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PPL Electric Utilities Annual Report to the Pennsylvania Public Utility Commission

PHASE IV OF ACT 129 PY14 ANNUAL REPORT (JUNE 1, 2022 – MAY 31, 2023) FOR PENNSYLVANIA ACT 129 OF 2008 ENERGY EFFICIENCY AND CONSERVATION PLAN

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September 30, 2023

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Acronyms

AHRI	Air Conditioning, Heating, and Refrigeration Institute
AMI	Advanced metering infrastructure
C&I	Commercial and industrial
CDD	Cooling degree day
CEI	Continuous energy improvement
CF	Coincidence factor
CHP	Combined heat and power
C.L.	Confidence limit
CSP	Conservation service provider or curtailment service provider
CSS	Cross-sector sales
Cv	Coefficient of variation
DLC	DesignLights Consortium
DR	Demand response
EDC	Electric distribution company
EDT	Eastern Daylight Time
EE&C	Energy efficiency and conservation
EFLH	Equivalent fuel load hours
EM&V	Evaluation, measurement, and verification
EISA	Energy Independence and Security Act
EUL	Effective useful life
FCM	Forward Capacity Market
GNE	Government, nonprofit, educational
HDD	Heating degree day
HER	Home energy report
HIM	High-impact measure
HOU	Hours of use
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating, and air conditioning
ICSP	Implementation conservation service provider
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
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
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, PY14, from June 1, 2022, to May 31, 2023
PYRTD	Program year reported to date
PYVTD	Program year verified to date
PYTD	Program year to date
QA/QC	Quality assurance/quality control
RTD	Phase IV to date reported gross savings
SEER	Seasonal energy efficiency rating
SKU	Stock keeping unit
SWE	Statewide evaluator
T&D	Transmission and distribution
tLED	Tubular LED
TRC	Total resource cost
TRM	Technical reference manual
VTD	Phase IV to date verified gross savings
WACC	Weighted average cost of capital
WRAP	Winter Relief Assistance Program

Types of Savings

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

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

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

Unverified Reported Gross: The Phase 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 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 TRM provides algorithms and assumptions to calculate annual savings, and Act 129 compliance targets for consumption reduction are based on the sum of the annual savings estimates of installed measures or behavior change.

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

Program Year Reported to Date (PYRTD): The reported gross energy and peak demand savings achieved by an EE&C program or portfolio within the current program year. 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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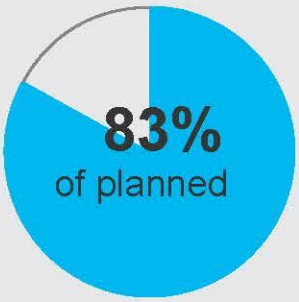
PORTFOLIO COMPLIANCE TARGETS

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 **736,833 MWh/yr***

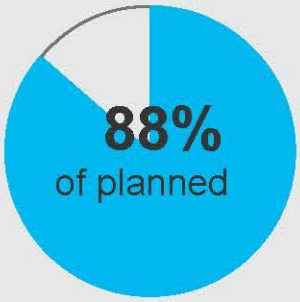


PY14 saved **256,971 MWh/yr**

*Includes Phase III carryover energy savings

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **70.22 MW/yr**



PY14 has reductions of **43.01 MW/yr**

LOW-INCOME PROGRAM

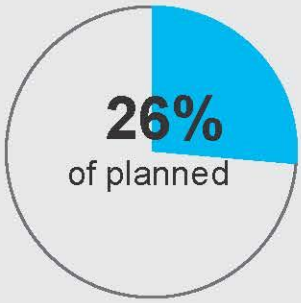
Phase IV has saved **53,111 MWh/yr***

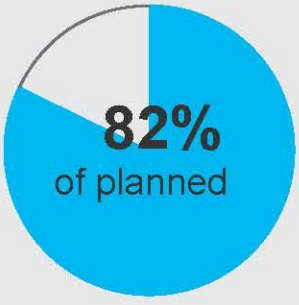
PY14 saved **12,872 MWh/yr**

*Includes Phase III carryover energy savings

EXPENDITURES ($1,000)

Phase IV expenditures **$82,755**





PY14 expenditures **$52,198**

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PORTFOLIO PARTICIPATION AND SATISFACTION

PY14 PARTICIPATION

A total of **829,509** participants

797,961 Residential

24,889 Low-Income

6,659 Non-Residential

PROGRAM SATISFACTION

86% Overall Portfolio Satisfaction

86% satisfied with Non-Residential Program

86% satisfied with Low-Income Program

85% satisfied with Residential Program

PARTICIPANT COMMENTS

"The staff guiding the application process were very helpful."

"I liked the way PPL [Electric Utilities] worked thru the contractor and made it seamless for me, the homeowner."

"I loved the personal visit to my home for a close-up assessment... I appreciate any and all efforts to help me improve my use of energy. It makes me feel supported in these difficult days we are dealing with."

"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!"

"...Getting the early letter of commitment [showing] minimum amount was helpful in the planning and approval [process] to keep the project moving quickly."

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 14 (PY14), 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 PY14. 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 PY14. Programs are operating effectively and are meeting their program objectives but are slightly behind planned savings for PY14. Recommendations are presented in each program section and focus on ways to fine-tune program implementation.

[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.

While gross verified energy savings achieved through PY14 did not meet those projected for the program year as shown in PPL Electric Utilities' EE&C plan,[2] savings achieved through PY14 (430,558 MWh/yr), plus Phase III carryover savings (306,275 MWh/yr), contribute 59% to the Phase IV overall five-year compliance target of 1,250,157 MWh/yr. In PY14, PPL Electric Utilities projected an estimate of 308,804 MWh/yr and achieved 256,971 MWh/yr in verified savings, or 83% of energy projections.

Gross verified demand reductions achieved through PY14 also did not meet those projected for the program year. In PY14, PPL Electric Utilities projected an estimate of 49.08 MW/yr and achieved 43.01 MW/yr in system-level verified energy reductions, or 88% of demand projections. Through PY14, total demand reductions of 70.22 MW/yr represent 31% of the Phase IV overall five-year compliance target of 229 MW/yr.

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 73% of the Phase IV low-income energy-savings compliance target through PY14 (53,111 MWh/yr), including carryover savings from Phase III (31,089 MWh/yr).

Through PY14, PPL Electric Utilities delivered programs for 27% of the Phase IV cumulative projected budget estimated in the EE&C plan, expending $82,754,753. The acquisition cost in PY14 is $0.20 per annual kWh and is $0.19 per annual kWh for Phase IV (EDC expenditures/first-year savings). The portfolio-level PY14 total cost of conserved energy (TRC costs/net present value [NPV] lifetime kWh, at generation) is $0.039/kWh. The portfolio-level PY14 utility cost of conserved energy (program administrator cost [PAC]/NPV lifetime kWh, at generation) is $0.020/kWh. The TRC includes PPL Electric Utilities' costs and the customers' costs. The PAC includes only PPL Electric Utilities' costs.

A portfolio is cost-effective when the TRC benefit-cost ratio exceeds 1.0. The PY14 and phase-to-date portfolio is cost-effective with a portfolio-level TRC of 1.63 (PY14) and 1.67 (phase-to-date).

The evaluated net-to-gross (NTG) ratio is 0.69, which includes spillover attributable to the Appliance Recycling and 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 sectors showed high levels of satisfaction with the programs, meeting or exceeding the customer satisfaction goal of 85% for each program. However, there were declines in satisfaction ratings for the Residential and Non-Residential programs, as well as the portfolio overall. With the combined *very satisfied* and *somewhat satisfied* responses, portfolio satisfaction was 86% (n=15,218) in PY14 compared to 90% satisfied in PY13 (n=15,825). The Non-Residential Program achieved 86% satisfaction in PY14 (n=38) compared to 96% in PY13 (n=31), and the Residential Program

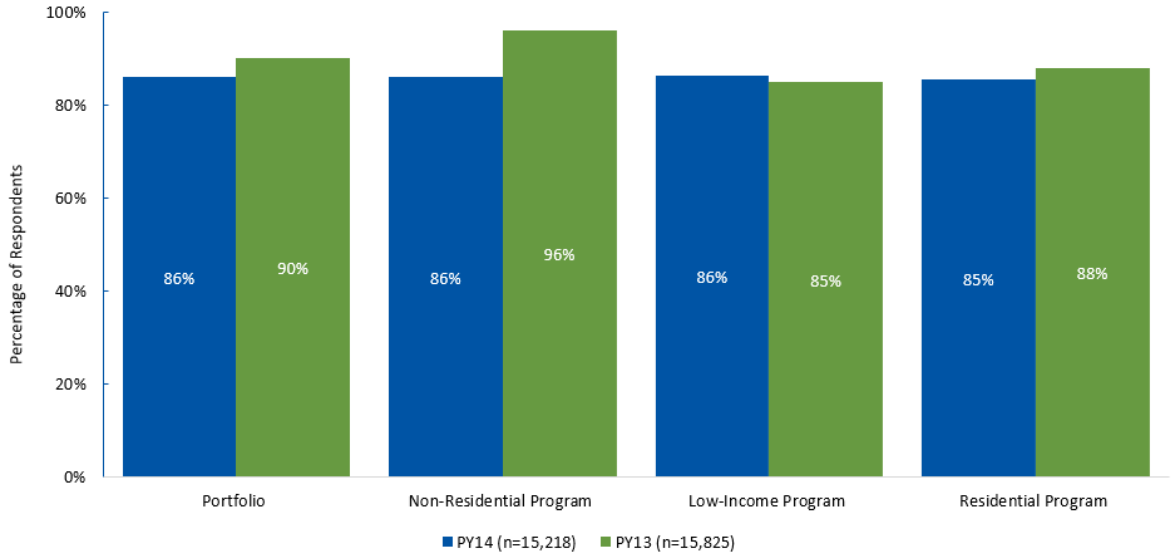
[2] PPL Electric Utilities Corporation. Revised December 30, 2022. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

[3] The customer satisfaction goal is listed in PPL Electric Utilities' EE&C Plan (Docket No. M-2020-3020824) filed December 2022.

declined from 88% in PY13 (n=15,688) to 85% in PY14 (n=15,063). All the declines noted between groups were statistically significant.[4]

Customer satisfaction for the Low-Income Program was slightly higher in PY14, with 86% satisfied (n=117) compared with 85% in PY13 (n=106). The difference was not significant.

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



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

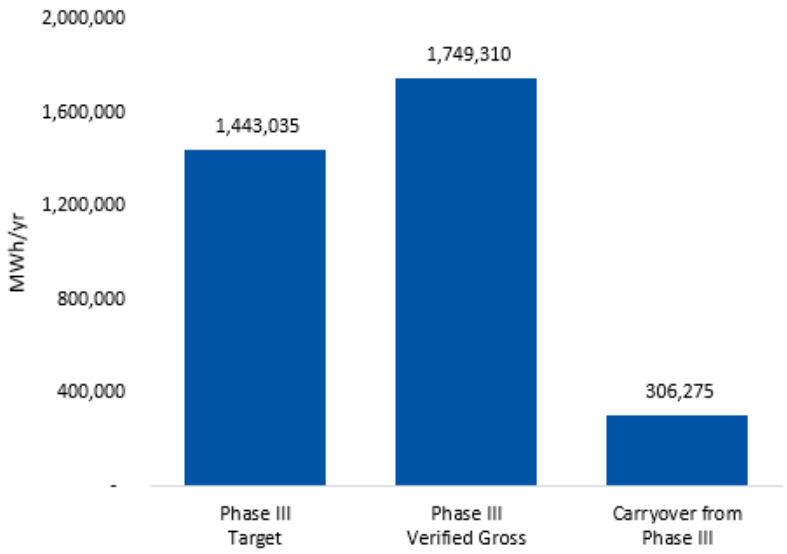
[4] Z-Test, $p < 0.05$

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

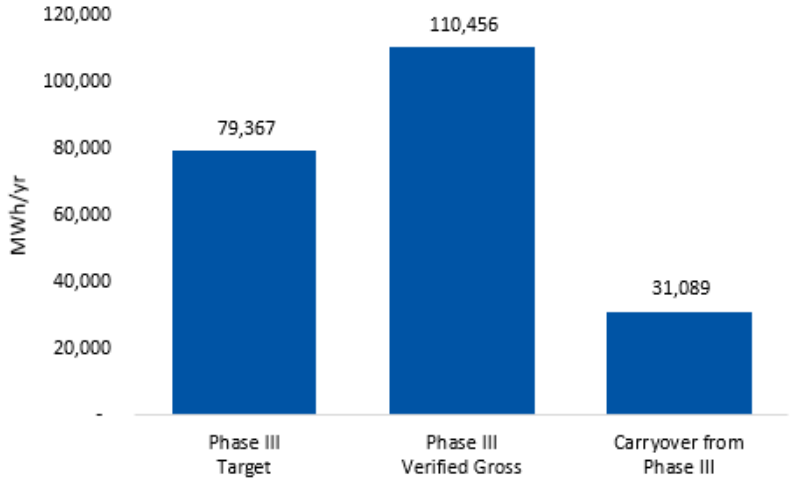


The PA PUC's Phase IV Implementation Order also allows EDCs to carry over savings in excess of the Phase III low-income savings goal.[5,6] Figure 2-2 shows the calculation of carryover savings for the low-income customer segment.

[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

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, the MWh totals in this report are presented at the meter level, while peak demand savings are adjusted for transmission and distribution losses to reflect system-level savings.

Table 2-1 shows the achievements to date since the beginning of PY14 on June 1, 2022.

Table 2-1. PY14 Energy and Demand Achievements to Date

PYTD[1]	Reported Gross Savings (PYRTD)	Verified Savings (PYVTD)	System-Level Verified Savings (PYVTD)	Unverified (PYRTD)	Realization Rate[2]
Energy Savings (MWh/yr)[3]	253,570[4]	256,971	N/A	10,528	106%
Peak Demand Reductions (MW/yr)[3]	40.46[4]	40.14	43.01	1.26	102%[5]

[1] Savings do not include unverified PY13 savings verified in PY14.
[2] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Additionally, realization rates are calculated by removing unverified reported savings from the denominator. If unverified savings are included in the denominator, the realization rate for energy is 101% and for demand is 99%.
[3] Savings may not match other tables or figures due to rounding.
[4] Reported savings without unverified savings are 243,042 MWh/yr and 39.20 MW/yr.
[5] Realization rates are applied to verified demand reductions before application of distribution losses.

Table 2-2 shows the Phase IV achievements to date including carryover savings. Including carryover savings from Phase III, PPL Electric Utilities has achieved 736,833 MWh/yr of verified savings to date. This represents 59% of the Phase IV energy savings compliance target of 1,250,157 MWh/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]	423,575[3]	736,833[4]	N/A	10,528	104%[5]
Peak Demand Reductions (MW/yr)[2]	67.12[3]	65.36	70.22	1.26	99%[6]

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. Additionally, realization rates are calculated by removing unverified reported savings from the denominator. If unverified savings are included in the denominator, the realization rate for energy is 102% and for demand is 97%.
[2] Savings may not match other tables or figures due to rounding.
[3] Reported savings without unverified savings are 413,047 MWh/yr and 65.86 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] Realization rates are applied to verified demand reductions before application of distribution losses.

The verified savings contribution from PY13 has changed since the final PY13 annual report. Cadmus verified savings for PY13 Low-Income in-home assessment jobs, Energy Efficient Homes new homes jobs, and Custom small jobs in PY14 and included these savings in the verified-to-date (VTD) gross totals. Additionally, PY13 energy savings were reduced by 1,425 MWh/yr and system-level demand reductions were reduced by 0.21 MW/yr in accordance with the statewide evaluator's (SWE) PY13 Annual Report.[7]

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 10,528 MWh/yr (709 MWh/yr for the Non-Residential and 9,819 MWh/yr for the Residential Programs). Unverified demand reductions total is 1.26 MW/yr (0.26 MW/yr for the Non-Residential and 0.99 MW/yr for Residential).[8] These savings will be verified in PY15.

[7] Pennsylvania Public Utility Commission. December 5, 2022. *SWE Annual Report Act 129 Program Year 13.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC., Brightline Group, and Optimal Energy. SWE Final Annual Report: Act 129 Program Year 13 (pa.gov)

[8] 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)

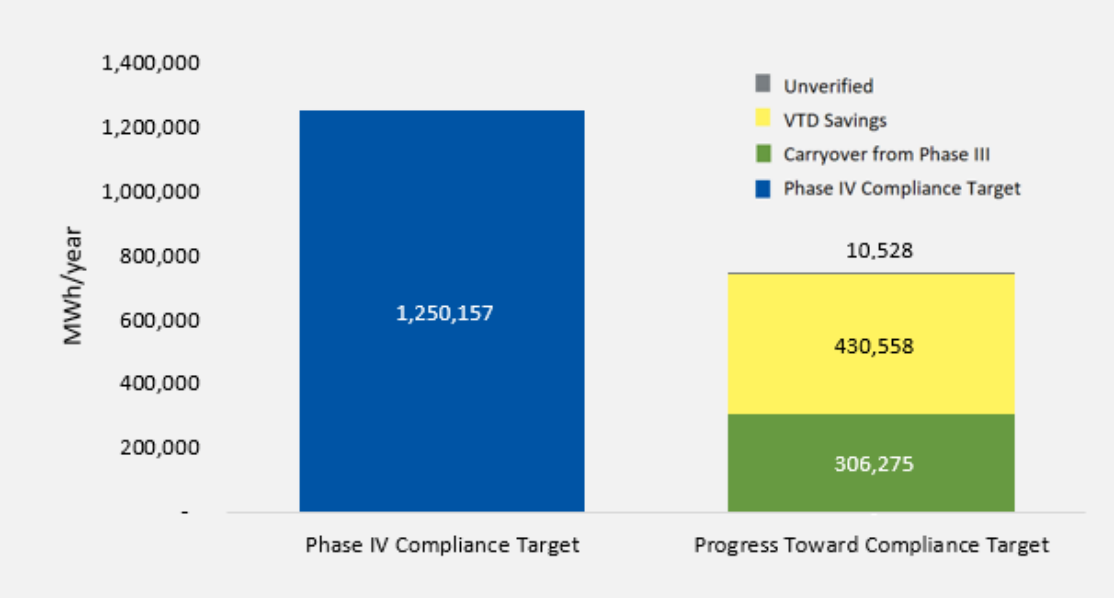
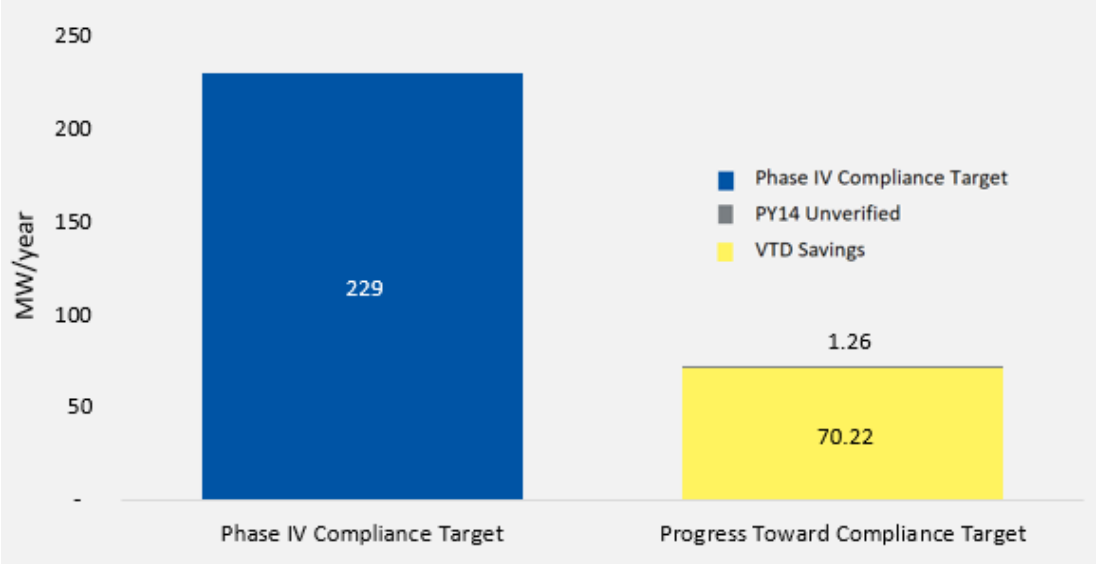


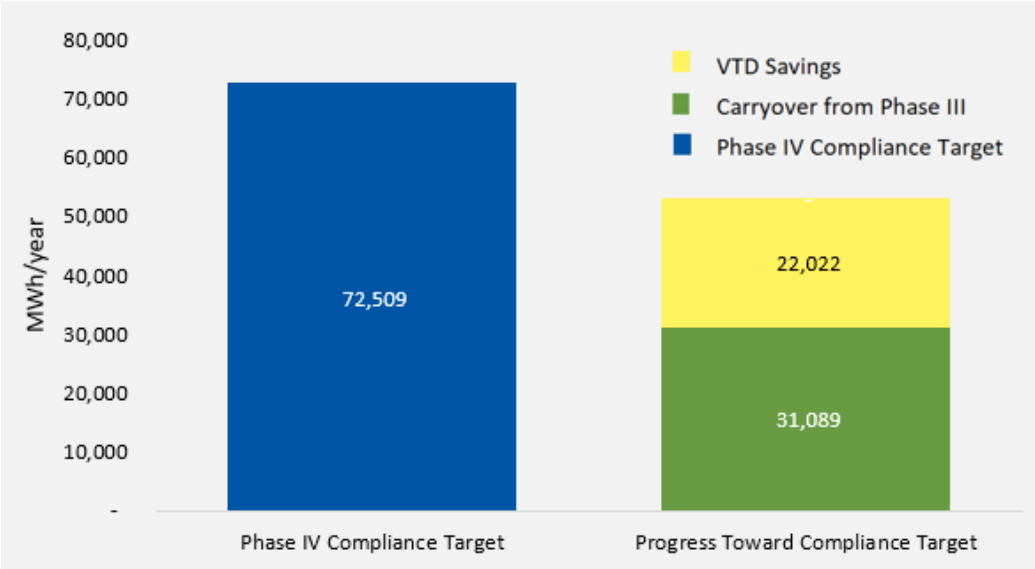
Figure 2-4. EE&C Plan Performance Toward Phase IV Portfolio Compliance Target (MW/yr)



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 72 EE&C measures to its residential and non-residential customer classes. There are 16 distinct PPL Electric Utilities' measures available to the low-income customer segment at no cost to the customer, which represents 22% of the total measures offered in the EE&C plan and exceeds the proportionate number of 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. PPL Electric Utilities has achieved 73% of the Phase IV low-income energy savings target.

Figure 2-5. EE&C Plan Performance Toward Phase IV Low-Income Compliance Target



2.2.1 Phase IV Performance, Multifamily Housing

In PY14, PPL Electric Utilities has achieved 4,437 MWh/yr of verified gross electric energy savings (PYVTD) from multifamily housing across all programs, including 3,876 MWh/yr of verified gross electric energy savings (PYVTD) from low-income households. For Phase IV, PPL Electric Utilities has achieved 7,347 MWh/yr of verified gross electric energy savings (VTD) from multifamily housing, including 5,965 MWh/yr of verified gross electric energy savings (VTD) from low-income households.[9] Additionally, there are 917 MWh/yr of reported savings attributed to multifamily that were not verified in PY14 but will be verified in PY15 and included in the Phase IV VTD total in PY15. None of these unverified savings are from low-income households. Beginning in PY15, PPL Electric Utilities will begin tracking and reporting on participation, installed measures, savings, and spending for projects serving common areas in affordable master-metered multifamily buildings through PPL Electric Utilities' Non-Residential Program.

2.3 Phase IV Performance by Customer Segment

Table 2-3 presents participation, savings, and spending by customer sector for PY14. The residential, small commercial and industrial (C&I), and large C&I sectors are defined by EDC tariff, and the residential low-income and government, nonprofit, educational (GNE) sector are defined by statute (66 Pa. C.S. § 2806.1). The residential low-income segment is a subset of the residential customer class,

[9] The Phase IV savings include 40 MWh/yr from unverified PY13 Low-Income savings verified in PY14. These multifamily savings are from low-income households.

and the GNE segment includes customers who are part of the residential, small C&I, or large C&I rate classes. Savings, spending, and participation values for the low-income and GNE segments have been removed from the parent sectors.

Table 2-3. PY14 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]	742,477	24,887	59,221	971	1,953	829,509
PYRTD MWh/yr[4]	44,197	10,696	105,742	76,061	16,873	253,570
PYRTD MW/yr[4]	6.41	1.20	17.16	12.90	2.79	40.46
PYVTD MWh/yr[4]	34,688	12,777	112,971	77,486	19,049	256,971[5]
System-Level PYVTD MW/yr[4]	5.27	1.52	19.47	13.55	3.20	43.01[5]
PY14 Incentives ($1000)[4],[6]	$6,770	$3,068	$11,647	$5,973	$2,637	$30,095

[1] This table does not include PY13 unverified savings verified in PY14.
[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 10,528 MWh/yr and 1.26 MW/yr of unverified savings.
[6] PPL Electric Utilities reports 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 2-4 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 EDC tariff.

Table 2-4. PY14 Energy and Demand Summary of Government, Nonprofit, and Education Sector Customers[1]

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[2]
PYRTD MWh/yr	67	11,031	5,758	16,856
PYRTD MW/yr	0.01	1.73	1.06	2.79
PYVTD MWh/yr	71	12,339	6,611	19,020
System-Level PYVTD MW/yr	0.01	1.97	1.21	3.20

[1] This table does not include PY13 unverified savings verified in PY14.
[2] Columns may not sum to totals due to rounding. These totals will not match the values in other tables showing totals by customer sector.

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

Table 2-5. 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]	1,506,801	50,569	119,753	1,843	3,483	1,682,449
RTD MWh/yr[3]	78,334	22,536	184,677	106,252	31,776	423,575
RTD MW/yr[3]	11.22	2.49	30.59	17.52	5.31	67.12
VTD MWh/yr[3],[4]	68,457	53,017[4]	195,776	108,994	35,403	736,833[4],[5]
System-Level VTD MW/yr[3]	9.98	2.55	33.79	17.99	5.91	70.22[5]
Phase IV Incentives ($1000)[6]	$11,142	$5,242	$16,981	$6,600	$3,095	$43,060

[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 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 PY13 unverified savings verified in PY14 and excludes 10,528 MWh/yr and 1.26 MW/yr of PY14 unverified savings and includes adjustments to savings made by the SWE.
[6] PPL Electric Utilities reports 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 certain programs and program components depending on the program delivery channel and data tracking practices. Table 2-6 provides a definition of participant by program and component, along with the current participation totals for PY14 and Phase IV.

Table 2-6. 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.	122	158
Efficient Equipment (downstream)	Unique job number; corresponds to each unique job that received a rebate.	809	1,297
Efficient Equipment (midstream)	Unique job number; corresponds to each purchase of discounted products.	5,728	10,521
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.	24,889	50,571
Residential Program			
Appliance Recycling	Unique job number; corresponds with each unique appliance decommissioned through the program component during the program year.	12,207	23,516
Efficient Lighting	Number of discounted bulbs sold.	744,963	1,520,777
Energy Efficient Homes New Homes	Unique job number; corresponds to a rebated project.	1,702	2,944
Energy Efficient Homes Audit and Weatherization	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	2,096	2,096
Energy Efficient Homes Online Marketplace	Unique job number; corresponds to a rebated project.	4,312	9,928
Energy Efficient Homes Equipment (downstream)	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	9,973	17,918
Energy Efficient Homes Equipment (midstream)	Unique job number; corresponds to each purchase of discounted products.	0	0
Energy Efficient Homes Instant Discount	Unique job number, corresponds to each discounted item purchased.	2,514	2,514
Student Energy Efficient Education	Number of participants is counted as the number of energy conservation kits delivered.	20,194	40,209
Portfolio Total		**829,509**	**1,682,449**

2.5 Summary of Impact Evaluation Results

During PY14, Cadmus completed impact evaluations for most program components in the portfolio. Table 2-7 summarizes the realization rates and NTG ratios by program component.

Table 2-7. PY14 Impact Evaluation Results Summary

Program	Component	Energy Realization Rate	Demand Realization Rate[1]	Net-to-Gross Ratio
Non-Residential	Custom	101%	102%	0.74[2]
	Efficient Equipment	110%	105%	0.63[4]
Low-Income	Low-Income	119%	116%	1.0[5]
Residential	Appliance Recycling	100%	100%	0.56[3]
	Efficient Lighting	102%	102%	1.07[3]
	Energy Efficient Homes	102%	82%	0.53[(6]
	Student Energy Efficient Education	N/A	N/A	1.0[5]
Portfolio Total		**106%**	**102%**	**0.69[7]**

[1] Realization rates are applied to verified demand reductions before application of distribution losses. Does not include unverified savings in the denominator.
[2] PY14 evaluated NTG ratio.
[3] PY13 evaluated NTG ratio.
[4] PY14 evaluated NTG ratios used for downstream subcomponents. PY11 evaluated NTG used for midstream lighting subcomponent. The NTG ratio for the overall Efficient Equipment component is the verified gross population energy savings-weighted average of the NTG ratios applied to each subcomponent.
[5] No free ridership is expected, nor measured, per the evaluation plan. Therefore, the NTG ratio is 1.0.
[6] PY14 evaluated NTG ratios used for audit and weatherization. PY13 evaluated NTG ratios used for new homes stratum and all downstream equipment stratum measures except for heat pump water heater measure. PY12 evaluated NTG ratio used for heat pump water heater measure. The NTG ratio for the overall component is the verified gross population energy savings weighted average of the NTG ratios applied to each measure.
[7] Weighted by PY14 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. Incremental annual savings estimates are presented in Section *2.6.1 Incremental Annual Energy Savings by Program* . Lifetime energy savings incorporate the effective useful life (EUL) of installed measures and estimate the total energy savings associated with program activity. Lifetime savings are used in the TRC test by program participants when assessing the economics of upgrades and by the statewide evaluator (SWE) when calculating the emissions benefits of Act 129 programs. Section *2.6.2 Lifetime Energy Savings by Program* presents the lifetime energy savings by program.

2.6.1 Incremental Annual Energy Savings by Program

Table 2-8 presents a summary of the PYTD energy savings by program for PY14 and for Phase IV to date. The energy impacts in this report are presented at the meter level and do not reflect adjustments for

transmission and distribution losses. The verified gross savings are adjusted by the energy realization rate, and the verified net savings are adjusted by both the realization rate and the NTG ratio.

Table 2-8. 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	199,144[1]	209,711	142,556	322,300	339,544	216,498
Low-Income	10,825	12,872	12,872	22,665	53,111[2]	22,022[3]
Residential	43,601[1]	34,388	20,921	78,609	68,991	44,217
Portfolio Total[4]	**253,570**	**256,971**	**176,348**	**423,575**	**736,833[2]**	**282,738[3]**

[1] Includes 709 MWh/yr and 9,819 MWh/yr of unverified savings for Non-Residential and Residential programs, respectively. Does not include PY13 unverified savings verified in PY14.
[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 PY13 final annual report was submitted:

- **Non-Residential**
  - **Custom Component:** 3,048 MWh/yr savings were reported, but not verified in PY13 final annual report. Those savings have since been verified with an energy realization rate of 106% and a NTGR of 0.22, which yields an additional 3,236 MWh/yr of gross verified energy savings and an additional 712 MWh/yr of net verified energy savings. These verified gross savings are attributed to the residential (205 MWh/yr), small C&I (1,090 MWh/yr), and large C&I (1,941 MWh/yr) sectors' VTD savings in Table 2-5.
- **Low-Income**
  - 103 MWh/yr savings were reported, but not verified in PY13 final annual report. Those savings have since been verified with an energy realization rate of 121% and a NTGR of 1.0, which yields an additional 124 MWh/yr of gross and net verified energy savings. These verified gross savings are attributed to the low-income sectors' VTD savings in Table 2-5.
  - SWE audit activities recommended a reduction of gross verified energy savings of 1,422 MWh/yr to 9,027 MWh/yr because the evaluation used a different wattage than recommended for a sample of LED lighting.
- **Residential**
  - **Energy Efficient Homes New Homes:** 2,933 MWh/yr savings were reported, but not verified in PY13 final annual report. Those savings have since been verified with an energy realization rate of 98% and a NTGR of 0.64, which yields an additional 2,867 MWh/yr of gross verified energy savings and an additional 1,835 MWh/yr of net verified energy savings.

These verified gross savings are attributed to the residential (2,867 MWh/yr) sectors' VTD savings in Table 2-5.

- **Energy Efficient Homes Online Marketplace**: SWE audit activities recommended an increase of gross verified energy savings of 0.19 MWh/yr to 2.03 MWh/yr because the evaluation omitted cross-sector sales for Online Marketplace.
- **Efficient Lighting**: SWE audit activities recommended a reduction of gross verified energy savings of 3.65 MWh/yr to 4,349 MWh/yr because the evaluation used incorrect lumens for a few models and used 365.25 hours of use instead of 365 hours of use.

2.6.2 Lifetime Energy Savings by Program

Table 2-9 presents the PYTD and P4TD lifetime energy savings by program. Lifetime savings are adjusted to account for reduced lighting savings following the 2020 Energy Independence and Security Act (EISA) backstop. Specifically, after the 2020 EISA implementation, screw-based LED savings are reduced to the difference in energy usage between the efficient bulb and the new baseline. No savings are included beyond 15 years, for any rebated item, per the Pennsylvania TRC Order.[10]

Table 2-9. 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	3,144,173	2,138,076	5,041,925	3,235,720
Low-Income	85,596	85,596	197,396	197,396
Residential	416,618	241,531	771,001	477,378
Portfolio Total	3,646,387	2,465,203	6,010,322	**3,910,495**

The previously reported VTD lifetime savings from prior years, for the following programs, have changed since the PY13 final annual report was submitted:

- **Non-Residential**
  - **Custom Component:** 3,048 MWh/yr savings were reported, but not verified in PY13 final annual report. Those savings have since been verified with an energy realization rate of 106% and a NTGR of 0.22, which yields an additional 48,539 MWh/yr of lifetime gross verified energy savings and an additional 10,679 MWh/yr of lifetime net verified energy savings.
- **Low-Income**
  - 103 MWh/yr savings were reported, but not verified in PY13 final annual report. Those savings have since been verified with an energy realization rate of 121% and a NTGR of 1.0, which yields an additional 809 MWh/yr of lifetime gross and net verified energy savings.

[10] 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 New Homes:** 2,933 MWh/yr savings were reported, but not verified in PY13 final annual report. Those savings have since been verified with an energy realization rate of 98% and a NTGR of 0.64, which yields an additional 43,004 MWh/yr of lifetime gross verified energy savings and an additional 27,867 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:[11, 12]

- Residential: 1.0875
- Small C&I: 1.0875
- Large C&I: 1.042
- GNE: 1.0719

Table 2-10 presents a summary of the peak demand impacts by energy efficiency program through the current reporting period.

Table 2-10. 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	33.10[(1)]	36.37	24.86	53.47	57.63	36.67
Residential	6.15	5.11	3.22	11.15	10.03	6.56
Low-Income	1.21[(1)]	1.53	1.53	2.50	2.56	2.56
Portfolio Total[(2)]	**40.46**	**43.01**	**29.61**	**67.12**	**70.22**	**45.79**

[(1)] Includes 0.26 MW/yr and 0.99 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.

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

12 For GNE records, the line loss multiplier was calculated as a blended rate of 1.0719 using the proportion of reported demand reductions of the residential and small C&I sectors compared to the large C&I sector (66% and 34%, respectively).

The previously reported VTD savings from prior years, for the following programs, have changed since the PY13 final annual report was submitted:

- **Non-Residential**
  - **Custom Component:** 0.56 MW/yr demand reductions were reported, but not verified in PY13 final annual report. Those demand reductions have since been verified with a demand realization rate of 114% and a NTGR of 0.22, which yields an additional 0.68 MW/yr of system-level gross verified demand reductions and an additional 0.12 MW/yr of net verified demand reductions. These verified system-level gross savings are attributed to the Residential (0.07 MW/yr), Small C&I (0.25 MW/yr), and Large C&I (0.36 MW/yr) sectors' VTD savings in Table 2-5.
- **Low-Income**
  - 0.01 MW/yr demand reductions were reported, but not verified in PY13 final annual report. Those demand reductions have since been verified with a demand realization rate of 121% and a NTGR of 1.0, which yields an additional 0.01 MW/yr of system-level gross and net verified demand reductions. These verified system-level demand reductions are attributed to the Low-Income sectors' VTD savings in Table 2-5.
  - SWE audit activities recommended a reduction of system-level gross demand reductions of 0.21 MW/yr because the evaluation used an incorrect baseline wattage for a sample of LED lighting.
- **Residential**
  - **Energy Efficient Homes New Homes:** 1.22 MW/yr demand reductions were reported, but not verified in PY13 final annual report. Those demand reductions have since been verified with a demand realization rate of 63% and a NTGR of 0.64, which yields an additional 0.84 MW/yr of system-level gross verified demand reductions and an additional 0.54 MW/yr of system-level net verified demand reductions. These system-level demand reductions are attributed to the Residential (0.84 MW/yr) sectors' VTD savings in Table 2-5.
  - **Energy Efficient Homes Online Marketplace and Downstream**: SWE audit activities recommended an increase of gross system-level verified demand reductions of 0.0006 MW/yr because the evaluation omitted cross-sector sales for Online Marketplace and failed to remove heat IE from heat pump water heater calculations.
  - **Efficient Lighting**: SWE audit activities recommended a reduction of system-level gross verified demand reduction of 0.0001 MW/yr because the evaluation used incorrect lumens for a few models and used 365.25 hours of use instead of 365 hours of use.

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 2-11 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 PY14.

Table 2-11. Planned FCM Nominations by Act 129 Program Year and PJM Delivery Year

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	1.4				
PY14	[1 to 10]		1.5	1.5	1.5	1.5			
PY15	[1 to 10]			[1 to 10]	[1 to 10]	[1 to 10]	[1 to 10]		
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**	**[3.8 to 12.8]**	**[4.8 to 22.8]**	**[4.4 to 31.4]**	**[3 to 30]**	**[2 to 20]**	**[1 to 10]**

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

Table 2-12 lists the measures selected by PPL Electric Utilities to be offered into PJM.

Table 2-12. PY14 Measures Selected for PJM

Measure Category	Measure	PY13	PY14
Large C&I Commercial Lighting	LED fixtures	✓	✓
	LED linear replacements	✓	✓
	LED screw-ins	✓	✓
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		✓

Lighting measures were nominated to qualify into PJM based on the ease of project measurement and verification and availability of PJM-required information. Other measures will be evaluated for potential offering into future PJM delivery years.

Qualified MW volume by rate class for PY14 and successfully monetized in PJM delivery year 2023-2024 (DY23/24):

- Large C&I: 0.398 MW
- Small C&I: 0.545 MW
- Residential: 0.381 MW
- Low-Income: 0.132 MW

These resources resulted in PJM revenues from DY23/24 that will be paid in full (in addition to DY22/23 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 2-13 summarizes key fuel switching metrics in PY14 and to date in Phase IV.

