/yr of lifetime gross verified energy savings and an additional 6,606 MWh/yr of lifetime net verified energy savings.

[8] The 2019 TRC Test Order for Phase IV of Act 129 was adopted by PA PUC order at Docket No. M-2019-3006868 on December 19, 2019.

- **Residential**
  - **Energy Efficient Homes Instant Discount:** 3,454 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 90% and a NTGR of 0.76, which yields an additional 15,249 MWh/yr of lifetime gross verified energy savings and an additional 11,590 MWh/yr of lifetime net verified energy savings.
  - **Energy Efficient Homes Online Marketplace:** 930 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 115% and a NTGR of 0.88, which additional 12,229 MWh/yr of lifetime gross verified energy savings and an additional 10,761 MWh/yr of lifetime net verified energy savings.
  - **Student Energy Efficient Education:** 5,434 MWh/yr savings were reported, but not verified in PY14 final annual report. Those savings have since been verified with an energy realization rate of 95% and a NTGR of 1.00, which yields an additional 42,459 MWh/yr of lifetime gross verified energy savings and an additional 42,459 MWh/yr of lifetime net verified energy savings.

2.7. Summary of Peak Demand Reduction Impacts by Program

Act 129 defines peak demand savings from energy efficiency as the average expected reduction in electric demand from 2:00 p.m. to 6:00 p.m. EDT on non-holiday weekdays from June through August. Unless indicated otherwise, verified peak demand impacts from energy efficiency in this report are presented at the system level, meaning they have been adjusted to account for transmission and distribution losses.

PPL Electric Utilities uses the following line loss percentages/multipliers by sector:[9, 10]

- Residential: 1.0875
- Small C&I: 1.0875
- Large C&I: 1.042
- GNE: 1.0726

Table 2-11 summarizes the peak demand impacts by energy efficiency program through the current reporting period.

[9] Pennsylvania Public Utility Commission. February 2021. *Technical Reference Manual.* Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards.

[10] For GNE records, the line loss multiplier was calculated as a blended rate of 1.0726 using the proportion of reported demand reductions of the residential and small C&I sectors compared to the large C&I sector (67% and 33%, respectively).

Table 2-11. Peak Demand Savings by Energy Efficiency Program (MW/Year)

Program Name	PYRTD (MW/yr)	System-Level PYVTD Gross (MW/yr)	System-Level PYVTD Net (MW/yr)	RTD (MW/yr)	System-Level VTD Gross (MW/yr)	System-Level VTD Net (MW/yr)
Non-Residential	35.41[1]	23.81	16.51	88.88	81.73	53.45
Low-Income	1.37	1.53	1.53	3.87	4.09	4.09
Residential	6.53[1]	6.51	4.10	17.69	17.52	11.54
Portfolio Total[2]	**43.32**	**31.86**	**22.14**	**110.44**	**103.34**	**69.08**

[1] Includes 10.08 MW/yr and 0.08 MW/yr of unverified savings for Non-Residential and Residential Programs, respectively.
[2] Total of individual program demand reductions may not sum to total due to rounding.

The previously reported VTD savings from prior years, for the following programs, have changed since the PY14 final annual report was submitted:

- **Non-Residential**
  - **Efficient Equipment Midstream Non-Lighting:** 0.26 MW/yr demand reductions were reported, but not verified in PY14 final annual report. Those demand reductions have since been verified with a demand realization rate of 98% and a NTGR of 0.94, which yields an additional 0.28 MW/yr of system-level gross verified demand reductions and an additional 0.27 MW/yr of net system-level verified demand reductions. These verified system-level gross savings are attributed to the Residential (0.18 MW/yr) and Small C&I (0.11 MW/yr customer sectors.
- **Residential**
  - **Energy Efficient Homes Instant Discount:** 0.39 MW/yr demand reductions were reported, but not verified in PY14 final annual report. Those demand reductions have since been verified with a demand realization rate of 85% and a NTGR of 0.76, which yields an additional 0.36 MW/yr of system-level gross verified demand reductions and an additional 0.27 MW/yr of net verified demand reductions. These verified system-level gross savings are attributed to the Residential customer sector.
  - **Energy Efficient Homes Online Marketplace:** 0.09 MW/yr demand reductions were reported, but not verified in PY14 final annual report. Those demand reductions have since been verified with a demand realization rate of 123% and a NTGR of 0.88, which yields an additional 0.12 MW/yr of system-level gross verified demand reductions and an additional 0.10 MW/yr of net verified demand reductions. These verified system-level gross savings are attributed to the Residential customer sector.
  - **Student Energy Efficient Education:** 0.52 MW/yr demand reductions were reported, but not verified in PY14 final annual report. Those demand reductions have since been verified with a demand realization rate of 89% and a NTGR of 1.00, which yields an additional 0.50 MW/yr of system-level gross verified demand reductions and an additional 0.50 MW/yr of net verified demand reductions. These verified system-level gross savings are attributed to the Residential customer sector.

2.7.1. Peak Demand Savings Nominated to PJM Forward Capacity Market (FCM)

For Phase IV of Act 129, EDCs are expected to retain the capacity rights to Act 129 projects and nominate a portion of the resources acquired to PJM Forward Capacity Market. If the resources clear, proceeds flow back to the rate class that generated the Act 129 savings to offset cost recovery via riders.

Table 2-12 summarizes PPL Electric Utilities' plans for wholesale recognition of Phase IV peak demand savings by Act 129 program year and PJM delivery year, including nominated MW savings from PY15.

Table 2-12. Planned FCM Nominations by Act 129 Program Year and PJM Delivery Year (DY)

Act 129 Program Year	Estimated MW Acquisition for FCM	DY 22/23 MW Range	DY 23/24 MW Range	DY 24/25 MW Range	DY 25/26 MW Range	DY 26/27 MW Range	DY 27/28 MW Range	DY 28/29 MW Range	DY 29/30 MW Range
PY13	1.4	1.4	1.4	1.4	0				
PY14	[1 to 10]		1.5	1.5	0	0			
PY15	[1 to 10]			1.9	1.9	1.9	1.9		
PY16	[1 to 10]				[1 to 10]	[1 to 10]	[1 to 10]	[1 to 10]	
PY17	[1 to 10]					[1 to 10]	[1 to 10]	[1 to 10]	[1 to 10]
Phase IV Total[(1)]	**[5.4 to 41.4]**	**1.4**	**2.8**	**4.8**	**[2.9 to 11.9]**	**[3.9 to 21.9]**	**[3.9 to 21.9]**	**[2 to 20]**	**[1 to 10]**

[(1)] Sum of rows may not match total due to rounding.

Table 2-13 lists the measures selected by PPL Electric Utilities to be offered into PJM.

Table 2-13. PY15 Measures Selected for PJM

Measure Category	Measure	PY13	PY14	PY15
Large C&I Commercial Lighting	LED fixtures	✓	✓	✓
	LED linear replacements	✓	✓	✓
	LED screw-ins	✓	✓	
	Custom			✓
Small C&I Commercial Lighting	LED fixtures	✓	✓	✓
	LED linear replacements	✓	✓	✓
Small C&I and Residential Efficient Lighting	LED bulged reflector	✓		
	LED candelabra base	✓	✓	✓
	LED globe	✓	✓	✓
	LED multifaceted reflector	✓		✓
	LED parabolic aluminized reflector	✓		✓
	LED reflector	✓	✓	✓
	LED retrofit kit	✓	✓	✓
	LED specialty	✓		✓
Low-Income	LED fixtures		✓	✓

PPL Electric Utilities nominated lighting measures to qualify into PJM based on the ease of project measurement and verification and availability of PJM-required information.

The qualified MW volumes by rate class for PY15, with anticipated monetization in PJM delivery year 2024-2025 (DY24/25), include the following:

- Large C&I: 0.751 MW
- Small C&I: 0.693 MW
- Residential: 0.127 MW
- Low-Income: 0.340 MW

These resources are anticipated to result in PJM revenues from DY24/25 that will be paid in full (in addition to DY23/24 revenues) to PPL Electric Utilities through the PJM-member curtailment service provider (CSP) and distributed proportionally to the associated rate classes.

2.8. Summary of Fuel-Switching Impacts

Act 129 allows EDCs to achieve electric savings by converting electric equipment to non-electric equipment. Table 2-14 summarizes key fuel-switching metrics in PY15 and to date in Phase IV.

Table 2-14. Fuel Switching Summary

Metric	PY15	P4TD
Number of Products Offered and Implemented		
Air-Source Heat Pump (ASHP)	2	17
Electric Baseboards	4	30
Electric Furnaces	4	11
Water Heaters Gas - Electric Resistance	15	43
Water Heaters Propane - Electric Resistance	9	36
Combined heat and power (CHP)	0	2
Verified Savings		
VTD Energy Savings Achieved via Fuel Switching (MWh/yr)	178	15,425
Phase IV Verified To-Date Increased Fossil Fuel Consumption Due to Fuel Switching Measures (MMBTU/yr)	0.61	52.64
Incentives		
Phase IV Verified To-Date Incentive Payments for Fuel Switching Measures ($1000)	$7	$1,028

2.9. Summary of Cost-Effectiveness Results

Table 2-15 presents a detailed breakdown of portfolio finances and cost-effectiveness. Cadmus calculated TRC benefits using gross verified impacts. PY15 NPV costs and benefits are expressed in 2023 dollars. NPV costs and benefits for P4TD financials are expressed in 2021 dollars.

Cadmus calculated TRC benefit-cost ratios 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. *Appendix C* shows the TRC ratios by program and for the portfolio.

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

Row	Cost Category	PYTD ($1,000)		P4TD[2] ($1,000)	
1	**Incremental Measure Costs (IMCs)**	**$105,936**		**$236,177**	
2	Rebates to Participants and Trade Allies	$19,115		$47,298	
3	Upstream/Midstream Incentives	$3,345		$8,446	
4	Material Cost for Self-Install Programs (EE&C Kits)	$1,139		$5,138	
5	Direct Installation Program Materials and Labor	$3,872		$5,662	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]	$78,465		$169,633	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$697	$462
8	Administration and Management[3]	$1,716	$3,423	$4,236	$10,716
9	Marketing	$2,433	$1,839	$5,231	$5,052
10	Program Delivery[4]	$0	$9,907	$0	$25,948
11	EDC Evaluation Costs	$1,691		$4,583	
12	SWE Audit Costs	$528		$1,252	
13	**Program Overhead Costs (Sum of rows 7 through 12)**[6]	**$21,537**		**$58,177**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)**[5, 6]	**$127,674**		**$295,871**	
15	Total NPV Lifetime Electric Energy Benefits	$78,555		$244,749	
16	Total NPV Lifetime Electric Capacity Benefits	$42,539		$143,277	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$8,701		$15,924	
18	Total NPV Lifetime Fossil Fuel Impacts	$8,669		$11,145	
19	Total NPV Lifetime Water Impacts	$13,188		$24,851	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$151,652**		**$439,946**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.19**		**1.49**	

[1] Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = $2021

[2] P4TD benefits does not include carry-over energy savings from Phase III

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

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

[5] Row 14 (portfolio-level TRC costs) includes excess incentives from the Residential Efficient Lighting program component; $200,728 in PY15 and $1,516,214 in P4TD. Per Phase IV TRC Order, excess incentives are to be treated as a TRC cost, so the sum of rows 1 through 13 do not add up to row 14.

[6] Sum of rows may not add up to total due to rounding.

2.10. Comparison of Performance to Approved EE&C Plan

Table 2-16 presents PY15 expenditures compared to the budget estimates set forth in the EE&C plan for PY15 and P4TD. PY15 values are expressed in 2023 dollars, and P4TD values are expressed in 2021 dollars. *Appendix C* presents program-level comparisons of expenditures to plans.

Table 2-16. Comparison of Expenditures to Phase IV EE&C Plan ($1,000)

Expenditures	Budget from EE&C Plan	Actual Expenditures[1]	Ratio (Actual/Plan)
PY15 Portfolio	$61,549	$57,198	93%
PIV TD	$183,488	$134,627	73%

Source: PPL Electric Utilities Phase IV EE&C plan, Table 6.
[1] Includes SWE audit costs.

Table 2-17 compares PY15 and P4TD verified gross program savings to the energy savings projections set forth in the EE&C plan. PPL Electric Utilities fell short of planned savings in PY15 due in part to Cadmus' plan to not verify all savings for the Custom and Energy Efficient Homes components in PY15 (which comprise about 20% of reported energy savings and about 23% of demand). *Appendix C* presents program-level comparisons of actual savings to plans.

Table 2-17. Comparison of Actual Program Savings to EE&C Plan Projections

Savings	EE&C Plan Projections	VTD Gross Savings	Ratio (Actual/Plan)
PY15 Portfolio MWh/yr	264,678	194,667	74%
PIV TD MWh/yr	865,571[1]	635,242[1]	73%
PY15 Portfolio MW/yr (System-Level)	52.81	31.86	60%
PIV TD MW/yr (System-Level)	148.81	103.34	69%

Source: PPL Electric Utilities Phase IV EE&C plan, Table 4 and Table 5.
[1] Excludes Phase III carryover.

2.10.1. Program Summary

This section provides a summary of why program savings in PY15 varied from projections estimated in the EE&C plan. The individual program chapters and appendices include more detail.

Non-Residential Program Components

For the Non-Residential Program, the energy realization rate was 95% and demand reduction realization rate was 88%. The realization rates were influenced by differences in building types and fixture wattage assumptions within the Midstream and Downstream Lighting subcomponents. The Non-Residential program fell short of the projected PY15 energy savings and demand reductions in PY15 due to Cadmus' plan to not verify all savings for the Custom component in PY15 (which comprise about 22% of reported energy savings and about 28% of demand).

Residential Program Components

The Residential Program exceeded projected PY15 energy savings as estimated in the EE&C Plan by approximately 24% and exceeded the PY15 projected demand savings by 15%. This was primarily due to an increase in participation across the residential components. Despite exceeding the projected savings, the Residential Program as a whole had energy and demand realization rate lower than 100%.

The energy realization rate was 89% and the demand realization rate was 93% for the Program overall. All the components besides Efficient Lighting had realization rates lower than 100% and this was due to

a variety of reasons ranging from corrected baseline conditions to updated installation rates, as well as updated per unit savings for appliance recycling.

Low-Income Program

Phase IV savings and carryover from Phase III brings the Low-Income Program to 93% of the Phase IV Low-Income compliance target, with two additional years to achieve the remaining 7%. Assuming energy savings achievements for the proceeding years continue at the same or higher levels, the Low-Income Program is on pace to exceed the EE&C Phase IV target of 72,509 MWh/yr in PY16.

The Low-Income energy realization rate was 110% and the demand realization rate was 103%. The factors that led to differences between reported and verified savings and the overall realization rate for the Low-Income Program in PY15 are included in *Section 6*.

2.10.2. PY16 Program Changes

PPL Electric Utilities has made the following program changes in PY16.

Non-Residential Program Components

- **Custom.** The Custom component allows customers to receive incentives for the completion of complex and comprehensive projects that involve measures not covered by the Efficient Equipment component. PPL Electric Utilities increased Custom incentives for Solar and CHP in PY16 to improve its project pipeline for Phase IV. Technical outreach and support will continue in PY16 to identify custom opportunities for customers. New in PY16 is a Building Operator Certification program offered in partnership with Pennsylvania College of Technology. This certification will educate customers and trade allies, while furthering workforce development efforts.
- **Efficient Equipment**. The Efficient Equipment component continues to offer incentives through downstream and midstream delivery channels. PPL Electric Utilities increased Direct Discount channel incentives in PY16 for interior lighting and equipment. In conjunction with the increased midstream incentives, the component also increased the pre-approval amount to drive participation. PPL Electric Utilities added HVAC Tune-Ups and Smart Thermostat measures to the component in April 2024 that will continue to be offered in PY16 and beyond. Technical webinars to support and educate customers will continue in PY16, with three planned.

Residential Program Components

- **Appliance Recycling.** The Appliance Recycling component continues to offer both contactless and in-home pickups, with over half of the participants still preferring the contactless option. In PY15, PPL Electric Utilities held three small appliance pick-up events and will continue offering these events throughout the PPL Electric Utilities territory in PY16. These are geographically focused events that encourage customers to sign up and drop off room air conditioners and dehumidifiers at a central location. In PY15, PPL Electric Utilities added a recycling pick-up option where customers can recycle a minimum of two small appliances without the need for a larger unit. PPL Electric Utilities plans to continue this option throughout the remainder of Phase IV.

- **Efficient Lighting – Specialty Bulbs**
  - This component has sunset and is no longer offered.
- **Energy Efficient Homes**
  - PPL Electric Utilities launched additional instant discount measures in retail businesses and the online marketplace in PY15 and saw high participation. In PY16, PPL Electric Utilities will remove spray foam and advanced power strips to pivot the portfolio toward more cost-effective measures and add air purifier rebates.
  - PPL Electric Utilities continues to offer virtual assessments and in-home audits. In addition, the Energy Efficient Homes component offers a comprehensive retrofit bonus that provides an additional incentive when customers complete upgrades such as air sealing and/or insulation and an HVAC equipment upgrade within one year of each other.
  - PPL Electric Utilities continues to recruit distributors to offer discounts at point-of-purchase through the midstream delivery channel.
  - The New Homes subcomponent expects strong performance in PY16 in efficient new home construction.
  - PPL Electric Utilities recently completed a Net Zero Energy Ready Homes pilot. Pilot homes satisfy the Department of Energy's Zero Energy Ready Home certification, and the pilot provided financial and technical support to four builders to upgrade five ENERGY STAR® homes to the Zero Energy Ready Home certification. PPL Electric Utilities conducted virtual and in-person tours of the homes as well as webinars on behind-the-walls upgrades and educational videos. The pilot helped identify common barriers, building science barriers, savings estimates, and various marketing approaches used to promote the homes.
  - PPL Electric Utilities' Deep Energy Retrofit pilot offered comprehensive whole-home solutions, testing delivery approaches using a single lead contractor as a point of contact and helping customers take advantage of additional rebates. After working with four pilot trade allies to install a comprehensive package of energy efficiency treatments, it became clear that the current market could not support the existing pilot design. PPL Electric Utilities pivoted to address some of the barriers by changing the structure to make it easier for the trade allies to participate. In addition, monthly webinars will continue in PY16 for customers to help them understand and take advantage of a whole-home approach, savings opportunities and the deep energy retrofit bonus.
  - PPL Electric Utilities will launch a behavioral program subcomponent in PY16. This subcomponent will encompass both paper and digital reports for treatment participants and will promote behavioral energy efficiency by motivating customers to become more efficient through similar home comparisons. PPL Electric Utilities will also offer an energy analyzer to educate all residential customers, as well as small and medium business customers, in PY16.

- **Student Energy Efficient Education.** The PY15 Student Energy Efficient Education component continued to actively engage students and teachers through interactive presentations. All three student cohorts, Bright Kids, Take Action, and Innovation, were fully subscribed for PY15, and high participation is expected in PY16.

Low-Income Program

- **Low-Income.** The Low-Income Program continues to offer a broad selection of no-cost energy-saving measures, services and education to qualifying low-income customers residing in single-family homes, individually and MMMF units, and manufactured homes. There was a higher customer preference for in-home assessments versus virtual appointments in PY15. PPL Electric Utilities expects this trend to continue in PY16, though it will continue to offer both appointment types. The program will continue to expand multifamily unit assessments for the remainder of Phase IV. In PY15, the program began dispersing water-saving kits to assessment-eligible customers to encourage enrollment and increase the number of water-savings measures installed. The program closely coordinates with other assistance programs, including the Low-Income Usage Reduction Program (LIURP) and OnTrack, and with natural gas utilities when feasible. PPL Electric Utilities is also working to coordinate services with local community-based assistance organizations like local food banks. In PY15, the program began offering appointments during evening and weekend hours to allow for more flexible scheduling for low-income customers. The program will expand customer self-scheduling of assessments, while still in early stages, in PY16. PPL Electric Utilities expects there will be continued need for both comprehensive and health and safety measures in PY16.

2.11. 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 their respective sections.

3. 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.

3.1. Program Finances

Table 3-1 shows program-specific and portfolio total finances for PY15. Columns in this table are adapted from the Direct Program Cost categories in the PA PUC's EE&C plan template for Phase IV.[11] Non-incentives include EDC materials, labor, and administration costs (including costs associated with an EDC's own employees) as well as ICSP materials, labor, and administration costs (including the program implementation contractor and the costs of any other outside vendors EDCs employ to support program delivery). The dollar figures shown in Table 3-1 are based on EDC tracking of expenditures with no adjustments to account for inflation.[12]

Table 3-1. PY15 Program and Portfolio Total Finances ($1,000)

Program	Incentives	Non-Incentives	Total Cost
Non-Residential	$21,985	$8,078	$30,062
Low-Income	$4,577	$3,394	$7,971
Residential	$7,488	$5,376	$12,864
Common Portfolio Costs[(1)]	**$0**	$5,773	$5,773
Portfolio Total	**$34,050**	**$22,621**	**$56,670**
SWE Costs[(2)]	$0	$0	$528
Total	**$34,050**	**$22,621**	**$57,198**

[(1)] Common Portfolio Costs are costs applicable to more than one customer class or more than one program or that provide portfolio-wide benefits. These costs include PPL Electric Utilities labor and materials, legal review, PPL Electric Utilities' tracking system, EE&C plan development, etc.
[(2)] SWE costs are outside of the 2% spending cap.

Table 3-2 shows program-specific and portfolio total finances since the inception of Phase IV.

[11] Pennsylvania Public Utility Commission. September 9, 2020. "Implementation of Act 129 of 2008—Phase IV. Energy Efficiency and Conservation Plan Template. Docket No. M-2020-3015228." https://www.puc.pa.gov/pcdocs/1676672.docx

[12] 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.

Table 3-2. Phase IV Program and Portfolio Total Finances ($1,000)

Program	Incentives	Non-Incentives	Total Cost
Non-Residential	$48,807	$20,980	$69,786
Low-Income	$9,855	$9,645	$19,499
Residential	$18,448	$14,069	$32,517
Common Portfolio Costs[1]	$0	$16,830	$16,830
Portfolio Total	**$77,109**	**$61,524**	$138,633
SWE Costs[2]	$0	$0	$1,320
Total	**$77,109**	**$61,524**	$139,953

[1] Common Portfolio Costs are costs applicable to more than one customer class or more than one program or that provide portfolio-wide benefits. These costs include PPL Electric Utilities labor and materials, legal review, PPL Electric Utilities' tracking system, EE&C plan development, etc.
[2] SWE costs are outside of the 2% spending cap.

3.2. 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 four customer sectors to ensure that the electric rate classes that finance the programs are the rate classes that receive the direct energy 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. Readers should be mindful of the differences between Table 3-3 and the information presented in *2.3. Phase IV Performance by Customer Segment*. For example, the low-income customer segment is a subset of PPL Electric Utilities' residential tariff(s) and therefore is not listed in Table 3-3.

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

Cost Recovery Sector	Rate Classes Included	PY15 Spending	P4TD Spending
Residential & Low-Income (100/200)	Residential (primarily RS)	$23,446	$60,504
Small C&I (300)	Small C&I (primarily GS1 & GS3)	$17,857	$44,603
Large C&I (400)	Large C&I (primarily LP4 & LP5)	$7,934	$20,094
GNE	Residential, Small C&I, and Large C&I	$7,961	$14,751
Portfolio Total[1]	-	**$57,198**	**$139,953**

[1] Includes costs for SWE audit.

4. Evaluation Activities

This section documents the gross impact and process evaluation activities conducted in PY15. This report documents and discusses the outcomes of these activities in subsequent sections. Not every program or program component receives an evaluation every year. Table 4-1 lists the activities for each program and component in PPL Electric Utilities' portfolio.

Table 4-1. PY15 Evaluation Activity Matrix

Program/Component	Gross Impact	Net Impact	Process
Non-Residential Program			
Custom	✓(1)	✓(2)	✓
Efficient Equipment Non-Lighting Downstream	✓	✓(2)	✓
Efficient Equipment Lighting Downstream	✓	✓(2)	✓
Efficient Equipment Non-Lighting (Midstream)	✓	✓	✓
Efficient Equipment Lighting (Midstream)	✓	✓	✓
Low-Income Program			
Low-Income Assessment	✓(3)		✓
Residential Program			
Appliance Recycling	✓	✓	✓
Efficient Lighting	✓(3)	✓(2)	
Energy Efficient Homes New Homes	✓	✓(2)	✓
Energy Efficient Homes Audit and Weatherization	✓(3)	✓(2)	✓
Energy Efficient Homes Equipment (downstream)	✓	✓	✓
Energy Efficient Homes Equipment (midstream) (1)			
Energy Efficient Homes Online Marketplace	✓	✓	✓
Energy Efficient Homes Instant Discount	✓(1)	✓	✓
Student Energy Efficient Education	✓		✓

(1) A portion or all of savings were unverified in PY15 and will be verified in PY16.
(2) Applying a historical NTG ratio to verified savings.
(3) Applying historical realization rate to verify a portion or all PY15 savings.

4.1. Impact Evaluation

Table 4-2 provides an impact evaluation overview for Phase IV with two rows for each initiative. Plans for upcoming years, including PY16, are tentative. The first row indicates the sampling and data collection frequency or which years the impact evaluation will be conducted. The second row shows how savings from the initiative will be presented in that year's final annual report, where:

- **V** = verified using the results of the impact evaluation completed that year.
- **H** = verified using the results of a historic impact evaluation.
- **U** = unverified until the results of the impact evaluation are available.

Table 4-2. Gross Impact Overview

Initiative	Plan	PY13	PY14	PY15	PY16	PY17
Non-Residential						
Custom Large	Sampling	Impact	Impact	Impact	Impact	Impact
	Reporting	V	V	V	V	V
Custom Small	Sampling	Two-year sample[1]		Two-year sample [1]		None
	Reporting	U	V	U	V	H
Custom CHP	Sampling	Impact	Impact	Impact	Impact	Impact
	Reporting	V	V	V	V	V
Efficient Equipment Non-Lighting (Downstream)	Sampling	Impact	Impact	Impact	Impact	None
	Reporting	V	V	V	V	H
Efficient Equipment Non-Lighting (Midstream)	Sampling	None	Two-year sample[1]		Impact	None
	Reporting		U	V	V	H
Efficient Equipment Lighting (Downstream)	Sampling	Impact	Impact	Impact	Impact	None
	Reporting	V	V	V	V	H
Efficient Equipment Lighting (Midstream)	Sampling	Impact	Impact	Impact	Impact	Impact
	Reporting	V	V	V	V	V
Low-Income						
Low-Income (Remote Energy Assessments)	Sampling	Impact	Impact	None	Impact	None
	Reporting	V	V	H	V	H
Low-Income (In-home Assessments)	Sampling	Two-year sample[1]		None	Impact	None
	Reporting	U	V	H	V	H
Low-Income (Welcome Kits)	Sampling	Impact	Impact	Impact	Impact	None
	Reporting	V	V	V	V	H
Residential						
Appliance Recycling (Refrigerators and Freezers)	Sampling	Impact	Impact	Impact	None	None
	Reporting	V	V	V	H	H
Appliance Recycling (Room Air Conditioners and Dehumidifiers)	Sampling	Impact	Impact	Impact	Impact	None
	Reporting	V	V	V	V	H
Energy Efficient Home (Audit and Weatherization)	Sampling	None	Impact	None	Impact	None
	Reporting		V	H	V	H
Energy Efficient Home (Midstream Equipment)	Sampling	None	None	Two-year sample[1]		None
	Reporting			U	V	H
Energy Efficient Home (Downstream Equipment)	Sampling	Impact	None	Impact	Impact	None
	Reporting	V	H	V	V	H
	Sampling	Impact	Two-year sample[1]		Impact	None

Initiative	Plan	PY13	PY14	PY15	PY16	PY17
Energy Efficient Home (Online Marketplace)	Reporting	V	U	V	V	H
Energy Efficient Home (New Homes)	Sampling	Two-year sample [1]		Impact	Impact	None
	Reporting	U	V	V	V	H
Energy Efficient Home (Instant Discount) [2]	Sampling	None	Two-year sample[1]		None	None
	Reporting		U	V	H	H
Efficient Lighting (Lighting)	Sampling	Impact	None	None	None	None
	Reporting	V	H	H		
Student Energy Efficient Education (All Strata)	Sampling	Impact	Two-year sample[1]		None	None
	Reporting	V	U	V	H	H

[1] In general, the two-year sample will include the first through fourth quarters (Q1-Q4) of the first year in the sample and Q1 and Q2 of the second year in the sample.
[2] Cadmus will verify spray foam and air purifiers for PY15 in PY16.

Impact evaluation activities varied by program in PY15. Table 4-3 lists the impact evaluation activities conducted for each program component in PY15. The individual program chapters and corresponding appendices discuss the impact evaluation activities, methodology, analysis, and findings.

Table 4-3. PY15 Impact Evaluation Activities by Program Component

Program and Component	Database Review	Desk Reviews	Site Visits	Metering	Engineering Analysis	Billing Analysis
Non-Residential Program						
Custom	✓	✓	✓	✓	✓	
Efficient Equipment Non-Lighting (downstream)	✓	✓	✓		✓	
Efficient Equipment Lighting (downstream)	✓	✓	✓		✓	
Efficient Equipment Non-Lighting (midstream)	✓	✓			✓	
Efficient Equipment Lighting (midstream)	✓	✓			✓	
Low-Income Program						
Low-Income Assessment	✓				✓	
Residential Program						
Appliance Recycling	✓	✓			✓	
Efficient Lighting	✓					
Energy Efficient Homes New Homes	✓	✓			✓	
Energy Efficient Homes Audit and Weatherization	✓					
Energy Efficient Homes Equipment (downstream)	✓	✓			✓	
Energy Efficient Homes Equipment (midstream)	✓					
Energy Efficient Homes Online Marketplace	✓	✓			✓	
Energy Efficient Homes Instant Discount	✓				✓	
Energy Efficient Homes Deep Energy Retrofit Pilot	✓					
Energy Efficient Homes High Performance Home Pilot	✓	✓			✓	
Student Energy Efficient Education	✓					

4.2. Process Evaluation

This section summarizes the process evaluation activities of PPL Electric Utilities' PY15 portfolio.

Table 4-4 lists the process evaluation activities conducted for each program in PY15, along with the total number of survey and interview respondents reached for each component and delivery channel. A more detailed explanation of program components' survey methodology is in their respective appendices.

Table 4-4. PY15 Portfolio Process Evaluation Activities by Component

Program and Component	Completed Participant Survey or Interview [1]	Participant Satisfaction Analysis	Stakeholder Interviews/ Feedback	Trade Ally Interviews	Market Actor Interviews	Logic Model Review	Secondary Research
Non-Residential Program							
Custom		✓(n =5)					
Efficient Equipment (downstream)		✓(n =45)					
Efficient Equipment Non-Lighting (midstream)	✓ (n=5)	✓ (n=5)	✓		✓ (n=5)		
Efficient Equipment Lighting (midstream)	✓ (n=23)[2]	✓ (n=48)[2]	✓	✓ (n=18)	✓ (n=9)		
Low-Income Program							
Low-Income Assessment		✓(n =439)					
Residential Program							
Appliance Recycling	✓ (n=286)	✓ (n=286)	✓				
Efficient Lighting							
Energy Efficient Homes New Homes			✓				
Energy Efficient Homes High Performance Homes				✓(n =4)			
Energy Efficient Homes Audit and Weatherization		✓(n =49)	✓				
Energy Efficient Homes Equipment (downstream)	✓ (n=325)	✓ (n=325)	✓				
Energy Efficient Homes Online Marketplace	✓ (n=87)	✓ (n=87)	✓				
Student Energy Efficient Education	✓ (n=15,460)	✓ (n=15,273)	✓				
Total	**16,186**	**16,562**	**N/A**	**22**	**14**	**N/A**	**N/A**

[1] Includes all survey modes: online, telephone, and paper. For additional details, see the program chapter and appendix. This may not match the totals used for program satisfaction, net-to-gross, or impact inputs.
[2] For Efficient Equipment midstream lighting interviews, completed participant surveys were completed with end-user purchasers while satisfaction ratings were provided by end-user purchasers (participants), trade ally purchasers (contractors), and market actors (distributors). All of these groups were included in participant satisfaction analysis. Two did not provide overall satisfaction.

PPL Electric Utilities

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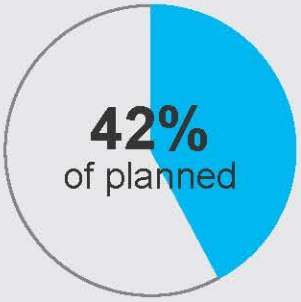
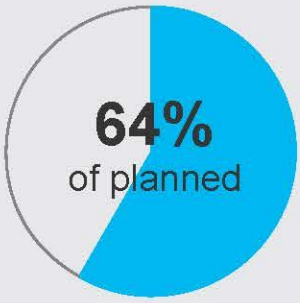
NON-RESIDENTIAL PROGRAM

The Non-Residential Program offers financial incentives to all large and small commercial and industrial customers, including government and education institutions and master metered low-income multifamily buildings.

VERIFIED ENERGY SAVINGS

Phase IV has saved **476,478 MWh/yr**

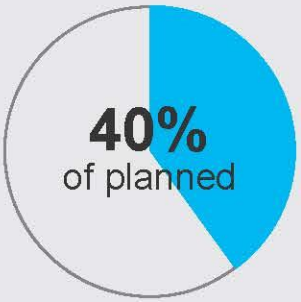


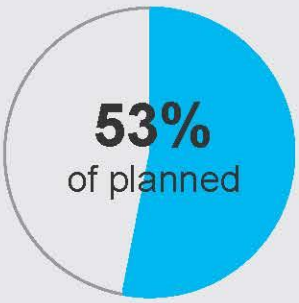


PY15 saved **136,239 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **81.73 MW/yr**





PY15 has reductions of **23.81 MW/yr**

PY15 PARTICIPATION

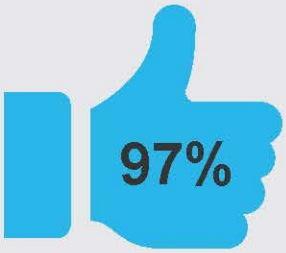
A total of **4,991** participants

235 Custom

147 Efficient Equipment Non-Lighting

4,609 Efficient Equipment Lighting

PARTICIPANT SATISFACTION



Satisfied with overall program

100% satisfied with Custom

95% satisfied with Efficient Equipment

5. Non-Residential 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 ICSP, CLEAResult, manages program operations and oversees rebate and incentive delivery. The evaluation methodology and findings for the two Non-Residential Program components are described in separate appendices.

The program comprises these two distinct components:

- **Efficient Equipment** offers lighting and equipment (non-lighting) through four delivery channels: downstream, direct discount, direct install, and midstream.
- **Custom** provides financial incentives to customers who install products or offer services that are not offered in PPL Electric Utilities' other programs.

5.1. Participation and Reported Savings by Customer Segment

Table 5-1 presents the participation counts, reported energy and demand savings, and incentive payments for the Non-Residential Program in PY15 by customer segment.

Table 5-1. PY15 Non-Residential Participation and Reported Impacts

Parameter	Residential (Non-LI)	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total[1],[2]
PYTD # Participants	38	2,965	663	1,325	4,991
PYRTD MWh/yr	2,480	79,363	70,322	32,921	185,086
PYRTD MW/yr	0.77	16.06	12.01	6.56	35.41
PYVTD MWh/yr[3]	-	50,403	60,562	25,274	136,239
System-Level PYVTD MW/yr[3]	-	8.53	10.58	4.70	23.81
PY15 Incentives ($1000)	$786	$11,650	$4,702	$4,847	$21,985

[1] The totals in this table do not include PY14 unverified savings verified in PY15.
[2] Total may not sum due to rounding.
[3] Savings for small Custom projects were left unverified in PY15 and will be verified in PY16; 41,612 MWh and 10.08 MW PY15 unverified savings.

Table 5-2 shows the Non-Residential Program's verified gross energy savings and demand reductions.

Table 5-2. Non-Residential Program Savings

Savings	PY13 Verified	PY14 Verified	PY15 Verified	PY15 Unverified	Phase IV Verified [1], [2]
MWh/yr	129,833	210,406	136,239	41,612	476,478
System-Level MW/yr	21.26	36.65	23.81	10.08[3]	81.73

[1] Phase IV verified savings may not match sum of program years due to rounding.
[2] Does not include PY15 unverified.
[3] This does not include the application of line losses.

5.2. Gross Impact Evaluation

Cadmus calculated gross verified savings using data from the PPL Electric Utilities' tracking database and a combination of evaluation activities, including records review, desk review, engineering analyses, site visits, and billing analysis. Table 5-3 and Table 5-4 show the gross energy savings and demand reduction realization rates for components of the Non-Residential Program in PY15. Additional details about the evaluation approach and findings are presented in *Appendix A* and *Appendix D*.

Table 5-3. PY15 Non-Residential Gross Impact Results for Energy

Component	PYRTD MWh/yr	Energy Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 90% C.L.[2]	PYVTD (MWh/yr)
Custom	55,108	100%	-	-	55,108
Efficient Equipment Non-Lighting	2,790	99%	0.72	15.4%	2,762
Efficient Equipment Lighting	85,576	92%	0.16	3.9%	78,369
Program Total[3][4]	**143,473**	**95%**	**0.10**	**2.2%**	**136,239**
Custom Small Unverified	**41,612**	-	-	-	-
Verified + Unverified Total[3][4]	**185,086**	**74%**	-	-	**136,239**
Midstream Non-Lighting Unverified (PY14 verified in PY15)	709	98%	0.04	1.4%	695

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates in this table do not include unverified savings in the denominator.
[2] Relative precision in this table is reported at the 90% confidence level and will not match tables in the appendices where relative precision is reported at the 85% confidence level.
[3] Savings may not match other tables or figures due to rounding.
[4] Totals may not sum due to rounding.

Table 5-4. PY15 Non-Residential Gross Impact Results for Demand

Component	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 90% C.L.[2]	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Custom	10.57	100%	-	-	10.57	11.13
Efficient Equipment Non-Lighting	0.54	100%	0.33	5.9%	0.54	0.59
Efficient Equipment Lighting	14.21	79%	0.16	4.3%	11.26	12.09
Program Total[3],[4]	**25.33**	**88%**	**0.08**	**2.1%**	**22.38**	**23.81**
Custom Small Unverified	**10.08**	-	-	-	-	-
Verified + Unverified Total[3], [4]	**35.41**	**63%**	-	-	**22.38**	**23.81**
Midstream Non-Lighting Unverified (PY14 verified in PY15)	0.26	98%	0.04	1.6%	0.26	0.28

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates are applied to verified demand reductions before application of distribution losses.
[2] Relative precision in this table is reported at the 90% confidence level and will not match tables in the appendices where relative precision is reported at the 85% confidence level.
[3] Savings may not match other tables or figures due to rounding.
[4] Totals may not sum due to rounding.

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

- For non-lighting projects, the adjustments that had the greatest effect on the overall realization rate were related to efficiencies and capacities in HVAC projects. These had inconsistent effects on individual project realization rates but lowered the realization rate overall.
- For lighting projects, inconsistencies between the reported and verified hours of use, coincidence factors, wattages, and control schemes caused changes in evaluated savings.

See *Appendix D.1.2* for more information on factors that affected observed realization rates for the Efficient Equipment component.

5.3. Net Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream delivery channels are provided in the Phase IV Evaluation Framework,[13] which discusses the common methods used to determine free ridership and spillover. For midstream lighting projects in the Efficient Equipment component, Cadmus used self-report interviews, administered by phone, to assess free ridership and spillover. Additional information about the NTG methodology is provided in *Appendix K Net Savings Impact Evaluation* and in *Appendix D*.

Because Cadmus did not conduct new primary research to assess net savings for Custom or Efficient Equipment downstream channel in PY15, the evaluation used the historic NTG ratios listed in Table 5-5.[14] Cadmus determined there was not enough information to conduct a robust midstream non-lighting NTG analysis and, as such, did not report a NTG ratio from primary research. For PY15 midstream non-lighting projects, Cadmus applied recommended NTG ratios from a recent New Jersey TRM NTG recommendations guidance document to midstream non-lighting measures.[15] 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 5-5 presents NTG ratios for the components of the Non-Residential Program in PY15.

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[13] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

[14] PPL Electric Utilities. September 30, 2023. *Phase IV of Act 129 Program Year 14 Annual Report (June 1, 2022–May 31, 2023).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

[15] New Jersey Board of Public Utilities. *New Jersey 2023 Triennial Technical Reference Manual for 2024 Filings.* May 23, 2023. https://njcepfiles.s3.amazonaws.com/QO23030150-+Tri2+EE1+%2B+EE2-+Order+Attch+C-+TRM.pdf

Table 5-5. PY15 Non-Residential Net Impact Evaluation Results

Component	Program Year	PYVTD (kWh/yr)	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision (at 85% CL)
Custom	PY14	55,107,793	26%	0%	0.74	3%
Efficient Equipment Non-Lighting	PY14	2,173,858	84%	0%	0.16	84%
Efficient Equipment Lighting	PY14	60,478,938	35%	0%	0.65	9%
Midstream Lighting	PY15	17,890,153	30%	0%	0.70	10%
Midstream Equipment Non-Lighting	PY15 Benchmarking	588,159	6%	0%	0.94[1]	-
Program Total	**-**	**136,238,900[2]**	**31%[3]**	**0%[3]**	**0.69[3]**	**6%**

[1] Midstream Agriculture NTGR is 0.95 and midstream food service is 0.81.
[2] May not sum due to rounding.
[3] Weighted by PY15 component verified gross energy savings.

The PY15 Non-Residential Program total NTG ratio of 0.69 is heavily weighted toward the Custom component and Efficient Equipment downstream lighting subcomponent NTG ratios, as the Custom component and the Efficient Equipment downstream lighting subcomponent represent 40% and 44% of the program's verified gross population energy savings, respectively.

5.3.1. High-Impact Measure Research

The Phase IV Evaluation Framework requires the identification and oversampling of high-impact equipment and services to assess free ridership with greater certainty. Midstream lighting and midstream non-lighting projects were prescribed as high-impact measures for the PY15 evaluation. Cadmus determined there was not enough information to conduct a robust midstream non-lighting NTG analysis and did not report a NTG ratio from PY15 primary research. The NTG research for midstream lighting high-impact measures represents 13% of the total Non-Residential Program verified gross energy savings in PY15.

Table 5-6 presents findings for PY15 high-impact measures.

Table 5-6. PY15 Non-Residential High-Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Efficient Equipment Midstream Lighting[1, 2]	30%[2]	0%	0.70
Total	**30%[2]**	**0%**	**0.70**

[1] Estimated from PY15 survey data.
[2] Weighted by the survey sample-verified program kWh/yr savings.

5.4. Verified Savings Estimates

In Table 5-7, Cadmus determined and applied realization rates and NTG ratios to the reported energy and demand savings estimates to calculate the verified savings estimates for the Non-Residential Program in PY15. Cadmus added these totals to the verified savings achieved in previous program years to calculate the P4TD program impacts.

Table 5-7. PY15 and P4TD Savings Summary for the Non-Residential Program

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	185,086[1]	35.41[1]
PYVTD Gross	136,239 [2]	23.81[2][3]
PYVTD Net	93,512[2]	16.51[2][3]
RTD	507,387[1]	88.88[1]
VTD Gross	476,478[4]	81.73[3][4]
VTD Net	310,671[4]	53.45[3][4]

[1] Includes 41,612 MWh/yr of unverified PY15 energy savings and 10.08 MW/yr of unverified PY15 demand reductions from the Custom subcomponent.
[2] Does not include PY14 unverified savings verified in PY15.
[3] Verified peak demand reductions include application of distribution losses.
[4] Includes PY14 unverified savings verified in PY15 and does not include PY15 unverified savings.

The VTD savings contribution from PY14 has changed since the final PY14 annual report. Cadmus verified savings for PY14 midstream Efficient Equipment non-lighting jobs in PY15 and included these savings in the VTD gross totals.

5.5. Forecasted Savings and Expenditures

Table 5-8 and Table 5-9 show Phase IV Non-Residential Program performance by sector compared to the original and revised EE&C Plan projections and Phase III performance, as per the June 2023 settlement agreement.

