

## PPL Electric Utilities Annual Report to the Pennsylvania Public Utility Commission

**PHASE IV OF ACT 129 PY13 ANNUAL REPORT  
(JUNE 1, 2021 – MAY 31, 2022)  
FOR PENNSYLVANIA ACT 129 OF 2008  
ENERGY EFFICIENCY AND CONSERVATION PLAN**



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**Prepared for:**  
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November 30, 2022 (Revised)

## Table of Contents

<b>1</b>	<b>Introduction.....</b>	<b>1</b>	6.4	Verified Savings Estimates.....	46
1.1	Executive Summary.....	3	6.5	Process Evaluation.....	47
<b>2</b>	<b>Summary of Achievements .....</b>	<b>6</b>	6.6	Program Finances and Cost-Effectiveness Reporting	50
2.1	Carryover Savings from Phase III of Act 129.....	6	6.7	Status of Recommendations .....	52
2.2	Phase IV Energy Efficiency Achievements to Date .....	7	<b>7</b>	<b>Residential Program .....</b>	<b>54</b>
2.3	Phase IV Performance by Customer Segment.....	10	7.1	Participation and Reported Savings by Customer Segment .....	55
2.4	Summary of Participation by Program .....	12	7.2	Gross Impact Evaluation.....	56
2.5	Summary of Impact Evaluation Results.....	14	7.3	Net Impact Evaluation .....	58
2.6	Summary of Energy Impacts by Program .....	14	7.4	Verified Savings Estimates.....	59
2.7	Summary of Peak Demand Reduction Impacts by Program .....	15	7.5	Process Evaluation.....	59
2.8	Summary of Fuel Switching Impacts .....	18	7.6	Program Finances and Cost-Effectiveness Reporting	62
2.9	Summary of Cost-Effectiveness Results .....	18	7.7	Status of Recommendations .....	65
2.10	Comparison of Performance to Approved EE&C Plan	20	<b>Appendix A. Site Inspection Summary.....</b>	<b>A-1</b>	
2.11	Findings and Recommendations .....	22	<b>Appendix B. PY13 and P4TD Summary by Customer Segment and LI Carveout.....</b>	<b>B-1</b>	
<b>3</b>	<b>Portfolio Finances and Cost Recovery .....</b>	<b>24</b>	<b>Appendix C. Summary of Program-Level Impacts, Cost-Effectiveness, and High-Impact Measure NTG .....</b>	<b>C-1</b>	
3.1	Program Finances.....	24	<b>Appendix D. Evaluation Detail – Efficient Equipment Component.....</b>	<b>D-1</b>	
3.2	Cost Recovery.....	24	<b>Appendix E. Evaluation Detail – Custom Component.....</b>	<b>E-1</b>	
<b>4</b>	<b>Evaluation Activities .....</b>	<b>26</b>	<b>Appendix F. Evaluation Detail – Low-Income Program .....</b>	<b>F-1</b>	
4.1	Impact Evaluation .....	26	<b>Appendix G. Evaluation Detail – Appliance Recycling Component.....</b>	<b>G-1</b>	
4.2	Process Evaluation .....	28	<b>Appendix H. Evaluation Detail – Efficient Lighting Component.....</b>	<b>H-1</b>	
<b>5</b>	<b>Non-Residential Program.....</b>	<b>30</b>	<b>Appendix I. Evaluation Detail – Energy Efficient Homes Component.....</b>	<b>I-1</b>	
5.1	Participation and Reported Savings by Customer Segment .....	31	<b>Appendix J. Evaluation Detail – Student Energy Efficient Education Component .....</b>	<b>J-1</b>	
5.2	Gross Impact Evaluation.....	31	<b>Appendix K. Net Savings Impact Evaluation .....</b>	<b>K-1</b>	
5.3	Net Impact Evaluation.....	33	<b>Appendix L. Survey Bias .....</b>	<b>L-1</b>	
5.4	Verified Savings Estimates .....	34	<b>Appendix M. Non-Energy Benefits .....</b>	<b>M-1</b>	
5.5	Process Evaluation .....	34			
5.6	Program Finances and Cost-Effectiveness Reporting	37			
5.7	Status of Recommendations .....	39			
<b>6</b>	<b>Low-Income Program.....</b>	<b>41</b>			
6.1	Participation and Reported Savings by Customer Segment .....	43			
6.2	Gross Impact Evaluation.....	44			
6.3	Net Impact Evaluation.....	46			

## Figures

Figure 1-1. Portfolio-Level Program Satisfaction <i>Very</i> and <i>Somewhat Satisfied</i> Combined.....	5
Figure 2-1. Carryover Savings from Phase III of Act 129 .....	6
Figure 2-2. Low-Income Carryover from Phase III.....	7
Figure 2-3. EE&C Plan Performance Toward Phase IV Portfolio Compliance Target (MWh/yr) .....	8
Figure 2-4. EE&C Plan Performance Toward Phase IV Portfolio Compliance Target (MW/yr).....	9
Figure 2-5. EE&C Plan Performance Toward Phase IV Low-Income Compliance Target.....	10
Figure 5-1. PY13 Non-Residential Program Overall Satisfaction .....	36
Figure 6.1. Drivers of High Program Satisfaction .....	49
Figure 7-1. PY13 Residential Program Overall Satisfaction .....	61
Figure D-1. PY13 Efficient Equipment Component Satisfaction.....	D-13
Figure D-2. PY13 Efficient Equipment Component Ease of Participation .....	D-14
Figure D-3. Efficient Equipment Component Drivers of Satisfaction .....	D-15
Figure D-4. Efficient Equipment Component Organization Types .....	D-16
Figure G-1. Appliance Recycling Component Satisfaction .....	G-12
Figure G-2. Drivers of High Appliance Recycling Satisfaction.....	G-13
Figure G-3. Appliance Recycling Ease of Participation .....	G-14
Figure G-4. Suggestions for Improving the Appliance Recycling Component .....	G-15
Figure H-1. PY13 Efficient Lighting Component Satisfaction.....	H-8
Figure I-1. PY13 Overall Satisfaction with Energy Efficient Homes by Subcomponent .....	I-12
Figure I-2. PY13 Satisfaction with Elements of the Downstream Equipment Subcomponent .....	I-13
Figure I-3. PY13 Satisfaction with Elements of the Online Marketplace Subcomponent .....	I-14
Figure I-4. Downstream Equipment Drivers of High Satisfaction.....	I-15
Figure I-5. Online Marketplace Drivers of High Satisfaction .....	I-16
Figure J-1. PY13 Participating Student Satisfaction with Student Energy Efficient Education Component Overall by Cohort .....	J-8
Figure J-2. PY13 Participating Teacher Satisfaction with Student Energy Efficient Education Component Overall .....	J-9

## Tables

Table 2-1. PY13 Energy and Demand Achievements to Date.....	7
Table 2-2. Phase IV Energy and Demand Achievements to Date.....	8
Table 2-3. Program Year 13 Summary Statistics by Customer Segment.....	11
Table 2-4. PY13 Energy and Demand Summary of Government, Nonprofit, and Education Sector Customers.....	11
Table 2-5. Phase IV Summary Statistics by Customer Segment.....	12
Table 2-6. EE&C Plan Participation by Program.....	13
Table 2-7. PY13 Impact Evaluation Results Summary.....	14
Table 2-8. Incremental Annual Energy Savings by Program (MWh/Year).....	15
Table 2-9. Lifetime Energy Savings by Program (MWh).....	15
Table 2-10. Peak Demand Savings by Energy Efficiency Program (MW/Year).....	16
Table 2-11. Planned FCM Nominations by Act 129 Program Year and PJM Delivery Year.....	17
Table 2-12. PY13 Measures Selected for PJM.....	17
Table 2-13. Fuel Switching Summary.....	18
Table 2-14. Summary of Portfolio Finances – Gross Verified.....	19
Table 2-15. Comparison of Expenditures to Phase IV EE&C Plan (\$1,000).....	20
Table 2-16. Comparison of Actual Program Savings to EE&C Plan Projections.....	20
Table 3-1. PY13 and Phase IV Program and Portfolio Total Finances (\$1,000).....	24
Table 3-2. EE&C Plan Expenditures by Cost-Recovery Category (\$1,000).....	25
Table 4-1. PY13 Evaluation Activity Matrix.....	26
Table 4-2. Gross Impact Overview.....	27
Table 4-3. PY13 Impact Evaluation Activities by Program Component.....	28
Table 4-4. PY13 Portfolio Process Evaluation Activities by Component.....	29
Table 5-1. Non-Residential Participation and Reported Impacts.....	31
Table 5-2. Non-Residential Gross Impact Results for Energy.....	32
Table 5-3. Non-Residential Gross Impact Results for Demand.....	32
Table 5-4. Non-Residential Net Impact Evaluation Results.....	33
Table 5-5. PY13 Non-Residential High-Impact Measure Net-to-Gross.....	34
Table 5-6. PY13 and P4TD Savings Summary.....	34
Table 5-7. Non-Residential Process Evaluation Activities.....	35
Table 5-8. Non-Residential Program Key Process Evaluation Findings.....	36
Table 5-9. Summary of Non-Residential Program Finances – Gross Verified.....	37
Table 5-10. Summary of Non-Residential Program Finances – Net Verified.....	38
Table 5-11. Status of Recommendations for the Non-Residential Program.....	40
Table 6.1. Low-Income Program Summary.....	42
Table 6.2. PY13 Low-Income Program Participation and Reported Impacts.....	43



Table 6.3. Low-Income Program Gross Impact Results for Energy .....	44
Table 6.4. Low-Income Program Gross Impact Results for Demand.....	45
Table 6.5. PY13 and P4TD Savings Summary .....	47
Table 6.6. Low-Income Component Process Evaluation Sampling Strategy .....	48
Table 6.7. Summary of Low-Income Program Finances – Gross and Net Verified.....	51
Table 6.8. Status of Recommendations for the Low-Income Program .....	53
Table 7-1. Residential Participation and Reported Impacts.....	56
Table 7-2. Residential Program Gross Impact Results for Energy .....	56
Table 7-3. Residential Program Gross Impact Results for Demand .....	57
Table 7-4. Residential Program Net Impact Evaluation Results .....	59
Table 7-5. PY13 and P4TD Savings Summary .....	59
Table 7-6. PY13 Residential Program Evaluation Activities.....	60
Table 7-7. Residential Program Key Process Evaluation Findings .....	61
Table 7-8. Summary of Residential Program Finances – Gross Verified .....	63
Table 7-9. Summary of Residential Program Finances – Net Verified.....	64
Table 7-10. Status of Recommendations for the Residential Program .....	67
Table A-1. PY13 Site Visit Summary .....	A-1
Table B-1. Summary of Low-Income Carveout Energy Savings (MWh/Year) .....	B-1
Table C-1. Incremental Annual Energy Savings by Program & Initiative (MWh/Year) .....	C-1
Table C-2. Peak Demand Savings by Energy Efficiency Program and Initiative (MW/Year) .....	C-2
Table C-3. PY13 and Phase IV Gross TRC Ratios by Program (\$1,000) .....	C-2
Table C-4. PY13 and Phase IV Net TRC Ratios by Program (\$1,000) .....	C-3
Table C-5. PY13 High Impact Measure Net-to-Gross .....	C-3
Table C-6. Comparison of PY13 Expenditures to Phase IV EE&C Plan (\$1,000) .....	C-4
Table C-7. Comparison of P4TD Expenditures to Phase IV EE&C Plan (\$1,000) .....	C-4
Table C-8. Comparison of PY13 Actual Program Savings to EE&C Plan Projections for PY13 .....	C-5
Table C-9. Comparison of Phase IV Actual Program Savings to EE&C Plan Projections for Phase IV .....	C-5
Table D-1. PY13 Efficient Equipment Non-Lighting Subcomponent Gross Impact Evaluation Sample Design.....	D-3
Table D-2. PY13 Efficient Equipment Lighting Subcomponent Gross Impact Evaluation Sample Design .....	D-4
Table D-3. PY13 Efficient Equipment Component Gross Impact Results for Energy.....	D-6
Table D-4. PY13 Efficient Equipment Component Gross Impact Results for Demand .....	D-6
Table D-5. PY13 Efficient Equipment Midstream Lighting Subcomponent Verified Savings Adjustments Summary (in Order of Frequency) .....	D-8
Table D-6. PY13 Efficient Equipment Component Net Impact Evaluation Sample Design by Stratum .....	D-10
Table D-7. Efficient Equipment Component Intention, Influence, and Free Ridership Score by Stratum.....	D-10

Table D-8. PY13 Efficient Equipment Component NTG Ratio Summary by Stratum.....	D-11
Table D-9. Efficient Equipment Component Process Evaluation Sampling Strategy.....	D-12
Table D-10. Efficient Equipment Sample Attrition.....	D-17
Table D-11. Efficient Equipment Downstream, Direct Discount, and Direct Install Lighting and Non-Lighting Component Logic Model.....	D-18
Table D-12. Efficient Equipment Component Downstream, Direct Discount, and Direct Install Lighting and Non-Lighting Component Logic Model Review.....	D-19
Table D-13. Efficient Equipment Midstream Lighting Component Logic Model.....	D-20
Table D-14. Efficient Equipment Midstream Lighting Component Logic Model Review.....	D-21
Table E-1. PY13 Custom Component Gross Impact Evaluation Sample Design.....	E-3
Table E-2. PY13 Custom Component Gross Impact Results for Energy.....	E-3
Table E-3. Custom Component Gross Impact Results for Demand.....	E-4
Table E-4. Custom Component Net Impact Evaluation Sample Design.....	E-4
Table E-5. PY13 Custom Component NTG Ratio Summary.....	E-5
Table E-6. PY13 Custom Component Process Evaluation Sampling Strategy.....	E-6
Table E-7. PY13 Custom Participant Satisfaction.....	E-7
Table E-8. PY13 Drivers of High Component Satisfaction.....	E-7
Table E-9. Respondent Firmographics.....	E-8
Table E-10. Custom Component Sample Attrition.....	E-8
Table E-11. Custom Component Logic Model.....	E-9
Table E-12. Custom Component Logic Model Review.....	E-10
Table F-1. PY13 Low-Income Program Component Gross Impact Evaluation Sample Design.....	F-3
Table F-2. PY13 Low-Income Record Review Findings.....	F-5
Table F-3. PY13 In-Service Rates for Energy-Saving Items.....	F-5
Table F-4. Low-Income Program Verified Energy Education Savings and Assumptions Summary Table.....	F-6
Table F-5. Low-Income Component Sample Attrition.....	F-7
Table F-6. PY13 Low-Income Component Logic Model.....	F-8
Table F-7. PY13 Low-Income Program Logic Model Review.....	F-9
Table G-1. Eligible Equipment and Incentives for the Appliance Recycling Component.....	G-2
Table G-2. Appliance Recycling Component Gross Impact Evaluation Sample Design.....	G-3
Table G-3. UEC Input Comparison for Refrigerator and Freezer Savings Algorithms.....	G-3
Table G-4. Historical PY13 Part-Use by Appliance Type.....	G-5
Table G-5. Prospective Part-Use by Appliance Type.....	G-5
Table G-6. Part-Use Adjusted Gross Per-Unit Savings.....	G-6
Table G-7. Appliance Recycling Component Gross Impact Results for Energy.....	G-6
Table G-8. Appliance Recycling Component Gross Impact Results for Demand.....	G-6
Table G-9. PY13 Appliance Recycling Component Net Impact Evaluation Sample Design.....	G-7

Table G-10. Final Distribution of Kept and Discarded Participant Appliances .....	G-8
Table G-11. Final Distribution of Discarded/Transferred Participant Appliances .....	G-8
Table G-12. Appliance Recycling Component NTG Ratio Summary .....	G-9
Table G-13. Appliance Recycling Component Process Evaluation Sampling Strategy.....	G-10
Table G-14. Appliance Recycling Component Sample Attrition .....	G-16
Table G-15. Appliance Recycling Component Logic Model.....	G-17
Table G-16. Appliance Recycling Component Logic Model Review .....	G-18
Table H-1. PY13 Efficient Lighting Component Gross Impact Evaluation Sample Design .....	H-2
Table H-2. PY13 Efficient Lighting Component Gross Impact Results for Energy.....	H-3
Table H-3. PY13 Efficient Lighting Component Gross Impact Results for Demand .....	H-3
Table H-4. PY13 Efficient Lighting Component Net Impact Evaluation Sample Design .....	H-4
Table H-5. PY13 Efficient Lighting Component Free Ridership Scores by Retailer Type .....	H-5
Table H-6. PY13 Efficient Lighting Component Lift-Based NTG Ratio Summary .....	H-5
Table H-7. PY13 Efficient Lighting Component Final NTG Ratio Summary.....	H-6
Table H-8. PY13 Efficient Lighting Component NTG Benchmarking.....	H-6
Table H-9. PY13 Efficient Lighting Component Process Evaluation Sampling Strategy.....	H-7
Table H-10. PY13 Efficient Lighting Component Sample Attrition .....	H-11
Table H-11. PY13 Efficient Lighting Component Logic Model .....	H-12
Table H-12. Efficient Lighting Component Logic Model Review .....	H-13
Table I-1. Energy Efficient Homes Component Gross Impact Evaluation Sample Design .....	I-3
Table I-2. PY13 Incentives and Verified Energy Savings and Demand Reductions by Subcomponent.....	I-4
Table I-3. Energy Efficient Homes Component Gross Impact Results for Energy .....	I-4
Table I-4. Energy Efficient Homes Component Gross Impact Results for Demand .....	I-4
Table I-5. Online Marketplace In-Service Rates .....	I-6
Table I-6. Energy Efficient Homes Component Net Impact Evaluation Sample Design .....	I-7
Table I-7. Energy Efficient Homes Component Intention, Influence, and Free Ridership Score by Stratum .....	I-8
Table I-8. Energy Efficient Homes Component Spillover Products and Savings for Refrigerator, Dehumidifier, CAC, DHP, ASHP, Smart Thermostat, and Other Equipment Categories.....	I-8
Table I-9. Energy Efficient Homes Component Spillover Calculation for Refrigerator, Dehumidifier, CAC, DHP, ASHP, Smart Thermostat, and Other Equipment Categories .....	I-9
Table I-10. Energy Efficient Homes Component – Downstream Equipment Stratum Net Impact Evaluation Results.....	I-9
Table I-11. Energy Efficient Homes Component NTG Ratio Summary .....	I-10
Table I-12. Energy Efficient Homes Component Process Evaluation Sampling Strategy.....	I-11
Table I-13. Energy Efficient Homes Sample Table.....	I-20
Table I-14. New Homes Subcomponent Sample Attrition Table.....	I-20
Table I-15. Energy Efficient Homes Program Component Logic Model .....	I-21
Table I-16. Energy Efficient Homes Component Logic Model Review .....	I-22

Table J-1. Energy-Savings Items by Cohort .....	J-3
Table J-2. Student Energy Efficient Education Component Gross Impact Evaluation Sample Design.....	J-4
Table J-3. Student Energy Efficient Education Component Gross Impact Results for Energy .....	J-4
Table J-4. Student Energy Efficient Education Component Gross Impact Results for Demand .....	J-4
Table J-5. Student Energy Efficient Education Component Process Evaluation Sampling Strategy .....	J-6
Table J-6 PY13 Satisfaction for the SEEE Component .....	J-7
Table J-7. Student Energy Efficient Education Component Logic Model .....	J-11
Table J-8. Student Energy Efficient Education Component Logic Model Review.....	J-12
Table K-1. Lift Free Ridership Scoring .....	K-4
Table K-2. PY13 Efficient Lighting Component Free Ridership Score by Retailer Type .....	K-5
Table K-3. PY13 Efficient Lighting Component Lift-Based NTG Ratio Summary.....	K-5



## Acronyms

<b>AHRI</b>	Air Conditioning, Heating, and Refrigeration Institute	<b>LED</b>	Light-emitting diode
<b>AMI</b>	Advanced metering infrastructure	<b>LIURP</b>	Low-income usage reduction program
<b>C&amp;I</b>	Commercial and industrial	<b>M&amp;V</b>	Measurement and verification
<b>CDD</b>	Cooling degree day	<b>MW</b>	Megawatt
<b>CEI</b>	Continuous energy improvement	<b>MWh</b>	Megawatt-hour
<b>CF</b>	Coincidence factor	<b>NPV</b>	Net present value
<b>CHP</b>	Combined heat and power	<b>NTG</b>	Net-to-Gross
<b>C.L.</b>	Confidence limit	<b>N/A</b>	Not Applicable
<b>CSP</b>	Conservation service provider or curtailment service provider	<b>O&amp;M</b>	Operations and maintenance
<b>CSS</b>	Cross-sector sales	<b>P3TD</b>	Phase III to date
<b>Cv</b>	Coefficient of variation	<b>P4TD</b>	Phase IV to date
<b>DLC</b>	DesignLights Consortium	<b>PA PUC</b>	Pennsylvania Public Utility Commission
<b>DR</b>	Demand response	<b>PAC</b>	Program administrator cost
<b>EDC</b>	Electric distribution company	<b>PSA</b>	Phase III to date preliminary savings achieved; equal to VTD + PYRTD
<b>EDT</b>	Eastern Daylight Time	<b>PSA+CO</b>	PSA savings plus carryover from Phase II
<b>EE&amp;C</b>	Energy efficiency and conservation	<b>PY</b>	Program Year: for example, PY13, from June 1, 2021, to May 31, 2022
<b>EFLH</b>	Equivalent fuel load hours	<b>PYRTD</b>	Program year reported to date
<b>EM&amp;V</b>	Evaluation, measurement, and verification	<b>PYVTD</b>	Program year verified to date
<b>EISA</b>	Energy Independence and Security Act	<b>PYTD</b>	Program year to date
<b>EUL</b>	Effective useful life	<b>QA/QC</b>	Quality assurance/quality control
<b>FCM</b>	Forward Capacity Market	<b>RTD</b>	Phase III to date reported gross savings
<b>GNE</b>	Government, nonprofit, educational	<b>SEER</b>	Seasonal energy efficiency rating
<b>HDD</b>	Heating degree day	<b>SKU</b>	Stock keeping unit
<b>HER</b>	Home energy report	<b>SWE</b>	Statewide evaluator
<b>HIM</b>	High-impact measure	<b>T&amp;D</b>	Transmission and distribution
<b>HOU</b>	Hours of use	<b>tLED</b>	Tubular LED
<b>HSPF</b>	Heating seasonal performance factor	<b>TRC</b>	Total resource cost
<b>HVAC</b>	Heating, ventilating, and air conditioning	<b>TRM</b>	Technical reference manual
<b>ICSP</b>	Implementation conservation service provider	<b>VTD</b>	Phase III to date verified gross savings
<b>IMC</b>	Incremental measure cost	<b>WRAP</b>	Weatherization Relief Assistance Program
<b>IMP</b>	Interim measure protocol		
<b>IPMVP</b>	International Performance Measurement and Verification Protocol		
<b>ISR</b>	In-service rate		
<b>kW</b>	Kilowatt		
<b>kWh</b>	Kilowatt-hour		
<b>KPI</b>	Key performance indicator		

## 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 or preliminary annual report.

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

**Phase 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.



## 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 **475,061 MWh/yr\***

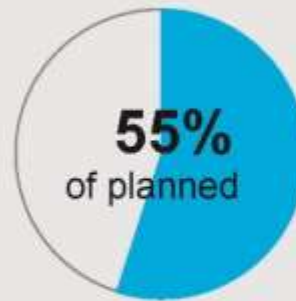


PY13 saved **168,786 MWh/yr**

\*Includes Phase III carryover energy savings

### VERIFIED DEMAND REDUCTIONS

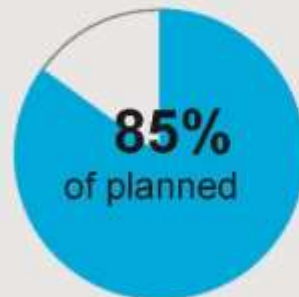
Phase IV has reductions of **25.89 MW/yr**



PY13 has reductions of **25.89 MW/yr**

### LOW-INCOME PROGRAM

Phase IV has saved **41,538 MWh/yr**

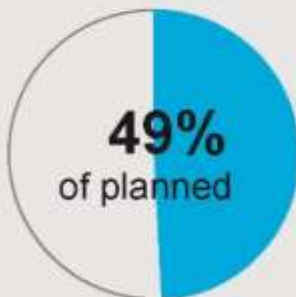


PY13 saved **10,449 MWh/yr**

\*Includes Phase III carryover energy savings

### EXPENDITURES (\$1,000)

Phase IV expenditures **\$30,557**



PY13 expenditures **\$30,557**



## PORTFOLIO PARTICIPATION AND SATISFACTION

### PY13 PARTICIPATION

A total of **852,940** participants



**821,941** Residential



**25,682** Low-Income



**5,317** Non-Residential

### PROGRAM SATISFACTION



**90%**

Satisfied with overall program

**96%**

satisfied with Non-Residential Program

**88%**

satisfied with Residential Program

**85%**

satisfied with Low-Income Program

### PARTICIPANT COMMENTS



"I was thankful for finding a place that would recycle the refrigerator."



"The contractor was the difference in getting this project completed."



"The program [is] fun and motivates students to really start thinking about energy conservation, building background for science lessons on electricity and conservation. The kids love the goodies, which vary from year to year. They were so excited to take home the power strips this year..."



"I guess the positive result was the energy savings with installing a new heat pump with smart thermostat vs. continuing with an oil fired furnace."



"...the rebates are great! Everyone wants to save money on electric! If it will help my cost decrease and I can get a rebate sometimes, I'm good with that."

## 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 13 (PY13), 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 PY13. Compliance with Act 129 savings goals are ultimately based on verified gross savings. This report also includes estimates of cost-effectiveness according to the Total Resource Cost test (TRC).<sup>1</sup>

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 program. This report presents the key findings and recommendations identified by the process evaluation and documents any changes to EE&C program delivery that were considered based on the recommendations.

### 1.1 Executive Summary

PPL Electric Utilities successfully launched all energy efficiency programs for Phase IV Act 129 in PY13. Programs are operating effectively and are meeting their program objectives but are slightly behind planned savings for PY13. Recommendations are presented in each program section and focus on ways to fine-tune program implementation.

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<sup>1</sup> 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 verified energy savings achieved through PY13 did not meet those projected for the program year as shown in PPL Electric Utilities' EE&C plan,<sup>2</sup> savings achieved in PY13 (168,786 MWh/yr) plus Phase III carryover savings (306,275 MWh/yr) contribute 38% to the Phase IV overall five-year compliance target of 1,250,157 MWh/yr. In PY13, PPL Electric Utilities projected an estimate of 292,089 MWh/yr and achieved 168,786 MWh/yr in verified savings, or 58% of energy projections.

Verified demand reductions achieved through PY13 also did not meet those projected for the program year. In PY13, PPL Electric Utilities projected an estimate of 46.92 MW/yr and achieved 25.89 MW/yr in verified energy reductions, or 55% of demand projections.

A small portion of this shortfall can be attributed to Cadmus' plan to not verify all savings for the Custom and Energy Efficient Homes components in PY13 (which comprise about 4% of reported energy savings and about 7% of demand), but most is due to lower than expected participation due to lingering impacts of the COVID-19 pandemic.

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 57% of the Phase IV low-income energy-savings compliance target in PY13 (10,449 MWh/yr), including carryover savings from Phase III (31,089 MWh/yr).

PPL Electric Utilities delivered programs for 10% of the Phase IV cumulative projected budget estimated in the EE&C Plan, expending \$30,556,937. The acquisition cost in PY13 and Phase IV is \$0.18 per annual kWh (EDC expenditures/first-year savings). The portfolio-level PY13 total cost of conserved energy (TRC costs/net present value [NPV] lifetime kWh, at generation) is \$0.035. The portfolio-level PY13 utility cost of conserved energy (program administrator cost [PAC]/NPV lifetime kWh, at generation) is \$0.016. The TRC includes PPL Electric Utilities' costs as well as the customers' costs. The PAC includes only PPL Electric Utilities' costs.

A portfolio is cost-effective when the TRC benefit-cost ratio exceeds 1.0. The PY13 and phase-to-date portfolio is cost-effective with a portfolio-level TRC of 1.85.

The evaluated net-to-gross (NTG) ratio is 0.62, 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.<sup>3</sup> Respondents to participant satisfaction surveys across all sectors showed high levels of satisfaction with the programs. With the combined *very satisfied* and *somewhat satisfied* responses, portfolio satisfaction for PY13 is 90% (n=15,825). The Non-Residential Program achieved customer satisfaction of 96% (n=31), the Low-Income Program achieved customer satisfaction of 85% (n=106), and the Residential Program achieved

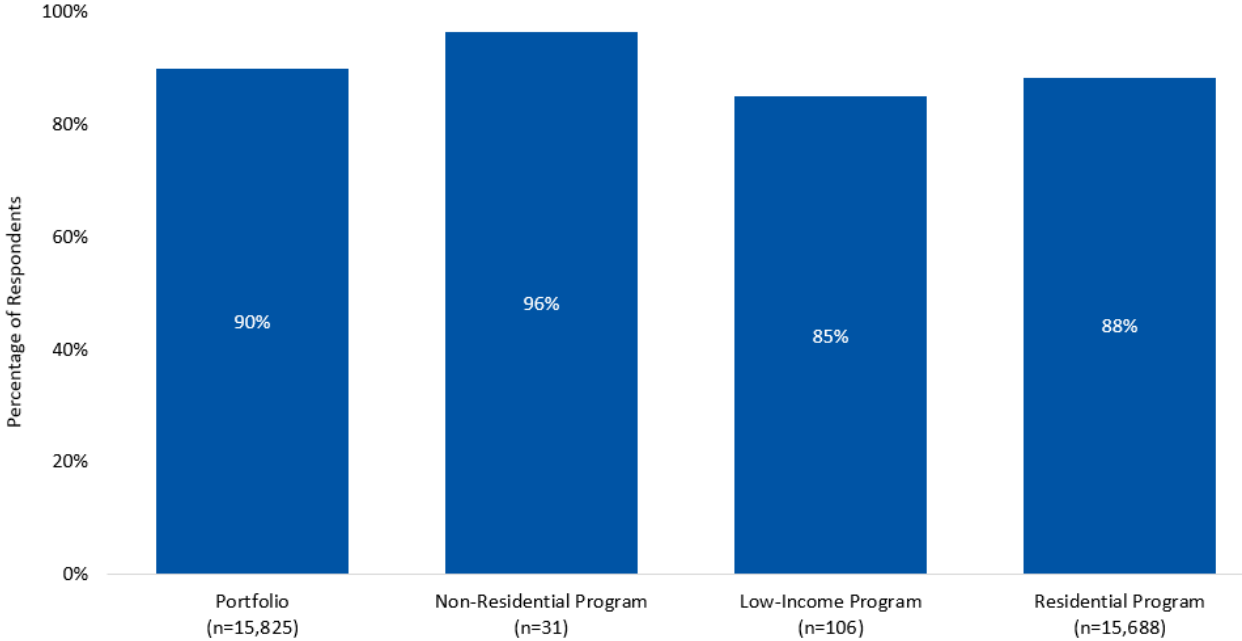
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<sup>2</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

<sup>3</sup> The customer satisfaction goal is listed in PPL Electric Utilities' EE&C Plan (Docket No. M-2020-3020824) filed May 2021.

customer satisfaction of 88% (n=15,688). All three programs met or exceeded the customer satisfaction goal of 85%.

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



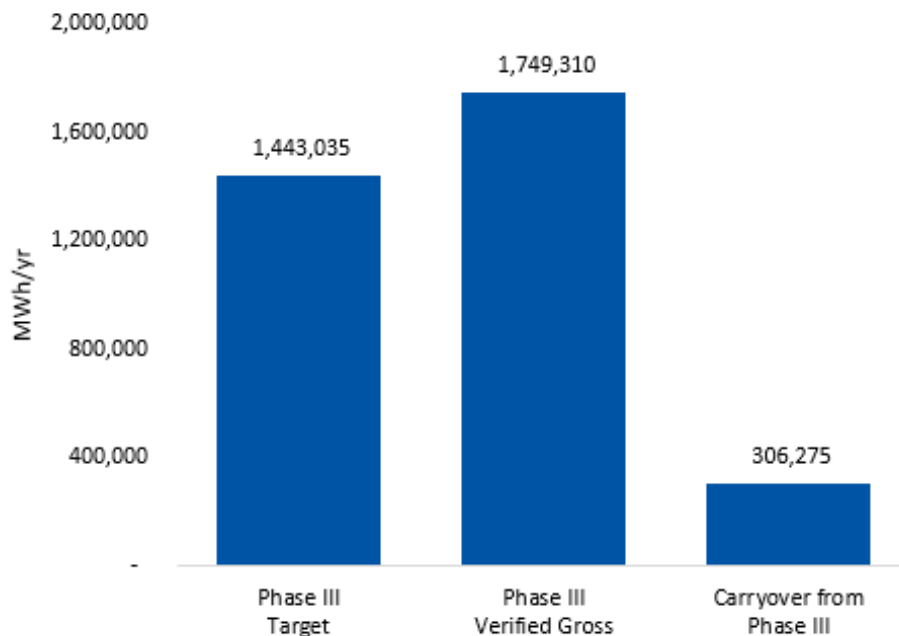
Source: Participant survey question, “How would you rate your overall satisfaction with the program/component?” Program satisfaction results include all responses to the satisfaction question, averaged to compute the portfolio-level satisfaction. These totals may not reflect number of “completed” surveys as reflected in Table 4-4. Non-Residential includes Custom and Efficient Equipment downstream survey respondents, Low-Income includes remote energy assessment survey respondents, and Residential includes Appliance Recycling, Energy Efficient Homes equipment, online marketplace, and new homes and students and teacher survey respondents.

## 2 Summary of Achievements

### 2.1 Carryover Savings from Phase III of Act 129

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

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

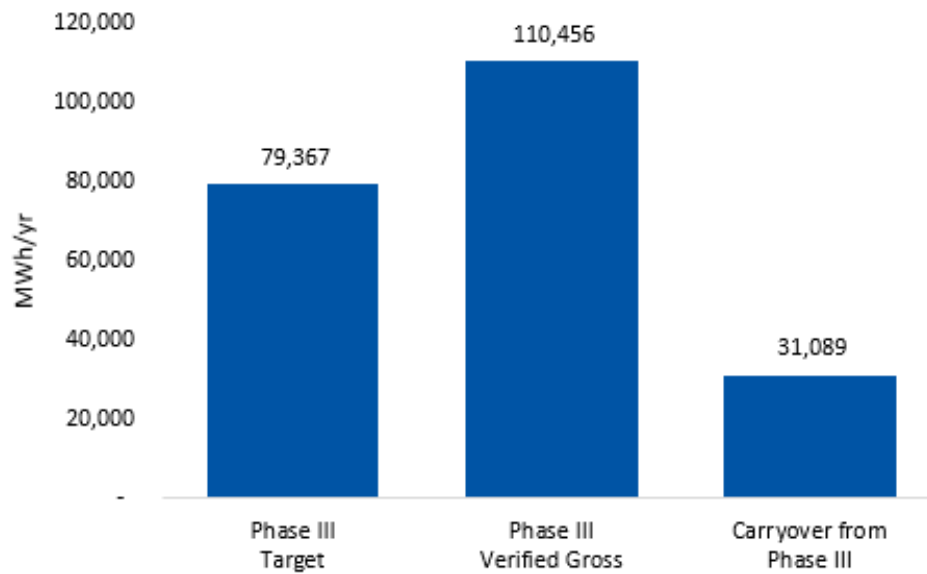


The PA PUC’s Phase IV Implementation Order also allows EDCs to carry over savings in excess of the Phase III low-income savings goal.<sup>4,5</sup> Figure 2-2 shows the calculation of carryover savings for the low-income customer segment.

<sup>4</sup> 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.

<sup>5</sup> 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 PY13 on June 1, 2021.