Table 2-13. Fuel Switching Summary

Metric	PY14	P4TD
Fuel Switching Measures Offered	• ASHP • Electric Baseboards • Electric Furnace • Water Heater Gas - Electric Resistance • Water Heater Propane - Electric Resistance • CHP	• ASHP • Electric Baseboards • Electric Furnace • Water Heater Gas - Electric Resistance • Water Heater Propane - Electric Resistance • CHP
Fuel Switching Measures Implemented	• ASHP - 9 • Electric Baseboards - 9 • Electric Furnace - 6 • Water Heater Gas - Electric Resistance - 15 • Water Heater Propane - Electric Resistance - 19 • CHP - 0	• ASHP - 15 • Electric Baseboards - 26 • Electric Furnace - 7 • Water Heater Gas - Electric Resistance - 28 • Water Heater Propane - Electric Resistance - 27 • CHP - 2
VTD Energy Savings Achieved via Fuel Switching (MWh/yr)	**342**	**15,247**
PIV TD **Increased Fossil Fuel Consumption Due to Fuel Switching Measures (MMBTU/yr)**	**1.17**	**52.03**
PIV TD Incentive Payments for Fuel Switching Measures ($1000)	**$12**	**$1,021**

2.9 Summary of Cost-Effectiveness Results

A detailed breakdown of portfolio finances and cost-effectiveness is presented in Table 2-14. TRC benefits were calculated using gross verified impacts. Net present value (NPV) PY14 costs and benefits are expressed in 2022 dollars. Net present value costs and benefits for P4TD financials are expressed in 2021 dollars.

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented later in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. *Appendix C* shows the TRC ratios by program and for the portfolio.

Table 2-14. Summary of Portfolio Finances – Gross Verified

Row	Cost Category[1]	PYTD ($1,000)		P4TD[2] ($1,000)	
1	**IMCs**	**$90,872**		**$137,706**	
2	Rebates to Participants and Trade Allies	$22,837		$29,960	
3	Upstream/Midstream Incentives	$2,886		$4,851	
4	Material Cost for Self-Install Programs (EE&C Kits)	$1,280		$3,411	
5	Direct Installation Program Materials and Labor	$1,776		$2,150	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]	$62,093		$97,334	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$697	$462
8	Administration and Management[3]	$1,381	$3,718	$2,679	$7,196
9	Marketing	$1,353	$1,738	$3,025	$3,318
10	Program Delivery[4]	$0	$10,499	$0	$16,465
11	EDC Evaluation Costs	$1,990		$3,050	
12	SWE Audit Costs	$396		$773	
13	**Program Overhead Costs (Sum of rows 7 through 12)**[6]	**$21,075**		**$37,664**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)**[5], [6]	**$112,762**		**$176,185**	
15	Total NPV Lifetime Electric Energy Benefits	$107,568		$171,372	
16	Total NPV Lifetime Electric Capacity Benefits	$62,411		$103,328	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$5,161		$8,033	
18	Total NPV Lifetime Fossil Fuel Impacts	$3,664		($1,050)	
19	Total NPV Lifetime Water Impacts	$4,796		$12,360	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$183,600**		**$294,043**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.63**		**1.67**	

[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 $815,592 of excess incentives from the Residential Efficient Lighting Program component. Per Phase IV TRC Order, excess incentives are to be treated as a TRC cost, so the sum of rows 1 and 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 2-15 presents PY14 expenditures compared to the budget estimates set forth in the EE&C plan for PY14 and P4TD. PY14 values are presented in 2022 dollars and P4TD values are presented in 2021 dollars. Program-level comparisons of actual savings to plans are presented in *Appendix A*.

Table 2-15. Comparison of Expenditures to Phase IV EE&C Plan ($1,000)

Expenditures	Budget from EE&C Plan[1]	Actual Expenditures	Ratio (Actual/Plan)
PY14 Portfolio	$63,715	$52,198	82%
PIV TD	$125,539	$82,755	66%

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

Table 2-16 compares PY14 and P4TD verified gross program savings compared to the energy savings projections set forth in the EE&C plan. Program-level comparisons of expenditures to plans are presented in *Appendix A*.

Table 2-16. Comparison of Actual Program Savings to EE&C Plan Projections

Savings	EE&C Plan Projections	VTD Gross Savings	Ratio (Actual/Plan)
PY14 Portfolio MWh/yr	308,804	256,971	83%
PIV TD MWh/yr	600,893[1]	430,558[1]	72%
PY14 Portfolio MW/yr (System-Level)	49.08	43.01	88%
PIV TD MW/yr (System-Level)	96.00	70.22	73%

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

2.10.1 Program Summary

The reasons program savings in PY14 varied from projections estimated in the EE&C plan are summarized below. Additional details can be found in the individual program chapters and program component appendices.

Non-Residential Program Components

The Non-Residential Program achieved 81% of the energy savings projections and 100% of the demand reductions estimated in the EE&C plan for PY14. The midstream non-lighting stratum of the Efficient Equipment component was not verified in PY14, leaving just over 700 MWh/yr and 0.26 MW/yr unverified. For the Non-Residential Program, the energy realization rate was 106% and demand reduction realization rate was 104%.

Residential Program Components

In PY14, the Residential Program achieved approximately 92% of the energy savings projections and 62% of the projected demand reductions estimated in the EE&C plan for PY14 due to two main factors. The SEEE component, along with two subcomponents of Energy Efficient Homes, were not verified in PY14, so over 9,800 MWh/yr and 1.0 MW/yr were unverified. Additionally, demand reductions from the New Homes subcomponent were lower than anticipated. The ICSP used a method for demand savings that was different than the PA TRM, resulting in a low realization rate that drove down demand savings for the Residential Program.

The energy realization rate was 102% and the demand realization rate was 91% for the Program overall. The Energy Efficient Homes component had a realization rate for demand of 82% (the only component with a realization rate below 100%) due primarily to the New Homes subcomponent.

Low-Income Program

In PY14, the Low-Income Program contributed energy savings of 18% of the Phase IV Low-Income compliance target. This combined with PY13 energy savings and the carryover from Phase III brings the Low-Income Program to 73% of the Phase IV Low-Income compliance target, with three additional years to achieve the remaining 27%. 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.

The Low-Income energy realization rate was 119% and the demand realization rate was 116%. The factors that led to differences between reported and verified savings and the overall realization rate for the Low-Income Program in PY14 are included in *6.2 Gross Impact Evaluation.*

2.10.2 PY15 Program Changes

PPL Electric Utilities has made the following program changes in PY15.

Non-Residential Program Components

Custom. The Custom component will continue to offer rebates in PY15 to both large C&I and small C&I customers for projects not included in the PA TRM. Custom incentives were lowered at the start of PY15. Technical outreach continues to identify custom opportunities for customers.

Efficient Equipment. The Efficient Equipment component will continue to offer incentives through downstream and midstream delivery channels. Efficient equipment incentives were lowered at the start of PY15. Additional support will be placed on expanding the midstream Food Service and HVAC networks; while launched in PY14, participation has been limited. Technical webinars began in PY15 with four initial webinars on various topics scheduled.

Residential Program Components

Appliance Recycling. This component will continue to offer customers the choice to schedule a contactless or in-home appliance pick-up as well as the small appliance recycling events that will be scheduled throughout PPL Electric Utilities' territory. In PY15, PPL Electric Utilities will begin neighborhood sweeps for small appliances, which offer pick-ups scheduled for specific areas and times to give customers another opportunity to recycle small appliances without including a refrigerator or freezer.

Efficient Lighting. At the end of PY14, PPL Electric Utilities sunset this component due to a planned change in federal regulations and stopped offering upstream incentives to manufacturers.

Energy Efficient Home. The midstream delivery channel for HVAC projects officially launched in PY14 but no sales were attributed to this channel. In PY15, PPL Electric Utilities will continue to build the distributor network to support the midstream offering and an administrative incentive will be provided

to distributors. PPL Electric Utilities continues to offer downstream incentives through the new homes, in-home audit or remote assessment and weatherization, and efficient equipment channels, measures through the Online Marketplace, and the comprehensive retrofit bonus. For PY15, air purifiers, room ACs, spray foam, pipe insulation and air filters have been added to the Online Marketplace. In PY14, the component introduced advanced power strips and dehumidifiers as instant discount measures and these offerings will continue in PY15. Also in PY15, air purifiers, room ACs, spray foam, air filters and pipe insulation are being introduced as instant discount measures.

Two pilot programs began in PY14 to expand energy efficiency for PPL Electric Utilities customers in existing residential homes and in new home construction. While the overarching pilot goal is the same, implementation is specific to each unique market.

The Deep Energy Retrofit Pilot for existing homes now has four lead home performance contractors that partner with up to ten subcontractors to provide whole-home services. This includes treatments for both building shell and mechanical upgrades. Outreach and sales are provided by each contractor but will be augmented by monthly pilot webinars as well as both email and social platform marketing.

The High-Performance New Homes Pilot will partner with four builders who currently participate in PPL Electric Utilities' ENERGY STAR® New Homes subcomponent. Each builder has committed to upgrading a single home to the Zero Energy Ready Home certification. Construction upgrades are being documented and used for various educational settings. This includes web-based promotion, live home tours and webinars.

Student Energy Efficient Education. In PY15, the Student Energy Efficient Education component will continue to focus on low-income schools and offer education and energy efficiency kits to students. In PY15, the kits have been slightly changed. The dusk-to-dawn bulb was replaced with two 15W bulbs and one 8W in all kits. In the Take Action and Innovation kits, the outlet gaskets, pipe wrap and weatherstripping have been removed. The component will implement another poster contest and the yearly student Innovation challenge.

Low-Income Program

Low-Income. This program continues to offer low- and no-cost energy-saving improvements and education to income-eligible customers residing in single-family homes, individually- and master-metered multifamily units, and manufactured homes. PPL Electric Utilities will continue to offer in-home and remote assessments. The program will continue to offer comprehensive measures through the in-home delivery channel. In PY15, the program will focus on increasing participation in all types of assessments, with an emphasis on in-home direct installations, comprehensive measures, and an expanded effort to reach multifamily customers. Additionally, the ICSP will make a transition from an LED welcome kit to a water kit to optimize peak demand savings.

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

Program-specific and portfolio total finances for PY14 are shown in Table 3-1. Columns in this table are adapted from the Direct Program Cost categories in the PA PUC's EE&C plan template for Phase IV.[13] 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 both 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.[14]

Table 3-1. PY14 Program and Portfolio Total Finances ($1,000)

Program	Incentives	Non-Incentives	Total Cost
Non-Residential	$20,477	$8,216	$28,693
Low-Income	$3,104	$3,209	$6,314
Residential	$6,514	$5,229	$11,743
Common Portfolio Costs [(1)]	$0	$5,053	$5,053
Portfolio Total	**$30,095**	**$21,707**	**$51,802**
SWE Costs [(2)]	-	-	$396
Total	**$30,095**	**$21,707**	**$52,198**

[(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.

Program-specific and portfolio total finances since the inception of Phase IV are shown in Table 3-2.

[13] 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

[14] 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	$26,822	$12,902	$39,724
Low-Income	$5,278	$6,251	$11,528
Residential	$10,960	$8,694	$19,653
Common Portfolio Costs[1]	$0	$11,057	$11,057
Portfolio Total	**$43,060**	**$38,903**	**$81,963**
SWE Costs[2]			$792
Total	**$43,060**	**$38,903**	**$82,755**

[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	PY14 Spending[1]	P4TD Spending[1]
Residential & Low-Income (100/200)	Residential (primarily RS)	$20,488	$36,988
Small C&I (300)	Small C&I (primarily GS1 & GS3)	$17,043	$26,725
Large C&I (400)	Large C&I (primarily LP4 & LP5)	$9,858	$12,145
GNE	Residential, Small C&I, and Large C&I	$4,809	$6,897
Portfolio Total	-	**$52,198**	**$82,755**

[1] Includes costs for SWE audit.

4 Evaluation Activities

This section documents the gross impact and process evaluation activities conducted in PY14. The outcomes of these activities are documented and discussed in upcoming sections of this report. 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. PY14 Evaluation Activity Matrix

Program/Component	Gross Impact	Net Impact	Process
Non-Residential Program			
Custom	✓	✓(1)	✓
Efficient Equipment Non-Lighting Downstream	✓	✓	✓
Efficient Equipment Lighting Downstream	✓	✓(2)	✓
Efficient Equipment Non-Lighting (Midstream)	(3)		✓
Efficient Equipment Lighting (Midstream)	✓	✓(4)	
Low-Income Program			
Low-Income Assessment	✓		✓
Residential Program			
Appliance Recycling	✓	✓(4)	✓
Efficient Lighting	✓(6)	✓(4)	
Energy Efficient Homes New Homes	✓	✓(5)	
Energy Efficient Homes Audit and Weatherization	✓	✓	✓
Energy Efficient Homes Equipment (downstream)	✓(6)	✓(4)	✓
Energy Efficient Homes Equipment (midstream)	(7)		✓
Energy Efficient Homes Online Marketplace	(3)		✓
Energy Efficient Homes Instant Discount	(3)		
Student Energy Efficient Education	(3)		✓

(1) Cadmus treated all measures in the Custom component as high-impact measures (HIM).
(2) Cadmus treated the downstream lighting delivery channel (direct discount, direct install, and prescriptive) as a HIM.
(3) Unverified in PY14 and will verify in PY15.
(4) Applying a historical NTGR to verified savings.
(5) Cadmus used interviews from PY13 and applied the NTGR to PY13 and PY14.
(6) Applying PY13 historical realization rate to verify PY14 savings.
(7) PPL Electric Utilities did not report any savings for this program component.

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 PY15, 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]		Two-year sample[1]	
	Reporting		U	V	U	V
Efficient Equipment Lighting (Downstream and Midstream)	Sampling	Impact	Impact	Impact	Two-year sample[1]	
	Reporting	V	V	V	U	V
Low-Income						
Low-Income (Welcome Kits and Remote Energy Assessments)	Sampling	Impact	Impact	None	Two-year sample[1]	
	Reporting	V	V	H	U	V
Low-Income (In-home Assessments)	Sampling	Two-year sample[1]		None	Two-year sample[1]	
	Reporting	U	V	H	U	V
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	Impact
	Reporting	V	V	V	V	V
Energy Efficient Home (Audit and Weatherization)	Sampling	None	Impact	None	Impact	None
	Reporting		V	H	V	H
Energy Efficient Home (Midstream Equipment)	Sampling	None	Two-year sample[1]		Two-year sample[1]	
	Reporting		U	V	U	V
Energy Efficient Home (Downstream Equipment)	Sampling	Impact	None	Impact	Impact	None
	Reporting	V	H	V	V	H
Energy Efficient Home (Online Marketplace)	Sampling	Impact	Two-year sample[1]		None	None
	Reporting	V	U	V	H	H
Energy Efficient Home (New Homes)	Sampling	Two-year sample [1]		None	Impact	None
	Reporting	U	V	H	V	H
Energy Efficient Home (Instant Discount)	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			
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 quarters 1 through 4 (Q1-Q4) of the first year in the sample and Q1 and Q2 of the second year in the sample.

Impact evaluation activities varied by program in PY14. Table 4-3 lists the impact evaluation activities conducted for each program component in PY14. The individual program chapters and corresponding appendices discuss the impact evaluation activities, methodology, analysis, and findings.

Table 4-3. PY14 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	✓					
Student Energy Efficient Education	✓					

4.2 Process Evaluation

This section summarizes the process evaluation activities of PPL Electric Utilities' PY14 portfolio. The individual program chapters and respective appendices identify opportunities and offer recommendations to improve the overall effectiveness of the design, implementation, enrollment process, quality assurance, and other elements for PPL Electric Utilities' energy efficiency programs.

Table 4-4 lists the process evaluation activities conducted for each program in PY14, 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. PY14 Portfolio Process Evaluation Activities by Component

Program and Component	Completed Participant Survey[1]	Participant Satisfaction Analysis	Stakeholder Interviews/ Feedback	Trade Ally Interviews	Market Actor Interviews	Logic Model Review	Secondary Research
Non-Residential Program							
Custom	✓ (n=12)	✓ (n=12)	✓				
Efficient Equipment Non-Lighting (downstream)	✓ (n=6)	✓ (n=5)	✓				
Efficient Equipment Lighting (downstream)	✓ (n=24)	✓ (n=21)	✓				
Efficient Equipment Non-Lighting (midstream)			✓	✓ (n=6)		✓	
Efficient Equipment Lighting (midstream)			✓				
Low-Income Program							
Low-Income Assessment	✓ (n=97)	✓ (n=117)	✓				
Residential Program							
Appliance Recycling	✓ (n=139)	✓ (n=139)	✓				
Efficient Lighting							
Energy Efficient Homes New Homes			✓				
Energy Efficient Homes Audit and Weatherization	✓ (n=68)	✓ (n=68)	✓				
Energy Efficient Homes Equipment (downstream)	✓ (n=155)	✓ (n=145)	✓				
Energy Efficient Homes (midstream)			✓	✓ (n=1)		✓	
Energy Efficient Homes Online Marketplace	✓ (n=105)	✓ (n=87)	✓				
Student Energy Efficient Education	✓ (n=14,624)	✓ (n=14,624)	✓				
Total	**15,230**	**15,218**	**N/A**	**7**	**0**	**N/A**	**N/A**

[1] Includes all survey modes: online, telephone, and paper. For additional detail, see program chapter and appendix. This may not match the totals used for program satisfaction, net-to-gross, or impact inputs.

PPL Electric Utilities

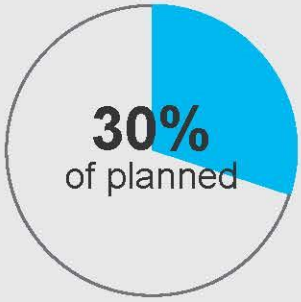
CADMUS

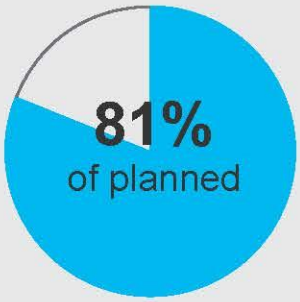
NON-RESIDENTIAL PROGRAM

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 **339,544 MWh/yr**

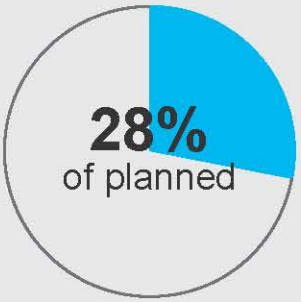


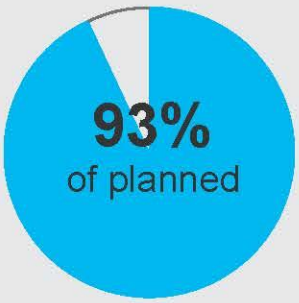


PY14 saved **209,711 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **57.63 MW/yr**





PY14 has reductions of **36.37 MW/yr**

PY14 PARTICIPATION

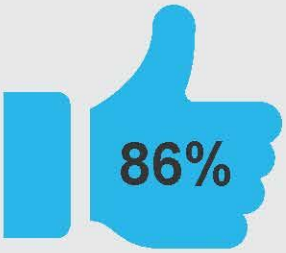
A total of **6,659** participants

122 Custom

129 Efficient Equipment Non-Lighting

6,408 Efficient Equipment Lighting

PARTICIPANT SATISFACTION



Satisfied with overall program

89% satisfied with Efficient Equipment

83% satisfied with Custom

5. Non-Residential Program

PPL Electric Utilities' Non-Residential Energy Efficiency Program offers financial incentives to customers in a non-residential 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 PY14 by customer segment.

Table 5-1. PY14 Non-Residential Participation and Reported Impacts [(1)]

Parameter	Residential (Non-LI)	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total [(2)]
PYTD # Participants	113	3,822	970	1,754	6,659
PYRTD MWh/yr	1,760	104,614	76,061	16,708	199,144
PYRTD MW/yr	0.53	16.91	12.90	2.77	33.10
PYVTD MWh/yr [(3)]	1,493	111,845	77,485	18,887	209,711
System-Level PYVTD MW/yr [(3)]	0.45	19.19	13.55	3.18	36.37
PY14 Incentives ($1000)	$384	$11,494	$5,973	$2,625	$20,477

[(1)] The totals in this table do not include PY13 unverified savings verified in PY14.
[(2)] Total may not sum due to rounding.
[(3)] Savings for midstream equipment were left unverified in PY14 and will be verified in PY15.

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	PY14 Unverified	Phase IV Verified[(1),(2)]
MWh/yr	129,833	209,711	709	339,544
System-Level MW/yr	21.26	36.37	0.26[(3)]	57.63

[(1)] Phase IV verified savings may not match sum of program years due to rounding.
[(2)] Does not include PY14 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 reductions

realization rates for components of the Non-Residential Program in PY14. Additional details about the evaluation approach and findings are presented in *Appendix A* and *Appendix E.*

Table 5-3. PY14 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	94,575	101%	0.03	1.0%	95,307
Efficient Equipment Non-Lighting	2,289	122%	0.4	10.6%	2,799
Efficient Equipment Lighting	101,570	110%	0.5	10.0%	111,605
Program Total [3][4]	**198,434**	**106%**	**0.3**	**5.2%**	209,711
Midstream Non-Lighting Unverified	709	-	-	-	-
Verified + Unverified Total [3][4]	**199,144**	**-**	**-**	**-**	**209,711**
Custom (PY13 verified in PY14)	3,048	106%	-	-	3,236

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

Table 5-4. PY14 Non-Residential Gross Impact Results for Demand

@EComponent	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	16.44	102%	0.05	1.8%	16.80	17.87
Efficient Equipment Non-Lighting	0.34	116%	0.4	12.7%	0.39	0.42
Efficient Equipment Lighting	16.06	105%	0.3	6.3%	16.84	18.08
Program Total[3,][4]	**32.84**	**104%**	**0.2**	**3.1%**	**34.03**	**36.37**
Midstream Non-Lighting Unverified	0.26	-	-	-	-	-
Verified + Unverified Total[3], [4]	**33.10**	**-**	**-**	**-**	**34.03**	**36.37**
Custom (PY13 verified in PY14)	0.56	114%	-	-	0.64	0.68

[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 with the greatest effect on the overall realization rate were 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.

Please see *Appendix D* and *Appendix E* for more information on factors that affected observed realizations rates for the Efficient Equipment component.

5.3 Net Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Phase IV Evaluation Framework,[15] which discusses the common methods used to determine free ridership and spillover. For the Custom component and downstream, direct discount, and direct install projects in the Efficient Equipment component, Cadmus used self-report surveys, administered online and 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* and *Appendix E.*

Cadmus did not conduct new primary research to assess net savings for midstream lighting in PY14 and used a historic NTG ratio of 0.62 from PY11.[16] 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 PY14.

Table 5-5. PY14 Non-Residential Net Impact Evaluation Results

Component	Program Year	PYVTD (kWh/yr)	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision (@ 85% CL)
Custom	PY14	95,306,730	26%	0%	0.74	3%
Efficient Equipment Non-Lighting	PY14	2,798,824	84%	0%	0.16	84%
Efficient Equipment Lighting	PY14	79,533,939	35%	0%	0.65	9%
Midstream Lighting	PY11	32,071,401	38%	0%	0.62	33%
Program Total	**-**	**209,710,893[1]**	**32%[2]**	**0%[2]**	**0.68[2]**	**9%**

[1] May not sum due to rounding.
[2] Weighted by PY14 component verified gross energy savings.

The PY14 Non-Residential Program total NTG ratio of 0.68 is heavily weighted toward the Custom component and Efficient Equipment Lighting component NTG ratios, as the Custom component and the

[15] 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.

[16] PPL Electric Utilities. February 15, 2021. *Phase III of Act 129 Program Year 11 Annual Report (June 1, 2019–May 31, 2020).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

Efficient Equipment Lighting components represent 45% and 38% 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. All projects in the Custom component are unique and considered high-impact measures, including solar projects. Commercial lighting is considered a high-impact measure. Overall, the NTG research for high-impact measures represents 84% of the total Non-Residential Program verified gross energy savings in PY14.

Table 5-6 presents findings for PY14 high-impact measures.

Table 5-6. PY14 Non-Residential High-Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Custom[1]	26%[2]	0%	0.74
Solar (CHP)[3]	38%	0%	0.62
Efficient Equipment Lighting[1, 4]	35%[2]	0%	0.65
Total	**30%[5]**	**0%**	**0.70**

[1] Estimated from PY14 survey data.
[2] Weighted by the survey sample-verified program kWh/yr savings.
[3] Solar projects are included in the Custom program component.
[4] Downstream Lighting, Direct Install, and Direct Discount Lighting stratums.
[5] Weighted by verified gross energy savings of high-impact measure population.

5.4 Verified Savings Estimates

In Table 5-7, the realization rates and NTG ratios determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Non-Residential Program in PY14. These totals are added to the verified savings achieved in previous program years to calculate the P4TD program impacts.

Table 5-7. PY14 and P4TD Savings Summary for the Non-Residential Program

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	199,144[2]	33.10[2]
PYVTD Gross	209,711[3]	36.37[1][3]
PYVTD Net	142,556[3]	24.86[1][3]
RTD	322,300[2]	53.47[2]
VTD Gross	339,544[4]	57.63[1][4]
VTD Net	216,498[4]	36.67

[1] Verified peak demand reductions include application of distribution losses.
[2] Includes 709 MWh/yr of unverified PY14 energy savings and 0.26 MW/yr of unverified PY14 demand reductions from the midstream non-lighting subcomponent.
[3] Does not include PY13 unverified savings verified in PY14.
[4] Includes PY13 unverified savings verified in PY14 and does not include PY14 unverified savings.

The VTD savings contribution from PY13 has changed since the final PY13 annual report. Cadmus verified savings for PY13 small Custom jobs in PY14 and included these savings in the VTD gross totals.

5.5 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 PY14 to assess participant satisfaction, assess 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 5-8. Modifications to Cadmus' evaluation plans are noted in *Appendix D* and *Appendix E*.

Table 5-8. Non-Residential Process Evaluation Activities

Activity	Audience	Methodology
Efficient Equipment Downstream Delivery Channels		
In-depth Interviews	Administration staff (n=3)	Telephone
Survey	Participants (n=30)[(1)]	Telephone and online
Efficient Equipment Midstream Delivery Channel		
In-Depth Interviews	Administration staff (n=2)	Telephone
In-Depth Interviews	Distributors (n=6)[(1)]	Telephone
Logic model review and Update (non-lighting only)	N/A	In-depth interviews and secondary research
Custom		
In-Depth Interviews	Administration staff (n=2)	Telephone
Survey	Participants (n=12)[(1)]	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.		

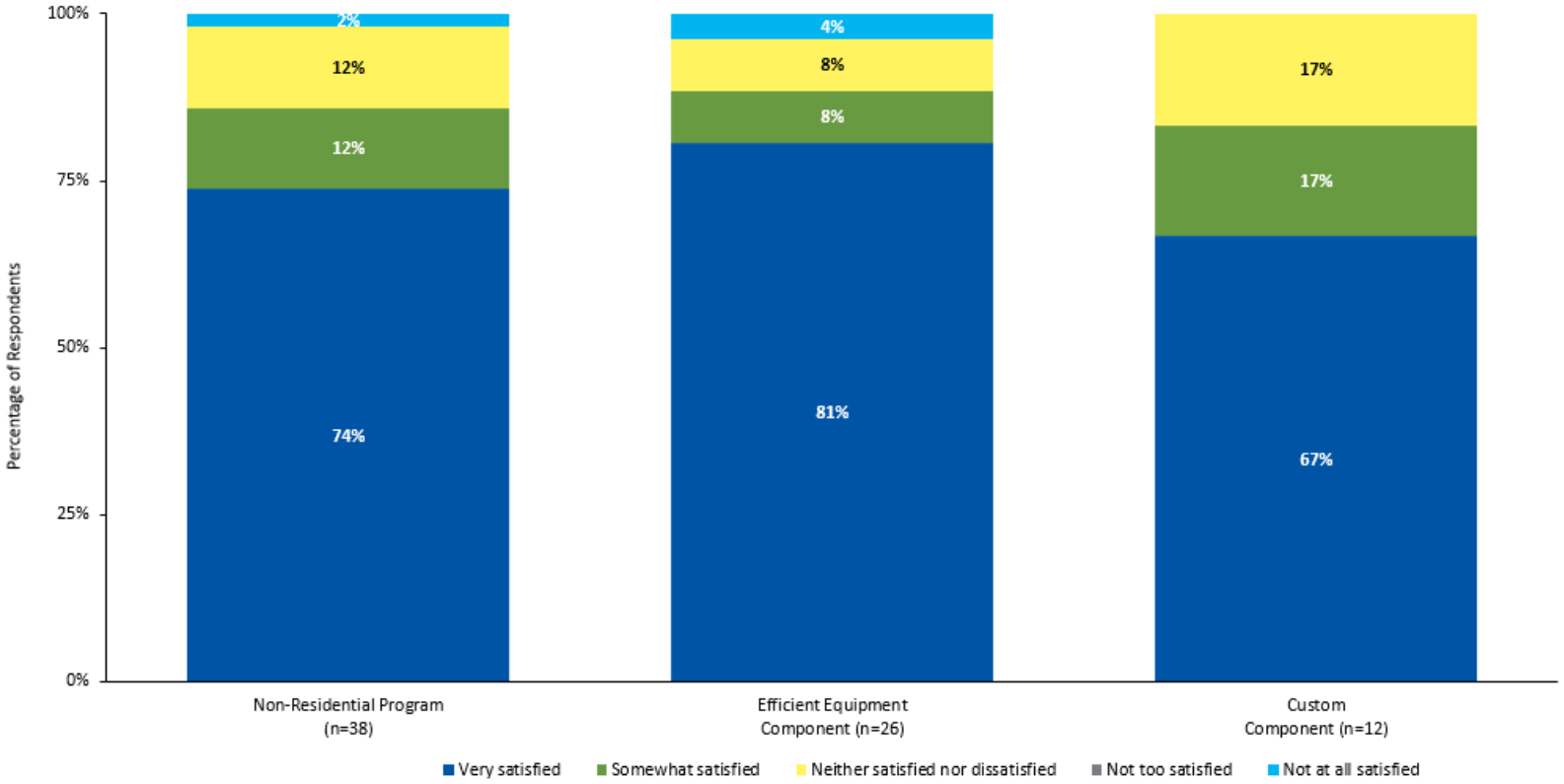
The staff interviews were conducted in February 2023 via phone, the distributor interviews were conducted in May and June 2023 and the participant surveys were conducted between April and June 2023 via phone and online.

5.5.1 Process Evaluation Key Findings

For Phase IV, PPL Electric Utilities established a goal to achieve 85% or more *very satisfied* and *somewhat satisfied* participants within the Non-Residential Program.[17] As shown in Figure 5-1, 86% of Non-Residential survey respondents (n=38) were satisfied with their program experience, which was a decrease from 96% (n=31) in PY13.

[17] 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.

Figure 5-1. PY14 Non-Residential Program Overall Satisfaction



Source: Participant survey question, "Thinking about your overall experience with the PPL Electric Utilities Business Energy Efficiency rebate program, how would you rate your satisfaction?" Not all respondents answered this question.

Table 5-9 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 5-9. Non-Residential Program Key Process Evaluation Findings

Program Component	Finding
Efficient Equipment Downstream Equipment	• The overall satisfaction rate was 89%. • A majority of the survey respondents (73%; n=26) reported that participating was either *very easy* or *easy*, a decline from 88% in PY13 (n=28). • Similar to PY13, the program components that most affected customers' satisfaction rating was the rebate amount (62%; n=26), reducing energy bills (62%), and increasing energy savings (58%). • Most survey respondents (72%; n=25) said their opinion of PPL Electric Utilities had either *improved significantly* or *improved somewhat* after participating in the Efficient Equipment component. • The percentage of customers who reported being likely to recommend the program component decreased from 85% in PY13 (n=26) to 77% in PY14 (n=26). • The main source of awareness of the program component is the contractor (39%), followed by a PPL Electric Utilities representative (14%; n=28).
Custom	• Ten of the 12 survey respondents were either *very* or *somewhat* satisfied with the program component. • Most survey respondents reported being satisfied with the installation experience, the quality of the installed product, the contractor they worked with, and the availability of the contractor in their area. • The main drivers of high satisfaction in PY14 were communication, increased energy savings, and the rebate amount. • Eight of the 12 survey respondents reported that it was *easy* to participate in this program component. • Seven of the 12 survey respondents reported having a better opinion of PPL Electric Utilities after participating in the Custom component. • Overall, 11 of the 12 survey participants were likely to recommend the component to a friend, family member, or colleague.

5.6 Program Finances and Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 5-10. The TRC benefits were calculated using gross verified impacts. NPV PY14 costs and benefits are expressed in 2022 dollars. Net present value costs and benefits for P4TD financials are expressed in 2021 dollars.

Table 5-10. Summary of Non-Residential Program Finances – Gross Verified

Row	Cost Category[1]	PYTD ($1,000)		P4TD[2] ($1,000)	
1	**IMCs**	**$70,857**		**$103,155**	
2	Rebates to Participants and Trade Allies	$18,599		$23,054	
3	Upstream/Midstream Incentives	$1,810		$2,727	
4	Material Cost for Self-Install Programs (EE&C Kits)	$0		$0	
5	Direct Installation Program Materials and Labor	$10		$11	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[6]	$50,438		$77,363	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management[3]	$194	$1,681	$341	$3,300
9	Marketing	$0	$350	$0	$904
10	Program Delivery[4]	$0	$5,607	$0	$7,600
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)**[6]	**$7,832**		**$12,145**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)[5], [6]**	**$78,689**		**$115,300**	
15	Total NPV Lifetime Electric Energy Benefits	$93,726		$145,722	
16	Total NPV Lifetime Electric Capacity Benefits	$53,600		$87,207	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$5,130		$7,969	
18	Total NPV Lifetime Fossil Fuel Impacts	($5,186)		($15,105)	
19	Total NPV Lifetime Water Impacts	$10		$10	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$147,279**		**$225,803**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.87**		**1.96**	

[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 5-11 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 5-11. Summary of Non-Residential Program Finances – Net Verified

Row	Cost Category [1]	PYTD ($1,000)		P4TD [2] ($1,000)	
1	**IMCs**	**$47,585**		**$66,650**	
2	Rebates to Participants and Trade Allies	$18,599		$23,054	
3	Upstream/Midstream Incentives	$1,810		$2,727	
4	Material Cost for Self-Install Programs (EE&C Kits)	$0		$0	
5	Direct Installation Program Materials and Labor	$10		$11	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)	$27,166		$40,858	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management [3]	$194	$1,681	$341	$3,300
9	Marketing	$0	$350	$0	$904
10	Program Delivery [4]	$0	$5,607	$0	$7,600
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)**	**$7,832**		**$12,145**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)[5] [6]**	**$55,417**		**$78,795**	
15	Total NPV Lifetime Electric Energy Benefits	$63,705		$93,007	
16	Total NPV Lifetime Electric Capacity Benefits	$36,213		$54,257	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$3,304		$5,303	
18	Total NPV Lifetime Fossil Fuel Impacts	($3,309)		($8,257)	
19	Total NPV Lifetime Water Impacts	$2		$2	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**	**$99,915**		**$144,312**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.80**		**1.83**	

[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.

5.7 Status of Recommendations

Overall, the Non-Residential Program met its customer satisfaction target but did not meet the planned PY14 savings. The program achieved 36.37 MW/yr in system-level demand reductions and 209,711 MWh/yr in verified energy savings. In addition, the program reported another 0.26 MW/yr and 709 MWh/yr from the Midstream Equipment component that will be evaluated in PY15. The majority of participants (86%) were *very* or *somewhat satisfied* with the component in which they participated. Overall, the Efficient Equipment and the Custom survey participants indicated having a high overall component satisfaction. Furthermore, rebate amount, reducing energy bills, and increasing energy savings remain the top drivers of satisfaction for the Efficient Equipment component. Table 5-12 provides recommendations, along with a summary of how PPL Electric Utilities plans to address the recommendation.

Conclusion 1: Customers who were dissatisfied with the Custom component indicated that additional information surrounding rebates (requirements, amount, and timing) would improve their program experience.	• Three respondents indicated they were not satisfied with the clarity of rebate application requirements or communication with PPL Electric Utilities and two were dissatisfied with communication with CLEAResult and rebate timing. One respondent was *not satisfied* with the rebate amount. See section *E.3.2 Improvement Suggestions.*
Conclusion 2: For Lighting, specification sheets or DLC/Energy Star QPLs showed different wattages when compared to claimed values. Additionally, for site visit projects, different fixture types were found to be installed compared to reported.	• For the Downstream Lighting subcomponent, 10 projects in the sample saw adjustments for wattages. See section *D.1.2 Gross Impact Results.*
Conclusion 3: For midstream lighting, the claimed facility type was either Office or Exterior, which does not cover all options in the TRM.	• Cadmus adjusted facility types on most projects (19 of 24) based on the findings from the desk review. See section *D.1.2 Gross Impact Results.*
Conclusion 4: Findings from the logger data analysis for threshold lighting projects saw fewer adjustments compared to PY13.	• Cadmus found that the evaluated HOU and CF exactly matched reported values for 50% of threshold lighting projects in the sample. In some cases, however, adjustments were made to evaluated CF. See section *D.1.2 Gross Impact Results.*

The impact and process evaluation activities in PY14 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 5-12).

Table 5-12. Status of Recommendations for the Non-Residential Program

Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Custom	**Conclusion 1:** Customers who were dissatisfied with the Custom component indicated that additional information surrounding rebates (requirements, amount, and timing) would improve their program experience.	**Recommendation 1:** Consider providing additional customer resources and communication through meetings with KAM's, site visits, or additional literature about program component details, including: eligibility requirements; application process; rebate amounts and timing; application and status; and trouble-shooting resources.	**Implemented -** PPL Electric Utilities consistently reviews and improves customer resources especially for trade ally driven outreach.
Efficient Equipment Lighting	**Conclusion 2:** For Lighting, specification sheets or DLC/Energy Star QPLs showed different wattages when compared to claimed values. Additionally, for site visit projects, different fixture types were found to be installed compared to reported.	**Recommendation 2:** Consider updating *ex ante* assumptions to match specification sheets and QPLs.	**Being considered**.
Efficient Equipment Lighting	**Conclusion 3:** For midstream lighting, the claimed facility type was either Office or Exterior, which does not cover all options in the TRM.	**Recommendation 3:** Consider increased data collection to report facility types.	**Rejected -** Customer, contractor, and/or distributor provided data was inaccurate. PPL Electric Utilities will use default hours of use for Unknown Building beginning in PY16 or earlier, if feasible.
Efficient Equipment Lighting	**Conclusion 4:** Findings from the logger data analysis for threshold lighting projects saw fewer adjustments compared to PY13.	**Recommendation 4:** Calculate CF directly from the metered data rather than the tables within the Appendix C workbook.	**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

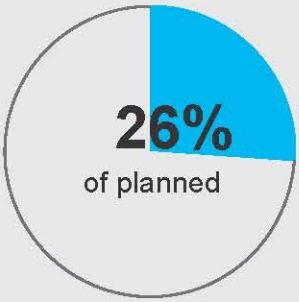
Phase IV has saved **53,111 MWh/yr***

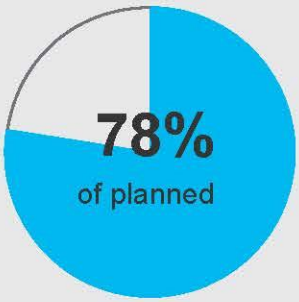
PY14 saved **12,872 MWh/yr**

*Includes Phase III carryover energy savings

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **2.56 MW/yr**





PY14 has reductions of **1.53 MW/yr**

PY14 PARTICIPATION

A total of **24,889** jobs completed

19,738 households received welcome kits

4,924 households received low-cost jobs

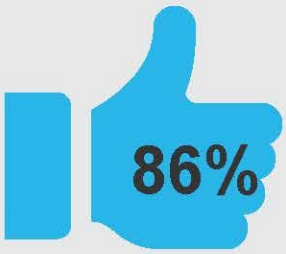
3,340 households received baseload jobs

312 households received full-cost jobs

2 master metered multifamily building jobs

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

PARTICIPANT SATISFACTION



Satisfied with overall program

85% satisfied with either on-site or REA

90% satisfied with remote energy assessments

79% satisfied with on-site assessments

86% satisfied with welcome kits

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.[18,19]

The Low-Income Program is delivered by CMC Energy, the ICSP, 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 LIURP, 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 residential 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 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 measures	Customers who receive an on-site energy assessment
Master-Metered Multifamily		Customers in PPL Electric Utilities' territory; master-metered multifamily buildings (tenant units); receive landlord's approval	On-site energy assessment and direct installation of measures	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 and heating, appliances, appliance recycling, and home health and safety. All qualifying customers receive a free energy assessment that evaluates their home for eligible energy-saving options. The home energy auditor refers to a preapproved list of

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

[19] 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.

products and services along with criteria to determine if appliances and other large equipment can be replaced cost-effectively. They also provide energy education and make recommendations to encourage customers to conserve energy.