Table 5-8. Phase IV Anticipated Total Large and Small C&I Savings (MWh/yr)

Sector	Program Component	Current Actuals + Pipeline (MWh)[1]	Original Plan (MWh)	Revised Plan (MWh)	Phase III Totals (MWh)[2]
Small C&I	Efficient Equipment	217,804	409,239	387,268	350,079
	Custom	211,597	161,077	257,545	42,276
Large C&I	Efficient Equipment	106,123	256,122	247,810	162,130
	Custom	281,681	544,117	233,298	133,388

[1] Includes PY13 VTD, PY14 VTD, PY15 VTD, PY15 unverified, and PY16 pipeline. Does not include verified or unverified Residential customer sector savings.
[2] GNE accounted for an additional 89,000 MWh/yr for Efficient Equipment and 134,000 MWh/yr for Custom in Phase III.

Table 5-9. Phase IV Anticipated Large and Small C&I Savings (MW/yr)

Sector	Program Component	Current Actuals + Pipeline (MW)[1]	Original Plan (MW)	Revised Plan (MW)	Phase III Totals (MW)[2]
Small C&I	Efficient Equipment	35.30	62.51	60.30	48.33
	Custom	52.85	22.90	63.57	5.00
Large C&I	Efficient Equipment	16.40	38.32	37.40	22.06
	Custom	53.03	68.30	30.64	15.41

[1] Includes PY13 VTD, PY14 VTD, PY15 VTD, PY15 unverified, and PY16 pipeline. Actuals include line losses while pipeline and PY15 unverified values do not. Does not include verified or unverified Residential customer sector savings.
[2] GNE accounted for an additional 13.85 MW/yr for Efficient Equipment and 19.73 for Custom in Phase III.

Table 5-10 shows the projected expenditures for the Small and Large C&I sectors for Phase IV, along with the planned expenditures.

Table 5-10. Phase IV Large and Small C&I Planned Expenditures (per $1,000)

Sector	Spend Type	Current Actuals + Pipeline ($)[1]	Original Plan ($)	Actual/Pipeline vs. Original Plan	Revised Plan ($)	Actual/Pipeline vs. Revised Plan
Small C&I[2]	Incentives	$53,353	$52,422	101%	$69,501	77%
	Non-Incentives	$22,624	$24,416	93%	$31,337	72%
Large C&I	Incentives	$27,340	$57,690	47%	$40,611	67%
	Non-Incentives	$17,332	$28,216	61%	$21,295	81%

[1] Includes PY13 VTD, PY14 VTD, PY15 VTD, and PY15 unverified.
[2] Plans include $2,000,000 allocated to the Low-Income Program for Master-Metered Multifamily

5.6. Process Evaluation

This section provides high-level results and findings from the process evaluation of the Non-Residential Program. Methodology and additional details for the Efficient Equipment and Custom components are discussed in *Appendix D* and *Appendix E*, respectively. Cadmus conducted a process evaluation in PY15 to assess participant satisfaction, evaluate what is working well and what could be improved, determine the influence of the component on decision-making, and make recommendations for program modification and improvement.

The evaluation activities are summarized in Table 5-11. Modifications to Cadmus' evaluation plans are noted *Appendix D* and *Appendix E*.

Table 5-11. Non-Residential Process Evaluation Activities

Activity	Audience	Methodology
Efficient Equipment Midstream Delivery Channel		
In-Depth Interviews	Administration staff (n=2)	Telephone
	Distributors (n=14)[1]	
	Contractors (n=18)[1]	
	End Users (n=28)[1]	
Efficient Equipment Downstream, Direct Install, and Direct Discount Delivery Channels		
Surveys	Participants (n=45)	Telephone and online
Custom		
Surveys	Participants (n=5)	Telephone and online

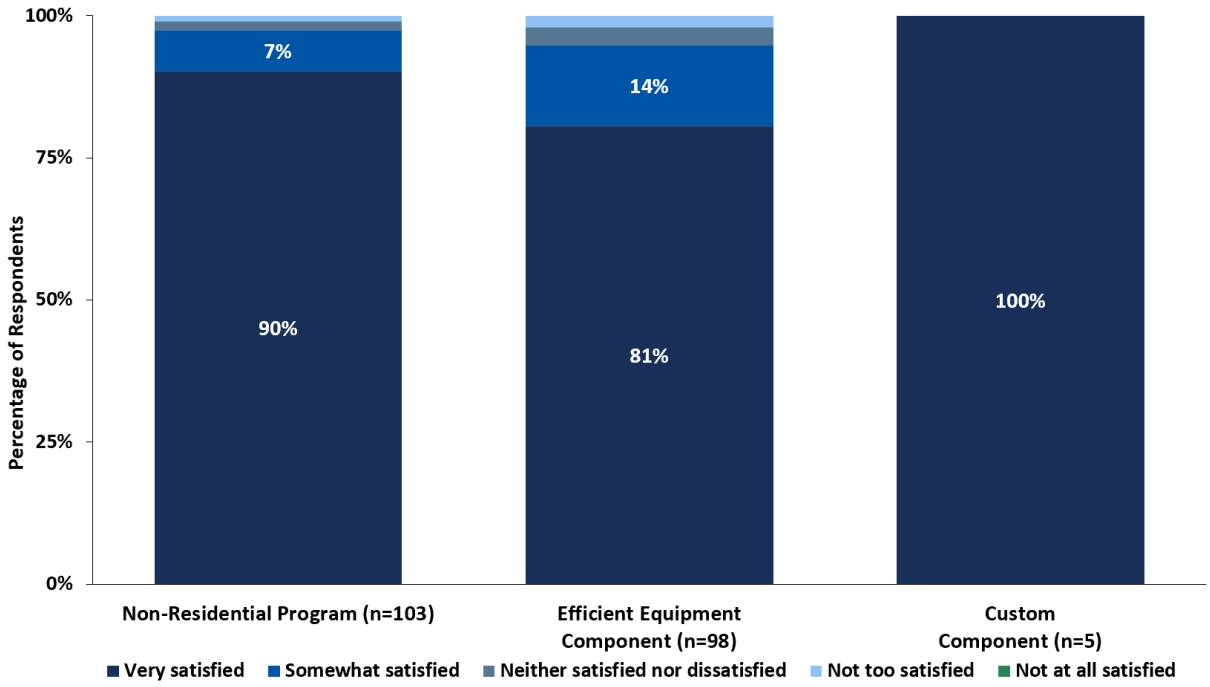
[1] Survey and interview respondents could skip questions, and not all answered each question, so the number of responses may differ from what is reported here.

Cadmus conducted staff interviews in April 2024 via phone and distributor, contractor, and end-user interviews between May and July 2024 via phone. The team completed surveys with Custom and downstream Efficient Equipment participants in July and August 2024.

5.6.1. Process Evaluation Key Findings

For Phase IV, PPL Electric Utilities established a goal to achieve 85% or more satisfied participants within the Non-Residential Program. As shown in Figure 5-1, the program exceeded this goal, with 97% of Non-Residential Program survey respondents reporting they were satisfied with their program experience in PY15.

Figure 5-1. PY15 Non-Residential Program Overall Satisfaction



Source: Distributor, contractor, and end-user midstream Efficient Equipment survey question: "Thinking about your overall experience with PPL Electric Utilities' Midstream Distributor Instant Discount Program, how would you rate your satisfaction? Would you say you are…?" Custom and downstream Efficient Equipment survey question: "Thinking about your overall experience with the PPL Electric Utilities Business Energy Efficiency Rebate Program, how would you rate your satisfaction?" Values less than 3% are not labeled in the chart. Not all respondents answered this question.

Table 5-12 shows key findings from individual process evaluations for components in the Non-Residential Program. Additional details for the program components are in *Appendix D and Appendix E* .

Table 5-12. Non-Residential Program Key Process Evaluation Findings

Program Component	Finding
Custom	• All participants were *very satisfied* with the overall program, and four of five found it *very easy* or *easy* to participate in the program. (See section *E.3.1 Component Experience*).
Efficient Equipment Midstream Lighting	• All end-user purchasers were at least *somewhat satisfied* with the energy savings from their upgraded lighting, and 84% (n=19) were *very satisfied.* (See section *D.3.2 Midstream Lighting*). • Most end-user (95%, n=20) and contractor (94%, n=18) purchasers were aware that they received an instant discount, and most distributors *always* (75%, n=8) tell their customers about the instant discount. (See section *D.3.2 Midstream Lighting*). • Most contractors (53%, n=17) rated the influence of instant discounts on their recommendations for high-efficiency lighting as *extremely influential* (the highest possible rating), and no contractors rated the influence of instant discounts lower than 3 out of 5. Most contractors (82%, n=17) also agreed the midstream lighting incentives were high enough to encourage their customers to choose high-efficiency lighting. (See section *D.3.2 Midstream Lighting*).
Efficient Equipment Midstream Non-Lighting	• All four agriculture end-user respondents were *very satisfied* with their program experience. Three were *very satisfied* with the energy savings from their upgraded lighting, and the fourth was *somewhat satisfied*. (See section *D.3.3 Midstream Agriculture Equipment*). • All four agriculture distributor respondents commented that limiting midstream non-lighting instant discounts to customers with non-residential rates has severely limited participation for agriculture measures since most of their PPL Electric Utilities customers are farms with residential rates. (See section *D.3.3 Midstream Agriculture Equipment*). • One interviewed food service end user was *not too satisfied* with their program experience due to the submission process but *very satisfied* with the energy savings from the upgraded equipment. (See section *D.3.4 Midstream Food Service Equipment*). • One interviewed food service distributor's opinion had not changed since being interviewed in PY14: this distributor's primary concern was difficulty in determining which products qualified for an instant discount. (See section *D.3.4 Midstream Food Service Equipment*).
Efficient Equipment Downstream, Direct Discount, and Direct Install	• Most respondents were *very* or *somewhat satisfied* with the component overall (93%; n=45), and 84% said it was *very easy* or *easy* to participate in it. (See section *D.3.1 Downstream, Direct Install, and Direct Discount*).

5.7. Program Finances and Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 5-13. The TRC benefits were calculated using gross verified impacts. PY15 NPV costs and benefits are expressed in 2023 dollars. NPV costs and benefits for P4TD financials are expressed in 2021 dollars.

Table 5-13. Summary of Non-Residential Program Finances – Gross Verified

Row	Cost Category	PYTD ($1,000)		P4TD[2] ($1,000)	
1	**IMCs**	**$80,600**		**$176,516**	
2	Rebates to Participants and Trade Allies	$15,304		$36,935	
3	Upstream/Midstream Incentives	$1,006		$3,694	
4	Material Cost for Self-Install Programs (EE&C Kits)	$0		$0	
5	Direct Installation Program Materials and Labor	$0		$11	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]	$64,290		$135,876	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management[3]	$143	$1,747	$470	$5,159
9	Marketing	$0	$485	$0	$1,398
10	Program Delivery[4]	$0	$4,216	$0	$11,462
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)**[6]	**$6,591**		**$18,489**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)[5], [6]**	**$87,190**		**$195,005**	
15	Total NPV Lifetime Electric Energy Benefits	$62,991		$203,049	
16	Total NPV Lifetime Electric Capacity Benefits	$33,060		$117,585	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$8,701		$15,860	
18	Total NPV Lifetime Fossil Fuel Impacts	($3,999)		($18,732)	
19	Total NPV Lifetime Water Impacts	$9		$18	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$100,761**		**$317,780**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.16**		**1.63**	

[1] Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = $2021.
[2] P4TD benefits do not include carry-over energy savings from Phase III.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
[4] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.
[5] Portfolio-level costs are not assigned to specific programs.
[6] Sum of rows may not add up to total due to rounding.

Table 5-14 presents program financials and cost-effectiveness on a net savings basis. A detailed description of net savings research is provided in *Appendix D* and *Appendix E*. As stated in the 2021 TRC Order, free rider incentives are not included as an additional program cost, as these would have occurred even in the absence of a program.

Table 5-14. Summary of Non-Residential Program Finances – Net Verified

Row	Cost Category	PYTD ($1,000)		P4TD ($1,000)	
1	**IMCs**	**$54,841**		**$116,890**	
2	Rebates to Participants and Trade Allies	$15,304		$36,935	
3	Upstream/Midstream Incentives	$1,006		$3,694	
4	Material Cost for Self-Install Programs (EE&C Kits)	$0		$0	
5	Direct Installation Program Materials and Labor	$0		$11	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)	$38,531		$76,249	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management [3]	$143	$1,747	$470	$5,159
9	Marketing	$0	$485	$0	$1,398
10	Program Delivery [4]	$0	$4,216	$0	$11,462
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)**	**$6,591**		**$18,489**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)[5] [6]**	**$61,432**		**$135,378**	
15	Total NPV Lifetime Electric Energy Benefits	$43,207		$132,580	
16	Total NPV Lifetime Electric Capacity Benefits	$22,531		$75,463	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$5,756		$10,524	
18	Total NPV Lifetime Fossil Fuel Impacts	($2,659)		($10,669)	
19	Total NPV Lifetime Water Impacts	$5		$7	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**	**$68,839**		**$207,905**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.12**		**1.54**	

[1] Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = $2021

[2] P4TD benefits do not include carry-over energy savings from Phase III

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

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

[5] Portfolio-level costs are not assigned to specific programs.

[6] Sum of rows may not add up to total due to rounding.

5.8. Status of Recommendations

In PY15, the Non-Residential Program achieved 23.81 MW/yr in system-level demand reductions and 136,239 MWh/yr in verified energy savings. Overall, the Non-Residential Program exceeded its customer satisfaction target with 97% overall program satisfaction. All of the Custom component participants (100%; n=5) and the majority of Efficient Equipment component participants (93% downstream, 98% midstream) were *very* or *somewhat satisfied* with the component in which they participated. Furthermore, rebate amounts, reducing energy bills, and increasing energy savings remain the top drivers of satisfaction for the Efficient Equipment component. Midstream Lighting respondents also frequently mentioned lower maintenance costs due to LEDs' longevity. Table 5-15 provides recommendations, along with a summary of how PPL Electric Utilities plans to address the recommendation.

Conclusion 1: For downstream non-lighting, discrepancies between reported and verified model, efficiency, or calculation methodology in two sampled HVAC projects led to savings adjustments. These adjustments resulted in both greater and lower savings than claimed, which yielded a low net impact to realization rates.	• Different HVAC equipment models and efficiencies were found to be installed compared to reported values for two sampled projects. (See section *E.1.2 Gross Impact Results*). • Additionally, a discrepancy in adherence to TRM methodology was also identified for one of the two projects. This occurred in the sampled ductless heat pump project in which both indoor and outdoor unit capacities were incorrectly included in savings calculations. (See section *E.1.2 Gross Impact Results*).
Conclusion 2: For downstream lighting, updates to projects' claimed control systems impacted verified savings negatively.	• For the downstream lighting subcomponent, 19% of projects in the sample (six out of 32 projects) were adjusted for control type. (See section *E.1.2. Gross Impact Results*).
Conclusion 3: For midstream lighting, variance in claimed and verified efficient and baseline wattages resulted in lowered realization rates.	• Cadmus adjusted efficient wattage (five of 23 projects) and baseline wattage (three of 23 projects) based on the findings from the desk review. (See section *E.1.2. Gross Impact Results*).
Conclusion 4: For midstream lighting, the claimed facility type was either Unknown or Exterior, which does not cover all options in the TRM.	• Cadmus adjusted facility types on 20 of 23 projects, affecting hours of use and coincidence factors for these projects. (See section *E.1.2. Gross Impact Results*).

The impact evaluation activities in PY15 led to the following findings and recommendations from Cadmus to PPL Electric Utilities, along with a summary of how PPL Electric Utilities plans to address the recommendation in program delivery (Table 5-15).

Table 5-15. Status of Recommendations for the Non-Residential Program

Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Efficient Equipment Non-Lighting	**Conclusion 1:** For downstream non-lighting, discrepancies between reported and verified model, efficiency, or calculation methodology in two sampled HVAC projects led to savings adjustments. These adjustments resulted in both greater and lower savings than claimed, which yielded a low net impact to realization rates.	**Recommendation 1:** Consider additional review of project invoices and/or post-inspection nameplate photos to apply accurate installed AHRI efficiencies for HVAC projects. Consider highlighting TRM methodology for ductless heat pump projects to ensure only indoor unit capacity is input in savings calculations.	**Being considered.**
Efficient Equipment Lighting	**Conclusion 2:** For downstream lighting, updates to projects' claimed control systems impacted verified savings negatively.	**Recommendation 2:** Consider ensuring that control systems are documented via specification sheets and photos when non-light switch controls are installed.	**Being considered.**
Efficient Equipment Lighting	**Conclusion 3:** For midstream lighting, variance in claimed and verified efficient and baseline wattages resulted in lowered realization rates.	**Recommendation 3:** Consider additional review of project files and TRM tables to ensure the proper efficient and baseline wattages are used.	**Being considered.**
Efficient Equipment Lighting	**Conclusion 4:** For midstream lighting, the claimed facility type was either Unknown or Exterior, which does not cover all options in the TRM.	**Recommendation 4:** Consider additional data collection to report facility types to calculate savings more closely to evaluated savings.	**Being considered.**

PPL Electric Utilities

CADMUS

LOW-INCOME PROGRAM

The Low-Income Program offers a broad selection of no-cost energy-saving improvements and education to income-eligible customers to help reduce their electricity consumption.

VERIFIED ENERGY SAVINGS

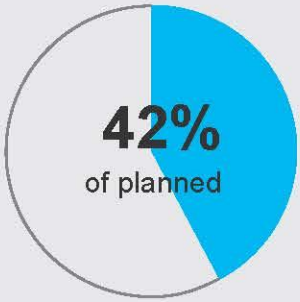
Phase IV has saved **67,173 MWh/yr***

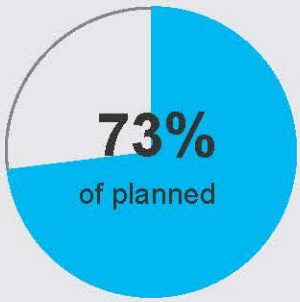
PY15 saved **14,062 MWh/yr**

*Includes Phase III carryover energy savings

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **4.09 MW/yr**





PY15 has reductions of **1.53 MW/yr**

PY15 PARTICIPATION

A total of **19,834** jobs completed

7,201 households received welcome kits

4,489 households received low-cost jobs

3,407 households received baseload jobs

1,859 households received full-cost jobs

41 master metered multifamily building jobs

Total job type exceeds number of households because some households received more than one treatment type.

PARTICIPANT SATISFACTION

88% Satisfied with overall program

89% satisfied with remote energy assessments

88% satisfied with on-site assessments

6. Low-Income Program

The Act 129 Low-Income Program is designed to reduce electric consumption for income-eligible 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.[16, 17]

The Low-Income Program is delivered by the ICSP, CMC Energy, which is responsible for outreach, customer recruitment, home energy assessments, education, customized kits of energy-saving items to customers, and managing the direct installation of energy-saving equipment in customers' homes. The ICSP also operates a customer call center, supports marketing and tracking activities for both Act 129 and Low-Income Usage Reduction Program, and uses qualified contractors for tasks that include installation and services and replacing outdated and inefficient equipment with program-qualifying energy-efficient equipment. PPL Electric Utilities administers the Low-Income Program and oversees ICSP activities, as summarized in Table 6-1.

Table 6-1. Low-Income Program Summary

Program Channel	Target Market	Eligibility Requirements	Delivery Channels	Participant Definition
Remote Energy Assessment (REA)	Income-eligible customers; household income must be at or below 150% of the Federal Poverty Guidelines	Customers in PPL Electric Utilities' territory; single-family homes, individually metered multifamily buildings, and manufactured homes; customers may choose which delivery method they prefer	Remote assessment via telephone and customized kit of items mailed to customer	Customers who receive a remote home energy assessment
In-Home (Direct Install)			On-site energy assessment and direct installation of technology	Customers who receive an on-site energy assessment
Master-Metered Multifamily (MMMF)		Customers in PPL Electric Utilities' territory; master-metered multifamily buildings (tenant units); receive landlord's approval	On-site energy assessment and direct installation of technology	Customers who receive an on-site energy assessment
Welcome Kits		Customers in PPL Electric Utilities' territory	Kit mailed to customer	Customers who receive a welcome kit

PPL Electric Utilities offers qualifying customers a range of energy-saving products and services, including HVAC, lighting, weatherization, water-saving, heating, appliances, and home health and safety. All qualifying customers receive a free energy assessment that evaluates their home for eligible energy-

[16] Household income must be at or below 150% of the Federal Poverty Guidelines.

[17] Individually metered income-eligible multifamily residences are eligible for the same improvements as individually metered single-family income-eligible residences under the Low-Income Program. Individually metered manufactured homes are eligible for the same improvements as any other type of individually metered home receiving services from the Low-Income Program.

saving options. The home energy auditor refers to a pre-approved list of products and services as well as criteria to determine if appliances and other large equipment can be replaced based on customer need and according to program guidelines. They also provide energy education and make recommendations to encourage customers to conserve energy.

In PY15, the ICSP provided eligible electric water heating customers with welcome kits containing three domestic hot water (DHW) saving products: one bathroom faucet aerator rated at 0.5 GPM, one kitchen faucet aerator rated at 1.25 GPM, and one energy-efficient showerhead rated at 1.5 GPM. Welcome kits contained instructions for product installation, including where to install each faucet aerator and a postcard. The postcard encouraged participation in an energy assessment through the Low-Income Program and provided participants with the ICSP contact phone number and program website.

In PY15, the ICSP continued to offer on-site assessments and remote assessments via telephone. Remote assessments began in June 2020 in response to the COVID-19 pandemic. All on-site and remote assessments involved an auditor visiting each room in the home and asking the resident questions about the home's energy-consuming equipment, ultimately gathering information about the home's water heater and heating fuel type, the number and wattage of light bulbs in each room, and the number of showers and sinks. Auditors also provided tips and education on how participants could save energy based on their energy needs, home, and energy-equipment condition. For remote assessments, the ICSP mailed a comprehensive kit of energy-saving items customized to each participant's responses. The kit contained LEDs, night lights, Tier 1 power strips, energy-efficient showerheads, and low-flow faucet aerators. If the remote energy assessment customer needed assistance, the ICSP arranged for an on-site visit. For on-site assessments, technicians directly installed equipment.

In PY15, PPL Electric Utilities provided four types of service (also known as job types) at no cost to income-qualified customers. The program offered baseload services to customers without electric heat and without an electric water heater, low-cost services to customers without electric heat but with electrically heated water, full-cost services to customers with both electric heat and electrically heated water, and a welcome kit to any eligible customer.

6.1. Participation and Reported Savings by Customer Segment

Table 6-2 shows the participation counts, reported and verified energy and demand savings, and incentives (i.e., value of improvements provided) for the Low-Income Program. Participants are defined as unique households (billing account number) who receive a welcome kit or a home assessment and program services.

Table 6-2. PY15 Low-Income Program Participation and Reported Impacts

Parameter	Residential Low-Income	Small C&I Low-Income	GNE Low-Income	Total[1]
PY15 # Participants[2]	15,969	37	4	**16,010**
PYRTD MWh/yr	12,199	520	54	**12,773**
PYRTD MW/yr	1.31	0.06	0.01	**1.37**
PYVTD MWh/yr	13,640	381	40	**14,062**
System-Level PYVTD MW/yr	1.48	0.05	0.01	**1.53**
PY15 Incentives ($1,000)	$4,287	$290	$0	**$4,577**

[1] Total may not match the sum of columns to rounding.
[2] This count is based on PY15 unique household participants. Note that this count of participants excludes repeat customers between strata.

Table 6-3 shows the Low-Income Program's verified gross energy savings and demand reductions.

Table 6-3. Low-Income Program Savings

Savings	PY13 Verified	PY14 Verified	PY15 Verified	Phase IV Verified[1]
MWh/yr	9,151[2]	12,872	14,062	67,173[3]
System Level MW/yr	1.02[4]	1.53	1.53	4.09

[1] Phase IV verified savings may not match sum of program years due to rounding.
[2] PY13 verified savings for the Low-Income Program were reduced by 1,422 MWh/yr to a total of 9,027 MWh/yr in accordance with the SWE's PY13 Annual Report findings. This total includes unverified PY13 savings of 124 MWh/yr verified in PY14.
[3] Phase IV Verified Savings include 31,089 MWh/yr carryover savings from Phase III.
[4] PY13 verified system-level demand reductions for the Low-Income Program were reduced by 0.21 MW/yr to a total of 1.02 system-level MW/yr in accordance with the SWE's PY13 Annual Report findings. This total includes unverified PY13 savings of 0.01 MW/yr verified in PY14.

6.2. Gross Impact Evaluation

In PY15, the Low-Income Program reported energy savings of 12,773 MWh/yr and achieved a program realization rate of 110%, weighted by stratum, as shown in Table 6-5. The program reported demand reductions of 1.37 MW/yr and achieved a program demand realization rate of 103%, as shown in Table 6-6. Both tables are shown by stratum (job type).

Cadmus applied historical realization rates from PY14 results to reported PY15 energy savings and demand reductions for the REA and on-site strata (Table 6-4). See the PY14 evaluation report for details on the PY14 evaluation approach.[18] Because welcome kits contained different equipment from PY14, Cadmus evaluated this group.

[18] PPL Electric Utilities. September 30, 2023. *Phase IV of Act 129 Program Year 14 Annual Report (June 1, 2022–May 31, 2023).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

Table 6-4. Low-Income Program Historic Realization Rates

Stratum	Historic Realization Rate	
	Energy Savings (MWh/yr)	Demand Reductions (MW/yr)
REA Baseload	99%	96%
REA Low-Cost	135%	138%
REA Full-Cost	102%	64%
On-Site Assessment Baseload	107%	102%
On-Site Assessment Low-Cost	117%	117%
On-Site Assessment Full-Cost	102%	64%
On-Site Assessment Master-Metered Multifamily	73%	76%

Table 6-5. PY15 Low-Income Program Gross Impact Results for Energy

Stratum[1]	PYRTD MWh/yr	Energy Realization Rate[2]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)[3]
Remote Energy Assessment					
REA Baseload	880	99%	0.12	5.2%	867
REA Low-Cost	2,033	135%	0.31	13.2%	2,738
REA Full-Cost	0.20	102%	-	7.0%	0.21
REA Subtotal[4]	**2,913**	**124%**	**0.42**	**9.6%**	**3,605**
On-Site Assessment					
On-Site Assessment Baseload	1,885	107%	0.03	1.7%	2,010
On-Site Assessment Low-Cost	3,619	117%	0.33	18.6%	4,233
On-Site Assessment Full-Cost	2,230	102%	0.13	7.0%	2,283
On-Site Assessment Master-Metered Multifamily	574	73%	-	-	421
On-Site Assessment Subtotal[4]	**8,308**	**108%**	**0.32**	**8.3%**	**8,947**
Welcome Kits					
Welcome Kit	1,552	97%	-	-	1,509
Welcome Kits Subtotal[4]	**1,552**	**97%**	**-**	**-**	**1,509**
Program Total[4]	**12,773**	**110%**	**0.31**	**5.6%**	**14,062**

[1] In PY15, Cadmus aggregated jobs by job type and delivery type.

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

[3] Savings may not match other tables or figures due to rounding.

[4] Total may not match the sum of rows due to rounding.

Table 6-6. PY15 Low-Income Program Gross Impact Results for Demand

Stratum[1]	PYRTD MW/yr	Demand Realization Rate[2]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)[3]	System-Level PYVTD (MW/yr)[3]
Remote Energy Assessment						
REA Baseload	0.10	96%	0.13	5.4%	0.10	0.11
REA Low-Cost	0.22	138%	0.32	13.8%	0.30	0.33
REA Full-Cost	0.00	64%	-	31.2%	0.00	0.00
REA Subtotal[4]	**0.32**	**125%**	**0.49**	**10.0%**	**0.40**	**0.43**
On-Site Assessment						
On-Site Assessment Baseload	0.21	102%	0.12	6.5%	0.22	0.24
On-Site Assessment Low-Cost	0.37	117%	0.34	19.2%	0.43	0.47
On-Site Assessment Full-Cost	0.24	64%	0.60	31.2%	0.16	0.17
On-Site Assessment Master-Metered Multifamily	0.06	76%	-	-	0.05	0.05
On-Site Assessment Subtotal[4]	**0.89**	**96%**	**0.43**	**10.5%**	**0.85**	**0.93**
Welcome Kits						
Welcome Kit	0.16	97%	-	-	0.16	0.17
Welcome Kits Subtotal[4]	**0.16**	**97%**	**-**	**-**	**0.16**	0.17
Program Total[4]	**1.37**	**103%**	**0.41**	**6.8%**	**1.41**	**1.53**

[1] In PY15, Cadmus aggregated jobs by job type and delivery type.
[2] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates are applied to verified demand reductions before the application of distribution losses.
[3] Savings may not match other tables or figures due to rounding.
[4] Total may not match the sum of rows due to rounding.

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

- The ICSP used single-family default TRM values to calculate savings attributable to DHW equipment included within the welcome kits (e.g., aerators, shower heads). However, because the kits were delivered to single-family and multifamily homes and the data do not indicate which home type kits were delivered to, Cadmus used unknown home-type defaults in its analysis. This impacted the number of persons estimated within a household as well as the number of fixtures (both sinks and showerheads).
- The ICSP provided welcome kits to 72 duplicate customers, with each customer receiving two kits. The ICSP indicated that this was an error. As such, Cadmus did not include savings for the duplicate kits in the verified savings.

In PY15, the welcome kits contained DHW equipment instead of two LED bulbs as in previous years within Phase IV. The energy and demand savings associated with the new DHW kits were greater and more cost-effective.

For details relating to the PY14 analysis, approach, and assumed historical realization rates used in PY15, please see the PY14 evaluation report. [19]

6.3. Net Impact Evaluation

The Low-Income Program is offered to income-eligible customers at no cost. No free riders are anticipated because income-constrained customers are not likely to purchase energy-efficient products on their own. A NTG ratio of 1.0 is appropriate for this program. Therefore, Cadmus did not estimate net savings.

6.4. Verified Savings Estimates

As shown in Table 6-7, Cadmus determined the realization rates and NTG ratios and applied these values to the reported energy savings and demand reduction estimates to calculate the verified savings estimates for the PY15 Low-Income Program. We added these totals to the verified savings achieved in previous- program years to calculate the P4TD program impacts.

Table 6-7. PY15 and P4TD Savings Summary for the Low-Income Program

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	12,773	1.37
PYVTD Gross	14,062	1.53[(1)]
PYVTD Net	14,062	1.53[(1)]
RTD	35,439	3.87
VTD Gross	67,173[(2)]	4.09[(1),(3)]
VTD Net	67,173	4.09[(1),(3)]

[(1)] Verified demand reductions include line-loss adjustments.
[(2)] Includes Phase III carryover of 31,089 MWh/yr. PY13 verified savings for the Low-Income Program were reduced by 1,422 MWh/yr to a total of 9,027 MWh/yr in accordance with the SWE's PY13 Annual Report findings. Includes 124 MWh/yr of PY13 unverified savings verified in PY14.
[(3)] PY13 verified system-level demand reductions for the Low-Income Program were reduced by 0.21 MW/yr to a total of 1.02 system-level MW/yr in accordance with the SWE's PY13 Annual Report findings. This includes unverified PY13 savings of 0.01 MW/yr verified in PY14.

No changes were made to reported VTD savings since the PY14 report was submitted.

6.5. Process Evaluation

As noted in the Low-Income PY15 evaluation plan, Cadmus minimized process evaluation activities to bimonthly check-ins with PPL Electric Utilities and the ICSP staff. This enabled Cadmus to stay apprised of developments associated with the Low-Income Program in PY15.

The evaluation plan originally included interviews with property managers in PY15, but due to an enhanced research plan to explore barriers among multifamily property owners serving low-income

[19] PPL Electric Utilities. September 30, 2023. *Phase IV of Act 129 Program Year 14 Annual Report (June 1, 2022–May 31, 2023).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

customers, the planned interviews were deferred to PY16 to align with the enhanced research with the same audience. In an additional change to the evaluation plan, Cadmus conducted a participant satisfaction survey to inform the process evaluation.

Table 6-8 lists the process evaluation sampling strategy. For the survey sample frame, Cadmus removed welcome kit participants, duplicate records, and customers who had requested no contact in a previous survey. See *Appendix L. Survey Bias* for details about Cadmus' approach to reducing survey bias and contact instructions.

Table 6-8. Low-Income Component Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Records Selected for Sample Frame	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Remote Energy Assessment and On-Site Participants	Participants who completed REAs or had in-home assessments completed	Online survey	117,317[2]	7,295[3]	N/A	All eligible	439[4]	100%
Program Total			117,317	7,295	-	-	**439**	**N/A**

[1] Percent contacted means the percentage of the sample frame contacted to complete surveys or interviews, even if the record was invalid.
[2] This represents the number of participants at the time of the evaluation survey. Process population size may differ from impact numbers.
[3] The sample frame is a list of participants with contact information who have an opportunity to complete the survey and who were sent an email 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, had only received a welcome kit, did not have valid contact information (email) or previously opted out of the online survey.
[4] This represents the number of respondents who completed the survey. The analysis used all responses to the survey.

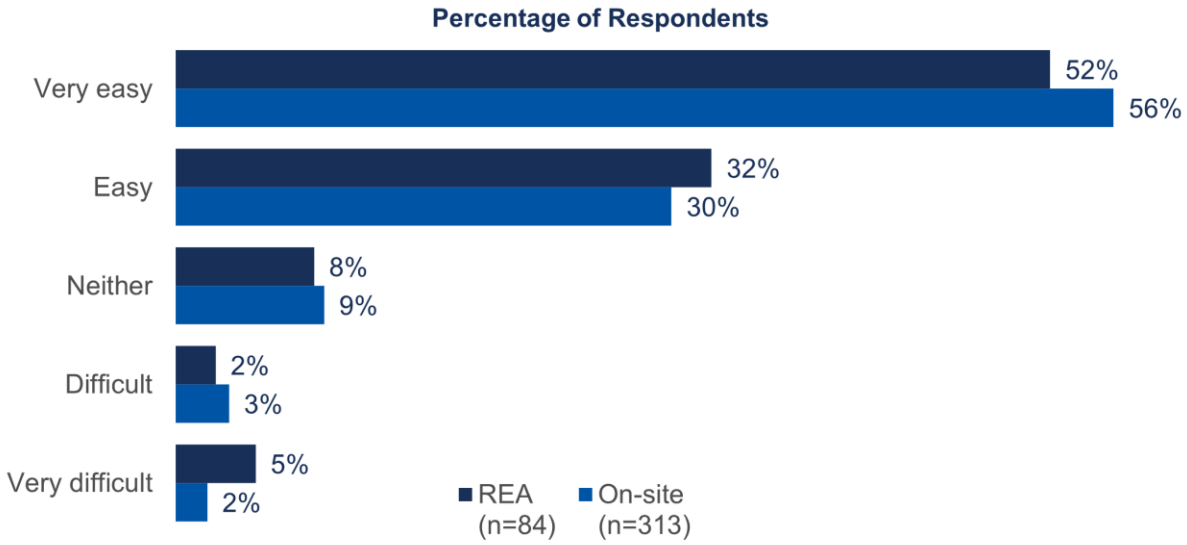
6.5.1. Program Experience

The program exceeded the overall customer satisfaction goal of 85%, with 88% (n=439, remote and on-site assessments) satisfied respondents.[20] Cadmus did not find any significant differences in satisfaction by program delivery channel (remote or on-site) in PY15.

Regardless of assessment type, most survey respondents found it easy to participate in the Low-Income Program, as shown in Figure 6-1.

[20] Of survey respondents, 4% were *neither satisfied nor dissatisfied*, 4% were *not too satisfied*, and 4% were *not at all satisfied* (n=439).

Figure 6-1. Ease of Program Participation



Source: Participant survey, "Overall, how easy was it to participate in the Winter Relief Assistance Program?"

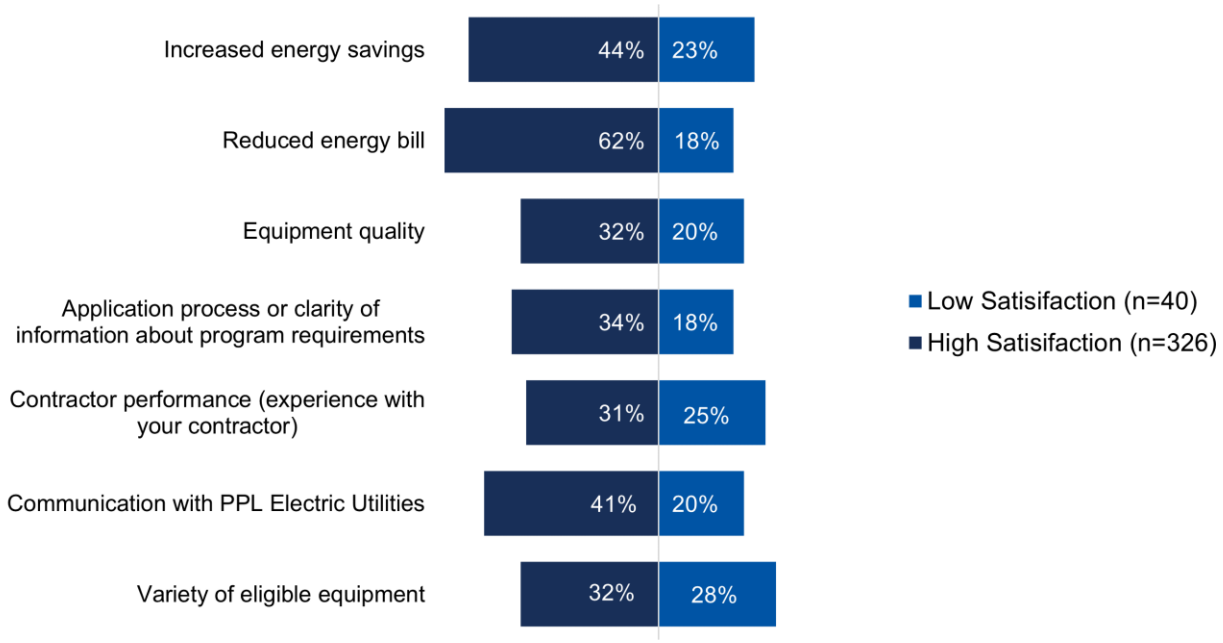
Four on-site respondents and one REA respondent who reported the program was difficult to participate in cited the quality of communication, while four respondents (three on-site, one REA) reported unsatisfactory customer service. They said that clearer explanations of program processes, updates, and responsiveness from the customer service center would make the program easier to participate in. Two respondents (one on-site, one REA) said that language barriers posed participation difficulties.

Drivers of Program Satisfaction

To better understand what drives program satisfaction, the survey asked participants what factor most affected their program satisfaction rating. Figure 6-2 shows the most common reasons REA and on-site respondents were *very* or *somewhat satisfied* with the program. For both respondent types, the most common driver for high satisfaction was the reduced energy bill.

Perceptions of the variety of eligible equipment were a main factor for on-site participants who were less satisfied with the program. Ten of 32 (31%) on-site respondents who rated satisfaction as *neither satisfied nor dissatisfied*, *not too satisfied*, or *not at all satisfied*, reported the energy savings were not what they were expecting. The 10 dissatisfied REA respondents who provided feedback provided diverse reasons for dissatisfaction, with the most frequently listed reasons being not receiving equipment (three responses), wanting more energy savings or a reduction in energy bill (three responses), and contractor performance (two responses).

Figure 6-2. REA and On-Site Drivers of High Program Satisfaction



Source: Participant survey, "What factor(s) most affected the overall experience rating you gave?" Multiple responses allowed.

Opinion of PPL Electric Utilities

Of 369 REA and on-site survey respondents who answered this question, over half (69%) said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 22% said their opinion had not changed, and 9% said their opinion decreased.

Of all REA and on-site participants who reported that their opinion of PPL Electric Utilities decreased following the program, some explained why. Seven respondents were not happy with increased monthly energy costs or the lack of a decrease in their monthly energy costs despite the energy savings equipment (one REA, six on-site). Seven respondents explained their opinion decreased because they had not yet received the measures or services they were promised (two REA, five on-site), and three on-site respondents said their issues were not addressed through participating in the program. For example, one of these respondents explained they live in a "very old apartment," and not much had "changed" since participating in the program—despite having installed window wrap or caulk, there is still poor insulation in the home. Another respondent said they asked for assistance with their air conditioner, freezer, and electricity costs but were denied.

Improvement Suggestions

REA and on-site respondents provided feedback for improvement. Over half (69%, n=302) of respondents reported no improvements, and 10% of respondents left positive comments about their experience with the program. However, some respondents had suggestions for improvements.

There were 13 respondents (one REA, 12 on-site) who suggested improvements to the number of or type of measures offered. Respondents most frequently cited windows (nine respondents), followed by surge protectors (two respondents), heating improvements (two respondents), home energy assessments (two respondents), and caulk (one respondent). Six respondents requested the opportunity to replace or upgrade appliances, with two specifically requesting refrigerator upgrades, one requesting window upgrades, and another suggesting air conditioners.

Additionally, 12 on-site respondents suggested improved communication, such as providing an estimate of when customers' homes will be inspected or when products will be delivered (two respondents), responding to customer inquiries (two respondents), following up with customers to ensure all their needs are being met (three respondents). Three other on-site participants said clarifying program offerings and specifying what products are to be delivered would be helpful.

Eight respondents said they would like the services promised to customers to be delivered (one REA, seven on-site), and five of these respondents said they had not received the replacement air conditioner they were expecting (with one explaining they had been waiting six months).

6.6. Program Finances and Cost-Effectiveness Reporting

Table 6-9 provides a detailed breakdown of program finances and cost-effectiveness. Cadmus calculated TRC benefits using gross verified impacts. PY15 NPV costs and benefits are expressed in 2023 dollars. NPV costs and benefits for P4TD financials are expressed in 2021 dollars. Net verified savings are equal to gross verified savings because the program is assumed to have an NTG ratio of 1.0.

Table 6-9. Summary of Low-Income Program Finances – Gross and Net Verified

Row	Cost Category	PYTD ($1,000)		P4TD ($1,000)	
1	**IMCs**	**$4,577**		**$9,281**	
2	Rebates to Participants and Trade Allies	$207		$256	
3	Upstream/Midstream Incentives	$0		$0	
4	Material Cost for Self-Install Programs (EE&C Kits)	$498		$3,374	
5	Direct Installation Program Materials and Labor	$3,872		$5,651	
6	**Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]**	$0		$0	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management[3]	$208	$736	$556	$2,006
9	Marketing	$0	$177	$0	$577
10	Program Delivery[4]	$0	$2,272	$0	$6,037
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)[6]**	**$3,394**		**$9,176**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)[5], [6]**	**$7,971**		**$18,458**	
15	Total NPV Lifetime Electric Energy Benefits	$2,935		$6,896	
16	Total NPV Lifetime Electric Capacity Benefits	$1,522		$3,778	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$0		$64	
18	Total NPV Lifetime Fossil Fuel Impacts	($78)		($59)	
19	Total NPV Lifetime Water Impacts	$8,954		$16,498	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)[6]**	**$13,334**		**$27,177**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.67**		**1.47**	

[1] Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = 2021.
[2] P4TD benefits does not include carryover energy savings from Phase III.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
[4] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as program delivery costs.
[5] Portfolio-level costs are not assigned to specific programs.
[6] Sum of rows may not add up to total due to rounding.

6.7. Status of Recommendations

Overall, the Low-Income Program continues to deliver reliable savings and receives positive ratings from participants. The Low-Income Program achieved 8,947 MWh/yr in verified savings from on-site assessments, 3,605 MWh/yr in verified savings from remote energy assessments, and 1,509 MWh/yr in verified savings from the welcome kits. The program achieved an overall customer satisfaction rating of 88% (n=439), exceeding the goal of 85%. Table 6-10 provides a recommendation, along with the recommendation status.

Conclusion 1: New DHW welcome kits offered in PY15 resulted in higher savings compared to previously offered welcome kits.

- Cadmus found the savings associated with the new DHW kits were greater and more cost-effective than those associated with previously offered LED kits. (See section *6.2 Gross Impact Evaluation*).

Cadmus' impact and process evaluation activities in PY15 led to the conclusion and recommendation shown in Table 6-10. The table also includes a summary of how PPL Electric Utilities plans to address the recommendation in program delivery.

Table 6-10. Status of Recommendation for the Low-Income Program

Program	Conclusion	Recommendation	EDC Status of Recommendation
Low-Income	New DHW welcome kits offered in PY15 resulted in higher savings compared to previously offered welcome kits.	Continue to offer DHW equipment in welcome kits.	**Implemented**.