Table 2-1. PY13 Energy and Demand Achievements to Date

PYTD	Reported Gross Savings (PYRTD)	Verified Savings (PYVTD)	System-Level Verified Savings (PYVTD)	Unverified (PYRTD)	Realization Rate <sup>(1)</sup>
Energy Savings (MWh/yr) <sup>(2)</sup>	170,005 <sup>(3)</sup>	168,786	N/A	6,084	103%
Peak Demand Reductions (MW/yr) <sup>(2)</sup>	26.66 <sup>(3)</sup>	23.99	25.89	1.78	96% <sup>(4)</sup>

<sup>(1)</sup> 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.  
<sup>(2)</sup> Savings may not match other tables or figures due to rounding.  
<sup>(3)</sup> Reported savings without unverified savings are 163,921 MWh/yr and 24.87 MW/yr.  
<sup>(4)</sup> 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 475,061 MWh/yr of verified savings to date. This represents 38% of the May 31, 2026, energy savings compliance target of 1,250,157 MWh/yr.

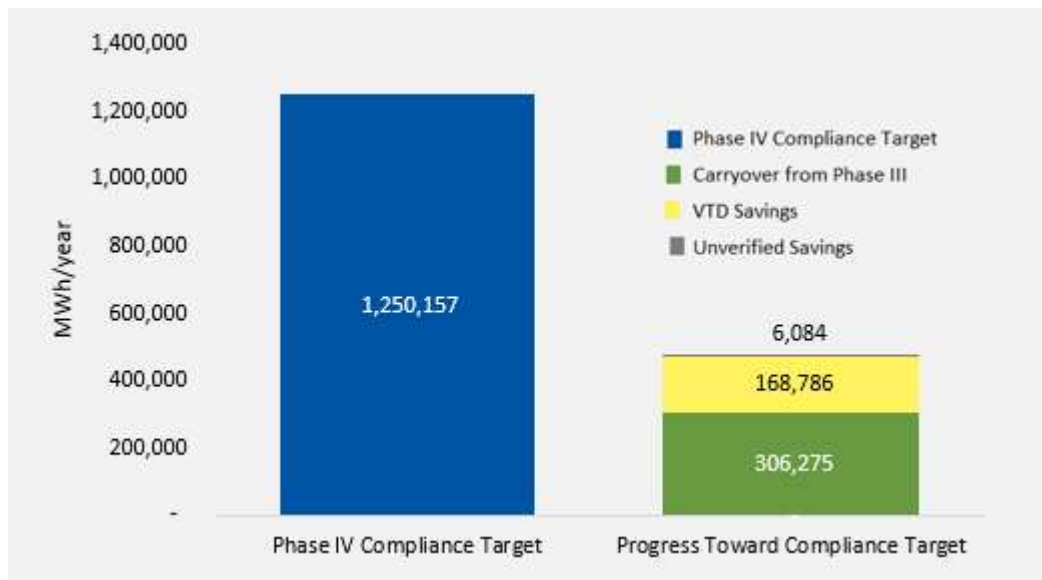
**Table 2-2. Phase IV Energy and Demand Achievements to Date**

P4TD	Reported Gross Savings (P4RTD)	Verified Savings (P4VTD)	System-Level Verified Savings (P4VTD)	Unverified (P4RTD)	Realization Rate <sup>(1)</sup>
Energy Savings (MWh/yr) <sup>(2)</sup>	170,005 <sup>(3)</sup>	475,061 <sup>(4)</sup>	N/A	6,084	103% <sup>(5)</sup>
Peak Demand Reductions (MW/yr) <sup>(2)</sup>	26.66 <sup>(3)</sup>	23.99	25.89	1.78	96% <sup>(6)</sup>

<sup>(1)</sup> 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.  
<sup>(2)</sup> Savings may not match other tables or figures due to rounding.  
<sup>(3)</sup> Reported savings without unverified savings are 163,921 MWh/yr and 24.87 MW/yr.  
<sup>(4)</sup> Verified energy savings include Phase III carryover of 306,275 MWh/yr.  
<sup>(5)</sup> Realization rate excludes Phase III carryover of 306,275 MWh/yr.  
<sup>(6)</sup> Realization rates are applied to verified demand reductions before application of distribution losses.

Figure 2-3 summarizes PPL Electric Utilities’ progress toward the Phase IV MWh portfolio compliance target, and Figure 2-4 summarizes progress toward the Phase IV MW portfolio compliance target. Unverified energy savings total is 6,084 MWh/yr (3,048 MWh/yr for the Non-Residential, 103 MWh/yr for Low-Income, and 2,933 MWh/yr for Residential). Unverified demand reductions total is 1.78 MW/yr (0.56 MW/yr for the Non-Residential, 0.01 MW/yr for Low-Income, and 1.22 MW/yr for Residential).<sup>6</sup> These savings will be verified in PY14.

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



<sup>6</sup> Sum of individual program-level demand reductions does not match total due to rounding.

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

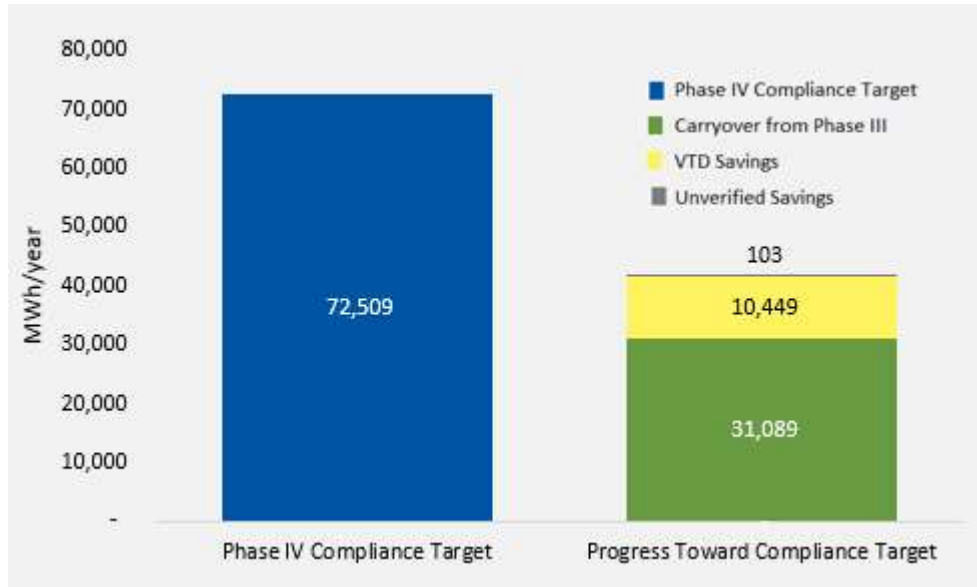


The Phase IV Implementation Order directed EDCs to offer conservation measures to the low-income customer segment based on the proportion of electric sales attributable to low-income households. PPL Electric Utilities’ target proportion is 9.95%. PPL Electric Utilities offers a total of 47 EE&C measures to its residential and non-residential customer classes. There are eight distinct PPL Electric Utilities’ measures available to the low-income customer segment at no cost to the customer, which represents 17.0% 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 verified-to-date (VTD) performance for the low-income customer segment to the Phase IV savings target. PPL Electric Utilities has achieved 57% 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 PY13, PPL Electric Utilities has achieved 2,870 MWh/yr of verified gross electric energy savings (PYVTD) from multifamily housing across all programs, including 2,049 MWh/yr of verified gross electric energy savings (PYVTD) from low-income households. Because PY13 is the first year in the phase, these totals also apply to Phase IV.

### 2.3 Phase IV Performance by Customer Segment

Table 2-3 presents participation, savings, and spending by customer sector for PY13. 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, and the GNE segment includes customers who are part of the 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. Program Year 13 Summary Statistics by Customer Segment**

Parameter	Residential (Non-LI)	Low-Income	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total <sup>(1)</sup>
Reported Number of Participants <sup>(2)</sup>	764,324	25,682	60,532	872	1,530	852,940
PYRTD MWh/yr <sup>(3)</sup>	34,136	11,840	78,934	30,191	14,903	170,005
PYRTD MW/yr <sup>(3)</sup>	4.80	1.29	13.43	4.62	2.51	26.66
PYVTD MWh/yr <sup>(3)</sup>	30,697	10,449	81,719	29,567	16,354	168,786 <sup>(4)</sup>
System-Level PYVTD MW/yr <sup>(3)</sup>	3.80	1.23	14.07	4.08	2.71	25.89 <sup>(4)</sup>
PY13 Incentives (\$1000) <sup>(3) (5)</sup>	\$4,372	\$2,174	\$5,334	\$627	\$458	\$12,965

<sup>(1)</sup> Columns may not sum to totals due to rounding.

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

<sup>(3)</sup> Savings may not match other tables or figures due to rounding.

<sup>(4)</sup> Excludes 6,084 MWh/yr and 1.78 MW/yr of unverified savings.

<sup>(5)</sup> 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.

The following table presents savings for the GNE sector as defined by statute (66 Pa. C.S. § 2806.1) for small and large C&I customer sectors defined EDC tariff.

**Table 2-4. PY13 Energy and Demand Summary of Government, Nonprofit, and Education Sector Customers**

Parameter	GNE Customers with Small C&I Rate Codes	GNE Customers with Large C&I Rate Codes	GNE Total (Small and Large C&I) <sup>(1)</sup>
PYRTD MWh/yr	4,116	10,769	14,884
PYRTD MW/yr	0.95	1.56	2.51
PYVTD MWh/yr	5,203	11,127	16,330
System-Level PYVTD MW/yr	1.03	1.68	2.71

<sup>(1)</sup> Columns may not sum to totals due to rounding. These totals do not include any savings in the GNE sector attributed to Residential rate codes and 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 <sup>(1)</sup>
Reported Number of Participants <sup>(2)</sup>	764,324	25,682	60,532	872	1,530	852,940
PYRTD MWh/yr <sup>(3)</sup>	34,136	11,840	78,934	30,191	14,903	170,005
PYRTD MW/yr <sup>(3)</sup>	4.80	1.29	13.43	4.62	2.51	26.66
VTD MWh/yr <sup>(3) (4)</sup>	30,697	41,538 <sup>(4)</sup>	81,719	29,567	16,354	475,061 <sup>(4) (5)</sup>
System-Level VTD MW/yr <sup>(3) (4)</sup>	3.80	1.23	14.07	4.08	2.71	25.89 <sup>(5)</sup>
Phase IV Incentives (\$1000) <sup>(6)</sup>	\$4,372	\$2,174	\$5,334	\$627	\$458	\$12,965

<sup>(1)</sup> Columns may not sum to totals due to rounding.  
<sup>(2)</sup> Verified participation totals discussed in each chapter and appendix and shown in the infographics may differ from the reported participation in this table.  
<sup>(3)</sup> Savings may not match other tables or figures due to rounding.  
<sup>(4)</sup> 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.  
<sup>(5)</sup> Excludes 6,084 MWh/yr and 1.78 MW/yr of unverified savings.  
<sup>(6)</sup> 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 PY13 and Phase IV.

**Table 2-6. EE&C Plan Participation by Program**

Program/Component	Participant Definition	PYTD Participation	P4TD Participation
<b>Non-Residential Program</b>			
Custom	Unique job number; commercially operable job that received an incentive payment during the reporting period.	36	36
Efficient Equipment (downstream)	Unique job number; corresponds to each unique job that received a rebate.	488	488
Efficient Equipment (midstream)	Unique job number; corresponds to each purchase of discounted products.	4,793	4,793
<b>Low-Income Program</b>			
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.	25,682	25,682
<b>Residential Program</b>			
Appliance Recycling	Unique job number; corresponds with each unique appliance decommissioned through the program during the program year.	11,309	11,309
Efficient Lighting	Number of discounted bulbs sold.	775,814	775,814
Energy Efficient Homes New Homes	Unique job number; corresponds to a rebated project.	1,242	1,242
Energy Efficient Homes Audit and Weatherization	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	0	0
Energy Efficient Homes Online Marketplace	Unique job number; corresponds to a rebated project.	5,616	5,616
Energy Efficient Homes Equipment (downstream)	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	7,945	7,945
Energy Efficient Homes Equipment (midstream)	Unique job number; corresponds to each purchase of discounted products.	0	0
Student Energy Efficient Education	Number of participants is counted as the number of energy conservation kits delivered.	20,015	20,015
<b>Portfolio Total</b>		<b>852,940</b>	<b>852,940</b>

## 2.5 Summary of Impact Evaluation Results

During PY13, Cadmus completed impact evaluations for most program components in the portfolio. Table 2-7 summarizes the realization rates and NTG ratios by program or evaluation component.

**Table 2-7. PY13 Impact Evaluation Results Summary**

Program	Component	Energy Realization Rate	Demand Realization Rate <sup>(1)</sup>	Net-to-Gross Ratio
Non-Residential	Custom	100%	100%	0.22 <sup>(2)</sup>
	Efficient Equipment	108%	95%	0.73 <sup>(3)</sup>
Low-Income	Low-Income	89%	88%	1.0 <sup>(4)</sup>
Residential	Appliance Recycling	100%	100%	0.56 <sup>(2)</sup>
	Efficient Lighting	102%	102%	1.07 <sup>(2)</sup>
	Energy Efficient Homes	104%	102%	0.52 <sup>(5)</sup>
	Student Energy Efficient Education	84%	89%	1.0 <sup>(4)</sup>
<b>Portfolio Total</b>		<b>103%</b>	<b>96%</b>	<b>0.62 <sup>(6)</sup></b>

<sup>(1)</sup> Realization rates are applied to verified demand reductions before application of distribution losses.  
<sup>(2)</sup> PY13 evaluated NTG ratio.  
<sup>(3)</sup> PY13 evaluated NTG ratios used for downstream subcomponents. PY11 evaluated NTG used for midstream lighting subcomponent. The 0.73 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.  
<sup>(4)</sup> No free ridership is expected, nor measured, per the evaluation plan. Therefore, the NTG ratio is 1.0.  
<sup>(5)</sup> 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. PY11 evaluated NTG ratio used for Online Marketplace stratum. The 0.52 NTG ratio for the overall component is the verified gross population energy savings weighted average of the NTG ratios applied to each measure.  
<sup>(6)</sup> Weighted by PY13 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 EE&C program activity are recorded as incremental annual, or “first-year,” savings and added to an EDC’s progress toward compliance. Incremental annual savings estimates are presented in section 2.6.1. Lifetime energy savings incorporate the effective useful life (EUL) of installed measures and estimate the total energy savings associated with EE&C program activity. Lifetime savings are used in the TRC test, by program participants when assessing the economics of upgrades, and by the statewide evaluator (SWE) when calculating the emissions benefits of Act 129 programs. Section 2.6.2 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 PY13 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	123,157 <sup>(1)</sup>	126,597	73,230	123,157	126,597	73,230
Low-Income	11,840 <sup>(1)</sup>	10,449	10,449	11,840	41,538 <sup>(2)</sup>	10,449 <sup>(4)</sup>
Residential	35,008 <sup>(1)</sup>	31,740	21,478	35,008	31,740	21,478
<b>Portfolio Total <sup>(3)</sup></b>	<b>170,005</b>	<b>168,786</b>	<b>105,157</b>	<b>170,005</b>	<b>475,061 <sup>(2)</sup></b>	<b>105,157<sup>(4)</sup></b>

<sup>(1)</sup> Includes 3,048 MWh/yr, 103 MWh/yr, and 2,933 MWh/yr of unverified savings for Non-Residential, Low-Income, and Residential programs, respectively.  
<sup>(2)</sup> 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.  
<sup>(3)</sup> Total may not match the sum of rows due to rounding.  
<sup>(4)</sup> 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.

### 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.<sup>7</sup>

**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	1,897,752	1,097,644	1,897,752	1,097,644
Low-Income	111,800	111,800	111,800	111,800
Residential	354,383	235,847	354,383	235,847
<b>Portfolio Total</b>	<b>2,363,935</b>	<b>1,445,291</b>	<b>2,363,935</b>	<b>1,445,291</b>

### 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. 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.

<sup>7</sup> 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.



PPL Electric Utilities uses the following line loss percentages/multipliers by sector.<sup>8,9</sup>

- Residential = 1.0875
- Small C&I = 1.0875
- Large C&I = 1.042
- GNE = 1.0788

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)	PYVTD Net (MW/yr)	RTD (MW/yr)	System-Level VTD Gross (MW/yr)	System-Level VTD Net (MW/yr)
Non-Residential	20.37 <sup>(1)</sup>	20.58	11.66	20.37	20.58	11.66
Residential	5.00 <sup>(1)</sup>	4.08	2.81	5.00	4.08	2.81
Low-Income	1.29 <sup>(1)</sup>	1.23	1.23	1.29	1.23	1.23
<b>Portfolio Total <sup>(2)</sup></b>	<b>26.66</b>	<b>25.89</b>	<b>15.69</b>	<b>26.66</b>	<b>25.89</b>	<b>15.69</b>
<sup>(1)</sup> Includes 0.56 MW/yr, 0.01 MW/yr, and 1.22 MW/yr of unverified savings for Non-Residential, Low-Income, and Residential programs, respectively.						
<sup>(2)</sup> Total of individual program demand reductions may not sum to total due to rounding.						

## 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 PY13.

<sup>8</sup> Pennsylvania Public Utility Commission. February 2021. *Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards.

<sup>9</sup> For GNE records, the line loss multiplier was calculated as a blended rate of 1.0788 using the proportion of reported demand reductions of the residential and small C&I sectors compared to the large C&I sector (81% and 19%, respectively).

**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 to 10]	[1 to 10]	[1 to 10]	[1 to 10]			
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]
<b>Phase IV Total</b>	<b>[5.4 to 41.4]</b>	<b>1.4</b>	<b>[2.4 to 11.4]</b>	<b>[3.4 to 21.4]</b>	<b>[4.4 to 31.4]</b>	<b>[4 to 40]</b>	<b>[3 to 30]</b>	<b>[2 to 20]</b>	<b>[1 to 10]</b>

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

**Table 2-12. PY13 Measures Selected for PJM**

Measure Category	Measure
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	

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 PY13 and successfully monetized in PJM delivery year 2022-2023 (DY22/23):

- Large C&I: 0.48 MW
- Small C&I: 0.54 MW
- Residential: 0.37 MW

These resources resulted in PJM revenues from DY22/23 that will be paid in full 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 PY13 and to date in Phase IV.

**Table 2-13. Fuel Switching Summary**

Metric	PY13	P4TD
Fuel Switching Measures Offered	<ul style="list-style-type: none"> <li>• ASHP</li> <li>• Electric Baseboards</li> <li>• Electric Furnace</li> <li>• Water Heater Gas - Electric Resistance</li> <li>• Water Heater Propane - Electric Resistance</li> <li>• CHP</li> </ul>	<ul style="list-style-type: none"> <li>• ASHP</li> <li>• Electric Baseboards</li> <li>• Electric Furnace</li> <li>• Water Heater Gas - Electric Resistance</li> <li>• Water Heater Propane - Electric Resistance</li> <li>• CHP</li> </ul>
Fuel Switching Measures Implemented	<ul style="list-style-type: none"> <li>• ASHP - 6</li> <li>• Electric Baseboards - 17</li> <li>• Electric Furnace - 1</li> <li>• Water Heater Gas - Electric Resistance - 13</li> <li>• Water Heater Propane - Electric Resistance - 8</li> <li>• CHP - 2</li> </ul>	<ul style="list-style-type: none"> <li>• ASHP - 6</li> <li>• Electric Baseboards - 17</li> <li>• Electric Furnace - 1</li> <li>• Water Heater Gas - Electric Resistance - 13</li> <li>• Water Heater Propane - Electric Resistance - 8</li> <li>• CHP - 2</li> </ul>
VTD Energy Savings Achieved via Fuel Switching (MWh/yr)	14,905	14,905
PIV TD Increased Fossil Fuel Consumption Due to Fuel Switching Measures (MMBTU/yr)	50.86	50.86
PIV TD Incentive Payments for Fuel Switching Measures (\$1000)	\$1,009	\$1,009

## 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) PY13 costs and benefits

are expressed in 2021 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 <sup>(1)</sup>	PYTD (\$1,000)		P4TD <sup>(2)</sup> (\$1,000)	
<b>1</b>	<b>IMCs</b>	<b>\$48,017</b>		<b>\$48,017</b>	
2	Rebates to Participants and Trade Allies	\$8,211		\$8,211	
3	Upstream/Midstream Incentives	\$2,103		\$2,103	
4	Material Cost for Self-Install Programs (EE&C Kits)	\$2,192		\$2,192	
5	Direct Installation Program Materials and Labor	\$459		\$459	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5) <sup>(6)</sup>	\$35,052		\$35,052	
		<b>EDC</b>	<b>CSP</b>	<b>EDC</b>	<b>CSP</b>
7	Program Design	\$697	\$462	\$697	\$462
8	Administration and Management <sup>(3)</sup>	\$1,363	\$3,655	\$1,363	\$3,655
9	Marketing	\$1,736	\$1,663	\$1,736	\$1,663
10	Program Delivery <sup>(4)</sup>	--	\$6,465	--	\$6,465
11	EDC Evaluation Costs	\$1,155		\$1,155	
12	SWE Audit Costs	\$396		\$396	
<b>13</b>	<b>Program Overhead Costs (Sum of rows 7 through 12) <sup>(6)</sup></b>	<b>\$17,592</b>		<b>\$17,592</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13) <sup>(5) (6)</sup></b>	<b>\$66,167</b>		<b>\$66,167</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$66,510		\$66,510	
16	Total NPV Lifetime Electric Capacity Benefits	\$41,459		\$41,459	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$34		\$34	
18	Total NPV Lifetime Fossil Fuel Impacts	\$6,735		\$6,735	
19	Total NPV Lifetime Water Impacts	\$7,748		\$7,748	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19) <sup>(6)</sup></b>	<b>\$122,486</b>		<b>\$122,486</b>	
<b>21</b>	<b>TRC Benefit-Cost Ratio (Row 20 divided by Row 14)</b>	<b>1.85</b>		<b>1.85</b>	

<sup>(1)</sup> Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = \$2021  
<sup>(2)</sup> P4TD benefits does not include carry-over energy savings from Phase III  
<sup>(3)</sup> Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.  
<sup>(4)</sup> 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.  
<sup>(5)</sup> Row 14 (portfolio-level TRC costs) includes \$557,394 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.  
<sup>(6)</sup> 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 PY13 expenditures compared to the budget estimates set forth in the EE&C plan for PY13 and P4TD. PY13 values are presented in 2021 dollars and P4TD values are presented in 2021 dollars. Program-level comparisons of expenditures to plans are presented in *Appendix C*.

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

Expenditures	Budget from EE&C Plan	Actual Expenditures	Ratio (Actual/Plan)
PY13 Portfolio	\$61,824	\$30,557	49%
PIV TD	\$61,824 <sup>(1)</sup>	\$30,557	49%

Source: PPL Electric Utilities Phase IV EE&C Plan, Table 6.  
<sup>(1)</sup> Includes SWE audit costs.

Table 2-16 compares PY13 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 C*.

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

Savings	EE&C Plan Projections	VTD Gross Savings	Ratio (Actual/Plan)
PY13 Portfolio MWh/yr	292,089	168,786	58%
PIV TD MWh/yr	292,089 <sup>(1)</sup>	168,786 <sup>(1)</sup>	58%
PY13 Portfolio MW/yr (System-Level)	46.92	25.89	55%
PIV TD MW/yr (System-Level)	46.92	25.89	55%

Source: PPL Electric Utilities Phase IV EE&C Plan, Table 4 and Table 5.  
<sup>(1)</sup> Excludes Phase III carryover.

### 2.10.1 Program Summary

The reasons program savings in PY13 varied from projections estimated in the EE&C Plan are summarized below. Additional details can be found in the individual program chapters and component appendices.

#### *Non-Residential Program Components*

The Non-Residential Program achieved 52% of the energy savings projections and 56% of the demand reductions estimated in the EE&C Plan for PY13. The small stratum of the Custom component was not verified in PY13, leaving just over 3,000 MWh/yr and 0.56 MW/yr unverified (about 8% of total reported savings and 9% of total demand reductions for the component).

Both Efficient Equipment and Custom components did not meet planned savings in PY13, but savings for the Custom component were much lower (about 60%) even accounting for the unverified savings from the small stratum. PY13 participation was also lower than projected for both components. For the Non-Residential Program, the energy realization rate was 105% and demand reduction realization rate was 96%.

## *Residential Program Components*

In PY13, the Residential Program achieved approximately 83% of the energy savings projections and 49% of the projected demand reductions estimated in the EE&C Plan for PY13 due to two main factors. The New Homes offering was not verified in PY13, so almost 3,000 MWh/yr and 1.22 MW/yr were unverified. No savings were reported for audit and weatherization measures in the PPL Electric Utilities' tracking database as initially planned; the program will instead report these savings in PY14 in the Energy Efficient Homes component. Participation was also lower than projected for all components (Appliance Recycling, Efficient Lighting, Energy Efficient Homes, and Student Energy Efficient Education), which limited savings.

The energy and demand realization rates were near 100% for the Program overall. The Student Energy Efficient Education component had a realization rate for demand of 89% (the only component with a realization rate below 100%) due to lower than planned installation rates.

## *Low-Income Program*

In PY13, the Low-Income Program contributed energy savings of 15% of the Phase IV Low-Income compliance target. This combined with the carryover from Phase III brings the Low-Income Program to 57% of the Phase IV Low-Income compliance target, with four additional years to achieve the remaining 43%. Assuming energy savings achievements for the proceeding years continues 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 89% and the demand realization rate was 88%. The factors that led to differences between reported and verified savings and the overall realization rate for the Low-Income Program in PY13 are included in *6.2 Gross Impact Evaluation*.

## 2.10.2 PY14 Program Changes

PPL Electric Utilities has made the following program changes in PY14.

### *Non-Residential Program Components*

**Custom.** This program component will continue in PY14 to offer rebates to both large C&I and small C&I customers for projects not included in the PA TRM.

**Efficient Equipment.** This program component will continue to offer incentives through downstream and midstream delivery channels. New in PY14 is the expansion of midstream to include distributor networks for food service, HVAC, and agriculture measures. Direct Discount has also created a Rapid Review option for qualified contractors to expedite the preapproval timeframe to five days.

### *Residential Program Components*

**Appliance Recycling.** This component will continue to offer customers the choice to schedule a contactless or in-home appliance pick-up. In addition, small appliance recycling events will be scheduled throughout PPL Electric Utilities' territory.

**Efficient Lighting.** This program component will continue to encourage customers to purchase and install specialty LED bulbs from local retail stores. Specialty lighting products are also offered on the Online Marketplace.

**Energy Efficient Home.** The midstream delivery channel for HVAC projects will officially launch in PY14. PPL Electric Utilities will continue to offer downstream incentives through the new homes, in-home audit and weatherization, and efficient equipment channels, measures through the Online Marketplace, and the comprehensive retrofit bonus and remote assessments. Two pilots will be in development in PY14. The Deep Energy Retrofits Pilot will identify barriers to customer participation in comprehensive measure packages and test several delivery approaches intended to mitigate these barriers and encourage higher homeowner participation and trade ally adoption. The Net Zero Energy Homes Pilot will provide financial and technical support to construct one to three net zero energy homes to demonstrate the successful implementation of residential new construction net zero standards in PPL Electric Utilities' territory.

**Student Energy Efficient Education.** This component will continue to offer education and energy efficiency kits to students. The program is planning to reintroduce hands-on activities with students and will reassess as needed.

### *Low-Income Program*

**Low-Income.** This program will continue to offer low- and no-cost energy-saving improvements and education to income-eligible customers residing in single-family homes, individually metered multifamily units, and manufactured homes. PPL Electric Utilities will continue to offer in-home and remote assessments. The program will also offer comprehensive measures through the in-home delivery channel. In PY14, the program will focus on increasing participation with in-home direct installations, comprehensive measures, and a renewed effort to reach multifamily customers.

## *2.11 Findings and Recommendations*

Impact and process evaluation activities completed by Cadmus led to recommendations for portfolio and program improvement. Cadmus verified energy savings and demand reductions, component logic model review, and participant surveys to inform the following portfolio-wide conclusion and recommendations. Specific recommendations and status updates for each program are in their respective sections.

**Conclusion:** PPL Electric Utilities successfully launched all energy efficiency programs for Phase IV Act 129 in PY13. Programs are operating effectively, meeting most of their program objectives, and achieving high participant satisfaction, but achieved savings are behind plans.

- **Recommendation 1a:** Continue focusing on ways to revise marketing activities across the portfolio to increase customer awareness of energy efficiency rebates and to remind customers of available opportunities.
- **Recommendation 1b:** Continue to cross-promote programs and components with existing program participants.



- **Recommendation 1c:** Continue to work with trade allies and other program component representatives to encourage customers to install energy-savings measures with deeper savings opportunities.

**EDC status:** PPL Electric Utilities is implementing these recommendations.

### 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 PY13 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.<sup>10</sup> 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.<sup>11</sup>

**Table 3-1. PY13 and Phase IV Program and Portfolio Total Finances (\$1,000)**

Program	Incentives	Non-Incentives	Total Cost
Non-Residential	\$6,346	\$4,686	\$11,031
Low-Income	\$2,174	\$3,041	\$5,215
Residential	\$4,446	\$3,465	\$7,911
<b>Common Portfolio Costs <sup>(1)</sup></b>	-	<b>\$6,004</b>	\$6,004
<b>Portfolio Total</b>	<b>\$12,965</b>	<b>\$17,196</b>	<b>\$30,161</b>
<b>SWE Costs <sup>(2)</sup></b>	-	-	\$396
<b>Total</b>	<b>\$12,965</b>	<b>\$17,196</b>	<b>\$30,557</b>

<sup>(1)</sup> 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.

<sup>(2)</sup> 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 3-2 and the information presented in 2.3. *Phase IV Performance by Customer Segment*.

<sup>10</sup> 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/pdocs/1676672.docx>

<sup>11</sup> 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.

For example, the low-income customer segment is a subset of PPL Electric Utilities’ residential tariff(s) and therefore is not listed in Table 3-2.

**Table 3-2. EE&C Plan Expenditures by Cost-Recovery Category (\$1,000)**

Cost Recovery Sector	Rate Classes Included	PY13 Spending <sup>(1)</sup>	P4TD Spending <sup>(1)</sup>
Residential & Low-Income (100/200)	Residential (primarily RS)	\$16,693	\$16,693
Small C&I (300)	Small C&I (primarily GS1 & GS3)	\$9,670	\$9,670
Large C&I (400)	Large C&I (primarily LP4 & LP5)	\$2,137	\$2,137
GNE	Residential, Small C&I, and Large C&I	\$2,057	\$2,057
<b>Portfolio Total</b>	-	<b>\$30,557</b>	<b>\$30,557</b>
<sup>(1)</sup> Includes costs for SWE audit.			

## 4 Evaluation Activities

This section documents the gross impact and process evaluation activities conducted in PY13. 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. PY13 Evaluation Activity Matrix**

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

### 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 PY14, 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
<b>Non-Residential</b>						
Custom Large	Sampling	Impact	Impact	Impact	Impact	Impact
	Reporting	V	V	V	V	V
Custom Small	Sampling	Two-year sample <sup>(2)</sup>		Two-year sample <sup>(2)</sup>		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 <sup>(1)</sup>	Impact	Impact	Two-year sample <sup>(2)</sup>	
	Reporting		V	V	U	V
Efficient Equipment Lighting (Downstream and Midstream)	Sampling	Impact	Impact	Impact	Two-year sample <sup>(2)</sup>	
	Reporting	V	V	V	U	V
<b>Low-Income</b>						
Low-Income (Welcome Kits and Remote Energy Assessments)	Sampling	Impact	Impact	None	Two-year sample <sup>(2)</sup>	
	Reporting	V	V	H	U	V
Low-Income (In-home Assessments) <sup>(3)</sup>	Sampling	Two-year sample <sup>(2)</sup>		None	Two-year sample <sup>(2)</sup>	
	Reporting	U	V	H	U	V
<b>Residential</b>						
Appliance Recycling (Refrigerators and Freezers)	Sampling	Impact	None	Impact	None	None
	Reporting	V	H	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 <sup>(1)</sup>	Impact	None	Impact	None
	Reporting		V	H	V	H
Energy Efficient Home (Midstream Equipment)	Sampling	None <sup>(1)</sup>	Impact	Impact	Two-year sample <sup>(2)</sup>	
	Reporting		V	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	None	None	Impact	None
	Reporting	V	H	H	V	H
Energy Efficient Home (New Homes) <sup>(4)</sup>	Sampling	Two-year sample <sup>(2)</sup>		Impact	None	None
	Reporting	U	V	V	H	H
Efficient Lighting (Lighting)	Sampling	Impact	None	Impact	None	None
	Reporting	V	H	V	H	H
Student Energy Efficient Education (All Strata)	Sampling	Impact	None	None	Impact	None
	Reporting	V	H	H	V	H
<p>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.  <sup>(1)</sup> PPL Electric Utilities did not report participation for this program component in PY13 so Cadmus adjusted the PY13 plans.  <sup>(2)</sup> 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.  <sup>(3)</sup> Due to timing, Cadmus did not verify in-home assessments and will verify these in PY14.  <sup>(4)</sup> Cadmus adjusted the evaluation plan for this component.</p>						

Impact evaluation activities varied by program in PY13. Table 4-3 lists the impact evaluation activities conducted for each program component in PY13. The individual program chapters and corresponding appendices discuss the impact evaluation activities, methodology, analysis, and findings.

**Table 4-3. PY13 Impact Evaluation Activities by Program Component**

Program and Component	Database Review	Desk Reviews	Site Visits	Metering	Engineering Analysis	Billing Analysis
<b>Non-Residential Program</b>						
Custom	✓	✓	✓	✓	✓	✓
Efficient Equipment Non-Lighting (downstream)	✓	✓	✓	✓	✓	
Efficient Equipment Lighting (downstream)	✓	✓	✓	✓	✓	
Efficient Equipment Non-Lighting (midstream)						
Efficient Equipment Lighting (midstream)	✓	✓		✓	✓	
<b>Low-Income Program</b>						
Low-Income Assessment	✓	✓			✓	
<b>Residential Program</b>						
Appliance Recycling	✓				✓	
Efficient Lighting	✓				✓	
Energy Efficient Homes New Homes	✓					
Energy Efficient Homes Audit and Weatherization						
Energy Efficient Homes Equipment (downstream)	✓	✓			✓	
Energy Efficient Homes (midstream)						
Energy Efficient Homes Online Marketplace	✓	✓			✓	
Student Energy Efficient Education	✓				✓	

## 4.2 Process Evaluation

This section summarizes the process evaluation activities of PPL Electric Utilities’ PY13 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 PY13, 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. PY13 Portfolio Process Evaluation Activities by Component**

Program and Component	Completed Participant Survey <sup>(1)</sup>	Participant Satisfaction Analysis	Stakeholder Interviews/ Feedback	Trade Ally Interviews	Market Actor Interviews	Logic Model Review	Secondary Research
<b>Non-Residential Program</b>							
Custom	3	✓	✓			✓	
Efficient Equipment Non-Lighting (downstream)	3	✓	✓			✓	
Efficient Equipment Lighting (downstream)	25	✓	✓			✓	
Efficient Equipment Non-Lighting (midstream)			✓				
Efficient Equipment Lighting (midstream)			✓			✓	
<b>Low-Income Program</b>							
Low-Income Assessment	113	✓	✓			✓	
<b>Residential Program</b>							
Appliance Recycling	344	✓	✓			✓	
Efficient Lighting		✓	✓		9	✓	✓
Energy Efficient Homes New Homes		✓	✓	16		✓	
Energy Efficient Homes Audit and Weatherization			✓				
Energy Efficient Homes Equipment (downstream)	304	✓	✓			✓	
Energy Efficient Homes (midstream)			✓				
Energy Efficient Homes Online Marketplace	94	✓	✓			✓	
Student Energy Efficient Education	14,929	✓	✓			✓	
<b>Total</b>	<b>15,815</b>	<b>N/A</b>	<b>N/A</b>	<b>16</b>	<b>9</b>	<b>N/A</b>	<b>N/A</b>
<sup>(1)</sup> 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.							