Starting in PY13 and continued in PY14, the ICSP provides eligible customers with welcome kits containing two 8-watt LED bulbs and a postcard that encourages participation in the Low-Income Assessment Program and provides the ICSP contact phone number and program website.

In spring 2022, the ICSP began to offer on-site assessments or remote assessments via telephone. Remote assessments began in June 2020 in response to the COVID-19 pandemic. The assessment, whether in-person or by telephone, involves visiting each room in the home and asking the resident questions about the home's energy-using equipment to gather 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 provide tips and education for how participants can save energy based on their energy needs and home and energy equipment conditions. If the assessment is completed remotely, the ICSP mails a comprehensive kit of energy-saving items customized to each participant's responses. The kit contains items such as LEDs, night lights, Tier 1 power strips, low-flow showerheads, and low-flow faucet aerators. If the remote energy assessment customer needs assistance, the ICSP will arrange for an on-site visit. If the assessment is completed on site, contractors directly install equipment.

PPL Electric Utilities provides four types of service (also known as job types) at no cost to the income-qualified customer. 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, 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 measures provided) for the Low-Income Program. Participants are defined as unique households (billing account number) that receive a welcome kit or a home assessment and program services.

Table 6-2. PY14 Low-Income Program Participation and Reported Impacts[1]

Parameter	Residential Low-Income	Small C&I Low-Income	GNE Low-Income	Total[1]
PY14 # Participants[2]	24,887	1	1	**24,889**
PYRTD MWh/yr	10,696	104	25	**10,825**
PYRTD MW/yr	1.20	0.01	0.002	**1.21**
PYVTD MWh/yr	12,777	76	19	**12,872**
System-Level PYVTD MW/yr	1.52	0.01	0.002	**1.53**
PY14 Incentives ($1,000)	-	$3,068	$36	$3,104

[1] The totals in this table do not include PY13 unverified savings verified in PY14.
[2] This count is based on PY14 unique household participants.

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	Phase IV Verified[1]
MWh/yr	9,151[2]	12,872	53,111[3]
System-Level MW/yr	0.95[4]	1.53	2.56

[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] Includes 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 PY14, the Low-Income Program reported energy savings of 10,825 MWh/yr and achieved a program realization rate of 119%, weighted by stratum, as shown in Table 6-4. The program reported demand reductions of 1.21 MW/yr and achieved a program demand realization rate of 116%, as shown in Table 6-5. Both tables are shown by stratum (job type). In contrast to the participant-level measure aggregation previously utilized in PY13, savings data are rolled up per job and delivery type in PY14. All previously unverified PY13 data were verified in PY14.

Table 6-4. PY14 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	2,391	99%	0.1	5.2%	2,357
REA Low-Cost	5,166	135%	0.3	13.2%	6,957
REA Full-Cost	10	102%	0.1	7.0%	11
REA Subtotal[4]	**7,567**	**123%**	**0.3**	**9.5%**	**9,324**
On-site Assessment					
On-Site Assessment Baseload	736	107%	0.03	1.7%	785
On-Site Assessment Low-Cost	1,631	117%	0.3	18.6%	1,908
On-Site Assessment Full-Cost	395	102%	0.1	7.0%	404
On-Site Assessment Master-Metered Multifamily	129	73%	-	-	95
On-site Assessment Subtotal[4]	**2,891**	**110%**	**0.4**	**10.3%**	**3,192**
Welcome Kits					
Welcome Kit	366	97%	-	-	356
Welcome Kits Subtotal[4]	**366**	**97%**	**-**	**-**	**356**
Program Total[4]	**10,825**	**119%**	**0.4**	**7.2%**	**12,872**
REA Baseload (PY13 verified in PY14)	2	99%	0.1	5.2%	2
REA Low-Cost (PY13 verified in PY14)	36	135%	0.3	13.2%	49
On-Site Assessment Baseload (PY13 verified in PY14)	19	107%	0.03	1.7%	20
On-Site Assessment Low-Cost (PY13 verified in PY14)	45	117%	0.3	18.6%	53
Welcome Kit (PY13 verified in PY14)	1	97%	-	-	1

[1] In PY14, jobs were aggregated 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 6-5. PY14 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	0.27	96%	0.1	5%	0.26	0.29
REA Low-Cost	0.55	138%	0.3	14%	0.76	0.83
REA Full-Cost	0.002	64%	0.6	31%	0.001	0.001
REA Subtotal[4]	**0.83**	**124%**	**0.4**	**10%**	**1.03**	**1.12**
On-site Assessment						
On-Site Assessment Baseload	0.08	102%	0.1	7%	0.09	0.09
On-Site Assessment Low-Cost	0.17	117%	0.3	19%	0.20	0.21
On-Site Assessment Full-Cost	0.07	64%	0.6	31%	0.05	0.05
On-Site Assessment Master-Metered Multifamily	0.01	76%	-	-	0.01	0.01
On-site Assessment Subtotal[4]	**0.34**	**100%**	**0.5**	**11%**	**0.34**	**0.37**
Welcome Kits						
Welcome Kit	0.04	95%	-	-	0.04	0.04
Welcome Kits Subtotal[4]	**0.04**	**95%**	**-**	**-**	**0.04**	0.04
Program Total[4]	**1.21**	**116%**	**0.4**	**7.5%**	**1.41**	**1.53**
REA Baseload (PY13 verified in PY14)	0.0002	96%	0.1	5%	0.0002	0.0002
REA Low-Cost (PY13 verified in PY14)	0.0038	138%	0.3	14%	0.0052	0.0057
On-Site Assessment Baseload (PY13 verified in PY14)	0.0021	102%	0.1	7%	0.0021	0.0023
On-Site Assessment Low-Cost (PY13 verified in PY14)	0.0051	117%	0.3	19%	0.0059	0.0064
Welcome Kit (PY13 verified in PY14)	0.0001	95%	-	-	0.0001	0.0001

[1] In PY14, jobs were aggregated 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 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:

- Cadmus based quantity of home occupants on home assessment data in place of PA TRM default assumptions.
- Cadmus applied the EER values in the PA TRM for room air conditioning (RAC) replacement and recycling.
- Cadmus applied LED hours of use (HOU), coincidence factor (CF), and interactive effects (IE) according to home assessment data.

The ICSP assumes the quantity of home occupants based on home type per the PA TRM. As in previous analyses, Cadmus used the number of occupants verified by the ICSP during the home assessment for water-saving equipment. This includes bathroom and kitchen low-flow aerators, low-flow showerheads, and thermostatic shower restriction valves (TSRV). In most cases within the on-site and REA low-cost strata, the number of occupants observed in the home assessment was greater than the TRM assumption, leading to greater *ex post* savings, and greater energy and demand realization rates. However, for master-metered multifamily (MMMF) data within the sample, the count of occupants observed in the home assessment were fewer than those assumed in the PA TRM, resulting in poor energy and demand realization rates for this stratum.

For replacing and recycling RACs the ICSP used a lower baseline EER value than the value in the PA TRM. An EER value of 7.0 was present in ICSP tracking database for all RAC measures within the sample. Per section 2.2.8 in the PA TRM, the baseline EER value is 9.8. Audit information to verify baseline RAC efficiencies were not available and the TRM default value was utilized. This resulted in lower measure-specific realization rate. While there were only seven RAC measures within the sample, these measures accounted for 12% of the total reported sample demand savings.

For the LED hours of use calculation in MMMF jobs, Cadmus followed the PA TRM protocol, which states that the all-bulbs hours of use (HOU) and coincidence factor (CF) inputs should be used within LED savings calculations for programs where it is known that the majority (> 90%) of the home's sockets are retrofitted with efficient lighting. The ICSP indicated that the efficient HOU and CF inputs (when fewer< 90% of home sockets are equipped with efficient lighting) were incorrectly used for LED installations within the MMMF data. This resulted in lower energy and demand realization rates. It is also noted that within the sample, the ICSP included interactive effects (IE) for all LED installations including exterior installations. This resulted in a higher energy realization rate and a lower demand realization rate across REA and on-site baseload and low-cost strata.

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 the energy efficiency products on their own. An NTG ratio of 1.0 is appropriate for this program. Therefore, the evaluation did not estimate net savings.

6.4 Verified Savings Estimates

As shown in Table 6-6, Cadmus determined the realization rates and NTG ratios and applied these values to the reported energy savings and demand reductions estimates to calculate the verified savings estimates for the PY14 Low-Income Program. We added these totals to the verified savings achieved in previous program years to calculate the P4TD program impacts.

Table 6-6. PY14 and P4TD Savings Summary for the Low-Income Program

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	10,825	1.21
PYVTD Gross	12,872[1]	1.53[1], [2]
PYVTD Net	12,872	1.53[1], [2]
RTD	22,665	2.50
VTD Gross	53,111[3]	2.56[2], [4]
VTD Net	22,022	2.56[2], [4]

[1] Does not include PY13 unverified savings verified in PY14.
[2] Verified demand reductions include line-loss adjustments.
[3] 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.
[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. Includes unverified PY13 savings of 0.01 MW/yr verified in PY14.

The VTD savings contribution from PY13 has changed since the final PY13 annual report. PY13 energy savings were reduced by 1,422 MWh/yr and system-level demand reductions were reduced by 0.21 MW/yr in accordance with the SWE's Annual Report findings. Cadmus verified savings for PY13 on-site assessment jobs in PY14 and included these savings in the VTD Gross totals.

6.5 Process Evaluation

This section summarizes the key findings of the Low-Income Program for PY14 from process evaluation activities for the on-site, remote energy assessment (REA), and welcome kit delivery channels. On-site participants receive a home energy assessment from an energy auditor who walks through the home and provides direct-install measures and energy services. REA participants receive a remote assessment, along with energy-saving items and services. Welcome kit participants receive a mailed package with two LED bulbs as encouragement to new customers to enroll in the Low-Income Assessment Program.

Cadmus conducted a process evaluation to assess participant satisfaction; gather stakeholder feedback; assess what is working well and what could be improved; review program operations, including customer promotional practices and outreach processes; and make recommendations for program modification and improvement. The evaluation activities were consistent with all but two of the planned activities. Cadmus deferred interviews with MMMF owners to PY15 due to low participation in PY14 and conducted monthly check in meetings with PPL Electric Utilities and the ICSP staff instead of in-depth interviews.

Cadmus conducted an online survey with Q1, Q2, and Q3 participants to assess program satisfaction, calculate energy education savings, and verify product installation. Cadmus administered the participant survey in March and April 2023. A total of 82 REAs, 44 on-site, and 102 welcome kits recipients completed or partially completed the online survey. Process survey analysis includes all respondents who answered a question even if they did not complete all questions in the survey, so this may differ from number of responses used in the impact analysis. Sample sizes noted in this report may also 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 about their experience, even if they did not complete the survey.

Table 6-7 lists the process evaluation sampling strategy. Cadmus reached out to every possible participant in the data provided (i.e., participants with valid email accounts). For REAs and welcome kits, participant survey completions exceeded quota and produced a measure of program satisfaction with ±10% precision at 90% confidence. For on-site assessments, Cadmus sent additional waves of invitations to participants in an attempt to reach 36 responses but did not reach the desired target. See *Appendix L. Survey Bias* for details about Cadmus' approach to reducing survey bias and contact instructions.

Table 6-7. 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 Participants	Participants who completed REAs	Online survey	4,716[2]	3,680[3]	0.33	30	58[4]	100%
On-Site Participants	Participants who had in-home assessments completed	Online survey	1,658[2]	1,225[3]	0.34	36	31[4]	100%
Welcome Kit Participants	Participants who received a welcome kit at the time of the survey	Online survey	13,697[2]	8,780[3]	0.33	30	86[4]	100%
Program Total			**17,775[5]**	**13,685**	**-**	**97**	**175**	**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. The final sample frame includes unique records in the PPL Electric Utilities database at the time of the surveys. After selecting all unique records, Cadmus removed any records from the population if the customer had participated in a survey in the last three months, had been selected for another program survey, did not have valid contact information (email) or previously opted out of the online survey.
[4] Analysis used all responses to the survey (n=228; 82 REA, 44 on-site assessments, and 102 welcome kits), not just completed surveys (n=175; 58 REAs, 31 on-site assessments, and 86 welcome kits).
[5] Rows do not add to 17,775 because a single participant may have participated in multiple strata of the Low-Income Program. In that case, Cadmus prioritized on-site, REAs, and then welcome kits, in that order. (For example, if someone received a welcome kit and then received an on-site assessment, they would have been considered an on-site participant for the survey as opposed to welcome kit.)

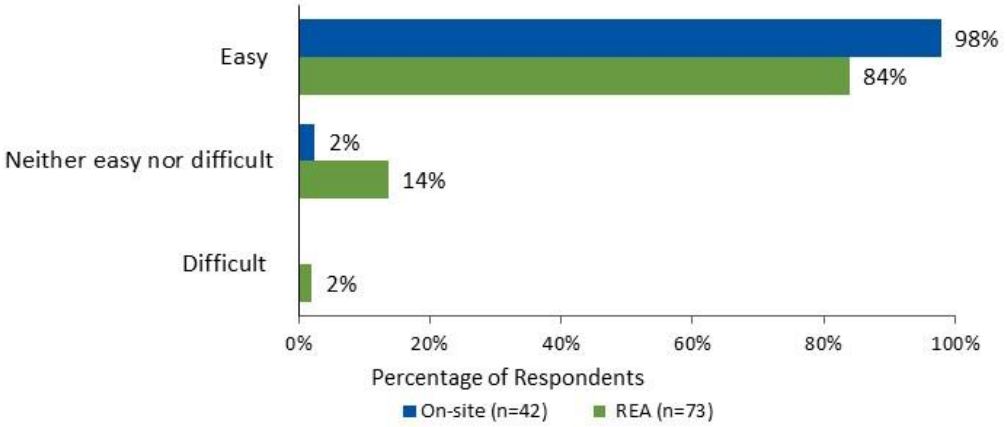
6.5.1 Program Experience

Program Satisfaction and Customer Effort

The program met the overall customer satisfaction goal of 85%, with 86% (n=117, remote and on-site assessments) satisfied respondents. However, Cadmus found differences in satisfaction by program delivery channel (remote, on-site, or welcome kit) in PY14. In particular, on-site respondents were least satisfied: 79% of on-site respondents (67% *very satisfied,* 12% *somewhat satisfied*, n=42), 90% of REA respondents (81% *very satisfied* and 9% *somewhat satisfied*; n=75), and 86% of welcome kit respondents (75% *very satisfied* and 11% *somewhat satisfied*; n=73) were satisfied with the program overall.[20,21]

Regardless of assessment type, most survey respondents found it easy to participate in the Low-Income Program, as shown in Figure 6-1. However, on-site respondents were significantly more likely to consider it easy to participate than REA respondents:[22] 98% (n=42) of on-site respondents found it *very easy* or *easy* to participate while only 84% (n=73) of REA respondents found it *very easy* or *easy* to participate. No additional survey responses contained context for the difference in ease between REA and on-site respondents.

Figure 6-1. Ease of Program Participation



Source: Participant survey, "Overall, how easy was it to participate in the WRAP program?"

[20] Of REA participants, 1% were *neither satisfied nor dissatisfied*, 7% were *not too satisfied*, and 1% were *not at all satisfied* (n=7). One REA participant did not answer the satisfaction question. Of on-site participants, 10% were *neither satisfied nor dissatisfied*, 10% were *not too satisfied*, and 2% were *not at all satisfied* (n=9). One on-site participant did not answer the satisfaction question.

[21] Of welcome kit recipients, 3% were *neither satisfied nor dissatisfied*, 1% were *not too satisfied*, and 10% were *not at all satisfied* (n=10). Six welcome kit respondents did not answer the overall satisfaction question.

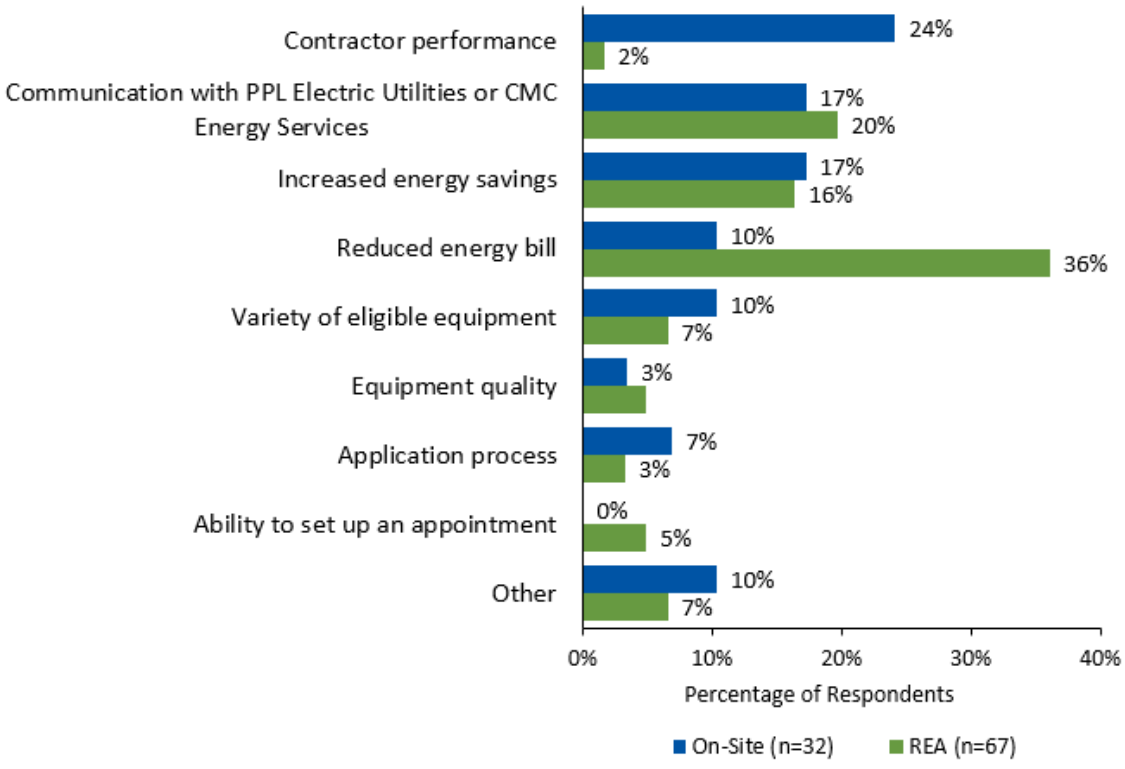
[22] Z-Test, $p < 0.05$

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 on-site respondents, the most common driver for high satisfaction was the performance of their auditor (24%, n=32). For REA respondents, the highest driver of satisfaction was seeing reduced energy bills (36%, n=67). For Welcome Kit respondents, the most common driver of high satisfaction was reduced energy bills (32%; n=71; Figure 6-3).

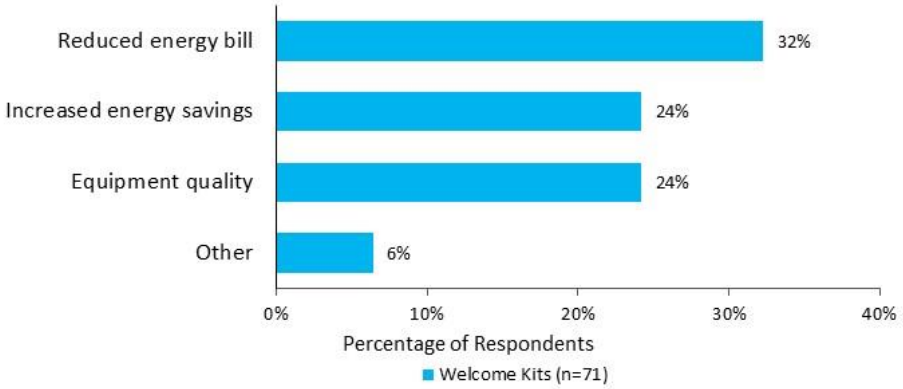
Perceptions of the resulting energy savings were also a factor for on-site participants that were less satisfied with the program. Four of nine (44%) on-site respondents who rated satisfaction as *neither satisfied nor dissatisfied*, *not too satisfied*, or *not at all satisfied*, reported the energy savings were not what they were expecting. The seven dissatisfied REA respondents gave more diverse reasons for dissatisfaction, such as other or don't know (3), the equipment quality (2), communication (1), and energy savings (1).

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



Source: Participant survey, "What factor most affected the overall experience rating you gave?" Similar to on-site and REA respondents, reduced energy bills were also the main driver of high program satisfaction for welcome kit respondents (32%, n=71), as shown in Figure 6-5.

Figure 6-3. Welcome Kit Drivers of High Program Satisfaction



Source: Participant survey, "What factor most affected the overall experience rating you gave?"

Eleven survey respondents who were *not too* or *not at all satisfied* with the REA and on-site delivery channels provided their reasons. For both REA and on-site delivery channels, similar to the most common drivers of high satisfaction, energy savings are the most prominent driver. Those who were less than satisfied did not think they were realizing enough energy or monetary savings on their monthly bills (four responses). Equipment quality (three responses) and communication (one response) also had an influence, but to a slightly lesser extent. Two respondents also said that the services they were hoping for were not provided. One dissatisfied respondent did not provide a response as to why.

For the welcome kit component, eight respondents were not satisfied, with seven of those being *not at all satisfied.* While three welcome kit respondents said a lack of benefit or poor quality of equipment, another common source of dissatisfaction was not receiving the kit (three responses). Two dissatisfied respondents did not provide responses as to why. Relatedly, in the intake survey question, almost a third of respondents (27%, n=102), reported not receiving a welcome kit at all.[23]

Opinion of PPL Electric Utilities and Likelihood to Recommend

Of 102 REA and on-site survey respondents, over half (59%) said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 31% said their opinion had not changed, and 9% (four respondents) said their opinion decreased.[24]

Of 67 welcome kit survey respondents, 52% said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 37% said their opinion had not changed, and 10% (seven respondents) said their opinion decreased.[25]

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[23] Due to the gap in time between when a customer might have received a welcome kit and took the survey, it is possible customers who received a welcome kit had since forgotten about the kit.

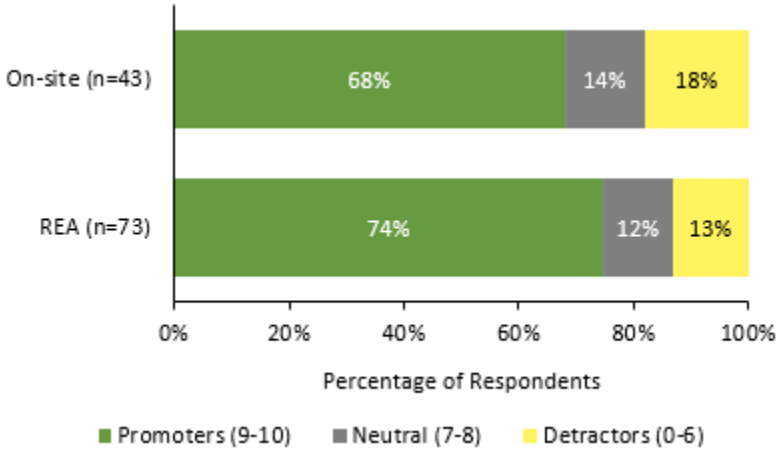
[24] Percentages may not sum to 100% due to rounding.

[25] Percentages may not sum to 100% due to rounding.

Of all REA, on-site, and welcome kit participants who reported a decreased opinion of PPL Electric Utilities, some explained why their opinion decreased following the program. Five respondents were not happy with their increased energy costs (three welcome kit, two on-site) despite the energy savings equipment. Four other respondents were displeased with the customer service and communication in the program (one welcome kit, one on-site, two REA)

Overall, 68% of on-site (n=43) and 74% of REA (n=73) respondents were likely to recommend the program to a friend, family member, or colleague, as shown in Figure 6-4.

Figure 6-4. Program Promoters



Source: Participant survey, "How likely is it that you would recommend this program to a friend, family member, or colleague?"

Improvement Suggestions

REA and on-site respondents provided feedback for improvement. Nearly half (46%, n=56) of respondents reported no improvements and 26% of respondents left positive comments about their experience with the program. However, some customers did have suggestions for improvements.

Eleven respondents (eight REA respondents, three on-site respondents) said improvements could be made in offering additional or different equipment. The most common requests include more LED lights (three respondents), dehumidifiers (two respondents), water heaters (two respondents), windows (two respondents), power strips (two respondents), and appliance recycling integration (one respondent).

In addition, five REA respondents desired improvement in communications, such as explaining all features of equipment (three respondents) or following up with recommendations (two respondents). Other REA participants also said additional support, such as follow up, guidance, or referrals in the installation process (four respondents), particularly for senior citizens (two respondents) would be helpful.

Seven respondents said they did not receive the services promised (three REA respondents and four on-site respondents). Specifically, on-site respondents said they expected additional services that were never provided but did not provide specifics.

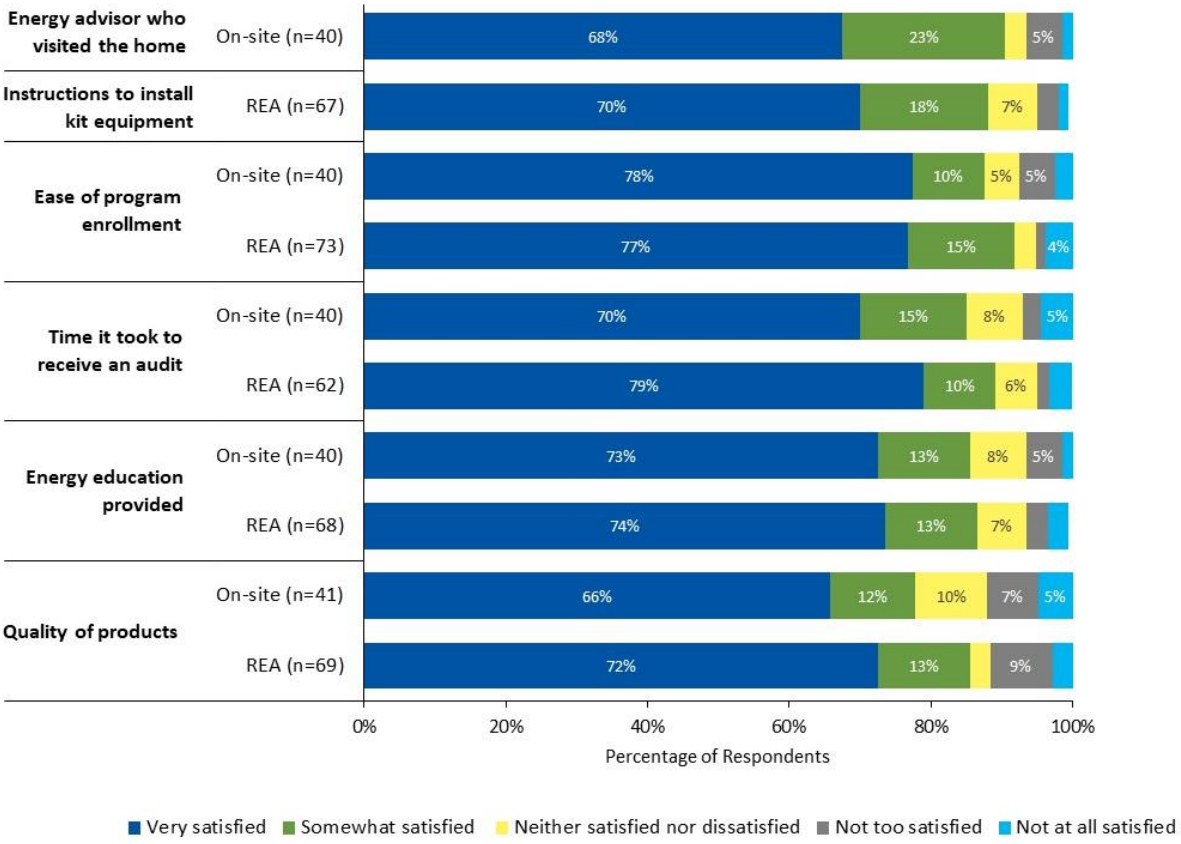
6.5.2 Additional Process Findings

Respondents answered additional questions about customer experiences, such as component satisfaction, sources of awareness, actions on recommendations, knowledge of energy efficiency, and perceived home comfort.

Program Component Satisfaction

Both REA and on-site respondents were asked to rate their satisfaction with different components of the program. As shown in Figure 6-5, on-site respondents were most satisfied with the energy advisors (91% *very* or *somewhat satisfied*, n=40), while REA respondents were most satisfied with the ease of program enrollment (92% *very* or *somewhat satisfied*, n=73). Both component respondents were least satisfied with the quality of products (78% *very* or *somewhat* satisfied for on-site, n=41; 85% *very* or *somewhat satisfied* for REA, n=69;).

Figure 6-5. Low-Income Program Component Satisfaction



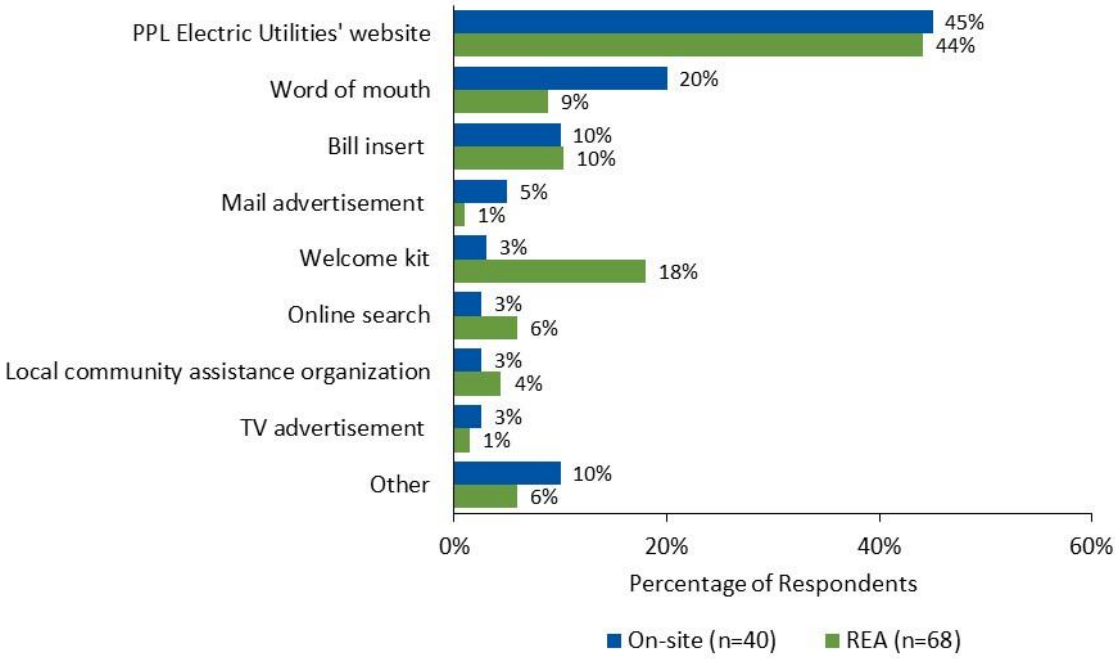
Source: REA and on-site responses to the participant survey, "How satisfied are you with the following aspects of the program?"

Awareness

In addition to program satisfaction, respondents answered questions about program awareness. As shown in Figure 6-6, most commonly, survey respondents learned about the program mainly through PPL Electric Utilities' website (45% on-site, n=40; 44% REA, n=68). While on-site respondents were also

likely to find out through word of mouth from a friend, family member, or colleague (20%), the second most common source of awareness for REA participants was from the welcome kit (18%).

Figure 6-6. Sources of Program Awareness

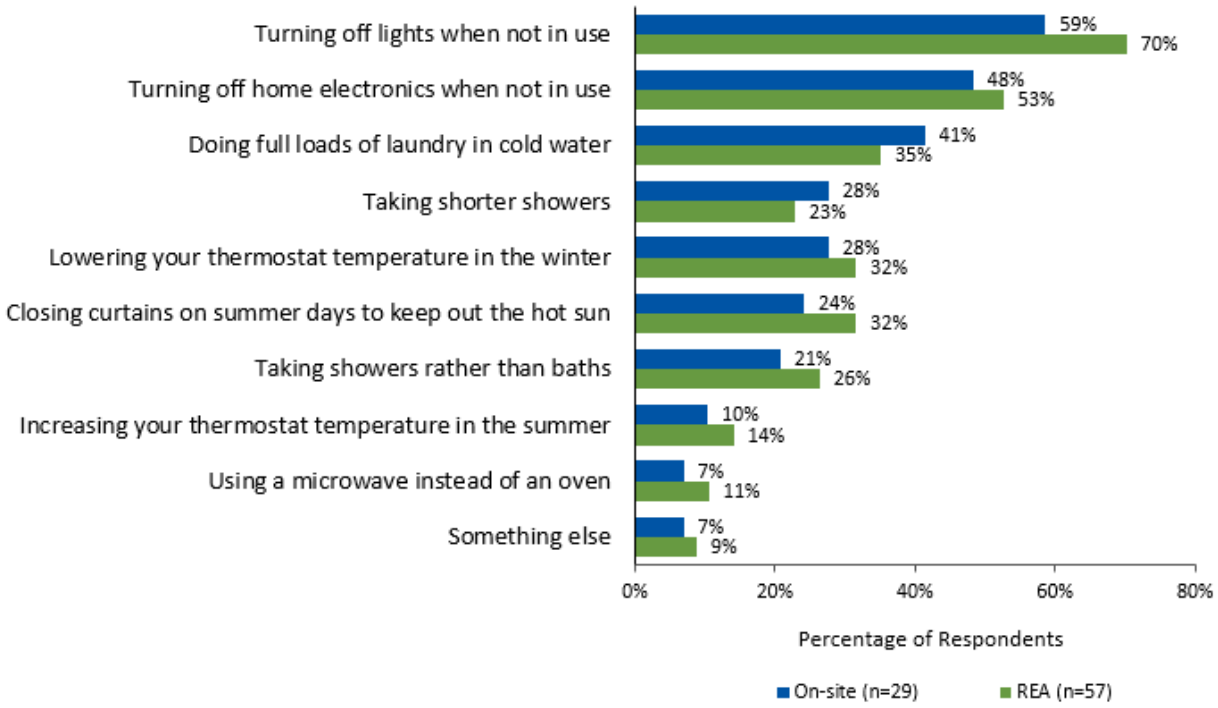


Source: Participant survey, "How did you first learn about WRAP?"

Actions on Recommendations

After the energy advisor provided energy savings recommendations, 98% (n=86) of respondents reported following at least one of the recommendations. As shown in Figure 6-7, the most common action respondents take is turning off the lights (59% on-site, n=29; 70% REA, n=57) and home electronics when not in use (48% on-site; 53% REA).

Figure 6-7. Participant's Energy Saving Behaviors

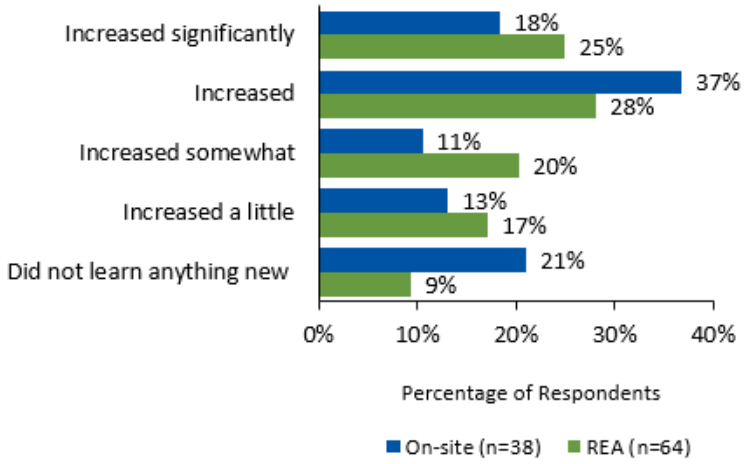


Source: Participant survey, "Which of the following recommendations did you follow?"; multiple responses allowed

Knowledge of Energy Efficiency

Survey respondents confirmed that participation in the program generally increases knowledge of energy efficiency. As shown in Figure 6-8, 79% (n=38) of on-site respondents reported their knowledge increased **at least** a little, with 18% reporting their knowledge *increased significantly.* A larger percentage of REA respondents said their knowledge increased **at least** a little, 90% (n=64), with 25% reporting their knowledge *increased significantly*.

Figure 6-8. Knowledge of Energy Efficiency

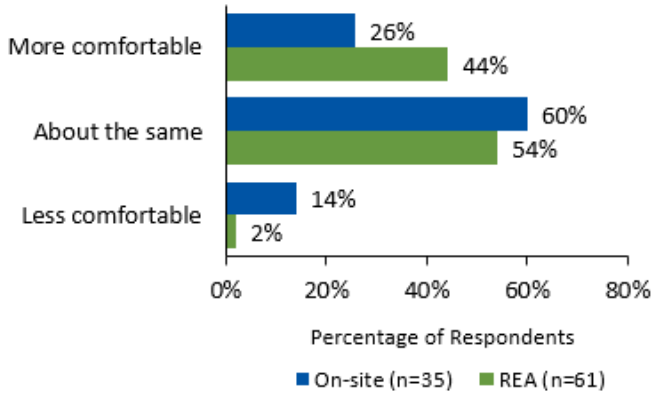


Source: Participant survey, "How did your knowledge of energy efficiency and energy conservation change after participating in the WRAP program?"

Home Comfort

As shown in Figure 6-9, across both on-site and REA segments, most respondents reported that their home comfort stayed the same after the assessment. However, 14% (n=35) of on-site respondents, as opposed to 2% (n=61) of REA respondents, reported homes being less comfortable after the WRAP program.[26]

Figure 6-9. Reported Home Comfort After Assessment



Source: Participant survey, "When thinking about the draftiness and temperatures within your home, which of the following statements best describes your home after participating in the WRAP program?"