PPL Electric Utilities

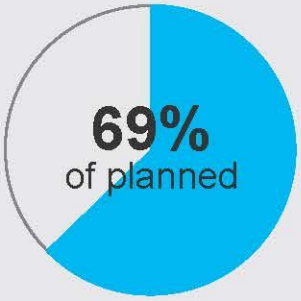
CADMUS

RESIDENTIAL PROGRAM

The Residential Program offers financial incentives to recycle inefficient appliances, purchase rebated efficient equipment and discounted lighting and equipment, build energy-efficient new homes, and educate students about energy efficiency.

VERIFIED ENERGY SAVINGS

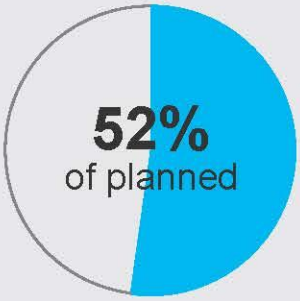
Phase IV has saved **122,680 MWh/yr**



PY15 saved **44,366 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **17.52 MW/yr**



PY15 has reductions of **6.51 MW/yr**

PY15 PARTICIPATION

A total of **200,217** rebates or discounts

99,012 Energy Efficient Homes*

67,447 Efficient Lighting (number of bulbs)

20,169 Student Energy Efficient Education

13,589 Appliance Recycling

*Includes number of instant discount purchases

PARTICIPANT SATISFACTION

Satisfied with overall program

97% satisfied with Appliance Recycling

86% satisfied with Energy Efficient Homes

85% satisfied with Student Energy Efficient Education

7. Residential Program

The Residential Program is a comprehensive offering comprising new construction, retrofit, appliance recycling, and kit delivery streams for PPL Electric Utilities' residential customers. The program ICSP, CLEAResult, manages program operations and oversees rebate and incentive delivery, with assistance from several subcontractors for specific markets and delivery mechanisms. The evaluation methodology and findings for each Residential Program component are described in separate appendices.

The program has four major components:

- **Appliance Recycling** offers an incentive to customers who turn in eligible, working appliances and provides free pick-up and environmentally sound recycling services. Eligible products include freezers, refrigerators, room air conditioners, and dehumidifiers. Participation is counted as the number of appliances recycled.
- **Energy Efficient Homes** offers incentives to home builders to construct program-qualifying homes more efficient than code, downstream incentives for high-efficiency products and equipment, instant discounts for qualifying energy-efficient products at retailers, discounted products via an Online Marketplace, and home energy audits, energy kits, and downstream rebates for weatherization solutions. Additionally, this component began offering midstream incentives through HVAC distributors in PY15 and introduced two pilot programs, the Deep Energy Retrofits pilot and the High Performance Homes pilot. Participation is counted as the number of rebated projects or homes.
- **Efficient Lighting** delivered upstream incentives to encourage customers to purchase and install specialty LED bulbs through buying down the price of program-qualified ENERGY STAR LEDs. This program component provided incentives to participating manufacturers to discount the prices of a variety of specialty bulbs sold at participating retail stores. The component was sunset in PY14 but due to the timing of manufacturer invoices, the program still reported a small number of savings in PY15. Participation is counted as the number of discounted bulbs sold.
- **Student Energy Efficient Education (SEEE)** offers free kits with energy-saving products and energy education for students and teachers in grade schools and high schools in PPL Electric Utilities territory. Participation is counted by the number of kits delivered.

7.1. Participation and Reported Savings by Customer Segment

Table 7-1 presents the participation counts, reported energy and demand savings, and incentive payments for the Residential Program in PY15 by customer segment.

Table 7-1. PY15 Residential Participation and Reported Impacts[1]

Parameter	Residential (Non-LI)	Residential (LI)	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total[2]
PY15 # Participants	194,914	-	5,235	6	61	200,216
PYRTD MWh/yr	60,753	-	238	4	45	61,040
PYRTD MW/yr	6.47	-	0.06	0.001	0.01	6.53
PYVTD MWh/yr[3]	44,095	-	226	4	41	44,366
System-Level PYVTD MW/yr[3]	6.44	-	0.06	0.001	0.01	6.51
PY15 Incentives ($1,000)	$7,431	$0	$55	$0	$2	$7,488

Note: This table does not include results from the Low-Income Program.
[1] The totals in this table do not include PY14 unverified savings verified in PY15.
[2] Total may not sum due to rounding.
[3] Savings for Energy Efficient Homes midstream HVAC and instant discount spray foam subcomponents were left unverified in PY15 and will be verified in PY16.

Table 7-2 shows the Residential Program's verified gross energy savings and demand reductions.

Table 7-2. Residential Program Savings

Savings	PY13 Verified	PY14 Verified[1]	PY15 Verified	PY15 Unverified	Phase IV Verified [2], [3]
MWh/yr	34,603[4]	43,710	44,366	11,229	122,680
System-Level MW/yr	4.92[5]	6.09	6.51	0.08[6]	17.52

[1] Includes savings left unverified in PY14 and verified in PY15.
[2] Phase IV verified savings may not match sum of program years due to rounding.
[3] Does not include PY15 unverified savings.
[4] PY13 verified savings for the Residential Program were reduced by 3.46 MWh/yr in accordance with the SWE's PY13 annual report findings.
[5] PY13 verified system-level demand reductions for the Residential Program were increased by 0.0005 MW/yr in accordance with the SWE's PY13 annual report findings.
[6] This does not include the application of line losses.

7.2. Gross Impact Evaluation

Cadmus conducted a gross impact evaluation for all Residential Program components in PY15 using a basic level of rigor. Evaluation methods and sampling approaches differed by component to reflect the unique design and delivery and historical performance. For Student Energy Efficient Education, Cadmus used a census approach. For Energy Efficient Homes, Cadmus conducted a verification survey to calculate installation rates and home characteristics and completed desk reviews of project documentation and contractor invoices. For the Appliance Recycling component, Cadmus surveyed a sample of participants to inform part-use factor. For the Audit and Weatherization subcomponent of

Energy Efficient Homes and the Efficient Lighting component, Cadmus used PY14 realization rates to calculate PY15 savings.

Cadmus did not verify savings for the Midstream Equipment subcomponent of the Energy Efficient Homes component and left certain measures from the Instant Discount subcomponent unverified. These savings will be verified in PY16.

Gross savings verification methodology details, sampling approach, and detailed findings are discussed in the individual appendices of this report (*Appendix G, Appendix H, Appendix I, and Appendix J)*.

The Residential Program overall achieved an 89% realization rate for energy (Table 7-3) and a 93% realization rate for demand (Table 7-4).

Table 7-3. PY15 Residential Program Gross Impact Results for Energy

PYRTD MWh/yr	PYRTD MWh/yr	Energy Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 90% C.L.[2]	PYVTD (MWh/yr)
Appliance Recycling	9,250	93%	7.80	12.8%	8,565
Efficient Lighting	385	102%	-	-	394
Energy Efficient Homes	34,525[3]	87%	8.28	13.6%	30,070
Student Energy Efficient Education	5,650	94%	0.76	1.3%	5,337
Residential Subtotal[4]	**49,811[3]**	**89%**	**5.84**	**9.6%**	**44,366**
Low-Income (Residential)[5]	12,773	110%	3.92	6.4%	14,062
Program Total[4]	**62,584**	**93%**	**4.53**	**7.4%**	**58,428**
Energy Efficient Homes Unverified	11,229	-	-	-	-
Total (Verified + Unverified)[4]	**73,813**	**79%**	-	**-**	**58,428**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Relative precision in this table is reported at the 90% confidence level and will not match tables in the appendices where relative precision is reported at the 85% confidence level.
[3] Reported totals do not include records left unverified. If including unverified savings, the realization rate for Energy Efficient Homes is 66% and the Residential Program is 73%.
[4]Totals may not sum due to rounding and may not match other tables or figures due to rounding.
[5] Low-Income is shown as a subsector of residential in this table per sampling requirements in the Evaluation Framework.

Table 7-4. PY15 Residential Program Gross Impact Results for Demand

Component	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 90% C.L.[2]	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Appliance Recycling	2.20	95%	5.15	8.5%	2.09	2.28
Efficient Lighting	0.06	102%	-	-	0.06	0.06
Energy Efficient Homes	3.60[3]	92%	10.63	17.5%	3.31	3.60
Student Energy Efficient Education	0.60	89%	0.78	1.3%	0.53	0.57
Residential Subtotal[4]	**6.45[3]**	**93%**	**6.16**	**10.1%**	**5.99**	**6.51**
Low-Income (Residential)[5]	1.37	103%	4.69	7.7%	1.41	1.53
Program Total[4]	**7.83**	**95%**	**5.07**	**8.3%**	**7.40**	**8.05**
Energy Efficient Homes Unverified	0.08	-	-	-	-	-
Total (Verified + Unverified)[4]	**7.91**	**95%**	**-**	**-**	**7.40**	**8.05**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Relative precision in this table is reported at the 90% confidence level and will not match tables in the appendices where relative precision is reported at the 85% confidence level.
[3] Reported totals do not include records left unverified. If including unverified savings, the realization rate for Energy Efficient Homes is 90% and the Residential Program is 92%.
[4] Totals may not sum due to rounding and may not match other tables or figures due to rounding.
[5] Low-Income is shown as a subsector of residential in this table per sampling requirements in the Evaluation Framework.

The following factors led to variation between the reported and verified savings and to the observed realization rates for the subcomponents or components verified in PY15:

- For the Appliance Recycling component, differences in realization rates were driven by a shift in the age of appliances recycled; in PY15, the share of pre-1990 units and the average age of recycled appliances decreased. Cadmus calculated the share of pre-1990 refrigerators recycled in the PY13 evaluation as 22% compared with 7% in PY15,[21] which resulted in slightly lower energy and demand savings (as newer units are more efficient).
- For the New Homes subcomponent of Energy Efficient Homes, differences in realization rates were due to model adjustments of the sampled homes based on a desk review of model inputs and changes to baseline home parameters. The realization rate for demand savings was lower than the energy realization rate; the main reason for lower *ex post* demand savings was due to the coincident factor. More information is found in *Appendix I.*
- The Downstream Equipment subcomponent of Energy Efficient Homes had energy realization rates lower than 100% and demand realization rates above 100%. The variations were due to two main reasons: equipment efficiency was recorded in the tracking database as seasonal energy efficiency ratio (SEER)2 and heat pump heating season performance factor (HSPF)2, but

[21] PPL Electric Utilities. November 30, 2022. *Phase IV of Act 129 Program Year 13 Annual Report (June 1, 2021–May 31, 2022).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. https://www.puc.pa.gov/pcdocs/1766201.pdf

Cadmus evaluated all equipment as SEER and HSPF per TRM guidance memos. Secondly, Cadmus verified different baseline equipment for several ductless heat pump and smart thermostat projects compared to what was in the tracking database. See *Appendix I* for more details.

- For the Instant Discount and Online Marketplace subcomponents of Energy Efficient Homes, realization rates were impacted by installation rates of purchased items. PY15 installation rates for kit measures, are found in *Appendix I.*
- Realization rates for the Student Energy Efficient Education Component were impacted by lower-than-planned installation rates for certain measures (kitchen aerators, showerheads, and smart strips), particularly in the Take Action cohort, which accounts for the most savings. The analysis also found that the saturation of electric water heaters was lower than planned.

7.3. Net Impact Evaluation

The methods used to determine net savings for the downstream, upstream, and midstream channels are provided in the Evaluation Framework,[22] which discusses the common methods used to determine free ridership and spillover.

- **Appliance Recycling.** Cadmus used self-report surveys, administered online, to assess free ridership and spillover.
- **Efficient Lighting.** Cadmus did not conduct new primary research to assess net savings for the Efficient Lighting component in PY15 and used a historic NTG ratio from PY13 to calculate net savings.
- **Energy Efficient Homes.**
  - For the Downstream Equipment stratum and Online Marketplace stratums, Cadmus used self-report surveys, administered online, to assess free ridership and spillover.
  - For the Audit and Weatherization stratums, Cadmus used historical NTG ratios from PY14 to calculate net savings.
  - For the Instant Discount stratum, Cadmus used PY15 evaluated measure-level NTG ratios from Downstream Equipment and Online Marketplace stratums to calculate net savings for PY15 Instant Discount stratum measures that were like PPL Electric Utilities program measures. Additionally, Cadmus used PY15 benchmarking NTG ratios to calculate net savings for measures where there was not a similar PPL Electric Utilities NTG primary researched value to leverage.
  - For the New Homes' stratum, Cadmus used the historical PY13 evaluated NTG.
  - For the PY15 High-Performance Homes stratum, Cadmus used a deemed NTG ratio of 1.00 to calculate net savings, per the evaluation plan.

[22] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

- **Student Energy Efficient Education.** Cadmus used a deemed NTG ratio of 1.00 to calculate net savings, per the evaluation plan.

Additional information about the NTG methodology used for the Audit and Weatherization stratum in the Energy Efficient Homes component is provided in *Appendix K Net Savings Impact Evaluation* and *Appendix I.*

Findings from net savings research are not used to adjust compliance savings in Pennsylvania. Instead, this research provides directional information for program planning purposes.

Table 7-5 presents NTG ratios for the components of the Residential Program in PY15.

Table 7-5. PY15 Residential Program Net Impact Evaluation Results

Component	PYVTD (kWh/yr)	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision (at 85% CL)
Appliance Recycling	8,565,413	50%	0%	0.50	5%
Efficient Lighting	393,784	N/A	N/A	1.07	15%
Energy Efficient Homes	30,070,252	40%	2%	0.62	8%
Student Energy Efficient Education	5,336,959	N/A	N/A	1.00	N/A
Program Total	**44,366,408[1]**	**N/A**	**N/A**	**0.65[2]**	**5%**

[1] May not sum due to rounding.
[2] Weighted by PY15 verified gross energy savings.

The PY15 Residential Program total NTG ratio of 0.65 is heavily weighted toward the Appliance Recycling and Energy Efficient Homes component NTG ratios, as these components represented 88% of the Residential Program verified gross population energy savings.

7.4. Verified Savings Estimates

As shown in Table 7-6, Cadmus applied the realization rates and NTG ratios to the reported energy and demand savings estimates to calculate the verified savings estimates for the Residential Program in PY15. These totals are added to the verified savings achieved in previous program years to calculate the P4TD program impacts.

Table 7-6. PY15 and P4TD Savings Summary for the Residential Program

Savings Type	Energy (MWh/yr)[1]	Demand (MW/yr)[1]
PYRTD	61,040[2]	6.53[2]
PYVTD Gross	44,366[3]	6.51[3],[4]
PYVTD Net	28,763[3]	4.10[3],[4]
RTD	139,649[2]	17.69[2]
VTD Gross	122,680	17.52[4]
VTD Net	81,430	11.54[4]

[1] Does not include the Low-Income Program.
[2] Includes 11,229 MWh/yr of unverified PY15 energy savings and 0.08 MW/yr of unverified PY15 demand reductions from the Energy Efficient Homes component (midstream and Instant Discount subcomponents (spray foam) and Deep Energy Retrofit pilot).
[3] Does not include PY14 unverified savings verified in PY15.
[4] Verified peak demand reductions include application of distribution losses.

The VTD savings contribution from PY14 has changed since the final PY14 annual report. Cadmus verified savings for PY14 Instant Discount, Online Marketplace, and SEEE in PY15 and included these savings in the VTD gross totals.

7.5. Process Evaluation

This section provides high-level results and findings from the process evaluation of the Residential Program. Methodology and additional details are discussed in the individual appendices of this report (*Appendix G*, *Appendix H*, *Appendix I* and *Appendix J*).

Cadmus conducted a process evaluation in PY15 to gather updates from program administration staff and ICSPs, assess participant experience, and make recommendations for program modification and improvement.

The evaluation activities are summarized in Table 7-7. Modifications to Cadmus' evaluation plans are noted in the individual program component appendices of this report.

Table 7-7. PY15 Residential Program Evaluation Activities

Activity	Audience	Methodology
Appliance Recycling		
In-depth Interviews	Administration staff (n=2)	Telephone
Surveys	Participants (n=286)[(1)]	Online
Energy Efficient Homes		
In-depth Interviews	Administration staff (n=5)	Telephone
	Builders (n=4)	Telephone
Surveys	Participants (n=461)[(1)]	Online
Student Energy Efficient Education (SEEE)		
In-depth Interviews	Administration staff (n=3)	Telephone
Surveys	Participant students and teachers (n=15,460)[(1)]	Paper and Online
[(1)] Represents completed surveys. Survey and interview respondents could skip questions and not all answered each question so the number of responses may differ from what is reported here.		

The staff interviews were conducted in February 2024 via phone, and the online participant surveys were conducted between March and April 2024. In-depth phone interviews with participating HVAC distributors were completed in January.

7.5.1. Process Evaluation Key Findings

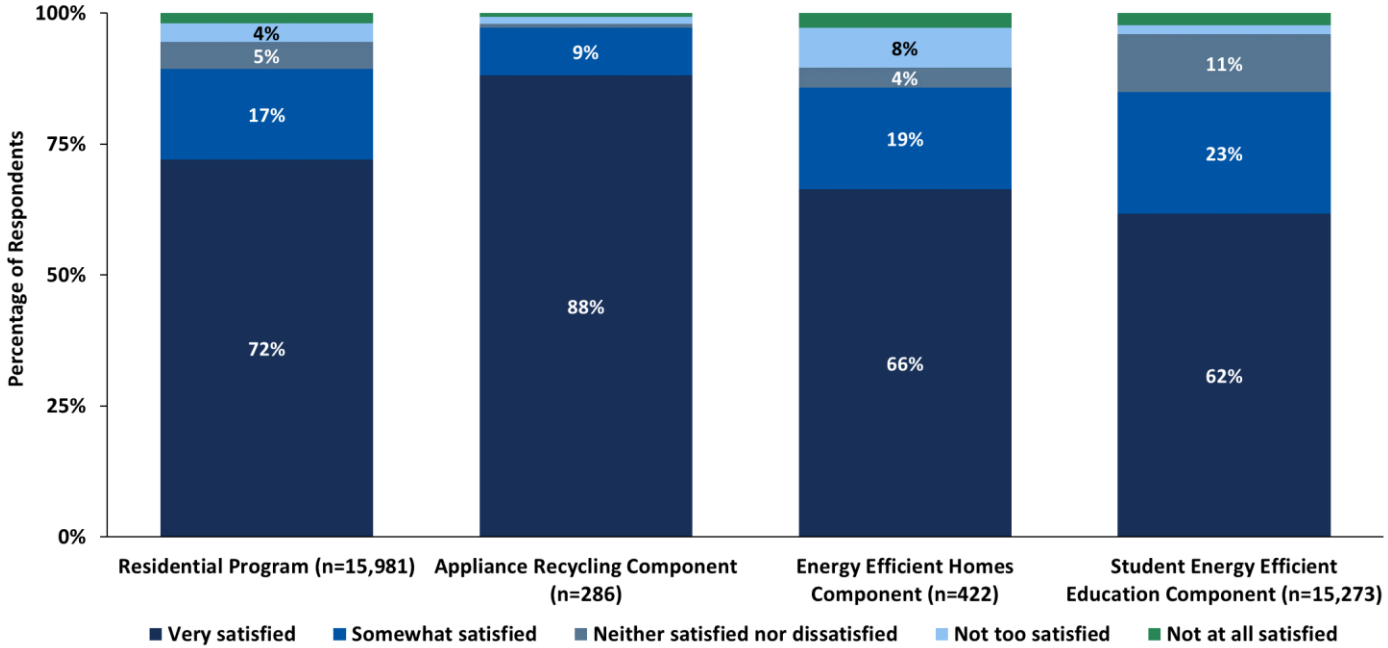
For Phase IV, PPL Electric Utilities established a Residential Program goal to achieve 85% or greater of *very satisfied* and *somewhat satisfied* customers,[23] which it met with 89% of participants reporting they were satisfied (Figure 7-1). As in PY14, the Appliance Recycling component garnered the highest participant satisfaction in PY15 with 97% (n=286) satisfied.[24] Additionally, 86% of customers were satisfied with the Energy Efficient Homes component (n=422), and 85% of student and teacher respondents (n=15,273) were satisfied with the Student Energy Efficient Education component.

Participant satisfaction with Appliance Recycling and Energy Efficient Homes program components increased in PY15. Satisfaction for the Student Energy Efficient Education is consistent with the 86% satisfaction (n=14,624) reported in PY14.

[23] The customer satisfaction goal is stipulated in PPL Electric Utilities' EE&C Plan (Docket No. M-2020-3020824) filed with the PA PUC, December 2022.

[24] Percentage may not match Figure 7-1 due to rounding.

Figure 7-1. PY15 Residential Program Overall Satisfaction



Source: PY15 Participant surveys question, "Thinking about your overall experience with the PPL Electric Utilities [PROGRAM] rebate program, how would you rate your overall satisfaction?" Percentages may not total 100% or match other sections of the report due to rounding.

Table 7-8 shows key findings from individual process evaluation for components in the Residential Program. Additional details are in the program component appendices.

Table 7-8. Residential Program Key Process Evaluation Findings

Program Component	Finding
Appliance Recycling	• Appliance Recycling remains the Residential Program component with the highest levels of participant satisfaction, with 97% of respondents reporting they were either *very satisfied* or *somewhat satisfied* (n=286). (See section *G.3.1 Program Component Experience*). • The program component expanded efforts to recycle dehumidifiers and room air conditioners in PY15 by initiating "neighborhood sweeps" for these units and allowing customers to schedule a pickup for two or more small units without requiring a refrigerator or freezer pickup. (See section *G.3.1 Program Component Experience*).
Energy Efficient Homes	• Downstream Equipment, Online Marketplace, and Audit and Weatherization participants were satisfied with their experience; 86% of respondents were *very satisfied* or *somewhat satisfied* (n=426). Overall satisfaction increased from PY14 by 8%. (See section *I.3.1 Program Component Experience*). • Downstream Equipment respondents' satisfaction was particularly driven by the rebate they received as well as increased energy savings. Online Marketplace respondents' satisfaction was driven by equipment quality and the amount of the instant discount received. Audit and Weatherization respondents' satisfaction was driven by increased energy savings and the application process. (See section *I.3.1 Program Component Experience*). • Smart thermostat recipients were more satisfied with their overall experience with the Online Marketplace than other shoppers. Eighty-six percent of thermostat recipients were satisfied compared to 82% of Online Marketplace participants overall (n=76). (Five respondents who viewed the Smart Thermostat Buyer's Guide said the guide was helpful, while four felt It was neither helpful nor unhelpful.) (See section *I.3.1 Program Component Experience*). • Refrigerator purchasers were more satisfied with their overall experience with the Downstream Equipment subcomponent than other participants. Ninety-five percent of refrigerator respondents were satisfied compared to 86% of Downstream Equipment participants overall (n=308). (See section *I.3.1 Program Component Experience*). • Audit and Weatherization overall satisfaction in PY15 (90%, n=42) increased by 6% from PY14 (84%, n=68). Downstream Equipment overall satisfaction in PY15 (86%, n=308) increased by 9% from PY14 (77%, n=145). Online Marketplace overall satisfaction in PY15 (82%, n=76) increased by 7% from PY14 (75%, n=87). (See section *I.3.1 Program Component Experience*).
SEEE	• Student satisfaction was similar to PY14 overall. Innovation students (high school) were more satisfied with the kits this year, which could be due to changes in kit measures: PPL Electric Utilities added general purpose LED bulbs and removed weatherization measures. (See section *J.3.1 Participant Satisfaction*). • The presentation portion was rated very highly across all cohorts, along with the component overall. (See section *J.3.1 Participant Satisfaction*).

7.6. Program Finances and Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 7-9. Cadmus calculated the TRC benefits using gross verified impacts. PY15 NPV costs and benefits are expressed in 2023 dollars. NPV costs and benefits for P4TD financials are expressed in 2021 dollars.

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

Row	Cost Category [1]	PYTD ($1,000)		P4TD ($1,000)	
1	**IMCs**	**$20,760**		**$50,380**	
2	Rebates to Participants and Trade Allies	$3,604		$10,106	
3	Upstream/Midstream Incentives	$2,339		$4,752	
4	Material Cost for Self-Install Program Components (EE&C Kits)	$642		$1,764	
5	Direct Installation Materials and Labor	$0		$0	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]	$14,175		$33,757	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management	$150	$399	$479	$1,470
9	Marketing	$0	$1,283	$0	$2,808
10	Program Delivery	$0	$3,419	$0	$8,449
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs (Sum of rows 7 through 12)**[6]	**$5,251**		**$13,207**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)**[5],[6],[7]	**$26,211**		**$65,103**	
15	Total NPV Lifetime Electric Energy Benefits	$12,629		$34,804	
16	Total NPV Lifetime Electric Capacity Benefits	$7,957		$21,914	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$0		$0	
18	Total NPV Lifetime Fossil Fuel Impacts	$12,746		$29,936	
19	Total NPV Lifetime Water Impacts	$4,226		$8,335	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$37,557**		**$94,989**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.43**		**1.46**	

[1] Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = $2021.
[2] P4TD benefits do not include carry-over energy savings from Phase III.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
[4] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.
[5] Portfolio-level costs are not assigned to specific programs.
[6] Sum of rows may not add up to total due to rounding.
[7] Row 14 (portfolio-level TRC costs) includes excess incentives from the Residential Efficient Lighting program component; $200,728 in PY15 and $1,516,214 in P4TD. Per Phase IV TRC Order, excess incentives are to be treated as a TRC cost, so the sum of rows 1 through 13 do not add up to row 14.

Table 7-10 presents program financials and cost-effectiveness on a net savings basis. A detailed description of NTGR research is provided in *Appendix G*, *Appendix H*, *Appendix I*, *Appendix J*, and *Appendix K*. As stated in the 2021 TRC Order, free rider incentives are not included as an additional program cost as these would have occurred even in the absence of the program.

Table 7-10. Summary of Residential Program Finances – Net Verified

Row	Cost Category[1]	PYTD ($1,000)		P4TD[2] ($1,000)	
1	**IMCs**	**$12,655**		**$30,449**	
2	Rebates to Participants and Trade Allies	$3,604		$10,106	
3	Upstream/Midstream Incentives	$2,339		$4,752	
4	Material Cost for Self-Install Program Components (EE&C Kits)	$642		$1,764	
5	Direct Installation Materials and Labor	$0		$0	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]	$6,070		$13,826	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management	$150	$399	$479	$1,470
9	Marketing	$0	$1,283	$0	$2,808
10	Program Delivery	$0	$3,419	$0	$8,449
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs (Sum of rows 7 through 12)**[6]	**$5,251**		**$13,207**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)**[5],[6],[7]	**$18,105**		**$45,220**	
15	Total NPV Lifetime Electric Energy Benefits	$8,096		$22,741	
16	Total NPV Lifetime Electric Capacity Benefits	$5,085		$14,537	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$0		$0	
18	Total NPV Lifetime Fossil Fuel Impacts	$8,427		$19,882	
19	Total NPV Lifetime Water Impacts	$4,183		$8,158	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$25,791**		**$65,318**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.42**		**1.44**	

[1] Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = $2021

[2] P4TD benefits does not include carry-over energy savings from Phase III

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

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

[5] Portfolio-level costs are not assigned to specific programs.

[6] Sum of rows may not add up to total due to rounding.

[7] Row 14 (portfolio-level TRC costs) includes excess incentives from the Residential Efficient Lighting program component; $198,746 in PY15 and $1,564,058 in P4TD. Per Phase IV TRC Order, excess incentives are to be treated as a TRC cost, so the sum of rows 1 through 13 do not add up to row 14.

7.7. Status of Recommendations

Overall, the Residential Program exceeded the PY15 planned energy savings and demand reductions by approximately 24% and 15%, respectively. Additionally, the Residential Program met its customer satisfaction target with 89% of participants reporting they were satisfied. The Student Energy Efficient Education component received a boost with a statistically significant improvement in kit satisfaction along with installation rates. Additionally, PPL Electric Utilities' new High Performance Home pilot successfully delivered high energy and demand savings and a positive experience for builders.

Table 7-11 provides recommendations, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: (Student Energy Efficient Education, SEEE) The program component is highly rated among teachers and students but there was a slight decrease in satisfaction with the presentations. Additionally, teachers suggested that video presentations reduced student engagement.	• Students and teachers alike rated the presentation highly, though PY15 saw a slight decrease (that was statistically significant) across all cohorts in students' satisfaction with this aspect of the program component. (See section *J.3.1 Participant Satisfaction*). • A subset of Take Action and Innovation teachers collectively expressed that the incorporation of videos reduces student engagement and distracts from the delivery of the content. The statistically significant decrease in presentation satisfaction among the Take Action students specifically further confirms this finding. (See section *J.3.1 Participant Satisfaction*). • Across all cohorts, there was a statistically significant increase in students' ratings of their satisfaction with the kits. This increase can be partly attributed to significantly higher kit satisfaction among Innovation students' ratings in PY15. (See section *J.3.1 Participant Satisfaction*).
Conclusion 2: (New Homes) Though the energy savings realization rate is 93%, Cadmus found some discrepancies that may be driven by the updated version of the modeling software developed to reflect the new PY15 baseline conditions. Specifically, the integrated REM/Rate –"PPL Savings Report" produced with REM/Rate v16.3.4 could be distorting savings.	• The ICSP used baseline parameters that aligned with the 2018 International Energy Conservation Code (IECC); however, these parameters did not always get updated in REM/Rate software to correctly calculate the integrated PPL Savings Report, which summarizes kWh/yr savings and feeds into PPL Electric Utilities' participant tracking database. Some of the discrepancies appeared when Cadmus reviewed the savings report outputs and may be due to inconsistencies within the algorithmic structure of the software, which cannot be observed directly. (See section *I.1.2 Gross Impact Results*). • Cadmus found that overall, homes modeled with the integrated "PPL Savings Report" in REM/Rate v16.3.4 overstated energy and demand savings. (See section *I.1.2 Gross Impact Results*).

Conclusion 3 (New Homes) PY15 program homes reflected more heat pump systems than PY14, affirming the program goal to encourage this technology. However, though Cadmus identified opportunities to change how heat pumps are recorded in the tracking data to improve evaluability. There is still room for growth in the adoption of heat pump water heater (HPWH) systems in program homes.

- All sampled homes in PY14 (n=25) used fuel-fired furnace heating systems. The PY15 sample (n=23) contained two homes that used ASHP, one dual-fuel ASHP (electric/propane) and one ground source heat pump. Meanwhile, no PY15 sampled homes had HPWH (except for one High Performance Home Pilot project), which was consistent with PY14. (See section *I.1.2 Gross Impact Results*).
- The tracking data only details the primary fuel type and does not distinguish between dual-fuel heat pumps from electric heat pumps. For instance, a home with a dual-fuel ASHP system will only have air-source heat pump and electric heating fuel recorded in the tracking data. (See section *I.1.2 Gross Impact Results*).

Conclusion 4: (High Performance Homes Pilot) Pilot homes showed higher energy and demand savings per home compared to new homes (particularly demand savings), though builders are skeptical that the market is ready for zero energy ready homes (ZERH) without more financial support. Builders were satisfied with this pilot, reporting it was influential in their decision to pursue a ZERH and in their technical learnings. One High Performance Home Pilot home with all-electric fuel achieved the highest savings compared to other pilot homes.

- High Performance Home Pilot homes (n=4) saved 147% kWh and approximately 1,800% kW on a per square foot basis compared to new homes (n=23), in part due to one very high-saving all-electric home. (See section *I.1.2 Gross Impact Results*).
- All builders rated their experience with this pilot as *very satisfied*. Additionally, builders reported a need for the pilot to provide technical assistance and incentives to cover the incremental costs of building to the specification. Most builders stated that while they are interested in pursuing more ZERH, it would depend on customers' willingness to pay and the availability of incentives in the future. (See section *I.1.2 Gross Impact Results*).
- Pilot staff also reported that the pilot went smoothly and that the technical guidance provided to Home Energy Raters was key. Staff said that for the pilot to become integrated as a long-term program offering in the future, cost-effectiveness of the current savings should be considered, and one pathway to increase energy savings-to-cost ratios is an all-electric home requirement, or at least an increased tier. (See section *I.1.2 Gross Impact Results*).

The impact and process evaluation activities in PY15 led to the following findings and recommendations from Cadmus to PPL Electric Utilities, along with a summary of how PPL Electric Utilities plans to address the recommendation in program delivery (Table 7-11).

Table 7-11. Status of Recommendations for the Residential Program

Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Student Energy Efficient Education	**Conclusion 1.** The program component is highly rated among teachers and students but there was a slight decrease in satisfaction with the presentations. Additionally, teachers suggested that video presentations reduced student engagement.	Consider reducing the use of videos in presentations to maintain student engagement.	**Implemented.** Use of videos has been reduced and more interaction challenges have been added.
Energy Efficient Homes – New Homes	**Conclusion 2.** Though the energy savings realization rate is 93%, Cadmus found some discrepancies that may be driven by the updated version of the modeling software developed to reflect the new PY15 baseline conditions. Specifically, the integrated REM/Rate –PPL Savings Report produced with REM/Rate v16.3.4 could be distorting savings. **Conclusion 3.** PY15 program homes reflected more heat pump systems than PY14, affirming the program goal to encourage this technology. However, though Cadmus identified opportunities to change how heat pumps are recorded in the tracking data to improve evaluability. There is still room for growth in the adoption of heat pump water heater (HPWH) systems in program homes.	Consider establishing savings thresholds for end-use components (such as heating, cooling, water heating, and lighting) to conduct a quality control review on the results of integrated savings reports. Create a user-defined reference home file to evaluate proper baselines regardless of software (REM/Rate) version updates.	**Being considered.**
Energy Efficient Homes – New Homes (High Performance Homes Pilot)	**Conclusion 4.** Pilot homes showed higher energy and demand savings per home compared to new homes (particularly demand savings), though builders are skeptical that the market is ready for zero energy ready homes (ZERH) without more financial support. Builders were satisfied with this pilot, reporting it was influential in their decision to pursue a ZERH and in their technical learnings. One High Performance Home Pilot home with all-electric fuel achieved the highest savings compared to other pilot homes.	Due to the success of the pilot and the market need for technical assistance with higher-performance homes, consider continuing the pilot. If it is not required that the high-performance tier be completely all-electric, consider a higher incentive tier for all-electric homes.	**Implemented with Condition.** PPL Electric Utilities will continue to offer higher incentives for High Performance Homes. The recommendation of offering an all-electric tier is being considered.

Appendix A. Site Inspection Summary

Table A-1 summarizes the program components and subcomponents that received verification site visits by Cadmus or the ICSP (listed in the Inspection Firm column), including the number of inspections and discrepancies and the resolution of the discrepancies.

Table A-1. PY15 Site Visit Summary

Program Component	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Custom	CLEAResult (the ICSP)	69	0	69	• Submitter's estimate of original savings was not accurate • Actual metered data used in place of estimates • Project not originally modeled accurately compared to installed condition • Project scope deviated from original submission
Custom	Warren Energy Engineering (on behalf of Cadmus)	13	0	0	• All site visits included projects in large stratum; therefore, site visits occurred during real-time evaluation and discrepancies were not expected. All equipment and quantities matched reported values
Efficient Equipment Downstream Lighting	Cadmus	0	1	1	• Small changes to wattages (rounded by implementer) and space conditioning
Efficient Equipment Downstream Lighting	CLEAResult (the ICSP)	66	0	22	• Wrong HOU given on Appendix C form versus customer feedback during on-site interviews • Wrong number of lights submitted on application • Wrong number of bulbs in the fixtures submitted on application • Incorrect wattage selected for baseline fixtures on application
Efficient Equipment Direct Discount Lighting	CLEAResult (the ICSP)	85	0	38	• Wrong number of lights submitted on application • Wrong number of bulbs in the fixtures submitted on application • Projects started before receiving pre-approval • Integrated fixtures not included on application • Projects over 120,000 kWh switched from prescriptive to customer-provided HOU
Midstream Lighting	CLEAResult (the ICSP)	47	0	5	• Wrong number of lights submitted on application • Lighting not yet installed • Lighting not yet installed

Program Component	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Efficient Equipment	CLEAResult (the ICSP)	11	0	6	• Project savings may have increased or decreased as a result of site visits, which resulted in the switch from prescriptive to customer-submitted HOU • Ineligible equipment removed from applications • Project scope deviated from original submission
Equipment (non-lighting)	DNV (on behalf of Cadmus)	0	2	1	• Ductless heat pump project—outdoor and indoor unit capacity included incorrect savings calculations per TRM; same project had slightly different installed models and AHRI efficiencies than reported
New Homes	PSD	79	0	66	• Appliances (30)—discrepancies most often due to misreported equipment efficiency ratings • Windows (24)—discrepancies most often due to misreported window area or the orientation of the windows • Ventilation (23)—discrepancies most often due to improperly set fan intervals or misreported ventilation type • Cooling Equipment (22)—discrepancies most often due to misreported efficiency ratings • Duct Leakage (14)—discrepancies most often due to misaligned duct leakage rates • Domestic Hot Water (13)—equipment discrepancies most often due to misreported efficiency ratings • Hatches (13)—discrepancies typically due to the size/dimensions of an attic hatch or the insulation affixed to the hatch
Energy Efficient Homes Air Sealing	CLEAResult	0	27	0	• No discrepancies found
Energy Efficient Homes Air Source Heat Pump	CLEAResult	7	104	0	• No discrepancies found
Energy Efficient Homes Attic Insulation (R0 to R49)	CLEAResult	1	51	1	• Discrepancies most often due to the projects not meeting program requirements (existing R-value over 30 or new R-value below 49)
Energy Efficient Homes Central AC	CLEAResult	7	38	1	• Discrepancy due to only coil and condenser installed, not a new furnace
Energy Efficient Homes Central Heat Fuel Switch	CLEAResult	0	3	0	• No discrepancies found
Energy Efficient Homes Ductless Heat Pump	CLEAResult	5	306	1	• Discrepancies most often because the energy efficiency ratio (EER)2 value was below the minimum of 11.7
Energy Efficient Homes Smart Thermostat	CLEAResult	0	7	2	• Discrepancies due to denials for thermostats installed in homes without electric-sourced heat or central air conditioning

Program Component	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Energy Efficient Homes Wall Insulation	CLEAResult	0	18	3	• Discrepancies because insulation not installed in a qualifying basement or crawlspace area of the home
Energy Efficient Homes Water Heater Fuel Switch	CLEAResult	0	11	3	• Discrepancies due to denials since the existing system already had a natural gas system or installation was in a newly constructed home

Appendix B. PY15 and P4TD Summary by Customer Segment and Low-Income Carveout

Table B-1 summarizes the Low-Income Program, initiatives, and customer segments that contributed to the low-income carveout in PY15 and P4TD.

Table B-1. Summary of Low-Income Carveout Energy Savings (MWh/Year)

Program	Customer Segment	PYVTD Gross (MWh/yr)	VTD Gross (MWh/yr)
Low-Income	Low-Income	13,640	35,568
	Small C&I	381	457
	GNE	40	59
Subtotal		**14,062**	**36,084**
Phase III Carryover		-	31,089
Total		**14,062**	**67,173**

Appendix C. Summary of Program-Level Impacts, Cost Effectiveness, and High-Impact Measure NTG

C.1. Program- and Initiative-Level Impacts Summary

Table C-1 summarizes the energy impacts by program and initiative through PY15.

Table C-1. Incremental Annual Energy Savings by Program and Initiative (MWh/Year)

Program/Initiative	PYRTD (MWh/yr)	PYVTD Gross (MWh/yr)[1]	PYVTD Net (MWh/yr)[1]	RTD (MWh/yr)	VTD Gross (MWh/yr)[2]	VTD Net (MWh/yr)[2, 3]
Non-Residential						
Custom	96,720	55,108	40,780	231,611	190,918	120,217
Efficient Equipment	88,366	81,131	52,733	275,776	285,561	190,454
Subtotal[4]	**185,086**	**136,239**	**93,512**	**507,387**	**476,478**	**310,671**
Low-Income						
Subtotal[4]	**12,773**	**14,062**	**14,062**	**35,439**	**67,173[5]**	**36,084**
Residential						
Appliance Recycling	9,250	8,565	4,283	25,729	25,035	13,506
Efficient Lighting	385	394	421	8,763	8,969	9,597
Energy Efficient Homes	45,755	30,070	18,722	88,369	73,390	43,042
Student Energy Efficient Education	5,650	5,337	5,337	16,788	15,286	15,286
Subtotal[4]	**61,040**	**44,366**	**28,763**	**139,649**	**122,680**	**81,430**
Portfolio Total[4]	**258,900**	**194,667**	**136,337**	**682,474**	**635,242[6]**	**428,185**
Carryover	-	-	-	-	306,275	-
Portfolio Total with Carryover[4]	**258,900**	**194,667**	**136,337**	**682,474**	**941,517**	**428,185**

[1] Does not include PY14 savings verified in PY15.
[2] Includes PY14 unverified savings, verified in PY15.
[3] VTD Net does not include carryover savings.
[4] Subtotals and totals may not match the sums of rows due to rounding and may not match figures or tables in other sections of the report due to rounding.
[5] Includes 31,089 MWh/yr of carryover attributed to the Low-Income Program.
[6] Excludes carryover attributed to the Low-Income Program.

Table C-2 summarizes peak demand impacts by energy efficiency program and initiative through the current reporting period.

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

Program/Initiative	PYRTD (MW/yr)	System-Level PYVTD Gross (MW/yr)[1]	System-Level PYVTD Net (MW/yr)[1]	RTD (MW/yr)	System-Level VTD Gross (MW/yr)[2]	System-Level VTD Net (MW/yr)[2]
Non-Residential						
Custom	20.65	11.13	8.24	43.48	35.98	23.00
Efficient Equipment	14.76	12.68	8.27	45.40	45.75	30.45
Subtotal[3]	**35.41**	**23.81**	**16.51**	**88.88**	**81.73**	**53.45**
Low-Income						
Subtotal[3]	**1.37**	**1.53**	**1.53**	**3.87**	**4.09**	**4.09**
Residential						
Appliance Recycling	2.20	2.28	1.14	5.88	6.27	3.38
Efficient Lighting	0.06	0.06	0.07	1.27	1.41	1.51
Energy Efficient Homes	3.68	3.60	2.32	8.94	8.29	5.10
Student Energy Efficient Education	0.60	0.57	0.57	1.60	1.55	1.55
Subtotal[3]	**6.53**	**6.51**	**4.10**	**17.69**	**17.52**	**11.54**
Portfolio Total[3]	**43.32**	**31.86**	**22.14**	**110.44**	**103.34**	**69.08**

[1] Does not include PY14 savings verified in PY15.
[2] Includes PY14 unverified savings, verified in PY15 and may not match figures or tables in other sections of the report due to rounding.
[3] Subtotals and totals may not match the sums of rows due to rounding.

C.2. Program-Level Cost-Effectiveness Summary

Table C-3 and Table C-4 show the TRC ratios by program and for the portfolio for PY15. Cadmus calculated the benefits using gross verified impacts. Costs and benefits are expressed in 2023 dollars.

Table C-3. PY15 Gross TRC Ratios by Program ($1,000)

Program/Initiatives	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Non-Residential				
Custom	$36,194	$28,676	1.26	$7,518
Efficient Equipment	$64,567	$58,514	1.10	$6,053
Non-Residential Subtotal[1]	**$100,761**	**$87,190**	**1.16**	**$13,571**
Residential				
Low-Income	$13,334	$7,971	1.67	$5,363
Appliance Recycling	$2,693	$2,097	1.28	$596
Efficient Lighting	$292	$271	1.08	$21
Energy Efficient Homes	$27,320	$22,615	1.21	$4,704
Student Energy Efficient Education	$7,252	$1,228	5.91	$6,024
Residential Subtotal[1],[2]	**$50,891**	**$34,182**	**1.49**	**$16,709**
Common Portfolio Costs	**n/a**	**$6,301**	**n/a**	**n/a**
Portfolio Total[1]	**$151,652**	**$127,674**	**1.19**	**$23,978**

Note: Costs and benefits are expressed as follows PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025
[1] Total may not match sum of rows due to rounding.
[2] Low-Income is shown as a subsector of residential in this table.