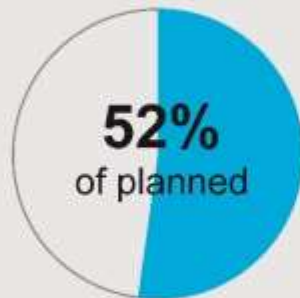
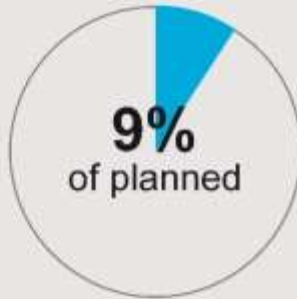


## NON-RESIDENTIAL PROGRAM

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

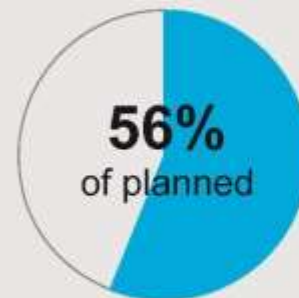
Phase IV has saved **126,597 MWh/yr**



PY13 saved **126,597 MWh/yr**

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **20.58 MW/yr**



PY13 has reductions of **20.58 MW/yr**

### PY13 PARTICIPATION

A total of **5,317** participants



**36** Custom

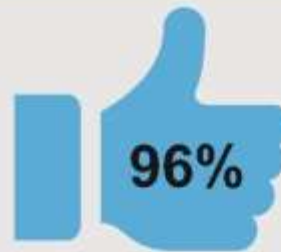


**32** Efficient Equipment Non-Lighting



**5,249** Efficient Equipment Lighting

### PARTICIPANT SATISFACTION



**96%**

Satisfied with overall program

**100%**

satisfied with Custom

**93%**

satisfied with Efficient Equipment

## 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. In PY13, PPL Electric Utilities did not report any midstream non-lighting participation.
- **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 PY13 by customer segment.

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

Parameter	Residential (Non-LI)	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total <sup>(1)</sup>
PYTD # Participants	74	3,002	871	1,370	5,317
PYRTD MWh/yr	327	77,878	30,190	14,761	123,157
PYRTD MW/yr	0.09	13.17	4.62	2.48	20.37
PYVTD MWh/yr	186	80,634	29,567	16,210	126,597
System-Level PYVTD MW/yr	0.03	13.79	4.08	2.68	20.58
PY13 Incentives (\$1000)	\$41	\$5,224	\$627	\$454	\$6,346

<sup>(1)</sup> Total may not sum due to rounding.

### 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 5-2 and Table 5-3 show the gross energy savings and demand reductions realization rates for components of the Non-Residential Program in PY13. Additional details about the evaluation approach and findings are presented in *Appendix D* and *Appendix E*.

**Table 5-2. Non-Residential Gross Impact Results for Energy**

Component	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 90% C.L. <sup>(2)</sup>	PYVTD (MWh/yr)
Custom	37,267	100%	-	0.00%	37,267
Efficient Equipment Non-Lighting	1,760	85%	0.18	4.45%	1,491
Efficient Equipment Lighting	81,081	108%	0.19	8.29%	87,839
<b>Program Total <sup>(3) (4)</sup></b>	<b>120,109</b>	<b>105%</b>	<b>-</b>	<b>5.74%</b>	<b>126,597</b>
Custom Unverified	3,048	-	-	-	-
<b>Verified + Unverified Total <sup>(3) (4)</sup></b>	<b>123,157</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>126,597</b>

<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.  
<sup>(2)</sup> 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.  
<sup>(3)</sup> Savings may not match other tables or figures due to rounding.  
<sup>(4)</sup> Totals may not sum due to rounding.

**Table 5-3. Non-Residential Gross Impact Results for Demand**

Component	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 90% C.L. <sup>(2)</sup>	PYVTD (MW/yr)	System- Level PYVTD (MW/yr)
Custom	5.84	100%	-	0.00%	5.84	6.30
Efficient Equipment Non-Lighting	0.23	88%	0.15	3.77%	0.20	0.22
Efficient Equipment Lighting	13.75	95%	0.71	7.70%	13.08	14.07
<b>Program Total <sup>(3) (4)</sup></b>	<b>19.81</b>	<b>96%</b>	<b>N/A</b>	<b>5.26%</b>	<b>19.11</b>	<b>20.58</b>
Custom Unverified	0.56	-	-	-	-	-
<b>Verified + Unverified Total <sup>(3) (4)</sup></b>	<b>20.37</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>19.11</b>	<b>20.58</b>

<sup>(1)</sup> 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.  
<sup>(2)</sup> 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.  
<sup>(3)</sup> Savings may not match other tables or figures due to rounding.  
<sup>(4)</sup> 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 adjustment with the greatest effect on the overall realization rate was to fan measures where fan horsepower was incorrectly reported as too high. While not consistent measure by measure, these adjustments caused a decrease in savings.
- For lighting projects, inconsistencies between the reported and verified hours of use, coincidence factors, 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,<sup>12</sup> 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 PY13 and used a historic NTG ratio of 0.62 from PY11.<sup>13</sup> 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 5-4 presents NTG ratios for the components of the Non-Residential Program in PY13.

**Table 5-4. Non-Residential Net Impact Evaluation Results**

Component	Program Year	PYVTD (kWh/yr)	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision (@ 85% CL)
Custom	PY13	37,267,035	78%	0%	0.22	97%
Efficient Equipment Non-Lighting	PY13	1,491,197	33%	0%	0.67	89%
Efficient Equipment Lighting	PY13	63,814,470	23%	0%	0.77	35%
Midstream Lighting	PY11	24,024,628	38%	0%	0.62	-
<b>Program Total</b>	-	<b>126,597,329<sup>(1)</sup></b>	<b>42%<sup>(2)</sup></b>	<b>0%<sup>(2)</sup></b>	<b>0.58<sup>(2)</sup></b>	<b>23%</b>
<sup>(1)</sup> May not sum due to rounding.						
<sup>(2)</sup> Weighted by PY13 component verified gross energy savings.						

The PY13 Non-Residential Program total NTG ratio of 0.58 is heavily weighted toward the non-Custom component NTG ratios, as the non-Custom component represents 71% of the program’s verified gross population energy savings.

#### 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 combined heat and power (CHP) projects. Commercial lighting contributes more than 5% to the sector and portfolio and is

<sup>12</sup> 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.

<sup>13</sup> 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.

considered a high-impact measure. Overall, the NTG research for high-impact measures represents 80% of the total Non-Residential Program verified gross energy savings in PY13.

Table 5-5 presents findings for PY13 high-impact measures.

**Table 5-5. PY13 Non-Residential High-Impact Measure Net-to-Gross**

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Custom <sup>(1)</sup>	78% <sup>(2)</sup>	0%	0.22
Combined Heating and Power (CHP) <sup>(3)</sup>	N/A	N/A	N/A
Efficient Equipment Lighting <sup>(1)</sup>	23% <sup>(2)</sup>	0%	0.77
<b>Total</b>	<b>43% <sup>(4)</sup></b>	<b>0%</b>	<b>0.57</b>

<sup>(1)</sup> Estimated from PY13 survey data.  
<sup>(2)</sup> Weighted by the survey sample-verified program kWh/yr savings.  
<sup>(3)</sup> CHP projects are included in the Custom Program. No PY13 CHP participants completed a survey.  
<sup>(4)</sup> Weighted by verified gross energy savings of high-impact measure population.

### 5.4 Verified Savings Estimates

In Table 5-6, 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 Non-Residential Program in PY13. These totals are added to the verified savings achieved in previous program years to calculate the P4TD program impacts.

**Table 5-6. PY13 and P4TD Savings Summary**

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	123,157	20.37
PYVTD Gross	126,597	20.58 <sup>(1)</sup>
PYVTD Net	73,230	11.66 <sup>(1)</sup>
PY Unverified	3,048	0.56
RTD	123,157	20.37
VTD Gross	126,597	20.58 <sup>(1)</sup>
VTD Net	73,230	11.66 <sup>(1)</sup>
Phase IV Unverified	3,048	0.56

<sup>(1)</sup> Verified peak demand reductions include application of distribution losses.

### 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 PY13 to assess participant satisfaction, inform the logic model review, 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 5-7. Modifications to Cadmus’ evaluation plans are noted in *Appendix D* and *Appendix E*.

**Table 5-7. Non-Residential Process Evaluation Activities**

Activity	Audience	Methodology
<b>Efficient Equipment Downstream Delivery Channels</b>		
In-depth Interviews	Administration staff (n=2)	Telephone
Survey	Participants (n=28)	Telephone and online
Logic Model Review and Update	N/A	In-depth interviews and secondary research
<b>Efficient Equipment Midstream Delivery Channel</b>		
In-Depth Interviews	Administration staff (n=2)	Telephone
Logic model review and Update (lighting only)	N/A	In-depth interviews and secondary research
<b>Custom</b>		
In-Depth Interviews	Administration staff (n=2)	Telephone
Survey	Participants (n=3)	Telephone and online
Logic Model Review and Update	N/A	In-depth interviews and secondary research

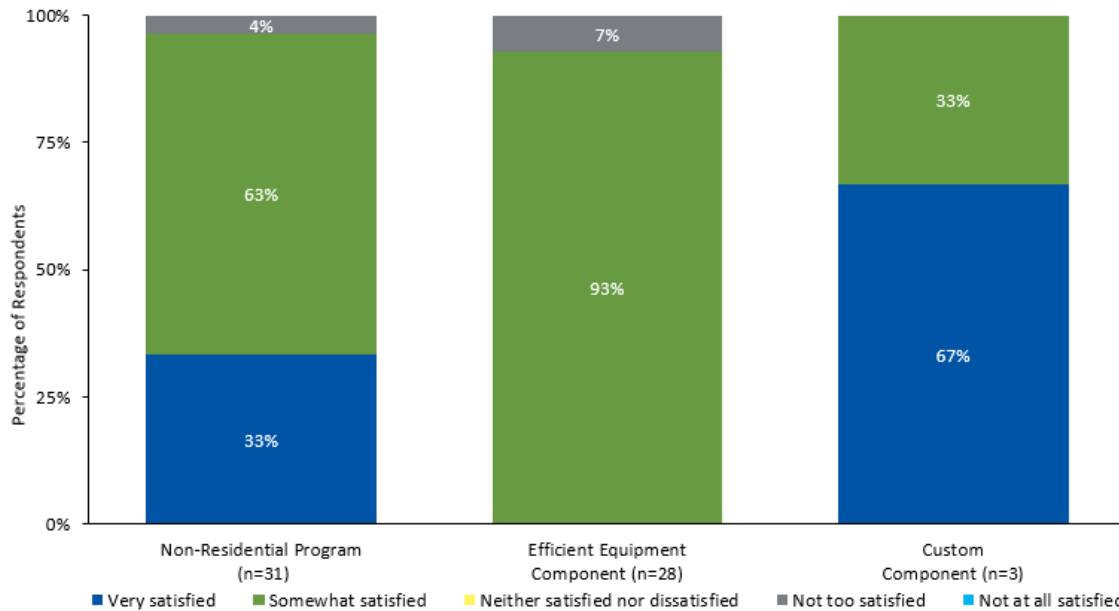
The staff interviews were conducted in February 2022 via phone, and the participant surveys were conducted between April and June 2022 via phone and online.

### 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.<sup>14</sup> As shown in Figure 5-1, 96% of Non-Residential survey respondents (n=31) were satisfied with their program experience.

<sup>14</sup> The customer satisfaction goal is stipulated in PPL Electric Utilities’ EE&C Plan (Docket No. M-2020-3020824) filed with the PA PUC, May 2021.

**Figure 5-1. PY13 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?”

Table 5-8 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 5-8. Non-Residential Program Key Process Evaluation Findings**

Program Component	Finding
Efficient Equipment Downstream Equipment	<ul style="list-style-type: none"> <li>Most of the respondents (93%) indicated that they were satisfied with the PPL Efficient Equipment downstream program (See <i>Program Component Satisfaction and Customer Effort</i> section in <i>D.3.1.</i>)</li> <li>A majority (88%) of the respondents indicated that it was easy to participate in the PPL Efficient Equipment downstream program. (See <i>Program Satisfaction and Customer Effort</i> section in <i>D.3.1.</i>)</li> <li>The rebate amount was the main driver for high satisfaction. (See <i>Drivers of Program Component Satisfaction</i> section in <i>D.3.1.</i>)</li> <li>Two of five respondents said that they needed more clarity on the rebate and how the program works, and one respondent suggested increasing the rebate amount. (See <i>Areas for Improvement</i> section in <i>D.3.1.</i>)</li> </ul>
Custom	<ul style="list-style-type: none"> <li>Two out of three respondents indicated that they were <i>very satisfied</i> with the PPL Electric Utilities Custom rebate program, while the other respondent said that they were <i>somewhat satisfied</i> (n=3). (See <i>E.3.1 Component Experience</i>.)</li> <li>A majority (two of three) of the respondents indicated that it was easy to participate in the Custom program. (See <i>E.3.1 Component Experience</i>.)</li> <li>Communication with PPL Electric Utilities and CLEAResult was a common driver for high satisfaction. (See <i>Drivers of Component Satisfaction</i> section in <i>E.3.1.</i>)</li> <li>One out of three respondents mentioned that it was disappointing that they could not track the rebate process in the portal, and they had to directly reach out to a representative to receive an update on their check. (See <i>Improvement Suggestions</i> section in <i>E.3.2.</i>)</li> </ul>



## 5.6 Program Finances and Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 5-9. The TRC benefits were calculated using gross verified impacts. Net present value (NPV) PY13 costs and benefits are expressed in 2021 dollars. Net present value costs and benefits for P4TD financials are expressed in the 2016 dollars.

**Table 5-9. Summary of Non-Residential Program Finances – Gross Verified**

Row	Cost Category <sup>(1)</sup>	PYTD (\$1,000)		P4TD <sup>(2)</sup> (\$1,000)	
<b>1</b>	<b>IMCs</b>	<b>\$34,924</b>		<b>\$34,924</b>	
2	Rebates to Participants and Trade Allies	\$5,341		\$5,341	
3	Upstream/Midstream Incentives	\$1,003		\$1,003	
4	Material Cost for Self-Install Programs (EE&C Kits)	--		--	
5	Direct Installation Program Materials and Labor	\$2		\$2	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5) <sup>(6)</sup>	\$28,578		\$28,578	
		<b>EDC</b>	<b>CSP</b>	<b>EDC</b>	<b>CSP</b>
7	Program Design	--	--	--	--
8	Administration and Management <sup>(3)</sup>	\$156	\$1,699	\$156	\$1,699
9	Marketing	--	\$570	--	\$570
10	Program Delivery <sup>(4)</sup>	--	\$2,260	--	\$2,260
11	EDC Evaluation Costs	--		--	
12	SWE Audit Costs	--		--	
<b>13</b>	<b>Program Overhead Costs <sup>(5)</sup> (Sum of rows 7 through 12) <sup>(6)</sup></b>	<b>\$4,686</b>		<b>\$4,686</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13) <sup>(5)</sup> <sup>(6)</sup></b>	<b>\$39,609</b>		<b>\$39,609</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$55,087		\$55,087	
16	Total NPV Lifetime Electric Capacity Benefits	\$35,336		\$35,336	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$0		\$0	
18	Total NPV Lifetime Fossil Fuel Impacts	\$1,109		\$1,109	
19	Total NPV Lifetime Water Impacts	\$1		\$1	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19) <sup>(6)</sup></b>	<b>\$91,533</b>		<b>\$91,533</b>	
<b>21</b>	<b>TRC Benefit-Cost Ratio (Row 20 divided by Row 14)</b>	<b>2.31</b>		<b>2.31</b>	

<sup>(1)</sup> Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = \$2021.

<sup>(2)</sup> P4TD benefits does not include carry-over energy savings from Phase III.

<sup>(3)</sup> Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

<sup>(4)</sup> 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.

<sup>(5)</sup> Portfolio-level costs are not assigned to specific programs.

<sup>(6)</sup> Sum of rows may not add up to total due to rounding.

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

Row	Cost Category <sup>(1)</sup>	PYTD (\$1,000)		P4TD <sup>(2)</sup> (\$1,000)	
<b>1</b>	<b>IMCs</b>	<b>\$21,166</b>		<b>\$21,166</b>	
2	Rebates to Participants and Trade Allies	\$5,341		\$5,341	
3	Upstream/Midstream Incentives	\$1,003		\$1,003	
4	Material Cost for Self-Install Programs (EE&C Kits)	--		--	
5	Direct Installation Program Materials and Labor	\$2		\$2	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)	\$14,820		\$14,820	
		<b>EDC</b>	<b>CSP</b>	<b>EDC</b>	<b>CSP</b>
7	Program Design	--	--	--	--
8	Administration and Management <sup>(3)</sup>	\$156	\$1,699	\$156	\$1,699
9	Marketing	--	\$570	--	\$570
10	Program Delivery <sup>(4)</sup>	--	\$2,260	--	\$2,260
11	EDC Evaluation Costs	--		--	
12	SWE Audit Costs	--		--	
<b>13</b>	<b>Program Overhead Costs <sup>(5)</sup> (Sum of rows 7 through 12)</b>	<b>\$4,686</b>		<b>\$4,686</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13) <sup>(5)</sup> <sup>(6)</sup></b>	<b>\$25,851</b>		<b>\$25,851</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$32,033		\$32,033	
16	Total NPV Lifetime Electric Capacity Benefits	\$19,587		\$19,587	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$0		\$0	
18	Total NPV Lifetime Fossil Fuel Impacts	\$3,113		\$3,113	
19	Total NPV Lifetime Water Impacts	\$1		\$1	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19)</b>	<b>\$54,734</b>		<b>\$54,734</b>	
<b>21</b>	<b>TRC Benefit-Cost Ratio (Row 20 divided by Row 14)</b>	<b>2.12</b>		<b>2.12</b>	

<sup>(1)</sup> Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = \$2021

<sup>(2)</sup> P4TD benefits does not include carry-over energy savings from Phase III

<sup>(3)</sup> Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

<sup>(4)</sup> 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.

<sup>(5)</sup> Portfolio-level costs are not assigned to specific programs.

<sup>(6)</sup> Sum of rows may not add up to total due to rounding.

## 5.7 Status of Recommendations

Overall, the Non-Residential Program in PY13 launched successfully and continued to deliver reliable savings and receive positive ratings from participants. The program achieved 20.58 MWh/yr in demand reductions and 126,597 MWh/yr in verified energy savings. In addition, the program reported another 0.56 MW/yr and 3,048 MWh/yr from the Custom component that will be evaluated in PY14. The majority of participants (96%) were *very* or *somewhat satisfied* with the component in which they participated.

Recommendations are provided in Table 5-11, along with a summary of how PPL Electric Utilities plans to address the recommendation.

**Conclusion 1:** The method of calculating hours of use (HOU) and coincidence factor (CF) for reported savings for threshold lighting projects should consistently use meter data analysis to reduce adjustments to verified savings

- In 6 out of 8 threshold efficient equipment lighting projects the reported and verified HOU and CF calculated using metered data did not match. The inconsistencies varied by project with some seeing increases and some seeing decreases in savings. See *Appendix D.1.2 Gross Impact Results*.

**Conclusion 2:** Hardcode values in the logger analysis workbooks instead of linking data with formulas leads to errors.

- Lighting logger analysis workbooks included with project documentation contained hardcoded values instead of formulas. This meant that when discrepancies arose it wasn't possible to find the source of the discrepancy. Errors occurred in 6 of 8 threshold projects. See *Appendix D.1.2 Gross Impact Results*.

**Conclusion 3:** The realization rates for 1/3 of non-threshold lighting projects were impacted because light switch controlled exterior lighting was mislabeled.

- In 10 of 33 Efficient Equipment lighting projects without light logger data, the 'Exterior, Photocell-Controlled' facility type was used for exterior lighting controlled by light switch instead of the 'Exterior' facility type which assumes no photosensors. See *Appendix D.1.2 Gross Impact Results*.

**Conclusion 4:** The facility types recorded in PPL Electric Utilities participant tracking database for Midstream lighting projects were inconsistent with the verified site facility type.

- For 25 of 32 sampled projects, the facility type in the PPL Electric Utilities participant tracking database did not match verified facility types. See *Appendix D.1.2 Gross Impact Results*.

**Conclusion 5:** Non-lighting projects had incorrectly reported horsepower values which resulted in a substantial reduction in realization rates to the projects.

- In 10 of 14 sampled fan control projects, applicants reported the individual fan horsepower as the sum of all fans' horsepower. The applicants did not set the fan quantity to one, so the controlled fan horsepower was artificially increased by a large factor. This caused varying realization rates from 5% to 20% in each project. See *Appendix D.1.2 Gross Impact Results*.

**Conclusion 6:** The overall realization rate for non-lighting projects was affected by one gas water heater project which was ineligible and received no verified savings.

- For one Efficient Equipment non-lighting project, a non-eligible gas water heater received incentives for the electric-only measure low flow pre-rinse sprayer. See *Appendix D.1.2 Gross Impact Results*.

The impact and process evaluation activities in PY13 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 5-11).

**Table 5-11. Status of Recommendations for the Non-Residential Program**

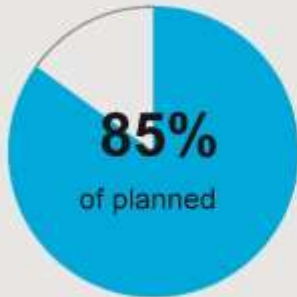
Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Efficient Equipment Lighting	<b>Conclusion 1:</b> The method of calculating hours of use (HOU) and coincidence factor (CF) for reported savings for threshold lighting projects should consistently use meter data analysis to reduce adjustments to verified savings	<b>Recommendation 1:</b> Use the metered HOU and CF data from the meter data analysis workbook instead of approximating with the custom schedule.	Being considered
Efficient Equipment Lighting	<b>Conclusion 2:</b> Hardcode values in the logger analysis workbooks instead of linking data with formulas leads to errors.	<b>Recommendation 2:</b> Use formulas in the logger analysis workbooks instead of using hardcoded values	Being considered
Efficient Equipment Lighting	<b>Conclusion 3:</b> The realization rates for 1/3 of non-threshold lighting projects were impacted because light switch controlled exterior lighting was mislabeled.	<b>Recommendation 3:</b> Use the appropriate control and facility type for exterior lighting to ensure accurate results and reduce errors resulting in adjustments to realization rates.	Being considered
Efficient Equipment Midstream Lighting	<b>Conclusion 4:</b> The facility types recorded in PPL Electric Utilities participant tracking database for Midstream lighting projects were inconsistent with the verified site facility type.	<b>Recommendation 4:</b> Incorporate facility type into the data collection process to achieve more accurate facility type data.	Being considered
Efficient Equipment Non-Lighting	<b>Conclusion 5:</b> Non-lighting projects had incorrectly reported horsepower values which resulted in a substantial reduction in realization rates to the projects.	<b>Recommendation 5:</b> Compare refrigeration measure motor horsepower and quantity inputs used in their reported savings with the invoices and cutsheets and make adjustments.	Being considered
Efficient Equipment Non-Lighting	<b>Conclusion 6:</b> The overall realization rate for non-lighting projects was affected by one gas water heater project which was ineligible and received no verified savings.	<b>Recommendation 6:</b> Provide more guidance in program manuals for measures with electricity/gas only eligibility.	Being considered

## 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 41,538 MWh/yr\*

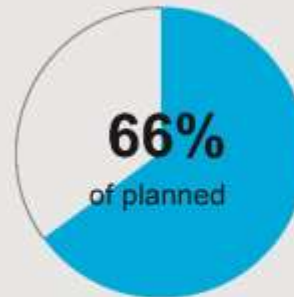
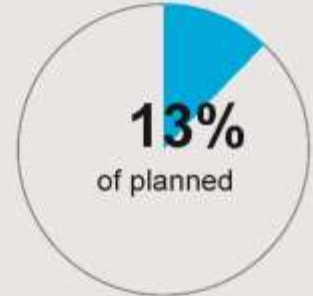


PY13 saved 10,449 MWh/yr

\*Includes Phase III carryover energy savings

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of 1.23 MW/yr



PY13 has reductions of 1.23 MW/yr

### PY13 PARTICIPATION



A total of 28,883 jobs completed

**3,057** households received baseload jobs

**4,187** households received low-cost jobs

**21,639** households received Welcome Kits

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

### PARTICIPANT SATISFACTION



**85%**

Satisfied with overall program

## 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.<sup>15,16</sup>

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, 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.

**Table 6.1. Low-Income Program Summary**

Program	Target Market	Eligibility Requirements	Delivery Channels	Participant Definition
<b>Remote Energy Assessment (REA)<sup>(1)</sup></b>	Income-eligible residential customers	Customers in PPL Electric Utilities’ territory; household income must be at or below 150% of the Federal Poverty Guidelines; 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
<b>Direct Install</b>			In-home energy assessment and direct installation of measures	Customers who receive an in-home energy assessment
<b>Welcome Kits</b>		Customers in PPL Electric Utilities’ territory; household income must be at or below 150% of the Federal Poverty Guidelines	Kit mailed to customer	Customers who receive a welcome kit

<sup>(1)</sup> Both remote and in-home energy assessments were completed in PY13. One in-home assessment was completed at the time of the survey (conducted in Q1, Q2, and Q3), but data were not available in time to be included in the survey sample. Only remote energy assessments (REAs) were analyzed and included in this report.

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 products and services along with criteria to determine if appliances and other large equipment can be

<sup>15</sup> Household income must be at or below 150% of the Federal Poverty Guidelines.

<sup>16</sup> 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.



replaced cost-effectively. They also provide energy education and make recommendations to encourage customers to conserve energy.

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

In the spring of 2022, the ICSP began to offer in-home assessments as well as remote assessments via telephone. The assessment, whether in-person or by telephone, involves visiting each room in the home and asking questions of the resident about the home’s energy-using equipment to gather information about the home’s water heater and heating fuel type, number and type of light bulbs in each room, and number of showers and sinks. Technicians 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 assessment is completed in-home, contractors directly install equipment.

PPL Electric Utilities provides three types of service (also known as job types) at no cost to the income-qualified customer. 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 electrically heated water. The welcome kit is offered to any eligible customer.

## 6.1 Participation and Reported Savings by Customer Segment

Table 6.2 presents 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 that receive a welcome kit and/or a home assessment and program services.

**Table 6.2. PY13 Low-Income Program Participation and Reported Impacts**

Parameter	Residential Low-Income	Total
PY13 # Participants <sup>(1)</sup>	25,682	<b>25,682</b>
PYRTD MWh/yr	11,840	<b>11,840</b>
PYRTD MW/yr	1.29	<b>1.29</b>
PYVTD MWh/yr	10,449	<b>10,449</b>
System-Level PYVTD MW/yr	1.23	<b>1.23</b>
PY13 Incentives (\$1000)	\$2,174	<b>\$2,174</b>
<sup>(1)</sup> This count is based on unique household participants.		



## 6.2 Gross Impact Evaluation

In PY13, the Low-Income Program reported energy savings of 11,840 MWh/yr and achieved a program energy realization rate of 89%, weighted by stratum, as shown in Table 6.3. The program reported demand reductions of 1.29 MW/yr and achieved a program demand realization rate of 88%, as shown in Table 6.4. Both tables are shown by program stratum (job type). Cadmus aggregated participant level measures and associated savings where individual households participated in more than one stratum. For example, if a customer received a welcome kit and a remote energy assessment, then all savings for that customer were rolled up into the remote energy assessment stratum. The delivery channel hierarchy follows as such, in ascending order: welcome kit, remote energy assessment, in-home assessment.

Home assessment data are shown only for remote energy assessments (REAs). Additional savings from in-home assessments were unverified due to timing, as these data were not available until the participant survey was completed in Q3. Cadmus will verify and analyze in-home assessment savings in PY14.

**Table 6.3. Low-Income Program Gross Impact Results for Energy**

Stratum	PYRTD MWh/yr <sup>(1)</sup>	Energy Realization Rate <sup>(2)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr) <sup>(3)</sup>
<b>Remote Energy Assessment</b>					
REA – Baseload	3,880	84%	1.02	3%	3,266
REA – Low-Cost	7,511	91%	1.68	5%	6,842
<b>REA Subtotal <sup>(4)</sup></b>	<b>11,391</b>	<b>89%</b>	<b>1.57</b>	<b>3%</b>	<b>10,109</b>
<b>Welcome Kits</b>					
Welcome Kits	346	98%	0	0%	340
<b>Welcome Kits Subtotal<sup>(4)</sup></b>	<b>346</b>	<b>98%</b>	<b>0</b>	<b>0%</b>	<b>340</b>
<b>Program Total <sup>(4)</sup></b>	<b>11,738</b>	<b>89%</b>	<b>0.98</b>	<b>3%</b>	<b>10,449</b>
<b>Unverified (in-home assessment)</b>	<b>103</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
<b>Total (Verified + Unverified) <sup>(4)</sup></b>	<b>11,840</b>	<b>89%</b>	<b>0.98</b>	<b>3%</b>	<b>10,449</b>

<sup>(1)</sup> Participants who received services through multiple channels were aggregated based on this ascending hierarchy:

welcome kit, remote energy assessment, in-home assessment. For example, if they received both a Welcome Kit and a remote energy assessment, they are included in the remote energy assessment stratum.

<sup>(2)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.

<sup>(3)</sup> Savings may not match other tables or figures due to rounding.

<sup>(4)</sup> Total may not match the sum of rows due to rounding.

**Table 6.4. Low-Income Program Gross Impact Results for Demand**

Stratum	PYRTD MW/yr <sup>(1)</sup>	Demand Realization Rate <sup>(2)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr) <sup>(3)</sup>	System- Level PYVTD (MW/yr)
<b>Remote Energy Assessment</b>						
REA – Baseload	0.43	84%	1.40	4%	0.36	0.40
REA – Low-Cost	0.81	90%	1.75	5%	0.72	0.79
<b>REA Subtotal <sup>(4)</sup></b>	<b>1.24</b>	<b>88%</b>	<b>1.70</b>	<b>3%</b>	<b>1.09</b>	<b>1.18</b>
<b>Welcome Kits</b>						
Welcome Kits	0.04	95%	0	0%	0.04	0.04
<b>Welcome Kits Subtotal <sup>(4)</sup></b>	<b>0.04</b>	<b>95%</b>	<b>0</b>	<b>0%</b>	<b>0.04</b>	<b>0.04</b>
<b>Program Total <sup>(4)</sup></b>	<b>1.28</b>	<b>88%</b>	<b>1.05</b>	<b>3%</b>	<b>1.13</b>	<b>1.23</b>
<b>Unverified (in-home assessment)</b>	<b>0.01</b>	-	-	-	-	-
<b>Total (Verified + Unverified) <sup>(4)</sup></b>	<b>1.29</b>	-	-	-	<b>1.13</b>	<b>1.23</b>
<sup>(1)</sup> Participants who received services through multiple channels were aggregated based on this ascending hierarchy: welcome kit, remote energy assessment, in-home assessment. For example, if they received both a Welcome Kit and a remote energy assessment, they are included in the remote energy assessment stratum. <sup>(2)</sup> 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. <sup>(3)</sup> Savings may not match other tables or figures due to rounding. <sup>(4)</sup> 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:

- Where the baseline bulb type was unknown or could not be verified, Cadmus assigned existing baseline bulb type to EISA 2020-backstop standard per the PA TRM.
- Cadmus based home occupancy rates on home assessment data.
- Cadmus used the home type recorded in the home assessment.
- Data on number of devices plugged into smart strips were missing from home assessment data. Cadmus assumed unspecified condition in unknown cases.

The ICSP reports existing baseline wattages in PPL Electric Utilities’ tracking database but not the existing baseline bulb type (incandescent, halogen, CFL, or EISA 2020-backstop bulb) nor how existing wattages were determined. Home assessments also do not record the existing baseline bulb type. The ICSP provided audio recordings of the assessment and supplemental data on baseline bulb type for sampled records. In some cases, the realization rate increased because the existing baseline bulb could be verified as a CFL, incandescent, or halogen bulb. In other cases, savings were lower due to unknown bulb type, for which Cadmus used the EISA 2020 baseline.

Cadmus found that the number of occupants, as reported in the home assessment records, was generally higher than the assumed number of occupants based on home type in the PA TRM. This substantially increased water heating savings for the REA stratum.

Cadmus also found that the reported number of occupants in PPL Electric Utilities’ tracking database data did not always match data recorded in home assessment records. Cadmus found differences in

eight of 17 sampled low-cost jobs and three of 17 sampled baseload jobs. In all cases, using data collected in the assessment records increased the savings.

Home type mapping is a proxy for occupants and the number of shower heads and faucets in a home, so these data are used as inputs in calculating savings for aerator, showerhead, and thermostatic shower restriction valve replacements. The PA TRM uses three home types—single-family, multifamily, and unknown—but in PY13 the ICSP reported more detailed home types. Cadmus mapped detached single-family homes to “single family” in the PA TRM and mapped row houses, duplexes, and other attached single-family homes to multifamily. Detached single-family homes had more occupants, more bathrooms, and more sinks on average.

Home assessment records did not always list the number of devices plugged into smart strips. As in Phase III, if a smart strip was installed in an entertainment center, but assessment records did not list the number of devices plugged in or the number of devices plugged in was less than three, then Cadmus used “unspecified.” This reduced savings and slightly lowered the overall realization rate for tier 1 smart strips. Using assessment data, Cadmus verified that 15 of 40 smart strips in the sample were tier 2. Tier 2 smart strips achieved greater savings than tier 1 smart strips when the number of devices plugged in was appropriate.

### 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

In Table 6.5 the realization rates and NTG ratios determined by Cadmus are applied to the reported energy savings and demand reductions estimates to calculate the verified savings estimates for the Low-Income Program in PY13. These totals are added to the verified savings achieved in previous program years to calculate the P4TD program impacts.

Due to the timing of participation, Cadmus did not verify energy savings and demand reductions for in-home assessments for PY13. Cadmus will verify all PY13 in-home assessment savings in PY14.

**Table 6.5. PY13 and P4TD Savings Summary**

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	11,840	1.29
PYVTD Gross	10,449	1.23 <sup>(1)</sup>
PYVTD Net	10,449	1.23 <sup>(1)</sup>
PY13 Gross Unverified	103	0.01
RTD	11,840	1.29
VTD Gross <sup>(2)</sup>	41,538	1.23 <sup>(1)</sup>
VTD Net <sup>(2)</sup>	41,538	1.23 <sup>(1)</sup>
Unverified Gross	103	0.01
<sup>(1)</sup> Demand reductions include line-loss adjustments.		
<sup>(2)</sup> Includes Phase III carryover of 31,089 MWh/yr.		

### 6.5 Process Evaluation

This section summarizes the key findings of the Low-Income Program for PY13 from process evaluation activities for the remote energy assessment (REA) and welcome kit strata. REA participants received a remote home energy assessment along with energy-saving items and services. Welcome kit respondents were mailed a package with two LED bulbs as encouragement to new customers to enroll in the Low-Income Program.

Cadmus conducted a process evaluation to assess participant satisfaction, inform the logic model review, 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 the planned activities.

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 2022. A total of 125 REA participants completed or partially completed the survey, and 42 welcome kit recipients completed or partially completed the 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. Only one in-home assessment was completed at the time of the survey so in-home assessment participants were not included in the sample population.<sup>17</sup>

Table 6.6 lists the process evaluation sampling strategy. Participant survey completions produced a measure of program satisfaction with ±10% precision at 90% confidence. See *Appendix L Survey Bias* for details about Cadmus’ approach to reducing survey bias and contact instructions.

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<sup>17</sup> The ICSP conducted 67 in-person assessments in PY13 Q4, and these will be analyzed in early PY14.

**Table 6.6. Low-Income 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 <sup>(1)</sup>
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	N/A	N/A	4	4	N/A	N/A
Remote Energy Assessment Participants	Participants who completed remote energy assessments	Online Survey	19,110 <sup>(2)</sup>	0.50	60 <sup>(3)</sup>	87 <sup>(4)</sup>	9,611 <sup>(5)</sup>	100%
Welcome Kit Participants	Participants who only received a welcome kit <sup>(6)</sup>	Online Survey		0.50	23	26 <sup>(4)</sup>		100%
<b>Program Total</b>			<b>19,110</b>	<b>-</b>	<b>87</b>	<b>117</b>	<b>9,611</b>	<b>100%</b>

<sup>(1)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews.