[26] Z-test, $p \leq 0.05$

6.6 Program Finances and Cost-Effectiveness Reporting

Table 6-8 provides a detailed breakdown of program finances and cost-effectiveness. Cadmus calculated TRC benefits using gross verified impacts. Net present value (NPV) PY14 costs and benefits are expressed in 2022 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 6-8. Summary of Low-Income Program Finances – Gross and Net Verified

Row	Cost Category[1]	PYTD ($1,000)		P4TD[2] ($1,000)	
1	**IMCs**	**$3,104**		**$5,130**	
2	Rebates to Participants and Trade Allies	$71		$68	
3	Upstream/Midstream Incentives	$0		$0	
4	Material Cost for Self-Install Programs (EE&C Kits)	$1,267		$2,923	
5	Direct Installation Program Materials and Labor	$1,766		$2,139	
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]	$246	$726	$367	$1,338
9	Marketing	$0	$205	$0	$416
10	Program Delivery[4]	$0	$2,033	$0	$3,976
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)**[6]	**$3,209**		**$6,098**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)[5], [6]**	**$6,314**		**$11,228**	
15	Total NPV Lifetime Electric Energy Benefits	$2,533		$4,233	
16	Total NPV Lifetime Electric Capacity Benefits	$1,441		$2,397	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$31		$64	
18	Total NPV Lifetime Fossil Fuel Impacts	($21)		$12	
19	Total NPV Lifetime Water Impacts	$4,768		$8,376	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[6]	**$8,753**		**$15,082**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.39**		**1.34**	

[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 3,192 MWh/yr in verified savings from on-site assessments, 9,324 MWh/yr in verified savings from remote energy assessments, and 356 MWh/yr in verified savings from the welcome kits. The majority of participants, 86%, were *very* or *somewhat satisfied* with the remote energy assessments and on-site assessments (n=117). As COVID-19 concerns lessened over PY14 and participants became more comfortable having auditors in their home, the ICSP continued to offer a choice of in-home or remote assessments for the entirety of PY14. Table 6-9 provides recommendations, along with a summary of how PPL Electric Utilities plans to address the recommendation.

Conclusion 1: Low satisfaction with the on-site component of the program could be related to dissatisfaction with certain measures (aerators and showerheads in particular) or unrealistic program expectations about the services and energy savings they would receive.	• Only 79% (n=42) of on-site respondents were satisfied with the program compared to 90% of REA respondents. (See section *6.5.1 Program Experience: Program Satisfaction and Customer Effort*) • Fourteen percent (n=35) of on-site respondents reported their home comfort decreasing after their assessment. This may be related to dissatisfaction with water saving measures, as they saw lower ISRs for on-site participants (compared to REA participants) this year: 83% bathroom aerators, 86% kitchen aerators, 71% TSRVs, and 86% showerheads. (See sections *6.5.2 Additional Process Findings: Home Comfort* and *Table F-3. PY14 In-Service Rates for Energy-Saving Items*) • When asked about their dissatisfaction and potential improvements to the program, several on-site respondents indicated that they did not see a reduced energy bill, and some reported they did not receive services they thought they would. (See sections *6.5.1 Program Experience: Drivers of Program Satisfaction and Improvement Suggestions; 6.5.2 Additional Process Findings: Awareness.)*
Conclusion 2: Occupant data collected by the ICSP often differs from TRM assumptions.	• Of the 98 water-saving equipment installations (bathroom and kitchen aerators, showerheads, and TSRVs) observed within the sample, the count of home occupants was greater than that assumed by home type within the TRM for 53 of the 98 installations. The evaluation also observed home assessment data for MMMF jobs (10 jobs, 25 installations) had consistently fewer home occupants than assumed by the TRM. (See section *6.2 Gross Impact Evaluation*.)

Cadmus' impact and process evaluation activities in PY14 led to the findings and recommendations shown in Table 6-9. The table also includes a summary of how PPL Electric Utilities plans to address the recommendation in program delivery.

Table 6-9. Status of Recommendations for the Low-Income Program

Program	Conclusion	Recommendation	EDC Status of Recommendation
On-site Assessments	**Conclusion 1:** Low satisfaction with the on-site component of the program could be related to dissatisfaction with certain measures (aerators and showerheads in particular) or unrealistic expectations for measures they will receive and resulting energy savings.	**Recommendation 1a:** Consider improving marketing materials and program intake processes to ensure correct expectations are set at the time of scheduling an appointment; for example, not every home is eligible for all measures or homes will experience different levels of savings even with the same measures installed.	**Implemented -** PPL Electric Utilities ensures customers understand which measures they are eligible for in marketing and during the assessment.
		Recommendation 1b: To better understand potential reasons for low ISRs, review installation instructions and messaging provided for measures that are left behind for the customer to install and ensure customers needing installation support have those measures directly installed by the auditor.	**Implemented -** The PPL Electric Utilities website includes videos and instruction documents for use by customers.
***Ex Ante* Savings Calculations (All job types)**	**Conclusion 2**: Occupant data collected by the ICSP often differs from TRM assumptions.	**Recommendation 2**: Consider using the count of occupants captured during home assessments when calculating savings related to water-saving equipment.	**Rejected -** This would require a substantial update to the tracking database and will be considered in Phase V, if needed.

PPL Electric Utilities

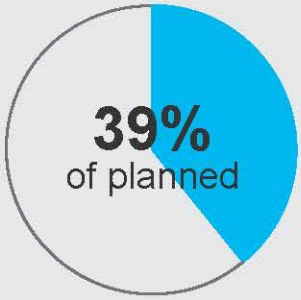
CADMUS

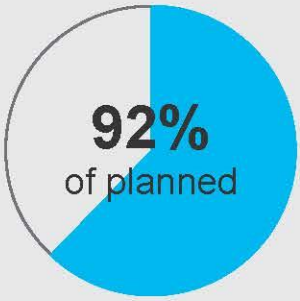
RESIDENTIAL PROGRAM

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 **68,991 MWh/yr**

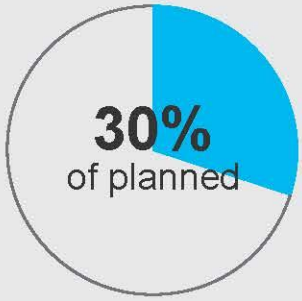


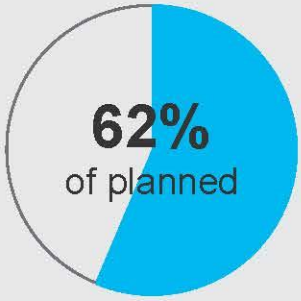


PY14 saved **34,388 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **10.03 MW/yr**





PY14 has reductions of **5.11 MW/yr**

PY14 PARTICIPATION

A total of **797,961** residential participants

744,963 Efficient Lighting (number of bulbs)

20,597 Energy Efficient Homes

20,194 Student Energy Efficient Education

12,207 Appliance Recycling

PARTICIPANT SATISFACTION

Satisfied with overall program

93% satisfied with Appliance Recycling

78% satisfied with Energy Efficient Homes

86% 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. A customer who recycles a refrigerator or freezer can also turn in room air conditioners and dehumidifiers. Participation is counted as the number of appliances recycled.
- **Energy Efficient Homes** offers incentives to home builders for building program-qualifying homes more efficient than code, downstream incentives for high-efficiency products and equipment, instant discounts on small appliances and products via an Online Marketplace, and home energy audits, energy kits, and downstream rebates for weatherization solutions. New in PY14, PPL Electric Utilities also offered instant discounts on small appliances at select retailers and began recruiting distributors for midstream incentives for high-efficiency HVAC equipment. 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 by buying down the price of program-qualified ENERGY STAR® LEDs. Incentives were provided to participating manufacturers to discount the prices of a variety of specialty bulbs sold at participating retail stores. This program component was sunset in PY14. 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 PY14 by customer segment.

Table 7-1. PY14 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]
PY14 # Participants	742,364	0	55,398	1	198	797,961
PYRTD MWh/yr	42,437	0	1,024	1	139	43,601
PYRTD MW/yr	5.89	0	0.24	0.00	0.02	6.15
PYVTD MWh/yr [3]	33,195	0	1,049	1	143	34,388
System-Level PYVTD MW/yr [3]	4.82	0	0.27	0.00	0.20	5.11
PY14 Incentives ($1000)	$6,385	$0	$117	$0	$12	$6,514

Note: This table does not include results from the Low-Income Program.
[1] The totals in this table do not include PY13 unverified savings verified in PY14.
[2] Total may not sum due to rounding.
[3] Savings for Energy Efficient Homes Online Marketplace and Instant Discount subcomponents and Student Energy Efficient Education were left unverified in PY14 and will be verified in PY15.

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	PY14 Unverified	Phase IV Verified [1][2]
MWh/yr	34,603[3]	34,388	9,819	68,991
System-Level MW/yr	4.92[4]	5.11	0.99[5]	10.03

[1] Phase IV verified savings may not match sum of program years due to rounding.
[2] Does not include PY14 unverified savings.
[3] PY13 verified savings for the Residential Program were reduced by 3.46 MWh/yr in accordance with the SWE's PY13 Annual Report findings.
[4] 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.
[5] 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 PY14 using a basic level of rigor. Evaluation methods and sampling approaches differed by component to reflect the unique design and delivery, and historic performance. For Appliance Recycling, Cadmus used a census approach. For Energy Efficient Homes, Cadmus conducted site visits, used a verification survey to calculate installation rates and home characteristics, and completed desk reviews of project documentation and contractor invoices. For the downstream equipment subcomponent of Energy Efficient Homes and for the Efficient Lighting component, Cadmus used PY13 realization rates to calculate PY14 savings.

Cadmus did not verify savings for the Student Energy Efficient Education component or the Online Marketplace and instant discount subcomponents of the Energy Efficient Homes component. These savings will be verified in PY15.

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 a 106% realization rate for energy (Table 7-3) and a 96% realization rate for demand (Table 7-4).

Table 7-3. PY14 Residential Program 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)
Appliance Recycling	8,548	100%	4.1	6.8%	8,569
Efficient Lighting	4,129	102%	0.0	0.0%	4,226
Energy Efficient Homes	21,106	102%	14.9	24.9%	21,593
Residential Subtotal [3]	**33,782**	**102%**	**9.4**	**15.5%**	**34,388**
Low-Income (Residential) [4]	10,825	119%	5.0	8.2%	12,872
Program Total [3]	**44,608**	**106%**	**7.0**	**11.5%**	**47,260**
Energy Efficient Homes Online Marketplace Unverified	930	-	-	-	-
Energy Efficient Homes Instant Discount Unverified	3,454	-	-	-	-
Student Energy Efficient Education Unverified	5,434	-	-	-	-
Total (Verified + Unverified) [3]	**54,427**	**-**	**-**	**-**	**47,260**
New Homes (PY13 verified in PY14)	2,933	98%	-	-	2,867

[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] Totals may not sum due to rounding and may not match other tables or figures due to rounding.
[4] Low-Income is shown as a subsector of residential in this table per sampling requirements in the Evaluation Framework.

Table 7-4. PY14 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	1.92	100%	4.1	7%	1.93	2.09
Efficient Lighting	0.60	102%	0.0	0%	0.61	0.66
Energy Efficient Homes	2.64	82%	6.2	10%	2.16	2.35
Residential Subtotal [3]	**5.16**	**91%**	**3.3**	**5%**	**4.70**	**5.11**
Low-Income (Residential) [4]	1.21	116%	5.2	9%	1.41	1.53
Program Total [3]	**6.37**	**96%**	**2.8**	**5%**	**6.11**	**6.64**
Energy Efficient Homes Online Marketplace Unverified	0.09	-	-	-	-	-
Energy Efficient Homes Instant Discount Unverified	0.39	-	-	-	-	-
Student Energy Efficient Education Unverified	0.52	-	-	-	-	-
Total (Verified + Unverified) [3]	**7.36**	**-**	**-**	**-**	**6.11**	**6.64**
New Homes (PY13 verified in PY14)	1.22	63%	-	-	0.77	0.84

[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] Totals may not sum due to rounding and may not match other tables or figures due to rounding.
[4] 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 PY14:

- For the New Homes subcomponent of Energy Efficient Homes, minor differences in model assumptions and observed mechanical systems on site led to a 98% energy realization rate, while more fundamental differences in demand savings methodologies between *ex ante* and *ex post* led to a low demand realization rate. More information is found in *Appendix I.*
- For the Audit and Weatherization subcomponent of Energy Efficient Homes, realization rates were impacted by installation rates of kit items and incorrect project parameters for insulation projects. For several insulation projects, Cadmus found differences in what was reported by participants in the verification survey and what was listed in the tracking database, as well as errors in the tracking data after a review of project invoices. Detailed information on these findings, and the PY14 installation rates for kit measures, are found in *Appendix I.*

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,[27] which discusses the common methods used to determine free ridership and spillover.

For the audit and weatherization stratum in the Energy Efficient Homes component, Cadmus used self-report surveys, administered online, to assess free ridership and spillover. Cadmus did not conduct new primary research to assess net savings for the Appliance Recycling component and the Efficient Lighting component in PY14 and historic NTG ratios from PY13 were used to calculate net savings. 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 PY14.

Table 7-5. PY14 Residential Program Net Impact Evaluation Results

Component	PYVTD (kWh/yr)	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision (@ 85% CL)
Appliance Recycling	8,569,186	45%	1%	0.56	5%
Efficient Lighting	4,225,828	N/A	N/A	1.07	15%
Energy Efficient Homes	21,593,067	48%	1%	0.53	22%
Program Total	**34,388,080**[(1)]	**N/A**	**N/A**	**0.60** [(2)]	**9%**

[(1)] May not sum due to rounding.
[(2)] Weighted by PY14 verified gross energy savings.

The PY14 Residential Program total NTG ratio of 0.60 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, the realization rates and NTG ratios determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Residential Program in PY14. These totals are added to the verified savings achieved in previous program years to calculate the P4TD program impacts.

[27] 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.

Table 7-6. PY14 and P4TD Savings Summary for the Residential Program

Savings Type	Energy (MWh/yr)[1]	Demand (MW/yr)[1]
PYRTD	43,601[2]	6.15[2]
PYVTD Gross	34,388[3]	5.11[3], [4]
PYVTD Net	20,921[3]	3.22[3], [4]
RTD	78,609[2]	11.15[2]
VTD Gross	68,991[5]	10.03[4], [5]
VTD Net	44,217[5]	6.56[4], [5]

[1] Does not include the Low-Income Program.
[2] Includes 9,819 MWh/yr of unverified PY14 energy savings and 0.99 MW/yr of unverified PY14 demand reductions from the Energy Efficient Homes component (Online Marketplace and Instant Discount subcomponents) and Student Energy Efficient Education.
[3] Does not include PY13 unverified savings verified in PY14.
[4] Verified peak demand reductions include application of distribution losses.
[5] PY13 energy savings were reduced by 3.46 MWh/yr and verified demand reductions for the Residential Program were increased by 0.0005 MW/yr in accordance with the SWE's PY13 Annual Report findings. Also, includes PY13 unverified savings verified in PY14 and does not include PY14 unverified savings.

The VTD savings contribution from PY13 has changed since the final PY13 annual report. Cadmus verified savings for PY13 Energy Efficient Homes New Homes jobs in PY14 and included these savings in the VTD Gross totals. Additionally, PY13 energy savings were reduced by 3.46 MWh/yr and system-level demand reductions were increased by 0.0005 MW/yr in accordance with the SWE's Annual Report findings.

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*, *and Appendix I*).

Cadmus conducted a process evaluation in PY14 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. PY14 Residential Program Evaluation Activities

Activity	Audience	Methodology
Appliance Recycling		
In-depth Interviews	Administration staff (n=2)	Telephone
Surveys	Participants (n=139)(1)	Online
Energy Efficient Homes		
In-depth Interviews	Administration staff (n=3)	Telephone
	Distributors (n=1)	Telephone
Surveys	Participants (n=328)(1)	Online
Logic model development (midstream HVAC only)	N/A	In-depth interviews and secondary research
Student Energy Efficient Education (SEEE)		
In-depth Interviews	Administration staff (n=2)	Telephone
Surveys	Participants (n=14,624)(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 2023 via phone, and the online participant surveys were conducted between March and April 2023. In-depth phone interviews with participating HVAC distributors were completed in January.

7.5.1 Process Evaluation Key Findings

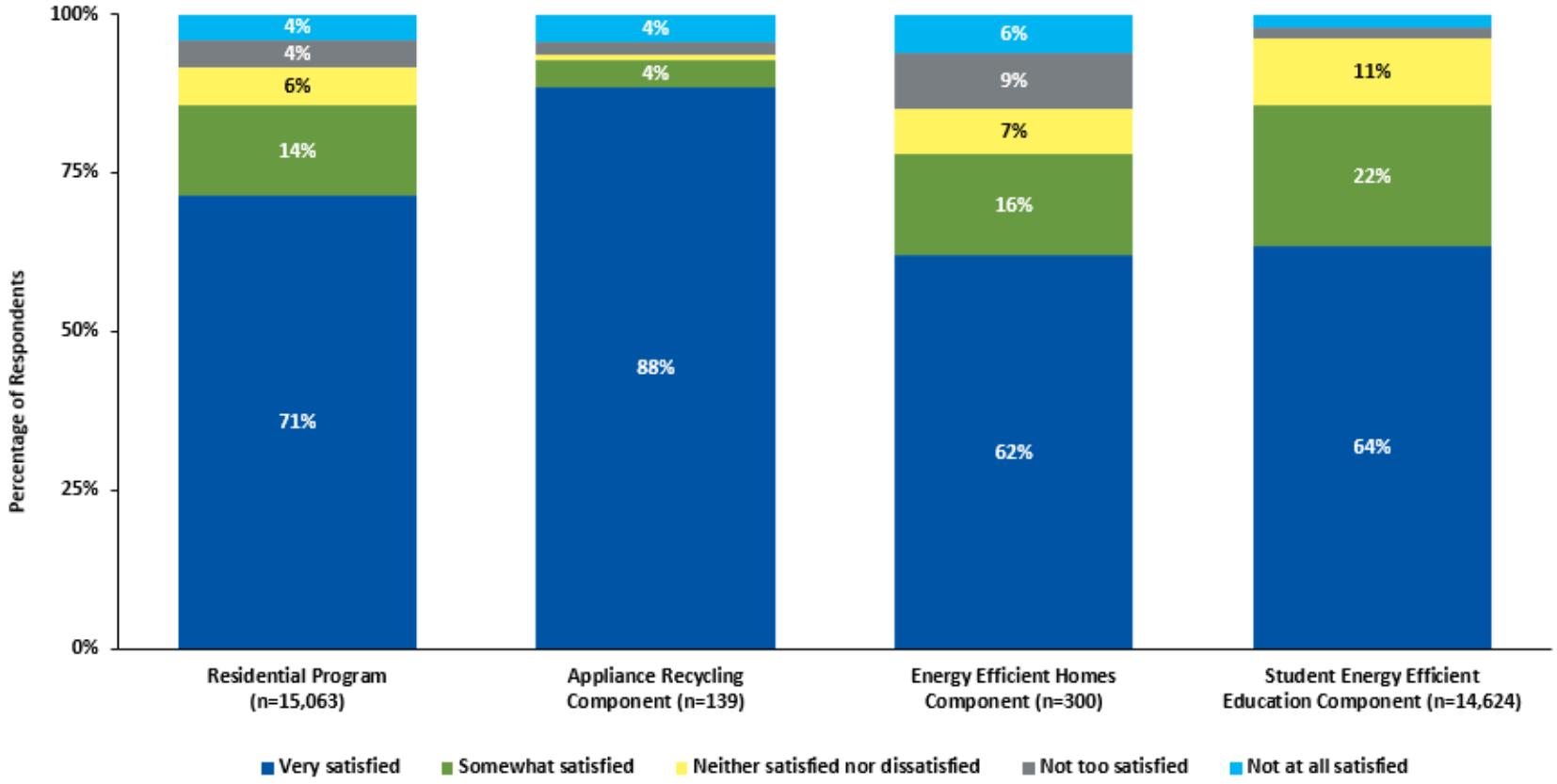
For Phase IV, PPL Electric Utilities established a Residential Program goal to achieve 85% or greater of *very satisfied* and *somewhat satisfied* customers,[28] which it met with 85% of participants reporting they were satisfied (Figure 7-1). As in PY13, the Appliance Recycling component garnered the highest participant satisfaction in PY14 with 93%[29] (n=139) satisfied. Additionally, 78% of customers were satisfied with the Energy Efficient Homes component (n=300) and 86% of student and teacher respondents (n=14,624) were satisfied with the Student Energy Efficient Education component.

Participant satisfaction with Appliance Recycling and Energy Efficient Homes program components significantly decreased in PY14. Satisfaction improved significantly for the Student Energy Efficient Education, increasing from 80% (n=14,929) in PY13 to 86% (n=14,624) in PY14.

[28] 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.

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

Figure 7-1. PY14 Residential Program Overall Satisfaction



Source: PY14 Participant surveys question, "Thinking about your overall experience with the PPL Electric Utilities [PROGRAM] rebate program, how would you rate your 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
Energy Efficient Homes	• Audit and Weatherization participants were satisfied with their experience; 84% of respondents were *very satisfied* or *somewhat satisfied* (n=68). Respondents in both groups noted a very positive experience with their contractor or auditor. Weatherization respondents' satisfaction was also particularly driven by the rebate they received for installing insulation as well as the reduction in their energy bill. Respondents who received an in-home audit reported the findings from the audit were more useful than those who received a virtual assessment.
Appliance Recycling	• Appliance Recycling remains the Residential Program component with the highest levels of participant satisfaction, with 93% of respondents reporting they were either *very satisfied* or *somewhat satisfied* (n=139). The program component did not undergo any significant changes in PY14.
Student Energy Efficient Education	• Student satisfaction improved significantly in PY14 compared to PY13. Overall, 86% of students (n=14,500) and 99% of teachers (n=124) were *very satisfied* or *somewhat satisfied.* Changes for PY14 included moving to all in-person presentations, the inclusion of dusk to dawn bulbs to all kits and an additional LED nightlight for the Take Action Cohort. Teachers had particularly positive comments about the PY14 presenters.
Efficient Lighting	• There were no process evaluation activities conducted for the Efficient Lighting component in PY14.

7.6 Program Finances and Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 7-9. The TRC benefits were calculated using gross verified impacts. NPV PY14 costs and benefits are expressed in 2022 dollars. Net present value 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**	**$16,911**		**$29,421**	
2	Rebates to Participants and Trade Allies	$4,166		$6,838	
3	Upstream/Midstream Incentives	$1,076		$2,125	
4	Material Cost for Self-Install Program Components (EE&C Kits)	$13		$488	
5	Direct Installation Materials and Labor	$0		$0	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[7]	$11,655		$19,971	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management	$181	$626	$343	$968
9	Marketing	$0	$919	$0	$1,632
10	Program Delivery	$0	$2,859	$0	$4,888
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs (Sum of rows 7 through 12)**[7]	**$4,585**		**$7,832**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)** [5] [6] [7]	**$22,311**		**$38,587**	
15	Total NPV Lifetime Electric Energy Benefits	$11,309		$21,417	
16	Total NPV Lifetime Electric Capacity Benefits	$7,369		$13,724	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$0		$0	
18	Total NPV Lifetime Fossil Fuel Impacts	$8,871		$14,043	
19	Total NPV Lifetime Water Impacts	$18		$3,973	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)** [7]	**$27,568**		**$53,157**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.24**		**1.38**	

[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] Row 14 (residential-level TRC Costs) include $815,592 of excess incentives from the Residential Efficient Lighting component. Per the Phase IV TRC Order, excess incentives are to be treated as a TRC cost, so the sum of rows 1 and 13 do not add up to row 14.
[7] Sum of rows may not add up to total due to rounding.

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 a program.

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

Row	Cost Category [1]	PYTD ($1,000)		P4TD [2] ($1,000)	
1	**IMCs**	**$9,430**		**$17,165**	
2	Rebates to Participants and Trade Allies	$4,166		$6,838	
3	Upstream/Midstream Incentives	$1,076		$2,125	
4	Material Cost for Self-Install Program Components (EE&C Kits)	$13		$488	
5	Direct Installation Materials and Labor	$0		$0	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)[7]	$4,175		$7,714	
		EDC	**CSP**	**EDC**	**CSP**
7	Program Design	$0	$0	$0	$0
8	Administration and Management [3]	$181	$626	$343	$968
9	Marketing	$0	$919	$0	$1,632
10	Program Delivery [4]	$0	$2,859	$0	$4,888
11	EDC Evaluation Costs	$0		$0	
12	SWE Audit Costs	$0		$0	
13	**Program Overhead Costs [5] (Sum of rows 7 through 12)**[7]	**$4,585**		**$7,832**	
14	**Total NPV TRC Costs (Sum of rows 1 and 13)**[5] [6] [7]	**$14,883**		**$26,380**	
15	Total NPV Lifetime Electric Energy Benefits	$6,598		$13,585	
16	Total NPV Lifetime Electric Capacity Benefits	$4,498		$9,027	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$0		$0	
18	Total NPV Lifetime Fossil Fuel Impacts	$4,854		$7,967	
19	Total NPV Lifetime Water Impacts	$15		$3,898	
20	**Total NPV TRC Benefits (Sum of rows 15 through 19)**[7]	**$15,965**		**$34,477**	
21	**TRC Benefit-Cost Ratio (Row 20 divided by Row 14)**	**1.07**		**1.31**	

[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] Row 14 (residential-level TRC Costs) include $867,716 of excess incentives from the Residential Efficient Lighting component. Per the Phase IV TRC Order, excess incentives are to be treated as a TRC cost, so the sum of rows 1 and 13 do not add up to row 14.

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

7.7 Status of Recommendations

The Residential Program met its customer satisfaction target and ran smoothly, but there were some discrepancies in reported versus verified savings that were either related to differing calculation methodologies (New Homes) or, what appear to be data entry errors (Weatherization), both of which can be corrected to improve the realization rates. The Student Energy Efficiency Education component was delivered particularly well, showing a statistically significant improvement in participant satisfaction between PY13 and PY14. For the New Homes subcomponent, we note a few opportunities to capture more energy and demand savings. Table 7-11 provides recommendations, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: The low demand realization rate for the New Homes subcomponent was primarily driven by differences in the coincidence factor used in *ex post* and *ex ante* savings calculations. Additionally, demand savings could be higher with the installation of more ENERGY STAR appliances and heat pump water heaters.	• New Homes achieved a 63% demand (kW) realization rate in PY14. • Using the PA TRM, the average coincidence factor for the site visit sample was 0.406. (See section *I.1.2 Gross Impact Results*). • To be eligible for peak demand savings, the PA TRM requires lighting and appliances to be ENERGY STAR certified. Site visits found LED lighting was installed in 96% of all locations but only 50% were found to be ENERGY STAR, and ENERGY STAR appliances installed by the builder occurred 44% of the time. There were no heat pump water heaters in the sampled homes. (See section *I.1.2 Gross Impact Results*). • Cadmus observed that if installed, heat pump water heaters could have saved an average of 0.177 kW of additional peak demand savings per sampled home. Homes built with all ENERGY STAR clothes washers, refrigerators, and clothes driers could provide .034 kW of additional peak demand savings per home. (See section *I.1.2 Gross Impact Results*).
Conclusion 2: The Audit and Weatherization energy and demand realization rates are lower than 100% due to various errors in the tracking data, as well as updated *ex post* installation rates for kit measures, which were lower than planned.	• For several projects in the Weatherization sample, Cadmus found inconsistencies between key project details in the tracking data and the PY14 verification survey or supporting project documentation. For example, some heating system types were recorded incorrectly in the tracking data, or in one case, an attic insulation project was categorized as basement wall insulation. (See section *I.1.2 Gross Impact Results*). • Installation rates of kit measures ranged from 24% to 72%, depending on the measure. (See section *I.1.2 Gross Impact Results*).

The impact and process evaluation activities in PY14 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. Status of Recommendations for the Residential Program

Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Energy Efficient Homes, New Homes	**Conclusion 1:** The low demand realization rate for the New Homes subcomponent was primarily driven by differences in the coincidence factor used in *ex post* and *ex ante* savings calculations. Additionally, demand savings could be higher with the installation of more ENERGY STAR appliances and heat pump water heaters.	**Recommendation 1a:** Consider possible ways to encourage builders to specify and promote ENERGY STAR appliances and heat pump water heaters, even if the design home is eligible for an incentive without them. For example, the subcontractor could offer more training and education on heat pump water heaters in particular, or a stand-alone bonus incentive.	**Being considered.**
		Recommendation 1b: The ICSP and its subcontractor should consider revising their demand savings methodology to align with the PA TRM to improve the realization rate.	**Implemented with condition** – The coincidence factor used to determine peak demand reduction has been adjusted. Analysis of non-weather dependent measures is ongoing.
Energy Efficient Homes, Audit and Weatherization	**Conclusion 2:** The Audit and Weatherization energy and demand realization rates are lower than 100% due to various errors in the tracking data, as well as updated *ex post* installation rates for kit measures, which were lower than planned.	**Recommendation 2a:** Update *ex ante* assumptions to reflect the latest ISRs, along with other verified inputs from the survey and tracking data (such as water heating fuel).	**Being considered.**
		Recommendation 2b: For weatherization projects, PPL Electric Utilities and the ICSP should consider ways to improve accuracy of data entry to match the specifics of the project.	**Implemented** – Data entry improvements will be made during program year 15.

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) and includes the number of inspections and discrepancies along with the resolution of the discrepancies.

Table A-1. PY14 Site Visit Summary

Program Components	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Non-Residential					
Custom	Warren Energy Engineering (on behalf of Cadmus)	13	6	7	• Unique discrepancies were found on all small sample sites though all equipment and quantities matched reported values • Visits were performed for all large-stratum projects during real-time evaluation, so all equipment and quantities matched reported values
Custom	CLEAResult (ICSP)	37	0	37	• Submitter estimate of original savings was not accurate • Actual metered data used in place of estimates • Project not modeled accurately originally compared to installed condition • Project scope deviated from original submission
Efficient Equipment Prescriptive Lighting	CLEAResult (ICSP)	92	0	31	• Wrong HOU given on Appendix C form vs. what was found from customer interviews on site • Wrong number of lights submitted on the application • Wrong amount of bulbs in the fixtures submitted • Incorrect wattage selected for baseline fixtures
	Cadmus	0	4	4	• Incorrect quantity and fixture type.
Direct Discount Lighting	CLEAResult (the ICSP)	81	0	13	• Wrong number of lights submitted on the application • Wrong amount of bulbs in the fixtures submitted • Projects started before receiving pre-approval • Integrated fixtures not used in application • Projects over 120,000 kWh/yr switched from prescriptive to customer provided HOU

Program Components	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Efficient Equipment Non-Lighting	CLEAResult (ICSP)	17	0	10	• Project savings may have increased or decreased as a result of site visits which made the projects switch from prescriptive to customer submitted HOU • Ineligible equipment removed from applications • Project scope deviated from original submission
	DNV (on behalf of Cadmus)	0	3	2	• Installed unit quantities of two line items were found to be reported incorrectly during the virtual inspection of an Air Conditioning project, one quantity was too high and the other was too low (by one each). • Total cooling capacity was found to be slightly different than reported during virtual inspection of an HVAC Guest Room Occupancy Sensor Project
Low-Income					
Low-Income (Baseload)	CMC (ICSP)	4	639 interim surveys and 482 quality confirmation surveys sent	74	• 55 customers said they had not installed all their LEDS, and 19 were not able to resolve the issue over the phone • 20 customers responded they had not installed all their tier I smart strips and six were not able to resolve the issue over the phone
Low-Income (Low-Cost)	CMC (ICSP)	7	496 interim surveys and 607 quality confirmation surveys sent	308	• 72 customers said they had not installed all their LEDs, and 35 were not able to resolve the issue over the phone • 109 customers said they could not install their showerheads, and 49 were not able to resolve the issue over the phone • 96 customers said they were not able to install all their aerators, and 60 were not able to solve over the phone • 31 customers said they could not install all their tier I smart strips, and 20 were not able to resolve over the issue over the phone

Program Components	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Residential					
Energy Efficient Homes – New Homes	PSD (ICSP)	84	0	77	• Windows (34) – Window discrepancies are most often caused by misreported window area or the orientation of the windows • Cooling Equipment (32) – Cooling Equipment discrepancies were most often caused by misreported efficiency ratings • Orientation (21) – Orientation discrepancies are caused by misreported building orientation • Appliances (18) – Appliance discrepancies were most often caused by misreported equipment efficiency ratings • Domestic Hot Water (16) – Water Heating Equipment discrepancies were most often caused by misreported efficiency ratings • Hatches (16) – Hatch discrepancies are typically the size/dimensions of an attic hatch, or the insulation affixed to the hatch • Heating Equipment (15) – Heating Equipment discrepancies were most often caused by misreported efficiency ratings
	Cadmus	25	0	25	• REM/Rate model did not reflect site visit findings (kWh) • Installed heating/cooling/DHW rated capacity and/or efficiency did not match model inputs • Appliance kWh/classification and lighting LED% did not match site visit findings • Model heating and cooling setpoints did not match modeling requirements listed in the PA TRM • In one case, the model listed a PV system for the design home but the as-built home did not have one installed
Energy Efficient Homes-Air Sealing	CLEAResult (ICSP)	0	4	1	• Denied due to air sealing not completed by a BPI certified contractor; no blower door testing was performed before or after the air sealing
Energy Efficient Homes-Air Source Heat Pump	CLEAResult (ICSP)	0	51	2	• No response from customer about inspection; duplicate rebate for system that had already been paid out
Energy Efficient Homes-Attic Insulation (R0 to R38)	CLEAResult (ICSP)	6	158	4	• Discrepancies most often were a result of the projects not meeting program requirements (existing R-value over 30 or new R-value below 49) or home has a fossil fuel heating system but no central A/C
Energy Efficient Homes-Central A/C	CLEAResult (ICSP)	1	25	1	• Model did not qualify for rebate
Energy Efficient Homes-Central Heat Fuel Switch	CLEAResult (ICSP)	0	36	2	• Customer installed ASHP, electric still main heat source; customer previously had gas heating.

Program Components	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Energy Efficient Homes-Ductless Heat Pump	CLEAResult (ICSP)	19	715	2	• Denial reasons were new construction and submitting rebate too far past installed date
Energy Efficient Homes-Smart Thermostat	CLEAResult (ICSP)	0	615	3	• Denials were for fossil fuel heating with no central A/C
Energy Efficient Homes-Wall Insulation	CLEAResult (ICSP)	0	57	5	• Discrepancies were a result of installations not completed in a qualifying basement or crawlspace area of the home, or new home construction
Energy Efficient Homes-Water Heater Fuel Switch	CLEAResult (ICSP)	0	28	0	• No discrepancies found
Energy Efficient Homes Variable Speed Pool Pump	CLEAResult (ICSP)	0	31	0	• No discrepancies found
TOTAL		**386**	**1,733 + low-income surveys**	**608**	

Appendix B. PY14 and P4TD Summary by Customer Segment and LI Carveout

Table B-1 presents a summary of the Low-Income Program, initiatives, and customer segments that contribute to the low-income carveout in PY14 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	12,777	21,198
	Small C&I	76	76
	GNE	19	19
Sub-total		**12,777**	**22,022**
Phase III Carryover			31,089
Total		**12,777**	**53,111**

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

C.1 Program- and Initiative-Level Impacts Summary

A summary of energy impacts by program and initiative through PY14 is presented in Table C-1.

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	94,575	95,307	70,527	134,891	135,810	79,438
Efficient Equipment	104,568	114,404	72,029	187,410	203,734	137,061
Subtotal [4]	**199,144**	**209,711**	**142,556**	**322,300**	**339,544**	**216,498**
Low-Income						
Subtotal [4]	**10,825**	**12,872**	**12,872**	**22,665**	**53,111[5]**	**22,022**
Residential						
Appliance Recycling	8,548	8,569	4,799	16,478	16,470	9,223
Efficient Lighting	4,129	4,226	4,522	8,378	8,575	9,175
Energy Efficient Homes	25,491	21,593	11,600	42,614	39,150	21,022
Student Energy Efficient Education	5,434	-	-	11,138	4,797	4,797
Subtotal [4]	**43,601**	**34,388**	**20,921**	**78,609**	**68,991**	**44,217**
Portfolio Total [4]	**253,570**	**256,971**	**176,348**	**423,575**	**430,558[6]**	**282,738**
Carryover	-	-	-	-	306,275	-
Portfolio Total with Carryover [4]	**253,570**	**256,971**	**176,348**	**423,575**	**736,833**	**282,738**

[1] Does not include PY13 savings verified in PY14.

[2] Includes PY13 unverified savings, verified in PY14.

[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 Low-Income Program.

A summary of the peak demand impacts by energy efficiency program and initiative through the current reporting period are presented in Table C-2.

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	16.44	17.87	13.22	22.83	24.85	14.76
Efficient Equipment	16.67	18.50	11.64	30.64	32.78	21.91
Subtotal [3]	**33.10**	**36.37**	**24.86**	**53.47**	**57.63**	**36.67**
Low-Income						
Subtotal [3]	**1.21**	**1.53**	**1.53**	**2.50**	**2.56**	**2.56**
Appliance Recycling	1.92	2.09	1.17	3.68	4.00	2.24
Efficient Lighting	0.60	0.66	0.71	1.21	1.35	1.44
Energy Efficient Homes	3.11	2.35	1.34	5.26	4.22	2.41
Student Energy Efficient Education	0.52	-	-	1.01	0.47	0.47
Subtotal [3]	**6.15**	**5.11**	**3.22**	**11.15**	**10.03**	**6.56**
Portfolio Total [3]	**40.46**	**43.01**	**29.61**	**67.12**	**70.22**	**45.79**

[1] Does not include PY13 savings verified in PY14.
[2] Includes PY13 unverified savings, verified in PY14 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-4shows the TRC ratios by program and for the portfolio for PY14. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

Table C-3. PY14 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	$64,886	$26,127	2.48	$38,760
Efficient Equipment	$82,393	$52,563	1.57	$29,830
Non-Residential Subtotal[1]	**$147,279**	**$78,689**	**1.87**	**$68,590**
Residential				
Low-Income	$8,753	$6,314	1.39	$2,439
Appliance Recycling	$2,577	$2,024	1.27	$553
Efficient Lighting	$2,693	$1,254	2.15	$1,440
Energy Efficient Homes	$22,297	$19,033	1.17	$3,264
Student Energy Efficient Education	$0	$0	N/A	$0
Residential Subtotal[1][2]	**$36,320**	**$28,625**	**1.27**	**$7,696**
Common Portfolio Costs	**n/a**	**$5,449**	**n/a**	**n/a**
Portfolio Total[1]	**$183,600**	**$112,762**	**1.63**	**$70,837**

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. PY14 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	$48,016	$20,125	2.39	$27,890
Efficient Equipment	$51,899	$35,292	1.47	$16,607
Non-Residential Subtotal[1]	**$99,915**	**$55,417**	**1.80**	**$44,497**
Residential				
Low-Income	$8,753	$6,314	1.39	$2,439
Appliance Recycling	$1,443	$2,024	0.71	-$581
Efficient Lighting	$2,155	$1,254	1.72	$901
Energy Efficient Homes	$12,367	$11,606	1.07	$762
Student Energy Efficient Education	$0	$0	N/A	$0
Residential Subtotal[1][2]	**$24,718**	**$21,197**	**1.17**	**$3,521**
Common Portfolio Costs	**n/a**	**$5,449**	**n/a**	**n/a**
Portfolio Total[1]	**$124,633**	**$82,063**	**1.52**	**$42,570**

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 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	$86,895	$36,335	2.39	$50,560
Efficient Equipment	$138,908	$78,965	1.76	$59,944
Non-Residential Subtotal[1]	**$225,803**	**$115,300**	**1.96**	**$110,503**
Residential				
Low-Income	$15,082	$11,228	1.34	$3,855
Appliance Recycling	$4,794	$3,505	1.37	$1,289
Efficient Lighting	$5,621	$2,347	2.39	$3,274
Energy Efficient Homes	$36,237	$32,072	1.13	$4,166
Student Energy Efficient Education	$6,505	$663	9.81	$5,842
Residential Subtotal[1][2]	**$68,240**	**$49,815**	**1.37**	**$18,425**
Common Portfolio Costs	**n/a**	**$11,071**	**n/a**	**n/a**
Portfolio Total[1]	**$294,043**	**$176,185**	**1.67**	**$117,857**

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	$51,251	$23,226	2.21	$28,025
Efficient Equipment	$93,061	$55,569	1.67	$37,492
Non-Residential Subtotal[1]	**$144,312**	**$78,795**	**1.83**	**$65,517**
Residential				
Low-Income	$15,082	$11,228	1.34	$3,855
Appliance Recycling	$2,685	$3,505	0.77	-$820
Efficient Lighting	$5,322	$2,347	2.27	$2,975
Energy Efficient Homes	$19,966	$19,865	1.01	$101
Student Energy Efficient Education	$6,505	$663	9.81	$5,842
Residential Subtotal[1] [2]	**$49,560**	**$37,608**	**1.32**	**$11,952**
Common Portfolio Costs	**n/a**	**$11,073**	**n/a**	**n/a**
Portfolio Total[1]	**$193,871**	**$127,476**	**1.52**	**$66,395**

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 net-to-gross (NTG) research are not used to adjust compliance savings in Pennsylvania. Instead, NTG research provides directional information for program planning purposes. Table C-7 presents NTG findings for high-impact measures (HIMs) studied in PY14.