Table C-4. PY15 Net TRC Ratios by Program ($1,000)

Program/Initiatives	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Non-Residential				
Custom	$26,793	$21,733	1.23	$5,061
Efficient Equipment	$42,046	$39,699	1.06	$2,347
Non-Residential Subtotal[1]	**$68,839**	**$61,432**	**1.12**	**$7,408**
Residential				
Low-Income	$13,334	$7,971	1.67	$5,363
Appliance Recycling	$1,347	$2,097	0.64	-$750
Efficient Lighting	$313	$271	1.15	$41
Energy Efficient Homes	$16,880	$14,509	1.16	$2,371
Student Energy Efficient Education	$7,252	$1,228	5.91	$6,024
Residential Subtotal[1],[2]	**$39,125**	**$26,076**	**1.50**	**$13,050**
Common Portfolio Costs	**n/a**	**$6,301**	**n/a**	**n/a**
Portfolio Total[1]	**$107,965**	**$93,809**	**1.15**	**$14,156**

Note: Costs and benefits are expressed as follows PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025
[1] Total may not match sum of rows due to rounding.
[2] Low-Income is shown as a subsector of residential in this table.

Table C-5 and Table C-6 summarizes cost-effectiveness by program for Phase IV of Act 129. Cost and benefits are expressed in 2021 dollars.

Table C-5. Phase IV Gross TRC Ratios by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Non-Residential				
Custom	$119,724	$62,345	1.92	$57,379
Efficient Equipment	$198,056	$132,660	1.49	$65,396
Non-Residential Subtotal[1]	**$317,780**	**$195,005**	**1.63**	**$122,775**
Residential				
Low-Income	$27,177	$18,458	1.47	$8,719
Appliance Recycling	$7,237	$5,407	1.34	$1,830
Efficient Lighting	$5,886	$2,593	2.27	$3,293
Energy Efficient Homes	$63,277	$54,079	1.17	$9,198
Student Energy Efficient Education	$18,589	$3,024	6.15	$15,565
Residential Subtotal[1],[2]	**$122,165**	**$83,561**	**1.46**	**$38,604**
Common Portfolio Costs	**n/a**	**$17,305**	**n/a**	**n/a**
Portfolio Total[1]	**$439,946**	**$295,871**	**1.49**	**$144,075**

Note: Costs and benefits are expressed as follows PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025
[1] Total may not match sum of rows due to rounding.
[2] Low-Income is shown as a subsector of residential in this table.

Table C-6. Phase IV Net TRC Ratios by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Non-Residential				
Custom	$75,553	$42,938	1.76	$32,615
Efficient Equipment	$132,351	$92,440	1.43	$39,911
Non-Residential Subtotal[1]	**$207,905**	**$135,378**	**1.54**	**$72,526**
Residential				
Low-Income	$27,177	$18,458	1.47	$8,719
Appliance Recycling	$3,906	$5,407	0.72	-$1,501
Efficient Lighting	$5,605	$2,593	2.16	$3,012
Energy Efficient Homes	$37,218	$34,195	1.09	$3,022
Student Energy Efficient Education	$18,589	$3,024	6.15	$15,565
Residential Subtotal[1],[2]	**$92,494**	**$63,678**	**1.45**	**$28,817**
Common Portfolio Costs	**n/a**	**$17,305**	**n/a**	**n/a**
Portfolio Total[1]	**$300,399**	**$216,361**	**1.39**	**$84,038**

Note: Costs and benefits are expressed as follows PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025
[1] Total may not match sum of rows due to rounding.
[2] Low-Income is shown as a subsector of residential in this table.

C.3. High Impact Measure Net-to-Gross

Findings from NTG research are not used to adjust compliance savings in Pennsylvania. Instead, NTG research provides directional information for program planning purposes. Midstream lighting and midstream non-lighting projects were prescribed as high-impact measures for the PY15 evaluation. Cadmus determined there was not enough information to conduct a robust midstream non-lighting NTG analysis and Cadmus did not report a NTG ratio from PY15 primary research. The NTG research for midstream lighting high-impact measures represents 13% of the total Non-Residential Program verified gross energy savings in PY15.

Table C-7 presents NTG findings for high-impact measures studied in PY15.

Table C-7. PY15 High Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Efficient Equipment Midstream Lighting[(1)]	30%[(1),(2)]	0%	0.70
Total	**30%[(1),(2)]**	**0%**	0.70

[(1)] Weighted by the survey sample-verified program kWh/yr savings.
[(2)] Estimated from PY15 survey data.

C.4. Program-Level Comparison of Performance to Approved EE&C Plan

Table C-8 presents PY15 expenditures, by program, compared to the budget estimates set forth in the EE&C plan for PY15.[25] All the dollars are presented in 2023 dollars.

Table C-8. Comparison of PY15 Expenditures to Phase IV EE&C Plan ($1,000)

Program	PY15 Budget from EE&C Plan[(1)]	PY15 Actual Expenditures[(2)]	Ratio (Actual/Plan)
Non-Residential	$31,742	$30,062	95%
Low-Income	$8,781	$7,971	91%
Residential	$12,406	$12,864	104%
Total Direct Program Costs[(3)]	**$52,929**	**$50,897**	96%
Common Portfolio Costs[(4)]	$8,620	$6,301	73%
Portfolio Total[(3)]	**$61,549**	**$57,198**	93%

[(1)] Budgets are from Table 6 of PPL Electric Utilities EE&C plan.
[(2)] Expenditures may not match the sum of incentives and program costs listed in the individual program cost-effectiveness tables due to rounding.
[(3)] Total may not match sum of rows due to rounding.
[(4)] Common costs include costs for SWE audit.

[25] PPL Electric Utilities Corporation. Revised December 30, 2022. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

Table C-9 presents P4TD expenditures, by program, compared to the budget estimates set forth in the EE&C plan through PY15 (not the full phase). All the dollars are presented in 2023 dollars.

Table C-9. Comparison of P4TD Expenditures to Phase IV EE&C Plan ($1,000)

Program	Phase IV Budget from EE&C Plan through PY15[1]	PIVTD Actual Expenditures[2]	Ratio (Actual/Plan)
Non-Residential	$92,880	$69,786	75%
Low-Income	$25,224	$19,499	77%
Residential	$39,524	$32,517	82%
Total Direct Program Costs[3]	**$157,628**	**$121,803**	77%
Common Portfolio Costs[4]	$25,860	$18,150	70%
Portfolio Total[3]	**$183,488**	**$139,953**	76%

[1] Budgets are from Table 6 of PPL Electric Utilities EE&C plan.
[2] Expenditures may not match the sum of incentives and program costs listed in the individual program cost-effectiveness tables due to rounding.
[3] Total may not match sum of rows due to rounding. Total will not match infographics because infographics are showing expenditures compared to full Phase IV goal.
[4] Common costs include costs for SWE audit.

Table C-10 compares PY15 verified gross program savings compared to the energy savings projections set forth in the EE&C plan.

Table C-10. Comparison of PY15 Actual Program Savings to EE&C Plan Projections for PY15

Program	EE&C Plan Projections for PY15 (MWh/yr)[1]	PY15 VTD Gross MWh/yr Savings[2]	Ratio (Actual/Plan)
Non-Residential[3]	214,307	136,239	64%
Low-Income[3]	14,617	14,062	96%
Residential[3]	35,754	44,366	124%
Total[3][4]	**264,678**	**194,667**	**74%**

[1] Projections from Table 4 of PPL Electric Utilities EE&C plan.
[2] Does not include PY14 unverified savings, verified in PY15.
[3] May not match totals in infographics due to rounding.
[4] Total may not match sum of rows due to rounding.

Table C-11 compares Phase IV actual programs savings to the EE&C projections through Phase IV to-date.

Table C-11. Comparison of Phase IV Actual Program Savings to EE&C Plan Projections for Phase IV To-Date

Program	EE&C Plan Through PY15[1]	VTD Gross MWh/yr Savings	Carryover MWh/yr	Total VTD Gross MWh/yr Savings	Ratio (Actual/Plan)
Non-Residential[2]	714,691	476,478	-	476,478	67%
Low-Income[2]	39,749	36,084	31,089	67,173	169%
Residential[2]	111,131	122,680	-	122,680	110%
Total[2][3]	**865,571**	**635,242**	**306,275[4]**	**941,517[5]**	**109%**

[1] Projections are from Table 4 of PPL Electric Utilities EE&C plan.
[2] May not match totals in infographics due to rounding.
[3] Total may not match sum of rows due to rounding. Total will not match infographics because infographics are showing savings compared to full Phase IV goal.
[4] Sum of Carryover column will not match total row because only 31,089 MWh/yr is attributed to a specific program. The remaining 275,186 MWh/yr is attributed to the portfolio.
[5] Sum of Total VTD Gross Savings column will not match total row because it includes portfolio-level carryover savings.

PPL Electric Utilities

CADMUS

EFFICIENT EQUIPMENT

This component of the Non-Residential Program promotes the purchase and installation of high-efficiency equipment and lighting through four delivery channels by offering financial incentives to offset purchase costs and by providing information on efficiency features and benefits.

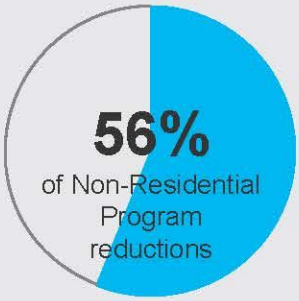
VERIFIED ENERGY SAVINGS

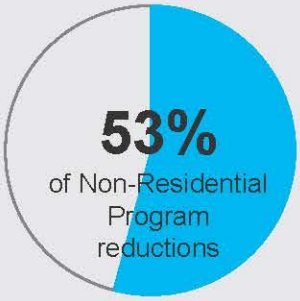
Phase IV has saved **285,561 MWh/yr**

PY15 saved **81,131 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **45.75 MW/yr**





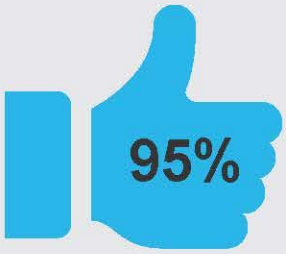
PY15 has reductions of **12.68 MW/yr**

PY15 PARTICIPATION

A total of **4,756** participants

- **4,609** Lighting
- **62** HVAC
- **30** Refrigeration
- **21** Motors
- **19** Agriculture
- **9** Other
- **6** Food Service

PARTICIPANT SATISFACTION



Satisfied with overall program component

98% Midstream participant satisfaction

93% Downstream participant satisfaction

Appendix D. Evaluation Detail – Efficient Equipment Component

PPL Electric Utilities' Non-Residential Efficient Equipment component promotes the purchase and installation of a wide range of high-efficiency equipment, including lighting, HVAC, refrigeration, motors/drives, commercial kitchen, agricultural, equipment controls, and new construction projects.

The component offers incentives for lighting and equipment (non-lighting) through four delivery channels:

- **Downstream Rebates.** Customers, contractors, or trade allies submit applications for review and validation by the Non-Residential ICSP. The ICSP reviews and validates all submitted applications, processes eligible projects, and pays incentives upon project completion and final savings calculations.
- **Direct Discount.** This delivery channel is supported by a network of qualified contractors and higher incentives. The ICSP helps the contractor orchestrate the project from beginning to end on behalf of the customer. After the contractor completes and updates the application, the Non-Residential ICSP completes the verification, and then reimburses the contractor with a check for the incentive.
- **Direct Install.** The Non-Residential ICSP targets hard-to-reach small C&I customers and provides a no-cost assessment to identify energy efficiency improvements and provide free LED bulbs and pre-rinse spray valves where needed.[26] After the assessment, the Non-Residential ICSP sends the customer an assessment report with additional recommendations to support the customer's overall energy efficiency and peak demand needs and goals, along with recommendations for qualified trade allies with whom they can work.
- **Midstream**. This delivery channel helps customers choose and procure certain high-efficiency products more quickly and easily than through typical downstream methods. Trade allies and customers may purchase high-efficiency products directly from participating and qualified midstream distributors and receive an immediate rebate at the point of purchase.

Cadmus uses "downstream" to collectively refer to projects in the downstream, direct discount, and direct install delivery channels of the Efficient Equipment component.

D.1. Gross Impact Evaluation

D.1.1. Gross Impact Methodology and Sampling Approach

Cadmus verified savings for the Efficient Equipment component from a sample of 32 PY15 downstream lighting projects, 23 PY15 midstream lighting projects, 22 PY15 downstream non-lighting projects, and 21 midstream non-lighting projects using a PY14/PY15 combined two-year sample. Cadmus verified PY14 unverified midstream non-lighting projects in PY15.

[26] Product installations are limited to up to two pre-rinse sprayers, 50 A19 bulbs, and 24 PAR30 bulbs.

Sampling Details

Due to the timing of the evaluation, Cadmus used records from Q1, Q2, and Q3 to create samples. Cadmus reviewed the records in Q4 and determined that the sampled projects for lighting and non-lighting already had a sufficient mix of projects to represent the population.

Downstream, Direct Discount, Direct Install, and Midstream Non-Lighting

The PA TRM has established kilowatt-hour savings thresholds at the end-use category level to determine whether customer-specific information is required for estimating *ex ante* or *ex post* savings. Cadmus evaluated non-lighting projects below the PA TRM threshold with a basic level of rigor according to the Phase IV Evaluation Framework.[27] The Efficient Equipment component did not report non-lighting projects above the defined threshold in the PA TRM in PY15.

Table D-1 summarizes the impact evaluation sampling strategy. Cadmus adjusted the planned sample sizes during the evaluation period to meet precision targets. Cadmus verified energy savings for the overall Efficient Equipment non-lighting subcomponent at 85% confidence with ±13.4% precision.

Table D-1. PY15 Efficient Equipment Non-Lighting Downstream and Midstream Subcomponent Gross Impact Evaluation Sample Design

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Non-Lighting				
Downstream	85/15; Cv of 0.50	~20	22	Desk review with optional phone interview and/or virtual site visit
Midstream PY14/PY15	85/15; Cv of 0.50	~20	21	Desk review with optional phone interview and/or virtual site visit

Downstream, Direct Discount, Direct Install, and Midstream Lighting

Lighting projects fell into three strata based on reported savings:

- More than 750 MWh per year (the lighting threshold in the PA TRM)
- 120 to 750 MWh per year
- Less than 120 MWh per year

Cadmus selected a random sample of projects from Q1, Q2, and Q3 in PY15 for all downstream and midstream lighting strata, evaluating lighting projects below the PA TRM threshold with a basic level of rigor and lighting projects at or above the threshold with an enhanced level of rigor.

[27] Pennsylvania Public Utility Commission. July 16, 2021. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc.

Table D-2 summarizes the impact evaluation sampling strategy. The gross impact evaluation activities resulted in verified energy savings estimates for the Efficient Equipment lighting subcomponent at 90% confidence with ±4.30% precision.

Table D-2. PY15 Efficient Equipment Lighting Subcomponent Gross Impact Evaluation Sample Design

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Lighting				
Downstream threshold (>750 MWh/yr)[1]	90/10	Up to 20	5	Enhanced Rigor
Downstream (120-750 MWh/yr)[1]		Up to 13	12	Basic Rigor
Downstream (<120 MWh/yr)[1]		Up to 12	15	Basic Rigor
Midstream[2]		Up to 23	23	Basic Rigor

[1] Assuming a Cv of 0.35 based on historical findings from Phase III.
[2] Assuming a Cv of 0.50.

Cadmus calculated annual sample sizes for the Efficient Equipment component to meet the Phase IV Evaluation Framework evaluation requirements of 85% confidence and ±15% precision. However, the sampling plan for the lighting subcomponent was designed to meet 90% confidence and ±10% precision (90/10) because lighting is a high-impact measure contributing 46% of reported energy savings and 40% of reported demand reductions to the Non-Residential Program.

Ex Post Verified Savings Methodology

Downstream, Direct Discount, and Direct Install Non-Lighting

Cadmus conducted desk reviews and virtual site visits on a sample of projects to verify installed equipment, operating conditions, and equipment details from project documentation, including invoices, specification sheets, and implementer calculation workbooks. Cadmus used these findings to calculate energy savings and demand reductions.

Midstream Non-Lighting

Cadmus conducted desk reviews on a sample of projects to confirm quantities, equipment eligibility, and operating conditions from project documentation, including invoices and specification sheets. Cadmus used these findings to calculate energy savings and demand reductions.

Downstream, Direct Discount, and Direct Install Lighting

Verified savings calculations incorporated quantity and eligibility confirmation and adjustments to *ex ante* assumptions of lighting equipment specifications and operating conditions for the sample of projects selected for desk reviews and virtual site visits. Cadmus reviewed all relevant project documentation, including invoices, specification sheets, lighting plans, and implementer's files for the PA TRM's Appendix C Lighting Audit and Design Tool for Commercial and Industrial Projects to evaluate

savings.[28] For threshold projects, Cadmus conducted a lighting logger data analysis to verify hours of use and coincidence factors. For a subset of projects in the lighting sample, Cadmus conducted phone interviews to confirm reported parameters and virtual site visits to verify reported energy and demand savings inputs and visually verify lighting installation and specifications.

Midstream Lighting

Verified savings calculations incorporated quantity and eligibility confirmation and adjustments to *ex ante* assumptions of lighting equipment specifications and operating conditions for the sample of projects selected for desk reviews and phone interviews. Cadmus reviewed customer invoices and the technical specifications of the reported installed equipment and verified these using the Design Lighting Consortium or ENERGY STAR Qualified Products Lists. Cadmus also confirmed the correct application of the baseline and efficient lighting pairing using the midstream lighting protocol in the PA TRM and verified the hours of use for the building type based on interview responses.

The interviewee was either the customer or the contractor who purchased and installed the rebated equipment for the customer. During the interview, Cadmus confirmed that the contact was familiar with the purchase and the installed location, verified the quantity of the reported lighting purchase, building type, hours of use, and space conditioning system with the data in PPL Electric Utilities' tracking database, and gathered information regarding the *in situ* baseline fixtures and lamps.

D.1.2. Gross Impact Results

Cadmus calculated realization rates for non-lighting and lighting strata by dividing total evaluated savings by total reported savings for the sampled projects. Gross verified savings was the sum of the reported savings of each project multiplied by the evaluated realization rate for the appropriate stratum.

Table D-3 shows the verified gross energy savings and demand reductions for the Efficient Equipment component.

Table D-3. Efficient Equipment Component Savings

Savings	PY13 Verified	PY14 Verified[(1)]	PY15 Verified	Phase IV Verified[(2)]
MWh/yr	89,330	115,100	81,131	285,561
System-Level MW/yr	14.28	18.78	12.68	45.75

[(1)]Includes PY14 savings from the midstream non-lighting strata verified in PY15 (695 MWh/yr and 0.28 MW/yr.)
[(2)]Phase IV verified savings may not match sum of program years due to rounding.

[28] The PA TRM Appendix C Lighting Audit & Design Tool documents the pre- and post-installation cases of the lighting retrofit to facilitate the calculation of energy and demand reductions for large lighting installations.

In PY15, the Efficient Equipment component reported energy savings of 88,366 MWh per year (Table D-4) and demand reductions of 14.76 MW per year (Table D-5).

Table D-4. PY15 Efficient Equipment Component Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Non-Lighting Subcomponent					
Downstream HVAC	606	102%	1.06	98.4%	615
Downstream HVAC - Certainty	148	100%	0.00	0.0%	148
Downstream Motors	292	100%	0.00	0.0%	292
Downstream Motors - Certainty	221	100%	0.00	0.0%	221
Downstream Other[2]	131	100%	0.00	0.0%	131
Downstream Other - Certainty	185	100%	0.00	0.0%	185
Downstream Refrigeration	415	100%	0.00	0.0%	415
Downstream Refrigeration - Certainty	167	100%	0.00	0.0%	167
Midstream Agriculture Equipment	539	98%	0.02	1.2%	529
Midstream Food Service Equipment	86	70%	0.05	12.5%	60
Non-Lighting Total[3], [4]	**2,790**	**99%**	**0.72**	**13.4%**	**2,762**
Lighting Subcomponent					
Downstream Threshold (>750 MWh/yr)	16,371	98%	0.08	4.6%	15,962
Downstream (120-750 MWh/yr)	32,555	95%	0.14	5.9%	31,018
Downstream (< 120 MWh/yr)	15,448	87%	0.36	13.9%	13,499
Midstream Lighting	21,202	84%	0.12	3.6%	17,890
Lighting Total[3], [4]	**85,576**	**92%**	**0.16**	**3.4%**	**78,369**
Component Total[3], [4]	**88,366**	**92%**	**0.20**	**3.3%**	**81,131**
Midstream Non-Lighting (PY14 verified in PY15)[3], [4]	709	98%	0.04	1.2%	695

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] The Other stratum includes measures such as high-efficiency battery charges, dishwashers, and ice machines.
[3] Savings may not match other tables or figures due to rounding.
[4] Totals may not sum due to rounding.

Table D-5. PY15 Efficient Equipment Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)[2]	System Level PYVTD (MW/yr)
Non-Lighting Subcomponent						
Downstream HVAC	0.11	107%	0.48	44.2%	0.12	0.13
Downstream HVAC - Certainty	0.09	100%	0.00	0.0%	0.09	0.09
Downstream Motors	0.04	100%	0.00	0.0%	0.04	0.04
Downstream Motors - Certainty	0.03	100%	0.00	0.0%	0.03	0.03
Downstream Other[3]	0.002	100%	0.00	0.0%	0.002	0.002
Downstream Other - Certainty	0.003	100%	0.00	0.0%	0.003	0.003
Downstream Refrigeration	0.05	100%	0.00	0.0%	0.05	0.06
Downstream Refrigeration – Certainty	0.02	100%	0.00	0.0%	0.02	0.02
Midstream Agriculture Equipment	0.19	98%	0.03	1.4%	0.19	0.20
Midstream Food Service Equipment	0.01	70%	0.05	12.7%	0.01	0.01
Non-Lighting Total[4], [5]	**0.54**	**100%**	**0.33**	**5.2%**	0.54	0.59
Lighting Subcomponent						
Downstream Threshold (>750 MWh/yr)	2.30	98%	0.08	4.8%	2.25	2.39
Downstream (120-750 MWh/yr)	4.53	92%	0.18	7.7%	4.16	4.47
Downstream (< 120 MWh/yr)	2.33	87%	0.34	13.3%	2.02	2.19
Midstream Lighting	5.06	56%	0.14	4.3%	2.83	3.04
Lighting Total[4], [5]	**14.21**	**79%**	**0.16**	**3.8%**	**11.26**	**12.09**
Component Total[4], [5]	**14.76**	**80%**	**0.20**	**3.5%**	**11.80**	**12.68**
Midstream Non-Lighting (PY14 verified in PY15) [4], [5]	0.26	98%	0.04	1.4%	0.26	0.28

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates are applied to verified demand reductions before application of distribution losses.

[2] PYVTD in this column represents meter-level savings before the application of line losses.

[3] The Other stratum includes measures such as high-efficiency battery chargers, dishwashers, and ice machines.

[4] Savings may not match other tables or figures due to rounding.

[5] Total may not sum due to rounding.

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

- **Downstream non-lighting**. For this subcomponent, Cadmus made the most significant adjustments to reported savings for HVAC projects. This included adjusting the installed model and efficiency of two sampled HVAC projects based on desk review and virtual verification findings. Cadmus also corrected the calculation methodology for one sampled project, which claimed savings for both the indoor and outdoor unit capacity of a ductless split heat pump instead of using only indoor capacity per the PA TRM.
- **Midstream non-lighting**. For this subcomponent, Cadmus made the most significant adjustments to reported savings for Food Service projects. This included adjusting the installed idle steam and convection energy rates used in the calculations for a sampled combination oven project from kilowatts to watts per the PA TRM interim measure protocol methodology. An adjustment was also made to a sampled dishwasher project that included booster savings after identifying the project was installed without a booster during a desk review.
- **Downstream and midstream lighting.** For this subcomponent, Cadmus most frequently adjusted the fixture wattages and hours of use in the reported energy savings and demand reductions estimates. Many of the fixture wattage updates included small changes based on rounding and the DesignLights Consortium listings. For threshold projects, Cadmus adjusted hours of use based on findings from the logger data analysis. For non-threshold downstream projects, Cadmus adjusted hours of use and coincidence factors after establishing facility type through the desk review or a site contact interview for projects as needed. For midstream lighting projects, the most common adjustments aside from hours of use and coincidence factors were fixture control and space condition types.

Site Visit and Desk Review Findings

Downstream, Direct Discount, and Direct Install Non-Lighting

For the gross impact evaluation of the non-lighting downstream subcomponent, 22 equipment projects were included in the evaluation sample. For these projects, Cadmus completed 22 desk reviews and two virtual site visits with phone interviews to verify the as-built conditions for each project and identify discrepancies in the project files. Verified savings incorporated site-specific data.

The primary adjustments to reported savings included corrections to the following:

- HVAC installed model and efficiency
- Ductless heat pump calculation methodology

Adjustments to HVAC installed efficiency had the greatest impact on verified energy savings.

Midstream Non-Lighting

For the gross impact evaluation of the non-lighting midstream subcomponent, 21 equipment projects were included in the PY14/PY15 combined evaluation sample. For these projects, Cadmus completed 21

desk reviews. Cadmus verified the as-built conditions for each project and identified discrepancies in the data reported by the ICSP in the project files. Verified savings incorporated site-specific data.

The primary adjustments made to savings included correcting the combination oven idle steam and convection energy rates and dishwasher booster input.

Downstream Lighting

Cadmus conducted virtual site visits and desk reviews for 32 downstream lighting projects in the impact evaluation sample to verify as-built conditions for each project and identify any discrepancies in inputs and savings. For the five threshold lighting projects in the impact evaluation sample, Cadmus analyzed logger data and calculated hours of use and coincidence factors. Cadmus used the results of the desk reviews and virtual site visits to determine the verified savings for each of the sampled projects.

Cadmus selected projects for virtual site visits based on project size, facility type, and available documentation. To verify downstream lighting savings, Cadmus conducted one virtual site visit, and 31 desk reviews. For one project with approximately 20 or more records in the PA TRM Appendix C, Cadmus selected and inspected a sample using 90% confidence with ±20% precision according to the Phase IV Evaluation Framework.[29]

Verified savings incorporated site- and equipment-specific data. Cadmus made adjustments to the following:

- Annual lighting hours of use calculated from metered logger data
- Fixture type and quantity
- Lighting control type
- Space cooling type
- Heating fuel type
- Fixture wattage
- Facility type

Cadmus most frequently adjusted reported lighting fixture or lamp wattage (15 of the 32 sampled projects), using DLC or ENERGY STAR data for evaluated savings. This was followed by lighting controls (six out of 32 sampled projects), where some fixtures reported as having controls had no documentation to support the claim. Cadmus most frequently adjusted reported savings based on PA TRM-deemed exterior lighting hours with photocell control. Desk reviews verified that exterior lighting for three projects did not include photocell control, which uses lower TRM-deemed hours. Cadmus also adjusted metered hours of use for four projects. In these cases, the reported hours of use were entered using a custom schedule, rather than directly referencing the results of the metered data.

Midstream Lighting

In PY15, Cadmus conducted desk reviews and phone interviews to verify savings for the sample of 23 midstream lighting projects in PPL Electric Utilities' tracking database. Cadmus adjusted calculation

[29] Sampling to meet 90% confidence with ±20% precision within a facility is based on section 3.3.3.2.3 in the evaluation framework prepared for the PA PUC. Pennsylvania Public Utility Commission. July 16, 2021. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc.

inputs to reported savings that differed from verified conditions As summarized in Table D-6. Since a project could have multiple adjustments, the total number of adjustments is greater than the sample size.

Table D-6. PY15 Efficient Equipment Midstream Lighting Subcomponent Verified Savings Adjustments Summary

Savings Adjustment Type	Number of Adjusted Projects	Percentage of Adjusted Projects[(1)]	Primary Reason for Adjustment
Facility Type	23	100%	Interview responses, specification sheets, or invoices indicated differing values.
Fixture Control Type	22	96%	
Hours of Use	20[(2)]	87%	
Coincidence Factor	20[(2)]	87%	
Energy Interactive Factor	20	87%	
Demand Interactive Factor	20	87%	
Post-Install Lamp/Fixture Wattage	5	22%	
Post-Install Lamp/Fixture Quantity	1	4%	
Pre-Install Lamp/Fixture Quantity	1	4%	

[(1)] Cadmus calculated the percentage of adjusted projects based on 23 verified sample projects.
[(2)] Hours of use and coincidence factor do not have as many adjustments as facility type because some reported projects had an incorrect facility type, but the reported hours of use and coincidence values were still correct.

D.2. Net Impact Evaluation

Net Impact Methodology

Cadmus applied the methods in the PA PUC's Evaluation Framework to determine net savings for downstream, upstream, and midstream delivery channels,[30] which discusses the standard methods for determining free ridership and spillover. Cadmus did not conduct new primary research to assess net savings for downstream lighting or non-lighting in PY15 and used a historic NTG ratio.

Midstream lighting. For this subcomponent, Cadmus conducted self-report interviews administered by phone to assess free ridership and spillover. Cadmus attempted to reach 84% of midstream lighting end-user participants to achieve the targeted number of interviews and attempted to recruit a census of all PY15 lighting distributors and lighting contractors.

Midstream non-lighting. Cadmus also attempted to recruit a census of all PY15 non-lighting participant end-users and distributors for the midstream non-lighting subcomponent. Cadmus completed interviews with three midstream agriculture equipment distributors that solely sold high-volume low-speed fans through the program and four end-user participants who purchased three low-speed fans,

[30] PA PUC. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

one ventilation fan, and one vacuum pump variable-speed drive controller.[31] Due to a combination of low equipment sales, small participant populations, and small analysis sample sizes in the midstream non-lighting stratum, Cadmus determined there was not enough information to conduct a robust midstream non-lighting NTG analysis and did not report an NTG ratio from PY15 primary research. Instead, Cadmus applied the recommended NTG ratios from a recent New Jersey TRM's *NTG Recommendations Guidance Document* to midstream non-lighting measures.[32] [33]

Midstream food service equipment. While Cadmus completed an interview with one of the two distributors for this subcomponent, it did not yield usable responses to the NTG questions to inform the NTG analysis. Cadmus completed one interview with an end-user participant who purchased a commercial dishwasher (out of a population of four end-user food service equipment participants).

Cadmus calculated net savings to inform future planning of the Efficient Equipment component. Energy savings and demand reduction compliance targets are met using verified gross savings.

Table D-7 lists the sampling strategy used to determine net savings for the midstream lighting strata.

Table D-7. PY15 Efficient Equipment Component Net Impact Evaluation Sample Design by Stratum

Stratum	Stratum Boundaries	Population Size[(1)]	Assumed Cv or Proportion in Sample Design	Assumed Confidence & Precision	Target Sample Size	Number of Records in Sample Frame[(2)]	Achieved Sample Size	% Sample Frame Contacted to Achieve Sample[(2)]
Midstream Lighting	Distributors	25	0.5	85/15	All eligible	25	9	100%
	End-users	2,008			23	592	22[(3)]	84%
	Purchasers/ contractors	1,373			23	319	18	100%
Midstream Lighting Total		3,406	-	-	46	936	49	-

[(1)] Population refers to the number of projects in PY15 at the time of the participant survey.
[(2)] The sample frame is the full list of contacts from which Cadmus selected the sample. Percent contacted means the percentage of the sample frame contacted to complete surveys. Cadmus attempted to reach a census by telephone.
[(3)] 22 end-users answered the NTG questions.

[31] In PY15 there were 17 unique midstream agriculture equipment end-user participants that purchased a total of 41 high volume low speed fans, six high efficiency ventilation fans and one vacuum pump VSD controller.

[32] New Jersey Board of Public Utilities. *New Jersey 2023 Triennial Technical Reference Manual for 2024 Filings.* May 23, 2023. https://njcepfiles.s3.amazonaws.com/QO23030150-+Tri2+EE1+%2B+EE2-+Order+Attch+C-+TRM.pdf

[33] Midstream non-lighting measures represent 0.7% of the PY15 Efficient Equipment component total verified kWh/yr savings.

Free Ridership – Midstream Lighting

Midstream lighting end users are the businesses that installed lighting and ultimately benefited from the program discount. Cadmus determined that end users were the most appropriate program actors to answer the survey questions to estimate free ridership (see *Self-Report Survey* section in *Appendix K. Net Savings Impact Evaluation*). End-user purchasers are the decision-makers at participant businesses who determine when to make upgrades and how much to invest in lighting equipment.

In PY15, free ridership for the midstream lighting subcomponent was 30%, based on end-user purchaser survey findings. Five of the 22 end-user projects accounted for 72% of the verified gross energy savings in the analysis sample and 23 percentage points of the overall 30% free ridership score.

Cadmus summed the intention and influence free ridership components to estimate the average free ridership by stratum, weighted by verified gross kWh per year savings. Table D-8 summarizes the intention, influence, and free ridership scores for the midstream lighting stratum.

Table D-8. Efficient Equipment Component Intention, Influence, and Free Ridership Score by Stratum

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Midstream Lighting	22	26%	4%	30%

Participant distributor and contractor interviews indicated that the midstream lighting subcomponent has influenced the stocking, promotion, and recommendation of component-eligible lighting equipment. Cadmus used this qualitative information to attribute the end-user influence ratings of distributor and contractor influence on their purchasing decisions as midstream lighting subcomponent factors in the influence free ridership component scoring.

Cadmus assessed free ridership for the PY15 midstream lighting subcomponent using the same NTG methodology used in the PY11 midstream lighting subcomponent free ridership analysis, which estimated free ridership at 38% free ridership from 24 end-user participant respondents.

Spillover – Midstream Lighting

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 from end-user participants and reviewed the data qualitatively for spillover activity. There were no definitive spillover activities reported by end-users.

Net-to-Gross – Midstream Non-Lighting

Cadmus applied NTG ratios from a recent New Jersey TRM NTG *Recommendations Guidance Document* for midstream non-lighting stratum measures.[34] Table D-9 shows the NTG ratios and the source of the NTG ratios applied to PY15 midstream non-lighting equipment measures, along with the overall PY15

[34] New Jersey Board of Public Utilities. *New Jersey 2023 Triennial Technical Reference Manual for 2024 Filings.* May 23, 2023. https://njcepfiles.s3.amazonaws.com/QO23030150-+Tri2+EE1+%2B+EE2-+Order+Attch+C-+TRM.pdf

midstream non-lighting stratum NTG ratio that is based on weighting the stratum subcomponent NTG ratios with PY15 gross verified kWh/yr savings.

Table D-9. Efficient Equipment Component NTG Ratios Applied to PY15 Midstream Non-Lighting Stratum Measures

Stratum Subcomponent	PYVTD kWh/yr	Free Ridership (%)	NTG Ratio	NTG Ratio Source
Midstream Agriculture	528,543	5%	0.95	NJ TRM (Agriculture)
Midstream Food Service	59,616	19%	0.81	NJ TRM (Kitchen Equipment)
Overall	**588,159**	**6%**	**0.94**	

D.2.1. Net-to-Gross Results

Table D-10 shows the NTG ratio results for the strata of the Efficient Equipment component.

Table D-10. PY15 Efficient Equipment Component NTG Ratio Summary by Stratum

Stratum	PYVTD kWh/yr	Evaluation Years	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Downstream, Direct Discount, Direct Install Lighting	60,478,938	PY14	35%[1]	0%	0.65	10%[2]
Downstream, Direct Discount, Direct Install Non-Lighting	2,173,858	PY14	84%[1]	0%	0.16	84%[3]
Midstream Lighting	17,890,153	PY15	30%	0%	0.70	10%[3]
Midstream Non-Lighting	588,159	Benchmarking	6%	0%	0.94	-
Component Total [4] [5]	**81,131,107**	**-**	**35%**	**0%**	**0.65**	**-**

[1] Weighted by the verified kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the component have a greater influence on the stratum-level free ridership estimate than do the respondents who achieved lower energy savings.
[2] At 90% confidence interval.
[3] At 85% confidence interval.
[4] Stratum-level free ridership, spillover, and NTG estimates were weighted by the stratum's verified kWh/yr component population savings to arrive at the Efficient Equipment component NTG ratio of 0.65.
[5] Totals may not sum due to rounding.

The Phase IV Evaluation Framework requires identifying and oversampling high-impact equipment and services to assess free ridership with greater certainty. In the Efficient Equipment component, Cadmus determined that midstream lighting projects contributed more than 5% of the overall PY15 savings to the nonresidential sector and classified commercial lighting as a high-impact product. Cadmus used responses to the NTG questions in the self-report survey from 22 midstream lighting end-user participants to calculate net savings. At 90% confidence, Cadmus calculated an NTG ratio of 0.70 with a relative precision of ±11% and at 85% confidence with a relative precision of ±10%.

D.3. Process Evaluation

In PY13, Cadmus completed a full process evaluation for the lighting and non-lighting downstream, direct discount, and direct install delivery channels. As such, Cadmus did not conduct a process evaluation in PY15 but did conduct a participant survey. Adding a participant survey for the

downstream, direct discount, and direct install delivery channels is a change to the approved evaluation plan. Cadmus also conducted interviews to inform the midstream process evaluation per the approved evaluation plan.

Downstream, Direct Discount, and Direct Install Participant Survey

Cadmus attempted to contact a census of participants between July and August 2024, completing 45 surveys of the 339 participants in the sample frame. Of the 45 respondents, 41 participated in the efficient lighting subcomponent and four in the non-lighting subcomponent. Cadmus made several attempts to reach participants through an initial email invitation, two email reminders, and several telephone calls.

Sample sizes noted in this report may vary by survey question because respondents could skip questions they chose not to answer; therefore, not all respondents provided answers to every question. Cadmus included all survey respondents who answered at least one question, even if they did not complete the survey.

See *Appendix L. Survey Bias* for details about Cadmus' approach to reducing survey bias and contact instructions.

Midstream Interviews

Cadmus conducted interviews with midstream lighting and non-lighting market actors to evaluate the performance of these subcomponents. Interviews were designed to assess NTG, participant satisfaction, what worked well, and what could be improved, as well as solicit recommendations for modifications and improvements.

The midstream evaluation activities were consistent with the planned activities for PY15, though the targeted number of interviews was not reached for all strata.

Cadmus attempted to contact a census of distributors, end users, and lighting contractors between May and July 2024, completing 57 interviews. An additional three respondents offered feedback but did not complete the interview. Lighting end-user purchasers were the only group where Cadmus did not have to contact every participant to meet the targeted number of completes. For other groups, Cadmus attempted a census. Cadmus conducted all interviews by telephone and reached out to distributors by email. Cadmus attempted to call all lighting contractors at least twice but did not meet the target for lighting contractors due to a low response rate (which was in part due to the fact that many of the contacts on the contractor list were end-user purchasers).

As with the survey, sample sizes noted in this report may vary by question because respondents could skip questions they chose not to answer; therefore, not all respondents provided answers to every question. Cadmus included all respondents who answered at least one question, even if they did not complete the interview.

See *Appendix L. Survey Bias* for details about Cadmus' approach to reducing survey bias and contact instructions.

Table D-11 lists the process evaluation sampling strategy.

Table D-11. Efficient Equipment Component Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records Selected for Sample Frame	Percent of Sample Frame Contacted to Achieve Sample[1]
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	2	N/A	Up to 3	2[2]	2	100%
Midstream Non-Lighting	Participating distributors	Telephone in-depth interviews	11[3]	N/A	All eligible	5[4]	11[5]	100%
	Participating end-users/purchasers	Telephone in-depth interviews	23[3]	N/A	Up to 20	5[4]	13[5]	100%
Midstream Lighting	Participating distributors	Telephone in-depth interviews	25[3]	N/A	All eligible	9	25[5]	100%
	Participating purchasers/ contractors	Telephone in-depth interviews	1,373[3]	N/A	23	18	319[5]	100%
	Participating end-users	Telephone in-depth interviews	2,008[3]	N/A	23	23	592[5]	84%
Downstream, direct install, direct discount	Participants	Online survey/Phone survey	680[3]	N/A	All eligible	45	339[5]	100%
Total			**4,122[3]**	-	-	**107**	**1,301[5]**	**91%**

[1] Percent contacted means the percentage of the sample frame contacted to complete surveys and interviews.

[2] Two interviewees on one call.

[3] Population size includes the number of unique records available at the time of the survey or interview.

[4] For Midstream Non-Lighting, Cadmus interviewed four agriculture and one food service distributors and four agriculture and one food service end-user purchasers.

[5] The sample frame is a list of participants 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 at the time of the surveys and interviews. 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 survey, did not have valid contact information (email or telephone number), participated in an impact interview, was a residential customer, was on PPL Electric Utilities' "do not call" list, or opted out of the online survey.

D.3.1. Downstream, Direct Install, and Direct Discount

Program Component Experience

The survey asked participants a series of questions to identify how satisfied they were with the program, the factors that impacted their satisfaction, and any improvements that would increase their satisfaction.

Program Component Satisfaction and Customer Effort

The Efficient Equipment component achieved high satisfaction in PY15, with 93% of respondents *very* or *somewhat satisfied* with the component (42 of 45 respondents). Additionally, 4% of the respondents were *neither satisfied nor dissatisfied* (two respondents), and 2% were *not at all satisfied* (one respondent).

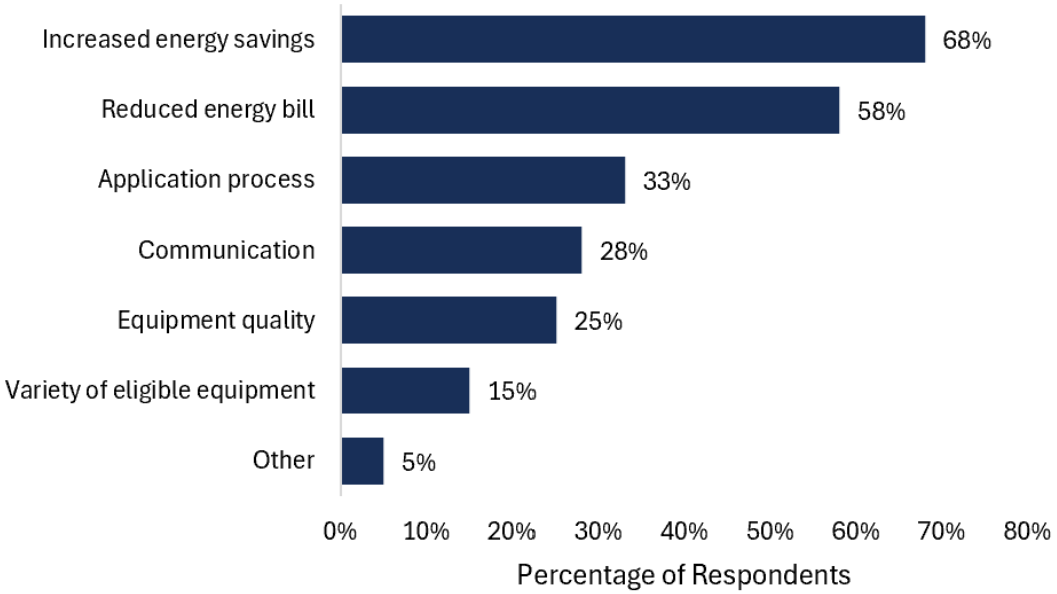
Most customers reported that participating was either *very easy* or *easy* (84%; n=43). One person who said it was difficult said a better application process would improve the program but did not provide additional detail.

Drivers of Program Component Satisfaction

Downstream, Direct Discount, and Direct Install

To better understand what drives satisfaction, the survey asked participants what factor(s) most affected their satisfaction rating. Figure D-1 details the factors that most affected the overall experience rating reported by respondents who rated their satisfaction as *very* or *somewhat satisfied*. The most common drivers of high satisfaction were increased energy savings (68%; n=40) and reduced energy bill (58%). The one dissatisfied respondent said their low satisfaction was driven by contractor performance.

Figure D-1. Efficient Equipment Component Drivers of Satisfaction



Source: Survey question, "What factor(s) most affected the overall experience rating you gave?"
(Multiple responses allowed; satisfied respondents only; n=40)

Opinion of PPL Electric Utilities and Likelihood to Recommend

Of the 42 respondents who answered this question, 48% said their opinion of PPL Electric Utilities had either *improved significantly* or *improved somewhat* after participating in the Efficient Equipment component, while 52% said their opinion had not changed.