<sup>(2)</sup> This represents the number of participants at the time of the evaluation. Process population size may differ from impact numbers.

<sup>(3)</sup> Though the original evaluation plan targeted 36 completed surveys for Direct Install participants and 24 REA participants, there was only one direct install appointment completed at the time of the survey fielding. Therefore, Cadmus targeted 60 completes for REAs.

<sup>(4)</sup> Analysis used all responses to the survey (n=167; 125 REA and 42 welcome kits), not just completed surveys (n=113; 87 REA and 26 welcome kit). Cadmus sent emails to all participants available (after sampling had occurred) at the time of fielding, resulting in overachievement of the original target sample size.

<sup>(5)</sup> Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities database at the time of the surveys. After selecting all unique records, Cadmus removed any records from the population if the customer had participated in a survey in the last three months, had been selected for another program survey, did not have valid contact information (email) or opted out of the online survey.

<sup>(6)</sup> These participants had only received a welcome kit at the time of the survey.

### 6.5.1 Program Experience

#### *Program Satisfaction and Customer Effort*

Cadmus found that 85% of REA participants (76% *very satisfied* and 9% *somewhat satisfied*; n=106) and 80% of welcome kit recipients (70% *very satisfied* and 10% *somewhat satisfied*; n=30;) were satisfied with the program overall.<sup>18,19</sup> Most survey respondents found it easy to participate in the Low-Income

<sup>18</sup> Of REA participants, 7% were *neither satisfied nor dissatisfied*, 5% were *not too satisfied*, and 4% were *not at all satisfied* (n=106). Nineteen respondents did not answer the overall satisfaction question.

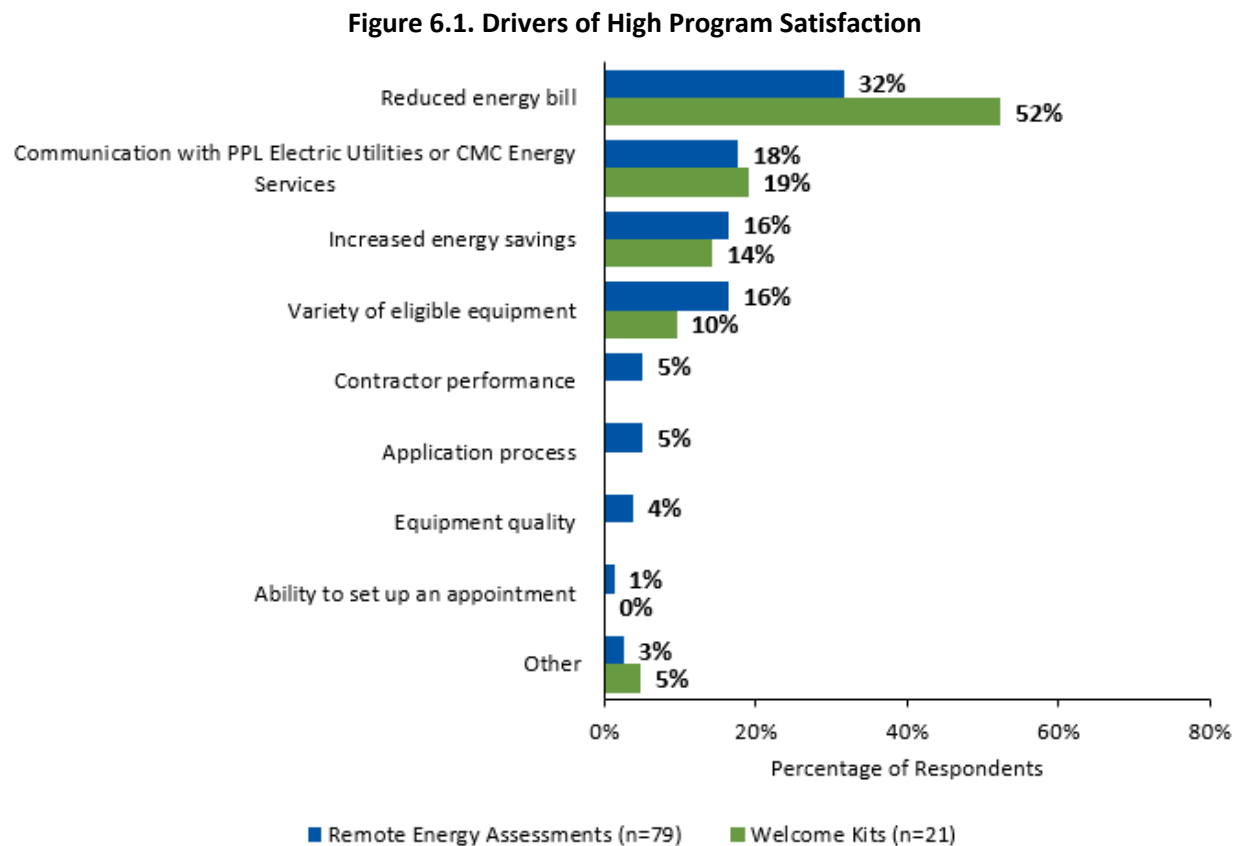
<sup>19</sup> Of welcome kit recipients, 0% were *neither satisfied nor dissatisfied*, 7% were *not too satisfied*, and 13% were *not at all satisfied* (n=30). Twelve respondents did not answer the overall satisfaction question.

Program. Eighty-nine percent (n=105) of REA respondents found it *very easy* or *easy* to participate, and 86% (n=30) of welcome kit recipients found it *very easy* or *easy* to participate.

## Drivers of Program Satisfaction

To better understand what drives program satisfaction, the survey asked participants what factor or factors most affected their program satisfaction rating.

Figure 6.1 shows the most common reasons respondents were *very* or *somewhat satisfied* with the program component. For both REA and welcome kit respondents, the most common reason was reduced energy bills.



Source: Participant survey, “What factor most affected the overall experience rating you gave?”  
(REA n=79; welcome kit n=21)

Fifteen respondents who were *not too* or *not very satisfied* with the program provided their reasons. Like the most common drivers of high satisfaction, those who were less than satisfied did not think they were realizing enough energy or monetary savings on their monthly bills (three responses). The variety of eligible equipment (one response) and communication (three responses) also had an influence. Of five REA respondents, three said they had not yet received the kit they requested and two did not think they were not receiving any benefits from the kits. Three welcome kit respondents were dissatisfied that the kit only included lightbulbs.

## *Opinion of PPL Electric Utilities and Likelihood to Recommend*

Of 102 REA survey respondents, 68% said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 27% said their opinion had not changed, and only 4% (four respondents) said their opinion decreased.<sup>20</sup>

Of 28 welcome kit survey respondents, 67% said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 19% said their opinion had not changed, and 15% (four respondents) said their opinion decreased.<sup>21</sup> Two of these respondents provided an explanation. Although the welcome kit provides additional information about how to participate more fully in the program, both said they did not receive significant services through the program.

Overall, 78% of REA (n=96) and 65% of welcome kit (n=27) respondents were likely to recommend the program to a friend, family member, or colleague.

### 6.5.2 Improvement Suggestions

Cadmus found that ambiguity in identifying the baseline bulb type was the main reason for differences between reported and verified savings. Cadmus listened to 30 audio recordings of sampled REA jobs and compared them with assessment records and supplemental documentation of bulb type provided by the ICSP and found 208 records with unknown or unconfirmed bulb types. In cases where the baseline bulb type was unknown, Cadmus used the EISA 2020 baseline. However, this could underestimate the actual savings represented by the LEDs that replaced incandescent bulbs that were classified as halogen bulbs. Through discussion of these results, the ICSP has already made an adjustment to the REA questionnaire so respondents can more accurately identify the bulb replaced by the LED.

### 6.6 Program Finances and Cost-Effectiveness Reporting

This section provides a detailed breakdown of program finances and cost-effectiveness. TRC benefits were calculated using gross verified impacts. Net present value (NPV) PY13 costs and benefits are expressed in 2021 dollars. NPV costs and benefits for P4TD financials are expressed in the PY13 dollars. Net verified savings are equal to gross verified savings because the program is assumed to have an NTG ratio of 1.0.

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<sup>20</sup> Percentages may not sum to 100% due to rounding.

<sup>21</sup> Percentages may not sum to 100% due to rounding.

**Table 6.7. Summary of Low-Income Program Finances – Gross and Net Verified**

Row	Cost Category <sup>(1)</sup>	PYTD (\$1,000)		P4TD <sup>(2)</sup> (\$1,000)	
<b>1</b>	<b>IMCs</b>	<b>\$2,174</b>		<b>\$2,174</b>	
2	Rebates to Participants and Trade Allies	--		--	
3	Upstream / Midstream Incentives	--		--	
4	Material Cost for Self-Install Programs (EE&C Kits)	\$1,716		\$1,716	
5	Direct Installation Program Materials and Labor	\$457		\$457	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5) <sup>(6)</sup>	\$0		\$0	
		<b>EDC</b>	<b>CSP</b>	<b>EDC</b>	<b>CSP</b>
7	Program Design	--	--	--	--
8	Administration and Management <sup>(3)</sup>	\$134	\$647	\$134	\$647
9	Marketing	--	\$221	--	\$221
10	Program Delivery <sup>(4)</sup>	--	\$2,040	--	\$2,040
11	EDC Evaluation Costs	--		--	
12	SWE Audit Costs	--		--	
<b>13</b>	<b>Program Overhead Costs <sup>(5)</sup> (Sum of rows 7 through 12) <sup>(6)</sup></b>	<b>\$3,041</b>		<b>\$3,041</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13) <sup>(5)</sup> <sup>(6)</sup></b>	<b>\$5,215</b>		<b>\$5,215</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$1,844		\$1,844	
16	Total NPV Lifetime Electric Capacity Benefits	\$1,047		\$1,047	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$34		\$34	
18	Total NPV Lifetime Fossil Fuel Impacts	\$32		\$32	
19	Total NPV Lifetime Water Impacts	\$3,792		\$3,792	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19) <sup>(6)</sup></b>	<b>\$6,748</b>		<b>\$6,748</b>	
<b>21</b>	<b>TRC Benefit-Cost Ratio (Row 20 divided by Row 14)</b>	<b>1.29</b>		<b>1.29</b>	

<sup>(1)</sup> Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = \$2021.  
<sup>(2)</sup> P4TD benefits does not include carry-over energy savings from Phase III.  
<sup>(3)</sup> Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.  
<sup>(4)</sup> 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.  
<sup>(5)</sup> Portfolio-level costs are not assigned to specific programs.  
<sup>(6)</sup> 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 10,109 MWh/yr in verified savings from assessments and another 340 MWh/yr in verified savings from the energy-saving items in the kits. The majority of participants, 85%, were *very or somewhat satisfied* with the remote home assessments. As COVID-19 concerns lessened over PY13 and participants became more comfortable having technicians in their home, the ICSP began offering a choice of in-home or remote assessments in March 2022. The ICSP conducted 67 in-home assessments in PY13 Q4, and these will be analyzed in early PY14.

Recommendations are provided in Table 6.8, along with a summary of how PPL Electric Utilities plans to address the recommendation.

**Conclusion 1:** Overall, the Low-Income Program is performing well, with steady and increasing participation levels and savings over PY13 while maintaining high satisfaction with remote assessments.

- The Low-Income Program verified 10,449 MWh/yr of energy savings and 1.23 MW/yr of system-level demand reductions during PY13. (See 6.2 *Gross Impact Evaluation* section.)
- Most (85%, n=106) respondents were satisfied with the Low-Income Program. (See *Program Satisfaction and Customer Effort* section.)
- Most (89%, n=105) respondents found it easy to participate in the Low-Income Program. (See *Program Satisfaction and Customer Effort* section.)

**Conclusion 2:** Although REA participants were highly satisfied with the program, Welcome Kit recipients were slightly less satisfied with the energy-saving kit they received.

- Most (80%, n=30) respondents were satisfied with the Welcome Kits, slightly lower than the 85% (n=106) of remote home assessments respondents who were satisfied with the program. (See *Program Satisfaction and Customer Effort* section.)
- Although the kit contained information to more fully participate in the program, less satisfied welcome kit respondents said they did not receive significant services through the program. (See *Program Satisfaction and Customer Effort* section.)

**Conclusion 3:** Cadmus could not verify some REA data collected by ICSP technicians on baseline bulb types.

- Cadmus used the PA TRM baseline bulb type and wattage assumption for 208 jobs where the baseline bulb type could not be verified. This accounts for approximately 80% of the sampled LED installations. (See *Improvement Suggestions* section.)

The impact and process evaluation activities in PY13 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 6.8).

**Table 6.8. Status of Recommendations for the Low-Income Program**

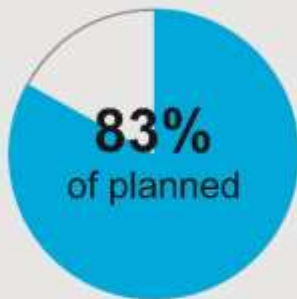
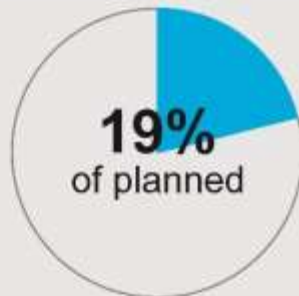
Program Component	Conclusion	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
<b>Remote Assessments</b>	<b>Conclusion 1:</b> Some data collected by ICSP technicians on baseline bulb types from the remote home assessments could not be verified.	<b>Recommendation 1:</b> For remote assessments, continue to have technicians probe for existing bulb characteristics (type and wattage) leading to more accurate bulb identification and documentation.	Implemented
<b>Welcome Kits</b>	<b>Conclusion 2:</b> Although REA participants were highly satisfied with the program, Welcome Kit recipients were slightly less satisfied with the energy-saving kit they received.	<b>Recommendation 2:</b> Consider sending a follow-up postcard to Welcome Kit recipients six months later if they have not yet signed up for a home energy assessment as a reminder of the services and additional energy-saving options available through the program.	Implemented. At this point, the program will send monthly emails to customers who received kits and have not participated in the full assessment. The ICSP will look at a pilot with follow-up postcards for Welcome Kit recipients.

## 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

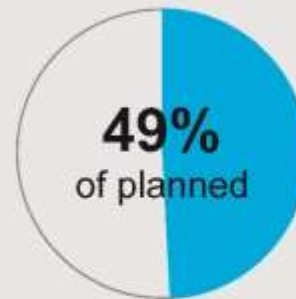
Phase IV has saved 31,740 MWh/yr



PY13 saved 31,740 MWh/yr

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of 4.08 MW/yr



PY13 has reductions of 4.08 MW/yr

### PY13 PARTICIPATION

A total of 821,941 residential participants

**775,814** Efficient Lighting (number of bulbs)

**20,015** Student Energy Efficient Education

**14,803** Energy Efficient Homes

**11,309** Appliance Recycling\*

\*Two of these participants are incentive corrections.

### PARTICIPANT SATISFACTION



Satisfied with overall program

**97%** satisfied with Appliance Recycling

**88%** satisfied with Energy Efficient Homes

**80%** 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 available to PPL Electric Utilities customers, and home energy audits and downstream rebates for weatherization solutions. Savings were not reported for home energy audits and weatherization solutions in PY13. In PY14 this component will also offer midstream incentives for high-efficiency HVAC equipment. Participation is counted as the number of rebated projects or homes.
- **Efficient Lighting** delivers upstream incentives to encourage customers to purchase and install specialty LED bulbs by buying down the price of program-qualified ENERGY STAR® LEDs. Incentives are provided to participating manufacturers to discount the prices of a variety of specialty bulbs sold at participating retail stores. 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 PY13 by customer segment.

**Table 7-1. Residential Participation and Reported Impacts**

Parameter	Residential (Non-LI)	Residential (LI)	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total <sup>(1)</sup>
PY13 # Participants	764,250	-	57,530	1	160	821,941
PYRTD MWh/yr	33,809	-	1,056	1	141	35,008
PYRTD MW/yr	4.71	-	0.26	0	0.03	5.00
PYVTD MWh/yr	30,510	-	1,085	1	143	31,740
System-Level PYVTD MW/yr	3.77	-	0.29	0.00	0.03	4.08
PY13 Incentives (\$1000)	\$4,332	-	\$110	<\$1	\$4	\$4,446

Note: This table does not include results from the Low-Income Program.  
<sup>(1)</sup> Total may not sum due to rounding.

## 7.2 Gross Impact Evaluation

Cadmus conducted a gross impact evaluation for all Residential Program components in PY13 using a basic level of rigor. Evaluation methods and sampling approaches differed by component to reflect the unique design and delivery. For Appliance Recycling, Efficient Lighting, and SEEE, Cadmus used a census approach. For Energy Efficient Homes, Cadmus sampled records according to the subcomponents and measure end-use categories and used a verification survey to calculate installation rates.

Gross savings verification methodology details, sampling approach, and detailed findings are discussed in the individual appendices of this report (*Appendix G Evaluation Detail – Appliance Recycling*, *Appendix H Evaluation Detail – Efficient Lighting*, *Appendix I Evaluation Detail – Energy Efficient Homes*, and *Appendix J, Evaluation Detail – Student Energy Efficient Education* ).

The Residential Program overall achieved a 99% realization rate for energy (Table 7-2) and a 99% realization rate for demand. (Table 7-3).

**Table 7-2. Residential Program Gross Impact Results for Energy**

Component	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 90% C.L. <sup>(2)</sup>	PYVTD (MWh/yr)
Appliance Recycling	7,931	100%	6.11	9.45%	7,900
Efficient Lighting	4,249	102%	0	0%	4,353
Energy Efficient Homes	14,190	104%	-	28.68%	14,689
Student Energy Efficient Education	5,704	84%	0.49	3.15%	4,797
<b>Residential Subtotal <sup>(3)</sup></b>	<b>32,074</b>	<b>99%</b>	<b>-</b>	<b>13.49%</b>	<b>31,740</b>
Low-Income (Residential) <sup>(4)</sup>	11,738	89%	0.98	3.57%	10,449
<b>Program Total <sup>(3)</sup></b>	<b>43,812</b>	<b>96%</b>	<b>-</b>	<b>10.18%</b>	<b>42,189</b>

Component	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 90% C.L. <sup>(2)</sup>	PYVTD (MWh/yr)
Unverified Savings (New Homes + Low-Income In-Home Assessment) <sup>(5)</sup>	3,036	-	-	-	-
<b>Total (Verified + Unverified) <sup>(3)</sup></b>	<b>46,848</b>	-	-	-	<b>42,189</b>

<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.  
<sup>(2)</sup> 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.  
<sup>(3)</sup> Totals may not sum due to rounding.  
<sup>(4)</sup> Low-Income is shown as a subsector of residential in this table per sampling requirements in the Evaluation Framework.  
<sup>(5)</sup> Includes 2,933 MWh/yr of unverified savings from the Residential (Energy Efficient Homes) Program and 103 MWh/yr from the Low-Income Program.

**Table 7-3. Residential Program Gross Impact Results for Demand**

Component	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 90% C.L. <sup>(2)</sup>	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Appliance Recycling	1.75	100%	4.45	6.89%	1.75	1.90
Efficient Lighting	0.61	102%	0	0	0.63	0.68
Energy Efficient Homes	0.92	102%	-	17.00%	0.94	1.03
Student Energy Efficient Education	0.49	89%	0.51	3.30%	0.43	0.47
<b>Residential Subtotal <sup>(3)</sup></b>	<b>3.78</b>	<b>99%</b>	-	<b>5.35%</b>	<b>3.75</b>	<b>4.08</b>
Low-Income (Residential) <sup>(4)</sup>	1.28	88%	1.05	3.78%	1.13	1.23
<b>Program Total <sup>(3)</sup></b>	<b>5.06</b>	<b>96%</b>	-	<b>4.21%</b>	<b>4.88</b>	<b>5.31</b>
Unverified Savings (New Homes + Low-Income In-Home Assessment) <sup>(5)</sup>	1.23	-	-	-	-	-
<b>Total (Verified + Unverified) <sup>(3)</sup></b>	<b>6.29</b>	-	-	-	<b>4.88</b>	<b>5.31</b>

<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.  
<sup>(2)</sup> 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.  
<sup>(3)</sup> Totals may not sum due to rounding.  
<sup>(4)</sup> Low-Income is shown as a subsector of residential in this table per sampling requirements in the Evaluation Framework.  
<sup>(5)</sup> Includes 1.22 MW/yr of unverified savings from the Residential (Energy Efficient Homes) Program and 0.01 MW/yr from the Low-Income Program.

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

- For Energy Efficient Homes, differences in reported versus verified baseline equipment and heating capacity led to increased realization rates for HVAC equipment, which raised the overall energy realization rate for the component.
- For Online Marketplace, energy and demand realization rates were lower than 100% primarily due to low installation rates, in particular for outlet gaskets, advanced power strips, LEDs in the Welcome Kit, and stand-alone smart thermostats. The installation rates are listed in *Appendix I Gross Impact Results*.



- For SEEE, energy and demand realization rates were lower than 100% primarily due to differences in installation rates used to calculate reported and verified savings. In addition, using PY13 Home Energy Worksheet (HEW) data, Cadmus verified an electric cooling saturation rate of 57%, which was lower than the reported savings assumption of 83%. More information can be found in *Appendix J.1.2 Gross Impact Results*.

## 7.3 Net Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,<sup>22</sup> which discusses the common methods used to determine free ridership and spillover. Determining net savings for an appliance retirement program follows the methodology described in Appendix B Common Methods for Appliance Recycling Programs in the Phase IV Evaluation Framework.<sup>23</sup> This is consistent with the Uniform Methods Project appliance recycling protocol to determine program net savings.<sup>24</sup>

For the Appliance Recycling component and downstream equipment in the Efficient Equipment component, Cadmus used self-report surveys, administered online, to assess free ridership and spillover. For the Efficient Lighting component, Cadmus conducted interviews with participating retailers, administered by phone, to assess free ridership and spillover. Cadmus developed an NTG methodology for this component based on guidance in the Evaluation Framework and in coordination with the SWE. Additional information about the NTG methodology is provided in *Appendix K Net Savings Impact Evaluation* and in *Appendix G, Appendix H, Appendix I, and Appendix J*.

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 7-4 presents NTG ratios for the components of the Residential Program in PY13.

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<sup>22</sup> 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.

<sup>23</sup> Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs*. Prepared by the Statewide Evaluation Team (NMR Group Inc., Demand Side Analytics LLC, Brightline Group, and Optimal Energy Inc.). Contracted under the Pennsylvania Public Utility Commission’s RFP 2020-2 for the Statewide Evaluator. Final version July 16, 2021. [https://www.puc.pa.gov/media/1584/swe-phaseiv\\_evaluation\\_framework071621.pdf](https://www.puc.pa.gov/media/1584/swe-phaseiv_evaluation_framework071621.pdf)

<sup>24</sup> Keeling, J., and D. Bruchs. 2017. “Chapter 7: Refrigerator Recycling Evaluation Protocol.” *The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures*. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68563. <http://www.nrel.gov/docs/fy17osti/68563.pdf>



**Table 7-4. Residential Program Net Impact Evaluation Results**

Component	PYVTD	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision (@ 85% CL)
Appliance Recycling	7,900,416	45%	1%	0.56	5%
Efficient Lighting	4,352,925	N/A <sup>(2)</sup>	N/A <sup>(2)</sup>	1.07 <sup>(2)</sup>	15%
Energy Efficient Homes	14,689,420	49%	1%	0.52	11%
Student Energy Efficient Education	4,796,921	0%	0%	1.00 <sup>(3)</sup>	-
<b>Program Total</b>	<b>31,739,682 <sup>(1)</sup></b>	<b>N/A</b>	<b>N/A</b>	<b>0.68 <sup>(4)</sup></b>	<b>5%</b>

<sup>(1)</sup> May not sum due to rounding.  
<sup>(2)</sup> See *Appendix H* and *Appendix K* for details about this analysis and the final results.  
<sup>(3)</sup> No free ridership is expected, nor measured, per the evaluation plan. Therefore, the NTG ratio is 1.0.  
<sup>(4)</sup> Weighted by PY13 program verified gross energy savings.

The PY13 Residential Program total NTG ratio of 0.68 is heavily weighted toward the Appliance Recycling and Energy Efficient Homes component NTG ratios, as these components represented 71% of the Residential Program verified gross population energy savings.

### 7.4 Verified Savings Estimates

As shown in Table 7-5, 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 PY13.

**Table 7-5. PY13 and P4TD Savings Summary**

Savings Type	Energy (MWh/yr) <sup>(1)</sup>	Demand (MW/yr) <sup>(1)</sup>
PYRTD	35,008 <sup>(2)</sup>	5.00 <sup>(2)</sup>
PYVTD Gross	31,740	4.08 <sup>(3)</sup>
PYVTD Net	21,478	2.81 <sup>(3)</sup>
RTD	35,008 <sup>(2)</sup>	5.00 <sup>(2)</sup>
VTD Gross	31,740	4.08 <sup>(3)</sup>
VTD Net	21,478	2.81 <sup>(3)</sup>

<sup>(1)</sup> Does not include the Low-Income Program.  
<sup>(2)</sup> Includes 2,933 MWh/yr of unverified energy savings and 1.22 MW/yr of unverified demand reductions from the Energy Efficient Homes component.  
<sup>(3)</sup> Verified peak demand reductions include application of distribution losses.

### 7.5 Process Evaluation

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

Cadmus conducted a full process evaluation in PY13 to assess participant satisfaction, inform the logic model review, 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 7-6. Modifications to Cadmus’ evaluation plans are noted in the individual program component appendices of this report.

**Table 7-6. PY13 Residential Program Evaluation Activities**

Activity	Audience	Methodology
<b>Appliance Recycling</b>		
In-depth Interviews	Administration staff (n=3)	Telephone
Surveys	Participants (n=140)	Online
Logic model review and update	N/A	In-depth interviews and secondary research
<b>Energy Efficient Homes</b>		
In-depth Interviews	Administration staff (n=3)	Telephone
	Participating Builders (n=18)	Telephone
Surveys	Participants (all eligible)	Online
Logic model review and update	N/A	In-depth interviews and secondary research
<b>Student Energy Efficient Education (SEEE)</b>		
In-depth Interviews	Administration staff (n=3)	Telephone
Surveys	Participants (all eligible)	Paper and Online
Logic model review and update	N/A	In-depth interviews and secondary research
<b>Efficient Lighting</b>		
In-depth Interviews	Administration staff (n=2)	Telephone
	Participating Retailers (n=23)	Telephone
Logic model review and update	N/A	In-depth interviews and secondary research

The staff interviews were conducted in February 2022 via phone, and the online participant surveys were conducted between March and April 2022. In-depth phone interviews with New Home builders and Efficient Lighting retailers were completed in June and July 2022.

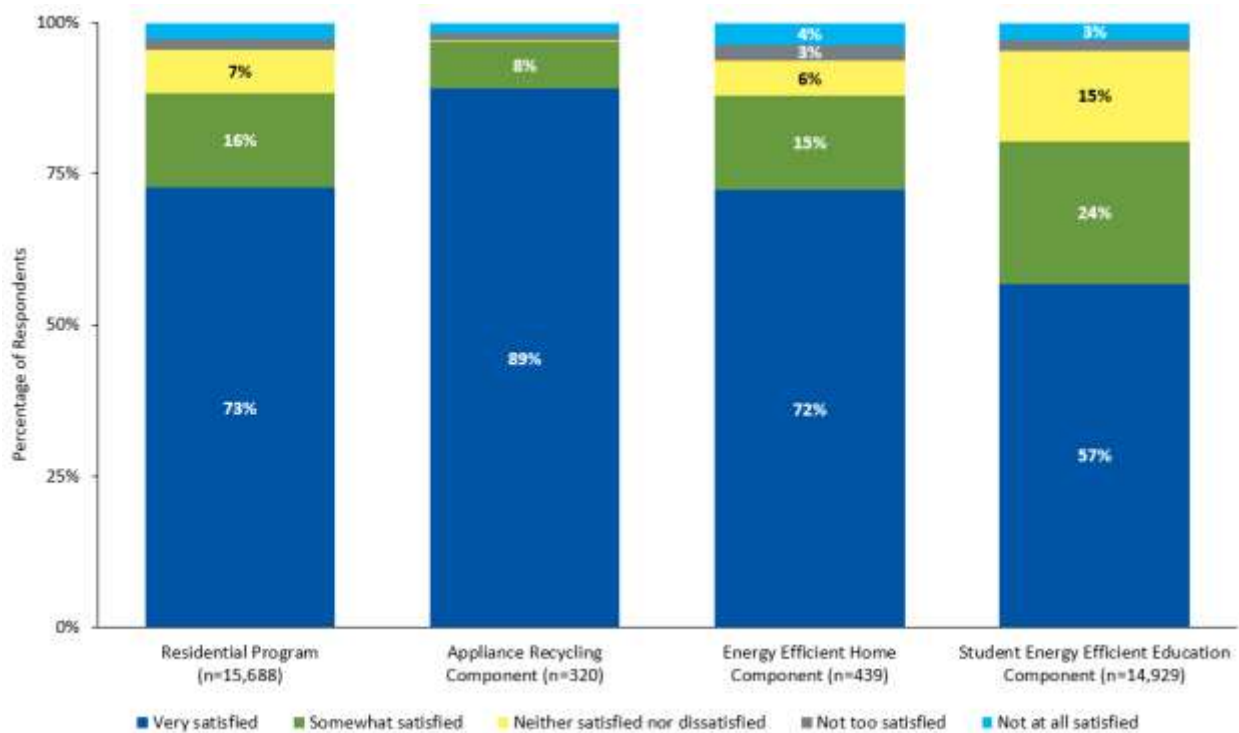
### 7.5.1 Process Evaluation Key Findings

For Phase IV, PPL Electric Utilities established a Residential Program goal to achieve 85% or greater of *very satisfied* and *somewhat satisfied* customers,<sup>25</sup> which it exceeded with 88% of participants reporting they were satisfied. As shown in Figure 7-1, the Appliance Recycling component garnered the highest participant satisfaction.

Cadmus also interviewed retail store partners participating in the Efficient Lighting component, which are not represented in Figure 7-1. All nine store representatives were satisfied with the overall program (five reported being *very satisfied*, and four reported being *somewhat satisfied*).

<sup>25</sup> The customer satisfaction goal is stipulated in PPL Electric Utilities’ EE&C Plan (Docket No. M-2020-3020824) filed with the PA PUC, May 2021.

Figure 7-1. PY13 Residential Program Overall Satisfaction



Source: PY13 Participant surveys question, “Thinking about your overall experience with the PPL Electric Utilities [PROGRAM] rebate program, how would you rate your satisfaction?” The Energy Efficient Home component includes Online Marketplace, Downstream Equipment, and New Homes responses. The Student Energy Efficiency Education includes student and teacher responses.<sup>26</sup> Percentages may not total 100% or match other sections of the report due to rounding.

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

Table 7-7. Residential Program Key Process Evaluation Findings

Program Component	Finding
EE Homes	<ul style="list-style-type: none"> <li>• Builders and customers were satisfied with the Energy Efficient Homes offering; 88% indicated that they were satisfied with the component overall. (See <i>Component Satisfaction in Appendix G.4.1 Program Component Experience.</i>)</li> <li>• Online Marketplace participants were 80% satisfied. Smart thermostat purchasers were less satisfied with their overall experience than other shoppers (66%, n=44), and free Welcome Kit recipients were more satisfied with their overall experience than other shoppers (89%, n=53). (See <i>Component Satisfaction in Appendix G.4.1 Program Component Experience.</i>)</li> <li>• Customers who purchased smart thermostats at the Online Marketplace often reported challenges with installation or compatibility with their HVAC system, resulting in a 56% installation rate for this product (n=49). (See <i>Component Satisfaction in Appendix G.4.1 Program Component Experience.</i>)</li> </ul>

<sup>26</sup> Cadmus considered teacher responses of *Excellent* and *Good* as *Very* or *Somewhat Satisfied*.

Program Component	Finding
Appliance Recycling	<ul style="list-style-type: none"> <li>• A large majority of respondents (97%) said they were satisfied with the Appliance Recycling component overall. (See <i>Component Satisfaction</i> in <i>Appendix G.4.1 Program Component Experience</i>.)</li> <li>• A large majority of respondents (97%) said it was easy to participate in the Appliance Recycling component. (See <i>Customer Effort</i> section in <i>Appendix G.4.1</i>.)</li> <li>• The appliance collection process was the main driver for high satisfaction, mentioned by 72% of satisfied participants. (See <i>Drivers of Program Component Satisfaction</i> section in <i>Appendix G.4.1</i>.)</li> </ul>
Student Energy Efficient Education	<ul style="list-style-type: none"> <li>• Overall 80% of participants gave positive ratings of the Student Energy Efficient Education component (80% <i>very satisfied</i> or <i>somewhat satisfied</i> for students, and 100% <i>excellent</i> or <i>good</i> for teachers). While teacher evaluation forms collect ratings of the various program aspects, student Home Energy Worksheets (HEWs) do not contain specific questions to identify which program factors contributed to student satisfaction with the program. (See <i>Appendix J.3.1, Participant Satisfaction</i>.)</li> <li>• Cadmus observed that the question wording and response scale for gauging satisfaction with the program varied between student and teacher participant types. (See <i>Appendix J.3.1, Participant Satisfaction</i>.)</li> </ul>
Efficient Lighting	<ul style="list-style-type: none"> <li>• Retailers were satisfied with the Efficient Lighting component overall as well as with the magnitude of the discounts provided through the component (8 of 9 reported being <i>very satisfied</i>, and 1 of 9 said they were <i>somewhat satisfied</i> with the discounts), but they were less satisfied with the variety of products discounted. The Efficient Lighting component narrowed its focus from all LED products to strictly specialty LEDs due to EISA’s baseline wattage backstop provision. (See <i>Appendix H.3.1 Retailer Experience and Satisfaction</i>.)</li> <li>• Retailers (n=7) estimated that LEDs comprise roughly 64% of their lighting stock and specialty LEDs comprise roughly 57% of their LED lighting stock. Large home improvement chains sold more LED fixtures (17%) than did smaller hardware franchises (10%). (See <i>Component Influence and EISA Legislation</i> section in <i>Appendix H.3.1 Program Component Experience</i>.)</li> <li>• In PY13, PPL Electric Utilities provided incentives exclusively for multi-packs and not single bulbs. Although the component sold 43% more specialty LEDs per month on average in PY13 compared to PY11,<sup>(1)</sup> monthly average energy savings decreased by 83% because of lower baseline wattages due to the EISA backstop provision. (See <i>Appendix H.1.2 Gross Impact Results</i>.)</li> </ul>
<p><sup>(1)</sup> The Efficient Lighting component was suspended for part of PY11 and all of PY12. To compare monthly average sales, Cadmus analyzed only the months in PY11 during which the component was active.</p>	

## 7.6 Program Finances and Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 7-8. The TRC benefits were calculated using gross verified impacts. Net present value (NPV) PY13 costs and benefits are expressed in 2021 dollars. Net present value costs and benefits for P4TD financials are expressed in the 2021 dollars.