Table C-7. PY14 High Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Custom[1]	26%[2]	0%	0.74
Solar[3]	38%	0%	0.62
Efficient Equipment Downstream Lighting[1][4]	35%[2]	0%	0.65
Total	**30%[5]**	**0%**	**0.70**

[1] Estimated from PY14 survey data.
[2] Weighted by the survey sample-verified program kWh/yr savings.
[3] Solar projects are included in the Custom program component.
[4] Downstream Lighting, Direct Install, and Direct Discount Lighting stratums.
[5] Weighted by verified gross energy savings of high-impact measure population.

All projects in the Custom component are unique and considered as high-impact measures. Commercial lighting contributes more than 5% to the sector and portfolio and is considered a high-impact measure. Overall, the NTG research for high-impact measures represents 84% of the total non-residential verified gross energy savings in PY14.

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

Table C-8 presents PY14 expenditures, by program, compared to the budget estimates set forth in the EE&C plan for PY14.[30] All the dollars are presented in 2022 dollars.

Table C-8. Comparison of PY14 Expenditures to Phase IV EE&C Plan ($1,000)

Program	PY14 Budget from EE&C Plan[1]	PY14 Actual Expenditures[2]	Ratio (Actual/Plan)
Non-Residential	$33,075	$28,693	87%
Low-Income	$8,380	$6,314	75%
Residential	$13,639	$11,743	86%
Total Direct Program Costs[3]	**$55,094**	**$46,749**	**85%**
Common Portfolio Costs[4]	$8,620	$5,449	63%
Portfolio Total[3]	**$63,715**	**$52,198**	**82%**

[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.

[30] 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 PY14 (not the full phase). All the dollars are presented in 2021 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 PY14[1]	PIVTD Actual Expenditures[2]	Ratio (Actual/Plan)
Non-Residential	$64,737	$38,358	59%
Low-Income	$16,443	$11,228	68%
Residential	$27,118	$19,094	70%
Total Direct Program Costs[3]	**$108,298**	**$68,680**	**63%**
Common Portfolio Costs[4]	$17,240	$11,590	67%
Portfolio Total[3]	**$125,539**	**$80,269**	**64%**

[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 PY14 verified gross program savings compared to the energy savings projections set forth in the EE&C plan.

Table C-10. Comparison of PY14 Actual Program Savings to EE&C Plan Projections for PY14

Program	EE&C Plan Projections for PY14 (MWh/yr)[1]	PY14 VTD Gross MWh/yr Savings[2]	Ratio (Actual/Plan)
Non-Residential[3]	258,592	209,711	81%
Low-Income[3]	12,885	12,872	100%
Residential[3]	37,327	34,388	92%
Total[3][4]	**308,804**	**256,971**	**83%**

[1] Projections from Table 4 of PPL Electric Utilities EE&C plan.
[2] Does not include PY13 unverified savings, verified in PY14.
[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 PY14[1]	VTD Gross MWh/yr Savings	Carryover MWh/yr	Total VTD Gross MWh/yr Savings	Ratio (Actual/Plan)
Non-Residential[2]	500,384	339,544	-	339,544	68%
Low-Income[2]	25,132	22,022	31,089	53,111	211%
Residential[2]	75,377	68,991	-	68,991	92%
Total[2][3]	**600,893**	**430,558**	**306,275[4]**	**736,833[5]**	**123%**

[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

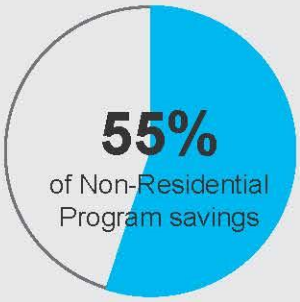
CADMUS

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

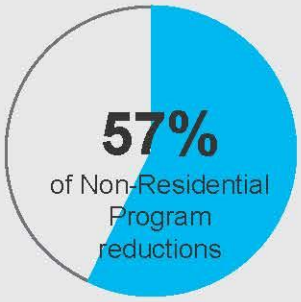
Phase IV has saved **203,734 MWh/yr**

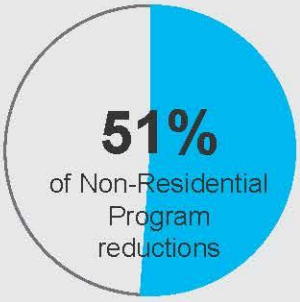


PY14 saved **114,404 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **32.78 MW/yr**





PY14 has reductions of **18.50 MW/yr**

PY14 PARTICIPATION

A total of **6,537** participants

- **6,408** Lighting
- **52** HVAC equipment
- **27** Other equipment
- **25** Agriculture
- **17** Refrigeration equipment
- **8** Water heating equipment

PARTICIPANT SATISFACTION

Satisfied with overall program component

Appendix D. Evaluation Detail Efficient Equipment

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 and eligible projects are processed and incentives paid 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. Once the project is complete and the application is updated, the Non-Residential ICSP completes the verification 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.[31] 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 collectively to 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 33 downstream lighting projects, 20 downstream non-lighting projects, and 24 midstream lighting projects. Cadmus did not verify any midstream non-lighting projects in PY14. These savings will be verified in PY15 as part of a combined PY14/PY15 sample.

[31] 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, and Direct Install Non-Lighting

The PA TRM has established kWh 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 TRM threshold with a basic level of rigor according to the Phase IV Evaluation Framework.[32] The Efficient Equipment component did not report any non-lighting projects above the threshold defined in the PA TRM in PY14.

The impact evaluation sampling strategy is summarized in Table D-1. Cadmus adjusted planned sample sizes during the evaluation period to ensure precision targets were met. For PY14, the sampling target for the downstream non-lighting subcomponent of 85% confidence and ±15% precision was achieved with the sample of 20 projects. Cadmus verified energy savings for downstream non-lighting projects at 85% confidence with ±0.02% precision.

Table D-1. PY14 Efficient Equipment Non-Lighting 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	20	Desk review with optional phone interview and/or virtual site visit

Downstream, Direct Discount, Direct Install, and Midstream Lighting

Cadmus categorized downstream lighting projects 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 PY14 for all downstream and the midstream lighting strata. Cadmus evaluated 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.

[32] 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.

The impact evaluation sampling strategy is summarized in Table D-2. The gross impact evaluation activities resulted in verified savings estimates for the Efficient Equipment lighting subcomponent at 90% confidence with ±8.72% precision.

Table D-2. PY14 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	8	Enhanced Rigor
Downstream (120-750 MWh/yr)[1]		Up to 13	13	Basic Rigor
Downstream (<120 MWh/yr)[1]		Up to 12	12	Basic Rigor
Midstream[2]		Up to 23	24 [3]	Basic Rigor

[1] Assuming a Cv of 0.35 based on historical findings from Phase III.
[2] Assuming a Cv of 0.50.
[3] One customer provided interview responses after an alternate project was interviewed and Cadmus included this additional project in the sample.

Cadmus calculated annual sample sizes for the Efficient Equipment component to meet the evaluation requirements in the Phase IV Evaluation Framework of 85% confidence and ±15% precision. However, the sampling plan for lighting subcomponent was designed to meet 90% confidence and ±10% precision (90/10) because lighting is a high-impact measure contributing 51% of reported energy savings and 49% of reported demand reductions to the Non-Residential Program.

Ex Post Verified Savings Methodology

Downstream, Direct Discount, and Direct Install Non-Lighting

Verified savings calculations incorporated installation rates and operating conditions and adjustments for equipment details from equipment specification sheets and invoices. Cadmus calculated energy savings and demand reductions for the sampled projects through desk reviews and virtual site visits, verifying the eligibility of installed equipment and installation rates for all sampled projects.

Downstream, Direct Discount, and Direct Install Lighting

Verified savings calculations incorporated installation rates 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 Appendix C Lighting Audit and Design Tool for Commercial and Industrial Projects, to evaluate savings.[33] 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

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

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 installation rates 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

Realization rates were calculated for non-lighting and lighting strata by dividing total evaluated savings by total reported savings for the sampled projects. Cadmus then multiplied the reported savings of each project by the evaluated realization rate for the appropriate stratum to determine gross verified savings.

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

Table D-3. Efficient Equipment Component Savings

Savings	PY13 Verified	PY14 Verified	Phase IV Verified [1]
MWh/yr	89,330	114,404	203,734
System-Level MW/yr	14.28	18.50	32.78

[1] Phase IV verified savings may not match sum of program years due to rounding and do not include PY14 unverified savings.

In PY14, the Efficient Equipment component reported energy savings of 104,568 MWh per year, as shown in Table D-4, and demand reduction of 16.67 MW per year, as shown in Table D-5.

Table D-4. PY14 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	473	213%	0.35	32.3%	1,005
Downstream HVAC - Convenience	299	91%	0.00	0.0%	273
Downstream Motors	34	112%	0.00	0.0%	38
Downstream Other[2]	235	100%	0.00	0.0%	235
Downstream Refrigeration	733	100%	0.00	0.1%	733
Downstream Refrigeration - Convenience	515	100%	0.00	0.0%	514
Non-Lighting Total[3], [4]	**2,289**	**122%**	**0.26**	**9.2%**	**2,799**
Unverified Midstream Equipment[5]	709	-		-	-
Total (Verified + Unverified) [3] [4]	**2,999**	**-**	**-**	**-**	**2,799**
Lighting Subcomponent					
Downstream Threshold (>750 MWh/yr)	31,653	97%	0.07	2.8%	30,639
Downstream (120-750 MWh/yr)	31,382	98%	0.07	3.0%	30,665
Downstream (< 120 MWh/yr)	18,802	97%	0.08	3.5%	18,230
Midstream Lighting	19,732	163%	1.01	30.7%	32,071
Lighting Total[3], [4]	**101,570**	**110%**	**0.51**	**8.7%**	**111,605**
Component Total[3], [4]	**104,568**	**110%**	**0.58**	**8.5%**	**114,404**

[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 projects in the appliances and water heating categories.
[3] Savings may not match other tables or figures due to rounding.
[4] Totals may not sum due to rounding.
[5] Savings will be verified at the end of PY15 because Cadmus is using a combined PY14/PY15 sampling strategy.

Table D-5. PY14 Efficient Equipment Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Energy 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	0.09	160%	0.41	38.0%	0.14	0.16
Downstream HVAC - Convenience	0.06	98%	0.00	0.0%	0.06	0.06
Downstream Motors	0.003	112%	0.00	0.0%	0.003	0.003
Downstream Other[3]	0.04	100%	0.00	0.0%	0.04	0.04
Downstream Refrigeration	0.09	100%	0.00	0.0%	0.09	0.09
Downstream Refrigeration - Convenience	0.06	100%	0.00	0.0%	0.06	0.07
Non-Lighting Total[4], [5]	**0.34**	**116%**	**0.22**	**11.1%**	**0.39**	**0.42**
Unverified Midstream Equipment[6]	0.26	-	-	-	-	-
Total (Verified + Unverified)[4], [5]	**0.61**	**-**	**-**	**-**	**0.39**	**0.42**
Lighting Subcomponent						
Downstream Threshold (>750 MWh/yr)	4.42	95%	0.13	4.9%	4.18	4.44
Downstream (120-750 MWh/yr)	4.44	97%	0.10	3.9%	4.29	4.61
Downstream (<120 MWh/yr)	2.83	101%	0.02	0.8%	2.84	3.08
Midstream Lighting	4.37	126%	0.54	16.5%	5.53	5.96
Lighting Total[4], [5]	**16.06**	**105%**	**0.31**	**5.5%**	**16.84**	**18.08**
Component Total[4], [5]	**16.67**	**105%**	**0.35**	**5.4%**	**17.23**	**18.50**

[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 projects in the Appliances and Water Heating categories.
[4] Savings may not match other tables or figures due to rounding.
[5] Total may not sum due to rounding
[6] Savings will be verified at the end of PY15 because Cadmus is using a combined PY14/PY15 sampling strategy.

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

For the Efficient Equipment non-lighting subcomponent, the most significant adjustment to reported savings estimates was to HVAC installed efficiency in a project involving installation of several packaged air conditioning units. The reported AHRI certificate IEER efficiency did not match with the exact unit model number. Cadmus identified that the correct AHRI certificate IEER was significantly lower. This resulted in lower kWh realization rates but had no effect on kW as demand savings are based on EER efficiency, rather than IEER, per the PA TRM. Cadmus also identified that existing motor efficiency was incorrectly reported for the single motor variable frequency drive project in this year's population. Correcting this based on nameplate photos received from the site contact resulted in a higher verified savings estimate.

For the lighting subcomponent, the most common adjustments to reported energy savings and demand reductions estimates were to the hours of use and fixture wattage. For threshold projects, these adjustments were based on Cadmus' logger data analysis. Cadmus adjusted hours of use and coincidence factors using findings from its 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 subcomponent, 20 equipment projects were included in the evaluation sample. For these projects, the Cadmus team completed 16 desk reviews, three desk reviews with virtual site visits, and one desk review with phone interview and documentation request. 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 reasons for adjustments to reported savings included corrections to the following:

- HVAC installed efficiency
- VFD measure existing motor efficiency

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

Downstream Lighting

Cadmus conducted virtual site visits and desk reviews for 33 downstream lighting projects in the impact evaluation sample to verify as-built conditions for each project and identify any discrepancies in inputs and savings reported by the ICSP. For the eight threshold lighting projects in the impact evaluation sample, Cadmus analyzed logger data and calculated hours of use and coincidence factors. The results of the desk reviews and virtual site visits were used 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 four virtual site visits, and 29 desk reviews (eight of which included phone interviews). For three projects 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.[34]

[34] 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.

Verified savings incorporated site- and equipment-specific data. Reasons for adjustments to the ICSP's reported data included corrections to the following:

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

Adjustments to reported lighting fixture or lamp wattage and TRM deemed hours of use were found to be most common, each affecting 10 projects of the 33 sampled. Evaluated lighting fixture or lamp wattage was based on Design Lights or ENERGY STAR data. TRM deemed hours of use adjustments were needed due to incorrect hours from the PA TRM being used, where the most common adjustment involved exterior fixtures (reported savings typically used the TRM deemed exterior lighting hours with photocell control, which are higher than the TRM deemed hours without photocell control). This was verified either through facility interviews or desk reviews. Adjustments to metered hours of use were the second most common factor and affected 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 PY14, Cadmus conducted desk reviews and phone interviews to verify savings for the sample of 24 midstream lighting projects in PPL Electric Utilities' tracking database. Cadmus adjusted calculation inputs to reported savings that differed from verified conditions.

Table D-6 shows the frequency and type of adjustment made to calculation inputs in the development of verified savings. A project can have multiple adjustments, so the total number of adjustments is greater than the sample size.

Table D-6. PY14 Efficient Equipment Midstream Lighting Subcomponent Verified Savings Adjustments Summary (in Order of Frequency)

Savings Adjustment Type	Number of Adjusted Projects	Percentage of Adjusted Projects[1]	Primary Reason for Adjustment
Facility Type	23	96%	Interview response, specification sheets, or invoices indicated differing values.
Fixture Control Type	23	96%	
Hours of Use	19[2]	79%	
Coincidence Factor	18[2]	75%	
Energy Interactive Factor	23	96%	
Demand Interactive Factor	23	96%	
Post-Install Lamp/Fixture Wattage	7	29%	
Post-Install Lamp/Fixture Quantity	2	8%	
Pre-Install Lamp/Fixture Quantity	2	8%	

[1] Percentage of adjusted projects is calculated based on the total of 24 sample project verifications.
[2] Hours of use and coincidence factor do not have as many adjustments as facility type because some projects were reported with an incorrect facility type, but the reported hours of use and coincidence values were still correct.

D.2 Net Impact Evaluation

D.2.1 Net Impact Methodology

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,[35] which discusses the common methods used to determine free ridership and spillover. For downstream, direct discount, and direct install projects in the Efficient Equipment component, Cadmus used a self-report survey, administered online and by phone, to assess free ridership and spillover. Cadmus attempted to reach a census of all PY14 participants by sending an initial email invitation, two reminder email messages, and making additional phone calls.

Cadmus did not conduct new primary research to assess net savings for midstream lighting in PY14 and used a historic NTG ratio of 0.62 from PY11. Cadmus plans to conduct net savings research in PY15 for midstream non-lighting projects and midstream lighting projects.

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 downstream lighting and equipment strata. The evaluation plan specified that each lighting delivery channel of the Downstream lighting stratum would be treated as a high impact measure (HIM) but based on the number of completed surveys Cadmus combined them into one HIM analysis sample.

Table D-7. PY14 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	Percent of Sample Frame Contacted to Achieve Sample[(2)]
Downstream, Direct Discount, Direct Install Lighting [(3)]	Downstream lighting projects	487[(4)]	0.5	85/15	Census	265	22	100%
Downstream, Direct Discount, Direct Install Non-Lighting	Downstream non-lighting projects	93[(5)]	0.5	85/15	Census	41	4	100%
Total		**580**	**-**	**-**	**-**	**306**	**26**	**100%**

[(1)] Population refers to number of projects in PY14 at the time of the participant survey.
[(2)] Sample frame is a list of contacts who have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame contacted to complete surveys. Cadmus attempted to reach a census by sending an initial email invitation, two reminder email messages, and making additional phone calls.
[(3)] Downstream lighting, direct discount, and direct install lighting were combined.
[(4)] Combined population of downstream, direct discount, and direct install lighting participants at the time of the survey.
[(5)] Combined population of downstream, direct discount, and direct install non-lighting participants at the time of the survey.

[35] 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.

Free Ridership

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 each 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
Downstream, Direct Discount, Direct Install Lighting	22	34%	1%	35%
Downstream, Direct Discount, Direct Install Non-Lighting	4	47%	37%	84%

Spillover

The survey did not collect enough information to reliably quantify spillover in commercial settings; therefore, spillover is reported qualitatively. Of the lighting stratum respondents, one purchased an undisclosed amount of LED bulbs for the building after participating in the Efficient Equipment component. One lighting stratum respondent purchased a high-efficiency ductless mini-split system after participating in the Efficient Equipment component. The respondents credited factors related to PPL Electric Utilities as having some level of influence on the decision to purchase. None of the equipment stratum respondents purchased additional energy-efficient equipment after participating in the Efficient Equipment component.

D.2.2 Net-to-Gross Results

Table D-9 shows the NTG ratio results for the strata of the Efficient Equipment component.

Table D-9. PY14 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	79,533,939	PY14	35%[(1)]	0%	0.65	10%[(2)]
Downstream, Direct Discount, Direct Install Non-Lighting	2,798,824	PY14	84%[(1))]	0%	0.16	84%[(3)]
Midstream Lighting	32,071,401	PY11	38%	0%	0.62	33%[(3)]
Component Total [(4)] [(5)]	**114,404,163**	**-**	**37%**	**0%**	**0.63**	**-**

[(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 0.63.
[(5)] Totals may not sum due to rounding.

The Phase IV Evaluation Framework requires the identification and oversampling of high-impact equipment and services to assess free ridership with greater certainty. In the Efficient Equipment

component, Cadmus determined that commercial lighting projects contributed greater than 5% of the overall PY14 savings to the non-residential sector and therefore classified commercial lighting as a high-impact product. For net savings calculations, eight lighting participants completed the NTG questions in the self-report survey. At 90% confidence, Cadmus calculated an NTG ratio of 0.65 with relative precision of ±10% and at 85% confidence with a relative precision of ±9%.

D.3 Process Evaluation

For lighting and non-lighting projects in the downstream, direct discount, and direct install delivery channels, Cadmus conducted a process evaluation to assess participant satisfaction, assess what is working well and what could be improved, determine influence of the component on decision-making, and make recommendations for component modification and improvement. The evaluation activities were consistent with the planned activities for PY14 although the targeted number of participant surveys was not reached.

Cadmus attempted to contact a census of participants between April and June 2023 and completed 30 surveys of the 306 participants in the sample frame. Of the 30 respondents, 24 are participants of the Efficient lighting subcomponent, and six of the Efficient Equipment subcomponent. Cadmus made several attempts to reach participants by sending an initial email invitation, followed by three email reminders, and making several telephone calls. Despite these attempts, the targets for survey participation were not reached due to lower participation and lower response rates than anticipated.

Participant survey completions produced a measure of component satisfaction at 90% confidence with ±2.4% precision. 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.

For midstream non-lighting equipment, Cadmus conducted a process evaluation in PY14, including distributor interviews, to inform the logic model review. Cadmus received useful responses from eight of 12 distributors contacted, and six completed interviews. Cadmus also interviewed staff from PPL Electric Utilities and the ICSP about the status of midstream lighting and non-lighting offerings. The evaluation activities were consistent with the planned activities.

Table D-10 lists the process evaluation sampling strategy.

Table D-10. 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]
Downstream, Direct Discount, Direct Install								
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	3	N/A	3	3[2]	3	100%
Non-Lighting	Participants	Online survey/Phone survey	93[3]	N/A	All eligible	6	41[4]	100%
Lighting	Participants	Online survey/Phone survey	487[3]	N/A	All eligible	24	265[4]	100%
Midstream (Lighting and Non-Lighting)								
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	2	N/A	2	2	2	100%
Non-Lighting	Participating distributors	Telephone in-depth interviews	12	N/A	All eligible	6	12	100%
Total			**597**	**-**	**>5**	**41**	**323**	**-**

[1] Percent contacted means the percentage of the sample frame contacted to complete surveys and interviews.
[2] Three interviewees in two calls.
[3] Population size includes number of unique records available at the time of the survey.
[4] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities database at the time of the surveys. After selecting all unique records, Cadmus removed any records from the population if the customer had participated in a survey in the last three months, had been selected for another survey, did not have valid contact information (email or telephone number), was on PPL Electric Utilities' do not call list, or opted out of the online survey.

D.3.1 Program Component Experience

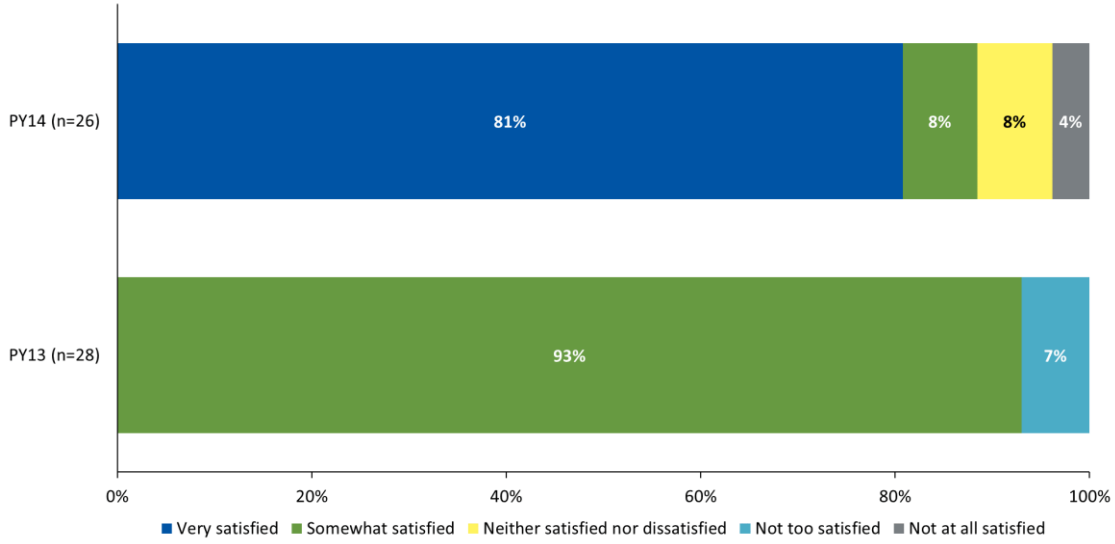
The survey participants were asked a series of questions to identify how satisfied they were with the program, along with those factors that impacted the program participants' satisfaction levels and any improvements that would increase their satisfaction.

Program Component Satisfaction and Customer Effort

Downstream, Direct Discount, and Direct Install

The Efficient Equipment component achieved high satisfaction in PY14 with 89% (n=26), although having decreased from 93% (n=28) in PY13, this difference is not statistically significant. Additionally, 8% of the respondents were *neither satisfied nor dissatisfied* and 4% were *not at all satisfied* (n=26). In PY13, the respondents only reported being *somewhat satisfied* with this component (93%), or *not too satisfied* (7%), while in PY14, 81% of respondents reported being *very satisfied* and 8% reported being *somewhat satisfied*. The participant who indicated being *not at all satisfied* with this component installed an LED fixture and further indicated having struggled finding the eligible equipment. Additionally, the 8% that indicated that they were *neither satisfied nor dissatisfied* (n=2) had installed an LED fixture (n=1) and heating and cooling equipment (n=1). Nevertheless, 81% of the respondents who reported having been *very satisfied* with the component (n=21) reported that a factor for such satisfaction was due to increasing energy savings. Figure D-1 shows a breakdown of the PY14 participants' satisfaction with the Efficient Equipment component overall compared to PY13.

Figure D-1. PY14 Efficient Equipment Component Satisfaction



Source: Survey question, "Thinking about your overall experience with the PPL Electric Utilities Business Energy Efficiency rebate program, how would you rate your satisfaction?"

Additionally, customers who reported participating being either *very easy* or *easy* decreased from 88% in PY13 (n=28) to 73% of the respondents (n=26) in PY14; however, this difference is not statistically significant. Furthermore, the survey respondents who indicated that the Business Energy Efficiency program was either *difficult* or *very difficult* to participate in were asked to describe what would have made the program easier to participate in. Some of their responses follow:

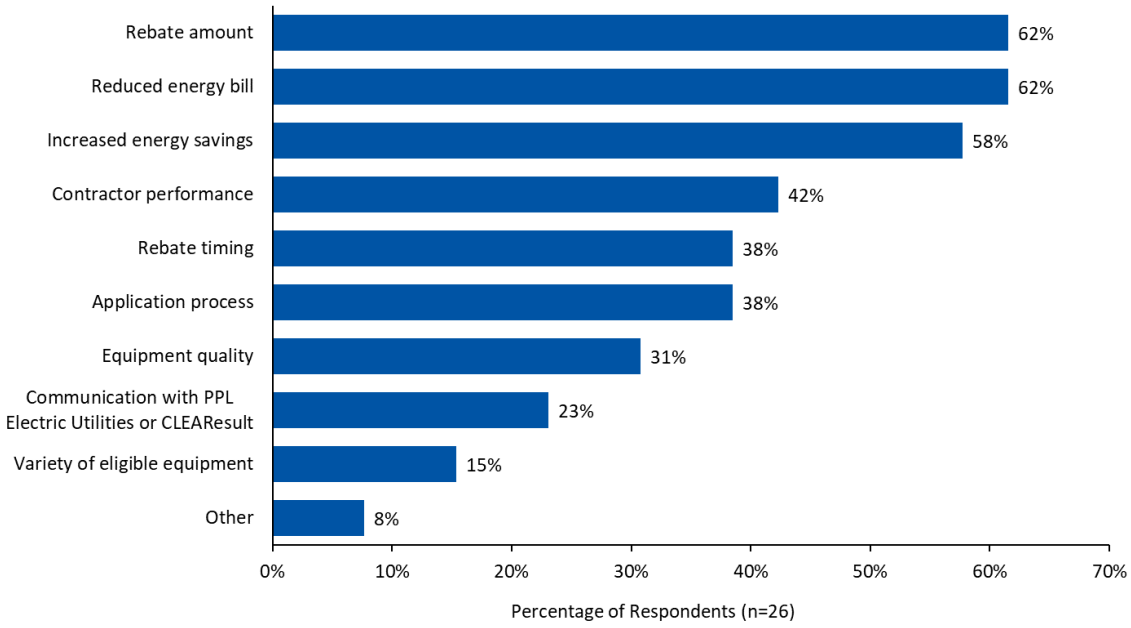
- Having the process more automated (n=1)
- Simplifying the application process (n=2)
- Simplifying the website and making it easier to navigate (n=2)

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-2 details the factors that most affected the overall experience rating reported by respondents. The "Other" responses included having a very knowledgeable PPL Electric Utilities agent and equipment availability. Similar to PY13, the rebate amount (62%; n=26), reducing energy bills (62%), and increasing energy savings (58%) (n=27)[36] continued to be the most commonly selected drivers of satisfaction.

Figure D-2. Efficient Equipment Component Drivers of Satisfaction



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

[36] Differences between PY14 and PY13 responses are not statistically significant with 90% confidence.

Opinion of PPL Electric Utilities and Likelihood to Recommend

Downstream, Direct Discount, and Direct Install

Of the 25 respondents who answered this question, 72% said their opinion of PPL Electric Utilities had either *improved significantly* or *improved somewhat* after participating in the Efficient Equipment component, while 28% said their opinion had not changed. In comparison, in PY13, 59% said that their opinion of PPL Electric Utilities had either *improved significantly* or *improved somewhat* after participating in the Efficient Equipment component, whereas 40% said that their opinion had not changed (n=27). Although there are noticeable differences between PY13 and PY14, these differences are not statistically significant. Furthermore, the survey respondents were asked to rate their likelihood to recommend the program, of which 77% of 26 respondents said they were likely to recommend the component to a friend, family member, or colleague, giving a rate of a 9 or 10 where zero is *not at all likely* and ten is *extremely likely*. This has slightly decreased from the 85% of participants who were likely to recommend the program in PY13 (n=26); however, this difference is not statistically significant.

Areas for Improvement

Downstream, Direct Discount, and Direct Install

Lastly, the survey respondents were asked to specify changes that PPL Electric Utilities or CLEAResult could implement in order to improve the Efficient Equipment component. Nine survey respondents provided improvements, which included:

- Offer savings for a wider range of equipment (n=3)
- Assigning CLEAResult staff to review application or having a point of contact for guidance (n=2)[37]
- Increasing incentives (n=1)
- Simplifying website. The respondent reported the website was confusing to navigate (n=1)
- Simplifying the application (n=1)
- Providing information about potential contractors (n=1)

Midstream Non-Lighting

Cadmus interviewed non-lighting equipment distributors who offered agriculture and food service equipment and heard about challenges that differed by industry and equipment type. Most of the participating distributors in PY14 offered agriculture equipment, and all these interviewees offered only one type of equipment covered by a program incentive (three sold high-volume low-speed fans and two sold VSD controllers on vacuum pumps). Cadmus also interviewed one food service distributor that sold almost every type of food service equipment that qualified for program incentives (the exceptions they did not offer were small combination ovens and half-size convection ovens.)

[37] PPL Electric Utilities assigns all projects to an outreach manager but these two respondents may have interpreted the question differently or are not the customer who interacts with the outreach manager.

All six distributors reported that the onboarding process was easy, and that ICSP staff provided all the support that was needed. One agriculture distributor who was early to join the program noted that the initial incentive application spreadsheet needed improvement, and that those improvements had been made. Another agriculture distributor who sold VSDs suggested that the program could provide them with physical brochures, both to familiarize the distributor with qualifying equipment specifications and that they could use to familiarize end users with the available incentives. (Brochures with equipment and incentive specifications in PDF format were available at the PPL Electric Utilities website.)

Cadmus interviewed five agriculture distributors and received open-ended feedback from two more who declined to be interviewed because they had not applied for any incentives through the program yet: six of these seven agriculture distributors reported that many of their sales did not qualify for midstream incentives because their customers had residential electric rates. Currently, only non-residential customers of PPL Electric Utilities can qualify for program incentives. One distributor reported that 75% of their fan customers had residential rates, and another reported 50% to 70% for their fan customers. A distributor who sold VSDs said that none of their sales had qualified due to the non-residential rate requirement, though they have had limited opportunities so far since they just joined the program. These distributors all strongly suggested that midstream incentives should be available to residential rate customers purchasing this equipment. The only agriculture distributor who did not mention residential rates as a barrier sold VSDs but had not yet applied for any incentives through the program.

The food service distributor faced a different set of challenges. They reported that there have been instances where the incentive portal told them a particular model of a product did not qualify for an incentive, but they were able to make the case to the ICSP that the model should qualify based on its specifications and the ICSP agreed and paid the incentive. The distributor suggested that the database could be improved to include more qualifying models to speed up the approval process, though acknowledged there are thousands of different makes and models of potentially qualifying equipment on the market. The food distributor also noted that program component incentives only cover electric equipment, but most of the cooking equipment they sell is gas-powered. However, fuel type was not an issue for ice machines and dishwashers.

D.3.2 Other Findings

Midstream Equipment Marketing

Midstream marketing expanded somewhat with the addition of new non-lighting equipment in PY14. The ICSP does not market the midstream delivery channel on its own to end users or trade allies, but it included the new offerings where appropriate in ongoing industry-targeted outreach (i.e., farm expos) and contractor newsletters. The ICSP's outreach to promote the midstream delivery channel remains focused on distributors, and the types of distributors who can potentially participate expanded with incentives for more types of equipment being offered. Program managers reported that response to the midstream offerings was stronger than expected from agriculture distributors, meeting expectations for food service, but challenging for HVAC. Only one distributor joined the midstream delivery channel to offer HVAC incentives, but they did not submit any incentive applications in PY14. Program managers

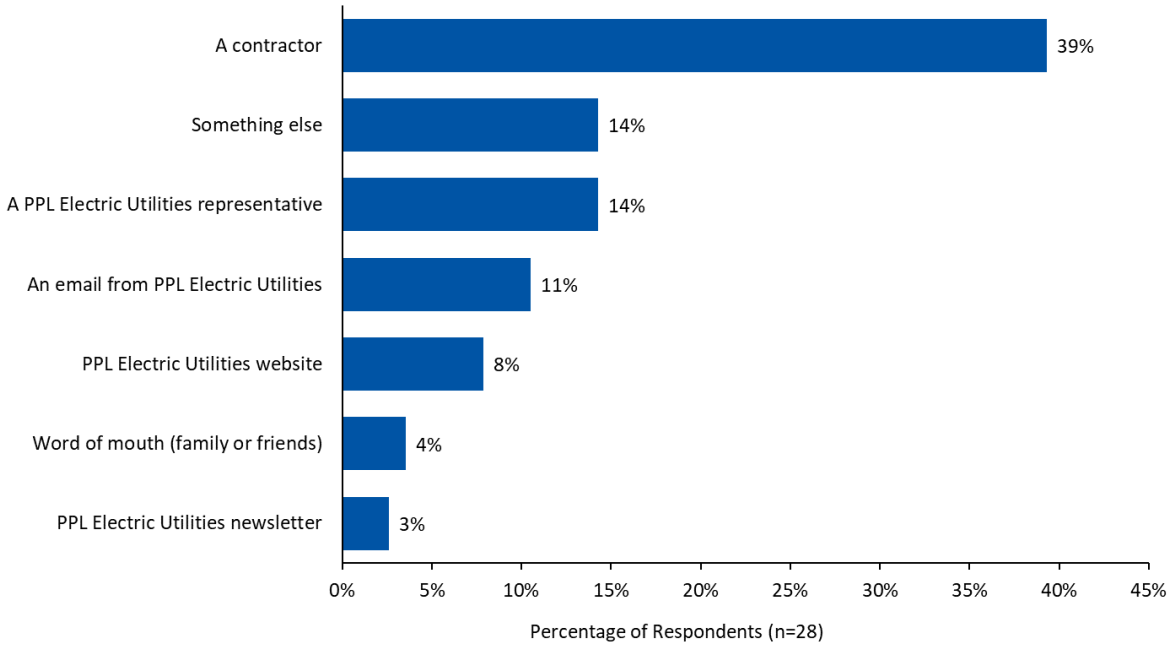
reported that the requirement for electric heating limits the portion of HVAC equipment that can qualify for a midstream incentive and speculated that this may be a barrier to distributor interest in the midstream offering.

Program Awareness

Downstream, Direct Discount, and Direct Install

Most respondents learned about the program component through a contractor (n=11), followed by a PPL Electric Utilities representative or something else[38] (n=4). Figure D-3 shows the primary distribution of their sources of program awareness provided by survey respondents.

Figure D-3. Component Awareness Source



Source: Survey question, "How did you first learn about the program?"

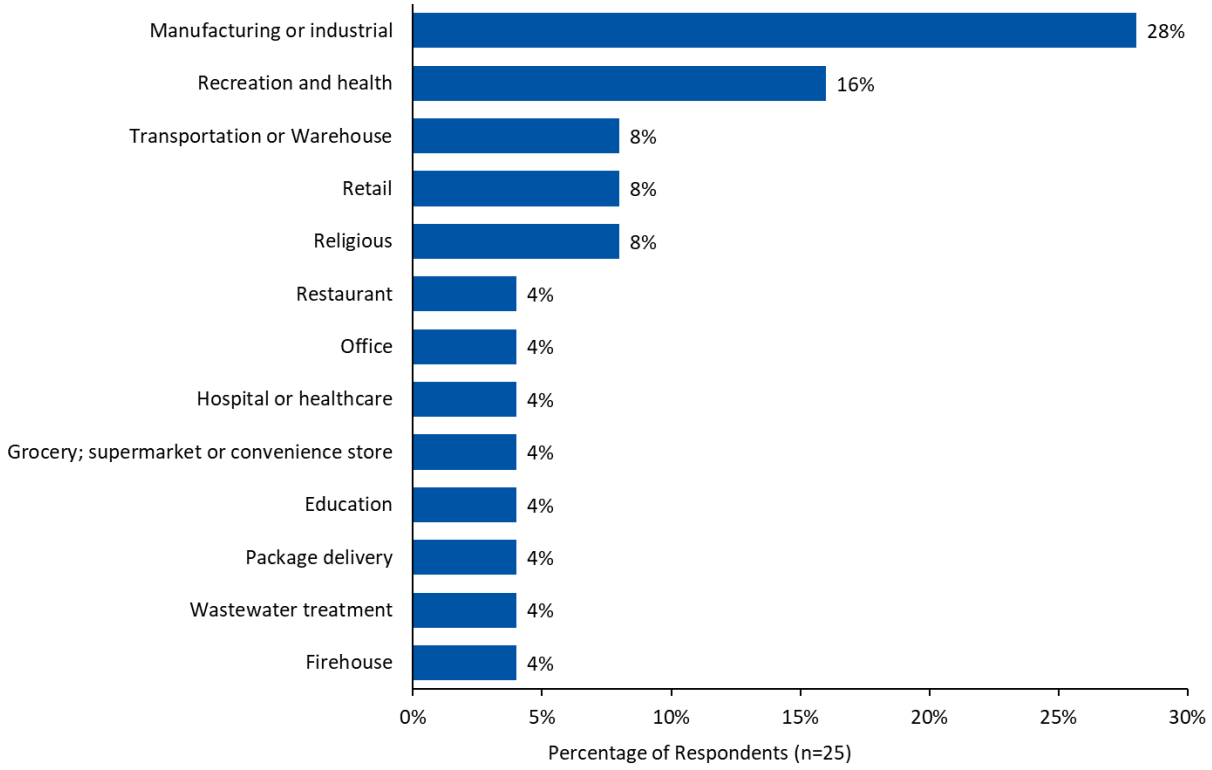
[38] Those who indicated *something else* did not provide details in the follow-up question.