Areas for Improvement

Downstream, Direct Discount, and Direct Install

Lastly, the survey asked respondents to specify changes that PPL Electric Utilities or the ICSP could implement to improve the Efficient Equipment component. Sixteen survey respondents provided improvements. Their suggestions fell into four primary topic areas:

- **Improve the process overall or specifically with the application process**
  - "Application process had some hiccups. [The] savings calculator didn't load properly and caused some delay. I had to find all the data originally entered and repeat. Budget process on my side delayed things a bit which didn't help."
  - "Application process seemed complicated. Was done mostly by electrical contractor and PPL [Electric Utilities] representative."
  - "The spreadsheet provided and the application process for lighting were very difficult to understand. It required a job aid, and a meeting with our rep."
  - "Make it more user friendly for people not in the construction/engineering fields."
  - "Make the process simpler and quicker."
  - "Simplify the process with rebate approval."
  - "Make the application better."
- **Communication**
  - "Give us more notification when the funds are about to run out for future projects."
  - "For the PPL [Electric Utilities] rep to contact provider directly for information on install of new equipment/appliances, etc."
  - "Better communication with [the implementer]."
  - "Improve the website"
- **Contractor engagement and performance**
  - "To make sure the contractor finishes the job the right way."
  - "Encourage contractors to participate. **** in Lehigh Valley was excellent but our contractor of many years was disinterested in participating."
- **Other**
  - "Have a clear pathway for new construction and one for renovations."
  - "Provide after install inspection report to facility owner."

- "It would be nice to be able to get an estimate on cost savings on our own (not via a third party contractor)."

Participant Survey Attrition

Table D-12 lists the total number of records contacted for the survey via online and telephone attempts and the outcome (final disposition) of each record. Additional details on Cadmus' survey methodology are in *Appendix L.*

Table D-12. Efficient Equipment Downstream Participant Sample Attrition

Description of Outcomes of Online and Telephone Participant Survey	Number of Records
Population (number of unique jobs)	**680**
Removed: inactive customer, residential sector, completed survey in past three months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list, or did not have accurate contact information	341
Survey Sample Frame	**339**
Not reached, refused, opted out, left message, email returned (bounce back), did not respond	294
Ineligible	0
Completed Surveys	**45**
Overall Response Rate	**13%**

D.3.2. Midstream Lighting

The interview respondents were asked a series of questions to identify how satisfied they were with the program, along with those factors that impacted the program participants' satisfaction levels and any improvements that would increase their satisfaction. Cadmus interviewed distributors, purchasing contractors, and end users.

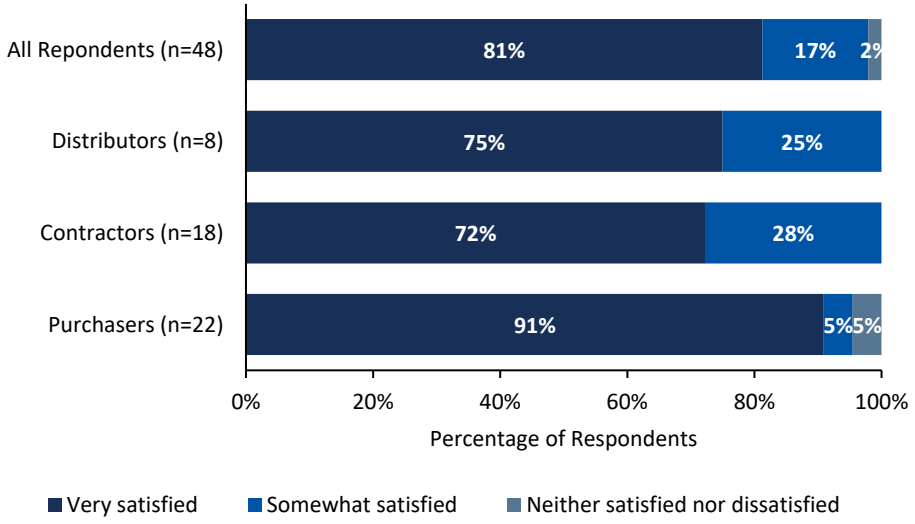
Program Updates

PPL Electric Utilities decreased midstream lighting incentives at the beginning of PY15 (June 2023) but restored the higher PY14 incentives for linear fixtures in kits, high bay, and exterior fixtures in April 2024. This was done to increase participation for those products, which had declined with the lower incentives. There were also incremental updates to the list of qualified lighting equipment.

Program Component Satisfaction and Customer Effort

Satisfaction with midstream lighting was high, with most respondents reporting they were *very satisfied* (81%) with the program overall. In PY15, one end-user purchaser gave a neutral *neither satisfied nor dissatisfied* rating (2%), while all the remaining purchasers and all contractors and distributors were *somewhat satisfied* or *very satisfied* (98%). Figure D-2 compares overall satisfaction ratings from purchasers, distributors, and contractors.

Figure D-2. PY15 Distributor, Contractor, and End-User Overall Satisfaction



Source: Distributor (G5), Contractor (D1), and End-User (D1) interview question: "Thinking about your overall experience with PPL Electric Utilities' Midstream Distributor Instant Discount Program, how would you rate your satisfaction? Would you say you are…?" Not all respondents answered this question.

Cadmus interviewers also asked end-user purchasers to rate their satisfaction with the energy savings of the lighting products they purchased: 84% (n=19) were *very satisfied,* while the remainder were *somewhat satisfied,* and none gave ratings lower than that. Almost all the contractor purchasers reported that their customers were satisfied with energy savings from their new lighting, though one volunteered that reducing maintenance costs was more important to their customers than energy savings.

Areas Working Well

Interview respondents discussed program aspects that worked well in the program.

Awareness. All but one end-user purchaser was informed about the midstream instant discount for their lighting project (95%, n=20): three learned about the instant discount from PPL Electric Utilities (two from the website and one from a representative), while the remainder learned about it from their distributor or supplier. Seventeen of 18 contractor purchasers (94%) were also aware that an instant discount was applied to their project when they made the purchase.

Motivation. Every end-user purchaser mentioned cost savings as a motivation for installing efficient lighting, either through a lower purchase price, energy savings, or both. Many also mentioned the longevity of LEDs, their lower maintenance costs, and the improved quality of light in their workplace.

Contractor promotion. Fifteen of 18 contractors (83%) *always* recommended high-efficiency LEDs to their customers, while two did so *often* and one only *sometimes* (their reason for not recommending efficient lighting more often was "too busy").

Distributor promotion. Most distributor respondents *always* (75%, n=8) told their customers shopping for lighting about the midstream instant discounts, while the rest did so *often* (25%). Eight of the nine distributors said they made use of marketing materials provided to them by the program implementer, while one distributor said they created their own materials instead.

Influence of discount. Nine of 17 contractors (53%) rated the influence of instant discounts on recommending high-efficiency lighting as *extremely influential* (highest possible rating), and none rated the influence of the instant discount lower than a 3 on a 5-point scale. Fourteen out of 17 contractors said that the program discounts for lighting products are sufficient to encourage customers to purchase program-eligible lighting, while three said the incentives were not high enough. Five of seven distributors also said that current incentives were sufficient to encourage the purchase of eligible efficient lighting, while two suggested that incentives on some types of lamps should be higher.

Program impact. Most distributors agreed that without the midstream lighting incentives, sales of program-qualified products would have been lower and that the availability of the instant discount has driven their stocking practices toward DLC and ENERGY STAR 5.1-compliant lighting. One distributor said this effect was more pronounced in the past: "[the program affected our stocking practices] more so in the past than currently; five or six years ago there were more lighting choices than there are now. We can't find any non-LEDs anymore. Now we're down to the SKU as the difference between [qualifying] items."

Areas for Improvement

Cadmus asked respondents if they had any suggestions to improve the midstream lighting component, or specific items to add to the qualified equipment list. Several respondents provided suggestions:

- **Distributors**
  - Two distributors stated they would like to see higher incentives.
  - Two distributors stated they would like the program to restore instant discounts for lamps that are no longer included in the program.
  - A distributor would like more communication from PPL Electric Utilities.
  - A distributor stated they would like a target list of commercial lighting change-out opportunities.
  - When asked if there were any additional materials of information the program could provide, distributors suggested: co-branding program materials from PPL Electric Utilities with the distributor companies, providing updated flyers and brochures, and "a way to find commercial customers in older buildings who haven't upgraded to LEDs yet."
  - New measures suggested for instant discounts: embedded-control fixtures, "more agriculture support for dairy farms."
- **End-User Purchasers**
  - An end-user purchaser suggested increasing incentives.

- An end-user purchaser stated they would like additional information on energy-saving projects and available incentives.
- End-user purchasers suggested several new measures for instant discounts: wall pack fixtures, 8-foot fixtures, screw-in lamps for outdoor poles, control systems, motors, and variable-frequency drives.

- **Contractor Purchasers**
  - A contractor suggested that incentives stay consistent from year to year, perhaps as a percentage of the price to aid their decision-making.
  - A contractor suggested increased advertising and promotion for Instant Discounts.

Other Findings

Cadmus asked contractor purchasers how often they work on non-lighting projects: 67% purchased and installed non-lighting equipment *always* or *often*, 11% did *sometimes* or *rarely*, and 22% of respondents *never* purchased and installed non-lighting equipment (i.e., they work on lighting projects exclusively).

Interview Attrition

Table D-13 lists the total number of records contacted via the telephone interviews and the outcome (final disposition) of each record.

Table D-13. Efficient Equipment Midstream Lighting Participant Interviews Sample Attrition

Description of Outcomes of Participant Interview (telephone)	Number of Records		
	Distributors	Purchasers/ Contractors	End Users
Population (Number of Unique Records)	**25**	**1,373**	**2,008**
Removed: inactive customer, completed survey or interview in past three months, on "opt out" list, selected for a different survey or interview, duplicate contact, on "do not contact" list, incomplete or invalid phone number	0	1,054	1,416
Interview Sample Frame (Records Attempted)	**25**	**319**	**592**
Not reached or non-working: No answer, answering machine, phone busy, refused or opted out, email returned (bounce back), did not respond	16	301	477
Removed: not contacted because interview target was reached	0	0	92
Completed Interviews	**9**	**18**	**23**
Overall Response Rate	**36%**	**6%**	**5%**

D.3.3. Midstream Agriculture Equipment

Cadmus interviewers asked participants a series of questions to identify how satisfied they were with the program, along with those factors that impacted the program participants' satisfaction levels and any improvements that would increase their satisfaction. Cadmus interviewed four distributors and four end-user purchasers; Cadmus' PY14 interviews with agriculture distributors indicated that installation contractors were not involved in the purchase process, so there were no contractors to interview.

Program Updates

PPL Electric Utilities launched midstream agriculture incentives in PY14, and incentive levels remained unchanged in PY15. Nine distributors participated in PY15, all of whom joined the program in PY14, though not all submitted projects for midstream discounts during PY15.

Program Component Satisfaction and Customer Effort

End-user purchasers reported high satisfaction with midstream agriculture offerings, with all four end-user respondents reporting that they were *very satisfied* with their experience with the midstream Instant Discount subcomponent.

Three of four end users interviewed stated they were *very satisfied* with the energy savings from the agricultural equipment they purchased through midstream lighting, while the fourth was *somewhat satisfied* and none were dissatisfied.

Areas Working Well

Three distributors rated the amount of effort required for, and satisfaction with, the process of joining the midstream subcomponent for agriculture equipment. All three reported that enrollment required only *a small amount* or *moderate amount* of effort, and all three were *very satisfied* or *somewhat satisfied* with the enrollment experience. Two distributor respondents reported that all the equipment they sell is eligible for a midstream instant discount, another estimated 75% of their sales were eligible, and the fourth did not provide an estimate. All agreed that the instant discounts helped drive sales of efficient equipment and thought the incentives were beneficial to their customers.

End-user purchasers appreciated the ease of participating in the program, and three of the four respondents mentioned the purchase price as a driver of their high satisfaction with the program. One end user who purchased two high volume low speed fans said, “We discussed it amongst ourselves previously, but then we heard we were able to save money [through the program] so we got the equipment. We are saving a lot of electricity with these fans.” Two of the end users learned about the instant discount verbally from distributors, one received a brochure from their distributor, and one saw it mentioned in an advertisement from their distributor. All four end users reported that they were required to provide their PPL Electric Utilities account number to receive the instant discount, but none said that this had any influence on their decision or impact on their experience.

Areas for Improvement

Lastly, respondents were asked to specify changes that PPL Electric Utilities or CLEAResult could implement to improve the midstream subcomponent. All four distributors interviewed expressed disappointment that PPL Electric Utilities customers with residential accounts could not receive an instant discount, and all mentioned that this severely limited the number of incentives for which they had applied. One distributor said, “We were told the rebate would go to the farmer, and because many farmers live on residential properties, they don’t qualify. We only did two or three [incentive applications] because so few of our customers could qualify. It was disappointing.” Another estimated that 90% of their efficient fan sales did not qualify due to the Non-Residential account requirement. All distributor respondents reported that the program had little influence on their overall sales or stocking

practices due to these limitations, as well as the fact that most of their customers are outside of PPL Electric Utilities territory: one estimated that only 35% of their sales are PPL Electric Utilities customers, and two distributors estimated that it was only 10%.

End-user purchasers offered two suggestions for improving the midstream subcomponent: one suggested allowing residential PPL Electric Utilities accounts to receive the instant discount, and another suggested the option to receive cash back instead of a reduced purchase price. When Cadmus asked end users if there were any efficient products they would recommend for inclusion in the midstream subcomponent, one suggested milking equipment with variable speeds and equipment for cooling milk.

Interview Attrition

Table D-14 lists the total number of records contacted for telephone interviews and the outcome (final disposition) of each record.

Table D-14. Efficient Equipment Midstream Agriculture Participant Interview Sample Attrition

Description of Outcomes of Participant Interviews (telephone)	Number of Records	
	Distributors	End Users
Population (Number of Unique Records)	**9**	**17**
Removed: incomplete or invalid phone number, duplicate contact info	0	8
Interview Sample Frame (Records Attempted)	**9**	**9**
Not reached or non-working: No answer, answering machine, phone busy, refused or opted out, email returned (bounce back), did not respond	5	5
Completed Interviews	**4**	**4**
Overall Response Rate	**44%**	**44%**

D.3.4. Midstream Food Service Equipment

Cadmus interviewers asked participants a series of questions to identify how satisfied they were with the program, along with those factors that impacted the program participants' satisfaction levels and any improvements that would increase their satisfaction. Cadmus interviewed one distributor and one end-user purchaser; Cadmus' PY14 interviews with food service distributors indicated that installation contractors were not involved in the purchase process, so there were no contractors to interview.

Program Updates

PPL Electric Utilities launched midstream food service incentives in PY14 and decreased the incentive amounts at the beginning of PY15. The same two distributors were participating in PY14 and PY15.

End-user Purchaser Feedback

Cadmus was only able to interview one food service equipment end-user purchaser of the four who participated in PY15. This respondent recalled learning about the midstream discount through an email, which they believed was from PPL Electric Utilities. The respondent was *not too satisfied* with the midstream subcomponent overall but *very satisfied* with the energy savings from the new commercial dishwasher. The respondent explained the reason for their dissatisfaction with the program: "I was the

first person to participate in the program. It was not with a supplier they typically worked with. Nobody knew how to do the program. After it was established, it was fine, but a bit odd at first having to deal with multiple parties to participate." This end user also explained that they had mostly worked directly with PPL Electric Utilities on the incentive application, rather than the distributor. They offered two suggestions for improving the program: clearer instructions on receiving the discount and reducing the paperwork required to apply.

Distributor Feedback

Cadmus completed an interview with one of the two food service equipment distributors participating in PY15. This distributor had also been interviewed in PY14, and in PY15 they simply stated that their opinions of the program were unchanged. See the PY14 evaluation report for details on these findings.[35]

Interview Attrition

Table D-15 lists the total number of records contacted via telephone and the outcome (final disposition) of each record.

Table D-15. Efficient Equipment Midstream Food Service Participant Interview Sample Attrition

Description of Outcomes of Participant Interview (online and telephone)	Number of Records	
	Distributors	End Users
Population (Number of Unique Records)	**2**	**6**
Removed: incomplete or invalid phone number, duplicate contact info	0	2
Interview Sample Frame (Records Attempted)	**2**	**4**
Not reached or non-working: No answer, answering machine, phone busy, refused or opted out, email returned (bounce back), did not respond	1	3
Completed Interviews	**1**	**1**
Overall Response Rate	**50%**	**25%**

[35] PPL Electric Utilities. September 30, 2023. *Phase IV of Act 129 Program Year 14 Annual Report (June 1, 2021–May 31, 2022).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

PPL Electric Utilities

CADMUS

CUSTOM

This component of the Non-Residential Program offers financial incentives to customers who install equipment that is not offered elsewhere in PPL Electric Utilities' Non-Residential Program.

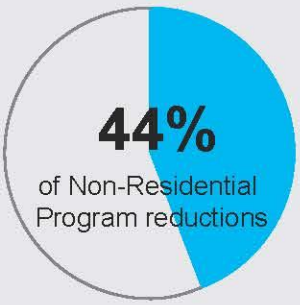
VERIFIED ENERGY SAVINGS

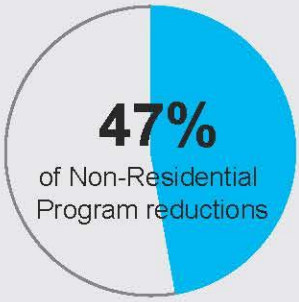
Phase IV has saved **190,918 MWh/yr**

PY15 saved **55,108 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **35.98 MW/yr**





PY15 has reductions of **11.13 MW/yr**

PY15 PARTICIPATION

A total of **235** participants

- **166** Photovoltaic
- **19** Compressed air
- **19** HVAC
- **11** Refrigeration
- **8** Process
- **6** Agriculture
- **6** Motors

PARTICIPANT SATISFACTION

Satisfied with overall program component

Appendix E. Evaluation Detail – Custom Component

Through the Custom component, PPL Electric Utilities offers incentives to support the completion of complex and comprehensive projects that involve improvements not covered by the Efficient Equipment component. These improvements include operational process improvements, retro-commissioning, equipment optimization, CHP, solar, advanced lighting controls, compressed air, and other custom improvements.

PPL Electric Utilities' Custom component is offered through a downstream delivery channel. The nonresidential ICSP, CLEAResult, works with customers and trade allies to identify and qualify custom projects. Customers or trade allies submit applications for review. The ICSP processes eligible projects and pays incentives upon project completion and final savings review.

A PY15 participant is defined as a project that was commercially operable between June 1, 2023, and May 31, 2024, and subsequently received an incentive payment.[36] Cadmus counted projects for which customers submitted an application during this period that did not receive an incentive or projects that were commissioned during this period that did not receive an incentive as participants in PY15. An individual customer may have multiple participating projects. In PY15, there were 235 projects representing 232 unique customers, which is a sizeable increase from the 134 projects reported in PY14.

E.1. Gross Impact Evaluation

E.1.1. Gross Impact Methodology and Sampling Approach

Cadmus evaluated all large stratum and CHP stratum projects, verifying savings at a high level of rigor and using approaches described in the International Performance Measurement and Verification Protocol (IPMVP). As indicated in the approved evaluation plan, Cadmus will verify savings for small stratum projects in PY16. A discussion of the approach by stratum follows.

[36] As defined by the Phase IV Evaluation Framework, savings claimed by an electric distribution company (EDC) are determined by the date the equipment is "installed and energized." Equipment that is installed and not commissioned or is not operating as intended is not considered commercially operable.

For the Custom component, Cadmus defined projects in three strata:

- **Large stratum.** Projects with an expected energy savings greater than 2 million kWh/yr. In PY15, Cadmus verified savings for 13 large stratum projects.[37,38] Cadmus included solar PV projects in the large stratum if their expected energy savings exceeded 1 million kWh/yr.[39]
- **CHP stratum.** Cadmus assigned all CHP projects to this stratum. In PY15, no CHP projects reported savings. Hence, Cadmus did not verify savings for any CHP projects.
- **Small stratum.** Cadmus did not verify the 222 projects assigned to the small stratum verified in PY15. They will be included in the small stratum sample and evaluated in PY16.

Table E-1 summarizes the impact evaluation sampling strategy.

Table E-1. PY15 Custom Component Gross Impact Evaluation Sample Design

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Large	Census	13	13(1)	Visual verification of measure and site-specific conditions; M&V including metering (in most cases); analysis of emergency management system or SCADA data; installation of metering equipment (in some cases) to clarify measure operating hours, power consumption, and other items; regression analysis against weather and other independent variables (as applicable); reporting of final results.
CHP	Census	0	0	

(1) Cadmus evaluated six projects (six non-solar large stratum, zero CHP stratum) with expected savings over two million kWh/yr in PY15. Seven solar projects with expected savings above 1 million kWh/yr were also evaluated in PY15. Savings for small stratum projects will be verified in PY16.

To calculate *ex post* savings with verified savings, Cadmus applied the sample-derived realization rate for each stratum to the respective population savings and then summed *ex post* and *ex ante* kWh savings across strata to calculate component-level realization rates and savings. Cadmus reported peak demand reductions (kW/yr) with the same approach.

Unverified savings do not factor into realization rates or into *ex ante* or *ex post* totals.

E.1.2. Gross Impact Results

Table E-2 shows the Custom component's verified gross energy savings and demand reductions.

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37 A total of 15 measures were verified in PY15, but these were reported across 13 projects. Two projects accounted for two measures each in PPL Electric Utilities participant database.

38 Five projects (all large stratum) had savings over 2 million kWh/yr. The other large stratum non-solar project had verified savings of approximately 0.5 million kWh/yr but was included in the large stratum because this project was originally pre-approved along with another project at the same site with an expected combined savings exceeding 2 million kWh/yr.

39 Seven Solar PV projects were in the large stratum. All seven had expected savings above 1 million kWh/yr, though the verified savings for one of them was slightly under 1 million kWh/yr.

Table E-2. Custom Component Savings

Savings	PY13 Verified	PY14 Verified	PY15 Verified	PY15 Unverified	Phase IV Verified [1],[2]
MWh/yr	40,503	95,307	55,108	41,612	190,918
System-Level MW/yr	6.98	17.87	11.13	10.08[3]	35.98

[1] Phase IV verified savings may not match sum of program years due to rounding.
[2] Phase IV verified does not include PY15 unverified savings.
[3] This does not include the application of line losses.

Cadmus only evaluated projects from large strata for the Custom component in PY15. In PY15, PPL Electric Utilities reported 96,720 MWh/yr gross energy savings (Table E-3) and 20.65 MW/yr in demand reductions (Table E-4).

Table E-3. PY15 Custom Component Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate[1]	Sample Cv or Error Ratio[2]	Relative Precision at 85% C.L.[2]	PYVTD (MWh/yr)
Large	55,108	100%	-	-	55,108
CHP	-	-	-	-	N/A
Subtotal[3]	**55,108**	**100%**	-	-	**55,108**
Unverified (Small)	41,612	-	-	-	-
Component Total[3]	**96,720**	**-**	**-**	**-**	**51,108**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] All large strata projects in PY15 were verified. Sampling was not conducted, so Cv and precision are not applicable.
[3] Total may not match the sum of rows due to rounding.

Table E-4. Custom Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio[2]	Relative Precision at 85% C.L.[2]	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Large	10.57	100%	-	-	10.57	11.13
CHP	-	-	-	-	-	-
Subtotal[3]	**10.57**	**100%**	-	-	**10.57**	**11.13**
Unverified (Small)	10.08	-	-	-	-	-
Component Total[3]	**20.65**	**-**	**-**	**-**	**10.57**	**11.13**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Cadmus applied realization rates to verified demand reductions before applying distribution losses.
[2] All large strata projects in PY15 were verified. Sampling was not conducted, so Cv and precision are not applicable.
[3] Total may not match the sum of rows due to rounding.

E.2. Net Impact Evaluation

E.2.1. Net Impact Methodology

The methods used to determine net savings for downstream, upstream, and midstream delivery channels are provided in the Evaluation Framework,[40] which discusses the common methods used to determine free ridership and spillover.

Cadmus did not conduct new primary research to assess net savings for Custom component in PY15 and used a historic NTG ratio from PY14 evaluation results. Cadmus calculated net savings to inform future planning of the Custom component. Energy savings and demand reduction compliance targets are met using verified gross savings.

E.2.2. Net-to-Gross Results

Table E-5 shows the free ridership, spillover, and NTG ratio for the Custom component.

Table E-5. PY15 Custom Component NTG Ratio Summary

Stratum	PYVTD kWh/yr	Evaluation Years	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Large	55,107,793	PY14	26%	0%	0.74	3%(1)

(1) At 90% confidence interval.

E.3. Process Evaluation

The approved evaluation plan did not include a participant survey, but PPL Electric Utilities added one to the PY15 evaluation. Table E-6 lists the process evaluation sampling strategy.

The participant survey asked questions about satisfaction and program ease. From July 17 through August 5, 2024, Cadmus made several attempts to reach participants through an initial email invitation, followed by two email reminders and several telephone calls. Five participants responded to the survey. See *Appendix M* for details about Cadmus' approach to reducing survey bias and contact instructions.

[40] PA PUC. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

Table E-6. PY15 Custom Component Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records in Sample Frame	Percent of Sample Frame Contacted to Achieve Sample[1]
Custom	Participants	Online survey	235[2]	N/A	Census	5[3]	19[4]	100%
Component Total			**235**	**-**	**-**	**5**	**19**	**100%**

[1] Percent contacted means the percentage of the sample frame contacted to complete surveys and interviews.
[2] Population size includes number of unique records available at the time of the survey field period.
[3] The achieved sample includes four manufacturing companies and one grocery store.
[4] The sample frame includes 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 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, had been selected for another program component survey, was a residential customer, did not have valid contact information (email or telephone number), was on the do not call list, or opted out of the online survey.

E.3.1. Component Experience

The survey asked respondents a series of questions to identify how satisfied they were with the program component and the factors that impacted their satisfaction levels.

The program component was delivered effectively in PY15, maintaining high levels of customer satisfaction. All of the respondents who responded to the survey were *very satisfied* with the program (n=5). Respondents gave reasons for their high satisfaction levels, with the top responses including communication with PPL Electric Utilities (three responses), application process (two responses), and reduced energy bill (two responses). Other responses included equipment quality, contractor performance, and increased energy savings (one response each).

Four of five respondents said participating in the program was *very easy* or *easy* while one said it was *neither easy nor difficult* (n=5). Two respondents offered suggestions for improvement:

- "They could make it easier. There are still a lot of hoops to jump through. The video meeting and the help were great." (Manufacturing/industrial respondents)
- "Increase in [the] amount and variation of refrigeration rebates." (Grocery store respondent)

Opinion of PPL Electric Utilities

Two of five survey respondents reported having a better opinion of PPL Electric Utilities after participating in the Custom component, and three said their opinions had not changed.

E.3.2. Survey Sample Attrition

Table E-7 lists the total number of records contacted for the survey via online and telephone attempts and the outcome (final disposition) of each record. Of 19 records in the sample frame, five participants

responded to the survey, for a 26% response rate. See *Appendix M* for additional details on survey methodology.

Table E-7. Custom Component Sample Attrition

Description of Outcomes of Online and Telephone Participant Survey	Number of Records
Population (number of unique jobs)	**235**
Removed: inactive customer, residential sector, completed survey in past three months, on "opt out" list, selected for a different survey, duplicate contact, on “do not contact” list, or did not have accurate contact information	216
Survey Sample Frame	**19**
Not reached, refused, opted out, left message, email returned (bounce back), did not respond	14
Ineligible	0
Completed Surveys	**5**
Overall Response Rate	**26%**

Appendix F. Evaluation Detail – Low-Income Program

F.1. Gross Impact Evaluation

Cadmus conducted the following activities to evaluate Low-Income Program participants:

- **Database Review.** Cadmus evaluated the census of projects in the welcome kit stratum for all welcome kit data using a combination of the PA TRM inputs and data from PPL Electric Utilities' tracking database. We also used algorithms and inputs from sections 2.3.7 and 2.3.8 of the 2021 TRM.

F.1.1. Job Type

PPL Electric Utilities provided four types of service (also known as job types) at no cost to the income-qualified customer: baseload, low-cost, full-cost, and welcome kits. The program offers baseload services to customers without electric heat and without an electric water heater, low-cost services to customers without electric heat but with electrically heated water, and full-cost services to customers with both electric heat and electrically heated water. The welcome kit is sent to any eligible customer who has not received a kit or participated in the Winter Relief Assistance Program within the past three years.

F.1.2. Gross Impact Methodology

In PY15, Cadmus coordinated with PPL Electric Utilities and the ICSP to collect the required data to verify energy savings and demand reductions for the Low-Income Program. The ICSP provided an extract of its tracking database of participant records, and Cadmus analyzed the census of projects for welcome kit installations but did not select a sample for PY15.

F.1.3. Gross Impact Results

Welcome Kit Findings

Findings from Cadmus' census evaluation are shown in Table F-1. These findings are the reasons for the differences between reported and verified savings.

Table F-1. PY15 Low-Income Desk Review Findings

Product	Finding	Number of Jobs	Effect on Savings
Welcome Kit Bathroom Aerators	"Unknown" home type TRM default values were used in place of "Single Family" values.[(1)]	7,201	Decrease
Welcome Kit Kitchen Aerators	"Unknown" home type TRM default values were used in place of "Single Family" values.	7,201	Decrease
Welcome Kit Showerheads	"Unknown" home type TRM default values were used in place of "Single Family" values.	7,201	Decrease
Welcome Kits	Seventy-two (72) duplicate welcome kits were provided to customers (i.e., 72 customers received two welcome kits).	72	Decrease

[(1)] This is explained in section 6.2 Gross Impact Evaluation.

F.2. Process Evaluation

F.2.1. Survey Sample Attrition

The PY15 customer surveys collected demographic information about Low-Income Program participants. Most survey respondents reported they lived in a single-family detached residence (34%; n=377) or a multifamily apartment or condo building with four or more units (28%). Twenty percent reported they lived in an attached house (townhouse, row house, or twin), 10% reported they lived in a mobile or manufactured home, and 9% reported they lived in a different dwelling type.[41]

Table F-2 lists the total number of records contacted via online survey and the outcome (final disposition) of each record (all strata). *Appendix L* includes additional detail on the survey methodology.

Table F-2. Low-Income Component Sample Attrition

Description of Outcomes of Online Participant Survey	Number of Records
Population (number of unique jobs at the time the sample was drawn)	**117,317**
Removed: Welcome kit only participant	36,307
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	62,772
Removed: incomplete or invalid email address or phone number	10,943
Survey Sample Frame (records attempted)	**7,295**
Not reached or non-working: Refused or opted out, email returned (bounce back), did not respond	6,766
Partially Completed Survey	90
Completed Surveys (online)	**439**
Overall Response Rate	**6%**

[41] The total does not sum to 100% due to rounding.

PPL Electric Utilities

CADMUS

APPLIANCE RECYCLING

This component of the Residential Program offers an incentive to customers who turn in eligible appliances and provides free pick-up and environmentally sound recycling services.

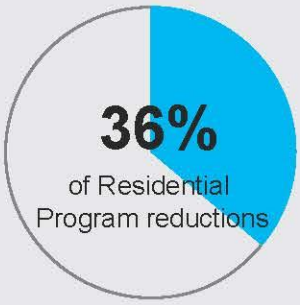
VERIFIED ENERGY SAVINGS

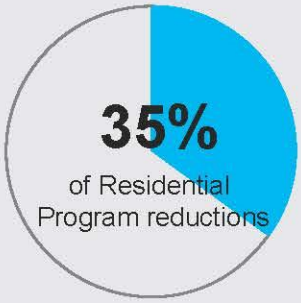
Phase IV has saved **25,035 MWh/yr**

PY15 saved **8,565 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **6.27 MW/yr**





PY15 has reductions of **2.28 MW/yr**

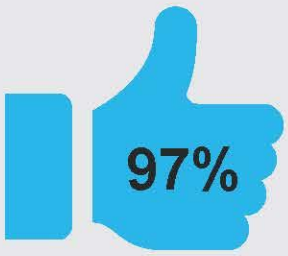
PY15 PARTICIPATION

A total of **8,849** customers recycled **13,587** units*

- **8,114** Refrigerators
- **2,444** Room air conditioners
- **1,613** Dehumidifiers
- **1,416** Freezers

*Does not include incentive adjustments

PARTICIPANT SATISFACTION



Satisfied with overall program component

96% found program participation easy

90% recommend appliance recycling program

Appendix G. Evaluation Detail – Appliance Recycling Component

In the Appliance Recycling component, PPL Electric Utilities offers an incentive to customers who turn in eligible appliances, while also providing free pick-up and environmentally sound recycling services. The component 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. For evaluation purposes, Cadmus defined participants as unique appliances decommissioned through the Appliance Recycling component during the program year.

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 component's delivery staff. In PY15, CLEAResult, the ICSP, delivered the Appliance Recycling component, along with its pick-up/recycling subcontractor, Key Recycling.

During PY15, participating customers had the option of requesting in-person pick-up or contactless curbside pick-up. Refrigerators had to measure between 10 and 30 cubic feet to qualify for pick-up. Both primary and secondary refrigerators and freezers were eligible. Eligible appliances had to be functional at the time of pick-up. If customers recycled a refrigerator or freezer, they could also turn in room air conditioners and dehumidifiers. During PY15, the ICSP held three bulk recycling events to collect room air conditioners and dehumidifiers from customers without requiring them to schedule a large appliance pick-up. The ICSP also initiated a new "neighborhood sweep" option to collect room air conditioners and dehumidifiers (without large appliances) from targeted geographies. After a successful trial run in Scranton in July 2023, the ICSP conducted additional neighborhood sweeps in September 2023 in Harrisburg, Lancaster, and Scranton. The ICSP also implemented stand-alone pickups for small appliances (dehumidifiers and room air conditioners) as part of the regular program at the end of PY15.

Table G-1 shows the appliance eligibility parameters and incentives for PY15, which were unchanged from the end of PY14.

Table G-1. Eligible Equipment and Incentives for the Appliance Recycling Component

Equipment	Eligibility Rating	Incentive Range
Refrigerator	Working unit; > 10 cubic feet and ≤ 30 cubic feet	$50
Freezer	Working unit; > 10 cubic feet and ≤ 30 cubic feet	$50
Room Air Conditioner	Working unit removed from mounting	$10
Dehumidifiers	Working unit	$10

G.1. Gross Impact Evaluation

G.1.1. Gross Impact Methodology and Sampling Approach

Cadmus contacted all Appliance Recycling participating customers with email addresses who recycled refrigerators and freezers in Q1 through Q3. Cadmus randomly selected a single appliance from each participating customer, with separate strata for refrigerators and freezers, to inform net savings, part-

use calculations, and unit energy consumption (UEC) inputs for appliances located in unconditioned spaces and primary use.

Cadmus reviewed a census of records for room air conditioners and dehumidifiers and based savings for dehumidifiers and room air conditioners on a reference city in the PA TRM. Cadmus verified that each participant's ZIP code was mapped to the correct reference city and verified the reported per-unit savings matched those listed in the PA TRM.

Table G-2 summarizes the impact evaluation sampling strategy. The impact evaluation activities produced results with ±15% precision at 85% confidence.

Table G-2. Appliance Recycling Component Gross Impact Evaluation Sample Design

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Room Air Conditioners and Dehumidifiers	85% confidence and ±15% precision; Cv assumed to be 0.50	Census	Census	Database review
Refrigerators and Freezers		140	280[1]	Participating customer survey
		Census	9,530	Database review and estimate UECs
Total		-	**9,530[2]**	

[1] Cadmus sent survey invitations to eligible participating customer who recycled refrigerators or freezers in an effort to get at least 140 participating customers to complete the survey for analysis. The population of refrigerators and freezers at the time of sampling was 7,017 units. The number of survey respondents used for the impact analysis differs from the number used for the process evaluation findings as the impact analysis excluded six survey respondents who did not fully complete the survey.
[2] Cadmus included the 280 survey respondents in the census of the database review so they were not counted twice in the total number of appliances. Since the total count does not include two records created for incentive corrections, it may not match other tables showing participants as unique job numbers.

Cadmus reviewed responses to the participating customer survey and quarterly participant records and confirmed the number of total and per household recycled appliances in the program tracking data.

Regression Variable Findings

Table G-3 summarizes component averages or proportions determined for each open variable in the PA TRM regression equation.

Table G-3. UEC Input Comparison for Refrigerator and Freezer Savings Algorithms

Equipment	Independent Variable	EDC Data Gathering Mean Value
Refrigerator Recycling	Appliance Age (years)	20.2
	Dummy: Manufactured Pre-1990	7%
	Appliance Size (cubic feet)	17.8
	Dummy: Single-Door Configuration	24%
	Dummy: Side-by-Side Configuration	23%
	Dummy: Percentage of Primary Usage (in the absence of the program)	51%
	Interaction: Located in Unconditioned space x cooling degree days (CDDs)	6.42
	Interaction: Located in Unconditioned space x heating degree days (HDDs)	0.97
Freezer Recycling	Appliance Age (years)	20.9
	Dummy: Manufactured Pre-1990	11%
	Appliance Size (cubic feet)	17.2
	Percentage of Chest Freezers	38%
	Interaction: Located in Unconditioned space x HDDs	10.97
	Interaction: Located in Unconditioned space x CDDs	1.69

Cadmus calculated gross verified savings and realization rates using data gathered from the PPL Electric Utilities participant tracking database from PY15 (appliance age, size, and configuration) and from the PY15 online survey of participating customers (primary versus secondary use and whether appliances were kept in conditioned spaces). Cadmus applied the HDDs and CDDs values reflecting the ZIP code to the climate region mapping specified in the PA TRM. Cadmus used these inputs to inform the open variables for the savings algorithms specified in the PA TRM.

Part-Use Factor Findings

Part-use is an adjustment factor specific to appliance recycling that Cadmus used to convert the annual UEC into an average per-unit gross savings.

As instructed in the PA TRM, Cadmus followed the methodology for recycled appliances described in the Uniform Methods Project to calculate part-use factors specific to the electric distribution company using PY15 participating customer survey data.[42]

Cadmus applied PY15 part-use values of 0.91 and 0.93 for refrigerators and freezers, respectively.

The part-use methodology relies on information from surveyed customers regarding pre-program usage patterns (i.e., how many months of the year prior to recycling the appliance was plugged in and

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

running). The final estimate of part-use reflects how appliances were likely to operate had they not been recycled (rather than how they previously operated). For example, it is possible that a primary refrigerator operated year-round would have become a secondary appliance and operated part of the time.

Using primary data gathered through the PY15 participating customer survey, Cadmus conducted the following activities to determine part-use:

- Determined whether recycled refrigerators were primary or secondary units (treating all stand-alone freezers as secondary units).
- Asked survey respondents who indicated they had recycled a secondary refrigerator or freezer if the appliance had operated year-round, operated for a portion of the preceding year, or was unplugged and not operated. Cadmus assumed all primary units operated year-round.
- Asked survey respondents who indicated they operated their secondary refrigerator or freezer for only a portion of the preceding year to estimate the total number of months that the appliance remained plugged in. This allowed for the calculation of the portion of the year in which the appliance remained in use. Cadmus determined that the average refrigerator, operating part-time, had a part-use factor of 0.33, or approximately four months. Freezers operating part of the time had a part-use factor of 0.25, or three months.

Table G-4 lists Cadmus' findings about how refrigerators and freezers operated prior to recycling.

Table G-4. Historical PY15 Part-Use by Appliance Type

Usage Type and Part-Use Category	Percent of Recycled Units	Part-Use Factor
Secondary Refrigerators Only (n=75)		
Not in Use	4%	0.00
Used Part Time	19%	0.33
Used Full Time	77%	1.00
Weighted Average	**N/A**	**0.84**
All Refrigerators (Primary and Secondary) (n=157)		
Not in Use	2%	0.00
Used Part Time	9%	0.33
Used Full Time	89%	1.00
Weighted Average	**N/A**	**0.92**
All Freezers (n=36)		
Not in Use	3%	0.00
Used Part Time	6%	0.25
Used Full Time	92%	1.00
Weighted Average	**N/A**	**0.93**

The part-use methodology accounts for how a customer used the appliance historically (prior to being recycled) and is not necessarily indicative of how the customer would have used the appliance had it not

been recycled. The prospective part-use factor accounts for this, combining prospective actions with historical part-use factors, with survey respondents' self-reported actions determining the likely future use of the appliance had the program *not* been available. This resulted in the distribution of likely future usage scenarios and corresponding part-use estimates. The weighted average of these future scenarios, shown in Table G-5, produced the part-use factor for refrigerators and freezers.

Table G-5. Prospective PY15 Part-Use by Appliance Type

Use Prior to Recycling	Likely Use Independent of Recycling	Part-Use Factor	Percentage of Survey Respondents[1]
Primary Refrigerators	Kept (as primary unit)	1.00	9%
	Kept (as secondary unit)	0.84	6%
	Discarded	0.92	34%
Secondary Refrigerators	Kept	0.92	25%
	Discarded	0.84	27%
Overall		**0.91**	**100%**
Freezers	Kept	0.93	38%
	Discarded	0.93	62%
Overall		**0.93**	**100%**

[1] Totals may not sum due to rounding.

Cadmus applied the part-use factors from Table G-5 to the modeled UEC from Table G-3 to calculate the average gross per-unit energy savings shown in Table G-6.

Table G-6. Prospective PY15 Part-Use by Appliance Type

Appliance	Average Per-Unit Annual Energy Consumption (kWh/yr)	Part-Use Factor	Adjusted Per-Unit Gross Energy Savings (kWh/yr)
Refrigerators	805	0.91	733
Freezers	738	0.93	686

G.1.2. Gross Impact Results

Table G-7 shows the Appliance Recycling component's verified gross energy savings and demand reductions.

Table G-7. Appliance Recycling Component Savings

Savings	PY13 Verified	PY14 Verified	PY15 Verified	Phase IV Verified[1]
MWh/yr	7,900	8,569	8,565	25,035
System-Level MW/yr	1.90	2.09	2.28	6.27

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

Table G-8 shows verified energy savings and realization rates by stratum for PY15, and Table G-9 shows verified demand savings and realization rates.

Table G-8. Appliance Recycling Component Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Refrigerators and Freezers	7,611	91%	8.53	10.0%	6,926
Room Air Conditioners and Dehumidifiers	1,639	100%	N/A	N/A	1,639
Component Total[2]	**9,250**	**93%**	**7.75**	**8.1%**	**8,565**

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

Table G-9. Appliance Recycling Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System Level PYVTD (MW/yr)
Refrigerators and Freezers	1.23	91%	8.53	10.0%	1.12	1.22
Room Air Conditioners and Dehumidifiers	0.98	100%	N/A	N/A	0.98	1.06
Component Total[2]	**2.20**	**95%**	**5.12**	**5.3%**	**2.09**	**2.28**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Cadmus applied realization rates to verified demand reductions before applying distribution losses.
[2] Totals may not sum due to rounding.

The verified realization rate for energy savings was 93%, and the verified demand realization rate was 95%. Realization rates were driven by a decrease in refrigerator and freezer UECs as the share of pre-1990 units and the average age of recycled appliances continue to decrease. Cadmus calculated the share of pre-1990 refrigerators recycled in the PY13 evaluation as 22% compared with 7% in PY15.[43] The average age of recycled refrigerators decreased from 22.8 years in PY13 to 20.2 years in PY15. The average age of freezers decreased by nearly six years since PY13, from 26.7 years to 20.9.

G.2. Net Impact Evaluation

G.2.1. Net Impact Methodology

Determining net savings for an appliance retirement program follows the methodology described in Appendix B Common Methods for Appliance Recycling Programs in the Phase IV Evaluation

[43] PPL Electric Utilities. November 30, 2022. *Phase IV of Act 129 Program Year 13 Annual Report (June 1, 2021–May 31, 2022).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. https://www.puc.pa.gov/pcdocs/1766201.pdf

Framework.[44] This is consistent with the Uniform Methods Project appliance recycling protocol to determine program net savings.[45]

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

Table G-10 lists the sampling strategy used to determine net savings for the Appliance Recycling component in PY15.

Table G-10. PY15 Appliance Recycling Component Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size[(1)]	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence and Precision	Plan Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample
Refrigerators and Freezers	Unique appliances	7,017[(1)]	0.5	85/15	4,521[(2)]	3,176	228[(2)]	100%
Total		**7,017**	**-**	**85/15**	**4,521**	**3,176**	**228**	**100%**

[(1)] Number of rebates for refrigerators and freezers available in PPL Electric Utilities' tracking database at the time of the PY15 survey.
[(2)] Plan sample size excluded records with missing contact information and selected a single appliance from each customer from customers who recycled multiple refrigerators or freezers and respondents who answered "Don't know" to any of the disposal questions. The number of respondents used in the net savings analysis differ from numbers used in the gross impact and process evaluation analysis.

Free Ridership

To estimate free ridership, Cadmus used the participating customer self-report survey, which asked respondents about the likelihood that a given appliance would have continued operating within the participating household absent program intervention. Appliances that survey respondents would not have kept or transferred to another household for continued use indicate free ridership.