**Table 7-8. Summary of Residential Program Finances – Gross Verified**

Row	Cost Category <sup>(1)</sup>	PYTD (\$1,000)		P4TD (\$1,000)	
<b>1</b>	<b>IMCs</b>	<b>\$10,920</b>		<b>\$10,920</b>	
2	Rebates to Participants and Trade Allies	\$2,870		\$2,870	
3	Upstream/Midstream Incentives	\$1,100		\$1,100	
4	Material Cost for Self-Install Programs (EE&C Kits)	\$476		\$476	
5	Direct Installation Program Materials and Labor	--		--	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5) <sup>(7)</sup>	\$6,474		\$6,474	
		<b>EDC</b>	<b>CSP</b>	<b>EDC</b>	<b>CSP</b>
7	Program Design	--	--	--	--
8	Administration and Management	\$171	\$372	\$171	\$372
9	Marketing	--	\$757	--	\$757
10	Program Delivery	--	\$2,166	--	\$2,166
11	EDC Evaluation Costs	--		--	
12	SWE Audit Costs	--		--	
<b>13</b>	<b>Program Overhead Costs (Sum of rows 7 through 12) <sup>(7)</sup></b>	<b>\$3,465</b>		<b>\$3,465</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13) <sup>(5) (6) (7)</sup></b>	<b>\$14,942</b>		<b>\$14,942</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$9,579		\$9,579	
16	Total NPV Lifetime Electric Capacity Benefits	\$5,076		\$5,076	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$0		\$0	
18	Total NPV Lifetime Fossil Fuel Impacts	\$5,594		\$5,594	
19	Total NPV Lifetime Water Impacts	\$3,956		\$3,956	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19) <sup>(7)</sup></b>	<b>\$24,205</b>		<b>\$24,205</b>	
<b>21</b>	<b>TRC Benefit-Cost Ratio (Row 20 divided by Row 14)</b>	<b>1.62</b>		<b>1.62</b>	

<sup>(1)</sup> Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = \$2021.

<sup>(2)</sup> P4TD benefits does not include carry-over energy savings from Phase III.

<sup>(3)</sup> Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

<sup>(4)</sup> 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.

<sup>(5)</sup> Portfolio-level costs are not assigned to specific programs.

<sup>(6)</sup> Row 14 (residential-level TRC Costs) include \$557,394 of excess incentives from the Residential Efficient Lighting Program 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.

<sup>(7)</sup> Sum of rows may not add up to total due to rounding.

Table 7-9 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, 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 7-9. Summary of Residential Program Finances – Net Verified**

Row	Cost Category <sup>(1)</sup>	PYTD (\$1,000)		P4TD <sup>(2)</sup> (\$1,000)	
<b>1</b>	<b>IMCs</b>	<b>\$6,650</b>		<b>\$6,650</b>	
2	Rebates to Participants and Trade Allies	\$2,870		\$2,870	
3	Upstream/Midstream Incentives	\$1,100		\$1,100	
4	Material Cost for Self-Install Programs (EE&C Kits)	\$476		\$476	
5	Direct Installation Program Materials and Labor	--		--	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5) <sup>(7)</sup>	\$2,204		\$2,204	
		<b>EDC</b>	<b>CSP</b>	<b>EDC</b>	<b>CSP</b>
7	Program Design	--	--	--	--
8	Administration and Management <sup>(3)</sup>	\$171	\$372	\$171	\$372
9	Marketing	--	\$757	--	\$757
10	Program Delivery <sup>(4)</sup>	--	\$2,166	--	\$2,166
11	EDC Evaluation Costs	--		--	
12	SWE Audit Costs	--		--	
<b>13</b>	<b>Program Overhead Costs <sup>(5)</sup> (Sum of rows 7 through 12) <sup>(7)</sup></b>	<b>\$3,465</b>		<b>\$3,465</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13) <sup>(5)</sup> <sup>(6)</sup> <sup>(7)</sup></b>	<b>\$10,672</b>		<b>\$10,672</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$6,618		\$6,618	
16	Total NPV Lifetime Electric Capacity Benefits	\$3,700		\$3,700	
17	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$0		\$0	
18	Total NPV Lifetime Fossil Fuel Impacts	\$3,345		\$3,345	
19	Total NPV Lifetime Water Impacts	\$3,884		\$3,884	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19) <sup>(7)</sup></b>	<b>\$17,547</b>		<b>\$17,547</b>	
<b>21</b>	<b>TRC Benefit-Cost Ratio (Row 20 divided by Row 14)</b>	<b>1.64</b>		<b>1.64</b>	

<sup>(1)</sup> Rows 1-13 are presented in nominal dollars (PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025); P4TD = \$2021.  
<sup>(2)</sup> P4TD benefits does not include carry-over energy savings from Phase III.  
<sup>(3)</sup> Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.  
<sup>(4)</sup> 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.  
<sup>(5)</sup> Portfolio-level costs are not assigned to specific programs.  
<sup>(6)</sup> Row 14 (residential-level TRC Costs) include \$557,394 of excess incentives from the Residential Efficient Lighting Program 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.  
<sup>(7)</sup> Sum of rows may not add up to total due to rounding.

## 7.7 Status of Recommendations

The Residential Program performed well in PY13. PPL Electric Utilities and its ICSP offered a holistic program with many opportunities for residential customers to obtain energy efficiency rebates and instant discounts. The various program components ran smoothly, according to all program actors Cadmus contacted.

Components are functioning as intended based on the review of the various logic models for each component, though PY13 participation was lower (and hence, savings were lower) than planned in the EE&C plan. Program participants were satisfied with their experience, and the program’s reported savings were, for the most part, accurate. The ICSP can make small enhancements to improve savings in PY14 by using the best available data collected during the PY13 participant verification survey and should consider a few updates to program delivery for certain components.

Recommendations are provided in Table 7-10, along with a summary of how PPL Electric Utilities plans to address the recommendations.

**Conclusion 1:** Low realization rates for the Online Marketplace subcomponent of Energy Efficient Homes were driven primarily by low installation rates for smart thermostats, along with some kit measures. Satisfaction among smart thermostat purchasers was also lower than other products purchased on the Marketplace, with customers citing incompatibility and installation challenges. Purchasers may not be reading all the resources provided to them on the Marketplace website.

- Cadmus found that smart thermostats had an ISR of 56% (n=49). Out of 22 people who did not install their smart thermostat, eight reported that it was due to compatibility issues and four reported installation challenges, despite PPL Electric Utilities publishing guidelines and manufacturer links to check compatibility. (See *Appendix I 1.1.2 Gross Impact Results Appendix I.*) The Marketplace also refers customers to manufacturer installation instructions.
- Sixty-six percent (n=44) of smart thermostat purchasers were satisfied with their overall experience with the Marketplace, compared to 80% of all Marketplace participants. Dissatisfied smart thermostat participants primarily cited issues with customer service or product installation. (See *Appendix I.4.2 Program Satisfaction and Customer Effort.*)
- Verified installation rates (ISRs) from the PY13 Online Marketplace participant survey were 23% to 41% lower than the ISRs used in the reported savings calculations for several measures. (See *Appendix I 1.1.2 Gross Impact Results.*)



**Conclusion 2:** Free Welcome Kits for new customers, a new offering in PY13, was a successful Online Marketplace expansion and creative method to engage new customers. The Welcome Kits substantially boosted Online Marketplace energy and demand savings, and customers were highly satisfied with their kit.

**Conclusion 3:** For the Student Energy Efficient Education component, teachers were highly satisfied with the program, providing positive ratings more often than students. To enhance data for continuous improvement and for future evaluations, several improvements could be made to the questionnaires to improve how participant experience is measured, resolve inconsistencies, as well as to gather more detailed information on how to improve student satisfaction.

**Conclusion 4:** Energy and demand realization rates for the Student Energy Efficient Education component were due to various differences between assumptions in the reported savings calculations and observed values from the Home Energy Worksheets (HEWs) for the kit products. Updating assumptions for PY14 using most recent HEW data should improve the realization rates.

**Conclusion 5:** Although the Efficient Lighting component sold 43% more specialty LED bulbs per month on average compared to PY11 (while the component was in operation), it generated 83% less monthly average energy savings because of lower baseline wattages. PPL Electric Utilities may be able to increase savings by offering incentives for eligible single bulbs.

- Welcome Kits made up 60% of Online Marketplace energy savings and 52% of demand savings, which represent a substantial contribution to this offering. (See *Appendix I Gross Impact Results.*)
- Free Welcome Kit recipients were more satisfied with their overall experience than other shoppers. Eighty-nine percent of kit recipients were satisfied compared to 80% of Online Marketplace participants overall (n=101). (See *Appendix I.4.2 Program Satisfaction and Customer Effort.*)
- Overall, 80% of students gave positive ratings of the Student Energy Efficient Education component (as measured by a rating of very or somewhat satisfied), and 100% of teachers rated the program as excellent or good. (See *Appendix J.3.1 Participant Satisfaction.*) Cadmus observed that the question wording and response scale for gauging satisfaction with the program varied on the ICSP subcontractor's questionnaires. The student questionnaire used a five-point rating scale, and the teacher questionnaire used a four-point scale with different rating categories.
- While Teacher evaluation forms collected ratings of the various program aspects, Student Home Energy Worksheets did not include questions about satisfaction with specific aspects of the program, such as kit products and the presentation. Gathering data on detailed program elements would be helpful for the ICSP to identify which program factors contribute most to student satisfaction and how to improve it to meet their goal of 85% satisfied participants. (See *Appendix J.3.1 Participant Satisfaction.*)
- Reported savings assumptions for the Student Energy Efficient Education component, primarily installation rates and electric cooling saturations, varied from observed inputs from the HEWs (See *Appendix J.1.2 Gross Impact Results.*)
- Reported savings for weatherstripping did not reflect the full length of weatherstripping included in each energy efficiency kit, which should be updated in the savings calculation. (See *Appendix J.1.2 Gross Impact Results.*)
- The Efficient Lighting component offered incentives exclusively for multi-packs in PY13. PPL Electric Utilities also did not host any giveaways, unlike in prior years. (See *Appendix H Evaluation Detail – Efficient Lighting Component.*)
- Retailers reported that incented specialty LED multi-packs comprised a small proportion of their overall LED bulb stock. Retailers recommended that PPL Electric Utilities expand incentives to more products where available. (See *Appendix H.3.2 Improvement Suggestions.*)

**Conclusion 6:** The Appliance Recycling Component continues to garner exceptionally high customer satisfaction, with nearly all participants satisfied with their experience and reporting that participation in the component was *easy*; the component had the highest satisfaction in the Residential Program.

- Customers were highly satisfied with their Appliance Recycling experience (97%) and found participating in the component easy (97%). (See *Appendix G.4.1 Program Component Experience*.)

**Conclusion 7:** Though programs ran smoothly, participation in every Residential Program component was lower than projected for PY13, which impacted the energy and demand savings the program achieved during the first year of Phase IV.

- See *2.10 Comparison of Performance to Approved EE&C Plan*.
- See component-specific appendices for PY13 participation, and projections for each component in the PPL Electric Utilities EE&C Plan.<sup>27</sup>

The impact and process evaluation activities in PY13 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 7-10).

**Table 7-10. Status of Recommendations for the Residential Program**

Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Energy Efficient Homes	<b>Conclusion 1:</b> Low realization rates for the Online Marketplace subcomponent of Energy Efficient Homes were driven primarily by low installation rates for smart thermostats, along with some kit measures. Satisfaction among smart thermostat purchasers was also lower than other products purchased on the Marketplace, with customers citing incompatibility and installation challenges. Purchasers may not be reading all the resources provided to them on the Marketplace website.	<b>Recommendation 1a:</b> Update <i>ex ante</i> savings assumptions with data gathered by the PY13 participant survey to reflect the most up-to-date installation rates. <b>Recommendation 1b:</b> For smart thermostat purchases on the Online Marketplace website, consider adding in a required confirmation that customer has checked HVAC compatibility, to improve installation rates and customer satisfaction. For example, this type of feature could be similar to a mandatory “terms and conditions” box, often required for online purchases.	Being considered

<sup>27</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

Program Component	Conclusion	Recommendation	EDC Status of Recommendation
Student Energy Efficient Education	<p><b>Conclusion 2:</b> For the Student Energy Efficient Education component, teachers were highly satisfied with the program, providing positive ratings more often than students. To enhance data for continuous improvement and for future evaluations, several improvements could be made to the questionnaires to improve how participant experience is measured, resolve inconsistencies, as well as to gather more detailed information on how to improve student satisfaction.</p>	<p><b>Recommendation 2:</b> Align program satisfaction question wording and rating scales between student HEWs and teacher evaluation forms. Add questions to student HEWs, similar to those in the teacher evaluation forms, that gauge satisfaction with program components separately, such as kits, presentations, and content, along with an overall satisfaction question.</p>	Implemented
Student Energy Efficient Education	<p><b>Conclusion 3:</b> Energy and demand realization rates for the Student Energy Efficient Education component were due to various differences between assumptions in the reported savings calculations and observed values from the Home Energy Worksheets (HEWs) for the kit products. Updating assumptions for PY14 using most recent HEW data should improve the realization rates.</p>	<p><b>Recommendation 3:</b> Revise reported savings inputs to reflect PY13 observed installation rates, electric cooling saturations, and other inputs. Revise reported savings inputs to reflect the full length of weatherstripping (in feet) that the participants receive in the demand savings calculation.</p>	Being considered
Efficient Lighting	<p><b>Conclusion 4:</b> Although the Efficient Lighting component sold 43% more specialty LED bulbs per month on average compared to PY11 (while the component was in operation), it generated 83% less monthly average energy savings because of lower baseline wattages. PPL Electric Utilities may be able to increase savings by offering incentives for eligible single bulbs.</p>	<p><b>Recommendation 4:</b> Consider offering incentives for single eligible specialty LEDs and hosting giveaways in PY14 to maximize energy and demand savings.</p>	Being considered
Residential Program (All Components)	<p><b>Conclusion 5:</b> Though programs ran smoothly, participation in every Residential Program component was lower than projected for PY13, which impacted the energy and demand savings the Program achieved during the first year of Phase IV.</p>	<p><b>Recommendation 5:</b> Consider increasing marketing activities across the board to increase awareness of energy efficiency rebates for residential customers and remind customers of available opportunities. For new customers who used the Online Marketplace to obtain a Free Welcome kit, consider setting up e-mail flows to keep these customers engaged, inform them about other rebate opportunities, and spur additional participation in other components.</p>	Implemented

## Appendix A. Site Inspection Summary

Table A-1 summarizes programs receiving 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. PY13 Site Visit Summary**

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
<b>Non-Residential</b>					
Custom	Warren Energy Engineering (on behalf of Cadmus)	8	0	0	<ul style="list-style-type: none"> <li>All visits were performed for projects in combined heat and power (CHP) and large stratum</li> </ul>
Custom	CLEAResult (ICSP)	8	17	25	<ul style="list-style-type: none"> <li>Contractor/customer estimate of original savings was not accurate</li> <li>Actual metered data used in place of estimates</li> <li>Project not modeled accurately compared to installed condition</li> <li>Project scope deviation and possibly not understanding projects installed for Custom</li> </ul>
Efficient Equipment Prescriptive Lighting	CLEAResult (ICSP)	22	51	26	<ul style="list-style-type: none"> <li>Wrong hours of use (HOU) recorded in Appendix C versus actual conditions found during customer interviews on site</li> <li>Wrong number of lights submitted on application</li> <li>Wrong number of bulbs in the ballast/fixture submitted</li> <li>Incorrect wattage selected for baseline fixtures</li> </ul>
	Cadmus	0	3	2	<ul style="list-style-type: none"> <li>Metered HOU and coincidence factor (CF) found to be incorrect when evaluating the light logger analysis</li> </ul>
Efficient Equipment Direct Discount Lighting	CLEAResult (ICSP)	40	94	6	<ul style="list-style-type: none"> <li>Wrong number of lights submitted on application</li> <li>Wrong number of bulbs in the ballast/fixture submitted</li> <li>Projects started before receiving preapproval</li> <li>Integrated fixtures not used in application</li> <li>Projects over 120,000 kWh/yr switched from prescriptive to customer-provided HOU (or custom)</li> <li>Hours removed when not over 120,000 kWh/yr</li> </ul>

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Efficient Equipment Non-Lighting	CLEAResult (ICSP)	1	1	2	<ul style="list-style-type: none"> <li>Project savings may have increased or decreased as a result of site visits which made the projects switch from prescriptive to customer-submitted HOU</li> <li>Ineligible equipment removed from applications</li> <li>Project scope deviation and possibly not understanding systems installed for Custom</li> </ul>
	DNV (on behalf of Cadmus)	0	1	1	<ul style="list-style-type: none"> <li>Incorrect controlled evaporator fan quantity and horsepower</li> </ul>
	DNV (on behalf of Cadmus)	0	1	1	<ul style="list-style-type: none"> <li>Change in controlled cooling capacity of guest room occupancy sensors</li> </ul>
Midstream Lighting	CLEAResult (ICSP)	44	103	10	<ul style="list-style-type: none"> <li>Product not found; shipped to location and moved to another facility</li> <li>Product not fully installed yet</li> <li>Product not installed in PPL Electric Utilities' territory (removed from program)</li> </ul>
<b>Low-Income</b>					
Low-Income (Baseload)	CMC (ICSP)	4	639 interim surveys 482 quality confirmation surveys sent	75	<ul style="list-style-type: none"> <li>55 customers said they had not installed all their LEDs, and 19 were not able to resolve the issue over the phone</li> <li>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</li> </ul>
Low-Income (Low-Cost)	CMC (ICSP)	7	496 interim surveys 607 quality confirmation surveys sent	308	<ul style="list-style-type: none"> <li>72 customers said they had not installed all their LEDs, and 35 were not able to resolve the issue over the phone</li> <li>109 customers said they could not install their showerheads, and 49 were not able to resolve the issue over the phone</li> <li>96 customers said they were not able to install all their aerators, and 60 were not able to solve over the phone</li> <li>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</li> </ul>

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
<b>Residential</b>					
Energy Efficient Homes – New Homes	PSD (ICSP)	47	0	38	<ul style="list-style-type: none"> <li>• 17 cooling Equipment discrepancies were most often caused by misreported efficiency ratings</li> <li>• 16 heating Equipment discrepancies were most often caused by misreported efficiency ratings</li> <li>• 16 window discrepancies are most often caused by misreported window area or the orientation of the windows</li> <li>• 15 appliance discrepancies were most often caused by misreported equipment efficiency ratings</li> <li>• 10 ceiling discrepancies were most often caused by misreported insulation values</li> <li>• 7 orientation discrepancies were caused by misreported building orientation</li> <li>• 5 duct location discrepancies were most often caused by not all duct locations being modeled</li> <li>• 5 lighting discrepancies involved an incorrectly reported percentage of energy-efficient bulbs; raters often miscount or fail to identify all the existing fixtures in the home, causing inconsistencies in reporting</li> </ul>
Energy Efficient Homes-Air Sealing	CLEAResult		1	1	<ul style="list-style-type: none"> <li>• Project was denied due to air sealing not completed by a BPI certified contractor and no blower door testing was performed before or after the air sealing</li> </ul>
Energy Efficient Homes-Air Source Heat Pump	CLEAResult		10	1	<ul style="list-style-type: none"> <li>• Invoice was voided as the installation of the new system was not completed</li> </ul>
Energy Efficient Homes-Attic Insulation (R0 to R38)	CLEAResult	3	50	5	<ul style="list-style-type: none"> <li>• Discrepancies most often were a result of the projects not meeting program requirements (existing R-value over 30 or new R-value below 49)</li> </ul>
Energy Efficient Homes-Central A/C	CLEAResult		3	0	<ul style="list-style-type: none"> <li>• No discrepancies found</li> </ul>
Energy Efficient Homes-Central Heat Fuel Switch	CLEAResult		18	2	<ul style="list-style-type: none"> <li>• Fuel switching savings were denied because the existing system was already a natural gas system or the installation was in a newly constructed home</li> </ul>
Energy Efficient Homes-Ductless Heat Pump	CLEAResult	17	218	2	<ul style="list-style-type: none"> <li>• Discrepancies were most often the result of the EER value below the minimum of 12.5</li> </ul>
Energy Efficient Homes-Smart Thermostat	CLEAResult		394	17	<ul style="list-style-type: none"> <li>• Denied rebates for thermostats installed in homes without electric sourced heat or CAC</li> </ul>

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In-Person	Virtual		
Energy Efficient Homes-Wall Insulation	CLEAResult		33	4	<ul style="list-style-type: none"> <li>Discrepancies were a result of installations not completed in a qualifying basement or crawlspace area of the home</li> </ul>
Energy Efficient Homes-Water Heater Fuel Switch	CLEAResult		7	1	<ul style="list-style-type: none"> <li>Fuel switching savings were denied because the existing system was already a natural gas system or the installation was in a newly constructed home</li> </ul>
<b>TOTAL</b>		<b>201</b>	<b>1,005+</b>	<b>527</b>	



## Appendix B. PY13 and P4TD Summary by Customer Segment and LI Carveout

Table B-1 presents a summary of the programs, initiatives and customer segments that contribute to the low-income carveout in PY13 and P4TD.

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

Program	Initiative	Customer Segment	PYVTD Gross (MWh/yr)	VTD Gross (MWh/yr)
Low-Income	Low-Income Assessment	Low-Income	10,449	41,538 <sup>(1)</sup>
<sup>(1)</sup> Includes 31,089 MWh/yr carryover savings from Phase III.				

## 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 PY13 is presented in Table C-1.

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

Program/Initiative	PYRTD (MWh/yr)	PYVTD Gross (MWh/yr)	PYVTD Net (MWh/yr)	RTD (MWh/yr)	VTD Gross (MWh/yr)	VTD Net (MWh/yr) <sup>(6)</sup>
<b>Non-Residential</b>						
Custom	40,315	37,267	8,199	40,315	37,267	8,199
Efficient Equipment	82,842	89,330	65,032	82,842	89,330	65,032
<b>Subtotal <sup>(5)</sup></b>	<b>123,157<sup>(1)</sup></b>	<b>126,597</b>	<b>73,230</b>	<b>123,157<sup>(1)</sup></b>	<b>126,597</b>	<b>73,230</b>
<b>Low-Income</b>						
<b>Subtotal <sup>(5)</sup></b>	<b>11,840<sup>(2)</sup></b>	<b>10,449</b>	<b>10,449</b>	<b>11,840<sup>(2)</sup></b>	<b>41,538 <sup>(7)</sup></b>	<b>10,449</b>
<b>Residential</b>						
Appliance Recycling	7,931	7,900	4,424	7,931	7,900	4,424
Efficient Lighting	4,249	4,353	4,670	4,249	4,353	4,670
Energy Efficient Homes	17,124	14,689	7,587	17,124	14,689	7,587
Student Energy Efficient Education	5,704	4,797	4,797	5,704	4,797	4,797
<b>Subtotal <sup>(5)</sup></b>	<b>35,008<sup>(3)</sup></b>	<b>31,740</b>	<b>21,478</b>	<b>35,008<sup>(3)</sup></b>	<b>31,740</b>	<b>21,478</b>
<b>Portfolio Total <sup>(5)</sup></b>	<b>170,005<sup>(4)</sup></b>	<b>168,786</b>	<b>105,157</b>	<b>170,005<sup>(4)</sup></b>	<b>168,786</b>	<b>105,157</b>
Carryover	N/A	N/A	N/A	N/A	306,275	N/A
<b>Portfolio Total with Carryover <sup>(5)</sup></b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>475,061</b>	<b>105,157</b>
<sup>(1)</sup> Includes 3,048 MWh/yr of unverified savings. <sup>(2)</sup> Includes 103 MWh/yr of unverified savings. <sup>(3)</sup> Includes 2,933 MWh/yr of unverified savings. <sup>(4)</sup> Includes 6,084 MWh/yr of unverified savings. <sup>(5)</sup> Subtotals and totals may not match the sums of rows due to rounding. <sup>(6)</sup> VTD Net does not include carryover savings. <sup>(7)</sup> Includes 31,089 MWh/yr of carryover attributed to the 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)	PYVTD Net (MW/yr)	RTD (MW/yr)	System-Level VTD Gross (MW/yr)	VTD Net (MW/yr)
<b>Non-Residential</b>						
Custom	6.40	6.30	1.39	6.40	6.30	1.39
Efficient Equipment	13.97	14.28	10.27	13.97	14.28	10.27
<b>Subtotal <sup>(5)</sup></b>	<b>20.37 <sup>(1)</sup></b>	<b>20.58</b>	<b>11.66</b>	<b>20.37 <sup>(1)</sup></b>	<b>20.58</b>	<b>11.66</b>
<b>Low-Income</b>						
<b>Subtotal <sup>(5)</sup></b>	<b>1.29 <sup>(2)</sup></b>	<b>1.23</b>	<b>1.23</b>	<b>1.29 <sup>(2)</sup></b>	<b>1.23</b>	<b>1.23</b>
<b>Residential</b>						
Appliance Recycling	1.75	1.90	1.06	1.75	1.90	1.06
Efficient Lighting	0.61	0.68	0.73	0.61	0.68	0.73
Energy Efficient Homes	2.14	1.03	0.54	2.14	1.03	0.54
Student Energy Efficient Education	0.49	0.47	0.47	0.49	0.47	0.47
<b>Subtotal <sup>(5)</sup></b>	<b>5.00 <sup>(3)</sup></b>	<b>4.08</b>	<b>2.81</b>	<b>5.00 <sup>(3)</sup></b>	<b>4.08</b>	<b>2.81</b>
<b>Portfolio Total <sup>(5)</sup></b>	<b>26.66 <sup>(4)</sup></b>	<b>25.89</b>	<b>15.69</b>	<b>26.66 <sup>(4)</sup></b>	<b>25.89</b>	<b>15.69</b>
<sup>(1)</sup> Includes 0.56 MW/yr of unverified savings.						
<sup>(2)</sup> Includes 0.01 MW/yr of unverified savings.						
<sup>(3)</sup> Includes 1.22 MW/yr of unverified savings.						
<sup>(4)</sup> Includes 1.78 MW/yr of unverified savings.						
<sup>(5)</sup> Subtotals and totals may not match the sums of rows due to rounding.						

## C.2 Program-Level Cost-Effectiveness Summary

Table C-3 shows the TRC ratios by program and for the portfolio. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars. Because this is the first year of the phase the PY13 and Phase IV results are the same.

**Table C-3. PY13 and Phase IV Gross TRC Ratios by Program (\$1,000)**

Program/Initiatives	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
<b>Non-Residential</b>				
Custom	\$22,903	\$10,704	2.14	\$12,199
Efficient Equipment	\$68,630	\$28,905	2.37	\$39,725
<b>Non-Residential Subtotal <sup>(1)</sup></b>	<b>\$91,533</b>	<b>\$39,609</b>	<b>2.31</b>	<b>\$51,923</b>
<b>Residential</b>				
Low-Income	\$6,748	\$5,215	1.29	\$1,533
Appliance Recycling	\$2,340	\$1,577	1.48	\$762
Efficient Lighting	\$3,058	\$1,153	2.65	\$1,904
Energy Efficient Homes	\$12,303	\$11,548	1.07	\$755
Student Energy Efficient Education	\$6,505	\$663	9.81	\$5,842
<b>Residential Subtotal <sup>(1) (2)</sup></b>	<b>\$30,954</b>	<b>\$20,157</b>	<b>1.54</b>	<b>\$10,797</b>
<b>Common Portfolio Costs</b>	<b>N/A</b>	<b>\$6,400</b>	<b>N/A</b>	<b>N/A</b>
<b>Portfolio Total <sup>(1)</sup></b>	<b>\$122,486</b>	<b>\$66,167</b>	<b>1.85</b>	<b>\$56,319</b>
Note: Costs and benefits are expressed as follows PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025				
<sup>(1)</sup> Total may not match sum of rows due to rounding.				
<sup>(2)</sup> Low-Income is shown as a subsector of residential in this table.				

Table C-4 presents PY13 cost-effectiveness using net verified savings to calculate benefits.

**Table C-4. PY13 and Phase IV Net TRC Ratios by Program (\$1,000)**

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
<b>Non-Residential</b>				
Custom	\$5,039	\$3,894	1.29	\$1,145
Efficient Equipment	\$49,696	\$21,957	2.26	\$27,738
<b>Non-Residential Subtotal <sup>(1)</sup></b>	<b>\$54,734</b>	<b>\$25,851</b>	<b>2.12</b>	<b>\$28,883</b>
<b>Residential</b>				
Low-Income	\$6,748	\$5,215	1.29	\$1,533
Appliance Recycling	\$1,310	\$1,577	0.83	(\$267)
Efficient Lighting	\$3,272	\$1,153	2.84	\$2,118
Energy Efficient Homes	\$6,460	\$7,278	0.89	(\$818)
Student Energy Efficient Education	\$6,505	\$663	9.81	\$5,842
<b>Residential Subtotal <sup>(1)(2)</sup></b>	<b>\$24,295</b>	<b>\$15,886</b>	<b>1.53</b>	<b>\$8,409</b>
<b>Common Portfolio Costs</b>	<b>N/A</b>	<b>\$6,400</b>	<b>N/A</b>	<b>N/A</b>
<b>Portfolio Total <sup>(1)</sup></b>	<b>\$79,029</b>	<b>\$48,139</b>	<b>1.64</b>	<b>\$30,891</b>
Note: Costs and benefits are expressed as follows PY13 = 2021, PY14 = 2022, PY15 = 2023, PY16 = 2024, PY17 = 2025				
<sup>(1)</sup> Total may not match sum of rows due to rounding.				
<sup>(2)</sup> 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-5 presents NTG findings for high-impact measures (HIMs) studied in PY13.

**Table C-5. PY13 High Impact Measure Net-to-Gross**

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Custom <sup>(1)</sup>	78% <sup>(2)</sup>	0%	0.22
Combined Heating and Power (CHP) <sup>(3)</sup>	N/A	N/A	N/A
Efficient Equipment Lighting <sup>(1)</sup>	23% <sup>(2)</sup>	0%	0.77
<b>Total</b>	<b>43% <sup>(4)</sup></b>	<b>0% <sup>(4)</sup></b>	<b>0.57</b>
<sup>(1)</sup> Estimated from PY13 survey data.			
<sup>(2)</sup> Weighted by the survey sample-verified program kWh/yr savings.			
<sup>(3)</sup> CHP projects are included in the Custom Program. No PY13 CHP participants completed a survey.			
<sup>(4)</sup> 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, including combined heat and power (CHP) projects. Commercial lighting contributes more than 5% to the sector and portfolio and is considered a high-impact measure. Overall, the NTG research for high-impact measures represents 80% of the total non-residential verified gross energy savings in PY13.

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

Table C-6 presents PY13 expenditures, by program, compared to the budget estimates set forth in the EE&C plan for PY13.<sup>28</sup> All the dollars are presented in 2021 dollars.

**Table C-6. Comparison of PY13 Expenditures to Phase IV EE&C Plan (\$1,000)**

Program	PY13 Budget from EE&C Plan <sup>(4)</sup>	PY13 Actual Expenditures <sup>(1)</sup>	Ratio (Actual/Plan)
Non-Residential	\$31,662	\$11,031	35%
Low-Income	\$8,063	\$5,215	65%
Residential	\$13,479	\$7,911	59%
<b>Total Direct Program Costs <sup>(2)</sup></b>	<b>\$53,204</b>	<b>\$24,157</b>	<b>45%</b>
Common Portfolio Costs <sup>(3)</sup>	\$8,620	\$6,400	74%
<b>Portfolio Total <sup>(2)</sup></b>	<b>\$61,824</b>	<b>\$30,557</b>	<b>49%</b>

<sup>(1)</sup> Expenditures may not match the sum of incentives and program costs listed in the individual program cost-effectiveness tables due to rounding.

<sup>(2)</sup> Total may not match sum of rows due to rounding.

<sup>(3)</sup> Common costs include costs for SWE audit.

<sup>(4)</sup> Budgets are from Table 6 of PPL Electric Utilities EE&C Plan.

Table C-7 presents P4TD expenditures, by program, compared to the budget estimates set forth in the EE&C plan through PY13 (not the full phase). All the dollars are presented in 2021 dollars.

**Table C-7. Comparison of P4TD Expenditures to Phase IV EE&C Plan (\$1,000)**

Program	Phase IV Budget from EE&C Plan through PY13 <sup>(4)</sup>	P4TD Actual Expenditures <sup>(1)</sup>	Ratio (Actual/Plan)
Non-Residential	\$31,662	\$11,031	35%
Low-Income	\$8,063	\$5,215	65%
Residential	\$13,479	\$7,911	59%
<b>Total Direct Program Costs <sup>(2)</sup></b>	<b>\$53,204</b>	<b>\$24,157</b>	<b>45%</b>
Common Portfolio Costs <sup>(3)</sup>	\$8,620	\$6,400	74%
<b>Portfolio Total <sup>(2)</sup></b>	<b>\$61,824</b>	<b>\$30,557</b>	<b>49%</b>

<sup>(1)</sup> Expenditures may not match the sum of incentives and program costs listed in the individual program cost-effectiveness tables due to rounding.

<sup>(2)</sup> 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.

<sup>(3)</sup> Common costs include costs for SWE audit.

<sup>(4)</sup> Budgets are from Table 6 of PPL Electric Utilities EE&C Plan.

Table C-8 compares P13 verified gross program savings compared to the energy savings projections set forth in the EE&C plan.

<sup>28</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

**Table C-8. Comparison of PY13 Actual Program Savings to EE&C Plan Projections for PY13**

Program	EE&C Plan Projections for PY13 (MWh/yr) <sup>(3)</sup>	PY13 VTD Gross MWh/yr Savings	Ratio (Actual/Plan)
Non-Residential <sup>(1)</sup>	241,792	126,597	52%
Low-Income <sup>(1)</sup>	12,247	10,449	85%
Residential <sup>(1)</sup>	38,050	31,740	83%
<b>Total <sup>(1) (2)</sup></b>	<b>292,089</b>	<b>168,786</b>	<b>58%</b>

<sup>(1)</sup> May not match totals in infographics due to rounding.  
<sup>(2)</sup> Total may not match sum of rows due to rounding.  
<sup>(3)</sup> Projections from Table 4 of PPL Electric Utilities EE&C Plan.

Table C-9 compares Phase IV actual programs savings to the EE&C projections through the end of Phase IV.

**Table C-9. Comparison of Phase IV Actual Program Savings to EE&C Plan Projections for Phase IV**

Program	EE&C Plan Through PY13 <sup>(4)</sup>	VTD Gross MWh/yr Savings	Carryover MWh/yr	Total VTD Gross MWh/yr Savings	Ratio (Actual/Plan)
Non-Residential <sup>(1)</sup>	241,792	126,597	-	126,597	52%
Low-Income <sup>(1)</sup>	12,247	10,449	31,089	41,538	339%
Residential <sup>(1)</sup>	38,050	31,740	-	31,740	83%
<b>Total <sup>(1) (2)</sup></b>	<b>292,089</b>	<b>168,786</b>	<b>306,275 <sup>(3)</sup></b>	<b>475,061</b>	<b>163%</b>

<sup>(1)</sup> May not match totals in infographics due to rounding.  
<sup>(2)</sup> 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.  
<sup>(3)</sup> 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.  
<sup>(4)</sup> Projections are from Table 4 of PPL Electric Utilities EE&C Plan.

## 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

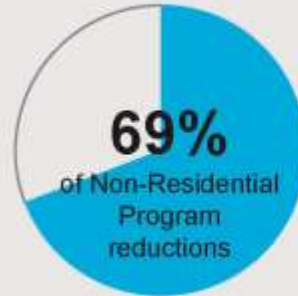
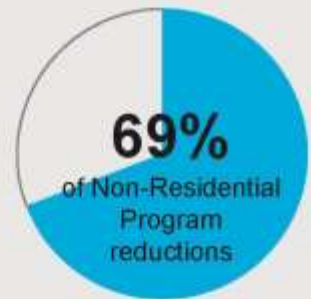
Phase IV has saved **89,330 MWh/yr**



PY13 saved **89,330 MWh/yr**

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of **14.28 MW/yr**



PY13 has reductions of **14.28 MW/yr**

### PY13 PARTICIPATION

A total of **5,281** participants



**5,249** Lighting



**13** HVAC equipment



**13** Refrigeration equipment



**6** Water heating equipment

### PARTICIPANT SATISFACTION



**93%**

Satisfied with overall program

**96%** satisfied with the time it took to receive the rebate

**88%** satisfied with contractor

**88%** satisfied with rebate amount

**80%** satisfied with the clarity of the application requirements

**77%** satisfied with the communication from the ICSP



## Appendix D. Evaluation Detail – Efficient Equipment Component

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

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

- **Downstream rebates.** Customers, contractors, or trade allies submit applications for review and validation by the Non-Residential ICSP. The ICSP reviews and validates all submitted applications, 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.<sup>29</sup> 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 40 downstream lighting projects, 13 downstream non-lighting projects, and 32 midstream lighting projects. PPL Electric Utilities did not report any midstream non-lighting projects in PY13.