Survey Participant Profile and Survey Sample Attrition

Downstream, Direct Discount, and Direct Install

The participant survey collected the following characteristics, as shown in Figure D-4.

Figure D-4. Efficient Equipment Component Organization Types



Source: Survey question, "What is the primary use of your facility?"

Table D-11 lists the total number of records contacted via the online and telephone survey and the outcome (final disposition) of each record. Additional details on survey methodology are in *Appendix L.*

Table D-11. Efficient Equipment Participant Survey Sample Attrition

Description of Outcomes of Participant Survey (online and telephone)	Number of Records			
	Non-Lighting (Equipment)	Downstream Lighting	Direct Discount Lighting	Direct Install Lighting
Population (Number of Unique Records)	**93**	**204**	**221**	**62**
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list, incomplete or invalid email address or phone number	52	132	73	17
Survey Sample Frame (Records Attempted)	**41**	**72**	**148**	**45**
Not reached or non-working: No answer, answering machine, phone busy, refused or opted out, email returned (bounce back), did not respond	35	64	136	41
Completed Surveys	**6**	**8**	**12**	**4**
Overall Response Rate	**15%**	**11%**	**8%**	**9%**

Midstream Non-Lighting

Table D-12 lists the total number of records contacted by email and telephone and the outcome (final disposition) of each record.

Table D-12. Efficient Equipment Distributor Interview Sample Attrition

Description of Outcomes of Telephone Interviews	Number of Records		
	Agriculture	Food Service	HVAC
Population (Number of Unique Records)	**9**	**3**[(1)]	**1**[(1) (2)]
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, incomplete or invalid email address or phone number	0	0	0
Interview Sample Frame (Records Attempted)	**9**	**3**[(1)]	**1**[(1)]
Not reached or non-working: No answer, answering machine, phone busy, refused or opted out, email returned (bounce back), did not respond	4[(3)]	2	1
Completed Interviews	**5**[(3)]	**1**	**0**
Overall Response Rate	**56%**	**33%**	**0%**

[(1)] One distributor offered both HVAC and Food Service equipment, so is shown in the subtotal for both in this table. Since this distributor is included in two columns of the table, the number of records appears to sum to 13 but the total number of distributors was 12.
[(2)] The HVAC distributor had eight locations in PPL Electric Utilities' service territory, but staff at these locations referred interviewers to the company's main office. Therefore, the HVAC distributor population is reported as one rather than eight.
[(3)] Two agriculture distributors declined to be interviewed because they had not sold any qualifying equipment, but they did offer open-ended feedback on their experience with the program so far.

D.3.3 Logic Model

Midstream Non-Lighting

Cadmus reviewed the logic model for the midstream non-lighting channel in the approved evaluation plan and made updates based on interviews with PPL Electric Utilities and the ICSP and secondary research. The midstream non-lighting logic model is shown in Table D-13.

Table D-13. Efficient Equipment Midstream Non-Lighting Component Logic Model

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
• Customer or building owner does not prioritize energy efficiency • Decision-makers choose to install cheaper, less efficient equipment with shorter payback • Customer is not informed about how their business or facility uses energy • Existing debt may limit funds to purchase new efficient equipment • Customers with agriculture businesses cannot qualify for non-residential incentives if they are in the residential rate class • Customer replaces HVAC equipment only upon failure and sees no need to replace functioning equipment • Customer is not informed about the most efficient HVAC equipment available when the need to replace it is immediate • Some efficient HVAC equipment may have a longer delivery time that would affect customer operations • Customer is unwilling to replace gas-powered heating and cooking equipment with electric equipment	• Recruit and educate distributors • Provide distributors with marketing materials • Determine eligibility through verification processes • Reimburse distributors for discounts on qualified product sales • Inform the end-use customer of the discount via a postcard	• Marketing materials distributed • Distributors are submitting projects • Projects are verified as eligible	• Increased component awareness • Increased customer and trade ally awareness of energy-efficient equipment • Increased installations of energy-efficient equipment • Rebated equipment is installed, leading to immediate energy and demand savings • Component effectiveness is confirmed through evaluation • Energy savings accrue from non-residential participants through installation of efficient equipment	• Lower electric bills for component participants • Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements	• Continued energy savings for the participants • PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency • Increasing PPL Electric Utilities' knowledge and experience operating this type of component • Environmental benefits are achieved

Cadmus reviewed the logic model and determined that the midstream non-lighting channel is mostly operating as expected. Table D-14 shows the outcome of the logic model review.

Table D-14. Efficient Equipment Midstream Non-Lighting Component Logic Model Review

Topics	Logic Model Components/ Goal	Status	PY14 Outcomes
Component Activities	• Recruit and educate distributors • Provide distributors with marketing materials • Determine eligibility through verification processes • Reimburse distributors for discounts on qualified product sales • Inform the end-use customer of the discount via a postcard	Achieved	• Conducted all activities as planned • In PY14, there were 12 participating distributors that between them offered almost all the equipment that qualified for midstream incentives
Outputs Produced by Component Activities	• Marketing materials distributed • Distributors are submitting projects • Projects are verified as eligible	Partially achieved	• Agriculture and Food Service distributors submitted applications and received incentives for equipment sold in PY14 but no applications were submitted for HVAC incentives
Short-Term Outcomes	• Increased component awareness • Increased customer and trade ally awareness of energy-efficient equipment • Increased installation of energy-efficient equipment • Rebated equipment is installed, leading to immediate energy and demand savings • Component effectiveness is confirmed through evaluation • Energy savings accrue from non-residential participants through installation of efficient equipment	Achieved	• Engaged distributors to begin participating in the program component
Intermediate Outcomes	• Lower electric bills for component participants • Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements	On track to meet component plans in subsequent years	• In PY14 (year 2), the midstream equipment subcomponent contributed 709 MWh/yr and 0.26 MW/yr of reported savings to the component
Long-Term Outcomes	• Continued energy savings for the participants • PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency • Increasing PPL Electric Utilities' knowledge and experience operating this type of component • Environmental benefits are achieved	Unable to assess	• Unable to assess at this time

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.

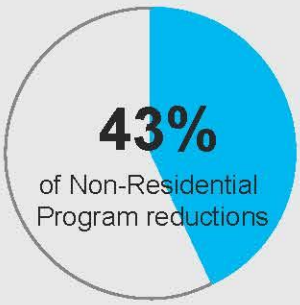
VERIFIED ENERGY SAVINGS

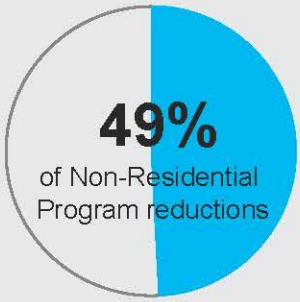
Phase IV has saved **135,810 MWh/yr**

PY14 saved **95,307 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **24.85 MW/yr**





PY14 has reductions of **17.87 MW/yr**

PY14 PARTICIPATION

A total of **122** participants

- **63** Photovoltaic
- **25** Refrigeration
- **10** Agricultural
- **14** Other unspecified
- **9** HVAC
- **1** Motors

PARTICIPANT SATISFACTION

Satisfied with overall program component

- **100%** satisfied with the contractor
- **100%** satisfied with the installation experience
- **92%** satisfied with the quality of energy efficiency product installed/received
- **75%** satisfied with the clarity of rebate application requirements
- **75%** satisfied with the rebate amount received from PPL Electric Utilities

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, combined heat and power (CHP), solar, advanced lighting controls, compressed air, and other custom improvements.

PPL Electric Utilities' Custom component is offered through a downstream approach. The non-residential ICSP, CLEAResult, works with customers and trade allies to identify and qualify custom projects. Customers or trade allies submit applications for review. Eligible projects are processed and incentives are paid upon project completion and final savings review.

A PY14 participant is defined as a project that was commercially operable between June 1, 2022, and May 31, 2023, and subsequently received an incentive payment.[39] Projects for which customers submitted an application during this period that did not receive an incentive or projects that were commissioned during this period that did not receive an incentive are not counted as participants in PY14. An individual customer may have multiple participating projects. In PY14, there were 134 projects representing 122 unique customers.

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, savings for small stratum projects in PY13 and PY14 were verified in PY14. A discussion of the approach, by stratum, follows.

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 PY14, Cadmus verified savings for 12 large stratum projects.[40] Solar PV projects were included in the large stratum if their expected energy savings exceeded 1 million kWh/yr.[41]

[39] As defined by the Phase IV Evaluation Framework, EDC-claimed savings 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.

[40] Eight projects (all large stratum) had savings over 2 million kWh/yr. The other two large stratum non-solar projects had verified savings of approximately 1 million kWh/yr but were included in the large stratum because the expected savings exceeded 2 million kWh/yr.

[41] Two Solar PV projects were in the large stratum. Both had expected savings slightly above 1 million kWh/yr, though the verified savings for one of them was slightly under 1 million kWh/yr.

- **CHP stratum.** All CHP projects were assigned to this stratum. In PY14, no CHP projects reported savings. Hence, Cadmus did not verify savings for any CHP projects.
- **Small stratum.** All small stratum projects from PY13 Q1 through PY14 Q3 were included in the sampling population and were verified in PY14. A total of 36 projects in PY13 and 122 projects in PY14 were assigned to the small stratum and seven were verified.

The impact evaluation sampling strategy is summarized in Table E-1.

Table E-1. PY14 Custom Component Gross Impact Evaluation Sample Design

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Large	Census	12[1]	12	Visual verification of improvement and site-specific conditions; M&V, including metering (in most cases); use of EMS or SCADA data
CHP	Census	0	0	
Small	80/15	8[2]	7	Most at high rigor, similar to large stratum projects (5); several qualified for a basic rigor approach in accordance with the Evaluation Framework (2).
Total Participants	**-**	**20**	**19**	**-**

[1] Ten projects (all non-solar large stratum) had expected savings of over 2 million kWh/yr. The two solar large stratum projects had expected savings greater than 1 million kW/yr.
[2] Combined PY13 and PY14 sample. Note that PPL Electric Utilities' tracking database includes three line items for components of a RTU replacement project that Cadmus evaluated as a single project. Cadmus targeted eight small stratum sites for evaluation but one site who had initially indicated cooperation, was unable to participate and due to timing an alternate was not chosen.

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, nor do they factor into *ex ante* or *ex post* totals. In PY14, Cadmus verified PY13 unverified savings in the Custom component through the application of the small stratum realization rate.

E.1.2 Gross Impact Results

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

Table E-2. Custom Component Savings

Savings	PY13 Verified	PY14 Verified	Phase IV Verified [1]
MWh/yr	40,503[2]	95,307	135,810
System-Level MW/yr	6.98[2]	17.87	24.85

[1] Phase IV verified savings may not match sum of program years due to rounding.
[2] PY13 verified savings include 3,236 MWh/yr and 0.68 MW/yr savings that were verified during the PY14 evaluation.

Projects evaluated for the Custom component in PY14 were in the large and small strata. In PY14, PPL Electric Utilities reported 94,575 MWh/yr gross energy savings (Table E-3) and 16.44 MW/yr in demand reductions (Table E-4).

Table E-3. PY14 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.	PYVTD (MWh/yr)
Large	82,696	100%	0.00	0.0%	82,696
CHP	0	N/A	N/A	N/A	NA
Small	11,879	106%	0.13	7.7%	12,610
Component Total[2]	**94,575**	**101%**	**0.04**	**1.1%**	**95,307**
Small (PY13 verified in PY14)	3,048	106%	0.13	7.7%	3,236

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Total may not match 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	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Large	13.87	100%	0.00	0.0%	13.87	14.71
CHP	N/A	N/A	N/A	N/A	N/A	N/A
Small	2.57	114%	0.12	7.0%	2.93	3.16
Component Total[2]	**16.44**	**102%**	**0.04**	**1.3%**	**16.80**	**17.87**
Small (PY13 verified in PY14)	0.56	114%	0.12	7.0%	0.64	0.68

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

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

- The overall small stratum realization rates for energy and demand were 106% and 114%, respectively. The maximum realization rate for energy (kWh) for a small stratum project was 141% and the minimum was 43%. Cadmus observed a similar distribution for demand.
- Cadmus found the reasons for differences between the claimed and verified savings were site-specific and not consistent across the stratum. Some examples follow:
  - A single small stratum project represented 80% of the savings in the small sample. The realization rates for energy and demand were 110% and 114%, respectively, for this project. For this compressed air project, Cadmus added energy use for the dryer, cooling tower, and cooling circulation pumps in the baseline. The ICSP did not meter these baseline systems and did not include an estimate of their baseline energy use in the claimed savings.
  - The lowest realization rate was for a different compressed air project. The ICSP adjusted for production in a manner that inflated the baseline energy use. The actual dependence on production was less than estimated. Cadmus also updated the way that the baseline compressor sequencing was modeled, which reduced the calculated energy use of the baseline configuration.

- Another project utilized TRM algorithms for a rooftop unit replacement. The claimed savings treated the units as serving computer room areas, but Cadmus determined that the units actually serve the main areas of a retail store. This resulted in an increase in energy savings and a decrease in demand reductions.
- Realization rates were close to 100% for energy for small stratum solar projects but there was more variation in the demand realization rates. The ICSP changed the way that they estimated demand for projects that use PV_{Watts} for claimed savings. The original method underestimated the peak demand savings. Demand realization rates for small strata solar projects were between 96% and 153%.

E.2 Net Impact Evaluation

E.2.1 Net Impact Methodology

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,[42] which discusses the common methods used to determine free ridership and spillover. Cadmus used a self-report survey, administered online and by telephone, to assess free ridership and spillover for the Custom component.

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

Table E-5 lists the methods and sampling strategy used to determine net savings for the Custom component in PY14. Cadmus conducted the survey during April and June 2023 and received responses from 12 of 90 Custom component participants.

Table E-5. Custom Component Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population[(1)]	Achieved Sample Size	Response Rate[(2)]	NTG Activity
Custom	Participants	90	12	13%	Self-report survey

[(1)] Population size includes number of unique records available at the time of the survey field period through mid-April of PY14. An additional 32 were removed from the population prior to survey launch due to opting out, having completed a previous survey in the past three months, or having incomplete contact information.
[(2)] Cadmus calculated the response rate as the number of respondents who answered the free ridership questions (n=12) divided by the number of records in the population.

[42] 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.

E.2.2 Net-to-Gross Results

Table E-6 shows the free ridership, spillover, and NTG ratio for the Custom component. The survey respondents represented 15% of the PY14 Custom component verified gross population savings. Free ridership was 26%, weighted by the verified gross savings of the projects they completed. One project estimated at 25% free ridership represented 89% of the Custom component analysis sample verified gross savings. Two respondents had a large stratum project, and 10 had small stratum projects. No respondents reported any attributable spillover activity as a result of their participation.

Table E-6. PY14 Custom Component NTG Ratio Summary

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Custom (all projects)	12	26%	0%	74%	3%[1]
[1] At 90% confidence interval.					

Table E-7 shows PY14 Custom component free ridership by stratum. The weighted average free ridership for small stratum projects is 39%, and these surveyed projects represent 4% of the analysis sample verified savings. The overall component free ridership estimate of 26% is heavily weighted toward the large stratum free ridership of 26%, as large stratum respondents represent 96% of the overall custom analysis sample verified savings.

Table E-7. PY14 Custom Component Free Ridership Comparison by Stratum

Stratum	n	Free Ridership (%)[1]	Percentage of Analysis Sample Verified Savings	Percentage of Component Population Stratum Verified Savings	Relative Precision at 85% C.L.
Custom – Large	2	26%	96%	17%	24%
Custom – Small	10	39%	4%	5%	10%
Component Total	**12**	**26%**	**100%**	**15%**	**19%**
[1] Weighted by verified kWh/yr savings.					

E.3 Process Evaluation

In PY14, Cadmus conducted a process evaluation to assess participant satisfaction, inform net savings research, and make recommendations for modifying and improving the Custom component. Process evaluation activities were consistent with planned activities. Table E-8 lists the process evaluation sampling strategy.

The participant survey asked questions about satisfaction, program ease, the likelihood of recommending the component to others, and other topics.

From April to June 2023, Cadmus made several attempts to reach participants through an initial email invitation, followed by three email reminders, and several telephone calls. Twelve participants responded to the survey. See *Appendix L* for details about Cadmus' approach to reducing survey bias and contact instructions. 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 E-8. PY14 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]
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	2	N/A	2	2	2	100%
Custom	Participants	Online survey	90[2]	N/A	Census	12[3]	58[4]	100%
Component Total			**92**	**-**	**-**	**14**	**60**	**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 through mid-April of PY14.

[3] Includes three large C&I projects, three small C&I projects, and six residential projects.

[4] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities database at the time of the 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, 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 respondents were asked a series of questions to identify how satisfied they were with the program component and its elements, along with those factors that impacted the participants' satisfaction levels, and any improvements that could increase their satisfaction.

The Custom component was delivered effectively in PY14 and maintained high levels of customer satisfaction. As shown in Table E-9, 10 of the 12 respondents to the PY14 survey were satisfied with the overall component compared to three out of three survey respondents in PY13.

Table E-9. PY14 Custom Participant Satisfaction

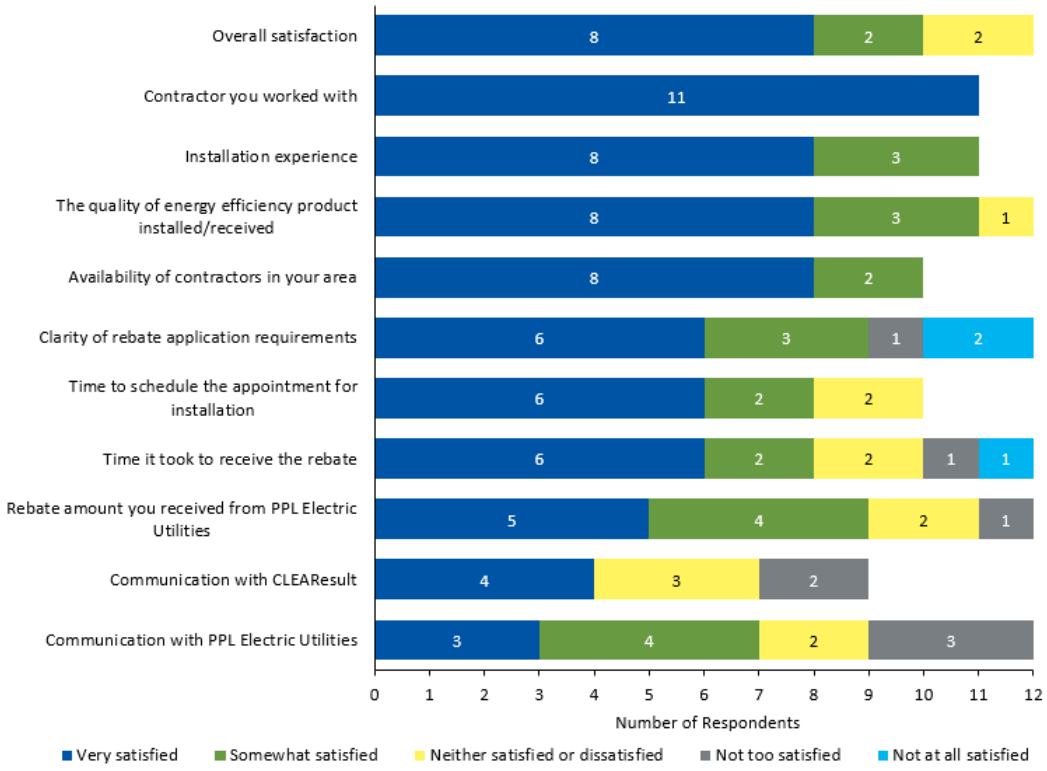
Satisfaction Level[(1)]	PY14	PY13
Very satisfied	8	2
Somewhat satisfied	2	1
Neither satisfied nor dissatisfied	2	0
Total	**12**	**3**

[(1)] Source: Participant survey, "Now, thinking about your overall experience with the PPL Electric Utilities Custom rebate program, how would you rate your satisfaction?"

The PY14 survey also asked customers about their satisfaction with specific elements of the component.[43] As shown in Figure E-1, of the 12 respondents, 11 stated they were satisfied with the contractor they worked with, and eight were satisfied with the installation experience, the quality of the energy efficiency products installed or received, and availability of contractors in their area. Some customers were not satisfied with elements related to rebates (clarity of application requirements, timing, and amounts) and communication they had with CLEAResult and PPL Electric Utilities.

[43] This question was not asked in PY13.

Figure E-1. PY14 Custom Component Satisfaction



Source: Survey question, "Thinking about the program, please indicate how satisfied you are with each element of your experience." (n's=7-12)

Drivers of Component Satisfaction

To better understand what drives satisfaction, the survey asked participants what factor or factors most affected their component satisfaction rating. The main drivers of **overall** satisfaction in PY14 were communication with PPL Electric Utilities or CLEAResult, increased energy savings, rebate amount, and rebate timing. Communication with PPL Electric Utilities or CLEAResult was the main driver in PY13 as well. Table E-10 shows the most common drivers of respondents who rated their overall satisfaction with the component as *very* or *somewhat satisfied*.

Table E-10. PY14 Drivers of High Component Satisfaction

Satisfaction Drivers[1]	PY14 (n=10)	PY13 (n=3)
Communication with PPL Electric Utilities or CLEAResult	5	2
Increased energy savings	5	0
Rebate amount	5	1
Rebate timing	4	1
Reduced energy bill	3	1
Application process	2	1
Contractor performance	2	0
Variety of eligible equipment	1	0

[1] Source: Participant survey, "What factor(s) most affected the overall experience rating you gave?" (Multiple responses allowed). Includes respondents who answered *very* or *somewhat satisfied* to this question.

Two respondents said they were *neither satisfied nor dissatisfied*. One said it was because of rebate timing and one said, "Not enough info[rmation] was given, [or] known or we did not ask enough [questions]."

In PY14, eight of the 12 respondents said that it was *easy* to participate in the Custom component, and two participants said that it was *neither easy nor difficult* while one respondent said it was *difficult* to participate, stating, "More information and detailed overall cost [were needed] and rebate savings were not clear about who got them .... we did not receive full disclosure or rebates." One respondent did not know.

Opinion of PPL Electric Utilities and Likelihood to Recommend

Seven of the 12 survey respondents reported having a better opinion of PPL Electric Utilities after participating in the Custom component, four said their opinions had not changed, and one respondent said their opinion had *decreased somewhat*. The survey asked the respondent who said their opinion of PPL Electric Utilities decreased why this was so, and their response was related to the difficulty they experienced having to attend multiple meetings at the job site and the stringency of the program component requirements.

Overall, 11 of the 12 survey participants were likely to recommend the component to a friend, family member, or colleague; three of the 12 participants in PY14 gave a 9 or 10 on a scale of 0 to 10, where 0 is *not likely at all* and 10 is *extremely likely*.

E.3.2 Improvement Suggestions

The survey asked respondents if they could provide suggestions for improving the component that could be implemented by PPL Electric Utilities or CLEAResult and four respondents provided their thoughts:

- Be more responsive to questions delivered via email (n=1)
- Provide information on rebate criteria and who will receive the rebate (n=1)
- Increasing awareness of the program component (n=1)
- Reduce the number of visits to the site for M&V, remove per project and yearly caps (n=1)

E.3.3 Other Findings

Survey Participant Profile and Survey Sample Attrition

The PY14 survey collected information about the facilities operated by Custom component participants shown in Table E-11.

Table E-11. Respondent Firmographics

Respondent Firmographic[1]	Responses
Farming	6
Lodging or housing	2
Office	1
Manufacturing or industrial	1
Retail	1
Transportation or Warehouse	1
[1] Source: Survey question, "What is the primary use of your facility?" (n=12)	

Table E-12 lists the total number of records contacted for the survey via online and telephone attempts and the outcome (final disposition) of each record. Of 58 records in the sample frame, 12 participants responded to the survey, for a 21% response rate. Additional details on survey methodology are provided in *Appendix L*.

Table E-12. Custom Component Sample Attrition

Description of Outcomes of Online and Telephone Participant Survey	Number of Records
Population (number of unique jobs)	**90**
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, or did not have accurate contact information	32
Survey Sample Frame	**58**
Not reached, refused, opted out, left message, email returned (bounce back), did not respond	46
Ineligible	0
Completed Surveys	**12**
Overall Response Rate	**21%**

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 reviewed all records in PPL Electric Utilities' tracking database and compared these to the participant records in the ICSP's database. Cadmus verified discrepancies with the ICSP prior to conducting any analyses.
- **Audit desk review.** Cadmus reviewed a random sample of 62 of the ICSP's assessment records for baseload, low-cost, and full-cost strata. Cadmus' reviews of home assessment records involved verifying reported home and measure data from participant records in the ICSP's database and relevant inputs for savings calculations using the PA TRM. Cadmus verified all data fields in the assessment records against the PPL Electric Utilities' tracking database (e.g., home address, water heater fuel type, heating fuel type, reported quantities, count of home occupants, and baseline conditions).
- **Engineering analysis.** Cadmus conducted an engineering analysis for baseload, low-cost, and full-cost strata and used the findings from the assessment records review as inputs to the engineering algorithms from the PA TRM,[44] when available, and the IL TRM for algorithms (not inputs) not listed in the PA TRM.[45]
- **Census evaluation.** Cadmus conducted a census evaluation for all welcome kit data using a combination of PA TRM inputs and data from PPL Electric Utilities' tracking database. Cadmus also used algorithms and inputs from section 2.1.1 of the PA TRM.
- **REA audio recordings review**. Cadmus reviewed 27 audio recordings from the ICSP's remote energy assessments (REAs) with program participants to verify *in situ* baseline bulb information. The audio recordings consisted of an ICSP staff member calling the resident, giving an overview of the program, providing the resident with energy education, and guiding the resident through their residence to record the number, type, and wattage of currently installed light bulbs in each room. Cadmus primarily reviewed recordings to verify the light bulb wattage and types that were currently installed in participants' homes to determine the baseline wattage for lighting savings calculations.

F.1.1 Job Type

As discussed in *Chapter 6. Low-Income Program*, PPL Electric Utilities provided four types of service (also known as job types) at no cost to the income-qualified customer; these are baseload, low-cost, full-cost, and welcome kits. Baseload services are offered to customers without electric heat and without an electric water heater. Low-cost services are offered to customers without electric heat but with

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

[45] IL TRM V10.0, Sections 5.4.4, 5.4.5, 5.4.8

electrically heated water. Full-cost services are offered to customers with both electric heat and electrically heated water. The welcome kit is offered to any eligible customer.

F.1.2 Gross Impact Methodology and Sampling Approach

In PY14, 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 Cadmus with an extract of its tracking database of participant records and the energy assessment records. Cadmus selected a random sample of participants to verify that products were installed as reported.

Cadmus designed the verification sample for the Low-Income Program to meet 85% confidence with ±15% precision. To examine savings in detail, Cadmus stratified the population into baseload, low-cost, full-cost, and MMMF job types. Cadmus sampled the population by project number instead of by account number for simplicity and consistency with previous years.[46]

The impact evaluation sampling strategy is summarized in Table F-1. Cadmus' energy evaluation produced results with ±7.15% precision at 85% confidence using a random sampling method to select a sample of homes for verification.

Table F-1. PY14 Low-Income Program Component Gross Impact Evaluation Sample Design

Sample Stratum	Population Size[(1)]	CP	Sampling Assumptions Cv in Sample Design[(2)]	Target Sample Size	Achieved Sample Size[(1)(3)]	Impact Evaluation Activity
Remote Energy Assessment						
REA – Baseload	2,398	85/15	0.35	~12	13	Participant surveys, recordings, desk review, and engineering analysis
REA - Low-Cost	3,336			~12	13	
Direct Install						
In-home—Baseload	964	85/15	0.30	~9	9	Desk review and engineering analysis
In-home—Low-cost	1,621			~9	9	
In-home--Full-cost	320			~9	9	
In-home--MMMF (all job types)	180			~9	9	
Welcome Kits						
Welcome Kits	19,743	N/A	N/A	Census	N/A	Census and database review
Program Total	**28,562**	-	-	-	-	-

[(1)] Population size and sample size counts are based on unique job numbers, which differs slightly from unique households.
[(2)] Initially, Cadmus used the planned Cv of 0.35 but, based on observed variance, changed the Cv to 0.42, which yielded a larger sample.
[(3)] Nine (9) dwelling units were randomly sampled within one (1) MMMF site in Q3.

[46] For baseload and low-cost jobs, account numbers generally correspond at a one-to-one ratio with project numbers, although some jobs receive multiple visits over the year or over multiple years.

At the end of the program year, within each stratum, Cadmus weighted and combined the realization rates for each sampled project into a single, stratum-level realization rate. To calculate verified savings, Cadmus applied each stratum-level realization rate to the respective population reported kW and kWh savings represented by each stratum. Cadmus then summed these stratum-level savings to estimate population total verified savings.

Energy Education and Behavior Savings

Cadmus evaluated the impacts of electric consumption associated with behavior changes by program participants using calculations derived from a combination of engineering estimates, secondary research, and survey data. Cadmus selected three behavioral recommendations—adjust thermostats, wash clothes in cold water, and take shorter or fewer showers—that reasonably corresponded to energy-saving activities in the PA TRM.

Adjust Thermostat for Heating and Cooling Season

Cadmus assumed that participants who adjusted their thermostats saved energy similar to savings from a programmable thermostat and applied the PA TRM's algorithms accordingly.[47]

Wash More Loads of Laundry in Cold Water

Cadmus estimated the energy savings from participants washing clothes in cold water in two steps:

1. Estimated the energy usage of a clothes washer (using algorithms from the PA TRM)[48]
2. Weighted the results based on PY14 survey responses

The participant answered a survey question about how often the energy-saving tip about washing clothes in cold water was followed. Cadmus assigned an approximate percentage of time that clothes were washed in cold water based on responses (i.e., "Always" indicated that 100% of laundry was washed in cold water, "More than half the time" assumed 75%, and so on). Cadmus then assessed the relative change before and after energy education was provided.

Take Shorter Showers

Cadmus assumed that participants who said they take shorter showers take a five-minute shower every time. Cadmus estimated shower energy use using section 2.3.8 in the 2021 PA TRM, then added a term to subtract the energy education recommendation for shower length from the 7.8-minute default.[49]

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[47] Pennsylvania Public Utility Commission. Technical Reference Manual. February 2021. Section 2.2.11.

[48] Section 2.3.5 of the PA TRM concerns the water heater temperature setback. One component in the algorithm estimates savings from the clothes washer. Cadmus used these savings to estimate energy consumption of a clothes washer.

[49] The PA TRM groups like terms and takes the difference of the variables that are changed. In this instance, Cadmus set the flow rate to be constant and changed the time of the showers.

F.1.3 Gross Impact Results

Detailed Desk Review Findings

Findings from Cadmus' review of records are shown in Table F-2. These findings, along with in-service rates (ISRs) of products and energy education savings, are the reasons for differences between reported and verified savings.

Table F-2. PY14 Low-Income Desk Review Findings

Product	Finding	Number of Jobs	Effect on Savings
Bathroom Aerators	Number of occupants observed in home assessment data were greater than those assumed in TRM	10	Increased
Kitchen Aerators	Number of occupants observed in home assessment data were greater than those assumed in TRM	9	Increased
Showerheads	Number of occupants observed in home assessment data were greater than those assumed in TRM	11	Increased
TSRVs	Number of occupants observed in home assessment data were greater than those assumed in TRM	12	Increased
RAC Replacement and Recycling	TRM baseline EER value used in place of ICSP provided value.	4	Decreased
LEDs	Interactive Effects not included for exterior LED installations	24	Increased kWh / Decreased kW
	All Bulbs hours of use and coincidence factor used in place of Efficient hours of use and coincidence factor for MMMF jobs	9	Decreased
Tier 1 Smart Strips	ISR calculated via survey data is greater than default TRM ISR	39	Increased

In-Service Rates

The participant survey asked questions about seven products—LEDs, LED nightlights, kitchen aerators, bathroom aerators, showerheads, tier 1 advanced power strips, and thermostatic shower restriction valves. Cadmus calculated the REA and on-site ISRs for these items, as shown in Table F-3.

Table F-3. PY14 In-Service Rates for Energy-Saving Items

Product	In-Service Rate	
	REA	On-site
LEDs	95%	98%
LED Nightlights	93%	100%
Kitchen Aerators	89%	86%
Bathroom Aerators	95%	83%
Showerheads	90%	86%
Tier 1 Advanced Power Strips	97%	100%
Thermostatic Shower Restriction Valves	75%	71%

Energy Education Savings Findings

Table F-4 shows the energy-savings recommendations considered in estimating energy education savings, any behavioral elements that energy education could change, PA TRM reference, and per-unit energy savings and demand reductions. The estimate for per-household verified energy education savings is 75.70 kWh/yr in PY14. The *ex ante* assumption was 60 kWh/yr per PPL Electric Utilities' participant tracking database. Verified energy savings were greater than the *ex ante* savings. As the table shows, the main driver in the energy education savings was adjusting the thermostat during colder months.

Table F-4. Low-Income Program Verified Energy Education Savings and Assumptions Summary

Energy Savings Recommendation	Behavioral Assumption	2022 PA TRM Reference	*Ex Post* Verified Savings	
			kWh/yr	kW/yr
Adjust Thermostats – Summer	Participants lower their thermostat in winter and raise it in summer	ENERGY STAR® Certified Connected Thermostats – Section 2.2.11	8.45	0.0031
Adjust Thermostats – Winter			53.21	0.0000
Wash Clothes in Cold Water	Participants increase number of loads of laundry they wash in cold water	Water Heater Temperature Setback– Section 2.3.5	10.37	0.0008
Take Shorter Showers	Participants decrease duration of each shower	Low Flow Showerheads – Section 2.3.8	3.66	0.0003
Total [(1)]			**75.70**	**0.0042**

[(1)] Each component is summed to get the total. Total may not sum due to rounding.

F.2 Process Evaluation

F.2.1 Survey Participant Profile and Survey Sample Attrition

The PY14 customer surveys collected demographic information about Low-Income Program participants. The majority of survey respondents reported the following characteristics.

- Lived in a single-family detached residence (on-site: 74%, n=14, REA: 33%, n=18; welcome kit: 40%, n=33)
- Had an average household size of 2.3 residents (on-site, n=49), 2.2 (REA, n=104), and 1.9 (welcome kit, n=119)[50]

[50] Average household size determined with an aggregation of PPL Electric Utilities' tracking database and survey data. Though the tracking database does have a field for number of occupants in the home, the survey asks this question for a more up-to-date understanding from the customer. Where possible, Cadmus used survey responses rather than data from PPL Electric Utilities' tracking database unless no survey data were available. For PY14, there were 26 on-site survey responses, 48 REA responses, and 73 Welcome Kit responses that were included in the analysis.

- Had an annual household income of $20,000 or less (on-site: 42%, n=8; REA: 87%, n=40; welcome kit: 67%, n=39)
- A vast majority of participants have internet access in their home (on-site 96%, n=26; REA 95%, n=52; welcome kit 91%, n=76)

Table F-5 lists the total number of records contacted via online survey and the outcome (final disposition) of each record (all strata). Additional details on survey methodology are in *Appendix L*.

Table F-5. Low-Income Component Sample Attrition

Description of Outcomes of Online Participant Survey	Number of Records
Population (number of unique jobs at the time sample was drawn)	**17,775**
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on “do not contact” list	1,851
Removed: incomplete or invalid email address or phone number	2,238
Survey Sample Frame (records attempted)	**13,686**
Not reached or non-working: Refused or opted out, email returned (bounce back), did not respond	13,426
Partially Completed Survey	85
Completed Surveys (online)	**175**
Overall Response Rate	**1%**

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.

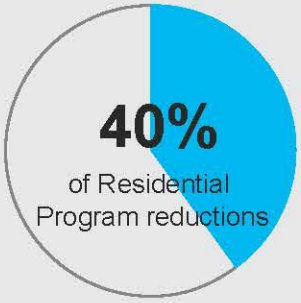
VERIFIED ENERGY SAVINGS

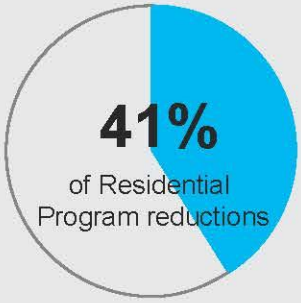
Phase IV has saved **16,470 MWh/yr**

PY14 saved **8,569 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **4.00 MW/yr**





PY14 has reductions of **2.09 MW/yr**

PY14 PARTICIPATION

A total of **8,223** customers recycled **12,206** units*

7,861 Refrigerators

1,836 Room air conditioners

1,326 Freezers

1,183 Dehumidifiers

*Does not include incentive corrections

PARTICIPANT SATISFACTION

Satisfied with overall program component

93% found program participation easy

91% 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 and provides 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 that were 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 PY14, CLEAResult, the ICSP, delivered the Appliance Recycling component along with its pick-up/recycling subcontractor, Key Recycling.

During PY14, participants had the option of requesting in-person home pick-up or contactless curbside pick-up. Refrigerators must measure between 10 and 30 cubic feet to qualify for pick-up. Both primary and secondary refrigerators and freezers are eligible. Eligible appliances must be functional at the time of pick-up. If customers recycle a refrigerator or freezer, they can also turn in room air conditioners and dehumidifiers. During PY14, four bulk recycling events were also held to collect room air conditioners and dehumidifiers.

Table G-1 shows the appliance eligibility parameters and incentives for PY14, which were unchanged from the end of PY13.

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

Cadmus' verification activities in PY14 for refrigerators and freezers were consistent with planned activities and were limited to updating the HDD and CDD mapping using the PA TRM ZIP code mapping rather than the NOAA weather stations mapped in PY13. Cadmus verified savings for refrigerators and freezers by applying the updated PY13 realization rates to PY14 reported savings.