Cadmus categorized survey respondents' self-reported discard methods as kept, transferred, or discarded, with discarded indicating free ridership (i.e., their action would have led to the removal of the appliance from the grid without program intervention).

Table G-11 shows the percentage of survey respondent units that would have been kept or discarded.

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[44] Pennsylvania Public Utility Commission. Final Version July 16, 2021. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by the Statewide Evaluation Team (NMR Group Inc., Demand Side Analytics LLC, Brightline Group, and Optimal Energy Inc.). Contracted under the Pennsylvania Public Utility Commission's RFP 2020-2 for the Statewide Evaluator. https://www.puc.pa.gov/media/1584/swe-phaseiv_evaluation_framework071621.pdf

[45] Keeling, J., and D. Bruchs. 2017. "Chapter 7: Refrigerator Recycling Evaluation Protocol." *The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures.* Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68563. http://www.nrel.gov/docs/fy17osti/68563.pdf

Table G-11. Final Distribution of Kept and Discarded Survey Respondent Appliances

Stated Action Absent Program	Indicative of Free Ridership	Refrigerators (n=170)	Freezer (n=58)
Kept	No	39%	38%
Discarded	Varies by Discard Method	61%	62%
Total		**100%**	**100%**
Note: Refrigerator and freezer response counts do not include "Don't know" or "Refused."			

After identifying the discard actions of the survey respondents (those who would not have kept their appliances), Cadmus then determined the share of appliances that would have been discarded or transferred to a new home. Table G-12summarizes the final distribution of disposed and transferred appliances.

Table G-12. Final Distribution of Discarded/Transferred Survey Respondent Appliances

Appliance	Discard/Transfer Scenario	Percentage from Participating Customer Survey
Refrigerator	Disposed	44%
	Transfer	16%
Freezer	Disposed	34%
	Transfer	28%

Secondary Market Impacts

If determined that a survey respondent would have transferred the unit that was recycled to another customer on the grid in the absence of the program, Cadmus then accounted for what the recipient might have done.

After estimating the share of transfer units subject to secondary market impacts (SMI), Cadmus used a decision tree to calculate the average per-unit program savings net of their combined effect. Cadmus integrated these savings into a combined estimate of savings net of free ridership and SMI for refrigerators, applying the midpoint assumptions recommended in the Uniform Methods Project when primary data were unavailable. Accounting for market effects resulted in three savings scenarios:

- Full per-unit gross savings
- Zero savings
- Partial savings (i.e., the difference between the energy consumption of the program unit and the new, standard-efficiency appliance acquired alternatively)

Cadmus calculated the replacement UEC for refrigerators and freezers using the ENERGY STAR average energy consumption of new comparably sized, standard-efficiency appliances with similar configurations as the program units.[46]

To calculate net per-unit savings, Cadmus used the weighted average of the three scenarios, weighted by the proportion of units in each scenario. The process for freezers was identical.

Spillover

Survey respondents indicated they had installed efficient equipment since recycling an appliance. Some respondents indicated they installed a new efficient refrigerator or freezer, but these were replacements for the appliances recycled, which were already purchased prior to recycling. Cadmus credited survey respondents who may have been influenced by the Flip Your Fridge campaign with spillover savings if they also responded that they had not considered getting rid of their appliance before learning of the program.[47]

Spillover as a percentage of program savings, when rounded to a whole percent, was zero percent.

G.2.2. Net-to-Gross Results

Table G-13 shows NTG ratio results for the Appliance Recycling component.

Table G-13. Appliance Recycling Component NTG Ratio Summary

Stratum	PYVTD MWh/yr	Evaluation Year	Free Ridership and SMI (%)	Spillover (%)	NTG Ratio
Refrigerators and Freezers	8,565	PY15	50%	0%	0.50[(1)]

[(1)] At 85% confidence interval.
Note: Refrigerator and freezer response counts do not include "Don't know" or "Refused."

Room air conditioners and dehumidifiers were not eligible for a stand-alone equipment pick-up through most of PY15 but were eligible for pick-up in conjunction with refrigerator or freezer recycling. Therefore, Cadmus assumed that the NTG ratio for refrigerators and freezers also applied to room air conditioners and dehumidifiers. However, eligibility did change in late March 2024 to allow stand-alone pick-up of small appliances if a customer had a minimum of two small appliances for pick-up. Cadmus will monitor the number of stand-alone pick-ups through PY16 to determine whether NTG assumptions should be revisited.

The Appliance Recycling component continues to reach a large share of PPL Electric Utilities customers who would have kept their appliances absent the recycling service. The majority of survey respondents said they would have disposed of their refrigerators (52%) and freezers (48%) in a way that would have

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[46] ENERGY STAR. Accessed July 2019. "Find and Compare ENERGY STAR Certified Refrigerators." https://www.energystar.gov/productfinder/product/certified-residential-refrigerators/results

[47] Flip Your Fridge introduces customers to both the Appliance Recycling offering as well as highlighting potential bill savings from upgrading to a new ENERGY STAR appliance simultaneously.

removed them from operating on the grid if they had not recycled them through the program. This results in a 50% NTG ratio for the Appliance Recycling component.

G.3. Process Evaluation

In PY15, Cadmus conducted a process evaluation to assess customer satisfaction and identify successes and challenges with implementing the Appliance Recycling component. Process evaluation activities were consistent with the planned activities, which included an online participating customer survey and stakeholder interviews.

For the participating customer survey, Cadmus contacted a census of eligible freezer records available at the time of the survey and a simple random sample of refrigerator records. This approach exceeded the planned number of respondents. Cadmus conducted one stakeholder interview with the program managers from PPL Electric Utilities and the ICSP.

Table G-14 lists the process evaluation sampling strategy. The survey produced a measure of program satisfaction with ±5% precision at 90% confidence. See *Appendix L. Survey Bias* for details about Cadmus' approach to reducing survey bias and contact instructions.

Table G-14. Appliance Recycling Component Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records Selected for Sample Frame	Percent of Sample Frame Contacted to Achieve Sample[1]
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities, ICSP, and ICSP subcontractors	Telephone in-depth interview	3	N/A	Up to 3	2	N/A	100%
Participating Customers	PY15 Appliance Recycling Component	Online survey	7,017[2]	-	140	286[3]	3,176[4]	100%
Program Total			**7,020**	**N/A**	**N/A**	**288**	**3,176**	**N/A**

[1] Percent contacted means the percentage of the sample frame contacted to complete the survey or interviews.
[2] Number of rebates for refrigerators and freezers available in PPL Electric Utilities' tracking database at the time of the PY15 survey.
[3] Respondents could skip questions, so the number of responses to individual questions may vary. The process and impact results included different numbers of respondents and did not match each other.
[4] The sample frame is a list of participating customers with email contact information drawn from the PPL Electric Utilities' tracking database. The final sample frame includes unique records in the PPL Electric Utilities 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, 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.

G.3.1. Program Component Experience

Cadmus contacted Appliance Recycling component participating customers with email addresses who recycled refrigerators and freezers in PY15 Q1 through Q3.[48] Survey respondents rated their satisfaction with Appliance Recycling and explained what drove their satisfaction ratings. They also rated ease of participation, likelihood of recommending Appliance Recycling, and how their participation influenced their opinion of PPL Electric Utilities. Some PY15 survey questions were not asked in PY14; in those cases, Cadmus compared PY15 results to PY13 results (when similar research was last completed).

Component Satisfaction

Of 286 survey respondents, 97% were satisfied with the PY15 Appliance Recycling component. Eighty-eight percent were *very satisfied,* and 9% were *somewhat satisfied* with the program overall.[49]

Drivers of Program Component Satisfaction

To better understand what drives program satisfaction, the survey asked respondents what factor(s) most affected their rating of the Appliance Recycling component.

Figure G-1 shows the most common drivers for respondents who were *very* or *somewhat satisfied* with the Appliance Recycling component. Of 274 respondents who answered this question, 69% said the collection process—when the contractor picks up the appliances—was the main driver of their positive experience. These results were very similar to PY13 survey results, except for communications with PPL Electric Utilities and program contractors being mentioned more often as a driver of positive experience in PY15 (41%) than in PY13 (33%).

Only eight PY15 survey respondents were less than *satisfied*. Three of these said a reason for their dissatisfaction was the collection process, which was also the most frequently mentioned driver for satisfied respondents. Another three respondents mentioned poor communications with program staff, two mentioned delayed rebate payments, and one apiece mentioned the rebate amount, the variety of equipment covered, the application process, and poor customer service from a representative over the phone.[50]

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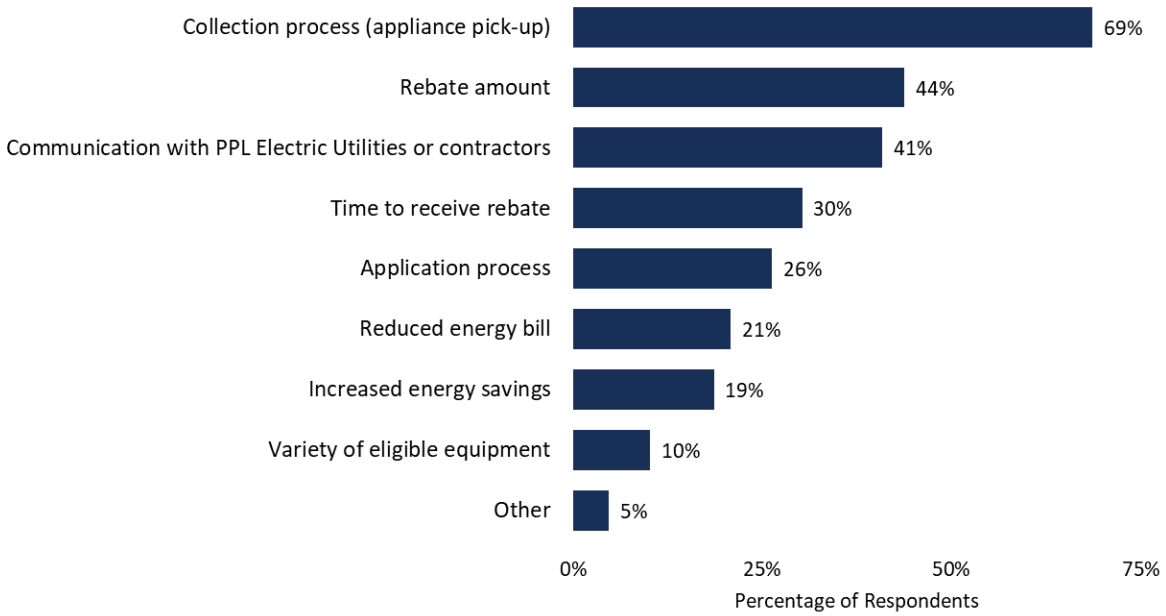
[48] Due to evaluation timing, Q4 data were not available at the time of the participating customer survey.

[49] Two respondents were *neither satisfied nor dissatisfied*, four were *not too satisfied*, and two were *not at all satisfied* with the program overall, totaling 3% of survey respondents (8 of 286).

[50] Respondents provided multiple responses.

Figure G-1. Drivers of High Satisfaction with Appliance Recycling



Source: Participating customer survey, "What factor(s) most affected the overall experience rating you gave?" (n=274 respondents who were *very satisfied* or *somewhat satisfied*; multiple responses allowed)

Customer Effort

Respondents also gave high ratings for ease of participating in Appliance Recycling, with 96% rating their experience as *very easy* (75%) or *easy* (21%), while only 1% rated it *difficult* and no one rated it *very difficult* (the remaining 3% rated it *neither easy nor difficult*; n=284). These ratings in PY15 were very similar to PY13 (74% *very easy*, 23% *easy*).

Opinion of PPL Electric Utilities and Likelihood to Recommend

Of 278 survey respondents who answered the question, 55% said their opinion of PPL Electric Utilities had improved after participating in the Appliance Recycling component, 44% said their opinion had not changed, and 1% said their opinion declined. The rate of respondents reporting that their opinion improved increased since the PY13 survey, when only 45% said their opinion improved and 54% said it was unchanged.

The survey asked the four respondents who said their opinion of PPL Electric Utilities decreased why this was so, and each gave a different reason. One had not received their rebate payment yet, one cited a lack of communication about the pick-up, one complained about being put on a waitlist,[51] and one complained about the lack of flexibility for scheduling a pick-up.

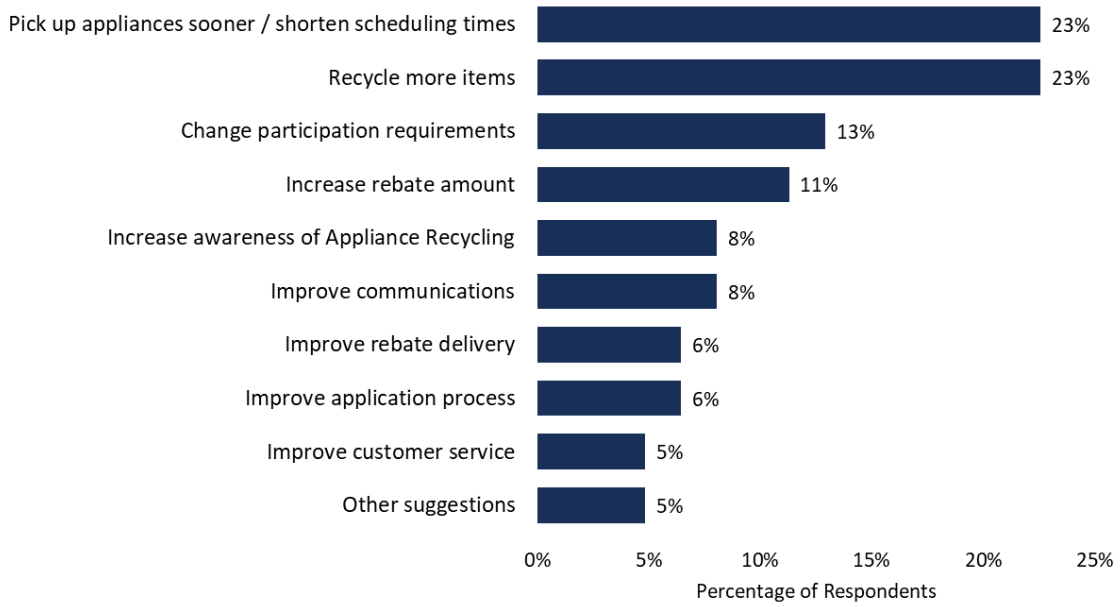
[51] In cases where pick-up dates were not available in the customers' area at a convenient time for them, the ICSP gave customers the option to be added to a waitlist. The ICSP contacted them when alternate dates were available in their area to schedule an appliance pick-up.

Overall, 90% (n=284) of respondents in PY15 were likely to recommend the program to a friend, family member, or colleague, equivalent to 91% giving the same ratings in PY13.[52]

G.3.2. Improvement Suggestions

When asked for one thing PPL Electric Utilities could change to improve the Appliance Recycling component, 62 respondents offered suggestions (Figure G-2). Of this subset, 23% suggested reducing the amount of time until pick-up, which was the top response in PY13 as well (28%). Twenty-three percent also suggested the program recycle more items than it currently does, an increase from 15% in PY13. Suggestions to improve communications fell from 15% in PY13 to 8% in PY15, consistent with more respondents mentioning program communications as a driver of high satisfaction in PY15 than PY13.

Figure G-2. Suggestions for Improving the Appliance Recycling Component



Source: Participating customer survey, "What is the one thing PPL Electric Utilities could change about the program to improve it? Please describe." (n=62; multiple responses allowed)

G.3.3. Other Findings

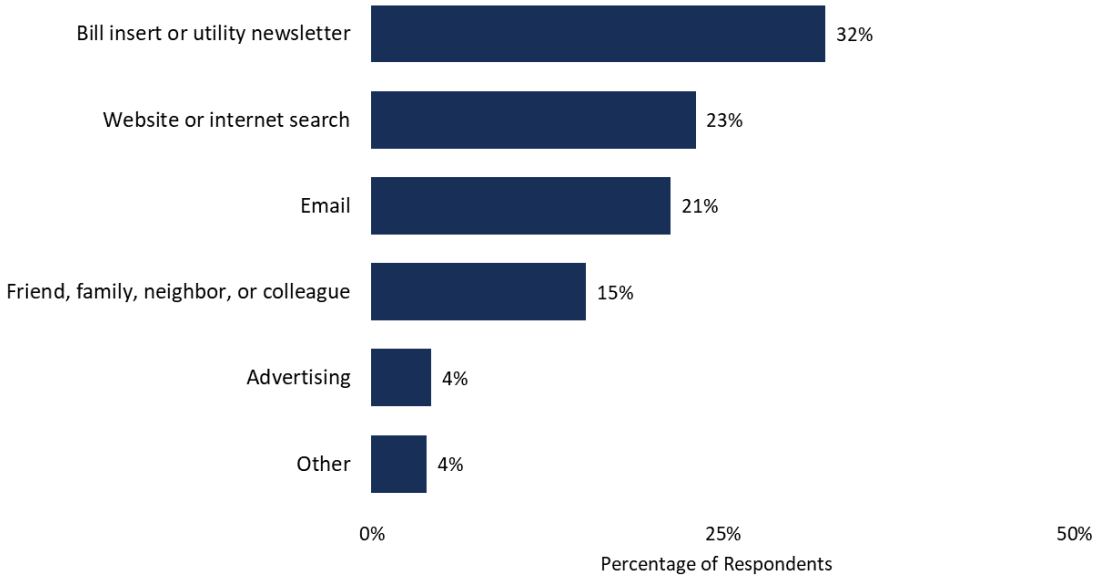
Sources of Awareness

A third of respondents learned about Appliance Recycling from utility bill inserts and utility newsletters (32%), with websites and internet search (23%) and emails (21%) also being common sources of awareness (Figure G-3; n=282). The "other" sources of program awareness (4%) included retail stores,

[52] Respondents were considered "likely to recommend" the program if they gave ratings of 9 or 10 on a 10-point rating scale where "10" means "extremely likely".

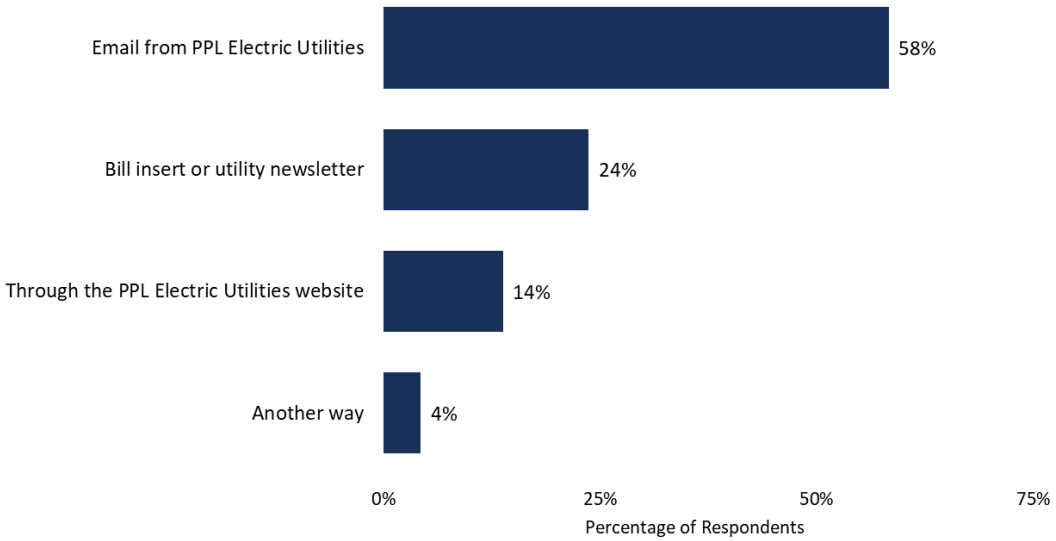
social media, and previous experience with the program. Most respondents would prefer to learn about energy efficiency programs via email from PPL Electric Utilities (58%, n=283; Figure G-4).

Figure G-3. Sources of Awareness of Appliance Recycling



Source: Participating customer survey, "Next, we have some questions about how you hear about offerings like Appliance Recycling. Please select how you first heard about the Appliance Recycling program? Please select only one response." (n=282)

Figure G-4. Preferred Channels for Information about Energy Efficiency Programs



Source: Participating customer survey, "Please select the best way for PPL Electric Utilities to inform you about energy-efficiency and conservation programs and rebates from the following list." (n=283)

Recycling Other Items

The PY15 Appliance Recycling participating customer survey included new questions about whether respondents recycled any items outside of the Appliance Recycling program, and if so, what and when.

- 90% of respondents did not recycle any other items in 2023 or 2024 (n=274).
  - 6% had recycled other items before participating in Appliance Recycling during PY15.
  - 4% recycled more items after participating in Appliance Recycling during PY15.
- Many of the other items recycled were the same items recycled through Appliance Recycling: dehumidifiers, small air conditioners, refrigerators, and freezers (14 out of 26 respondents).
  - The recycled items mentioned that were not covered by Appliance Recycling were computers, monitors, printers, TVs, and electronics. One respondent recycled a washing machine.

Survey Respondent Profile and Survey Sample Attrition

The PY15 Appliance Recycling survey collected the following demographic information:

- Most respondents lived in a single-family detached residence (87%; 238 of 273).
- Respondents had an average household size of 2.4 people (n=258).
- Respondents averaged 64 years of age (n=218).
- Most respondents had completed some post-high school education (78%; 206 of 264).
- Most respondents had an annual household income of $50,000 or greater (68%; 115 of 168).

Table G-15 lists the total number of records contacted for the survey and the outcome (final disposition) of each record. Additional details on survey methodology are in *Appendix L. Survey Bias*.

Table G-15. Appliance Recycling Component Sample Attrition

Description of Outcomes of Online Survey	Number of Records
Population (number of unique records)	**7,017**
Removed: missing contact information, duplicate contact information, inactive customer, completed survey in past three months, selected for a different survey, duplicate contact, on "opt out" list, on "do not contact" list	2,496
Removed: excess refrigerator records (only need to contact 2,500 to meet target; random selection)	1,345
Survey Sample Frame (invitations attempted)	**3,176**
Non-working: email returned (bounce back)	133
Not reached: refused or opted out, did not respond	2,722
Disqualified Surveys: screened out	3
Partially Completed Surveys: not reported	32
Completed Surveys (reported)	**286**
Overall Response Rate	**9%**

PPL Electric Utilities

CADMUS

EFFICIENT LIGHTING - SPECIALTY BULBS

This component of the Residential Program encourages residential customers to purchase and install specialty LED bulbs by providing incentives to participating manufacturers to discount the prices of a variety of bulbs sold at local retail stores.

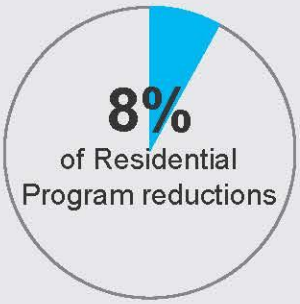
VERIFIED ENERGY SAVINGS

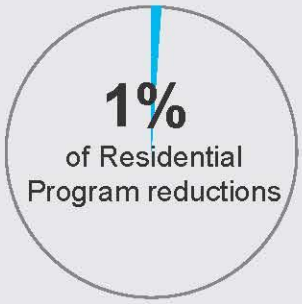
Phase IV has saved **8,969 MWh/yr**

PY15 saved **394 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **1.41 MW/yr**





PY15 has reductions of **0.06 MW/yr**

PY15 PARTICIPATION

A total of **67,447** bulbs sold

BULB TYPE

- **41%** LED candelabra bulbs
- **33%** LED reflector bulbs
- **19%** LED globes
- **7%** LED fixtures

RETAIL CHANNEL

- **65%** from home improvement stores
- **16%** from hardware stores
- **11%** from mass merchandise stores
- **5%** from other stores (including giveaways)
- **1%** from membership club stores
- **1%** from discount stores
- **<1%** from lighting and electronics stores

Appendix H. Evaluation Detail – Efficient Lighting Component

The Efficient Lighting component has encouraged residential customers to purchase and install specialty LED bulbs by lowering the price of component-qualified ENERGY STAR LEDs. This program component provided upstream incentives to participating manufacturers to discount the prices of a variety of specialty bulbs sold at local retail stores, including stores targeting income-eligible customers. PPL Electric Utilities originally targeted residential customers through this component, but the offering has been available to all its customers and anyone who purchased discounted bulbs from participating retailers.

The ICSP, CLEAResult, managed component operations and provided support to participating retailers and manufacturers. At the end of PY14, PPL Electric Utilities sunset this component and stopped offering upstream incentives to manufacturers due to changes in federal lighting efficiency standards. The final program LEDs were processed in the first quarter of PY15 and are included in the results below.

Because of the upstream design of the Efficient Lighting component, the identities of purchasers are not known. Participants are defined as units sold through the component.

H.1. Gross Impact Evaluation

H.1.1. Gross Impact Methodology and Sampling Approach

Cadmus applied a historical realization rate from PY13 results to reported PY15 energy savings and demand reductions (Table H-1). See the PY13 evaluation report for details on the PY13 evaluation approach.[53]

Table H-1. Efficient Lighting Component Historic Realization Rates

Savings	Historic Realization Rate
Energy Savings (MWh/yr)	102%
Demand Reductions (MW/yr)	102%

H.1.2. Gross Impact Results

Table H-2 shows the Efficient Lighting component's verified gross energy savings and demand reductions.

[53] PPL Electric Utilities. November 30, 2022. *Phase IV of Act 129 Program Year 13 Annual Report (June 1, 2021–May 31, 2022).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

Table H-2. Efficient Lighting Component Savings

Savings	PY13 Verified	PY14 Verified	PY15 Verified	Phase IV Verified[1]
MWh/yr	4,349[2]	4,226	394	8,969
System-Level MW/yr	0.68[3]	0.66	0.06	1.41

[1] Phase IV verified savings may not match the sum of program years due to rounding.
[2] PY13 verified savings for the Efficient Lighting component were reduced by 3.65 MWh/yr to conform with the SWE's PY13 Annual Report findings.
[3] PY13 verified demand reductions for the Efficient Lighting component were reduced by 0.0001 MW/yr to conform with the SWE's PY13 Annual Report findings.

The Efficient Lighting component reported energy savings of 385 MWh/yr, as shown in Table H-3, and demand reduction of 0.06 MW/yr, as shown in Table H-4.

Table H-3. PY15 Efficient Lighting Component Gross Impact Results for Energy

Stratum	PYRTD (MWh/yr)	Energy Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Efficient Lighting	385	102%	N/A	N/A	394

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

Table H-4. PY15 Efficient Lighting Component Gross Impact Results for Demand

Stratum	PYRTD (MW/yr)	Demand Realization Rate [1] [2]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Efficient Lighting	0.06	102%	N/A	N/A	0.06	0.06

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Realization rates are applied to verified demand reductions before application of distribution losses. Distribution losses are based on customer sector.

H.2. Net Impact Evaluation

H.2.1. Net Impact Methodology

Cadmus did not conduct new primary research to assess net savings for the Efficient Lighting component in PY15 and used a historical NTG ratio of 107% from PY13. Additional details about the methodology are found in the PY13 Annual Report.[54]

H.2.2. Net-to-Gross Results

Table H-5 shows the lift-based NTG ratio result for the Efficient Lighting component.

[54] PPL Electric Utilities. November 30, 2022. *Phase IV of Act 129 Program Year 13 Annual Report (June 1, 2021–May 31, 2022).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

Table H-5. PY15 Efficient Lighting Component Lift-Based NTG Ratio Summary

Stratum	Gross PYVTD (kWh/yr)	Research Evaluation Year	NTG Ratio	Net PYVTD (kWh/yr)
Participating Retailers	393,784	PY13	107%	421,348

H.3. Process Evaluation

Because a full process evaluation was completed in PY13, Cadmus did not conduct a process evaluation in PY15. This is consistent with the approved evaluation plan.

PPL Electric Utilities

CADMUS

ENERGY EFFICIENT HOMES

This component of the Residential Program provides a wide range of energy-efficient products, rebates, education, and services that give customers a variety of customizable and comprehensive solutions to increase their home's energy efficiency.

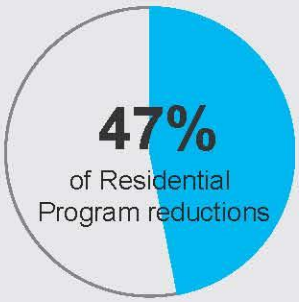
VERIFIED ENERGY SAVINGS

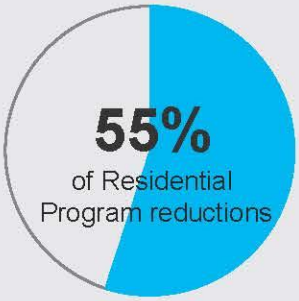
Phase IV has saved **73,390 MWh/yr**

PY15 saved **30,070 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **8.29 MW/yr**





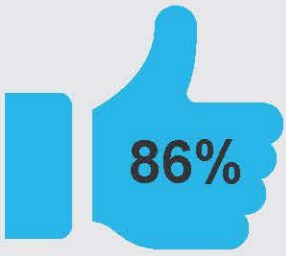
PY15 has reductions of **3.60 MW/yr**

PY15 PARTICIPATION

A total of **99,012** received rebates for

- **80,512** Instant discount
- **9,805** Efficient equipment (downstream and midstream)
- **5,492** Online marketplace
- **1,427** New homes
- **1,050** Weatherization
- **726** Online and in-home audit and energy conservation kits

PARTICIPANT SATISFACTION



Satisfied with overall program component

- **91%** in-home audit, online assessment, and weatherization participants satisfied with program
- **86%** downstream equipment participants satisfied with program
- **82%** online marketplace participants satisfied with program

Appendix I. Evaluation Detail – Energy Efficient Homes Component

The Energy Efficient Homes component is designed for new construction and existing homes. The component offers a wide range of energy-efficient products, rebates, education, and services that give customers various customizable solutions to increase their homes' energy efficiency.

In PY15, the component had five subcomponents: Downstream Equipment, the Online Marketplace, Audit and Weatherization, Instant Discount, and New Homes. In PY15, PPL Electric Utilities also administered two pilot programs: High Performance Homes (new construction) and Deep Energy Retrofit.

PPL Electric Utilities' energy efficiency program staff provides overall strategic direction and program management. CLEAResult, the ICSP, manages the Energy Efficient Homes component with the assistance of two subcontractors. Performance Systems Development is responsible for the New Homes subcomponent, and Energy Federation, Inc., is responsible for the Online Marketplace subcomponent and kit distribution. Retailers participating in the Instant Discount offering include hardware and home improvement stores.

For the New Homes subcomponent and High Performance Homes pilot, a participant is defined as a single-family home or a tenant unit in a newly constructed multifamily building. For the remaining subcomponents and pilots of Energy Efficient Homes, a participant is defined as a rebated project, and each project is assigned a unique job number in PPL Electric Utilities' participant tracking database.

I.1. Gross Impact Evaluation

I.1.1. Gross Impact Methodology and Sampling Approach

Cadmus used findings from desk reviews, participant surveys, and database reviews to evaluate savings from the Downstream Equipment, Instant Discount, Online Marketplace, and New Homes subcomponents in PY15. For the New Homes subcomponent, Cadmus also verified High Performance Homes pilot savings. Activities were consistent with the evaluation plan.

The approach for evaluating savings for the Audit and Weatherization subcomponent was consistent with the planned activities and applied the results of the PY14 evaluation; however, Midstream Equipment remains unverified for PY15 due to low levels of participation. Cadmus plans to evaluate Midstream Equipment savings in PY16.

Table I-1 summarizes the evaluation sampling strategy. Cadmus evaluated the subcomponents with basic levels of rigor and used different sampling approaches for each subcomponent.

For the Downstream Equipment subcomponent, Cadmus attempted to survey a census of participants and used a nested stratified random sampling approach to select a subset of surveyed sites for desk reviews. Cadmus also attempted to survey a census of participants for the Online Marketplace subcomponent. Cadmus conducted a database review for all rebated products for the Instant Discount measures and used the Downstream Equipment and Online Marketplace participant surveys to calculate

an in-service rate (ISR) for individual measures. Survey findings also contributed to the process evaluation.

Table I-1. Energy Efficient Homes Component Gross Impact Evaluation Sample Design

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size[1]	Impact Evaluation Activity
Audit and Weatherization	N/A	N/A	N/A	Apply PY14 historical realization rate to PY15 reported savings
New Homes	85/15 (Cv=0.50)	23	23	Desk review of REM/Rate & Ekotrope models, database review, and engineering analysis
Downstream Equipment	85/15 (Cv=0.50)	≥ 30	374	Participant survey, attempted census, desk reviews
		30	30	Nested stratified random sample for desk reviews
Online Marketplace	85/15 (Cv=0.50)	≥ 23	101	Combined two-year PY14/PY15 sampling approach, participant survey, attempted census, database review
Instant Discount	Census	N/A	N/A	Combined two-year PY14/PY15 verification approach, database review; invoice review
Midstream HVAC Equipment	N/A	N/A	N/A	No activities due to low participation in PY15
High Performance Homes	N/A	5	4	Desk review of REM/Rate & Ekotrope models, database review and engineering analysis
Deep Home Retrofit	N/A	N/A	N/A	No activities: savings will be verified in PY16

[1] The number of respondents who answered questions about the ISR may not equal the total number of survey respondents used in the process section of the report, infographics, or net savings analysis.

The impact evaluation activities verified energy savings with ±11% precision at 85% confidence and demand reductions with ±16% precision at 85% confidence.

Ex Post Savings Calculation

New Homes

Cadmus reviewed REM/Rate and Ekotrope model inputs to verify energy savings and peak cooling demand for a sample of 23 program homes and used the analysis from PY14 site visits to inform PY15 demand savings. Cadmus weighted and combined the realization rates of each sampled project into a single subcomponent-level realization rate and applied the sample-derived realization rate to the remaining population savings to calculate subcomponent-level *ex post* savings. Summing *ex post* and *ex ante* kWh and kW savings produced subcomponent-level savings.

Cadmus verified savings per the PA TRM using participant tracking database inputs and project documentation. The demand savings calculations relied on the zip code of each evaluated home to map

the coincidence factor from the PA TRM Appendix A. Cadmus then applied this value to the cooling demand savings, also applying the additional demand savings for lighting and appliances from data gathered during PY14 site visits, weighted on a per square foot basis.

For PY15, Cadmus also reviewed the reference home assumptions, following the PA TRM guidance that the new construction baseline changed to IECC 2018 for homes permitted in PY15 or later. As such, Cadmus reviewed the permit date for each home in the sample to apply the correct baseline.

Cadmus used the same approach described above to evaluate the High Performance Homes pilot, verifying a census of four pilot homes reported in PY15.

Audit and Weatherization

The reported PY15 energy savings and demand reductions in Table I-2 used a historical realization rate from PY14 results. See the PY14 evaluation report for details on the PY14 evaluation approach.[55]

Table I-2. Energy Efficent Homes Audit and Weatherization Historical Realization Rates

Savings	Historical Realization Rate	
	Weatherization	Audits
Energy Savings (MWh/yr)	62%	62%
Demand Reductions (MW/yr)	95%	64%

Equipment

Cadmus weighted and combined the realization rates for each sampled project for each stratum into a single stratum-level realization rate. To calculate *ex post* savings for each stratum, Cadmus applied the sample-derived realization rate for each stratum to the respective population savings and then summed *ex post* and *ex ante* kWh savings across strata to calculate component-level realization rates and savings.

Cadmus verified savings per the PA TRM and relied on inputs from PPL Electric Utilities' participant tracking database, project documentation, third-party sources such as ENERGY STAR, AHRI, and product manufacturer websites, or deemed inputs from the PA TRM, where relevant.

Online Marketplace

Cadmus used a two-year sampling approach to evaluate PY14 and PY15 for the Online Marketplace subcomponent. To calculate *ex post* savings for each component measure, Cadmus applied the survey-derived installation rates for each stratum to all sampled measures and then applied the sample-derived realization rate for each stratum to the respective population savings. Cadmus then summed *ex post* and *ex ante* kWh savings across strata to calculate component-level realization rates and savings.

[55] PPL Electric Utilities. September 30, 2023. *Phase IV of Act 129 Program Year 14 Annual Report (June 1, 2022–May 31, 2023).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

Cadmus verified savings per the PA TRM and relied on inputs from PPL Electric Utilities' participant tracking database, project documentation, third-party sources such as ENERGY STAR, AHRI, and product manufacturer websites, or deemed inputs from the PA TRM, where relevant.

Instant Discount

Cadmus used a two-year sampling approach to evaluate PY14 and PY15 for the Instant Discount subcomponent. To calculate *ex post,* Cadmus completed a database review on a census of all measures except for spray foam, which remains unverified in PY15, due to a change in SWE evaluation methodology. Cadmus then summed *ex post* and *ex ante* kWh savings across all tracking database records to calculate component-level realization rates and savings.

I.1.2. Gross Impact Results

Table I-3 shows the verified gross energy savings and demand reductions for Energy Efficient Homes.

Table I-3. Energy Efficient Homes Component Savings

Savings	PY13 Verified	PY14 Verified[1]	PY15 Verified	PY15 Unverified[2]	Phase IV Verified[3]
MWh/yr	17,556[4]	25,763	30,070	11,229	73,390
System-Level MW/yr	1.87[5]	2.83	3.60	0.08	8.29

[1] Includes PY15 verified energy and demand savings of 4,170 MWh/yr and 0.48 MW/yr for Online Marketplace and Instant Discount.
[2] Line loss adjustments are applied to savings after verification.
[3] Phase IV verified savings may not match the sum of program years due to rounding and do not include PY15 unverified savings.
[4] PY13 verified savings for the Energy Efficient Homes component were increased by 0.19 MWh/yr to conform with the SWE's PY13 Annual Report findings. Includes PY14 verified savings of 2,867 MWh/yr for New Homes.
[5] PY13 verified demand reductions for the Energy Efficient Homes component were increased by 0.0005 MW/yr to conform with the Statewide Evaluator's PY13 Annual Report findings. Includes PY14 verified savings of 0.84 MW/yr for New Homes.

Table I-4 shows incentive costs, verified electric savings, and demand reductions by subcomponent.

Table I-4. PY15 Incentives and Verified Energy Savings and Demand Reductions by Subcomponent

Parameter	Downstream Equipment[1]	Midstream Equipment[2]	Online Marketplace	New Homes[3]	Audit and Weatherization[1], [4]	Instant Discount[5]	Total[6]
PY15 Participants	9,794	11	5,492	1,427	1,776	80,512	99,012
PYRTD (MWh/yr)	17,941[7]	6	1,259	3,726	701[7]	22,122	45,755
PYRTD (MW/yr)	1.10	0.00	0.13	0.81	0.04	1.60	3.68
PYVTD (MWh/yr)	15,077	-	1,293	3,479	437	9,785	30,070
PYVTD (MW/yr)	1.27	-	0.14	0.56	0.04	1.30	3.31
System-Level PYVTD (MW/yr)	1.38	-	0.15	0.60	0.04	1.41	3.60
PY15 Incentives ($1,000)	$2,338[8]	$3	$343	$1,284	$403[9]	$1,798	$6,169

[1] Cadmus did not evaluate savings for the Deep Energy Retrofits projects that were part of this subcomponent. These savings will be verified in a later year.
[2] Cadmus did not evaluate savings for the subcomponent and will verify savings using a PY15/PY16 combined sample.
[3] The High Performance Homes pilot is included with New Homes totals in this table.
[4] Cadmus used the PY14 historical realization rates for this subcomponent.
[5] Cadmus left savings for spray foam unverified and plans to verify in PY16.
[6] Column sums may not add up to the total column due to rounding.
[7] Downstream Equipment includes 16.53 MWh/yr and 0.0004 MW/yr reported savings attributed to Deep Home Retrofits. Audit and Weatherization includes 0.46 MWh/yr and 0.00003 MW/yr reported savings attributed to Deep Energy Retrofits.
[8] Includes $1,086 from Deep Energy Retrofit pilot incentives.
[9] Includes $34 from Deep Energy Retrofit pilot incentives.

In PY15, the Energy Efficient Homes component reported energy savings of 45,755 MWh/yr, as shown in Table I-5, and demand reduction of 3.68 MW/yr, as shown in Table I-6.

Table I-5. Energy Efficient Homes Component Gross Impact Results for Energy

Stratum	PYRTD (MWh/yr)	Energy Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Downstream Equipment HVAC	17,503	84%	0.79	25%	14,624
Downstream Equipment Other	206	117%	-		241
Downstream Equipment Appliances	215	99%	0.01	1%	212
Downstream Subtotal[2]	**17,924**	**84%**	**0.90**	**24%**	**15,077**
Weatherization	569	62%	3.00	92%	356
Audit	131	62%	0.11	3%	81
Audit and Weatherization Subtotal[2],[3]	**700**	**62%**	**3.57**	**74%**	**437**
New Homes Subtotal[3]	**3,710**	**93%**	**0.20**	**6%**	**3,464**
Online Marketplace Kits	284	127%	0.16	11%	362
Online Marketplace Other	968	95%	0.14	3%	917
Online Marketplace Weatherization	7	197%	0.72	45%	13
Online Marketplace Subtotal[3]	**1,259**	**103%**	**0.18**	**4%**	**1,293**
Instant Discount Subtotal[3]	**10,916**	**90%**	**-**	**-**	**9,785**
High Performance Homes Subtotal[3]	**15**	**97%**	**-**	**-**	**15**
Component Subtotal[3]	**34,525**	**87%**	**1.08**	**11%**	**30,070**
Unverified Instant Discount	11,206	-	-	-	-
Unverified Midstream Equipment	6	-	-	-	-
Unverified Deep Energy Retrofit	17[4]	-	-	-	-
Unverified Subtotal[3]	**11,229**	-	-	-	-
Total (Verified + Unverified)[3]	**45,755**	**-**	**-**	**-**	**30,070**
Online Marketplace (PY14 verified in PY15)	930	115%	0.39	7%	1,074
Instant Discount (PY14 verified in PY15)	3,454	90%	-	-	3,096

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Cadmus used the PY14 historical realization rates for the Audit and Weatherization subcomponent.
[3] Total may not match the sum of rows due to rounding.
[4] Includes 16.53 MWh/yr for Downstream Equipment and 0.46 MWh/yr for weatherization improvements.

Table I-6. Energy Efficient Homes Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System Level PYVTD (MW/yr)
Downstream Equipment HVAC	0.98	117%	**1.4**	**45%**	1.15	1.25
Downstream Equipment Other	0.07	117%	-	-	0.08	0.09
Downstream Equipment Appliances	0.04	99%	**0.0**	**1%**	0.04	0.05
Downstream Subtotal[2]	**1.10**	**116%**	**1.5**	**41%**	**1.27**	**1.38**
Weatherization	0.03	95%	**0.3**	**92%**	0.03	0.03
Audit	0.01	64%	**0.1**	**3%**	0.01	0.01
Audit and Weatherization Subtotal[2],[3]	**0.04**	**88%**	**0.4**	**8%**	**0.04**	**0.04**
New Homes Subtotal[3]	**0.81**	**69%**	**0.4**	**12%**	**0.56**	**0.60**
Online Marketplace Kits	0.02	139%	**0.1**	**9%**	0.03	0.04
Online Marketplace Other	0.10	104%	**0.2**	**5%**	0.11	0.12
Online Marketplace Weatherization	0.00	715%	**2.1**	**105%**	0.00	0.00
Online Marketplace Subtotal[3]	**0.13**	**111%**	**0.2**	**4%**	**0.14**	**0.15**
Instant Discount Subtotal[3]	**1.52**	**85%**	-	**0%**	**1.30**	**1.41**
High Performance Homes Subtotal[3]	**0.003**	**101%**	-	**0%**	**0.003**	**0.003**
Component Subtotal[3]	**3.60**	**92%**	**1.5**	**16%**	**3.31**	**3.60**
Unverified Instant Discount	0.08	-	-	-	-	-
Unverified Midstream Equipment	0.001	-	-	-	-	-
Unverified Deep Energy Retrofit	0.0004[4]	-	-	-	-	-
Unverified Subtotal[3]	**0.08**	**-**	**-**	**-**	**-**	**-**
Total (Verified + Unverified)[3]	**3.68**	**-**	**-**	**-**	**-**	**3.60**
Online Marketplace (PY14 verified in PY15)	0.09	123%	0.3	6%	0.11	0.12
Instant Discount (PY14 verified in PY15)	0.39	85%	-	-	0.33	0.36

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Cadmus applied the realization rates to verified demand reductions before applying distribution losses.
[2] Cadmus used the PY14 historical realization rates for the Audit and Weatherization subcomponent.
[3] Total may not match the sum of rows due to rounding.
[4] Includes 0.00042 MW/yr for Downstream Equipment and 0.00003 MW/yr for weatherization improvements.