#### Sampling Details

PPL Electric Utilities did not report participation in quarter 1 (Q1) and, due to the timing of the evaluation, Cadmus used records from Q2 and Q3. Cadmus additionally sampled non-lighting projects

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<sup>29</sup> Product installations are limited to up to two pre-rinse sprayers, 50 A19 bulbs and 24 PAR30 bulbs.



from the first month of Q4. Cadmus reviewed the remaining records in Q4 and determined that the sample frames 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* and/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.<sup>30</sup> The Efficient Equipment component did not report any non-lighting projects above the threshold defined in the PA TRM in PY13.

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 PY13, the sampling target for the downstream non-lighting subcomponent of 85% confidence and 15% precision was achieved with the sample of 13 projects. Cadmus verified savings for downstream non-lighting projects at 85% confidence with ±3.84% precision.

**Table D-1. PY13 Efficient Equipment Non-Lighting Subcomponent  
Gross Impact Evaluation Sample Design**

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
<b>Non-Lighting</b>				
Downstream	85/15; Cv of 0.50	20	13	Desk review with optional phone interview and/or virtual site visit

**Downstream, Direct Discount, Direct Install, and Midstream Lighting**

Downstream lighting projects were categorized into three strata based on reported savings:

- >750 MWh/yr (the lighting threshold in the PA TRM)
- 120-750 MWh/yr
- <120 MWh/yr

Cadmus selected a random sample of projects from quarters 2 and 3 (Q2 and Q3) in PY13 for the non-threshold downstream and the midstream lighting strata. Cadmus verified a census of projects for Q2 and Q3 that were above the PA TRM threshold of 750 MWh/yr. 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.

<sup>30</sup> 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 ±8.29% precision.

**Table D-2. PY13 Efficient Equipment Lighting Subcomponent Gross Impact Evaluation Sample Design**

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
<b>Lighting</b>				
Downstream threshold (>750 MWh/yr) <sup>(1)</sup>	90/10	34	8	Desk review with optional phone interview and/or virtual site visit
Downstream (120-750 MWh/yr) <sup>(1)</sup>			16	Desk review with optional phone interview and/or virtual site visit
Downstream (<120 MWh/yr) <sup>(1)</sup>			16	Desk review with optional phone interview
Midstream <sup>(2)</sup>		Up to 23	32	Desk review with phone interview
<sup>(1)</sup> Assuming a Cv of 0.35 based on historical findings from Phase III.				
<sup>(2)</sup> Assuming a Cv of 0.50.				

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 sub-component was designed to meet 90% confidence and ±10% precision (90/10) because lighting is a high-impact measure contributing 66% of reported energy savings and 67% 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. Cadmus verified 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,<sup>31</sup> to evaluate savings. 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

<sup>31</sup> 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

For the jobs included in the evaluation sample, Cadmus reviewed customer invoices and the technical specifications of the reported installed equipment and verified these using the DLC 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.

Cadmus used desk reviews combined with phone interviews to verify the equipment installed for all sampled jobs. The site contact 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. Cadmus 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. Cadmus also gathered information regarding the *in situ* baseline fixtures and lamps.

### *D.1.2 Gross Impact Results*

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

In PY13, the Efficient Equipment component reported energy savings of 82,842 MWh/yr, as shown in Table D-3, and demand reduction of 13.97 MW/yr, as shown in Table D-4.

**Table D-3. PY13 Efficient Equipment Component Gross Impact Results for Energy**

Stratum	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
<b>Non-Lighting Subcomponent</b>					
Downstream HVAC	262	107%	0.04	3%	281
Downstream Other <sup>(2)</sup>	1,498	81%	0.11	5%	1,210
<b>Non-Lighting Total <sup>(3) (4)</sup></b>	<b>1,760</b>	<b>85%</b>	<b>0.18</b>	<b>4%</b>	<b>1,491</b>
<b>Lighting Subcomponent</b>					
Downstream Threshold (>750 MWh/yr)	31,611	101%	0.02	1%	31,973
Downstream (120-750 MWh/yr)	21,533	101%	0.04	1%	21,646
Downstream (< 120 MWh/yr)	10,609	96%	0.10	4%	10,195
Midstream	17,329	139%	1.03	27%	24,025
<b>Lighting Total <sup>(2) (3) (4)</sup></b>	<b>81,081</b>	<b>108%</b>	<b>0.19</b>	<b>7%</b>	<b>87,839</b>
<b>Component Total <sup>(2) (3) (4)</sup></b>	<b>82,842</b>	<b>108%</b>	<b>0.20</b>	<b>7%</b>	<b>89,330</b>
<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings. <sup>(2)</sup> The Other stratum includes projects in the Refrigeration and Water Heating measure category. <sup>(3)</sup> Savings may not match other tables or figures due to rounding. <sup>(4)</sup> Totals may not sum due to rounding.					

**Table D-4. PY13 Efficient Equipment Component Gross Impact Results for Demand**

Stratum	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System- Level PYVTD (MW/yr) <sup>(2)</sup>
<b>Non-Lighting Subcomponent</b>						
Downstream HVAC	0.05	105%	0.08	5%	0.05	0.05
Downstream Other <sup>(3)</sup>	0.18	83%	0.10	4%	0.15	0.16
<b>Non-Lighting Total <sup>(4) (5)</sup></b>	<b>0.23</b>	<b>88%</b>	<b>0.15</b>	<b>3%</b>	<b>0.20</b>	<b>0.22</b>
<b>Lighting Subcomponent</b>						
Downstream Threshold (>750 MWh/yr)	4.50	82%	0.27	9%	3.71	3.94
Downstream (120-750 kWh/yr)	3.27	100%	0.01	0%	3.26	3.52
Downstream (< 120 kWh/yr)	1.58	111%	0.37	14%	1.75	1.89
Midstream	4.40	99%	0.71	19%	4.37	4.71
<b>Lighting Total <sup>(4) (5)</sup></b>	<b>13.75</b>	<b>95%</b>	<b>0.71</b>	<b>7%</b>	<b>13.08</b>	<b>14.07</b>
<b>Component Total <sup>(4) (5)</sup></b>	<b>13.97</b>	<b>95%</b>	<b>0.73</b>	<b>7%</b>	<b>13.28</b>	<b>14.28</b>
<sup>(1)</sup> 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. <sup>(2)</sup> PYVTD in this column represents system-level savings (application of line losses). <sup>(3)</sup> The Other stratum includes projects in the Refrigeration and Water Heating measure category. <sup>(4)</sup> Savings may not match other tables or figures due to rounding. <sup>(5)</sup> Total may not sum due to rounding.						

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

For the non-lighting component, the most common adjustment was to circulating fan horsepower for electronically commutated motors (ECMs). Horsepower was reported as the product of the number of fans and total fan horsepower, which artificially increased the reported horsepower. Cadmus corrected reported horsepower to be for the individual fan.

For the lighting component, the most common adjustments were to the hours of use and coincidence factors. For threshold projects, these resulted from inaccurately analyzing logger data. Cadmus adjusted hours of use and coincidence factors using findings from its logger data analysis. For non-threshold downstream and midstream lighting projects, Cadmus adjusted hours of use and coincidence factors after establishing facility type through the desk review or the site contact interview.

## *Site Visit and Desk Review Findings*

### **Downstream, Direct Discount, and Direct Install Non-Lighting**

For the gross impact evaluation of the Non-Lighting subcomponent, the Cadmus team completed nine desk reviews and four virtual site visits for the 13 equipment projects included in the evaluation sample. The Cadmus team 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.

Reasons for adjustments to reported savings included corrections to the following:

- Motor horsepower and quantity
- Hot water fuel type

Adjustments to motor horsepower and quantity had the greatest impact on verified savings.

### **Downstream Lighting**

Cadmus conducted virtual site visits and desk reviews for 40 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 36 desk reviews (eight of which included phone interviews). If a project had 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.<sup>32</sup> Cadmus also interviewed facility representatives to determine operating schedules and estimate lighting hours of use.

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 annual hours of use and coincidence factor were the most common, affecting 12 projects of the 40 sampled. Adjustments were needed due to incorrect hours from the PA TRM being used or if the reported savings were based on approximating the custom hours of use and coincidence factor using the Appendix C schedule instead of findings from the lighting logger data analysis. Adjustments to wattage were the second most common factor and affected six projects.

### Midstream Lighting

In PY13, Cadmus conducted desk reviews and phone interviews to verify savings for the sample of 32 midstream lighting jobs in PPL Electric Utilities' tracking database. Cadmus adjusted calculation inputs to reported savings that differed from verified conditions.

Table D-5 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-5. PY13 Efficient Equipment Midstream Lighting Subcomponent Verified Savings Adjustments Summary (in Order of Frequency)**

Savings Adjustment Type	Number of Adjusted Jobs	Percentage of Adjusted Jobs <sup>(1)</sup>	Primary Reason for Adjustment
Facility Type	31	97%	Not typically known by ICSP, default is Unknown/Misc.
Fixture Control Type	31	97%	Adjusted TRM defaults to match the verified control type (e.g., daylighting photosensors, timeclocks, occupancy sensors) for the space where equipment was installed.
Hours of Use	25 <sup>(2)</sup>	78%	Based on facility type.
Coincidence Factor	25 <sup>(2)</sup>	78%	Based on facility type.
Energy Interactive Factor	20	63%	Based on space conditioning and heating fuel, verified during site visit or desk review.

<sup>32</sup> 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 Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC. Final version May 8, 2018.

Savings Adjustment Type	Number of Adjusted Jobs	Percentage of Adjusted Jobs <sup>(1)</sup>	Primary Reason for Adjustment
Demand Interactive Factor	12	38%	Based on space conditioning, verified during site visit or desk review.
Post-Install Lamp/Fixture Wattage	6	19%	Reported wattages differed from tested and verified wattages documented by DesignLights Consortium (DLC). Three adjustments were due to rounding.
Post-Install Lamp/Fixture Quantity	2	6%	Revised if Cadmus could not confirm installation of the lamps sold as part of the job, the lamps were intended as spares (and therefore put in storage), and/or the customer did not plan to install them before the end of the evaluation period. The installation rate for the evaluation sample was 99.7%.
Pre-Install Lamp/Fixture Quantity	2	6%	Primarily due to de-lamping (fewer lamps installed than those replaced).
<sup>(1)</sup> Percentage of adjusted jobs is calculated based on the total of 32 sample job verifications. <sup>(2)</sup> 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,<sup>33</sup> 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 PY13 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 PY13 and used a historic NTG ratio of 0.62 from PY11. Cadmus plans to conduct net savings research in PY14 for midstream non-lighting projects and in PY15 for the 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-6 lists the sampling strategy used to determine net savings for downstream lighting and equipment strata.

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<sup>33</sup> 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 D-6. PY13 Efficient Equipment Component Net Impact Evaluation Sample Design by Stratum**

Stratum	Stratum Boundaries	Population Size <sup>(1)</sup>	Assumed Cv or Proportion in Sample Design	Assumed Confidence & Precision	Target Sample Size	Number of Records in Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample <sup>(2)</sup>
Downstream, Direct Discount, Direct Install Lighting <sup>(3)</sup>	Downstream lighting projects	456 <sup>(4)</sup>	0.5	85/15	69	199	8 <sup>(5)</sup>	100%
Downstream, Direct Discount, Direct Install Non-Lighting	Downstream non-lighting projects	34 <sup>(4)</sup>	0.5	85/15	23	13	2 <sup>(6)</sup>	100%
<b>Total</b>		<b>490</b>	-	-	<b>92</b>	<b>212</b>	<b>10</b>	<b>100%</b>

<sup>(1)</sup> Population refers to number of projects in PY13 at the time of the participant survey.

<sup>(2)</sup> 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.

<sup>(3)</sup> Downstream lighting, direct discount, and direct install lighting were combined.

<sup>(4)</sup> Combined population of downstream, direct discount, and direct install lighting participants at the time of the survey.

<sup>(5)</sup> Seventeen respondents did not respond to the intention free ridership questions and are not included in the NTG analysis.

<sup>(6)</sup> One respondent did not respond to the intention free ridership questions and is not included in the NTG analysis.

### Free Ridership

Cadmus summed the intention and influence free ridership components to estimate the average free ridership by stratum, weighted by verified gross kWh/yr savings. Table D-7 summarizes the intention, influence, and free ridership scores for each stratum.

**Table D-7. 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	8	21%	2%	23%
Downstream, Direct Discount, Direct Install Non-Lighting	2	28%	5%	33%

### 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 additional 10 LED bulbs for the building after participating in the Efficient Equipment component. The respondent 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-8 shows the NTG ratio results for the strata of the Efficient Equipment component.

**Table D-8. PY13 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	63,814,470	PY13	23% <sup>(1)</sup>	0%	0.77	41% <sup>(2)</sup>
Downstream, Direct Discount, Direct Install Non-Lighting	1,491,197	PY13	33% <sup>(1)</sup>	0%	0.67	89% <sup>(3)</sup>
Midstream Lighting	24,024,628	PY11	38%	0%	0.62	N/A
<b>Component Total <sup>(4)</sup> <sup>(5)</sup></b>	<b>89,330,294</b>	<b>-</b>	<b>27%</b>	<b>0%</b>	<b>0.73</b>	<b>-</b>

<sup>(1)</sup> 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.  
<sup>(2)</sup> At 90% confidence interval.  
<sup>(3)</sup> At 85% confidence interval.  
<sup>(4)</sup> 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 0.73.  
<sup>(5)</sup> 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 PY13 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 0.77 with relative precision of 41% and at 85% confidence with a relative precision of 35%.

### 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, inform the logic model review, 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 PY13 although the number of participant surveys was not reached.

Cadmus attempted to contact a census of participants between April and June 2022 and completed 28 surveys of the 233 participants in the sample frame. Cadmus made several attempts to reach participants by sending an initial email invitation, followed by two 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 ±8.6% precision.

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

For midstream lighting, Cadmus conducted a process evaluation in PY13 to inform the logic model review. Because the midstream non-lighting subcomponent is expected to begin in PY14, Cadmus interviewed staff from PPL Electric Utilities and the ICSP about the launch date and the status of progress. The evaluation activities were consistent with the planned activities.

Table D-9 lists the process evaluation sampling strategy.

**Table D-9. 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 <sup>(1)</sup>
<b>Downstream, Direct Discount, Direct Install</b>								
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	Participants	Online survey	34 <sup>(2)</sup>	0.5	23	3	13 <sup>(3)</sup>	100%
Lighting	Participants	Online survey	456 <sup>(2)</sup>	0.5	69	25	199 <sup>(3)</sup>	100%
<b>Midstream (Lighting and Non-Lighting)</b>								
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	4 <sup>(4)</sup>	N/A	4	4	4	100%
<b>Total</b>			<b>496</b>	<b>-</b>	<b>98</b>	<b>34</b>	<b>218</b>	<b>100%</b>
<sup>(1)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys and interviews. <sup>(2)</sup> Population size includes number of unique records available at the time of the survey. <sup>(3)</sup> 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 Utility’s do not call list, or opted out of the online survey. <sup>(4)</sup> Cadmus completed two interviews about the midstream lighting subcomponent and two about the midstream equipment subcomponent.								

### D.3.1 Program Component Experience

#### Program Component Satisfaction and Customer Effort

##### Downstream, Direct Discount, and Direct Install

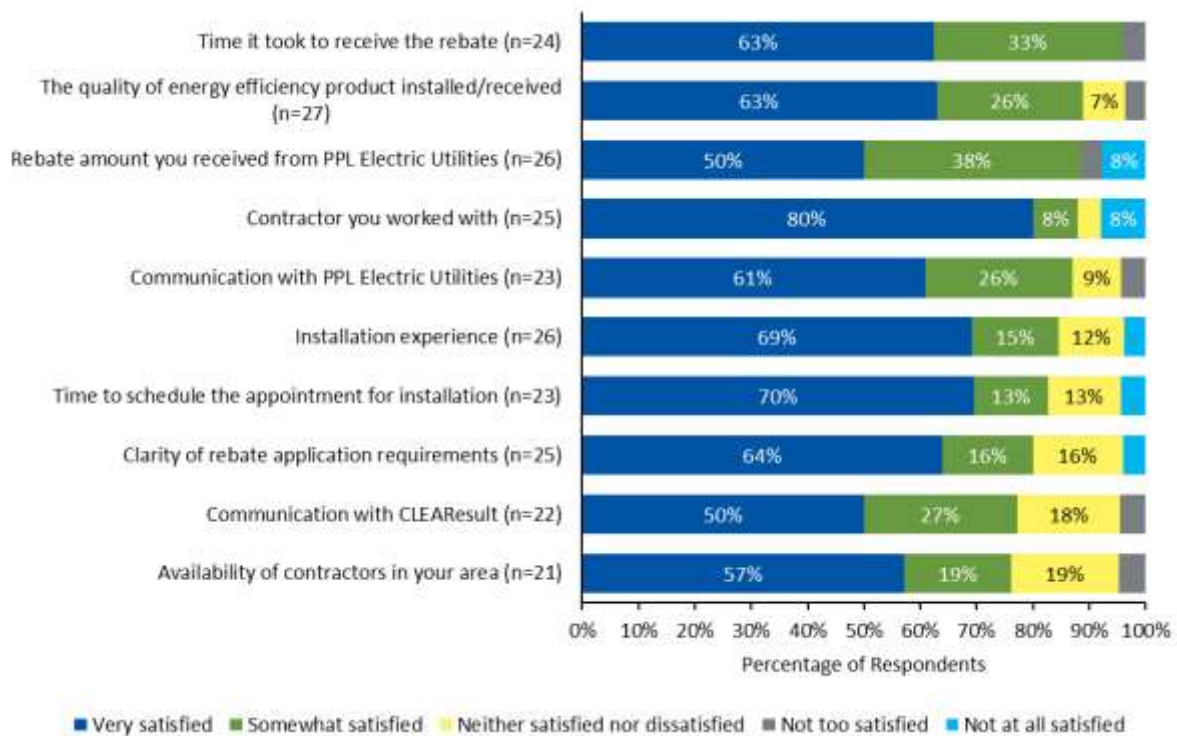
The Efficient Equipment component achieved high satisfaction in PY13 with 88% of the respondents (n=28) finding it easy to participate with a 93% satisfaction rate (93% *somewhat satisfied*; n=28).<sup>34</sup>

Respondents were most satisfied with the time it took to receive the rebate (96% *very satisfied* or *somewhat satisfied*; n=23), followed by the quality of energy efficiency measures installed/received (89%; n=24), and the rebate amount and the contractor they worked with (both 88%; n=23).

Respondents were least satisfied with the availability of contractors (76% *very satisfied* or *somewhat satisfied*; n=16). Figure D-1 presents detailed results.

Respondents answered questions about the ease or difficulty of participating with several customer touchpoints (Figure D-2). In general, respondents found participating *very easy* or *easy*.

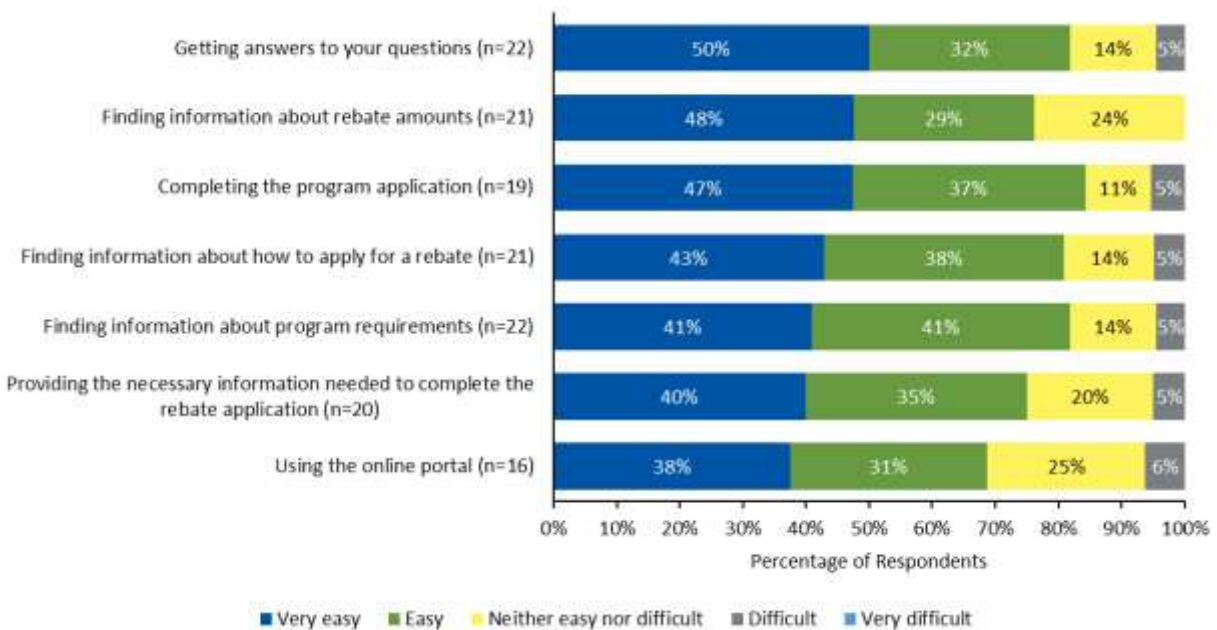
**Figure D-1. PY13 Efficient Equipment Component Satisfaction**



Source: Survey question, “Thinking about the program, please indicate how satisfied you are with each element of your experience.”

<sup>34</sup> Additionally, no respondents were *neither satisfied nor dissatisfied* and 7% were *not too satisfied* (n=28).

**Figure D-2. PY13 Efficient Equipment Component Ease of Participation**



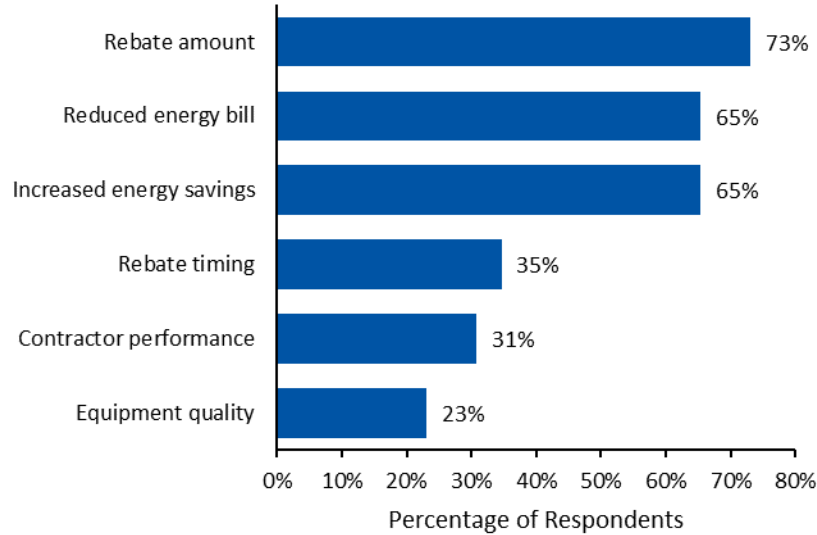
Source: Survey question, “Overall, how easy or difficult were the following?” Totals may not sum due to rounding.

### *Drivers of Program Component Satisfaction*

#### **Downstream, Direct Discount, and Direct Install**

To better understand what drives satisfaction with the component, the survey asked participants what factor(s) most affected their satisfaction rating. Figure D-3 details the factors that most affected the overall experience rating reported by respondents.

**Figure D-3. Efficient Equipment Component Drivers of Satisfaction**



Source: Survey question, “What factor(s) most affected the overall experience rating you gave?” (n=27; multiple responses allowed)

### *Opinion of PPL Electric Utilities and Likelihood to Recommend*

#### **Downstream, Direct Discount, and Direct Install**

Of 27 survey respondents, 16 said their opinion of PPL Electric Utilities had improved after participating in the Efficient Equipment component, and 11 said their opinion had not changed. Twenty-four respondents said they were likely to recommend the component to a friend, family member, or colleague.

### *Areas for Improvement*

#### **Downstream, Direct Discount, and Direct Install**

Two respondents said more information about the rebate and component would improve the component. One respondent said, “New lights have an audible buzz to them... supply lighting without a buzzing sound.” Another respondent complimented the contractor.

### *D.3.2 Other Findings*

#### *Midstream Marketing*

PPL Electric Utilities and the ICSP revised marketing in response to lower than projected sales of midstream lighting equipment. Since PY11, marketing efforts focused on an informational campaign to keep the availability of incentives in customers’ minds. In PY13, the marketing campaign shifted to emphasize call-to-action messaging (e.g., replace equipment before failure). PPL Electric Utilities and the ICSP also targeted the industries more likely to engage (e.g., warehouses and other businesses that were

relatively unaffected by the COVID-19 pandemic) and provided technical outreach to large customers to help them identify projects.

## Survey Participant Profile and Survey Sample Attrition

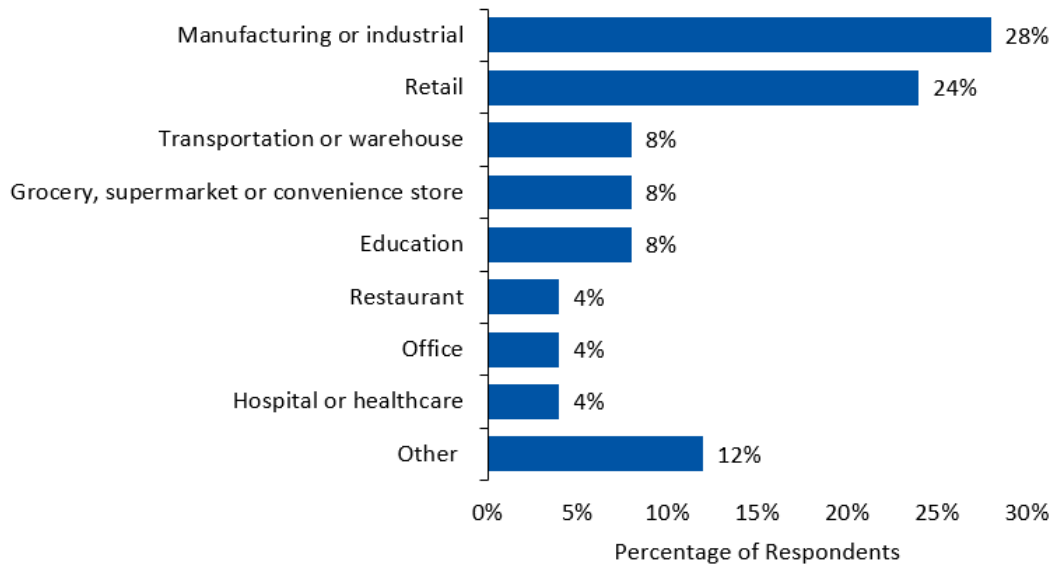
### Downstream, Direct Discount, and Direct Install

The participant survey collected the following characteristics:

- Most respondents had 51 to 100 people employed at the facility (25%; n=24).
- Most respondents had a facility with square footage of 10,001 to 50,000 (38%; 9 of 24).
- Most respondents reported that the primary use of the facility was manufacturing or industrial (28%, n=7) and retail (24%, n=6).

Figure D-4 shows the primary uses provided by survey respondents.

**Figure D-4. Efficient Equipment Component Organization Types**



Source: Survey question, “What is the primary use of your facility?” (n=25)

Table D-10 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 Survey Bias*.

**Table D-10. Efficient Equipment Sample Attrition**

Description of Outcomes of Online Participant Survey	Number of Records			
	Non-Lighting (Equipment)	Downstream Lighting	Direct Discount Lighting	Direct Install Lighting
<b>Population (Number of Unique Records)</b>	<b>34</b>	<b>271</b>	<b>158</b>	<b>27</b>
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	<b>21</b>	<b>181</b>	<b>70</b>	<b>6</b>
<b>Survey Sample Frame (Records Attempted)</b>	<b>13</b>	<b>90</b>	<b>88</b>	<b>21</b>
Not reached or non-working: No answer, answering machine, phone busy, refused or opted out, email returned (bounce back), did not respond	10	76	79	19
<b>Completed Surveys</b>	<b>3</b>	<b>14</b>	<b>9</b>	<b>2</b>
<b>Overall Response Rate</b>	<b>23%</b>	<b>16%</b>	<b>10%</b>	<b>10%</b>

### *D.3.3 Logic Model*

#### *Downstream, Direct Install, and Direct Discount Non-Lighting and Lighting*

Cadmus reviewed the logic model in the approved evaluation plan developed by Cadmus in Phase III and made updates based on interviews with PPL Electric Utilities and the ICSP and from secondary research. Cadmus made several updates to the logic model due to the addition of the direct install delivery channel to the Efficient Equipment component offerings. The updated logic mode is shown in Table D-11.

**Table D-11. Efficient Equipment Downstream, Direct Discount, and Direct Install Lighting and Non-Lighting Component Logic Model**

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Customer or building owner does not prioritize energy efficiency</li> <li>• Decision-makers choose to install cheaper, less efficient equipment with shorter payback</li> <li>• Owners are not informed about how their facility uses energy</li> <li>• Existing debt may limit funds to purchase new efficient equipment</li> <li>• Customers place a priority on fluctuating commodity prices</li> <li>• Customers typically replace equipment only upon failure</li> <li>• Customers see no need to replace functioning equipment</li> <li>• Customers are not informed about the most efficient equipment available when the need to replace it is immediate. Some efficient equipment may have a longer delivery time that would affect customer operations</li> <li>• Customers are unaware of benefits of installing and properly maintaining energy efficient equipment</li> <li>• Customers do not properly maintain equipment, and savings benefits erode over time</li> </ul>	<ul style="list-style-type: none"> <li>• Management and strategic direction</li> <li>• Trade allies’ support</li> <li>• Marketing</li> <li>• Rebate form submission</li> <li>• Eligibility verification</li> <li>• Customer education</li> <li>• Purchase and installation of equipment by the customer or by a contractor</li> <li>• Rebate processing and payment</li> </ul>	<ul style="list-style-type: none"> <li>• Marketing materials distributed</li> <li>• Customers are submitting projects</li> <li>• Projects are verified as eligible</li> </ul>	<ul style="list-style-type: none"> <li>• Increased component awareness</li> <li>• Increased customer and trade ally awareness of energy-efficient equipment</li> <li>• Increased installations of energy-efficient equipment</li> <li>• Rebated equipment is installed, leading to immediate energy and demand savings</li> <li>• Component effectiveness is confirmed through EM&amp;V</li> <li>• Energy savings accrue from non-residential participants through installation of efficient equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Customers experience lower electric bills</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Continued energy savings for the participants.</li> <li>• PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency</li> <li>• Increasing PPL Electric Utilities’ knowledge and experience operating this type of component</li> <li>• Environmental benefits are achieved</li> </ul>



Cadmus reviewed the logic model for the downstream, direct discount, and direct install delivery channels for both lighting and non-lighting equipment and determined that these components are operating as expected. Table D-12 shows the outcome of the logic model review.

**Table D-12. Efficient Equipment Component Downstream, Direct Discount, and Direct Install Lighting and Non-Lighting Component Logic Model Review**

Topics	Logic Model Components/ Goal	Status	PY13 Outcomes
<b>Component Activities</b>	<ul style="list-style-type: none"> <li>• Management and strategic direction</li> <li>• Trade allies’ support</li> <li>• Marketing</li> <li>• Rebate form submission</li> <li>• Eligibility verification</li> <li>• Customer education</li> <li>• Purchase and installation of equipment by the customer or by a contractor</li> <li>• Rebate processing and payment</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Conducted all activities as planned</li> <li>• Removed preapproval from prescriptive downstream rebates in February 2022</li> </ul>
<b>Outputs Produced by Component Activities</b>	<ul style="list-style-type: none"> <li>• Marketing materials distributed</li> <li>• Customers are submitting projects</li> <li>• Projects are verified as eligible</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Customers are participating, but due to challenges with supply chain issues, participation is lower than planned</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Increased component awareness</li> <li>• Increased customer and trade ally awareness of energy-efficient equipment</li> <li>• Increased installations of energy-efficient equipment</li> <li>• Rebated equipment is installed, leading to immediate energy and demand savings</li> <li>• Component effectiveness is confirmed through EM&amp;V</li> <li>• Energy savings accrue from non-residential participants through installation of efficient equipment</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Achieved 93% satisfaction, as reported in participant surveys</li> <li>• Contributed 52% to PY13 Non-Residential Program verified energy savings and 47% of PY13 Non-Residential Program verified demand reductions</li> </ul>
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>• Customers experience lower electric bills</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	On track to meet in subsequent years	<ul style="list-style-type: none"> <li>• In PY13 (year 1), downstream Efficient Equipment achieved 5% of planned Non-Residential Program Phase IV energy savings and 5% of planned system-level Non-Residential demand reductions <sup>(1)</sup></li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Continued energy savings for the participants</li> <li>• PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving market toward improved energy efficiency</li> <li>• Increasing PPL Electric Utilities’ knowledge and experience operating this type of component</li> <li>• Environmental benefits are achieved</li> </ul>	Unable to assess	<ul style="list-style-type: none"> <li>• Unable to assess at this time</li> </ul>

<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

*Midstream Lighting*

Cadmus reviewed the logic model for the midstream lighting channel in the approved evaluation plan and made updates based on interviews with PPL Electric Utilities and the ICSP and secondary research. As indicated in the evaluation plan, Cadmus will review and update the logic model for the midstream equipment channel in PY14. The midstream lighting logic model is shown in Table D-13.

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

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Customer or building owner does not prioritize energy efficiency.</li> <li>• Decision-makers choose to install cheaper, less efficient equipment with shorter payback</li> <li>• Owners are not informed about how their facility uses energy.</li> <li>• Existing debt may limit funds to purchase new efficient equipment.</li> <li>• Customers place a priority on fluctuating commodity prices.</li> <li>• Customers typically replace equipment only upon failure.</li> <li>• Customers see no need to replace functioning equipment.</li> <li>• Customers are not informed about the most efficient equipment available when the need to replace it is immediate. Some efficient equipment may have a longer delivery time that would affect customer operations.</li> <li>• Customers are unaware of the benefits of installing and properly maintaining energy efficient equipment.</li> <li>• Customers do not properly maintain equipment, and savings benefits erode over time.</li> </ul>	<ul style="list-style-type: none"> <li>• Recruit and educate distributors</li> <li>• Provide distributors with marketing materials</li> <li>• Determine eligibility through verification processes</li> <li>• Reimburse distributors for discounts on qualified product sales</li> <li>• Inform the end-use customer of the discount via a postcard</li> </ul>	<ul style="list-style-type: none"> <li>• Marketing materials distributed</li> <li>• Distributors are submitting projects</li> <li>• Projects are verified as eligible</li> </ul>	<ul style="list-style-type: none"> <li>• Increased component awareness</li> <li>• Increased customer and trade ally awareness of energy-efficient equipment</li> <li>• Increased installations of energy-efficient equipment</li> <li>• Rebated equipment is installed, leading to immediate energy and demand savings</li> <li>• Component effectiveness is confirmed through EM&amp;V</li> <li>• Energy savings accrue from non-residential participants through installation of efficient equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Lower electric bills for component participants</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Continued energy savings for the participants</li> <li>• PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency</li> <li>• Increasing PPL Electric Utilities' knowledge and experience operating this type of component</li> <li>• Environmental benefits are achieved</li> </ul>

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

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

Topics	Logic Model Components/ Goal	Status	PY13 Outcomes
<b>Component Activities</b>	<ul style="list-style-type: none"> <li>Recruit and educate distributors</li> <li>Provide distributors with marketing materials</li> <li>Determine eligibility through verification processes</li> <li>Reimburse distributors for discounts on qualified product sales</li> <li>Inform the end-use customer of the discount via a postcard</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>Conducted all activities as planned</li> <li>Increased the threshold amount requiring pre-approval from \$3,000 to \$8,000</li> </ul>
<b>Outputs Produced by Component Activities</b>	<ul style="list-style-type: none"> <li>Marketing materials distributed</li> <li>Distributors are submitting projects</li> <li>Projects are verified as eligible</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>Distributors are participating, but due to challenges with supply chain issues, participation is lower than planned</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>Increased component awareness</li> <li>Increased customer and trade ally awareness of energy-efficient equipment</li> <li>Increased installation of energy-efficient equipment</li> <li>Rebated equipment is installed, leading to immediate energy and demand savings</li> <li>Component effectiveness is confirmed through EM&amp;V</li> <li>Energy savings accrue from non-residential participants through installation of efficient equipment</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>Contributed 19% of PY13 verified Non-Residential energy savings and 23% of PY13 verified Non-Residential demand reductions</li> </ul>
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>Lower electric bills for component participants</li> <li>Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	On track to meet in subsequent years	<ul style="list-style-type: none"> <li>In PY13 (year 1), midstream lighting achieved about 2% of planned Phase IV energy savings and 2% of planned Phase IV demand reductions<sup>(1)</sup></li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>Continued energy savings for the participants</li> <li>PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency</li> <li>Increasing PPL Electric Utilities' knowledge and experience operating this type of component</li> <li>Environmental benefits are achieved</li> </ul>	Unable to assess	<ul style="list-style-type: none"> <li>Unable to assess at this time</li> </ul>

<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.