The impact evaluation sampling strategy is summarized in Table G-2. 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		N/A	N/A	N/A

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[(1)]
Refrigerator Recycling	Appliance Age (years)	22.84
	Dummy: Manufactured Pre-1990	22%
	Appliance Size (cubic feet)	18.91
	Dummy: Single-Door Configuration	0.05
	Dummy: Side-by-Side Configuration	0.21
	Dummy: Percentage of Primary Usage (in absence of the program)	0.42
	Interaction: Located in Unconditioned space x CDDs	6.84[(2)]
	Interaction: Located in Unconditioned space x HDDs	1.03[(2)]
Freezer Recycling	Appliance Age (years)	26.72
	Dummy: Manufactured Pre-1990	36%
	Appliance Size (cubic feet)	17.04
	Percentage of Chest Freezers	0.33
	Interaction: Located in Unconditioned space x HDDs	12.07[(2)]
	Interaction: Located in Unconditioned space x CDDs	1.87[(2)]

[(1)] Values calculated in PY13, except where noted.
[(2)] Updated in PY14.

Cadmus calculated gross verified savings and realization rates using data gathered from the PPL Electric Utilities participant tracking database from PY13 (appliance age, size, and configuration) and from the PY13 online survey of participants (primary versus secondary use and whether appliances were kept in conditioned spaces) with one difference from the PY13 annual report. Cadmus updated the HDDs and CDDs from those presented in Table G-3 of the PY13 report to reflect the ZIP code to climate region mapping specified in the PA TRM. The table also includes updated HDD and CDD values, along with the input values from PY13 for the other open variables. The updated CDD and HDD values decreased annual per-unit kWh consumption for refrigerators by one kWh, from 1,019 kWh in PY13 to 1,018 kWh

in PY14, and increased annual consumption of freezers by two kWh per-unit. 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 is used to convert the annual UEC into an average per-unit gross savings.

Cadmus applied PY13 part-use values of 0.82 and 0.69 for refrigerators and freezers, respectively. The *Part-Use Factor Findings* section of Appendix G in the PY13 Annual Report details the part-use analysis Cadmus conducted in PY13.

G.1.2 Gross Impact Results

Table G-4 shows the Appliance Recycling component's verified gross energy savings and demand reductions.

Table G-4. Appliance Recycling Component Savings

Savings	PY13 Verified	PY14 Verified	Phase IV Verified[1]
MWh/yr	7,900	8,569	16,470
System-Level MW/yr	1.90	2.09	4.00

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

Table G-5 shows verified energy savings and realization rates by stratum for PY14. Table G-6 shows verified demand savings and realization rates.

Table G-5. 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	7,339	100%	4.59	7%	7,361
Room Air Conditioners and Dehumidifiers	1,209	100%	N/A	N/A	1,209
Component Total[2]	**8,548**	**100%**	**4.54**	**6%**	**8,569**

[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-6. 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	1.18	100%	6.37	10%	1.19	1.29
Room Air Conditioners and Dehumidifiers	0.74	100%	N/A	N/A	0.74	0.80
Component Total [2]	**1.92**	**100%**	**4.53**	**6%**	**1.93**	**2.09**

[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] Totals may not sum due to rounding.

The realization rates were 100% because, as stated in the PY14 evaluation plan, the PY13 verified realization rates were applied to PY14 reported savings.

G.2 Net Impact Evaluation

G.2.1 Net Impact Methodology

Cadmus did not conduct new primary research to assess net savings for the Appliance Recycling component in PY14 and used a historic NTG ratio of 0.56 from PY13.[51]

G.2.2 Net-to-Gross Results

Table G-7 shows the NTG ratio results for the Appliance Recycling component.

Table G-7. Appliance Recycling Component NTG Ratio Summary

Stratum	PYVTD MWh/yr	Evaluation Year	Free Ridership and SMI (%)	Spillover (%)	NTG Ratio
Refrigerators and Freezers	8,569	PY13	45%	1%	0.56

[51] PPL Electric Utilities. November 30, 2022. *Phase IVI of Act 129 Program Year 13 Annual Report (June 1, 2021–May 31, 2022).* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

G.3 Process Evaluation

In PY14, Cadmus conducted a limited process evaluation consistent with the planned activities, with the exception of an additional survey to assess overall satisfaction with the Appliance Recycling component. The evaluation included a stakeholder interview and an online customer satisfaction survey. The results of the online customer satisfaction survey are found in *Section 7.5.1, Process Evaluation Key Findings* of this report. The participant survey did not inform the PY14 impact findings.

Table G-8 lists the process evaluation sampling strategy.

Table G-8. 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[(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 ICSP subcontractors	Telephone in-depth interview	2	N/A	2	2	N/A	100%
Appliance Recycling Participants	All participants	Online survey	6,745[(3)]	85/15	All eligible	139[(4)]	4,582	51%
Total			**6,747**	**-**	**-**	**141**	**4,582**	**-**

[(1)] Sample frame is a list of participants and stakeholders 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. After selecting all unique records, Cadmus removed any records from the population for customers who did not have valid contact information (email or telephone number), were on the do not call list, or opted out of the online survey.
[(2)] Percent contacted means the percentage of the sample frame contacted to complete the survey or interviews.
[(3)] Number of participants in the PPL Electric Utilities' tracking database at the time of the PY14 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.

PPL Electric Utilities

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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.

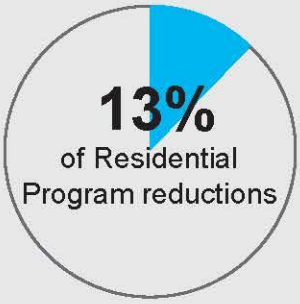
VERIFIED ENERGY SAVINGS

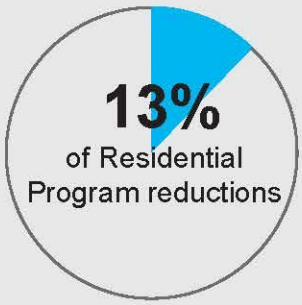
Phase IV has saved **8,575 MWh/yr**

PY14 saved **4,226 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **1.35 MW/yr**





PY14 has reductions of **0.66 MW/yr**

PY14 PARTICIPATION

A total of **744,963** bulbs sold

BULB TYPE

39%	LED candelabra bulbs
36%	LED reflector bulbs
15%	LED fixtures
10%	LED globes

RETAIL CHANNEL

64%	from home improvement stores
14%	from mass merchandise stores
7%	from hardware stores
6%	from membership club stores
4%	from discount stores
4%	from other stores (including giveaways)
<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. The component provided upstream incentives to participating manufacturers to discount the prices of a variety of specialty bulbs sold at local retail stores. The component targeted residential customers but has been available to all PPL Electric Utilities 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.

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 PY14 energy savings and demand reductions (Table H-1). See the PY13 evaluation report for details on the PY13 evaluation approach.[52]

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.

Table H-2. Efficient Lighting Component Savings

Savings	PY13 Verified	PY14 Verified	Phase IV Verified [(1)]
MWh/yr	4,349[(2)]	4,226	8,575
System-Level MW/yr	0.68[(3)]	0.66	1.35

[(1)] Phase IV verified savings may not match 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.

[52] 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.

The Efficient Lighting component reported energy savings of 4,129 MWh/yr, as shown in Table H-3, and demand reduction of 0.60 MW/yr, as shown in Table H-4.

Table H-3. PY14 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	4,129	102%	N/A	N/A	4,226
[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

Table H-4. PY14 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	0.60	102%	N/A	N/A	0.61	0.66
[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 PY14 and used a historic NTG ratio of 107% from PY13. Additional details about the methodology are found in the PY13 Annual Report.[53]

H.2.2 Net-to-Gross Results

Table H-5 shows the lift-based NTG ratio result for the Efficient Lighting component.

Table H-5. PY14 Efficient Lighting Component Lift-Based NTG Ratio Summary

Stratum	Gross PYVTD	Research Evaluation Year	NTG Ratio	Net PYVTD
Participating Retailers	4,226	PY13	107%	4,522

H.3 Process Evaluation

Because a full process evaluation was completed in PY13, Cadmus did not conduct a process evaluation in PY14. This is consistent with the approved evaluation plan.

[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.

PPL Electric Utilities

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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.

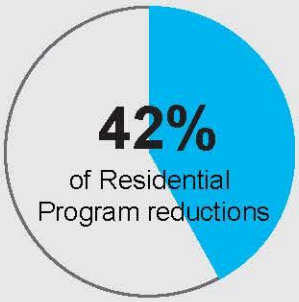
VERIFIED ENERGY SAVINGS

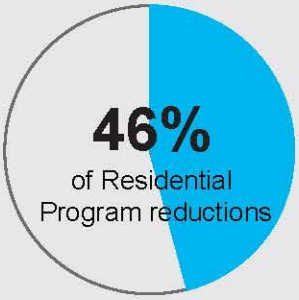
Phase IV has saved **39,150 MWh/yr**

PY14 saved **21,593 MWh/yr**

VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **4.22 MW/yr**





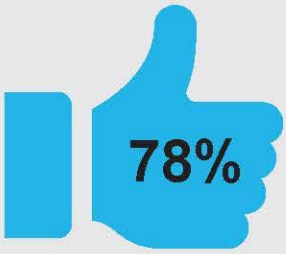
PY14 has reductions of **2.35 MW/yr**

PY14 PARTICIPATION

A total of **20,597** received rebates for

- **9,973** Efficient equipment
- **4,312** Online marketplace
- **2,514** Instant discount
- **1,204** Weatherization
- **1,702** New homes
- **892** Online and in-home audit and energy conservation kits

PARTICIPANT SATISFACTION



Satisfied with overall program component

- **85%** in-home audit and online assessment participants satisfied with program
- **83%** weatherization participants satisfied with program
- **77%** equipment participants satisfied with program
- **75%** online marketplace participants satisfied

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 home's energy efficiency.

In PY14, the component had five subcomponents: Downstream Equipment, the Online Marketplace, Audit and Weatherization, Instant Discount, and New Homes.

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 (PSD) is responsible for the New Homes subcomponent, and Energy Federation, Inc. (EFI) is responsible for the Online Marketplace subcomponent and kit distribution. Participating retailers for the Instant Discount offering include hardware and home improvement stores.

For all subcomponents 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. For the New Homes subcomponent, a participant is defined as a single-family home or a tenant unit in a newly constructed multifamily building.

I.1 Gross Impact Evaluation

I.1.1 Gross Impact Methodology and Sampling Approach

Cadmus used findings from desk reviews, participant surveys, and site visits to evaluate savings from the Audit and Weatherization and New Homes subcomponents in PY14. For the New Homes subcomponent, Cadmus also verified PY13 savings. Activities were consistent with the evaluation plan with the exception that Cadmus conducted 25 site visits for the New Homes subcomponent, whereas the plan's stated target was 23.

The approach for evaluating savings for the Downstream Equipment, Instant Discount, and Online Marketplace subcomponents was consistent with the planned activities. The Downstream Equipment subcomponent applied the results of the PY13 evaluation. The savings for Instant Discount and Online Marketplace subcomponents were left unverified and will use a combined two-year sampling approach in PY15.

The evaluation sampling strategy is summarized in Table I-1. Cadmus evaluated the subcomponents with basic levels of rigor and used different sampling approaches for each subcomponent.

For the Audit and Weatherization subcomponent, Cadmus attempted to survey a census of participants and used a nested simple random sampling approach to select a subset of surveyed sites for desk reviews for weatherization measures. The participant survey findings contributed to both the process and impact evaluations. For the audit measures, Cadmus conducted a database review for all rebated products and used the participant survey 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	85/15 (Cv=0.50)	≥ 23	26	Survey – Audit participants
		23	23	Survey and desk review – Weatherization participants
New Homes[2]	85/15 (Cv=0.50)	23	25	Desk review of REM/Rate models
				Site visits
Downstream Equipment	N/A	N/A	N/A	Applying PY13 historical realization rate to PY14 reported savings
Online Marketplace	N/A	N/A	N/A	Combined two-year sampling approach to evaluate PY14 and PY15; PY14 savings will be verified in PY15
Instant Discount	N/A	N/A	N/A	Combined two-year sampling approach to evaluate PY14 and PY15; PY14 savings will be verified in PY15
Midstream HVAC Equipment	N/A	N/A	N/A	No activities, because there was no participation in PY14

[1] The number of respondents who answered questions pertaining to the in-service rate may not equal the total number of survey respondents used in the process section of the report or the infographics.
[2] The New Homes stratum included PY13 and PY14 homes, as savings for this subcomponent were verified with a combined PY13/PY14 evaluation sample.

The impact evaluation activities verified energy savings with ±22% precision at 85% confidence and demand reductions with ±9% precision at 85% confidence.

Ex Post Savings Calculation

Audit and Weatherization

Within the strata for which sampling was applied, Cadmus calculated a single, stratum-level realization rate, weighted by each sampled project's evaluated savings. To calculate *ex post* savings for each stratum, Cadmus 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 subcomponent-level realization rates and savings.

Cadmus verified savings in accordance with the PA TRM and relied on inputs from PPL Electric Utilities' tracking database, project documentation, or deemed inputs from the PA TRM, where relevant.

New Homes

Cadmus conducted site visits to corroborate REM/Rate model inputs for verified energy savings and to gather site-specific information for demand savings following the PA TRM for lighting and appliances. Cadmus weighted and combined the realization rates of each sampled project into a single subcomponent-level realization rate. To calculate subcomponent-level *ex post* savings, Cadmus applied the sample-derived realization rate to the population savings. Cadmus then summed *ex post* and *ex ante* kWh and kW savings to calculate subcomponent-level savings.

Cadmus verified savings in accordance with the PA TRM and relied on inputs from PPL Electric Utilities' participant tracking database; project documentation; data collection through site visits; third-party

sources such as ENERGY STAR, AHRI, and product manufacturer websites; or deemed inputs from the PA TRM where relevant. Cadmus visited a random sample of 25 homes. Cadmus used the zip code of the visited home to map the coincidence factor from the PA TRM Appendix A and applied this value to the cooling demand savings.

Cadmus evaluated additional demand savings for lighting and appliances by using PA TRM algorithms. Cadmus used ENERGY STAR qualified product lists (QPLs) to verify the installed lighting and appliances qualified for additional demand savings and applied the measure-specific coincidence factors defined in the PA TRM for demand savings. Cadmus also used AHRI databases to verify the installed equipment's ratings for savings calculations where relevant.

Downstream Equipment

Cadmus applied an historical realization rate from PY13 results to reported PY14 energy savings and demand reductions (Table I-2). See the PY13 evaluation report for details on the PY13 evaluation approach.[54]

Table I-2. Energy Efficent Homes Downstream Equipment Subcomponent Historical Realization Rates

Savings	Historical Realization Rate		
	HVAC/Smart Thermostats	Water Heating	Appliances
Energy Savings (MWh/yr)	106%	103%	100%
Demand Reductions (MW/yr)	107%	101%	100%

Online Marketplace and Instant Discount

Cadmus is using a two-year sampling approach to evaluate PY14 and PY15 for the Online Marketplace and Instant Discount subcomponents. Cadmus will not report verified savings from PY14 until the completion of the combined PY14/PY15 impact analysis.

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	PY14 Unverified(1)	Phase IV Verified(2)
MWh/yr	17,556(3)	21,593	4,385	39,150
System-Level MW/yr	1.87(4)	2.35	0.48	4.22

(1) Line loss adjustments are applied to savings after verification.
(2) Phase IV verified savings may not match sum of program years due to rounding and do not include PY14 unverified savings.
(3) 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 verified savings of 2,867 MWh/yr for New Homes that were verified in PY14.
(4) PY13 verified demand reductions for the Energy Efficient Homes component were increased by 0.0005 MW/yr to conform with the SWE's PY13 Annual Report findings. Includes verified savings of 0.84 MW/yr for New Homes that were verified in PY14.

[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 I-4 shows incentive costs, verified electric savings, and demand reductions by subcomponent.

Table I-4. PY14 Incentives and Verified Energy Savings and Demand Reductions by Subcomponent

Parameter	Downstream Equipment[1]	Online Marketplace[2]	New Homes	Audit and Weatherization	Instant Discount[2]	Total[3]
PY14 Participants	9,973	4,312	1,702	2,096	2,514	20,597
PYRTD (MWh/yr)	16,056	930	4,217	833	3,454	25,491
PYRTD (MW/yr)	1.07	0.09	1.43	0.14	0.39	3.11
PYVTD (MWh/yr)	16,952	-	4,122	520	-	21,593
PYVTD (MW/yr)	1.13	-	0.90	0.13	-	2.16
System-Level PYVTD (MW/yr)	1.23	-	0.98	0.14	-	2.35
PY14 Incentives ($1000)	$2,274	$144	$1,177	$280[3]	$458	$4,333

[1] Cadmus used the PY13 historical realization rates for this subcomponent.
[2] Cadmus did not evaluate savings for the subcomponent and will verify savings using a PY14/PY15 combined sample.
[3] Sum of columns may not add up to total column due to rounding.

In PY14, the Energy Efficient Homes component reported energy savings of 25,491 MWh/yr, as shown in Table I-5, and demand reduction of 3.11 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	14,472	106%	1.16	31.4%	15,340
Downstream Equipment Water Heating	923	103%	0.02	1.3%	951
Downstream Equipment Appliances	308	100%	0.00	0%	308
Downstream Equipment Other	353	100%	0.00	0%	353
Downstream Subtotal[2],[3]	**16,056**	**106%**	**1.48**	**27.2%**	**16,952**
Audit	161	62%	0.16	4.7%	100
Weatherization	672	62%	3.00	92.3%	420
Audit and Weatherization Subtotal[3]	**833**	**62%**	**3.59**	**74.1%**	**520**
New Homes Subtotal[3]	**4,217**	**98%**	**0.06**	**2.8%**	**4,122**
Component Subtotal[3]	**21,106**	**102%**	**1.27**	**21.7%**	**21,593**
Unverified Online Marketplace	930	-	-	-	-
Unverified Instant Discount	3,454	-	-	-	-
Unverified Subtotal[3]	**4,385**	-	-	-	-
Total (Verified + Unverified)[3]	**25,491**	**-**	**-**	**-**	**21,593**
New Homes (PY13 verified in PY14)	2,933	98%	0.06	2.8%	2,867

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Cadmus used the PY13 historical realization rates for the Downstream Equipment subcomponent.
[3] Total may not match the sum of rows due to rounding.

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	0.81	107%	0.57	22.3%	0.87	0.95
Downstream Equipment Water Heating	0.08	100%	0.03	1.9%	0.08	0.08
Downstream Equipment Appliances	0.07	101%	0.00	0.0%	0.07	0.07
Downstream Equipment Other	0.12	101%	0.00	0.0%	0.12	0.13
Downstream Subtotal[2] [3]	**1.07**	**105%**	**0.64**	**16.4%**	**1.13**	**1.23**
Audit	0.01	64%	0.09	2.7%	0.01	0.01
Weatherization	0.13	95%	0.32	92.3%	0.12	0.14
Audit and Weatherization Subtotal [3]	**0.14**	**93%**	**0.47**	**9.2%**	**0.13**	**0.14**
New Homes Subtotal[3]	**1.43**	**63%**	**0.15**	**2.8%**	**0.90**	**0.98**
Component Subtotal[3]	**2.64**	**82%**	**0.57**	**9.1%**	**2.16**	**2.35**
Unverified Online Marketplace	0.09	-	-	-	-	-
Unverified Instant Discount	0.39	-	-	-	-	-
Unverified Subtotal[3]	**0.48**	**-**	**-**	**-**	**-**	**-**
Total (Verified + Unverified)[3]	**3.11**	**-**	**-**	**-**	**2.16**	**2.35**
New Homes (PY13 verified in PY14)	1.22	63%	0.15	2.8%	0.77	0.84

[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] Cadmus used the PY13 historical realization rates for the Downstream Equipment subcomponent.
[3] Total may not match the sum of rows due to rounding.

The following sections describe the factors that led to variation between the reported and verified savings and to the observed realization rates.

Audit and Weatherization

Energy and demand realization rates for the Audit and Weatherization subcomponent varied greatly from measure to measure and were less than 100% due to survey-verified inputs such as in-service rates (ISRs) and to findings from reviewing project documentation during desk reviews.

Audit Measures

Cadmus made the following adjustments to savings for audit measures.

- Cadmus updated ISRs for outlet gaskets, and advanced power strips using data from the PY14 participant survey. For kit measures for which there were not enough survey responses, Cadmus applied either a historical ISR or PA TRM default. Verified ISRs were lower than reported ISRs for many measures, which lowered the realization rate. Comparisons are shown in Table I-7.

Table I-7. Audit Measure *Ex Ante* to *Ex Post* ISR Comparison

Measure	*Ex Ante* ISR	*Ex Post* ISR
Globe LED	92%	92%
Reflector LED	92%	92%
Nightlight	76%	45%
Weatherstripping	72%	72%
Outlet Gasket	62%	24%
Advanced Power Strip	86%	45%
Bathroom Aerator	41%	28%
Kitchen Aerator	42%	28%
Pipe Insulation	62%	62%
Showerhead	44%	35%
Water Heater Setback	100%	27%

- Cadmus also used survey-verified values for electric water heating saturation, heating fuel saturation, cooling saturation, and climate region weights using a combination of the PY14 participant survey and the participant tracking database for customer ZIP code mapping. Updating the electric water heater saturation, heating fuel type, and cooling saturation had a positive impact on both energy and demand realization rates.
- For advanced power strips, Cadmus used survey data to determine end use (home entertainment or home office) and weighted evaluated savings accordingly. The verified power strip use resulted in slightly lower energy and demand savings relative to the unspecified end-use value the PA TRM used for *ex ante* and therefore had a slightly negative impact on the realization rate.

Weatherization

Cadmus compared survey responses to the participant tracking data and reviewed application forms and contractor invoices as part of the desk review process for weatherization measures. Cadmus made adjustments to savings for nine out of 23 sampled projects.

- Six projects showed HVAC system types in the participant tracking database that disagreed with survey data. Cadmus evaluated these projects using the customer-provided HVAC system types. For two projects, the participant tracking database showed air source heat pumps as the heating system, while the customer specified non-electric heating. Another project showed a heating system type of "other" in the participant tracking database; however, *ex ante* savings were calculated using electric resistance heating. Evaluated savings used a ductless heat pump, as it was specified in this participant's survey response.
- One project had a slightly higher value for total square footage of insulation in the participant tracking database than stated on the project invoice. Cadmus evaluated this project using the value from the invoice.
- The invoice for one project revealed that the scope of the project included the removal of existing insulation before installation of new insulation. The participant tracking database

showed the total R-value of existing insulation plus the added insulation, which was incorrect. Cadmus evaluated this project using the R-value of added insulation only from the invoice.

- One project was miscategorized as basement wall insulation in the participant tracking database, which led to high *ex ante* savings. The invoice showed that it was an attic insulation project. Square footage and insulation R-value from the invoice matched the tracking data. Cadmus evaluated this as an attic insulation project.

New Homes

The energy realization rate for the New Homes subcomponent was slightly less than 100% due to model adjustments of the sampled homes based on site visit data collection. Model adjustments were made for the following:

- Heating and cooling system capacity and/or efficiency to align with AHRI ratings
- Domestic hot water volume and/or energy factor (EF) to align with AHRI ratings
- Appliance energy use to align with ENERGY STAR ratings
- Percentage LED lighting to reflect on-site observations

One model included savings attributed to a solar PV system, but the site visit showed no solar PV system had been installed. Six of the 25 models did not undergo any adjustments.

The demand realization rate was 63%. The low realization rate was mainly due to a difference in the coincidence factor (used in *ex post* versus *ex ante* demand savings). For each home in the sample, Cadmus used the home's location to determine the reference city coincidence factor, as specified in the PA TRM Appendix A, and applied that to cooling equipment demand savings. The average coincidence factor was 0.406 for the site visit sample. Cadmus also calculated additional demand savings for lighting and appliances using PA TRM algorithms and default coincidence factors. The inclusion of lighting and appliance measures added an average of 0.038 kW per home, which raised the realization rate by 3.4%.

Other Site Visit Findings

The peak demand savings from lighting and appliances varied from home to home and depended on ENERGY STAR qualification, per the PA TRM, and whether the home builder installed the unit or if the owner purchased it after moving in. LED lighting contributed the most additional demand savings potential (up to 0.079 kW per home), but only about half of the fixtures in the sample were ENERGY STAR-rated. The potential for demand savings from appliances was smaller, led by clothes washers (0.013 kW/home) and refrigerators (0.011 kW/home), followed by dishwashers (0.007 kW/home) and clothes dryers (0.003 kW/home).

No heat pump water heater (HPWH) equipment was installed in the sampled homes. If installed, this equipment could provide up to an estimated 0.177 kW of additional demand savings per home. Electric resistance water heaters comprised 56% of the sampled homes.

I.2 Net Impact Evaluation

I.2.1 Net Impact Methodology

The common methods used to determine free ridership, spillover, and net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework.[55] Cadmus used online self-report surveys to assess free ridership and spillover for the Audit and Weatherization stratum.

Cadmus calculated net savings to inform future program planning. Energy savings and demand reduction compliance targets are met using verified gross savings. The New Homes stratum interviews were conducted in PY13 and are being reported for the first time in PY14 because PY13 savings were verified in PY14.

Table I-8 lists the methods and sampling strategy used to determine net savings for the Audit and Weatherization stratum in PY14 and New Homes stratum in PY13.

Table I-8. Energy Efficient Homes Component Net Impact Evaluation Sample Design

Stratum	Evaluation Year	Stratum Boundaries	Population Size	Achieved Sample Size	NTG Activity
Audit and Weatherization – Audit	PY14	Participants (Customers)	675(2)	13(3)	Participant online survey
Audit and Weatherization – Weatherization	PY14		663(2)	43(4)	
New Homes(1)	PY13	Participant Builders	66	16	Telephone in depth interview
Component Total			**1,404**	**72**	

(1) PY13 savings were verified in PY14. PY13 NTG results are applied to PY14 verified gross savings. PY13 NTG results were not reported in the PY13 evaluation.
(2) Number of participants in the PPL Electric Utilities' tracking database at the time of the PY14 survey, which occurred before the end of the program year.
(3) Achieved sample size is based on number of survey respondents answering the first free ridership question C4 , "Which of the following would have happened if you had not received the $[Field-Incentive] in-home audit rebate from PPL Electric Utilities?" and answering at least one of the questions from C5a to C5d, "Please rate the following items on how much influence each item had on your decision to complete [Field-MEASURE] project. Please use a scale from 1 to 5, 1 meaning no influence, and 5 meaning the item was extremely influential in your decision. C5a. The $[Incentive] rebate for the in-home audit, C5b. PPL Electric Utilities' information about energy efficiency, C5c. Information about the in-home audit program from your auditor before the in-home audit occurred, C5d. Information about saving energy provided by the auditor before the in-home audit occurred.
(4) Achieved sample size is based on number of survey respondents answering the first free ridership question C1 , "Which of the following would have happened if you had not received the $[Field-Incentive] [Field-MEASURE] rebate from PPL Electric Utilities?" and answering at least of one of the questions from C2a to C2b, "Please rate the following items on how much influence each item had on your decision to complete [Field-MEASURE] project. Please use a scale from 1 to 5, 1 meaning no influence, and 5 meaning the item was extremely influential in your decision. C2a. The $[Incentive] rebate for the [MEASURE], C2b. PPL Electric Utilities' information about energy efficiency.

[55] 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.

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-9 summarizes the intention, influence, and free ridership scores for each stratum.

Table I-9. Energy Efficient Homes Component Intention, Influence, and Free Ridership Score by Stratum

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Audit and Weatherization – Audit	13	20%	12%	32%
Audit and Weatherization – Weatherization	43	38%	20%	58%
New Homes	16	31%	5%	36%

Spillover

Table I-10 lists the quantity of spillover energy-efficient equipment types that the respondents for the Audit and Weatherization stratum attributed to PPL Electric Utilities. The table also lists the per-unit energy savings and source of the estimated energy savings used in the spillover analyses. No participant spillover activity was found through the PY13 New Homes stratum NTG analysis.

Table I-10. Energy Efficient Homes Component Spillover Products and Savings for Audit and Weatherization Stratum

Spillover Product	Audit and Weatherization Respondent Quantity	Per-Unit Savings (kWh/yr)	Savings Source
Air Conditioning Equipment	4[(1)]	332	PY14 PPL Electric Utilities Gross Verified Savings
Clothes Washer	4	95	2021 PA TRM
Dishwasher	3	23	2021 PA TRM
Insulation	25 square feet	0.57	PY14 PPL Electric Utilities Gross Verified Savings
Refrigerator	7	56	PY14 PPL Electric Utilities Gross Verified Savings
Smart Thermostat	1	541	PY14 PPL Electric Utilities Gross Verified Savings
Weather Stripping	1	5	PY14 PPL Electric Utilities Gross Verified Savings

[(1)] 50% of per-unit savings kWh/yr applied to one unit due to a maximum PPL Electric Utilities influence rating of three, on a 1 to 5 scale, with 1 meaning *not at all influential* and 5 meaning *extremely influential*.

Table I-11 shows the spillover results for the PY14 Audit and Weatherization stratum of the Energy Efficient Homes component.

Table I-11. Energy Efficient Homes Component Spillover Calculation for Audit and Weatherization Stratum

Variable	Variable Description	Audit and Weatherization Stratum	Source
A	Survey Sample Size (n)	56	Survey Data
B	Total Survey Sample Spillover kWh/yr Savings	2,559	Survey Data/Engineering Estimates
C	Average Spillover kWh/yr Savings Per Survey Respondent	45.7	Variable B ÷ Variable A
D	Program Component Participant Population	1,603[(1)]	Participant Tracking Data
E	Spillover kWh/yr Savings Extrapolated to the Participant Population	73,257	Variable C × Variable D
F	Evaluated Program Component Population kWh/yr Savings	519,636	Evaluated Gross Impact Analysis
G	Spillover Percentage Estimate	14%	Variable E ÷ Variable F

[(1)] 1,603 unique participants.

I.2.2 Net-to-Gross Results

Table I-12 shows the Audit and Weatherization stratum free ridership, spillover, and NTG ratios by substratum.

Table I-12. Energy Efficient Homes Component – Audit and Weatherization Stratum Net Impact Evaluation Results

Stratum	PYVTD kWh/yr	Evaluation Year	Free Ridership (%)[(1)]	Spillover (%)	NTG Ratio
Audit and Weatherization – Audit	99,511	PY14	32%	14%	0.82
Audit and Weatherization – Weatherization	420,124	PY14	58%	14%	0.56
Stratum Total [(2),(3)]	**519,636**	**-**	**53%**	**14%**	**0.61**

[(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)] Subcomponent-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 0.61 for the Audit and Weatherization stratum.

[(3)] Total may not match sum of rows due to rounding.

Table I-13 shows the NTG ratio results for the Audit and Weatherization, Downstream Equipment, and New Homes strata of the Energy Efficient Homes component. The overall Energy Efficient Homes component NTG ratio of 0.53 is heavily weighted towards the Downstream Equipment stratum NTG ratio of 0.51, as this stratum represents 79% of the Energy Efficient Homes component verified gross population energy savings.

Table I-13. Energy Efficient Homes Component NTG Ratio Summary

Stratum	PYVTD kWh/yr	Evaluation Year	Free Ridership (%)[1]	Spillover (%)	NTG Ratio
Audit and Weatherization	519,636	PY14	53%	14%	0.61
Downstream Equipment	16,951,704	PY13	50%	1%	0.51
New Homes	4,121,728	PY13	36%	0%	0.64
Component Total[3],[4]	**21,593,067**	**-**	**48%**	**1%**	**0.53**

[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] PY13 evaluated NTG ratios used for all downstream equipment stratum measures except for heat pump water heater measure. PY12 evaluated NTG ratio used for heat pump water heater measure.

[3] 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 0.53.

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

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, the ICSP's subcontractors, and HVAC distributors. The research objectives for the process evaluation were to assess participant satisfaction, review component changes and performance, assess component design and market actor experience, develop a logic model for the Midstream HVAC offering, and make recommendations for improvement. Table I-14 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 about Cadmus' approach to reducing survey bias and contact instructions.

Process activities were consistent with planned activities with a few exceptions. For the interview with the midstream equipment distributors, Cadmus contacted all participating distributors for an interview, but one was unable to participate due to recent staff changes, resulting in just one completed interview. Cadmus also completed two additional online surveys to measure customer satisfaction among Downstream Equipment and Online Marketplace subcomponent participants. The results from these surveys are included in the overall Energy Efficient Homes satisfaction score, found in Chapter 7, Section *7.5.1 Process Evaluation Key Findings* of this report.

For the Audit and Weatherization subcomponent survey, which was a planned process evaluation activity, a total of 68 respondents completed the online survey in April through May 2023 (26 Audit participants and 42 Weatherization participants). The Audit stratum includes respondents who received either an in-home audit or a virtual energy assessment. Where relevant, Cadmus distinguishes between these respondent groups in this report to explore their distinct experiences. 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 I-14. 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	3	3	100%
Component Participants	Weatherization	Online survey	663[3]	85/15	All eligible	42[4]	435	100%
	Audit	Online survey	675[3]	85/15	All eligible	26[4]	511	100%
	Downstream Equipment	Online survey	6,890[3]	85/15	All eligible	155[4]	2,739	100%
	Online Marketplace	Online survey	3,618[3]	85/15	All eligible	105[4]	3,257	100%
	Midstream Distributors	Telephone in-depth interview	2	85/15	All eligible	1	2	100%
Component Total			**11,851**	**-**	**-**	**332**	**6,947**	**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 PY14 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.

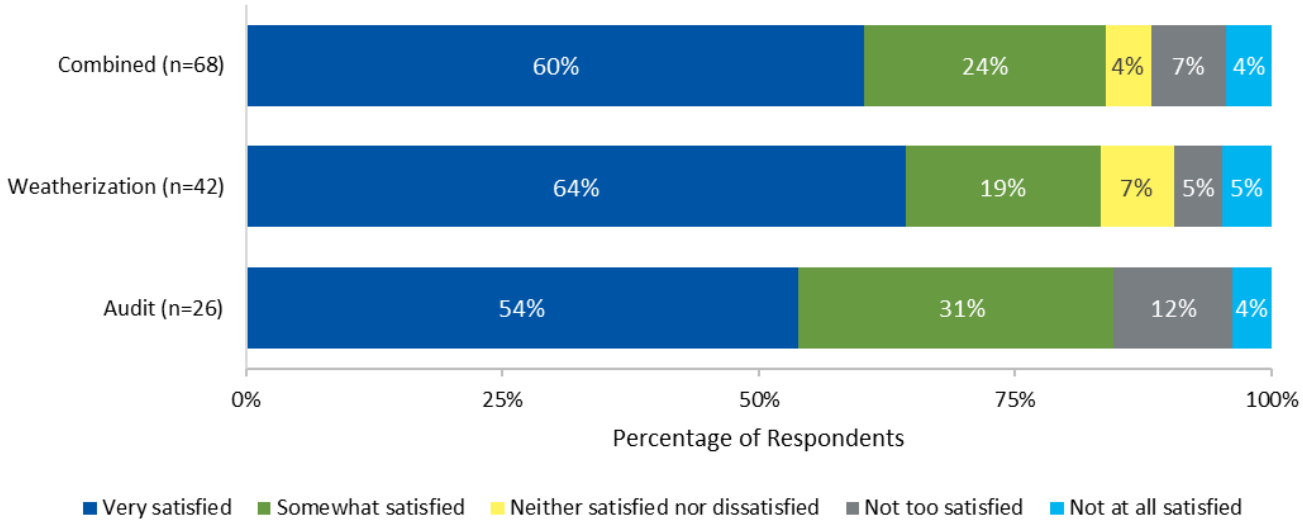
I.3.1 Program Component Experience

Audit and Weatherization respondents rated satisfaction with their experience with different aspects of this subcomponent, provided insights about their satisfaction ratings, and rated their likelihood to recommend the Energy Efficient Homes component and the effect of their participation on their opinion of PPL Electric Utilities.

Program Component Satisfaction and Customer Effort

Across the subcomponents, nearly all respondents were satisfied with their experience (Figure I-1), with 84% overall satisfaction (as measured by responses of *very* or *somewhat satisfied*; n=68).

Figure I-1. PY14 Overall Satisfaction with Energy Efficient Homes by Subcomponent



Source: Audit and Weatherization 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.

Audit

When asked how easy it was to participate, 22 Audit respondents said the process was *very easy* (n=8) or *easy* (n=14). When asked to rate the findings they received from the energy audit, six of those who participated in the in-home audit (n=11) said that the findings were *very useful*, and three said the findings were *somewhat useful*. Respondents who received a virtual assessment said the findings were less useful, with five respondents rating the findings as *very useful*, and six rating findings *somewhat useful* (n=15).

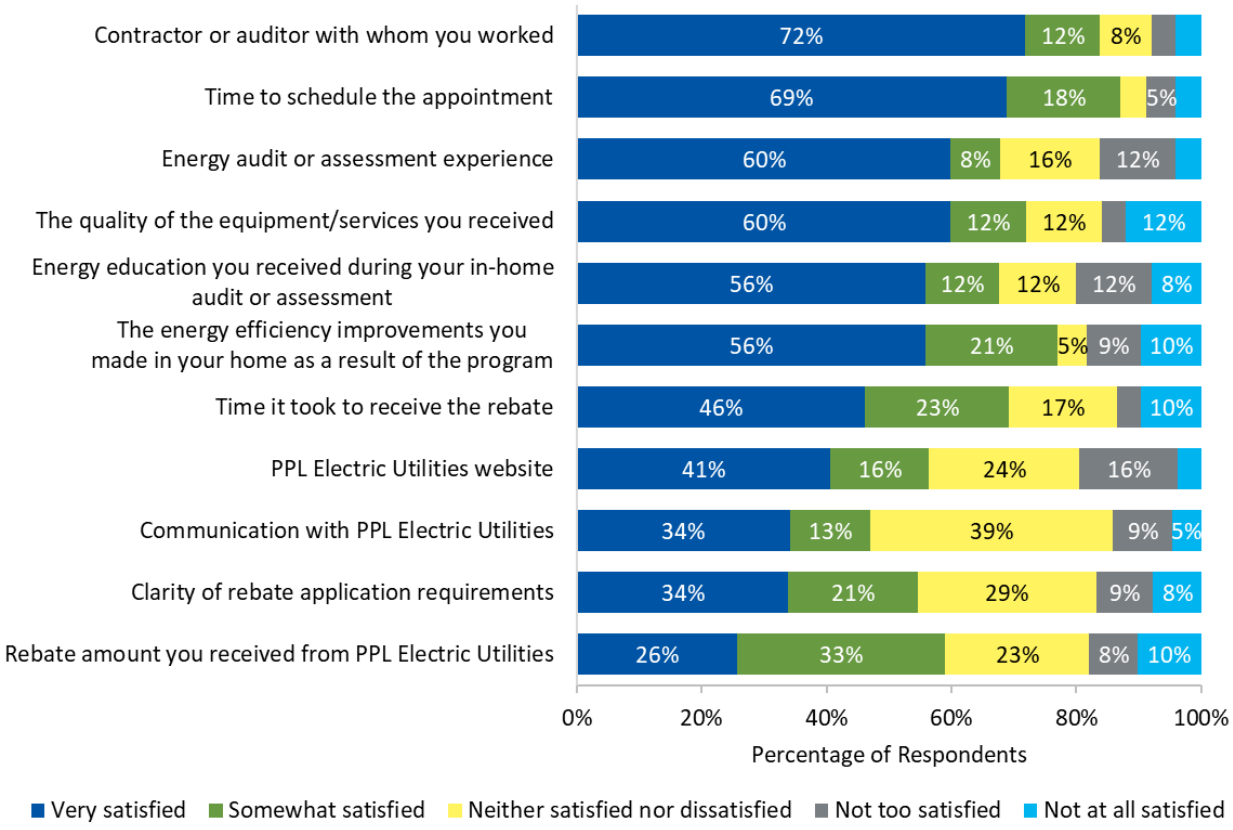
Regarding the implementation of recommended actions, one of the in-home audit respondents (n=11) reported that they had implemented the audit report's recommendations at the time of the survey, compared to five of virtual assessment respondents (n=14). Of the in-home audit respondents, seven had taken some of the recommended actions and planned to take others, while eight of virtual assessment respondents reported the same. Three of 11 in-home audit respondents had implemented

some recommendations but did not intend to take further actions. Only one virtual assessment respondent did not plan to take any of the recommended actions, citing that the recommendations lacked specificity.