The following sections describe the factors that led to discrepancies between the reported and verified savings and the observed realization rates.

Downstream Equipment

Energy and demand realization rates for the HVAC end-use in the Downstream Equipment subcomponent differ from 100% because equipment efficiency was recorded in the tracking database as

SEER2 and heat pump HSPF2; however, Cadmus evaluated all equipment as SEER and HSPF per TRM guidance memos. This generated further complications because the rated capacity may change when HVAC systems receive an updated AHRI certification. Approximately 67% of ductless heat pumps sampled had a different rated heating capacity, and 22% had a different rated cooling capacity when cross-checked in the AHRI database. Air source heat pumps and central air conditioners had similar issues but matched much more closely.

There were additional deviations due to differences in reported and survey-verified baseline heating and cooling equipment:

- For one ductless heat pump project, reported savings used a ductless heat pump baseline for cooling, and two ductless heat pump projects assumed no cooling. However, the verification survey found room air conditioners were the baseline equipment.
- Another project assumed no cooling, but the verification survey found a central air conditioner as the baseline equipment.
- For two ductless heat pump projects, reported savings used an electric furnace baseline for heating equipment. However, the verification survey found non-electric heating was the baseline equipment.
- One ductless heat pump project's reported savings assumed no heat; however, the verification survey found an air-source heat pump was the baseline equipment.

Overall, this led to HVAC equipment realization rates lower than 100% for energy and higher than 100% for demand.

Cadmus also identified discrepancies for smart thermostats that affected realization rates. Among the three sampled smart thermostat projects, two survey respondents provided different existing thermostat types than reported in the tracking data. One respondent said it was self-installed, but it was reported as a professional installation. The other respondent said the equipment controlled an electric furnace and central air conditioner, but it was reported as an air-source heat pump. Overall, this led to smart thermostat realization rates higher than 100% for both energy and demand.

Variable-speed pool pumps were discontinued for PY15 following new federal regulations that preclude the use of the assumed baseline technology, single-speed pool pumps. However, all program units for PY15 were installed in PY14 and can therefore claim savings. Reported savings are consistent with the TRM default assumptions for a 1 HP motor. Cadmus calculated savings based on the nameplate power of the installed unit of 1.5 HP. This resulted in energy and demand realization rates above 100% for pool pumps.

New Homes and High Performance Homes Pilot

The energy realization rate for the New Homes subcomponent was 93% due to model adjustments of the sampled homes based on a desk review of model inputs and changes to baseline home parameters.

The energy realization rate for the High Performance Homes pilot was 97%, primarily due to model adjustments of the sampled homes based on a desk review of model inputs and changes to baseline

home parameters. One home had higher reported kWh savings than reported in the PPL Electric Utilities' savings report project documentation.

Cadmus made the following model adjustments to the New Homes sample and the High Performance Homes pilot sample:

- Aligned reference cities in models with TRM zip code look-ups for 11 of 23 New Homes projects and 2 of 4 High Performance Homes projects
- Corrected model inputs to address discrepancies for 6 of 23 New Homes projects, with the most common adjustments addressing duct leakage rates and slab dimensions inputs
- Made baseline adjustments

For baseline adjustments, Cadmus used the PY14 baseline (based on 2015 IECC) for homes with permit dates before June 1, 2023, and the PY15 (based on 2018 IECC) baseline for homes with permit dates on or after June 1, 2023, which represents the start of PY15:

- After the permit date review, baseline changes affected 14 of 23 sampled homes: 13 changed from PY15 to PY14 baselines, and one changed from PY14 to PY15. Two of the four pilot home baselines changed from PY15 to PY14.
- Cadmus created a custom user-defined reference home file to evaluate PY14 baselines in REM/Rate v16.3.4. The integrated PPL Electric Utilities' savings report in this version of REM/Rate uses PY15 baseline values.

The PY15 evaluation included a technical baseline value review for PY15. Cadmus found that the baseline parameters used by the ICSP aligned with the 2018 IECC; however, these parameters did not always get transferred to correctly calculate the integrated PPL Electric Utilities' savings report. This report is the model output that summarizes kWh/yr savings and feeds into program tracking data. Some of the discrepancies may be due to inconsistencies with baseline assumptions used in REM/Rate software. Cadmus found that, overall, homes modeled with the integrated PPL Electric Utilities' savings report in REM/Rate v16.3.4 overstated energy and demand savings. Four of the 23 New Homes models and one of four High Performance Homes models did not undergo any adjustments.

The demand realization rate for New Homes sample was 69%. The low realization rate was mainly due to a difference in the coincidence factor (used in *ex post* versus *ex ante* demand savings) and model adjustments previously stated. Cadmus used the location of each home in the sample to determine the reference city coincidence factor as specified in the PA TRM Appendix A and applied it to cooling equipment demand savings. The average coincidence factor was 0.397 for the New Homes sample. Cadmus also applied additional demand savings for lighting and appliances from the PY14 analysis, which totaled the average lighting kW per square foot from PY14 site visits times the square feet of each sampled home. The additional appliance demand for each sampled home in PY15 equaled the average appliance total kW from PY14 site visits. The additional lighting and appliance demand added an average of 0.042 kW per home, which raised the realization rate by 9.7%. The additional demand savings increased in PY15 due to the increasing average sample home size (4,000 square feet in PY15 versus 3,688 square feet in PY14).

The High Performance Homes pilot had a demand realization rate of 101%. The demand savings realization rate for the pilot homes was higher than the New Homes sample due to higher additional demand savings attributed to 100% ENERGY STAR appliances (required for Department of Energy [DOE] ZERH certification), and one home had a heat pump water heater. Demand savings for lighting and appliances used model inputs supplemented with PY14 data from site visits to perform engineering calculations aligned with the PA TRM algorithms. HPWH demand savings used model inputs. Without the additional demand savings for lighting, appliances, and HPWH, the High Performance Home pilot would have only achieved a 21% demand realization rate in PY15.

High Performance Home Pilot

The High Performance Home pilot included new construction homes that satisfy the DOE ZERH certification. A ZERH is a high-performance home that is ready for a renewable energy system that can offset most or all the home's annual energy use.

The High Performance Homes pilot included four homes that reported savings in PY15, including one all-electric home with HPWH. Additional homes are expected to report savings in PY16. The four homes included the following mechanical systems:

- Heating/cooling
  - Two fuel-fired furnaces with central AC
    - 96.1% AFUE/15.0 SEER
    - 96.0% AFUE/18.0 SEER
  - One dual-fuel heat pump (electric/propane)
    - 9.5 HSPF and 96.0% AFUE/16.0 SEER
  - One air-source heat pump
    - 12.0 HSPF/22.0 SEER
- Hot water heating
  - Two fuel-fired instant water heaters (natural gas and propane): 0.95 EF each
    - One HPWH: 3.45 EF
    - One natural gas storage heater: 0.69 EF

On average, these homes achieved higher electric energy savings and significantly higher demand savings than the New Homes sample due to more efficient building envelope insulation and air sealing levels, combined with greater equipment efficiencies. Although homes were built “solar-ready” for homeowner installation per the DOE ZERH specification, none of the builders installed solar systems.

As summarized in Table I-7, the High Performance Homes pilot exceeded the sample of New Homes’ electric kWh savings by 47% and demand savings by approximately 1,800% on average per square foot.

Table I-7. High Performance Homes Savings Summary

New Homes Sample vs. High Performance Homes Pilot PY15					
Program	Avg SF	Electric Energy Savings (kWh/yr)		Peak Demand Savings (kW)	
		Average Savings per home	kWh/SF	Average Savings per home	kW/SF
New Homes Sample (n=23)	4,000	2,566	0.641	0.0422	0.000011
High Performance Homes Pilot	3,954	3,728	0.943	0.7967	0.000202

The High Performance Homes sample also had slightly lower roof insulation (but higher exterior wall and foundation wall insulation), more efficient windows, and tighter envelopes than the New Homes sample. Overall, the High Performance Homes pilot had greater electric water heating efficiency and heat pump (air-source and dual-fuel heat pumps) HSPF than New Homes. These envelope characteristics, combined with higher cooling efficiency, electric water heating efficiency, and heat pump heating efficiency, contributed to High Performance Homes' higher electric energy and demand savings.

Table I-8 compares the average home envelope characteristics in Climate Zone 5A (in which all PY15 High Performance Homes were located), electric water heating energy factor, and HSPF between the two programs.

Table I-8. Building Characteristics Summary

New Homes vs. High Performance Homes Building Characteristics (Climate Zone 5A)		
Characteristic	High Performance Homes	New Homes
Roof R Value	45.00	46.33
Exterior Wall R Value	20.76	13.63
Foundation Wall R Value	21.08	17.41
Window U-factor	0.280	0.297
Air Leakage CFM50[(1)]	1,076	1,476
Cooling SEER	17.75	14.86
Electric Water Heating Energy Factor	3.45	0.93
HSPF[(2)]	10.75	9.00

[(1)] A lower CFM50 value (cubic feet per minute at 50 Pascals) represents a tighter envelope.
[(2)] Includes ASHP and dual-fuel heat pump values only.

Online Marketplace

Energy and demand realization rates for the Online Marketplace subcomponent fluctuated from measure to measure primarily due to updated ISRs, but overall realization rates were slightly above 100%. Cadmus calculated ISRs using online survey results from participants, stratifying measures into categories of kit measures, weatherization measures, and other measures. Smart thermostats and outlet gaskets have ISRs independent of the survey strata as they are significantly different than other measures and have large enough samples individually. Cadmus applied the default ISR for LEDs from the PA TRM. *Ex ante* savings used ISRs from the PY13 evaluation report.

Table I-9 lists the *ex ante* and *ex post* ISRs for each Online Marketplace product—as a stand-alone purchase or as a product in the welcome kit—along with the difference. The welcome kit and smart thermostat categories each contributed almost 40% of the Online Marketplace's PY14 and PY15 reported energy savings, and air purifiers contributed another 19%. The remaining measures combined represent less than 5% of total subcomponent savings; the low ISRs for several kit measures substantially reduced overall realization rates.

Table I-9. Online Marketplace In-Service Rates

Measure Category	Stratum	*Ex Ante* ISR	*Ex Post* ISR	Difference
Stand-Alone Purchases				
Dehumidifier	Appliance	100%	73%	-27%
Air Purifier	Appliance	100%	73%	-27%
Advanced power strip	Appliance	77%	73%	-4%
Thermostat	Thermostat	56%	75%	19%
Weatherstripping	Weatherization	59%	89%	30%
Door Sweep	Weatherization	59%	89%	30%
Pipe Insulation	Weatherization	62%	89%	27%
Welcome Kits				
LED Nightlight	Kits	60%	83%	23%
Showerhead	Kits	39%	83%	44%
Bathroom Aerator	Kits	26%	83%	57%
Kitchen Aerator	Kits	37%	83%	46%
Pipe Insulation	Kits	26%	83%	57%
APS	Kits	63%	83%	20%
LED	Kits	52%	98%	46%
Outlet Gasket	Outlet Gasket	21%	28%	6%

Cadmus also used verification surveys to update HVAC system fuel and type saturations for smart thermostats. *Ex ante* savings assumed a 50-50 split between air-source heat pump and central AC with gas heat. The PY15 survey revealed that only 18% of survey respondents heat their homes with heat pumps, and 78% have non-electric heat. Additionally, only 78% of respondents' homes had central cooling systems controlled by a smart thermostat. The increase in ISR and decrease in electric HVAC saturation relative to *ex ante* resulted in an energy realization rate of approximately 100% for smart thermostats in PY15. Welcome kits had realization rates well above 100% due to higher ISRs for all kit measures in PY15. Air purifiers have a realization rate equal to their ISR (73%) because *ex ante* savings assumed a 100% ISR.

Instant Discount

Energy and demand realization rates for the Instant Discount subcomponent were also largely driven by ISRs. Table I-10 lists the *ex ante* and *ex post* ISRs for each Instant Discount measure. The *ex ante* ISR was assumed to be 100% for all measures except smart strips, which had an ISR built into the PA TRM deemed savings value, and pipe insulation, which had an ISR based on the PY13 evaluation report. As such, the overall energy and demand realization rates are less than 100%.

Table I-10. Instant Discount In-Service Rates

Measure Category	*Ex Ante* ISR	*Ex Post* ISR	Difference	*Ex Post* Source
Stand-Alone Purchases				
Dehumidifier	100%	83%	-17%	Survey Data. Combined air purifier and dehumidifier data from Online Marketplace and Downstream Equipment.
Air Purifier	100%	83%	-17%	Survey Data. Combined air purifier and dehumidifier data from Online Marketplace and Downstream Equipment.
Advanced Smart strip	86%	74%	-12%	Survey Data. Average of non-weatherization measures from Online Marketplace.
Room AC	100%	83%	-17%	Survey Data. Combined air purifier and dehumidifier data from Online Marketplace and Downstream Equipment.
Air Filter	100%	100%	0%	Deemed. Assumed to be 100%.
Pipe Insulation	62%	89%	27%	Survey Data. Average of weatherization measures from Online Marketplace.

Except for advanced power strips and air purifiers, each measure's realization rate is fully explained by its ISR. Through the database review, Cadmus found that approximately 2% of power strips sold through the Instant Discount channel were Tier 2, where all reported savings for power strips were consistent with a Tier 1 power strip. Cadmus evaluated air purifiers based on deemed savings tables from the PA TRM, which are binned according to the unit's rated clean air delivery rate (CADR). Cadmus evaluated savings using the smoke-free CADR; however, reported savings used a combination of smoke- and dust-free CADR, which categorized units near the extreme end of a bin differently. This affected about 14% of units, which decreased *ex post* savings. An additional 5% of air purifiers in the program tracking data appeared to be using an incorrect savings algorithm, which resulted in underreported savings. Based on Cadmus' review, this was likely a database error, as this set of air purifiers appeared to be using deemed savings for advanced power strips. Applying the correct PA TRM algorithm resulted in increased *ex post* savings. These discrepancies offset one another and resulted in air purifier realization rates only slightly lower than the ISR alone for PY15.

I.2. Net Impact Evaluation

I.2.1. Net Impact Methodology

Cadmus applied methods outlined in the Evaluation Framework to determine free ridership, spillover, and net savings for downstream, upstream, and midstream programs.[56] Cadmus used online self-report surveys to assess free ridership and spillover for the Downstream Equipment and Online Marketplace strata. However, due to unique challenges presented by an upstream program design, in which customer purchases of discounted products are not tracked, Cadmus applied measure-level PY15 NTG ratios estimated from self-report data gathered through the Downstream Equipment and Online

[56] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

Marketplace subcomponents. Cadmus also applied the recommended NTG ratios from a recent New Jersey TRM NTG recommendations guidance document to Instant Discount stratum measures where there was not a similar PPL Electric Utilities NTG researched value to leverage.[57] This was a change to the approved evaluation plan.

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

Table I-11 lists the methods and sampling strategy used to determine net savings for the Downstream Equipment and Online Marketplace strata in PY15. Net savings for Midstream Equipment will be assessed in PY16. Cadmus assigned an NTG ratio of 1.0 for pilot projects in High Performance Homes.

Table I-11. Energy Efficient Homes Component Net Impact Evaluation Sample Design

Stratum	Evaluation Year	Stratum Boundaries	Population Size[(1)]	Achieved Sample Size[(2)]	NTG Activity
Downstream Equipment – Refrigerator	PY15	Participants (Customers)	1,436	38[(3)]	Participant online survey
Downstream Equipment – Dehumidifier	PY15		632	34[(3)]	
Downstream Equipment – Central Air Conditioner	PY15		780	25[(3)]	
Downstream Equipment – Air-Source Heat Pump	PY15		1,454	35[(3)]	
Downstream Equipment – Ductless Heat Pump	PY15		2,167	111[(3)]	
Downstream Equipment - Smart Thermostat	PY15		1,048	37[(3)]	
Downstream Equipment – Heat Pump Water Heater	PY15		367	21[(3)]	
Downstream Equipment – Other	PY15		170	9[(3)]	
Online Marketplace	PY15	PY14/PY15 Participants	6,818	67[(4)]	Participant online survey

[(1)] The population sizes differ between impact, process, and net savings analysis.

[(2)] The number of respondents used in the net savings analysis differs from the number used in the gross impact and process evaluation.

[(3)] Achieved sample size is based on the number of survey respondents answering the first free ridership question, "Which of the following would have happened if you had not received the $[Field-REBATE] to purchase your [MEASURE]?" and answering at least of one of the questions, "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 on your decision. The $[REBATE] for the [MEASURE], C8b. PPL Electric Utilities' information about energy efficiency.

[(4)] The achieved sample size is based on the number of survey respondents answering the free ridership questions for discounted measure participants and kit measures participants.

[57] New Jersey Board of Public Utilities. *New Jersey 2023 Triennial Technical Reference Manual for 2024 Filings.* May 23, 2023. https://njcepfiles.s3.amazonaws.com/QO23030150-+Tri2+EE1+%2B+EE2-+Order+Attch+C-+TRM.pdf

Free Ridership

Cadmus summed the intention and influence free ridership components to estimate the average total intention and influence free ridership by stratum, weighted by verified gross kWh/yr savings.

Table I-12 summarizes the intention, influence, and free ridership scores for the Downstream Equipment and Online Marketplace strata.

Table I-12. Energy Efficient Homes Component Intention, Influence, and Free Ridership Score by Stratum

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Downstream Equipment – Refrigerator	38	40%	17%	57%
Downstream Equipment – Dehumidifier	34	30%	14%	44%
Downstream Equipment – Central Air Conditioner	25	32%	24%	56%
Downstream Equipment – Air-Source Heat Pump	35	31%	16%	47%
Downstream Equipment – Ductless Heat Pump	111	33%	20%	53%
Downstream Equipment – Smart Thermostat	37	31%	12%	43%
Downstream Equipment – Heat Pump Water Heater	21	34%	12%	46%
Downstream Equipment – Other	9	22%	10%	32%
Online Marketplace – Smart Thermostat (Discounted)	39	10%	4%	14%
Online Marketplace – Dehumidifier (Discounted)	9	22%	18%	40%
Online Marketplace – Air Purifier (Discounted)	3	25%	8%	33%
Online Marketplace – Weatherstripping (Discounted)	3	17%	13%	30%
Online Marketplace – Advanced Power Strip (Discounted and Kits combined)	11	20%	2%	22%
Online Marketplace – Pipe Insulation (Discounted and Kits combined)	5	0%	0%	0%
Online Marketplace – LED Bulbs (Kits)	9	17%	1%	18%
Online Marketplace – LED Nightlight (Kits)	10	9%	4%	13%
Online Marketplace – High-Efficiency Showerhead (Kits)	5	5%	5%	10%
Online Marketplace – High-Efficiency Bathroom Faucet Aerator (Kits)	4	0%	0%	0%
Online Marketplace – High-Efficiency Kitchen Faucet Aerator (Kits)	4	0%	0%	0%
Online Marketplace – Outlet Gaskets (Kits)	6	0%	6%	6%

Spillover

Table I-13 lists the quantity of spillover energy-efficient equipment types that the respondents for the Downstream Equipment and Online Marketplace strata attributed to PPL Electric Utilities. The table also lists the per-unit energy savings and the source of the estimated energy savings used in the spillover analyses.

Table I-13. Energy Efficient Homes Component Spillover Calculation

Spillover Product	Respondent Quantity	Per-Unit Savings (kWh/yr)	Savings Source
Downstream Equipment			
Air Source Heat Pump	4[(1)]	846	PY15 PPL Electric Utilities Gross Verified Savings
Central Air Conditioner	2	213	PY15 PPL Electric Utilities Gross Verified Savings
Clothes Dryer	4	25	2021 PA TRM
Clothes Washer	6[(1)]	95	2021 PA TRM
Dehumidifier	2[(1)]	141	PY15 PPL Electric Utilities Gross Verified Savings
Dishwasher	6	23	2021 PA TRM
Ductless Heat Pump	2	1,379	PY15 PPL Electric Utilities Gross Verified Savings
Freezer	1	27	2021 PA TRM
Heat Pump Water Heater	1	1,307	PY15 PPL Electric Utilities Gross Verified Savings
Insulation	9 projects[(1)]	327	PY15 PPL Electric Utilities Gross Verified Savings
Pipe Insulation	1	16	PY15 PPL Electric Utilities Gross Verified Savings
Refrigerator	11	62	PY15 PPL Electric Utilities Gross Verified Savings
Online Marketplace			
Central Air Conditioner	2	213	PY15 PPL Electric Utilities Gross Verified Savings
Clothes Dryer	1	25	2021 PA TRM
Clothes Washer	1	95	2021 PA TRM
Freezer	1	27	2021 PA TRM
Insulation	2 projects	327	PY15 PPL Electric Utilities Gross Verified Savings

[(1)] 50% of per-unit savings kWh/yr applied to one unit or project due to a maximum PPL Electric Utilities influence rating of three, on a 1 to 5 scale, with 1 meaning not at all influential and 5 meaning extremely influential.

Table I-14 shows the spillover results for the PY15 evaluated equipment categories of the Downstream Equipment and Online Marketplace strata.

Table I-14. Energy Efficient Homes Component Spillover Calculation for Downstream Equipment Categories and Online Marketplace

Variable	Variable Description	Downstream Equipment	Online Marketplace	Source
A	Survey Sample Size (n)	310	67	Survey Data
B	Total Survey Sample Spillover kWh/yr Savings	11,835	1,226	Survey Data/Engineering Estimates
C	Average Spillover kWh/yr Savings Per Survey Respondent	38.2	18.3	Variable B ÷ Variable A
D	Program Participant Population	8,054[(1)]	5,492[(2)]	Program Tracking Data
E	Spillover kWh/yr Savings Extrapolated to the Participant Population	307,840	100,504	Variable C × Variable D
F	Evaluated Program Population kWh/yr Savings	15,076,842	1,293,035	Evaluated Gross Impact Analysis
G	Spillover Percentage Estimate	2%	8%	Variable E ÷ Variable F

[(1)]8,054 unique PY15 participants.
[(2)]5,492 unique PY15 participants.

I.2.2. Net-to-Gross Results

Table I-15 shows the Downstream Equipment strata free ridership, spillover, and NTG ratios by equipment category.

Table I-15. Energy Efficient Homes Component – Downstream Equipment Net Impact Evaluation Results

Equipment Category	PYVTD kWh/yr	Evaluation Year	Free Ridership (%)[(1)]	Spillover (%)	NTG Ratio
Refrigerator	105,004	PY15	57%	2%	0.45
Dehumidifier	107,420	PY15	44%	2%	0.58
Central Air Conditioner	220,680	PY15	56%	2%	0.46
Air Source Heat Pump	1,752,542	PY15	47%	2%	0.55
Ductless Heat Pump	11,185,999	PY15	51%	2%	0.51
Smart Thermostat	610,788	PY15	43%	2%	0.59
Heat pump Water Heater	675,754	PY15	46%	2%	0.56
Other	418,654	PY15	32%	2%	0.70
Total[(2),(3)]	**15,076,842**	**-**	**50%**	**2%**	**0.52**

[(1)] Free ridership estimates were weighted by the survey sample-verified component kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the component have a greater influence on the equipment-level free ridership estimate than do respondents who achieved lower energy savings.
[(2)] Equipment- level free ridership, spillover, and NTG estimates were weighted by the product's verified kWh/yr component population savings to arrive at the Downstream Equipment stratum NTG ratio of 0.52.
[(3)] Total may not match the sum of rows due to rounding.

Table I-16 shows the Online Marketplace strata free ridership, spillover, and NTG ratios by measure category.

Table I-16. Energy Efficient Homes Component – Online Marketplace Net Impact Evaluation Results

Measure Category	PYVTD kWh/yr	Evaluation Year	Free Ridership (%)[1]	Spillover (%)	NTG Ratio
Smart Thermostat (Discounted)	494,151	PY15	14%	8%	0.94
Dehumidifier (Discounted)	10,680	PY15	40%	8%	0.68
Air Purifier (Discounted)	400,818	PY15	33%	8%	0.75
Weatherstripping (Discounted)	11,790	PY15	30%	8%	0.78
Advanced Power Strip (Discounted and Kits combined)	134,397	PY15	22%	8%	0.86
Pipe Insulation (Discounted and Kits combined)	6,383	PY15	0%	8%	1.08
LED Bulbs (Discounted and Kits combined)	42,544	PY15	18%	8%	0.90
LED Nightlight (Kits)	41,149	PY15	13%	8%	0.95
High-Efficiency Showerhead (Kits)	92,440	PY15	10%	8%	0.98
High-Efficiency Bathroom Faucet Aerator (Kits)	7,147	PY15	0%	8%	1.08
High-Efficiency Kitchen Faucet Aerator (Kits)	40,399	PY15	0%	8%	1.08
Outlet Gaskets (Kits)	11,138	PY15	6%	8%	1.02
Total[2],[3]	**1,293,035**	**-**	**20%**	**8%**	**0.88**

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

[2] Measure-level free ridership, spillover, and NTG estimates were weighted by the subcomponent population's verified kWh/yr savings to arrive at an NTG ratio of 0.88 for the Online Marketplace stratum.

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

Primary NTG research was not conducted for the Instant Discount stratum in PY15. Cadmus applied measure-level NTG ratios from the PY15 Online Marketplace and PY15 Downstream Equipment NTG research for measures similar to Instant Discount stratum measures. In addition, Cadmus applied recommended NTG ratios from a recent New Jersey TRM NTG recommendations guidance document for Instant Discount stratum measures where there was not a similar PPL Electric Utilities NTG researched value to leverage.[58] Table I-17 shows the NTG ratios and the source of the NTG ratios applied to PY15

[58] New Jersey Board of Public Utilities. *New Jersey 2023 Triennial Technical Reference Manual for 2024 Filings.* May 23, 2023. https://njcepfiles.s3.amazonaws.com/QO23030150-+Tri2+EE1+%2B+EE2-+Order+Attch+C-+TRM.pdf

Instant Discount stratum measures, along with the overall PY15 Instant Discount stratum NTG ratio that is based on weighting the measure level NTG ratios by PY15 gross verified kWh/yr savings.[59]

Table I-17. Energy Efficient Homes Component NTG Ratios Applied to PY15 Instant Discount Stratum Measures

Instant Discount Stratum Measure	PYVTD kWh/yr	Free Ridership (%)	NTG Ratio	NTG Ratio Source
Advanced Power Strip	4,676,906	22%	0.78	PY15 PPL EEH Online Marketplace
Air Filter	287,195	40%	0.60	NJ TRM (Furnace/Air Handler Filter Whistle)
Air Purifier	1,729,804	33%	0.67	PY15 PPL EEH Online Marketplace
Dehumidifier	1,976,478	44%	0.56	PY15 PPL EEH Downstream Equipment
Pipe Insulation	1,091,388	0%	1.00	PY15 PPL EEH Online Marketplace
Room Air Conditioner	22,773	46%	0.54	NJ TRM (Room A/C Unit)
Overall	**9,784,545**	**27%**	**0.73**	

Table I-18 shows the NTG ratio results for each stratum of the Energy Efficient Homes component. The overall Energy Efficient Homes component NTG ratio of 0.62 is heavily weighted towards the Downstream Equipment stratum NTG ratio of 0.52, as this stratum represents 50% of the Energy Efficient Homes component verified gross population energy savings.

Table I-18. Energy Efficient Homes Component NTG Ratio Summary

Stratum	PYVTD kWh/yr	Evaluation Year	Free Ridership (%)[(1)]	Spillover (%)	NTG Ratio
Audit and Weatherization	436,653	PY14	53%	14%	0.61
Downstream Equipment	15,076,842	PY15	50%	2%	0.52
Online Marketplace	1,293,035	PY15	20%	8%	0.88
Instant Discount	9,784,545	PY15/Benchmarking	27%	0%	0.73
New Homes	3,464,266	PY13	36%	0%	0.64
High Performance Homes	14,910	Deemed	0%	0%	1.00
Component Total[(2),(3)]	**30,070,252**	**-**	**40%**	**2%**	**0.62**

[(1)] Stratum-level free ridership estimates were weighted by the survey sample-verified component kWh/yr savings. This method ensured that respondents who achieved higher energy savings through the component products had a greater influence on the equipment-level free ridership estimate than did the respondents who achieved lower energy savings.
[(2)] The stratum-level free ridership, spillover, and NTG ratio estimates were weighted by the component population's verified kWh/yr savings to arrive at the final Energy Efficient Homes component NTG ratio of 0.62.
[(3)] Total may not match sum of rows due to rounding.

[59] Weatherization measures are not included in the table due to PY15 gross savings for Instant Discount stratum weatherization measures being reported as unverified in PY15. PY15 savings will be verified in the PY16 evaluation report. Participant spillover associated with the benchmarked NTG analyses were not applied to Instant Discount stratum measures due to participant spillover not being a primary focus of the design of upstream retailer instant discount programs.

I.3. Process Evaluation

Cadmus conducted a full process evaluation of the Energy Efficient Homes component using data collected through an online participant survey and interviews with staff from PPL Electric Utilities, the ICSP, and the ICSP's subcontractors. The research objectives for the process evaluation were to assess participant satisfaction, review component changes and performance, assess component design and market actor experience, and make recommendations for improvement. Table I-19 shows the sampling strategy for the process evaluation. The results from the participant survey produced a measure of component satisfaction with ±10% precision at 90% confidence. See *Appendix L. Survey Bias* for details on Cadmus' approach to reduce survey bias and contact instructions.

Process activities were consistent with planned activities, with a few exceptions. Due to the low sample size, Cadmus did not complete the interviews with the midstream equipment distributors and purchasers or the midstream customer survey. However, Cadmus plans to conduct these activities in PY16. Cadmus also completed one additional online survey to measure customer satisfaction among Audit and Weatherization subcomponent participants, as requested by PPL Electric Utilities. The results from these surveys are included in the Process Evaluation findings in this chapter, along with the overall Energy Efficient Homes satisfaction score found in Chapter 7, Section *Process Evaluation Key Findings* of this report.

A total of 412 respondents—325 in Downstream Equipment and 87 in Online Marketplace subcomponents—completed the online survey from May through June 2024. For the Audit and Weatherization subcomponent satisfaction survey, which was not a planned process evaluation activity, 49 respondents completed the online survey in July 2024 (12 Audit participants and 37 Weatherization participants).

Cadmus also completed interviews with builders participating in the High Performance Homes Builder pilot program. These interviews assessed pilot experience, the impact of technical assistance, market barriers, and the influence of the pilot, and gathered feedback for improvement.

Sample sizes noted in this report may vary by survey or interview question because respondents could skip questions they chose not to answer; therefore, not all respondents provided answers to every question. Cadmus included all survey and interview respondents who answered at least one question, even if they did not complete the survey or interview.

Table I-19. Energy Efficient Homes Component Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records in 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, ICSP, and the ICSP's subcontractors	Telephone in-depth interview	3	N/A	Up to 3	2	N/A	100%
Component Participants	Downstream Equipment	Online survey	6,406 [3]	85/15	All eligible	325[4]	3,750	100%
	Online Marketplace	Online survey	6,818 [3]	85/15	All eligible	87[4]	2,391	100%
	Weatherization	Online survey	2,901	85/15	All eligible	37[4]	735	100%
	Audit	Online survey				12[4]		
Pilot Program	High Performance Homes	In-depth builder interviews	4	N/A	4	4	N/A	100%
		In-depth implementor interview	3	N/A	1	3	N/A	100%
Component Total			**16,135**	**-**	**-**	**470**	**6,876**	**100%**

[1] Sample frame is a list of participants and stakeholders with contact information who had a chance to complete the survey or interview. 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 that did not have valid contact information (email or telephone number), was on the do not call list, or opted out of the online survey.

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

[3] Number of participants in the PPL Electric Utilities' tracking database at the time of the PY15 survey, which occurred before the end of the program year.

[4] Achieved sample size shows the number of respondents who completed the survey. When reporting, Cadmus included all responses in the analysis, even if the respondent did not complete the survey. The number of respondents used in the process evaluation differs from numbers used in the gross impact and net impact analysis.

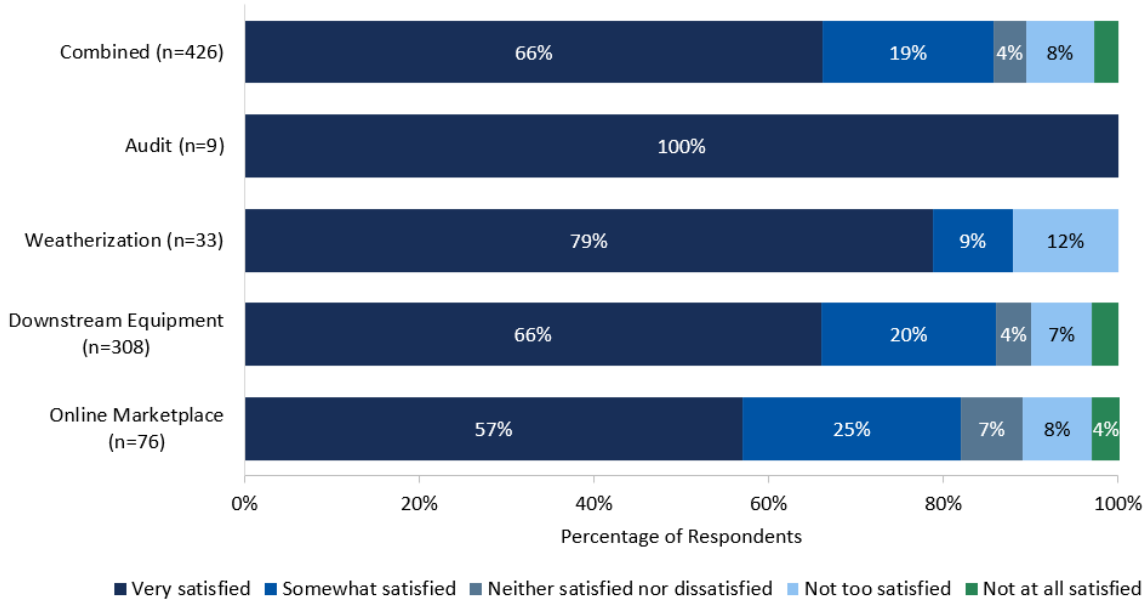
I.3.1. Program Component Experience

Downstream Equipment, Online Marketplace, and Audit and Weatherization respondents rated satisfaction with their experience with different aspects of the Energy Efficient Homes component, provided insights about their satisfaction ratings, and rated the effect of their participation on their opinion of PPL Electric Utilities.

Program Component Satisfaction and Customer Effort

Across all subcomponents, nearly all respondents were satisfied with their experience (Figure I-1), with 86% overall satisfaction (as measured by responses of *very* or *somewhat satisfied*).[60]

Figure I-1. PY15 Overall Satisfaction with Energy Efficient Homes by Subcomponent



Source: Downstream Equipment, Online Marketplace, and Customer Satisfaction Participant Survey/Guide, "Thinking about your overall experience with the PPL Electric Utilities [program], how would you rate your satisfaction?" Totals may not sum due to rounding. Due to rounding the sum of *very* and *somewhat satisfied* shown here may not match the totals in the infographic. Sample sizes reflect partially completed surveys.

Drivers of Program Component Satisfaction

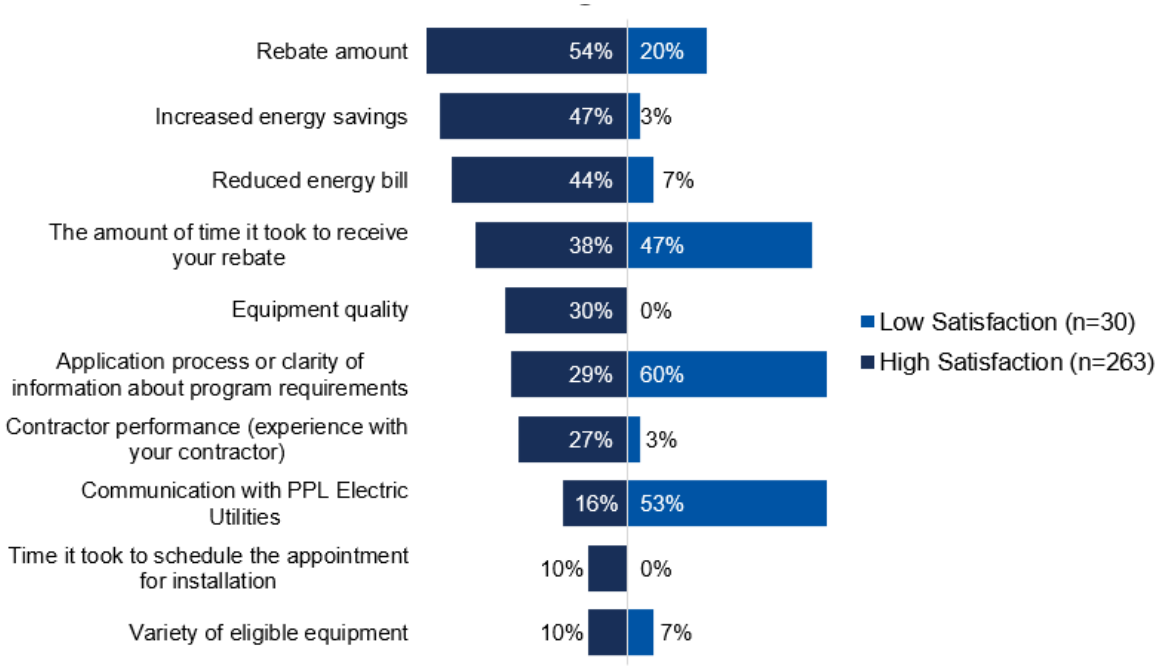
To better understand what drives satisfaction, the survey asked participants of the Downstream Equipment, Online Marketplace, and Audit and Weatherization subcomponents what factor(s) led to their satisfaction rating. In Downstream Equipment, as shown in Figure I-2, drivers of positive experiences were the rebate amount (54%, n=263), increased energy savings (47%), and reduced energy bill (44%).

Thirty Downstream Equipment respondents who were *neither satisfied nor dissatisfied*, *not too satisfied*, or *not at all satisfied* with their overall experience with the rebate provided a reason for their

[60] Due to rounding the sum of *very* and *somewhat satisfied* shown in the figure may not match the totals in the infographic. Sample sizes reflect partially completed surveys

dissatisfaction (Figure I-2). Rebated equipment in this group included ductless heat pumps, smart thermostats, dehumidifiers, air-source heat pumps, refrigerators, central air conditioners, fuel switch water heaters, heat pump water heaters, and pool pumps. The main reasons these participants cited as impacting their experience were the application process or clarity of information about program requirements (60%), communication with PPL Electric Utilities (53%), and the amount of time it took to receive rebates (47%).

Figure I-2. Drivers of High and Low Satisfaction for Downstream Equipment



Source: Participant Survey, "What factor(s) most affected the overall experience rating you gave?" (n=293; multiple responses allowed)

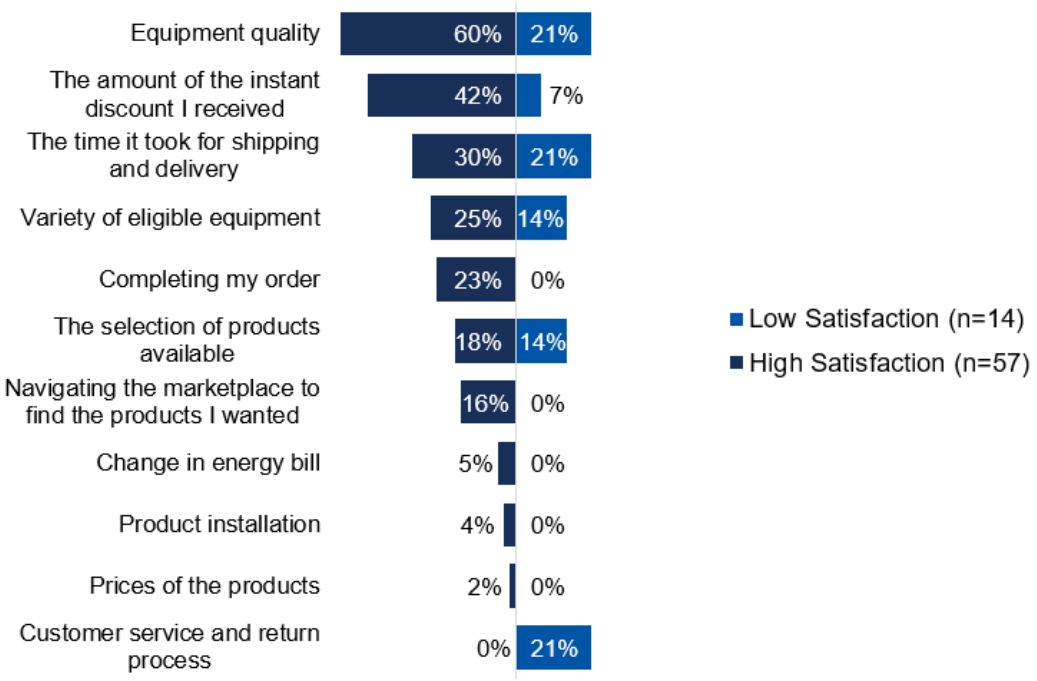
As shown in Figure I-3, for the Online Marketplace respondents, the top drivers of high satisfaction were equipment quality (60%, n=57), the amount of the instant discount received (42%), and the time it took for shipping and delivery (30%).

Fourteen respondents were *neither satisfied nor dissatisfied, not too satisfied,* or *not at all satisfied* with their overall experience with the Online Marketplace (these respondents all purchased various products on the Marketplace).

Six thermostat purchasers provided feedback on their low ratings: three said equipment quality, one said shipping and delivery time, and another said the Instant Discount amount. One respondent had difficulty communicating with the customer service representative and could not return the item. One dehumidifier purchaser cited equipment quality, another reported shipping and delivery delays, and a third had difficulties with returns. This respondent specifically mentioned difficulty returning an item, stating they eventually spoke to someone who said they would send a return form but never did. One air purifier buyer and one weatherstripping buyer both cited product selection. Purchasers of advanced

power strips, door sweeps, and pipe insulation did not provide feedback on their low ratings. Respondents could select more than one factor as a reason for their satisfaction rating.

Figure I-3. Online Marketplace Drivers of High and Low Satisfaction

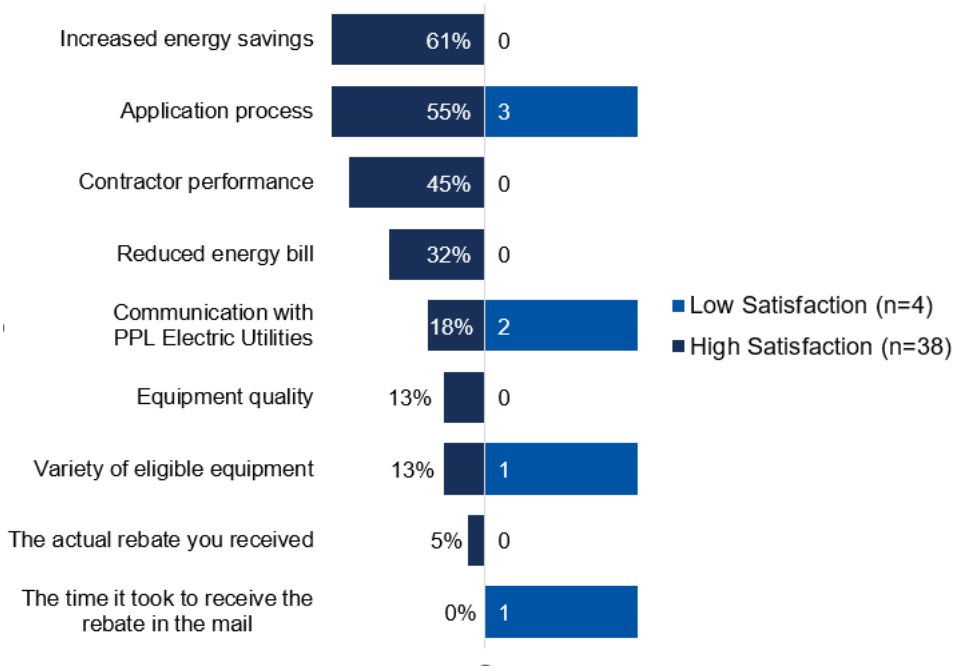


Source: Participant Survey, "What factor(s) most affected the overall experience rating you gave?" (n=71; multiple responses allowed)

As shown in Figure I-4, the top drivers of high satisfaction for the Audit and Weatherization respondents were increased energy savings (61%, n=38), the application process (55%), and contractor performance (45%).