## 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

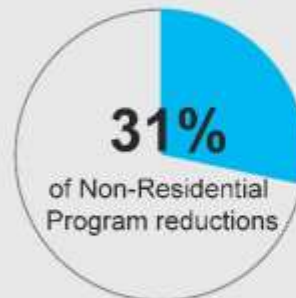
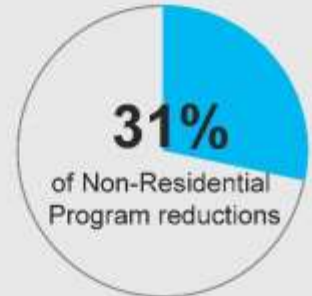
Phase IV has saved 37,267 MWh/yr



PY13 saved 37,267 MWh/yr

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of 6.30 MW/yr



PY13 has reductions of 6.30 MW/yr

### PY13 PARTICIPATION

A total of 36 participants



Photovoltaic



Refrigeration



HVAC



Agricultural



Motors



Combined Heating and Power (CHP)



Compressed Air



Other unspecified

### PARTICIPANT SATISFACTION



Satisfied with overall program

## Appendix E. Evaluation Detail – Custom Component

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

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 PY13 participant is defined as a project that was commercially operable between June 1, 2021, and May 31, 2022, and subsequently received an incentive payment.<sup>35</sup> 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 PY13. An individual customer may have multiple participating projects. In PY13, there were 36 participants.

### 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 will be 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 PY13, three large stratum projects reported savings.<sup>36</sup> Cadmus verified savings for three large stratum projects.
- **Combined heat and power (CHP) stratum.** All CHP projects were assigned to this stratum. In PY13, two CHP projects reported savings. Cadmus verified savings for both projects.

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<sup>35</sup> 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.

<sup>36</sup> Four projects (two CHP stratum, two large stratum) had savings over 2 million kWh/yr. One additional large stratum project that had been preapproved previously (PY9) had savings of approximately 1.3 million kWh/yr.

- **Small stratum.** The 31 projects assigned to the small stratum were not verified in PY13. They will be included in the small stratum sample and evaluated in PY14.

The impact evaluation sampling strategy is summarized in Table E-1. In PY13, all custom projects in the large and CHP strata were evaluated.

**Table E-1. PY13 Custom Component Gross Impact Evaluation Sample Design**

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Large	Census	3 <sup>(1)</sup>	3	Visual verification of measure and site-specific conditions; M&V including metering (in most cases); analysis of EMS or SCADA data; installation of metering equipment (in some cases) to clarify measure operating hours, power consumption, and other items; regression analysis against weather and other independent variables (as applicable); reporting of final results.
CHP	Census	2	2	
<b>Total Participants</b>	-	<b>5</b>	<b>5</b>	-

<sup>(1)</sup> Four projects (two CHP stratum, two large stratum) with savings over two million kWh/yr were evaluated in PY13. One additional project was evaluated in the Large stratum with savings of approximately 1.3 million kWh/yr that had been preapproved previously.

To calculate *ex post* savings with verified savings, 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 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.

### E.1.2 Gross Impact Results

All projects evaluated for the Custom component in PY13 were in the large and CHP strata; therefore, the realization rate was 100%. In PY13, this component reported energy savings of 40,315 MWh/yr, as shown in Table E-2, and demand reduction of 6.40 MW/yr, as shown in Table E-3. Both the large and CHP strata are evaluated prior to being reported, so *ex ante* savings are equal to *ex post* savings and, therefore, the realization rates for both are 100%.

**Table E-2. PY13 Custom Component Gross Impact Results for Energy**

Stratum	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio <sup>(2)</sup>	Relative Precision at 85% C.L. <sup>(2)</sup>	PYVTD (MWh/yr)
Large	22,712	100%	0%	0%	22,712
CHP	14,555	100%	0%	0%	14,555
<b>Subtotal <sup>(3)</sup></b>	<b>37,267</b>	<b>100%</b>	<b>0%</b>	<b>0%</b>	<b>37,267</b>
<b>Unverified (Small)</b>	<b>3,048</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
<b>Component Total <sup>(3)</sup></b>	<b>40,315</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.  
<sup>(2)</sup> All projects in PY13 were verified. Sampling was not conducted, so Cv and precision are not applicable.  
<sup>(3)</sup> Total may not match the sum of rows due to rounding.



**Table E-3. Custom Component Gross Impact Results for Demand**

Stratum	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio <sup>(2)</sup>	Relative Precision at 85% C.L. <sup>(2)</sup>	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Large	4.09	100%	0%	0%	4.09	4.44
CHP	1.75	100%	0%	0%	1.75	1.86
<b>Subtotal <sup>(3)</sup></b>	<b>5.84</b>	<b>100%</b>	<b>0%</b>	<b>0%</b>	<b>5.84</b>	<b>6.30</b>
<b>Unverified (Small)</b>	<b>0.56</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
<b>Component Total <sup>(3)</sup></b>	<b>6.40</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

<sup>(1)</sup> 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 applying distribution losses.  
<sup>(2)</sup> All projects in PY13 were verified. Sampling was not conducted, so Cv and precision are not applicable.  
<sup>(3)</sup> Total may not match the sum of rows due to rounding.

## E.2 Net Impact Evaluation

### E.2.1 Net Impact Methodology

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,<sup>37</sup> 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-4 lists the methods and sampling strategy used to determine net savings for the Custom component in PY13. Because small strata projects are being verified in PY14, the net savings analysis was completed only for survey respondents in the large and CHP project strata. Cadmus conducted the survey during April and May 2022 and received responses from two of the three large project participants. None of the CHP project participants completed the survey.

**Table E-4. Custom Component Net Impact Evaluation Sample Design**

Stratum	Stratum Boundaries	Population <sup>(1)</sup>	Achieved Sample Size	Response Rate <sup>(2)</sup>	NTG Activity
Custom	Participants	5	2	40%	Self-report survey

<sup>(1)</sup> The large and CHP strata totaled five projects. After selecting unique participants, Cadmus removed any records from the population if customers had participated in a survey in the last three months, did not have a valid contact information (email address or telephone number), were on the do not call list, or opted out of the online survey. This left three in the sample frame.  
<sup>(2)</sup> Response rate is calculated as the number of respondents who answered the free ridership questions (n=2) divided by the number of records in the population.

<sup>37</sup> 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-5 shows the NTG ratio results for the large stratum of the Custom component. The two survey respondents represented 43% of the large stratum’s verified gross population savings. Free ridership was 78%, weighted by the verified gross savings of the projects they completed. One project represented 88.8% of the large stratum verified gross savings and was estimated at 75% free ridership. The other represented 11.2% of the large stratum verified gross savings and was estimated at 100% free ridership. Neither respondent reported any attributable spillover activity as a result of their participation.

**Table E-5. PY13 Custom Component NTG Ratio Summary**

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Custom – Large	2	78%	0%	0.22	147% <sup>(1)</sup>
<b>Component Total</b>	<b>2</b>	<b>78%</b>	<b>0%</b>	<b>0.22</b>	<b>147%</b>

<sup>(1)</sup> At 90% confidence interval.

### E.3 Process Evaluation

In PY13, Cadmus conducted a process evaluation to assess participant satisfaction, inform the logic model review, inform net savings research, and make recommendations for modifying and improving the Custom component. Process evaluation activities were consistent with planned activities. Table E-6 lists the process evaluation sampling strategy.

The participant survey asked questions about satisfaction, the influence of the contractor or design engineer on project design, the likelihood of recommending the component to others, and other topics.

During April and May 2022, Cadmus made several attempts to reach participants through an initial email invitation, two email reminders, and several telephone calls. Three participants—two with large stratum projects and one with a small stratum project—responded to the survey. See *Appendix L Survey Bias* for details about Cadmus’ approach to reducing survey bias and contact instructions.



**Table E-6. PY13 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 <sup>(1)</sup>
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	23 <sup>(2)</sup>	0.5	Census	3 <sup>(3)</sup>	14 <sup>(4)</sup>	100%
<b>Component Total</b>			<b>25</b>	<b>0.5</b>	-	<b>5</b>	<b>16</b>	<b>100%</b>
<p><sup>(1)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews.</p> <p><sup>(2)</sup> Population size includes number of unique records available at the time of the survey field period through mid-April of PY13.</p> <p><sup>(3)</sup> Includes two large strata participants and one small strata participant.</p> <p><sup>(4)</sup> 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.</p>								

### E.3.1 Component Experience

The Custom component was delivered effectively in PY13 and maintained high levels of customer satisfaction. As shown in Table E-7, all three respondents to the PY13 survey were satisfied with the overall component.

**Table E-7. PY13 Custom Participant Satisfaction**

Satisfaction Level	Responses
Very satisfied	2
Somewhat satisfied	1
<b>Total</b>	<b>3</b>
Source: Participant survey, “Now, thinking about your overall experience with the PPL Electric Utilities Custom rebate program, how would you rate your satisfaction?” (n=3)	

Two of three respondents said that it was *easy* to participate in the Custom component, while the other participant said that it was *neither easy nor difficult*.

### 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 driver of overall satisfaction was communication with PPL Electric Utilities or the ICSP, CLEAResult. Table E-8 shows the most common drivers of respondents who were *very* or *somewhat satisfied* with the component.

**Table E-8. PY13 Drivers of High Component Satisfaction**

Satisfaction Drivers	Responses
Communication with PPL Electric Utilities or CLEAResult	2
Application process	1
Increased energy savings	1
Rebate amount	1
Rebate timing	1
Reduced energy bill	1
<b>Total Respondents</b>	<b>3</b>
Source: Participant survey, “What factor(s) most affected the overall experience rating you gave?” (n=3; multiple responses allowed)	

### Opinion of PPL Electric Utilities and Likelihood to Recommend

One survey respondent reported having a better opinion of PPL Electric Utilities after participating in the Custom component, while the other two said their opinions had not changed.

All three respondents rated their likelihood to recommend the component to a friend, family member, or colleague as a 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

One of the three respondents suggested providing more updates on the payment requests through the portal, explaining it was disappointing not to be able to track the rebate process in the portal and having to reach out directly to a representative to receive an update on the check.

### E.3.3 Other Findings

#### Survey Participant Profile and Survey Sample Attrition

The PY13 survey collected information about the facilities operated by Custom component participants, as shown in Table E-9.

**Table E-9. Respondent Firmographics**

Respondents	Employed in Facility	Facility Size	Facility Use
Respondent 1 – Large Stratum	101 to 250	Over 100,000 square feet	Agriculture
Respondent 2 – Large Stratum	51 to 100	Did not know	Wastewater treatment facility
Respondent 3 – Small Stratum	0 to 10	1 to 5,000 square feet	Restaurant

Table E-10 lists the total number of records contacted for the survey via online and telephone attempts and the outcome (final disposition) of each record. Of 14 records in the sample frame, three participants responded to the survey, for a 21% response rate. Additional details on survey methodology are provided in *Appendix L Survey Bias*.

**Table E-10. Custom Component Sample Attrition**

Description of Outcomes of Online and Telephone Participant Survey	Number of Records
<b>Population (number of unique jobs)</b>	<b>23</b>
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, or did not have accurate contact information	9
<b>Survey Sample Frame</b>	<b>14</b>
Not reached, refused, opted out, left message, email returned (bounce back), did not respond	11
Ineligible	0
<b>Completed Surveys</b>	<b>3</b>
<b>Overall Response Rate</b>	<b>21%</b>

### E.3.4 Logic Model

Cadmus reviewed the Phase III logic model and made updates for Phase IV based on interviews with the program managers from PPL Electric Utilities and the ICSP and on secondary research. The updated logic model is shown in Table E-11.

**Table E-11. Custom Component Logic Model**

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Customer or building owner does not prioritize energy efficiency</li> <li>• Decision-makers choose to install cheaper, less efficient equipment with shorter payback</li> <li>• Owners are not informed about how their facility uses energy</li> <li>• Existing debt may limit funds to purchase new efficient equipment</li> <li>• Customers place a priority on fluctuating commodity prices</li> <li>• Customers typically replace equipment only upon failure and/or see no need to replace functioning equipment</li> <li>• Customers are not informed about most efficient equipment available when need to replace it is immediate</li> <li>• Some efficient equipment may have a longer delivery time that would affect customer operations</li> <li>• Customers are unaware of the benefits of installing and properly maintaining energy efficient equipment</li> <li>• Customers do not properly maintain equipment; savings benefits erode over time</li> </ul>	<ul style="list-style-type: none"> <li>• Technology assistance and education to customers and trade allies</li> <li>• Marketing and outreach</li> <li>• Application processing</li> <li>• Development of quality assurance/quality control (QA/QC) and evaluation plan processes</li> <li>• Incentive payment processing</li> </ul>	<ul style="list-style-type: none"> <li>• Inform and maintain trade allies active in the component</li> <li>• Marketing materials</li> <li>• Incentives paid</li> <li>• Rebate application and processing/payment systems</li> </ul>	<ul style="list-style-type: none"> <li>• Increased customer and trade ally awareness of the component and its energy-efficient opportunities</li> <li>• Initiatives through the Custom component, once adopted, provides immediate energy savings and peak demand reductions</li> <li>• Incentives are processed</li> <li>• Component effectiveness is confirmed through the evaluation plan and QC</li> </ul>	<ul style="list-style-type: none"> <li>• Experience and feedback that lead to updated components, additional marketing and equipment installations, and continued energy savings and peak demand reductions</li> <li>• Customers experience lower electric bills</li> <li>• Customers and trade allies are more aware of PPL Electric Utilities components</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing PPL Electric Utilities’ knowledge and experience operating this type of component</li> <li>• Environmental benefits are achieved</li> <li>• PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency</li> <li>• With experience, some products no longer need to be treated as custom and can be rebated as prescriptive</li> </ul>

Cadmus reviewed the logic model and determined that the Custom component is operating as expected. Table E-12 shows the outcome of the logic model review.

**Table E-12. Custom Component Logic Model Review**

Topics	Logic Model Components/ Goal	Status	PY13 Outcomes
<b>Component Activities</b>	<ul style="list-style-type: none"> <li>• Technology assistance and education to customers and trade allies</li> <li>• Marketing and outreach</li> <li>• Application processing</li> <li>• Development of quality assurance/quality control (QA/QC) and evaluation plan processes</li> <li>• Incentive payment processing</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Conducted all activities as planned</li> </ul>
<b>Outputs Produced by Component Activities</b>	<ul style="list-style-type: none"> <li>• Inform and maintain trade allies active in the component</li> <li>• Marketing materials</li> <li>• Incentives paid</li> <li>• Rebate application and processing/payment systems</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Incentives have been paid and the rebate application process is working as expected</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Increased customer and trade ally awareness</li> <li>• Immediate energy savings and peak demand reductions</li> <li>• Incentives are processed</li> <li>• Component effectiveness is confirmed through the evaluation plan and QC.</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• All survey respondents were satisfied with the component, particularly with communications with PPL Electric Utilities or the ICSP</li> <li>• Contributed 29% to PY13 Non-Residential verified energy savings and 31% of PY13 Non-Residential verified demand reductions</li> </ul>
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>• Experience and feedback that lead to updated components, additional marketing and equipment installations, and continued energy savings and peak demand reductions</li> <li>• Customers experience lower electric bills</li> <li>• Customers and trade allies are more aware of PPL Electric Utilities components</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	Monitoring progress	<ul style="list-style-type: none"> <li>• In PY13 (year 1), the Custom component achieved 3% of planned Non-Residential Phase IV verified energy savings and 3% of planned system-level Non-Residential Phase IV verified demand reductions(1)</li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Increasing PPL Electric Utilities’ knowledge and experience operating this type of component</li> <li>• PPL Electric Utilities achieves long-term energy savings and peak demand reductions, moving the market toward improved energy efficiency</li> <li>• Environmental benefits are achieved</li> <li>• With experience, some products no longer need to be treated as custom and can be rebated as prescriptive</li> </ul>	Unable to assess at this time	<ul style="list-style-type: none"> <li>• Unable to assess at this time</li> </ul>

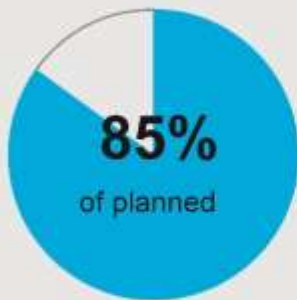
<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

## 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 41,538 MWh/yr\*

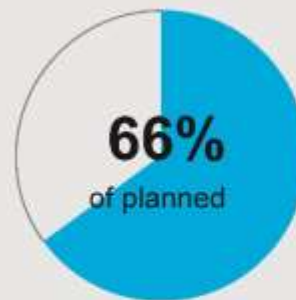


PY13 saved 10,449 MWh/yr

\*Includes Phase III carryover energy savings

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of 1.23 MW/yr



PY13 has reductions of 1.23 MW/yr

### PY13 PARTICIPATION



A total of 28,883 jobs completed

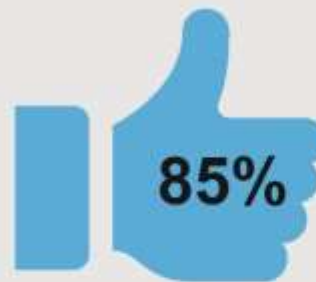
3,057 households received baseload jobs

4,187 households received low-cost jobs

21,639 households received Welcome Kits

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

### PARTICIPANT SATISFACTION



85%

Satisfied with overall program

## 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 records review.** Cadmus reviewed a random sample of 34 of the ICSP’s assessment records for baseload and low-cost strata.<sup>38</sup> One in-home assessment was originally included in the random sample but was later excluded because survey data were not yet available. Savings for this project were left unverified. Cadmus’ reviews of home assessment records involved verifying reported quantities 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, and baseline conditions).
- **Engineering analysis.** Cadmus conducted an engineering analysis for baseload and low-cost strata and used the findings from the assessment records review as inputs to the engineering algorithms from the PA TRM,<sup>39</sup> when available, and the IL TRM for algorithms (not inputs) not listed in the PA TRM.<sup>40</sup>
- **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 30 audio recordings from the ICSP’s remote energy assessments (REAs) with program participants to verify products sent to program participants. 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 types and wattage 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 three types of service (also known as job types) at no cost to the income-qualified customer. Baseload services are offered to customers without electric heat and without an electric water heater. Low-cost services are offered to

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<sup>38</sup> There were no full-cost jobs in master-metered multifamily buildings.

<sup>39</sup> Pennsylvania Public Utility Commission. February 2021. *Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards.

<sup>40</sup> IL TRM V10.0, Sections 5.4.4, 5.4.5, 5.4.8



customers without electric heat but with electrically heated water. The welcome kit is offered to any eligible customer.

Customers are eligible for all energy-saving items, but most do not receive all items. Though bathroom and kitchen aerators, low-flow shower heads, and thermostatic shower restriction valves were offered in the baseload stratum, only about 5% of total items delivered were to baseload jobs. Cadmus used the appropriate PA TRM protocols for evaluating savings.

## F.1.2 Gross Impact Methodology and Sampling Approach

In PY13, 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 REA participants to verify that products were installed as reported.

Cadmus designed the verification sample for the Low-Income Program to meet 85% confidence with  $\pm 15\%$  precision. Cadmus did not include data from PY13 Q4 in the sample because data were not available before the survey was conducted. To examine savings in detail, Cadmus organized the population into baseload and low-cost strata. Cadmus continued to sample the population by project number instead of by account number for simplicity and consistency with previous years.<sup>41</sup>

The impact evaluation sampling strategy is summarized in Table F-1. Cadmus' energy evaluation produced results with  $\pm 3.3\%$  precision at 85% confidence using a random sampling method to select a sample of homes for verification.

**Table F-1. PY13 Low-Income Program Component Gross Impact Evaluation Sample Design**

Stratum <sup>(1)</sup>	Population Size <sup>(2)</sup>	CP	Sampling Assumptions Cv in Sample Design <sup>(3)</sup>	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Baseload	3,046	85/15	0.42	17	17	Desk review and engineering analysis
Low-Cost	4,167			17	17	
Welcome Kits	21,868	N/A	N/A	Census	Census	Census and database review
<b>Program Total</b>	<b>29,081</b>	-	-	-	-	-

<sup>(1)</sup> PPL Electric Utilities did not report any master-metered multifamily jobs in PY13 and, due to evaluation timing, savings for in-person assessment were left unverified and not included in the population frame.

<sup>(2)</sup> Population size count is based on unique job numbers, which differs slightly from unique households.

<sup>(3)</sup> 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.

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

<sup>41</sup> 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.



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.<sup>42</sup>

### **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)<sup>43</sup>
2. Weighted the results based on PY13 survey responses

The participant answered a survey question about how often the energy-saving tip provided to wash 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 PA TRM, then added a term to subtract the energy education recommendation for shower length from the 7.8-minute default.<sup>44</sup>

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<sup>42</sup> Pennsylvania Public Utility Commission. *Technical Reference Manual*. August 2019, February 2021 Revision. Section 2.2.11.

<sup>43</sup> 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.

<sup>44</sup> 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. PY13 Low-Income Record Review Findings**

Product	Finding	Number of Jobs	Effect on Savings
LEDs	Used self-reported <i>in situ</i> baseline wattage gathered from the ICSP’s REA	204	Decrease
	LED installation shown for area of home in audit record not verified on phone call	1	Decrease
	Used EISA 2020 baseline wattage assumption of 45 lumens/watt in cases where bulb type was unknown	4	Decrease
Tier 1 Smart Strips	Smart strips installed in entertainment center with less than three devices plugged in	6	Decrease
	Smart strips installed in entertainment center with an unknown number of devices plugged in	18	Decrease
Showerheads	Multifamily home initially mapped by ICSP to single-family and corrected per audit report	5	Increase
Bathroom Aerators	Multifamily home initially mapped by ICSP to single-family and corrected per audit report	5	Increase
Kitchen Aerators	Multifamily home initially mapped by ICSP to single-family and corrected per audit report	5	Increase
TSRVs	Multifamily home initially mapped by ICSP to single-family and corrected per audit report	4	Increase

#### 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 ISRs for these items, as shown in Table F-3.

**Table F-3. PY13 In-Service Rates for Energy-Saving Items**

Product	In-Service Rate
LEDs	93%
LED Nightlights	94%
Kitchen Aerators	77%
Bathroom Aerators	88%
Showerheads	88%
Tier 1 Advanced Power Strips	93%
Thermostatic Shower Restriction Valves	92%

### 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 118.19 kWh/yr in PY13. 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 Table**

Energy Savings Recommendation	Behavioral Assumption	2021 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	21.63	0.00790
Adjust Thermostats – Winter			79.15	0
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	11.08	0.0009
Take Shorter Showers	Participants decrease duration of each shower	Low Flow Showerheads – Section 2.3.8	6.33	0.0005
<b>Total <sup>(1)</sup></b>			<b>118.19</b>	<b>0.0093</b>

<sup>(1)</sup> Each component is summed to get the total. Total may not sum due to rounding.

## F.2 Process Evaluation

### F.2.1 Other Findings

#### Survey Participant Profile and Survey Sample Attrition

The PY13 customer surveys collected demographic information about Low-Income Program participants. The majority of respondents had the following characteristics.

- Lived in a single-family detached residence (REA: 45%, n=86; welcome kit: 35%, n=26)
- Had an average household size of 2.4 residents (REA, n=84) and 2.5 (welcome kit, n=26)
- Had an annual household income of \$20,000 or less (REA: 64%, n=72; welcome kit: 60%, n=25)
- Nearly half the participants had completed high school (49% REA, n=80; 48% welcome kits, n=23), and nearly half had gone on to secondary education (46% REA, 48% welcome kits).

Table F-5 lists the total number of records contacted via online survey and the outcome (final disposition) of each record (including both REA and welcome kit records). Additional details on survey methodology are in *Appendix L Survey Bias*.

**Table F-5. Low-Income Component Sample Attrition**

Description of Outcomes of Online Participant Survey	Number of Records
<b>Population (number of unique jobs at the time sample was drawn)</b>	<b>19,110</b>
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	1,533
Removed: incomplete or invalid email address or phone number	7,966
<b>Survey Sample Frame (records attempted)</b>	<b>9,611</b>
Not reached or non-working: Refused or opted out, email returned (bounce back), did not respond	9,444
Partially Completed Survey	54
<b>Completed Surveys (online)</b>	<b>113</b>
<b>Overall Response Rate</b>	<b>1%</b>

*F.2.2 Logic Model*

Cadmus reviewed the logic model in the approved evaluation plan and made updates based on interviews with the program managers from PPL Electric Utilities and the ICSP and secondary research. The updated logic mode is shown in Table F-6.

**Table F-6. PY13 Low-Income Component Logic Model**

Barriers	Program Activities	Outputs Produced by Program Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Low awareness of energy efficiency benefits</li> <li>• Customers lack awareness of and trust for energy efficiency assistance resources and PPL Electric Utilities programs</li> <li>• General age and condition of low-income housing</li> <li>• Prevalence of renters</li> <li>• High cost of energy efficiency measures</li> <li>• Limited opportunities for energy efficiency education</li> <li>• Limited English fluency in some subpopulations</li> <li>• Discomfort with allowing auditors and contractors into home</li> <li>• Negative experiences with late bills or shut-off notices may make low-income customer hesitant to engage with utility</li> </ul>	<ul style="list-style-type: none"> <li>• Proactive outreach to LIURP-qualified and community organization referrals (Identify participants, establish eligibility, provide outreach)</li> <li>• ICSP provides welcome kits, assessment scheduling, assessments, direct install items, energy education</li> <li>• ICSP assesses health and safety needs, baseline conditions</li> <li>• ICSP recommends health and safety upgrades, additional energy efficiency upgrades, refers participating contractors</li> <li>• Contractors provide upgrades funded by PPL Electric Utilities</li> </ul>	<ul style="list-style-type: none"> <li>• Income-qualified participants are enrolled</li> <li>• Participants receive:                             <ul style="list-style-type: none"> <li>▪ Kit measures</li> <li>▪ Home assessments</li> <li>▪ Energy education</li> <li>▪ Health and safety referrals</li> <li>▪ Retrofit/energy upgrade referrals</li> <li>▪ Encouragement for deeper savings</li> <li>▪ Measures installed</li> <li>▪ Health and safety upgrades completed</li> <li>▪ Energy efficiency upgrades completed</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Increased awareness about other needed services</li> <li>• Increased program awareness</li> <li>• PPL Electric Utilities energy efficiency programs recognized as trusted resource</li> <li>• Increased participant knowledge of energy efficiency and conservation</li> <li>• Increased customer satisfaction with PPL Electric Utilities</li> <li>• Participants engage in energy-saving behaviors provided in energy education</li> <li>• Energy savings accrue from participant households through installation of efficient equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Steady and increasing participation</li> <li>• Increased home comfort, health, and safety</li> <li>• Participants engage in other energy efficiency behaviors/activities</li> <li>• Energy savings and peak demand reductions accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Increased awareness for energy efficiency opportunities and PPL Electric Utilities programs</li> <li>• Lower arrears/fewer non-payment issues</li> <li>• Participants engage in deeper retrofits and energy efficiency behaviors even if low-income eligibility status changes</li> <li>• Energy savings continue to result from energy-efficient equipment upgrades and conservation behaviors in the participating income eligible population</li> </ul>

Cadmus reviewed the logic model and determined that the Low-Income Program is operating as expected, though more information is needed to track several key progress indicators. Table F-7 shows the outcomes of the PY13 logic model review for participants who received assessments.

**Table F-7. PY13 Low-Income Program Logic Model Review**

Topics	Logic Model Program/Goal	Status	PY13 Outcomes
<b>Program Activities</b>	Proactive outreach to LIURP-qualified and community organization referrals (Identify participants, establish eligibility, provide outreach)	Achieved	<ul style="list-style-type: none"> <li>Marketing activities: On-Track participant list utilized for cold calls</li> <li>Community organization referrals &amp; outreach unavailable PY13</li> </ul>
	ICSP provides welcome kits, assessment scheduling, conducts assessments, direct install measures, energy education	Achieved	<ul style="list-style-type: none"> <li>Welcome kits provided; assessment summaries and details provided after remote energy assessments or in-home assessments</li> <li>In-home visits began in March 2022</li> </ul>
	ICSP assesses health and safety needs, assesses baseline conditions	Achieved	<ul style="list-style-type: none"> <li>Health and safety assessments completed for each participant home.</li> </ul>
	ICSP recommends health and safety upgrades, additional energy efficiency upgrades, refers participating contractors	Track in future years	<ul style="list-style-type: none"> <li>Unavailable PY13</li> </ul>
	Contractors provide PPL Electric Utilities funded upgrades	Achieved	<ul style="list-style-type: none"> <li>Remote energy assessments and in-home energy assessments completed</li> </ul>
<b>Outputs Produced by Program Activities</b>	The ICSP enrolls income-qualified participants, completes audits, installs energy-saving products, and serves clients.	Achieved	<ul style="list-style-type: none"> <li>Remote energy assessments and in-home energy assessments completed</li> </ul>
	Participants receive energy efficiency measures and upgrades: kit measures, assessments, energy education, health and safety referrals, retrofit/energy upgrade referrals, encouragement for deeper savings	Achieved	<ul style="list-style-type: none"> <li>Each participant received measures installed through the program: LED bulbs, tier 1 smart strips, LED night lights, bathroom aerators, showerheads, kitchen aerators, and thermostatic shower restriction valves.</li> </ul>
	Measures installed	Achieved	<ul style="list-style-type: none"> <li>Completed phone-based installation verification for remote energy assessments</li> <li>Measures directly installed starting in March 2022 for in-home assessments.</li> </ul>
	Health and safety upgrades completed	Achieved	<ul style="list-style-type: none"> <li>The following health and safety measures were installed through the program: smoke detectors, CO detectors, smoke or CO detector battery replacements, air purifiers, and dehumidifiers.</li> </ul>

Topics	Logic Model Program/Goal	Status	PY13 Outcomes
<b>Short-Term Outcomes</b>	Increased awareness about other needed services.	Achieved	<ul style="list-style-type: none"> <li>Participants were provided with information about other available assistance and organizations to contact.</li> </ul>
	Increased program awareness	Track in future years	<ul style="list-style-type: none"> <li>Unavailable PY13</li> </ul>
	PPL Electric Utilities energy efficiency programs recognized as trusted resource	Achieved	<ul style="list-style-type: none"> <li>68% (n=102) of respondents said their opinion of PPL Electric Utilities improved as a result of participating in the program</li> </ul>
	Increased participant knowledge of energy efficiency and conservation	Track in future years	<ul style="list-style-type: none"> <li>Unavailable PY13</li> </ul>
	Increased customer satisfaction with PPL Electric Utilities	Track in future years	<ul style="list-style-type: none"> <li>85% (n=106) of participants satisfied overall with the program</li> </ul>
	Participants engage in energy-saving behaviors provided in energy education	Achieved	<ul style="list-style-type: none"> <li>99% of respondents reported taking action after receiving recommendations from their energy advisor</li> </ul>
	Energy savings accrue from participant households through installation of efficient equipment	On track	<ul style="list-style-type: none"> <li>Contributed 85% to Low-Income PY13 planned energy savings (MWh/yr) and 66% of planned demand reductions (MW/yr)<sup>(1)</sup></li> </ul>
<b>Intermediate Outcomes</b>	Steady and increasing participation	Track in future years	<ul style="list-style-type: none"> <li>Remote energy assessments and in-home energy assessments completed; will track in future years</li> </ul>
	Increased home comfort, health, and safety	Track in future years	<ul style="list-style-type: none"> <li>Homes received health and safety upgrade measures.</li> </ul>
	Participants engage in other energy efficiency behaviors/activities	On track	<ul style="list-style-type: none"> <li>99% of respondents reported taking action after receiving recommendations from their energy advisor</li> </ul>
	Energy savings and peak demand reductions accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements	On track	<ul style="list-style-type: none"> <li>In PY13 (year 1), including Phase III carryover savings, the Low-Income Program achieved 57% of the Phase IV Low-Income Program energy savings compliance target and 13% of planned system-level Low-Income Program Phase IV demand reductions<sup>(1)</sup></li> </ul>
<b>Long-Term Outcomes</b>	Energy savings continue to result from energy-efficient equipment upgrades and conservation behaviors in the participating income-eligible population	Unable to assess at this time	<ul style="list-style-type: none"> <li>Unable to assess at this time</li> </ul>
	Increased awareness for energy efficiency opportunities and PPL Electric Utilities programs		
	Lower arrears/non-payment issues		
	Participants engage in deeper retrofits and energy efficiency behaviors even if low-income eligibility status changes		
<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. <i>Energy Efficiency and Conservation Plan Act 129 Phase IV</i> . Docket No. M-2020-3020824.			



## 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

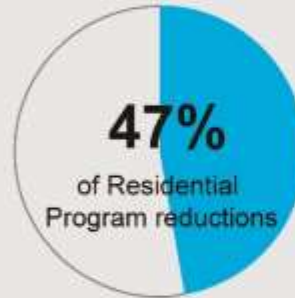
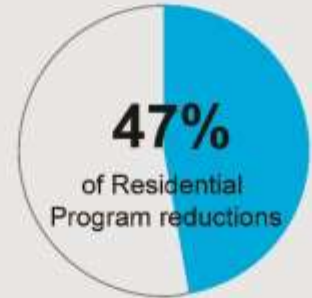
Phase IV  
has saved  
7,900 MWh/yr



PY13 saved  
7,900 MWh/yr

### VERIFIED DEMAND REDUCTIONS

Phase IV has  
reductions of  
1.90 MW/yr



PY13 has  
reductions of  
1.90 MW/yr

### PY13 PARTICIPATION

A total of 7,981 customers  
recycled 11,307 units\*



**7,032** Refrigerators



**1,634** Room air conditioners



**1,578** Freezers



**1,063** Dehumidifiers

\*Does not include incentive corrections

### PARTICIPANT SATISFACTION



Satisfied with  
overall program

**95%** satisfied with clarity of program requirements and eligibility

**89%** satisfied with communications with the contractors who picked up your appliance

**88%** satisfied with the time it took to receive your rebate

**81%** satisfied with the amount of time between scheduling your pick-up and the day your appliance was picked up



## 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 in this appendix, 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’s delivery staff. In PY13, CLEAResult, the ICSP, delivered the Appliance Recycling component along with its pick-up/recycling subcontractor, Key Recycling.

During PY13, 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 the program. 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 PY13, a limited number of bulk recycling events were held for the first time since these events were suspended during PY12 due to the COVID-19 pandemic.

Table G-1 shows the appliance eligibility parameters and incentives. PPL Electric Utilities increased the incentive for refrigerators and freezers from \$35 to \$50 in October 2021.