Reasons for not pursuing some or all of the recommended actions varied among respondents who had undergone an in-home audit. One respondent mentioned financial constraints, stating that they could not afford the suggested actions. Another expressed satisfaction with the current energy efficiency of their home and that further improvements were unnecessary. One respondent did not think the recommendations provided aligned with their specific home requirements.

When asked about various elements of delivery, Audit respondents said they were *very* or *somewhat satisfied* with each subcomponent element at least 47% of the time (Figure I-2). Respondents were most satisfied with the time to schedule their appointment for an in-home audit or virtual assessment, with 87% (n=26) indicating they were *very* or *somewhat satisfied.*

Figure I-2. PY14 Satisfaction with Elements of the Audit Subcomponent

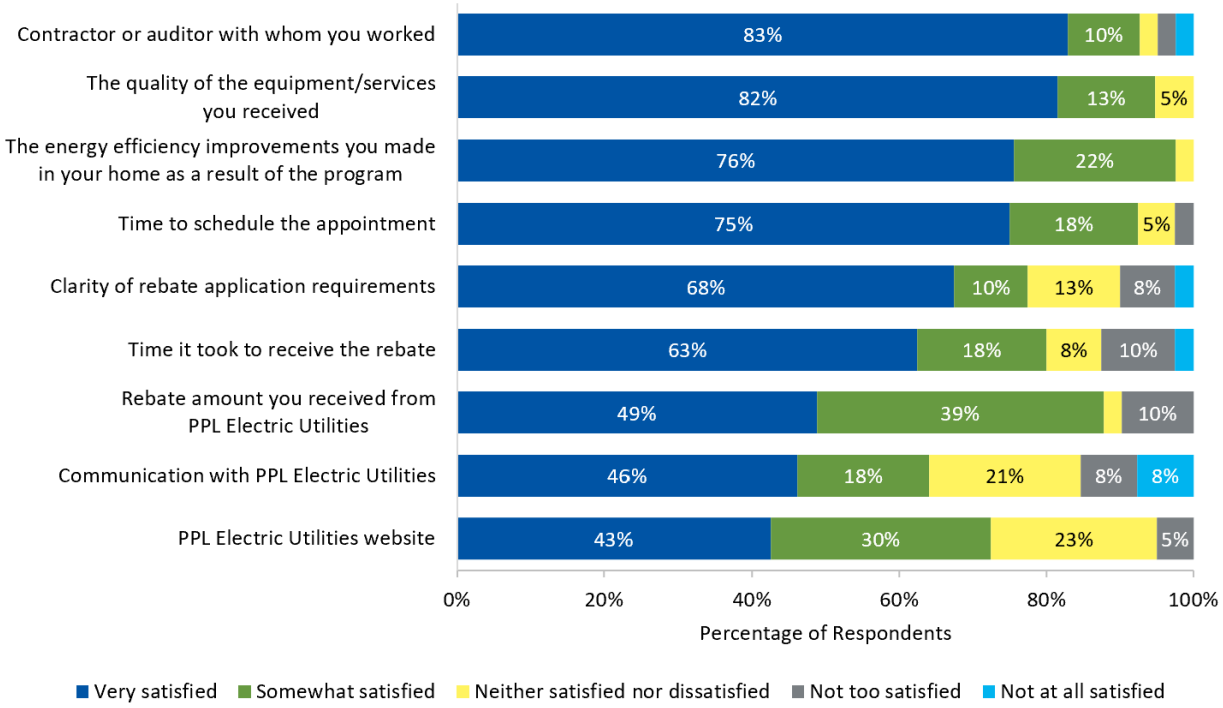


Source: Participant survey, "Thinking about the program, please indicate how satisfied you are with each element of your experience with your contractor, time to schedule the appointment, PPL Electric Utilities website, time it took to receive the rebate, rebate amount you received from PPL Electric Utilities, clarity of information about program requirements, communication with PPL Electric Utilities, quality of the services you received, energy efficiency improvements you made in your home as a result of the program, energy audit or assessment experience, energy education you received during your audit or assessment." Totals may not sum due to rounding. (n=24 to 26)

Weatherization

When asked how easy it was to participate, the majority of Weatherization respondents said the process was *very easy* (43%) or *easy* (41%) (n=42). When asked about various elements of delivery, Weatherization respondents said they were *very* or *somewhat satisfied* with each element at least 64% of the time (Figure I-3). Respondents were most satisfied with the contractor or auditor (93%), the quality of equipment/services they received (95%), and the energy efficiency improvements they made in their home as a result of their participation (98%).

Figure I-3. PY14 Satisfaction with Elements of the Weatherization Subcomponent



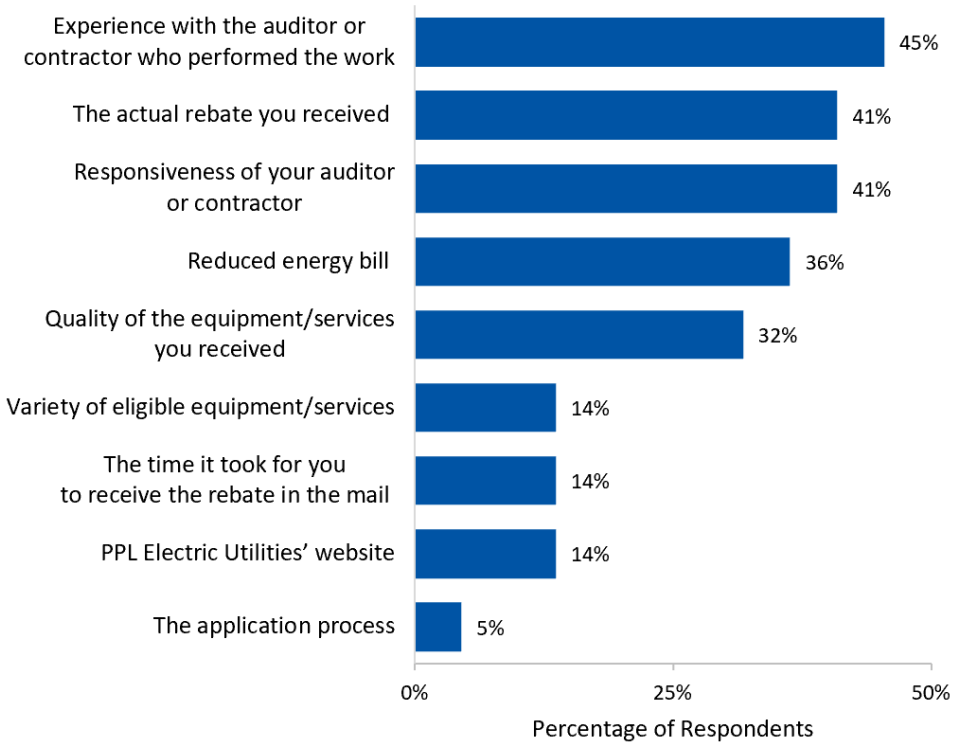
Source: Participant survey, "Thinking about the program, please indicate how satisfied you are with each element of your experience with your contractor, time to schedule the appointment, PPL Electric Utilities website, time it took to receive the rebate, rebate amount you received from PPL Electric Utilities, clarity of information about program requirements, communication with PPL Electric Utilities, quality of the services you received, energy efficiency improvements you made in your home as a result of the program." Totals may not sum due to rounding. (n=37 to 40)

Drivers of Program Component Satisfaction

To better understand what drives satisfaction, the survey asked participants of the Audit and Weatherization subcomponent what factor or factors led to their satisfaction rating. In Audit, shown in Figure I-4, of 22 respondents who rated their satisfaction with the component as *very* or *somewhat satisfied*, top drivers of high satisfaction were the experience with the auditor or contractor who performed the work (45%), rebates they received (41%), and responsiveness of the auditor or contractor (41%). Respondents could cite multiple factors, so percentages add to over 100%.

Four Audit respondents said that they were *neither satisfied nor dissatisfied*, *not too satisfied*, or *not at all satisfied* with their overall experience due to various factors such as the experience with the auditor or contractor, the quality of the equipment or services provided, the limited variety of eligible equipment or services, and the perceived lack of a reduction in their energy bill (one response for all factors). In their own words, one respondent specifically mentioned not finding the audit or assessment valuable, and another expressed dissatisfaction with the items included in the kit.

Figure I-4. Audit Drivers of High Satisfaction

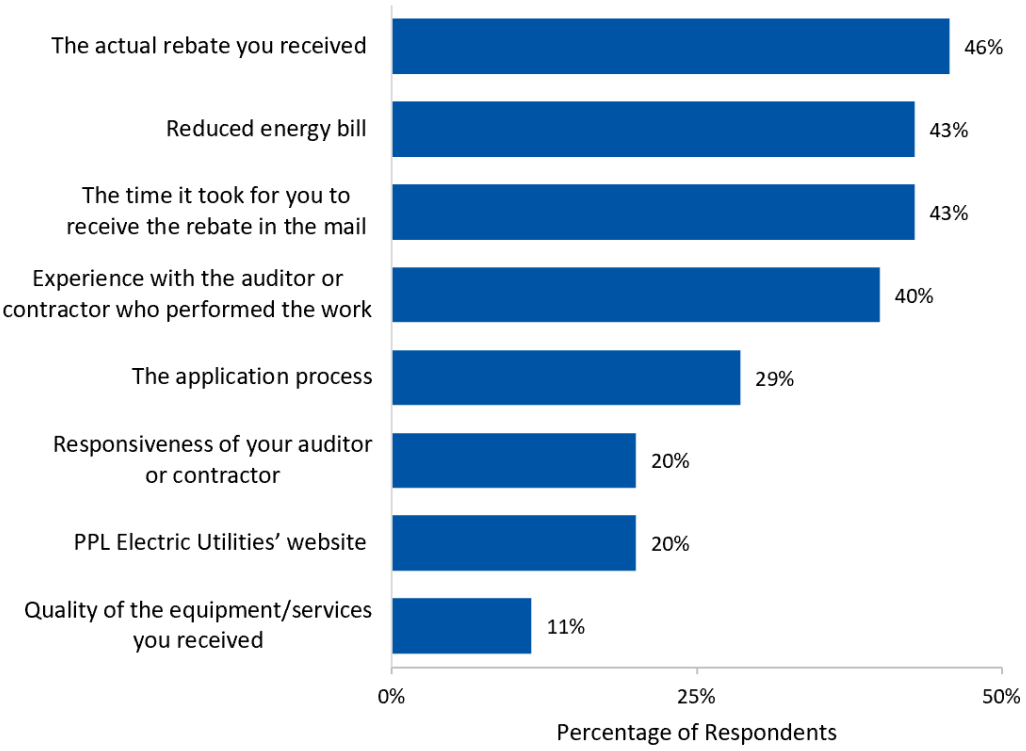


Source: Participant survey, "What factor(s) most affected the overall experience rating you gave?" (n=22; multiple responses allowed) Analysis reflects respondents who rated their overall satisfaction with the component *very* or *somewhat satisfied*.

For satisfied Weatherization respondents (n=35), drivers of high satisfaction were the rebates (46%), the reduced energy bill (43%), and the short time it took to receive the rebate in the mail (43%), as shown in Figure I-5. The findings highlight the importance customers place on rebates, cost savings through lower energy bills, and positive interactions with professionals.

For the seven respondents who were *neither satisfied nor dissatisfied*, *not too satisfied*, or *not at all satisfied* with their overall experience, top drivers for the low rating were related to the application process (three respondents), the reduced energy bill (or lack of a reduction in their bill) (three respondents), the PPL Electric Utilities' website (two respondents), and the time it took to receive the rebate in the mail (two respondents). Respondents could cite more than one factor as a reason for their satisfaction rating.

Figure I-5. Weatherization Drivers of High Satisfaction



Source: Participant survey, "What factor(s) most affected the overall experience rating you gave?" (n=35; multiple responses allowed) Analysis reflects respondents who rated their overall satisfaction with the component *very* or *somewhat satisfied.*

Opinion of PPL Electric Utilities and Likelihood to Recommend

Offerings in the Audit and Weatherization subcomponent had an impact on how customers view PPL Electric Utilities. Forty-five percent of Audit respondents (n=27) and 50% of Weatherization respondents (n=42) 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.

A majority of respondents were likely to recommend the Energy Efficient Homes component to a friend, family member, or colleague—65% of Weatherization respondents (n=43) and 56% of Audit respondents (n=27).[56]

Midstream HVAC Distributor Satisfaction and Market Insights

In PY13 and PY14, PPL Electric Utilities began recruiting HVAC distributors to participate in the new midstream offering, which incentivizes distributors for qualifying sales of high-efficiency air source heat pumps and ductless mini-splits. Cadmus interviewed one of two distributors who indicated interest in the delivery channel in early PY14. The other distributor declined the interview due to recent staff changes. The distributor who was interviewed was *very satisfied* with their experience with the Energy

[56] As measured by a rating of 9 or 10 on a scale of 0 to 10, where 0 is not at all likely and 10 is extremely likely.

Efficient Homes Midstream HVAC Equipment offering, noting that the ICSP had been very responsive and helpful with the onboarding process. However, this distributor had not made any eligible sales through the delivery channel and therefore had limited feedback on how it was running. The respondent said that their business unit tends to focus on refrigeration, but that they saw the PPL Electric Utilities midstream delivery channel as an opportunity to grow their HVAC business and hoped the midstream delivery channel could help them establish a stronger HVAC presence in the region.

Challenges with Selling Qualifying Equipment through the Midstream Channel

Cadmus asked about challenges the distributor had encountered, particularly related to completing qualifying sales. The respondent expressed the desire for higher incentives to enhance participation and explained that they do not typically carry SEER-16 units, do very few sales annually, and that sales of high-efficiency heat pumps are low because their market does not demand it.

Program Component Promotion and Training

When asked about plans to promote the PPL Electric Utilities residential Midstream HVAC Equipment offering to contractors and any marketing strategies they intend to employ, the distributor did not have any specific plans, noting that they believed that PPL Electric Utilities would provide marketing materials.

Improvement Suggestions

Cadmus asked survey respondents what PPL Electric Utilities could do to improve the Energy Efficient Homes component. Not all respondents had a suggestion.

For the Audit, 10 respondents (n=24) made a suggestion and, of these, four suggested expanding the product selection and three suggested improving customer service and communication about the application and component. Other suggestions were related. Four respondents asked that PPL Electric Utilities expand the eligibility guidelines for qualifying products or equipment, and one asked that PPL Electric Utilities simplify the application process or rebate process. One respondent encouraged PPL Electric Utilities to improve contractor performance.

For the Weatherization, 21 respondents (n=40) made a suggestion and, of these, nine suggested increasing the amount of the rebates or the number of rebates available. Six respondents suggested improving customer service and communication about the application and component, and three asked that PPL Electric Utilities simplify the application process or rebate process. Another two asked that PPL Electric Utilities expand the eligibility guidelines for qualifying products or equipment. One respondent encouraged PPL Electric Utilities to improve its website performance.

I.3.2 Other Findings

Participant Profile and Survey Sample Attrition

Audit and Weatherization

The PY14 surveys collected demographic information about participants in the Audit and Weatherization subcomponent. Respondents had the following characteristics:

- Lived in a single-family detached residence (73%; n=62)
- Had an average household size of 2.4 people (n=62)
- Averaged 62 years of age (n=59)
- Had completed some college education or more (86%; n=62)
- Had an annual household income of $50,000 or greater (50%; n= 52)

Table I-15 lists the total number of records contacted via online survey and the outcome (final disposition) of each record. Additional details on survey methodology are in ***Appendix L.***

Table I-15. Energy Efficient Homes Online Participant Survey Sample Attrition

Description of Outcomes of Online Participant Survey	Number of Records	
	Audit	Weatherization
Population (number of unique jobs)	**675**	**663**
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on “do not contact” list	145	167
Removed: incomplete or invalid email address or phone number	19	61
Survey Sample Frame (records attempted)	**511**	**435**
Not reached or non-working: Opted out, email returned (bounce back), did not respond	437	387
Partially completed survey; ineligible for survey	48	6
Completed Surveys (online)	**26**	**42**
Overall Response Rate	**5%**	**9%**

Midstream

Table I-16 lists the total number of records contacted via telephone and the outcome (final disposition) of each record.

Table I-16. Energy Efficient Homes Distributor Interview Sample Attrition

Description of Outcomes of Telephone Interviews	Number of Records
Population (Number of Unique Records)	**2**
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on “do not contact” list, incomplete or invalid email address or phone number	**0**
Survey Sample Frame (Records Attempted)	**2**
Refused	1
Completed Interviews	**1**
Overall Response Rate	**50%**

I.3.3 Logic Model

Cadmus created a logic model for the Midstream HVAC component based on interviews with the program managers from PPL Electric Utilities and the ICSP and on secondary research. The logic mode is shown in Table I-17. Because there was no participation in the Midstream HVAC offering in PY14, Cadmus did not review the performance or operation against the logic model.

Table I-17. Midstream HVAC Subcomponent Logic Model

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
• Cost of high-efficiency HVAC equipment • Distributors not stocking or promoting high-efficiency HVAC equipment	• Incentives paid to distributors, which are passed on to purchasers as point-of-purchase discounts • Engage distributors through training and technical support to stock and promote HVAC equipment • Support distributors with a payment for additional administrative workload to participate in the program subcomponent	• Qualified HVAC products are purchased from participating distributors and installed by market actors • Program tracking data and participant data are collected from distributors and maintained for evaluability • Distributors communicate the discount to contractors and dealers through various promotional activities, such as kickoff meetings, promotions, and announcements	• Participating distributors stock and sell more qualifying equipment • Contractors purchase more qualifying equipment due to instant discount and education • Energy savings and peak demand reduction accrue through installation of efficient equipment • Increased awareness among distributors and contractors • Increased distributor and contractor knowledge of high efficiency HVAC options	• PPL Electric Utilities is trusted resource for energy efficiency information • Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements • Distributors and contractors engage in word-of-mouth marketing to others related to the subcomponent	• Distributors in Pennsylvania stock and sell more high-efficiency HVAC equipment due to an increase in demand among customers and contractors • Broad market awareness, supply, and demand of high-efficiency HVAC • Improved energy grid resilience

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.

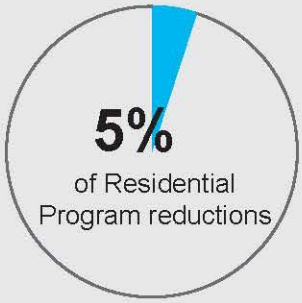
VERIFIED ENERGY SAVINGS

Phase IV
has saved
4,797 MWh/yr

*PY14 will be verified in PY15

VERIFIED DEMAND REDUCTIONS

Phase IV has
reductions of
0.47 MW/yr



*PY14 will be verified in PY15

PY14 PARTICIPATION

A total of **20,194** participants

5,057 Bright Kids (2nd – 3rd grades)

10,137 Take Action (5th – 7th grades)

5,000 Innovation (9th – 12th grades)

PARTICIPANT SATISFACTION

Satisfied with overall program component

99% Teachers

94% Bright Kids (2nd – 3rd grades)

85% Take Action (5th – 7th grades)

77% Innovation (9th – 12th grades)

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 or 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. (In PY14, activities extended into February 2023.) Students receive educational materials and a take-home kit of energy-saving items to install at home. The kits are tailored to each grade level participating in the component.

Compared to PY13 when teachers could choose between in-person and virtual presentations, the component ceased to offer virtual presentations in PY14. In PY14, the SEEE component also revised items in the energy-savings kits.

The SEEE component provides kits to students in three cohorts:

- Bright Kids (2nd – 3rd grades)
- Take Action (5th – 7th grades)
- Innovation (9th – 12th grades)

Table J-1 shows the kit items by cohort. Each kit included installation instructions and a cross-promotional insert of other program components offered by PPL Electric Utilities for residential customers. New for all cohorts in PY14 were dusk-to-dawn bulbs for exterior applications that have a sensor to turn on when light is low. The kits for the Bright Kids cohort also included a card communicating water heater setback instructions, while the Take Action kits added a second nightlight in PY14.

Table J-1. Energy-Savings Items by Cohort

Cohort	Kit Items[1]
Bright Kids	LED nightlight, Tier 1 advanced power strip, dusk-to-dawn bulb
Take Action	2 LED nightlights, kitchen aerator, showerhead, Tier 1 advanced power strip, furnace filter whistle, weatherstripping (17 ft), hot water pipe insulation (3 ft), 10 outlet gaskets, dusk-to-dawn bulb
Innovation	Kitchen aerator, bathroom aerator, showerhead, Tier 1 advanced power strip, furnace filter whistle, weatherstripping (17 ft), hot water pipe insulation (3 ft), 10 outlet gaskets, dusk-to-dawn bulb

[1] All cohorts also received a card that included instructions for setting back water heater temperatures.

Each kit distributed is counted as a participant and is recorded in CLEAResult's 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. Teachers are also requested to complete evaluation forms following their participation.

The ICSP subcontracted with National Energy Foundation (NEF), whose responsibilities included recruiting schools and teachers, creating curricula correlated with Pennsylvania academic standards, securing support of the component by the Pennsylvania Department of Education. As in PY13, Energy Federation Incorporated is the vendor responsible for assembling and delivering kits to schools. The ICSP provides 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 developed a combined two-year sampling approach to evaluate PY14 and PY15. Cadmus will not report verified savings from PY14 until the completion of the combined PY14/PY15 impact analysis.

J.1.2 Gross Impact Results

Table J-2 shows the Student Energy Efficient Education component's verified gross energy savings and demand reductions.

Table J-2. Student Energy Efficient Education Component Savings

Savings	PY13 Verified	PY14 Unverified	Phase IV Verified [1]
MWh/yr	4,797	5,434	4,797
System-Level MW/yr	0.47	0.52[2]	0.47

[1] Phase IV verified savings includes only PY13 results since Cadmus left PY14 savings unverified.
[2] This does not include line losses. These are applied to verified reductions only.

In PY14, the SEEE component reported energy savings of 5,434 MWh/yr, as shown in Table J-3, and demand reductions of 0.52 MW/yr, as shown in Table J-4. Savings for PY14 are unverified and will be verified in PY15.

Table J-3. Student Energy Efficient Education Component Gross Impact Results for Energy

Stratum	PYRTD MWh/yr
Bright Kids	555
Take Action	3,208
Innovation	1,671
Component Total [1]	**5,434**
[1] Total may not match the sum of rows due to rounding.	

Table J-4. Student Energy Efficient Education Component Gross Impact Results for Demand

Stratum	PYRTD MW/yr
Bright Kids	0.05
Take Action	0.30
Innovation	0.16
Component Total [1]	**0.52**
[1] Total may not match the sum of rows due to rounding.	

J.2 Net Impact Evaluation

The SEEE component is offered specifically to schools. The kits are provided free of charge to teachers, who include the kits as part of the school's curriculum and in turn give the kits to their students to take home. No free riders are anticipated because Cadmus does not expect teachers nor the households to 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 a net-to-gross ratio of 1.0.

J.3 Process Evaluation

In PY14, Cadmus conducted a process evaluation of the SEEE component to assess student participant satisfaction and teacher satisfaction and assess what is working well and what could be improved. The evaluation activities were consistent with the planned activities. Table J-5 lists the process evaluation sampling strategy. Completed HEWs produced a measure of component satisfaction with ±0.49% 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-5. 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	2[3]	N/A	100%
Students	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered paper and online HEWs	20,194	N/A[2]	All surveys returned	14,500[4]	All available	100%[2]
Teachers	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered Teacher evaluation forms	764[5]	N/A[2]	All surveys returned	124	All available	100%
Component Total			**20,961**	**-**	**-**	**14,626**	**-**	**-**

[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] Due to turnover, the NEF contact for the main portion of PY14 was not available at the time of the interview.
[4] Sample size represents the number of returned HEWs with the satisfaction question answered, which may differ from the number of HEWs used for the Impact evaluation.
[5] 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, 86% of participants were satisfied with their experience with the SEEE component in PY14, as shown in Table J-6. 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 participate compared to the smaller number of teachers. Overall satisfaction across participating teachers and students rose significantly in PY14 compared to PY13 (p<0.0001).

Table J-6 PY14 Satisfaction for the SEEE Component

Stratum	Overall Satisfaction[(1)]
Students (n=14,500)	86%
Teachers (n=124)	99%
Overall Satisfaction	86%

[(1)] As measured by a rating of *very* or *somewhat satisfied*

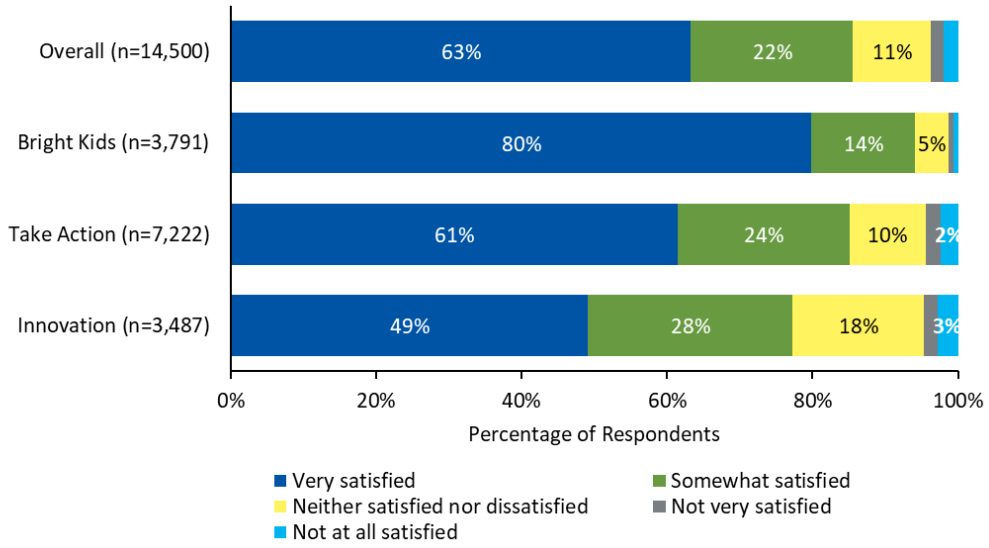
The ICSP's subcontractor, NEF, includes a satisfaction question on the student HEW and on the evaluation form distributed to participating teachers. In PY14, the question wording and response scale for overall satisfaction with the component in the teacher evaluation forms changed to align with the response scale in the student HEWs. Cadmus measured overall satisfaction via a five-point rating scale for both students and teachers (*very satisfied*, *somewhat satisfied*, *neither satisfied nor dissatisfied*, *not very satisfied*, or *not at all satisfied*).

Student Satisfaction

Student participants completed HEWs, either online or on paper forms that teachers could copy and distribute. Of the 20,194 student participants, 14,500 (72%) completed HEWs and answered the satisfaction question. Figure J-1 summarizes the results by cohort. Of the students who responded to the question, 86% said they were *very satisfied* (63%) or *somewhat satisfied* (22%) with the component overall.[57] By cohort, satisfaction ranged from 77% *very satisfied* or *somewhat satisfied* for the cohort with the oldest students, Innovation, to 85% for Take Action, and 94% for Bright Kids. Compared to PY13 (80%), overall satisfaction among participating students increased significantly in PY14 (p<0.0001).

[57] Using a higher precision than presented in Figure J-1, the sum of *very satisfied* (63.23%) and *somewhat satisfied* (22.33%) adds to 86%.

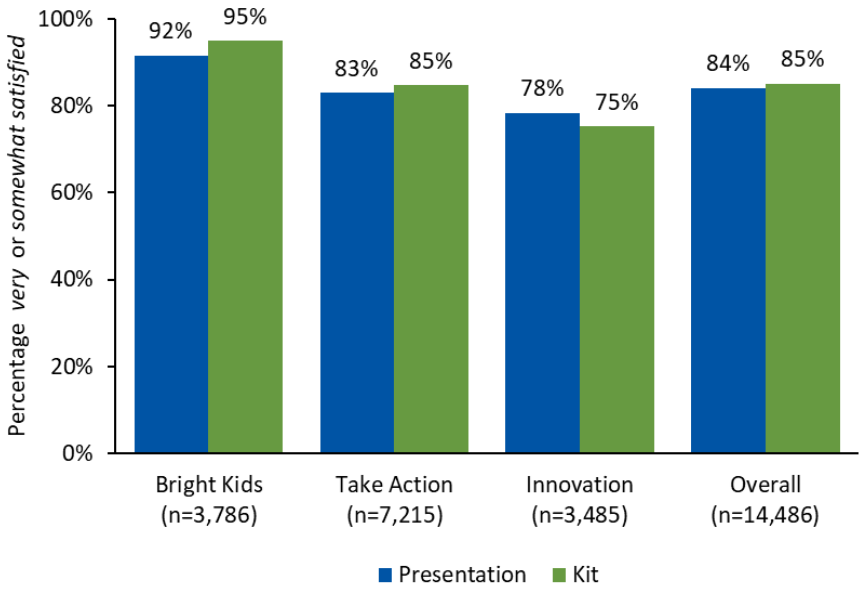
Figure J-1. PY14 Overall Student Satisfaction by Cohort



Source: Home Energy Worksheet Q11 (Bright Kids), Q25 (Take Action), and Q25 (Innovation): "Please rate your overall satisfaction with the Think! Energy program." Total may not sum to 100% due to rounding. Sum of *very* and *somewhat satisfied* may not match percentage reported on infographic due to rounding.

Starting in PY14, the HEWs included separate satisfaction ratings questions for the presentation and the kit. Of the students who responded to the questions, a similar proportion said they were *very satisfied* or *somewhat satisfied* with the presentation (84%) as the kit (85%), generally tracking with overall satisfaction with the component (Figure J-2).

Figure J-2. PY14 Student Satisfaction with Presentations and Kits by Cohort



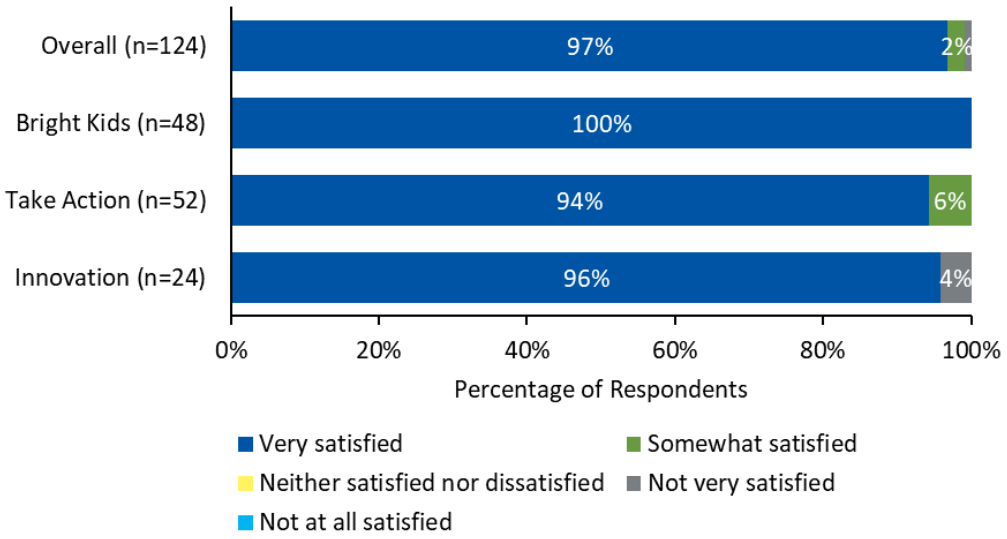
Source: Home Energy Worksheet Q9 (Bright Kids), Q23 (Take Action), and Q23 (Innovation): "How satisfied are you with the presentation?" and Q10 (Bright Kids), Q24 (Take Action), and Q24 (Innovation): "How satisfied are you with the energy efficiency kit?"
Not all HEW respondents answered each question.

Teacher Satisfaction

After participating in the teacher's classroom presentation, NEF asked teachers to rate delivery of the SEEE component. Of 764 participating teachers in PY14, 16% (124 teachers) completed evaluation forms and provided a rating.

Figure J-3 summarizes the results of teacher satisfaction. Nearly all teachers who responded to the survey rated the component as either *very satisfied* (97%) or *somewhat satisfied* (2%) (n=124). Teachers of the Bright Kids cohort rated their impression of the component as *very satisfied* (100%) more often than did teachers of the Take Action and Innovation cohorts (94% and 96%, respectively).

Figure J-3. PY14 Participating Teacher Satisfaction with Student Energy Efficient Education Component Overall



Source: Teacher Evaluation Q5: "Please share your impression of Think! Energy Program – Overall Experience."

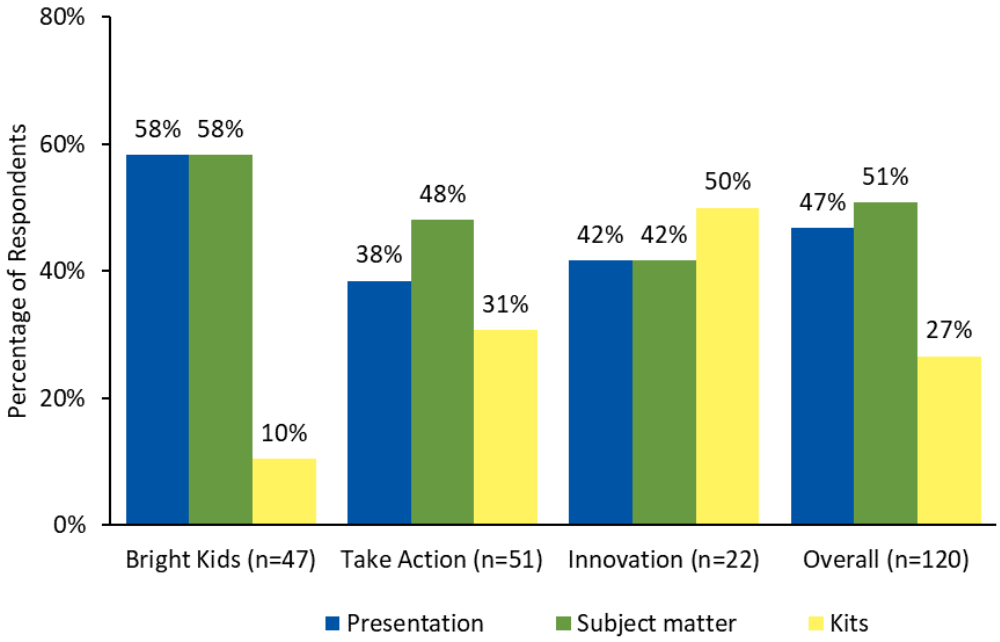
Teacher Feedback

The evaluation forms invited teachers to provide open-ended comments about their experience with the component and teachers left overwhelmingly positive comments. Cadmus identified and categorized comments into four common topics that reflected compliments on different aspects of the component, allowing more than one topic per teacher. The most common comments across teachers from all cohorts were positive feedback on the subject matter covered by the component (51% of respondents) and compliments on the quality of the presentation (47%), followed by usefulness of the kits (27%). Figure J-4 summarizes the results by cohort. The presentation received

> "The program is interactive, just the right length and kids enjoy it. This is one of the best programs I've ever had in school for my kids. The kids love it and it empowers them to be part of the conservation of energy solution!"
> *-Take Action Teacher*

more compliments among teachers with younger-aged students, whereas the kit received more positive comments among Innovation classroom teachers.

Figure J-4. PY14 Positive Teacher Comments by Topic and Cohort



Source: Teacher Evaluation Form synthesized responses to Q8: "What would you tell other teachers about the program?"; Q9: "What would you tell the sponsor about the program?"; and Q10: "Additional comments and suggestions." Totals sum to more than 100% due to respondents citing more than one topic; not all respondents answered each question in the teacher evaluation form.

When teachers expressed appreciation for the content provided by the component, they were grateful that the component promoted responsible energy use, that the subject matter was practical, and that it supplemented their existing curriculum:

- "This program is vital for helping young energy users to understand their environment and how they can best take care of what they're given!" [Bright Kids]
- "A great way to get kids thinking about conserving energy and become adults who care about protecting our environment! Thank you for providing this opportunity for our students to learn about being responsible energy users!" [Take Action]
- "My students were excited to learn ways to help their families save money. We are currently working on a Global Innovation project with Ignite My Future and this tied right into our project. Thank you for reaching out to our students in urban schools and educating them on ways to save money in their homes." [Take Action]
- "We extended the lesson with a craft, photo, and writing summary."[Bright Kids]
- "It's a great program and covers science standards covered on state test." [Take Action]

- "It is a great program to supplement a unit on Natural Resources or Electricity in a science class." [Innovation]

In PY14, teachers provided particularly high marks on the quality of the presentations, noting specifically how engaging the presenters were and how well they connected with the students, especially compared to other years:

- "Susan and Mary Lou were phenomenal. They held the student's attention…I look forward to the presentation again next year." [Bright Kids]
- "Great job by presenters. They care and are passionate about their topic. Loved it!" [Bright Kids]
- "This was an excellent assembly; the kids really got into the new format with videos and such…The presenters we had this year were PHENOMENAL. We've been doing this assembly for many years, and the presenters really make or break it—these two were hands down the best we've ever seen." [Take Action]
- "Our presenter was top notch. I was really impressed with his ability to control the pace and deliver a great presentation to our students." [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*

Suggested Improvements

In PY14, teachers had few suggestions for improvement which slightly contrasted with PY13 when some participating teachers suggested improving the interactivity of presentations and expressed that they missed receiving the LED light bulbs. In PY14, one teacher noted that the pipe wrap did not fit well into the bags, which led to some disruption among students in the Innovation cohort. A teacher in the Bright Kids cohort wished for a return of the circuit activity. One teacher suggested that teachers should also receive a kit.

J.3.2 Other Findings

Survey Participant Profile

The PY14 HEWs collected demographic information about participants in the SEEE component. Respondents had the following characteristics:

- Lived in a single-family detached residence (79%; n=14,520)
- Had an average household size of 4.6 people (n=14,527)

Appendix K. Net Savings Impact Evaluation

K.1 Downstream 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,[58] 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 was multiplied by the participant's respective *ex post* kWh/yr savings to calculate intention-based free rider savings.

[58] 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 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,[59] 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 non-residential 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.

[59] 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 in PY14 either in PY13 or PY14, depending on when they were finalized.

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 population.

Appendix M. Non-Energy Benefits

Cadmus quantified non-energy benefits in accordance with the Phase IV TRC order.[60]

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 total resource cost (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 electric distribution companies (EDCs) should continue to include fossil fuel benefits, consistent with the 2016 TRC Test and the 2018 guidance memo.[61]

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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[60] 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.

[61] SWE. *Guidance on the Inclusion of Fossil Fuel and H_2O Benefits in the TRC Test*. March 25, 2018.