There were four respondents who were *neither satisfied nor dissatisfied, not too satisfied,* or *not at all satisfied* with their overall experience with the program. The drivers for their low ratings were related to the application process (three respondents), communication with PPL Electric Utilities (two respondents), variety of eligible equipment (one respondent), or the time it took to receive the rebate in the mail (one respondent).

Figure I-4. Audit and Weatherization Drivers of High and Low Satisfaction



Source: Participant Survey, "What factor(s) most affected the overall experience rating you gave?" (n=42; multiple responses allowed)

Helpfulness of Buyer's Guides

The survey asked Online Marketplace respondents if they had reviewed the Buyer's Guides on the Marketplace website, showing them an image of the website as a reminder. Fifteen respondents said they had reviewed the guide. When asked which guide they viewed, five respondents said the advanced power strip guide, and 10 said the smart thermostat guide.

The survey asked respondents who viewed either Buyer's Guide how helpful the guide was in deciding what to purchase. Four of the five advanced power strip respondents said the guide was *very helpful,* and one respondent said it was *helpful*. Three of the 10 smart thermostat respondents found the guide *very helpful,* and two found it *helpful*. Four respondents said it was *neither helpful nor unhelpful,* and one did not answer this question.

Opinion of PPL Electric Utilities

Offerings in the Downstream Equipment, Online Marketplace, and Audit and Weatherization subcomponents impacted how customers view PPL Electric Utilities. Forty-nine percent of Downstream Equipment respondents (n=301) and 39% of Online Marketplace respondents (n=64) said their opinion of PPL Electric Utilities had improved. Fifty-three percent of Audit and Weatherization respondents (n=40) said their opinion of PPL Electric Utilities had improved. Less than 10% in each subcomponent said their opinion of PPL Electric Utilities had decreased, and the rest said their opinion had not changed.

When asked why their opinion of PPL Electric Utilities decreased since participating in the program, 16 Downstream Equipment respondents provided reasons. Five ductless heat pump purchasers reported

application or rebate issues, while another found the process time-consuming. One smart thermostat purchaser cited application or rebate issues, one was confused about the requirements and qualifications, and one cited communication issues. Both heat pump water heater purchasers found the process time-consuming. Both air-source heat pump buyers experienced confusion with program requirements and qualifications. One refrigerator purchaser, one pool pump buyer, and one dehumidifier purchaser also cited application or rebate issues.

When asked why their opinion of PPL Electric Utilities decreased after ordering a product from the Online Marketplace, two thermostat respondents provided specific reasons. One said, "The marketplace was fine, but [the] installation was not completed as the thermostat did not apply to my existing system." The other respondent said, "No exception was made with the return policy. I know it took me a while, but that was because it was a challenge to install."

When asked why their opinion of PPL Electric Utilities decreased since participating in the program, two Audit and Weatherization respondents provided specific reasons. One respondent said, "[I] was told false information about my rebate check. They had to send out three [rebate checks] before it was correct, and I [finally] received [it]." The second respondent was dissatisfied with PPL Electric Utilities' response.

Improvement Suggestions

The survey asked respondents what PPL Electric Utilities could do to improve the Energy Efficient Homes component. Not all respondents had a suggestion.

For the Downstream Equipment subcomponent, 87 respondents (27%; n=325) suggested improvements, and of these, 36 respondents suggested improving the application process and tracking or improving customer service. Another 23 of the 87 respondents requested that PPL Electric Utilities broaden rebates for qualifying products or increase rebate amounts. Fifteen respondents suggested that PPL Electric Utilities clarify or improve the eligibility guidelines for qualifying products or equipment. Other suggestions included timely delivery of rebates (10 respondents) or increasing advertising to raise awareness of the offerings (three respondents).

For the Online Marketplace, 19 respondents (22%; n=87) made suggested improvements that fell into the following categories:[61]

- Expand and improve product offerings (nine responses)
- Improve customer service (four responses)
- Implement faster shipping (three responses)
- Communicate product value (three responses)
- Improve smart thermostat compatibility guidelines (one response)

[61] Respondents could provide multiple responses.

Respondents said they would like to see more smart thermostats, air conditioners, and water heaters on the Online Marketplace.

For the Audit and Weatherization subcomponent, 15 respondents (31%; n=49) made a suggestion. Suggested improvements fell into the following categories:

- Improve application or rebate process (six responses)
- Improve customer experience and product offerings (three responses)
- Increase awareness of the program (three responses)
- Increase the amount of rebates or offer more rebates (two responses)
- Provide educational information on tax credits for energy efficiency (1=one response)

I.3.2. Pilot Findings

Pilot Design and Delivery

Cadmus interviewed implementors to understand the High-Performance Homes pilot's design and activities. The findings are summarized below.

Pilot Goals

The pilot program sought to identify the obstacles and knowledge gaps between the approaches taken in New Homes and the DOE's ZERH certification, particularly in cost and expertise. The interviewed pilot staff confirmed the pilot chose ZERH standards as a level above the existing ENERGY STAR tier, as ZER homes need tighter envelopes, better insulation, higher efficiency mechanicals, and better ventilation. Likewise, the incentives were designed to cover the incremental cost between a typical PPL Electric Utilities program component home and one that meets the ZERH standard. PPL Electric Utilities granted an average of $23,000 per project to cover the incremental costs involved in building to the ZERH standard. The pilot initially aimed for three builders to participate and exceeded their goal with four participants who built five homes (one pilot home will be reported and verified in PY16).

Participant Recruitment and Educational Activities

The ICSP and its subcontractors, CLEAResult and PSD, used their network of Home Energy Raters (HERs raters) to recruit builders into the pilot. ICSP staff explained that they first contacted HERs raters to tell them about the pilot program and opportunities to participate; raters then recommended the program to builders. In some cases, the ICSP also reached out to builders on a case-by-case basis. Staff at PSD reported that raters working with the pilot did not have prior experience with ZERH, and PSD provided technical assistance, such as guiding raters in challenges that did not go according to plan. Once the homes were complete, the pilot showcased them in open houses and webinar events. Event themes included "the home of the future is available today," aiming to educate participants on the differences between code built and ZERH standards.

Builder Feedback

Cadmus interviewed all of the builders in the pilot program (four) to assess their pilot experience. The findings are compiled below by topic area.

ZERH Experience

None of the builders had designed and built a ZERH before the pilot; however, all builders regularly received incentives through the PPL Electric Utilities New Homes program or another Pennsylvania program for energy-efficient program homes. The ZERH criteria were not a concern for builders to construct. However, all builders said the heaviest lift was understanding ZERH requirements to make sure their designs aligned. One builder stated, "My idea with this pilot was that I was figuring it out as I went along with my partners... I was learning it as I was going and knew I would be doing it better the next time around." When asked which criteria were initially challenging to understand or design, two builders said paying attention to the details in insulation to achieve the efficiency required, two had uncertainty with solar square footage and orientation, one cited ductwork in conditioned spaces, and one cited the paperwork.

Public Outreach and Education

Builders had very positive feedback on the open houses that the ICSP coordinated. All of the respondents highlighted the success of open houses, citing high interest and turnout from a range of stakeholders, including trades and the public. One builder stated, "We had people stay after to dig in deeper. Everyone wanted to save financially with energy efficiency [in their] homes, and folks wanted to know what would be different from other homes." According to the builders, customers at the open houses were most interested in insulation/envelope tightness, monitoring air quality/controlling air changes, and the energy recovery ventilator system. One noted that due to the interest in the envelope, their open house displayed images of the walls in different stages of construction to demonstrate efficiency. Builders also appreciated the open house marketing, as it portrayed their work in a positive light and generated publicity for their business.

Impact of Technical Assistance

Three of the four builders learned new techniques they hope to integrate into their buildings from their participation in the pilot, and three of the four builders reported that they would not change anything about their rating and technical assistance process, with most builders having very positive feedback for their raters, along with the technical program team. One builder described their rater as "the MVP—he knows incentives and process and programs, he fills out what's needed, he gets over the finish line, and keeps his antenna up for what's out there. He suggests... incremental changes that get the score up or down." One builder was less satisfied with their rater, attributing challenges to growing pains and organizational turnover. Overall, multiple builders confirmed there is demand for more technical assistance and education on deeper energy efficiency and ZERH strategies. One builder reported receiving calls from other builders asking for tips.

Market Barriers and Influence of the Pilot

Two builders said the top barriers for customers to engage with energy-efficient homes are education, and two said price. All builders agreed that most customers do not care about the internal mechanics beyond basic functioning in their homes, but they do care about its external appearance.

Without the pilot, none of the builders would have built a ZERH, citing the barriers of awareness (two respondents), education (two respondents), and client budget (two respondents), which the pilot's

design considered in the program's development. All builders reported that they would consider building ZER homes in the future, but their hesitations include client interest/willingness to pay for ZERH (two respondents), cost (two respondents), and the design requirements.

Program Satisfaction and Suggestions for Improvement

When asked about ways to improve the pilot, three of the four builders had no suggestions for the program. One builder suggested higher incentive levels, opportunities to reduce the administrative burden, and improved responsiveness from the DOE as areas they would like to see improved. All the builders had positive feedback that the program was well run, with two builders initiating interest in doing the program again. On a five-point word scale ranging from *very satisfied* to *not at all satisfied*, all builders gave the pilot the highest possible rating for their overall satisfaction: *very satisfied.*

> *"We had a blast doing this, learning, talking, getting out in the community and getting homes built, and we would love to do this again... folks ask us 'how did you get into this program; we want to get into this too!'"*
> – Participating Builder

Future Program Design

Builders explained that barriers to advancing ZERH include cost and, specifically, concern about low demand among clients who are not willing to pay the incremental cost. Despite providing incentives during the pilot, the ICSP shared concerns that dual-fuel ZERHs may not generate enough savings above ENERGY STAR homes to be cost-effective enough for a longer-term program offering. Analysis by the ICSP found that gas-fueled heating and water heating equipment result in only slightly better electric savings than ENERGY STAR-certified homes. The ICSP said to generate cost-effective savings, PPL Electric Utilities could consider an all-electric pilot, incorporate a tiered incentive structure with higher incentives to all-electric homes in future phases of the pilot, or include this type of tiered structure into their existing New Construction program.

I.3.3. Other Findings

Participant Profile and Survey Sample Attrition

Equipment, Online Marketplace, and Audit and Weatherization

The PY15 surveys collected demographic information about participants in the Energy Efficient Homes component.[62] Figure I-5 shows the characteristics of the respondents.

[62] Includes data on Online Marketplace, Downstream Equipment, and Audit and Weatherization.

Figure I-5. Energy Efficient Homes Participant Profile

Attribute	Downstream Equipment[1]	Online Marketplace[2]	Audit and Weatherization[3,4]
Housing type – percent living in a single-family detached home	85%	76%	83%
Average household size	2.2 people	2.1 people	-
Average age	66 years of age	55 years of age	-
Completed some college education or more	74%	78%	-
Household income of $50,000 or more	62%	60%	-

[1] Downstream equipment (n=233-305)
[2] Online Marketplace (n=53-63)
[3] The customer satisfaction survey included only one demographic question: "What type of residence do you live in?"
[4] Audit and Weatherization (n=41)

Table I-20 lists the total number of records contacted via online survey and the outcome (final disposition) of each record. Additional details on the survey methodology are in *Appendix L*.

Table I-20. Energy Efficient Homes Online Participant Survey Sample Attrition

Description of Outcomes of Online Participant Survey	Number of Records		
	Downstream Equipment	Online Marketplace	Audit and Weatherization
Population (number of unique jobs)	**6,406**	**6,818**	**2,901**
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	2,654	4,425	2,105
Removed: incomplete or invalid email address or phone number	2	2	61
Survey Sample Frame (records attempted)	**3,750**	**2,391**	**735**
Not reached or non-working: Opted out, email returned (bounce back), did not respond	3,362	2,277	686
Partially completed survey; ineligible for survey	63	27	0
Completed Surveys (online)	**325**	**87**	**49**
Overall Response Rate	**9%**	**4%**	**7%**

PPL Electric Utilities

CADMUS

STUDENT ENERGY EFFICIENT EDUCATION

This component of the Residential Program provides a school-based energy efficiency education curriculum through classroom presentations to students and classroom materials for teachers.

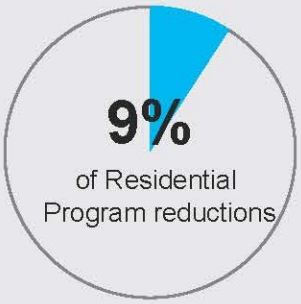
VERIFIED ENERGY SAVINGS

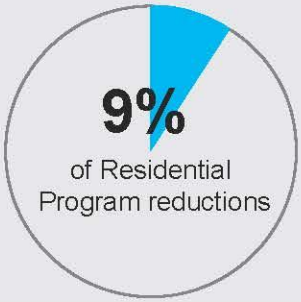
Phase IV has saved **15,286 MWh/yr**

PY15 saved **5,337 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **1.55 MW/yr**





PY15 has reductions of **0.57 MW/yr**

PY15 PARTICIPATION

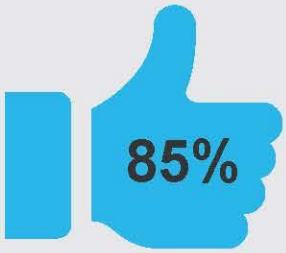
A total of **20,169** participants

5,176 Bright Kids (2nd – 3rd grades)

10,506 Take Action (5th – 7th grades)

4,487 Innovation (9th – 12th grades)

PARTICIPANT SATISFACTION



Satisfied with overall program component

92% Bright Kids (2nd – 3rd grades)

83% Take Action (5th – 7th grades)

81% Innovation (9th – 12th grades)

99% Teachers

Appendix J. Evaluation Detail – Student Energy Efficient Education Component

The Student Energy Efficient Education (SEEE) component provides a school-based energy efficiency education curriculum through classroom presentations to students and classroom materials for teachers. The component includes a poster contest for elementary and middle grades to submit posters illustrating how they would save energy and help the environment. The SEEE component invites participating students at the high school level to participate in an Innovation Challenge to communicate innovative ideas about increasing energy and water efficiency, communicated through artwork, a science project, an essay, literature, photography, music, a service project, video, website project, or any other work of innovation. The curriculum is offered once during the school year, typically in the fall. Students receive educational materials and a take-home kit of energy-saving items to install at home. PPL Electric Utilities updated the component in PY15 to replace some hands-on presentation content with videos.

The SEEE component provides kits to students in three cohorts:

- Bright Kids (2nd – 3rd grades)
- Take Action (5th – 7th grades)
- Innovation (9th – 12th grades)

The kits are tailored to each grade level participating in the component. Table J-1 shows the kit items by cohort. Each kit included installation instructions and a cross-promotional insert of other program components PPL Electric Utilities offers residential customers. In PY15, general-purpose LED light bulbs (one 8w A19 LED and two 15w A21 LEDs) replaced dusk-to-dawn bulbs across all kit types. Additionally, PY15 Take Action and Innovation kits no longer offer weatherstripping, hot water pipe wrap, or outlet gaskets.

Table J-1. SEEE Energy-Savings Items by Cohort

Cohort	Kit Items [1]
Bright Kids	LED nightlight, 8w A19 LED light bulb, two 15w A21 LED light bulbs, Tier 1 advanced power strip
Take Action	LED nightlight, 8w A19 LED light bulb, two 15w A21 LED light bulbs, showerhead, kitchen faucet aerator, Tier 1 advanced power strip, furnace whistle
Innovation	8w A19 LED light bulb, two 15w A21 LED light bulbs, showerhead, kitchen faucet aerator, bathroom faucet aerator, Tier 1 advanced power strip, furnace whistle

[1] Take Action and Innovation cohorts also received a Hot Water Gauge card with instructions for measuring and setting back water heater temperatures.

CLEAResult distributes and records each kit as a participant in the residential ICSP database and PPL Electric Utilities tracking database with an identifier for school, classroom, and teacher. PPL Electric Utilities did not collect or record utility account numbers of classroom students who received a kit.

The ICSP also develops home energy worksheets (HEWs), which students may complete and submit online or in hard copy. The HEWs ask questions to track installation rates of the items in the kits and collect information about participant demographics and component satisfaction. The program offers

mini-grants as incentives for teachers to return 25% or more of HEWs, with amounts starting at $10 and going up to $50 for response rates of 80% or more. Teachers are also requested to complete evaluation forms following their participation.

The ICSP subcontracted with the National Energy Foundation to recruit schools and teachers, create curricula correlated with Pennsylvania academic standards, and secure support of the component by the Pennsylvania Department of Education. As in PY14, Energy Federation Incorporated assembled and delivered kits to schools in PY15. The ICSP provided oversight and direction to its subcontractors.

PPL Electric Utilities collaborated with the ICSP on the SEEE component's strategic direction while maintaining overarching responsibility for Act 129 administration, program component support, evaluation, and data management.

J.1. Gross Impact Evaluation

J.1.1. Gross Impact Methodology and Sampling Approach

Cadmus used a combined two-year sampling approach and conducted the PY14 and PY15 impact evaluation for the SEEE component using survey data gathered from both years through paper and online HEWs to estimate savings for all items in the kits.

Table J-2 summarizes the impact evaluation sampling strategy. Cadmus used a census approach, stratifying data by education-level cohorts using a combined sample across PY14 and PY15. The impact evaluation verified energy and demand savings with ±0.8% relative precision, both at 85% confidence.

Cadmus computed cohort-level metrics because the items in the kits differed for each cohort. To calculate cohort-level *ex post* savings, Cadmus applied the cohort-level realization rates to cohort-level *ex ante* savings. The estimated component-level *ex post* savings is the sum of cohort-level *ex post* savings.

Table J-2. Student Energy Efficient Education Component Gross Impact Evaluation Sample Design

Stratum	Reported Population Size [1]	Sampling Assumptions [2]	Achieved Sample Size [3]	Impact Evaluation Activity
Bright Kids 2nd – 3rd grades	10,233	N/A	7,650	PY14/PY15 paper and online HEWs
Take Action 5th – 7th grades	20,643	N/A	15,264	PY14/PY15 paper and online HEWs
Innovation 9th – 12th grades	9,487	N/A	7,054	PY14/PY15 paper and online HEWs
Component Total	**40,363**	**N/A**	**29,968**	**N/A**

[1] Population size is based on the number of kits distributed according to PPL Electric Utilities' participant tracking database and includes PY14 and PY15 participants.
[2] Because this component's evaluation plan did not include sampling, Cv and targeted precision are not meaningful for planned assumptions.
[3] The achieved sample size is based on the number of HEWs included in the HEW data file from the ICSP and does not match the total in PPL Electric Utilities' participant tracking database.

J.1.2. Gross Impact Results

Table J-3 shows the Student Energy Efficient Education component's verified gross energy savings and demand reductions.

Table J-3. Student Energy Efficient Education Component Savings

Savings	PY13 Verified	PY14 Verified[1]	PY15 Verified	Phase IV Verified[2]
MWh/yr	4,797	5,152	5,337	15,286
System-Level MW/yr	0.47	0.50	0.57	1.55

[1] PY14 savings were verified in PY15.
[2] Phase IV verified savings may not match the sum of program years due to rounding.

In PY15, the SEEE component reported energy savings of 5,650 MWh/yr (Table J-4) and demand reductions of 0.60 MW/yr (Table J-5).

Table J-4. Student Energy Efficient Education Component Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate[1]	Sample Cv or Error Ratio[2]	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Bright Kids	736	100%	0.11	0.5%	739
Take Action	3,410	89%	0.27	1.1%	3,021
Innovation	1,504	105%	0.19	1.7%	1,578
Component Total[3]	**5,650**	**94%**	**0.28**	**0.8%**	**5,337**
Bright Kids (PY14 verified in PY15)	555	100%	0.11	0.5%	556
Take Action (PY14 verified in PY15)	3,208	89%	0.20	1.1%	2,842
Innovation (PY14 verified in PY15)	1,671	105%	0.18	1.7%	1,754

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Although this evaluation did not include sampling, Cv and precision can be calculated from the actual number of responses from the HEWs in the kits and the evaluation forms given to teachers.
[3] Total may not match the sum of rows due to rounding.

Table J-5. Student Energy Efficient Education Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio[2]	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Bright Kids	0.08	91%	0.09	0.5%	0.07	0.07
Take Action	0.36	87%	0.27	1.1%	0.31	0.34
Innovation	0.16	91%	0.20	1.9%	0.15	0.16
Component Total[3]	**0.60**	**89%**	**0.29**	**0.8%**	**0.53**	**0.57**
Bright Kids (PY14 verified in PY15)	0.05	91%	0.09	0.5%	0.05	0.05
Take Action (PY14 verified in PY15)	0.30	87%	0.20	1.1%	0.26	0.29

Stratum	PYRTD MW/yr	Demand Realization Rate[1]	Sample Cv or Error Ratio[2]	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Innovation (PY14 verified in PY15)	0.16	91%	0.20	1.9%	0.15	0.16

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Realization rates are applied to verified demand reductions before application of distribution losses.
[2] Although this evaluation did not include sampling, Cv and precision can be calculated from the actual number of responses from the HEWs in the kits and the evaluation forms given to teachers.
[3] Total may not match the sum of rows due to rounding.

In PY15, verified savings were lower than reported savings primarily due to differences in the installation rates in the Take Action cohort and, to a lesser degree, the PY15 Innovation cohort.

The following factors contributed to the overall energy and demand reduction realization rates for the PY14 and PY15 cohorts' SEEE subcomponents:[63]

- The largest cohort, Take Action, included the lowest installation rates, which reduced the overall realization rate for the component as a whole (see Table J-6).
  - The Take Action cohort in PY15 had lower ISRs for kitchen aerators, showerheads, and smart strips than assumed in *ex ante* calculations. The e*x post* installation rates for kitchen aerators was 25%, and the *ex ante* ISR was 28%. The *ex post* ISR for showerheads was 28%, and the *ex ante* ISR was 35%. The *ex post* ISR for smart strips was 72% and the *ex ante* ISR was 86%. These low ISRs significantly reduced realization rates for the Take Action cohort, as these three measures accounted for 77% of reported savings for the combined PY14 and PY15 Take Action cohort.
- The *ex post* percentage of homes with electric water heat was 48%, whereas *ex ante* was 54%.
- *Ex post* calculations used an electric cooling saturation of 46% from Innovation HEW responses and 51% from the Take Action cohort. These inputs were lower than the *ex ante* calculations, which used the evaluated PY13 cooling saturation of 57%. This difference in cooling equipment saturation reduced demand reduction realization rates for outlet gaskets and weatherstripping in the PY14 kits.

[63] The overall demand realization rates were lower than the overall energy realization rates due to differences in each measure's contribution to energy and demand savings. For example, nightlights do not contribute any demand savings; therefore, they had no impact on the demand realization rates.

J.1.3. In-Service Rates

Table J-6 shows the ISRs for each product included in the kits in PY14 and PY15.

Table J-6. Product-Level In-Service Rates

Product	Cohort	PY14 ISR		PY15 ISR	
		Ex ante	*Ex post*	*Ex ante*	*Ex Post*
Bright Kids					
Lighting	8W LED bulbs	N/A	N/A	92%	92%
	15W LED bulbs	N/A	N/A	92%	92%
	LED nightlight	20%	88%	20%	85%
	Dusk-to-dawn bulb	92%	92%	N/A	N/A
Other[(1)]	Smart Strip	86%	78%	86%	76%
Take Action					
Lighting	Dusk-to-dawn bulb	92%	92%	N/A	N/A
	8W LED bulbs	N/A	N/A	92%	92%
	15W LED bulbs	N/A	N/A	92%	92%
	LED nightlight	20%	68%	20%	65%
Water Saving	Kitchen aerator	28%	24%	28%	25%
	Showerhead	35%	30%	35%	28%
	Water heater setback	20%	29%	20%	28%
	Pipe insulation	30%	29%	N/A	N/A
Other	Furnace Whistle	19%	21%	19%	19%
	Outlet gaskets	25%	51%	N/A	N/A
	Weatherstripping	62%	31%	N/A	N/A
	Smart Strip	86%	71%	86%	72%
Innovation					
Lighting	8W LED bulbs	N/A	N/A	92%	92%
	15W LED bulbs	N/A	N/A	92%	92%
	Dusk-to-dawn bulb	92%	92%	N/A	N/A
Water Saving	Bathroom aerator	28%	32%	28%	35%
	Kitchen aerator	28%	28%	28%	32%
	Pipe insulation	43%	42%	N/A	N/A
	Showerhead	35%	34%	35%	36%
	Water heater setback	20%	29%	20%	33%
Other	Furnace Whistle	29%	25%	29%	26%
	Outlet gaskets	23%	58%	N/A	N/A
	Weatherstripping	62%	37%	N/A	N/A
	Smart Strip	86%	74%	86%	76%

[(1)] The PY14 Bright Kids cohort also received water heater setback measures, but the HEW responses did not include questions to estimate ISRs. Cadmus applied the overall cohort-level realization rate to these measures.

J.2. Net Impact Evaluation

The SEEE component is explicitly offered to schools. The program provides kits free of charge to teachers, who include the kits as part of the school's curriculum and give them to their students to take home. Cadmus did not evaluate free ridership as there is no expectation that teachers or households will voluntarily purchase and provide the items in the kits to students in the absence of the component. Spillover is also not measured. The SEEE component is assumed to have an NTG ratio of 1.0.

J.3. Process Evaluation

In PY15, Cadmus conducted a process evaluation of the SEEE component to assess student and teacher satisfaction with both the kits and energy efficiency presentation, what worked well, and what could be improved. The evaluation activities were consistent with the planned activities. Table J-7 lists the process evaluation sampling strategy. Completed HEWs produced a measure of component satisfaction with ±0.50% precision at 85% confidence. Sample sizes noted in this report may vary by survey question because respondents could skip questions they chose not to answer; therefore, not all respondents provided answers to every question. Cadmus included all survey respondents who answered at least one question, even if they did not complete the survey.

Table J-7. Student Energy Efficient Education Component Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records in Sample Frame	Percent of Sample Frame Contacted to Achieve Sample[1]
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	3	N/A[2]	Up to 3	3	N/A	100%
Students	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered paper and online HEWs	20,169	N/A[2]	All surveys returned	15,277[3]	All available	100%
Teachers	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered Teacher evaluation forms	775[4]	N/A[2]	All surveys returned	183	All available	100%
Component Total			**20,947**	-		**15,463**	-	

[1] Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews.
[2] Because this component's evaluation did not include sampling, Cv and target precision are not meaningful.
[3] Sample size represents the number of returned HEWs, which may differ from the number of HEWs used for the Impact evaluation.
[4] Quantity reflects the number of unique teachers, where each unique teacher is identified by the participant code.

J.3.1. Participant Satisfaction

Students and teachers participate in the SEEE component by receiving kits, presentations, and curriculum. Overall, 85% of participants were satisfied with their experience with the SEEE component in PY15, as shown in Table J-8. Though teachers were more satisfied than students, student experience accounts for the majority of the satisfaction score due to the much higher number of students who participated than the smaller number of teachers. Overall satisfaction across participating teachers and students in PY15 is comparable to that of PY14 (86%).

Table J-8 PY15 Satisfaction for the SEEE Component

Stratum	Overall Satisfaction[(1)]
Students (n=15,091)	85%
Teachers (n=182)	99%
Overall Satisfaction (n=15,273)	**85%**

[(1)] As measured by a rating of *very* or *somewhat satisfied*

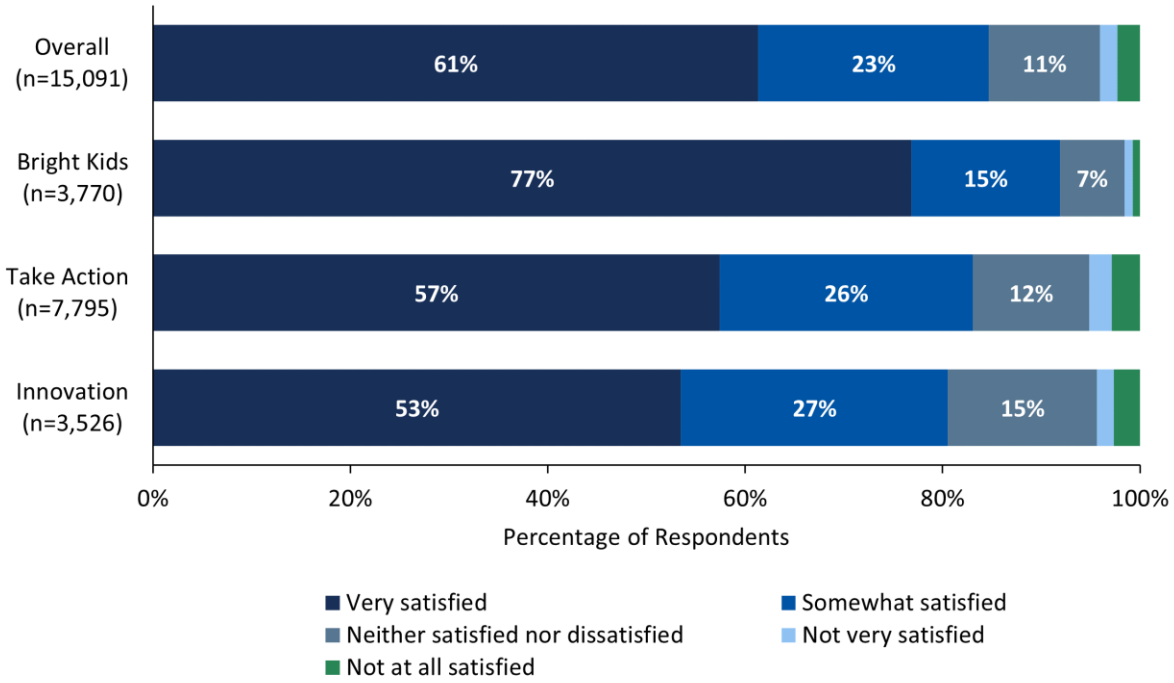
The student HEW and the evaluation form distributed to participating teachers includes a satisfaction questions. Both questionnaires measure overall satisfaction via a five-point rating scale (*very satisfied*, *somewhat satisfied*, *neither satisfied nor dissatisfied*, *not very satisfied*, or *not at all satisfied*).

Student Satisfaction

Teachers received a HEW template they could copy and distribute, which allowed students to complete the HEW on paper or online. Of the 20,169 student participants, 15,277 (76%) completed HEWs, and 15,091 (75%) answered the satisfaction question. Figure J-1 summarizes the results by cohort. Of the students who responded to the question, 85% said they were *very satisfied* (61%) or *somewhat satisfied* (23%) with the component overall.[64] By cohort, satisfaction ranged from 81% *very satisfied* or *somewhat satisfied* for Innovation students to 92% for Bright Kids students. Overall satisfaction in PY15 is consistent with that of participating students in PY14 (85% and 86% respectively).

[64] Using a higher precision than presented in Figure J1, the sum of *very satisfied* (61.33%) and *somewhat satisfied* (23.34%) adds to 85%.

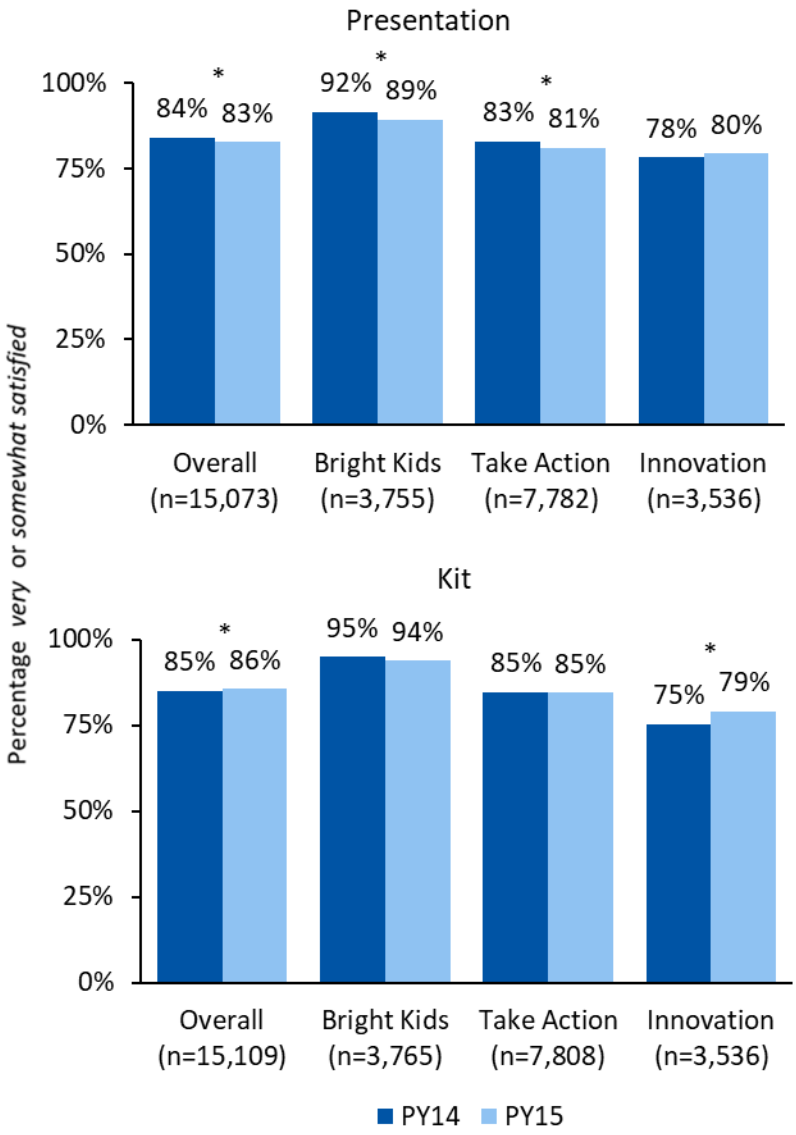
Figure J-1. PY15 Overall Student Satisfaction by Cohort



Source: Home Energy Worksheet: "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 or in report text due to rounding.

The HEWs included separate satisfaction ratings questions for the presentation and the kit. As shown in Figure J-2, of the students who responded, satisfaction with the presentation was slightly lower in PY15 compared to PY14. The lower satisfaction rating was primarily due to ratings from Bright Kids and Take Action students. Conversely, satisfaction with the kits nudged slightly higher in PY15, with an increase in Innovation students reporting being *very* or *somewhat satisfied* with kits.

Figure J-2. PY15 Student Satisfaction with Presentations and Kits by Cohort



Source: Home Energy Worksheet:
"How satisfied are you with the presentation?" and "How satisfied are you with the energy efficiency kit?" Not all HEW respondents answered each question.
* Statistically significant difference between years, p<0.01.

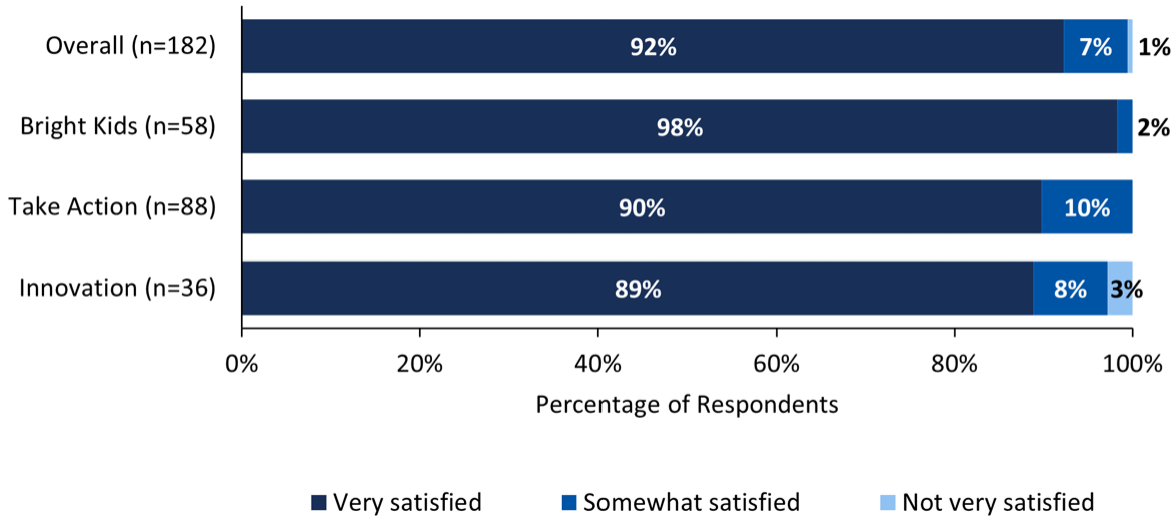
Teacher Satisfaction

After participating in the teacher's classroom presentation, presenters asked teachers to rate the delivery of the SEEE component. Of 775 participating teachers in PY15, 24% (183 teachers) completed evaluation forms, and 182 teachers provided a rating.

Figure J-3 summarizes the results of the teacher satisfaction survey. Nearly all teachers who responded to the survey rated the component as either *very satisfied* (92%) or *somewhat satisfied* (7%; n=182). This was similar to results from PY14 (data not shown). Teachers of the Bright Kids cohort rated their

impression of the component as *very satisfied* (98%) significantly more often than did teachers of the Take Action and Innovation cohorts (90% and 89%, respectively; $p<0.05$).

Figure J-3. PY15 Participating Teacher Satisfaction with Student Energy Efficient Education Component Overall



Source: Teacher Evaluation: "Please share your impression of Think! Energy Program – Overall Experience."

Teacher Feedback

The evaluation forms invited teachers to provide open-ended comments about their experience with the component, and teachers left overwhelmingly positive comments. In PY15, teachers continued to provide very positive feedback on the quality of the presentations, specifically noting how well students responded to the program overall due to the engaging presenters.

"This program is incredibly beneficial for the students, as preparing them to conserve energy sources now will have a lasting impact on their, and our, future!"
-Take Action Teacher

They also expressed the value of the content covered in the presentations, along with the free kit contents:

- "Excellent interactive presentation—the children really enjoyed it. Everyone especially liked the bags they received at the end of the program." (Bright Kids)
- "This is a wonderful program that we are proud to be a part of for over a decade now! The presenters are highly qualified and do a great job of interacting with the students. We like how the program is fresh and new each year. Keep up the good work!" (Take Action)
- "Your presenters were engaging and interactive. Students were engaged and learned." (Take Action)
- "This program is extremely valuable to our students! It allows them to actively participate and connects with them, as they are directly responsible for the amount of electricity and water that they use." (Innovation)

- "It was simple for students to relate to but taught an important topic! It also served as an intro to our energy science unit." (Bright Kids)
- "It is a great program to supplement a unit on Natural Resources and introduces energy & water conservation principles, which is a beneficial skill for our future young adults." (Innovation)

"The ladies doing the presentation are so kid friendly! The program was very informative for the kids and on a level they could comprehend. We loved the presentation!"
--Bright Kids Teacher

- "The students seem really excited by the kits—I had a few asking for an extra one for their grandparents. They seemed [to be] into saving their parents money and saving electricity. Getting the students involved in saving resources is a great thing that I would recommend to my fellow teachers. It was a great way to discuss resources and conservation with my environmental science students." (Innovation)
- "I truly appreciate that you are willing to provide the materials to the students for no charge. Many of our families are in need, and many more are just on that borderline where something new—even if it saves money in the long run - is out of their budgets. I also cannot thank you enough for the teacher incentives… I have purchased many items for my classroom that I otherwise would not have been able to get!" (Take Action)

Suggested Improvements

In PY15, teachers had various suggestions for improvement. While most comments on the PY15 presentations were quite positive, a subset of teachers did not like the new videos shown in the presentations this year, particularly among teachers in the Take Action and Innovation cohorts. Among teachers in the Take Action cohort:

- "I preferred last year's presentation with the hand motions, etc.—more engaging for the students. I did notice it was more watching than active like in years past. Still great though!" (Take Action)
- "I recommend letting the presenters do the hands-on presentation again instead of the video presentation." (Take Action)
- "Some of the skits in the videos dragged on a little. I would also recommend making sure presenters are equipped with microphones—it was hard to hear during some parts." (Take Action)
- "Personally, I did not like the new videos shown in the presentation this year. I felt like they were somewhat confusing and took away from the educational content of the presentation. I thought the videos from last year were better. My students used to always love participating in the ThinkEnergy! Bingo game the presenters used to play with the audience." (Take Action)

Teachers in the Innovation cohort mainly requested having access to a recording of the presentation and, like the Take Action teachers, they suggested offering a more interactive and engaging presentation to students to better hold their attention:

- "The presentation is a bit dull and doesn't keep the students' attention. Work with the teachers to do something like a school-wide scavenger hunt or stations. Most schools have 1-1 devices now and could do something more interactive." (Innovation)
- "Possibly having a recording of the presentation to share with students who were unable to attend. Due to the limited options of class periods, some of my AP Environmental Science students were unable to attend without missing another important class, and I think they could have really benefitted from a recording." (Innovation)
- "It would be good to have a presentation to share with the students who were unable to attend the presentation and for teachers to review with students. During the pandemic, there was a game the students played, and it was very useful." (Innovation)

Survey Participant Profile

The PY15 HEWs collected demographic information about participants in the SEEE component. Respondents had the following characteristics:

- Lived in a single-family detached residence (79%; n=15,145)
- Had an average household size of 4.6 people (n=15,185)

Appendix K. Net Savings Impact Evaluation

K.1. Self-Report Survey Methodology

K.1.1. 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 IV Evaluation Framework,[65] 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. Free ridership estimates by product or stratum 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, the survey asked the following key questions to determine how the nonresidential 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 we multiplied by the participant's respective *ex post* kWh/yr savings to calculate intention-based free rider savings.

[65] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

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 program influence from participants' ratings of how important various program elements were in their decision to purchase energy-efficient equipment.

K.1.2. Spillover

Following methods defined in the Phase IV Evaluation Framework,[66] 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 nonresidential surveys do not provide enough information to reliably quantify spillover; therefore, potential spillover activity is reported qualitatively.

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.

[66] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and Optimal Energy, Inc. Final version July 16, 2021.

Appendix L. 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 surveys that Cadmus fielded.

L.1. 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, if applicable, 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 two reminder email invitations, 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 populations.

Appendix M. Non-Energy Benefits

Cadmus quantified non-energy benefits in accordance with the Phase IV TRC order.[67]

M.1. Non-Energy Benefits of Water-Saving Measures

Non-energy benefits associated with water-saving products include the gallons of water saved. According to the recommendation in the SWE Guidance Memo of 2018, Cadmus assumed $0.01 in avoided cost, per-gallon saved, in TRC testing (after gross-up for distribution losses). Cadmus assumed 24.5% losses on water distribution, based on guidance. The avoided cost of water is escalated over the TRC test horizon using the same inflation/escalation assumption embedded elsewhere in the TRC model.

M.2. Non-Energy Benefits of Fossil Fuel Savings

Cadmus calculated fossil fuel benefits in accordance with the direction provided by the 2021 TRC Order. The Pennsylvania Public Utility Commission directed that EDCs should continue to include fossil fuel benefits, consistent with the 2016 TRC Test and the 2018 guidance memo.[68]

M.3. Lighting Interactive Effects

Cadmus calculated lighting interactive effects according to the TRC order, which states:

> "Interactive effects from efficient lighting installations in businesses with electric heat have been captured in the Pennsylvania Technical Reference Manual since the 2009 TRM and interactive effects from homes with electric heat were added in the 2014 TRM. The objective of the TRM is to capture the electric impacts of EE&C measures. The impact of EE&C measures on fossil fuel consumption is a TRC matter, … *Phase IV Act 129 programs will utilize a simplifying approach of monetizing all fossil fuel impacts using the avoided cost of natural gas rather than requiring a separate avoided cost forecast for fuel oil and propane and tracking heating fuel distributions among EE&C plan participants with fossil fuel heat.*"

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[67] 2021 TRC Test Final Order - Final order on the TRC Test for Phase IV of Act 129. From the Public Meeting of December 19, 2019, at Docket No. M-2019-3006868. Entered December 19, 2019.

[68] SWE. Guidance on the Inclusion of Fossil Fuel and H_2O Benefits in the TRC Test. March 25, 2018.