**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	\$35 to \$50
Freezer	Working unit; > 10 cubic feet and ≤ 30 cubic feet	\$35 to \$50
Room Air Conditioner	Working unit removed from mounting	\$10
Dehumidifiers	Working unit	\$10

### G.1 Gross Impact Evaluation

#### G.1.1 Gross Impact Methodology and Sampling Approach

Cadmus contacted all Appliance Recycling participants with email addresses who recycled refrigerators and freezers in Q2 and Q3.<sup>45</sup> Cadmus randomly selected a single appliance from each participant, with separate strata for refrigerators and freezers, to inform net savings and part-use calculations.

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<sup>45</sup> PPL Electric Utilities did not report participation in quarter 1 (Q1) and due to the timing of the evaluation, records from quarters two and three were used for evaluation. Cadmus reviewed the records in Q4 and determined the measure mix was reflective of the PY13 participants in the population when the sample frame was selected.

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	2,697	Census database review
Refrigerators & Freezers		140	344 <sup>(1)</sup>	Participant survey via sample
		Census	8,610	Census database review and estimate UECs
<b>Total</b>		<b>140</b>	<b>11,307 <sup>(2)</sup></b>	

<sup>(1)</sup> Cadmus sent survey invitations to all eligible participants in an effort to get at least 140 participants to complete the survey for analysis. The population of participants at the time of sampling was 4,856 customers.  
<sup>(2)</sup> The 344 participants surveyed were also included in the census of database review so are not counted twice in the total number of appliances. The total count does not include the two records that were for incentive corrections and is why this may not match other tables showing participants as unique job numbers.

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

*Regression Variable Findings*

Table G-3 summarizes program averages or proportions determined through primary data gathering for each open variable in the Pennsylvania Phase IV Technical Reference Manual (PA TRM) regression equation.

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

Equipment	Independent Variable	PY13 EDC Data Gathering Mean Value
Refrigerator Recycling	Appliance Age (years)	22.8
	Dummy: Manufactured Pre-1990	22%
	Appliance Size (cubic feet)	18.91
	Dummy: Single-Door Configuration	5.1%
	Dummy: Side-by-Side Configuration	21%
	Dummy: Percent of Primary Usage (in absence of program)	42%
	Interaction: Located in Unconditioned space x CDDs	0.97
	Interaction: Located in Unconditioned space x HDDs	6.71
Freezer Recycling	Appliance Age (years)	26.7
	Dummy: Manufactured Pre-1990	36%
	Appliance Size (cubic feet)	17.04
	% of freezers that are chest freezers	33%
	Interaction: Located in Unconditioned space x HDDs	11.89
	Interaction: Located in Unconditioned space x CDDs	1.73

Cadmus calculated gross verified savings and realization rates by gathering data from the PPL Electric Utilities participant tracking database (appliance age, size, and configuration) and from an online survey of program participants (primary versus secondary use and whether appliances were kept in conditioned spaces). Cadmus used this information as 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 unit energy consumption (UEC) into an average per-unit gross savings.

As instructed in the PA TRM, to calculate EDC-specific part-use factors Cadmus followed the methodology for recycled appliances described in the Uniform Methods Project.<sup>46</sup> Cadmus calculated part-use factors using PY13 participant survey data.

The part-use methodology relies on information from surveyed customers regarding pre-program usage patterns, that is, how many months of the year prior to recycling that the appliance was plugged in and running. The final estimate of part-use reflects how appliances were likely to operate had they not been recycled (rather than how they previously operated). For example, it is possible that a primary refrigerator operated year-round would have become a secondary appliance and operated part of the time.

Using primary data gathered through the PY13 participant survey, Cadmus took the following steps to determine part-use:

1. Determined whether recycled refrigerators were primary or secondary units (treating all stand-alone freezers as secondary units).
2. Asked participants who indicated they had recycled a secondary refrigerator or freezer if the appliance had operated year-round, operated for a portion of the preceding year, or was unplugged and not operated. Cadmus assumed all primary units operated year-round.
3. Asked participants who indicated they operated their secondary refrigerator or freezer for only a portion of the preceding year to estimate the total number of months that the appliance remained plugged in. This allowed for the calculation of the portion of the year in which the appliance remained in use. Cadmus determined that the average refrigerator, operating part-time, had a part-use factor of 0.31, or approximately four months. Freezers operating part of the time had a part-use factor of 0.23, or three months.

These three steps resulted in information about how refrigerators and freezers operated prior to recycling, as shown in Table G-4.

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<sup>46</sup> National Renewable Energy Laboratory. "Chapter 7: Refrigerator Recycling Evaluation Protocol." *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. September 2017. <https://www.nrel.gov/docs/fy17osti/68563.pdf>

**Table G-4. Historical PY13 Part-Use by Appliance Type**

Usage Type and Part-Use Category	Percent of Recycled Units	Part-Use Factor
<b>Secondary Refrigerators Only</b>		
<b>n = 126</b>		
Not in Use	12%	0.00
Used Part Time	24%	0.31
Used Full Time	63%	1.00
<b>Weighted Average</b>	<b>N/A</b>	<b>0.71</b>
<b>All Refrigerators (Primary and Secondary)</b>		
<b>n = 270</b>		
Not in Use	7%	0.00
Used Part Time	14%	0.31
Used Full Time	79%	1.00
<b>Weighted Average</b>	<b>N/A</b>	<b>0.84</b>
<b>All Freezers</b>		
<b>n = 90</b>		
Not in Use	21%	0.00
Used Part Time	13%	0.23
Used Full Time	66%	1.00
<b>Weighted Average</b>	<b>N/A</b>	<b>0.69</b>

The part-use methodology accounts for how an appliance was used historically (prior to being recycled) and is not necessarily indicative of how the appliance would have been used had it not been recycled. The prospective part-use factor accounts for this, combining prospective actions with historical part-use factors, with participants’ self-reported actions determining the likely future use of the appliance had the program *not* been available. This resulted in the distribution of likely future usage scenarios and corresponding part-use estimates. The weighted average of these future scenarios, shown in Table G-5, produced the part-use factor for refrigerators and freezers.

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

Use Prior to Recycling	Likely Use Independent of Recycling	Part-Use Factor	Percentage of Participants <sup>(1)</sup>
Primary Refrigerators	Kept (as primary unit)	1.00	10%
	Kept (as secondary unit)	0.71	6%
	Discarded	0.84	27%
Secondary Refrigerators	Kept	0.71	28%
	Discarded	0.84	30%
<b>Overall</b>		<b>0.77</b>	<b>100%</b>
Freezers	Kept	0.69	44%
	Discarded	0.69	56%
<b>Overall</b>		<b>0.69</b>	<b>100%</b>

<sup>(1)</sup> Totals may not sum due to rounding.

Applying the part-use factors from Table G-5 to the modeled UEC from Table G-6 yields the average gross per-unit energy savings. Average gross savings for refrigerators is 837 kWh/yr and for freezers is 595 kWh/yr.

**Table G-6. Part-Use Adjusted Gross Per-Unit Savings**

Appliance	Average Per-Unit Annual Energy Consumption (kWh/yr)	Part-Use Factor	Adjusted Per-Unit Gross Energy Savings (kWh/yr)
Refrigerators	1,021	0.82	837
Freezers	862	0.69	595

**G.1.2 Gross Impact Results**

Table G-7 shows verified energy savings and realization rates by stratum for PY13. Table G-8 shows verified demand savings and realization rates.

**Table G-7. Appliance Recycling Component Gross Impact Results for Energy**

Stratum	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Refrigerators and Freezers	6,858	100%	4.44	7%	6,827
Room Air Conditioners and Dehumidifiers	1,073	100%	0.00	NA	1,073
<b>Program Total <sup>(2)</sup></b>	<b>7,931</b>	<b>100%</b>	<b>6.11</b>	<b>8%</b>	<b>7,900</b>

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

<sup>(2)</sup> Totals may not sum due to rounding.

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

Stratum	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System Level PYVTD (MW/yr)
Refrigerators and Freezers	1.11	100%	6.17	10%	1.10	1.20
Room Air Conditioners and Dehumidifiers	0.65	100%	0.00	N/A	0.65	0.70
<b>Component Total <sup>(2)</sup></b>	<b>1.75</b>	<b>100%</b>	<b>4.45</b>	<b>6%</b>	<b>1.75</b>	<b>1.90</b>

<sup>(1)</sup> 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.

<sup>(2)</sup> Totals may not sum due to rounding.

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

The part-use factor for refrigerators decreased from 87% in PY10, the last time Cadmus fielded a participant survey to estimate part-use, to 82% in PY13. The part-use factor for freezers also decreased, from 80% in PY10 to 69% in PY13.

For refrigerators, evaluated per-unit kWh savings were 4% greater than *ex ante* per-unit kWh savings, 837.4 kWh compared with 808.1 kWh, respectively. For freezers, evaluated per-unit kWh were 20% lower than *ex ante* per-unit kWh savings, 594.8 kWh compared with 744.9 kWh, respectively. The relatively modest increase in per-unit refrigerator savings, which accounted for 62% of all appliances recycled, along with the decrease in freezer savings resulted in an energy realization rate of 99.7% for the Appliance Recycling component.

## G.2 Net Impact Evaluation

### G.2.1 Net Impact Methodology

Determining net savings for an appliance retirement program follows the methodology described in Appendix B Common Methods for Appliance Recycling Programs in the Phase IV Evaluation Framework.<sup>47</sup> This is consistent with the Uniform Methods Project appliance recycling protocol to determine program net savings.<sup>48</sup>

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

Table G-9 lists the sampling strategy used to determine net savings for the Appliance Recycling in PY13.

**Table G-9. PY13 Appliance Recycling Component Net Impact Evaluation Sample Design**

Stratum	Stratum Boundaries	Population Size <sup>(1)</sup>	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Plan Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample
Refrigerators and Freezers	Unique appliances	4,856 <sup>(1)</sup>	0.5	85/15	140	3,254	325 <sup>(2)</sup>	100%
<b>Total</b>		<b>4,856</b>	-	-	<b>140</b>	3,254	<b>325</b>	<b>100%</b>

<sup>(1)</sup> Number of rebates for refrigerators and freezers available in PPL Electric Utilities’ tracking database at the time of the PY13 survey.  
<sup>(2)</sup> Nineteen respondents did not respond to free ridership questions and are not included in the NTG analysis.

### Free Ridership

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

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

<sup>47</sup> Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs*. Prepared by the Statewide Evaluation Team (NMR Group Inc., Demand Side Analytics LLC, Brightline Group, and Optimal Energy Inc.). Contracted under the Pennsylvania Public Utility Commission’s RFP 2020-2 for the Statewide Evaluator. Final version July 16, 2021. [https://www.puc.pa.gov/media/1584/swe-phaseiv\\_evaluation\\_framework071621.pdf](https://www.puc.pa.gov/media/1584/swe-phaseiv_evaluation_framework071621.pdf)

<sup>48</sup> Keeling, J., and D. Bruchs. 2017. “Chapter 7: Refrigerator Recycling Evaluation Protocol.” *The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures*. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68563. <http://www.nrel.gov/docs/fy17osti/68563.pdf>

Table G-10 shows the percentage of participant units that would have been kept or discarded.

**Table G-10. Final Distribution of Kept and Discarded Participant Appliances**

Stated Action Absent Program	Indicative of Free Ridership	Refrigerators (n=243)	Freezer (n=82)
Kept	No	50%	50%
Discarded	Varies by Discard Method	50%	50%
<b>Total</b>		<b>100%</b>	<b>100%</b>
Note: Refrigerator and freezer response counts do not include “Don’t know” or “Refused.”			

After identifying the discard actions of the participants (those who would not have kept their appliance), Cadmus then determined the share of appliances that would have been discarded or transferred to a new home. The final distribution is shown in Table G-11.

**Table G-11. Final Distribution of Discarded/Transferred Participant Appliances**

Appliance	Discard/Transfer Scenario	Percentage from Participant Survey
Refrigerator	Disposed	60%
	Transfer	40%
Freezer	Disposed	67%
	Transfer	33%

*Secondary Market Impacts*

If Cadmus determined that a participant would have transferred the unit that was recycled to another customer on the grid in the absence of the program, it is important to account for what the would-be acquirer might have done.

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

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

Cadmus calculated the replacement UEC for refrigerators and freezers using the ENERGY STAR average energy consumption of new comparably sized, standard-efficiency appliances with similar configurations as the program units.<sup>49</sup>

Net per-unit savings are the weighted average of the three scenarios, weighed by the proportion of units in each scenario. The process for freezers was identical.

### Spillover

Participants indicated they had installed efficient measures since recycling an appliance. Some respondents indicated they installed a new efficient refrigerator or freezer, but these were replacements for the appliances recycled, which were already purchased prior to recycling. Customers who may have been influenced the “Flip Your Fridge” campaign were credited with spillover savings if they also responded that they had not considered getting rid of their appliance before learning of the program.<sup>50</sup> Many respondents installed LED bulbs, but because of the upstream efficient lighting delivery channel, Cadmus cannot account for bulbs already claimed by the Efficient Lighting component.

Spillover as a percent of program savings, when rounded to a whole percent, was one percent.

### G.3 Net-to-Gross Results

Table G-12 shows the NTG ratio results for the refrigerator and freezer strata of the Appliance Recycling component.

**Table G-12. Appliance Recycling Component NTG Ratio Summary**

Stratum	n	Free Ridership & SMI (%)	Spillover (%)	NTG Ratio	Relative Precision
Refrigerators and Freezers	318	45%	1%	0.56	5% <sup>(1)</sup>
<sup>(1)</sup> At 85% confidence interval. Note: Refrigerator and freezer response counts do not include “Don’t know” or “Refused.”					

Room air conditioners and dehumidifiers are not offered as stand-alone equipment eligible for pick-up but are picked up in conjunction with refrigerator or freezer recycling. Therefore, Cadmus assumes that the NTG ratio for refrigerators and freezers also applies to room air conditioners and dehumidifiers.

The Appliance Recycling component continues to reach a large share of PPL Electric Utilities customers who would have kept their appliance absent the recycling service. Self-reported actions taken by survey respondents indicate that 43% of refrigerators and 44% of freezers would have been kept had they not been recycled. This results in a 56% NTG ratio for the Appliance Recycling component.

<sup>49</sup> ENERGY STAR. “Find and Compare ENERGY STAR Certified Refrigerators.” <https://www.energystar.gov/productfinder/product/certified-residential-refrigerators/results>

<sup>50</sup> Flip Your Fridge introduces customers to both the Appliance Recycling offering as well as highlighting potential bill savings from upgrading to a new ENERGY STAR appliance simultaneously.



### G.4 Process Evaluation

In PY13, Cadmus conducted a process evaluation to assess customer satisfaction, inform the logic model review, and identify successes and challenges with implementing the Appliance Recycling component. Process evaluation activities were consistent with the planned activities, which included an online participant survey, stakeholder interview, and logic model review.

For the participant survey, Cadmus contacted a census of eligible records available at the time of the survey, which resulted in exceeding the planned number of respondents. Cadmus conducted two of three planned stakeholder interviews but did not interview the ICSP’s subcontractor because the program manager and the ICSP said it was not necessary.

Table G-13 lists the process evaluation sampling strategy. Responses to the participant survey produced a measure of program satisfaction with ±2% precision at 90% confidence. See *Appendix L Survey Bias* for details about Cadmus’ approach to reducing survey bias and contact instructions.

**Table G-13. Appliance Recycling Component Process Evaluation Sampling Strategy**

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records Selected for Sample Frame	Percent of Sample Frame Contacted to Achieve Sample <sup>(1)</sup>
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities, ICSP, and ICSP subcontractors	Telephone in-depth interview	3	N/A	Up to 3	2	N/A	100%
Participants	PY13 Appliance Recycling Component	Online survey	4,856 <sup>(2)</sup>	-	140	344 <sup>(3)</sup>	3,254 <sup>(4)</sup>	100%
<b>Program Total</b>			<b>4,859</b>	<b>N/A</b>	<b>N/A</b>	<b>346</b>	<b>3,254</b>	<b>N/A</b>

<sup>(1)</sup> Percent contacted means the percentage of the sample frame contacted to complete the survey and/or interviews.  
<sup>(2)</sup> Number of rebates for refrigerators and freezers available in PPL Electric Utilities’ tracking database at the time of the PY13 survey.  
<sup>(3)</sup> Respondents could skip questions so the number of responses to individual questions may vary.  
<sup>(4)</sup> Sample frame is a list of participants with email contact information drawn from the PPL Electric Utilities’ tracking database. The final sample frame includes unique records in the PPL Electric Utilities database at the time of the survey. After selecting all unique records, Cadmus removed any records from the population if the customer had participated in a survey in the last three months, had been selected for another program survey, did not have valid contact information (email or telephone number), was on the do not call list, or opted out of the online survey.

### G.4.1 Program Component Experience

Cadmus contacted all Appliance Recycling component participants with email addresses who recycled refrigerators and freezers in PY13 Q2 through Q3.<sup>51</sup> Survey respondents rated their satisfaction with their experience with different aspects of Appliance Recycling, explained what drove their satisfaction ratings, and also rated ease of participation, likelihood of recommending Appliance Recycling, and the effect of their participation on their opinion of PPL Electric Utilities.

#### Component Satisfaction

Of 320 survey respondents, 97% were satisfied with the PY13 Appliance Recycling component. Eighty-nine percent were *very satisfied*, and 8% were *somewhat satisfied* with the program overall.<sup>52</sup>

Respondents also showed high levels of satisfaction for individual component elements (Figure G-1), especially with the contractors who picked up the appliances (93% *very* and *somewhat satisfied*; n=328), their COVID-19 safety precautions (94%; n=223),<sup>53</sup> and the clarity of application requirements (95%; n=338). The element with the lowest satisfaction was the amount of time between scheduling and appliance pick-up (82% satisfied; n=340).

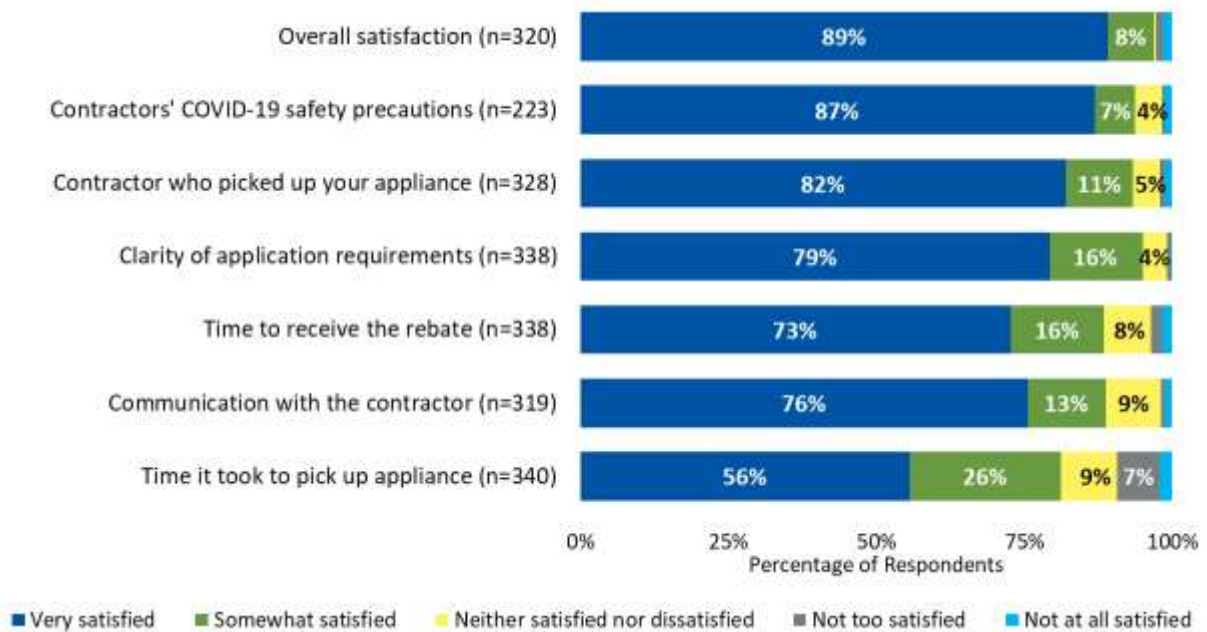
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<sup>51</sup> PPL Electric Utilities did not report any participation in Q1 and due to evaluation timing, Q4 data were not available at the time of the participant survey.

<sup>52</sup> One respondent (less than 1%) was *neither satisfied nor dissatisfied*, 1% were *not too satisfied*, and 2% were *not at all satisfied* with the overall program. Not all survey respondents answered this question.

<sup>53</sup> Sixty-nine percent of respondents (n=341) reported that they interacted with the contractors who picked up their appliances. The 31% who did not interact with the contractors were not asked to rate COVID-19 safety precautions.

Figure G-1. Appliance Recycling Component Satisfaction



Source: Participant survey, “Thinking about your overall experience with PPL Electric Utilities Appliance Recycling program, how would you rate your satisfaction?”, “Thinking about the program, please indicate how satisfied you are with each element of your experience.”, “How satisfied were you with how well the contractors practiced COVID-19 safety precautions?” (only asked if respondent interacted with the contractors). Percentages of 3% or less are not labeled in the figure. Due to rounding the sum of *very* and *somewhat satisfied* shown here may not match the totals in the infographic.

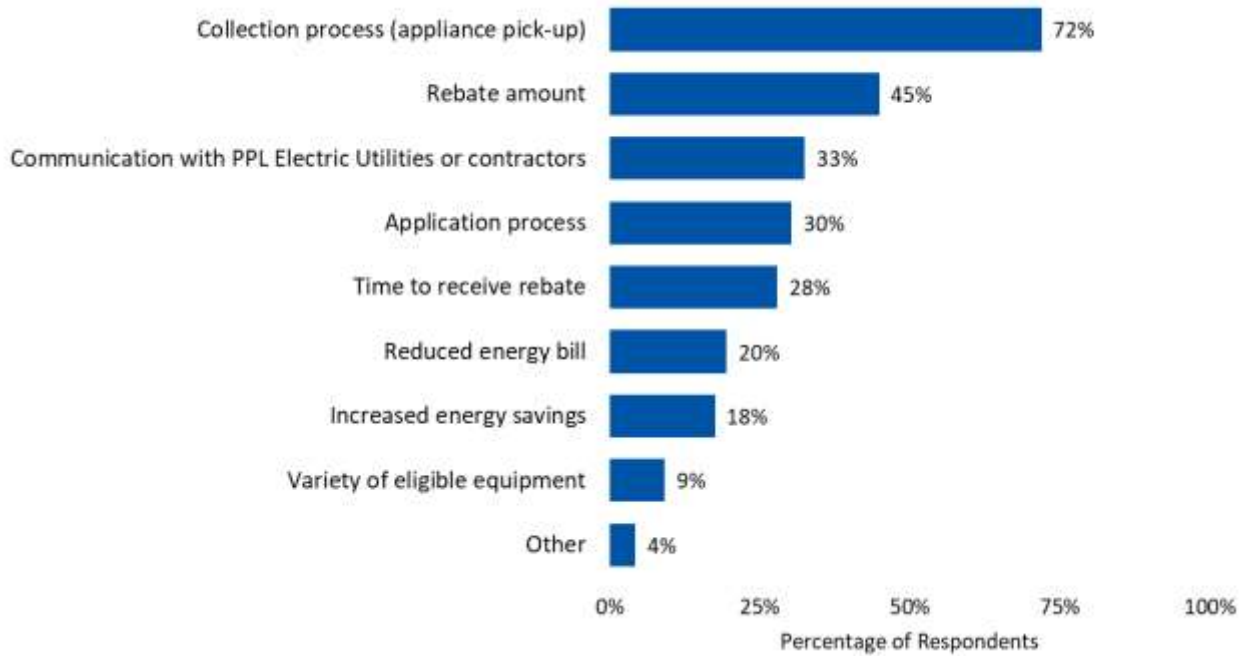
### Drivers of Program Component Satisfaction

To better understand what drives program satisfaction, the survey asked participants what factor(s) most affected their rating of the Appliance Recycling component.

Figure G-2 shows the most common drivers for respondents who were *very* or *somewhat satisfied* with the Appliance Recycling component. Of 307 respondents, 72% said the collection process—when the contractor picks up the appliances—was the largest driver of their positive experience.

Only nine survey respondents said they were *not too satisfied* or *not at all satisfied*. Five of these said the reason was the collection process, which was also the most frequently mentioned driver for satisfied respondents. Five responded with *something else*: two said they had not received their rebate check yet, and one each said contractors damaged the respondent’s property, did not follow COVID-19 protocols, and picked up a unit though the respondent had cancelled the pick-up the day before.

Figure G-2. Drivers of High Appliance Recycling Satisfaction

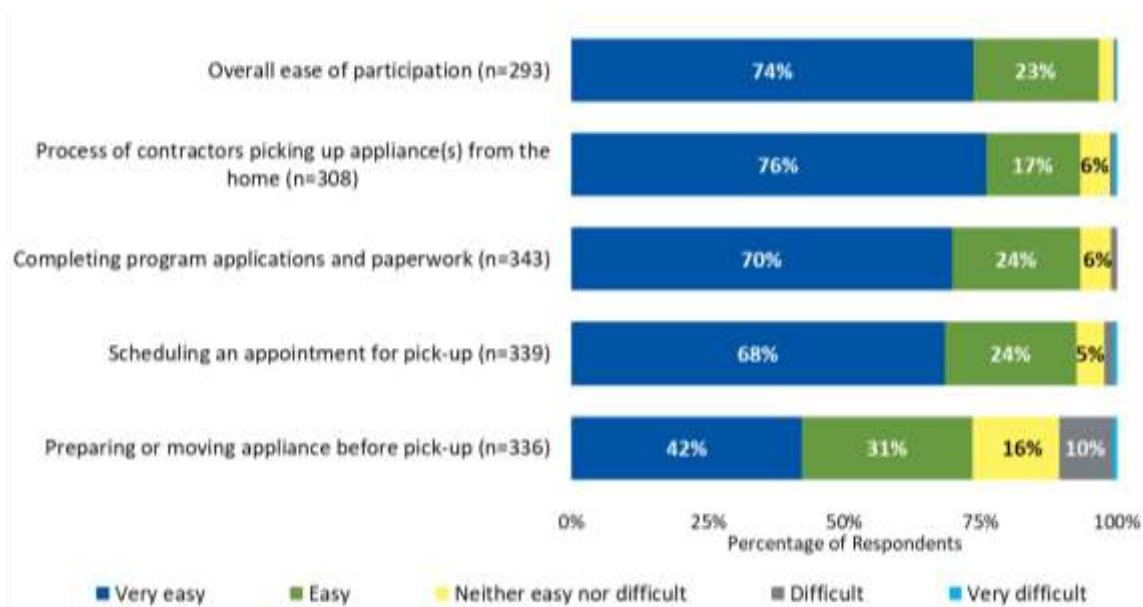


Source: Participant survey, “What factor(s) most affected the overall experience rating you gave?” (n=307; multiple responses allowed)

*Customer Effort*

Almost all respondents rated the Appliance Recycling component as *very easy* (74%) or *easy* (23%) to participate in overall, while only two respondents (less than 1%) rated it *difficult* or *very difficult* (Figure G-3). Most survey respondents rated the pick-up process, completing the application, and scheduling pick-up as *very easy* or *easy*. Preparing or moving the appliance prior to pick-up was rated the least easy aspect of participation.

**Figure G-3. Appliance Recycling Ease of Participation**



Source: Participant survey, “Overall, how easy was it to participate in the Appliance Recycling program?” and “Overall, how easy were the following?” Percentages of 3% or less are not labeled in the figure.

*Opinion of PPL Electric Utilities and Likelihood to Recommend*

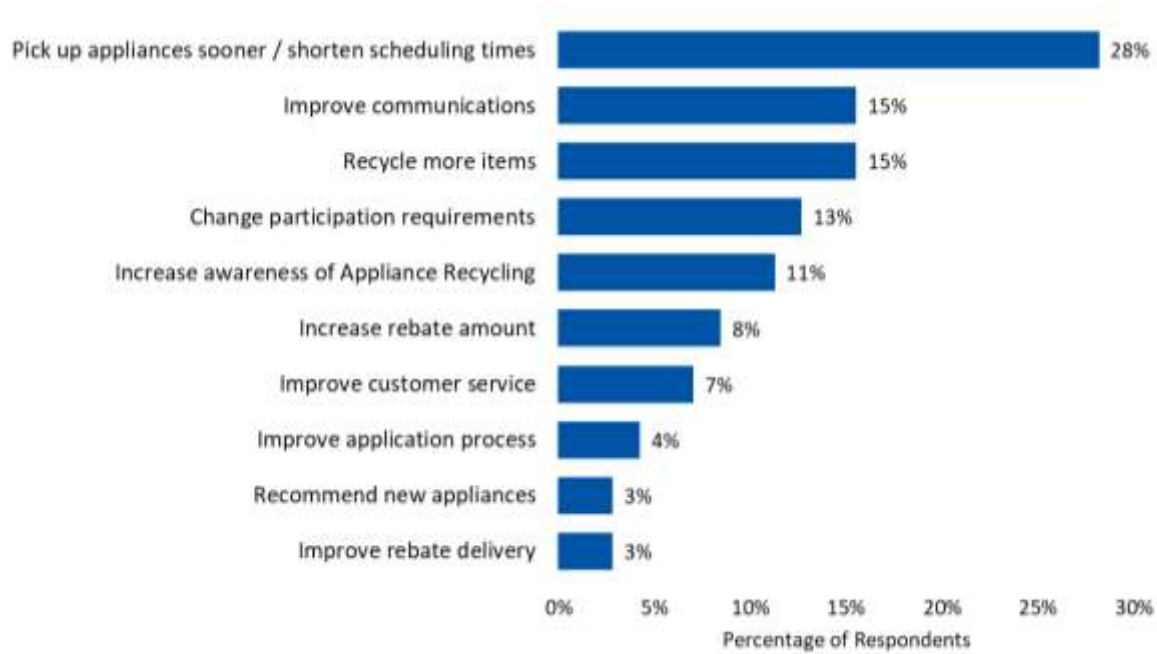
Of 340 survey respondents who answered the question, 45% said their opinion of PPL Electric Utilities had improved after participating in the Appliance Recycling component, 54% said their opinion had not changed, and 1% said their opinion decreased. The survey asked the four respondents who said their opinion of PPL Electric Utilities decreased why this was so, and their responses concerned issues relating to the Appliance Recycling collection process.

Overall, 91% (n=344) were likely to recommend the program to a friend, family member, or colleague.

*G.4.2 Improvement Suggestions*

When asked for one thing PPL Electric Utilities could change to improve the Appliance Recycling component, 71 respondents offered suggestions (Figure G-4). Twenty-eight percent suggested reducing the amount of time until pick-up, which corresponds with respondents giving the time it took to pick up appliances lower ratings than other elements of Appliance Recycling.

**Figure G-4. Suggestions for Improving the Appliance Recycling Component**



Source: Participant survey, “What is the one thing PPL Electric Utilities could change about the program to improve it? Please describe.” (n=71; multiple responses allowed)

### G.4.3 Other Findings

#### Survey Participant Profile and Survey Sample Attrition

The PY13 Appliance Recycling participant survey collected demographic information:

- Lived in a single-family detached residence (87%; 290 of 335)
- Had an average household size of 2.3 people (n=303)
- Averaged 62 years of age (n=253)
- Had completed some college education or more (77%; 244 of 317)
- Had an annual household income of \$50,000 or greater (70%; 138 of 198)

Table G-14 lists the total number of records contacted for the survey and the outcome (final disposition) of each record. Additional details on survey methodology are in *Appendix L Survey Bias*.

**Table G-14. Appliance Recycling Component Sample Attrition**

Description of Outcomes of Online Participant Survey	Number of Records
<b>Population (number of unique records)</b>	<b>4,856</b>
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	635
Removed: incomplete or invalid email address	967
<b>Survey Sample Frame (records attempted)</b>	<b>3,254</b>
Not reached or non-working: refused or opted out, email returned (bounce back), did not respond	2,875
Partially Completed Survey	35
<b>Completed Survey (online)</b>	<b>344</b>
<b>Overall Response Rate</b>	<b>11%</b>

*G.4.4 Logic Model*

Cadmus reviewed the logic model in the approved evaluation plan and made updates based on interviews with the program managers from PPL Electric Utilities and the ICSP and secondary research. The updated logic model is shown in Table G-15.

**Table G-15. Appliance Recycling Component Logic Model**

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Customers lack awareness of the benefits of recycling old appliances</li> <li>• Customers desire to keep secondary appliances in addition to primary</li> <li>• Customers desire to sell or transfer old, working appliances rather than recycle them, keeping inefficient appliances on the grid</li> </ul>	<ul style="list-style-type: none"> <li>• Offer rebate and free appliance pick-up to customers recycling qualifying refrigerators, freezers, dehumidifiers, and room air conditioners</li> <li>• Promote Appliance Recycling offering to customers</li> <li>• Schedule and complete appliance pickups at customer homes</li> <li>• Deliver energy efficiency information and other program opportunities to customers</li> <li>• Deliver picked-up appliances to recycling center for decommissioning</li> <li>• Host recycling events so customers can drop off their small appliances</li> </ul>	<ul style="list-style-type: none"> <li>• Component operating infrastructure in place (online scheduling is developed, vendors are hired); data requirements, rebate forms, and marketing materials are developed</li> <li>• Working units are recycled due to rebates and program support</li> <li>• Component tracking data and participant data are collected and maintained for evaluability, market research, and cross-marketing opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Inefficient appliances are removed from the electric grid</li> <li>• Increased customer awareness of Appliance Recycling</li> <li>• Increased participant knowledge of energy efficiency and conservation</li> <li>• Customers are satisfied with the service and satisfaction with PPL Electric Utilities is improved</li> <li>• Energy savings and peak demand reduction accrue from participant households through removal of inefficient appliances</li> </ul>	<ul style="list-style-type: none"> <li>• Customers use less energy and have lower energy bills</li> <li>• Fewer inefficient appliances are sold on the secondary market</li> <li>• Fewer appliances go to landfills, reducing environmental impact of refrigerants</li> <li>• Participants engage with more PPL Electric Utilities programs due to their experience with Appliance Recycling</li> <li>• Participants engage in other energy-efficiency behaviors/activities</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	<ul style="list-style-type: none"> <li>• The appliance market is transformed (inefficient appliances are no longer available)</li> <li>• Broad market awareness of energy efficiency opportunities and PPL Electric Utilities programs</li> <li>• Improved energy grid resilience and environmental outcomes from properly recycled units</li> </ul>



Cadmus reviewed the logic model and determined that the Appliance Recycling component is operating as expected. Table G-16 shows the outcome of the logic model review.

**Table G-16. Appliance Recycling Component Logic Model Review**

Topics	Logic Model Components/ Plan	Status	PY13 Outcomes
<b>Component Activities</b>	<ul style="list-style-type: none"> <li>• Offer rebate and free appliance pick-up to customers recycling qualifying refrigerators, freezers, and small appliances</li> <li>• Promote Appliance Recycling offering to customers</li> <li>• Schedule and complete appliance pickups at customer homes</li> <li>• Host recycling events so customers can drop off their small appliances</li> <li>• Deliver energy efficiency information and other program opportunities to customers</li> <li>• Deliver picked-up appliances to recycling center for decommissioning</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Conducted all activities as planned</li> <li>• Resumed in-home collections (suspended during PY12 due to COVID-19), but continued to offer contactless pick-up as an option in PY13</li> <li>• Increased incentives from \$35 to \$50 to drive participation</li> <li>• Resumed in-person pick-up events (suspended during PY12 due to COVID-19)</li> <li>• Hosted three recycling events</li> </ul>
<b>Outputs Produced by Component Activities</b>	<ul style="list-style-type: none"> <li>• Component operating infrastructure in place (online scheduling is developed, vendors are hired); data requirements, rebate forms, and marketing materials are developed</li> <li>• Component offering uptake occurs: working units are recycled due to rebates and program support</li> <li>• Component tracking data and participant data are collected and maintained for evaluability, market research, and cross-marketing opportunities</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Participation and energy savings grew in PY13 compared with PY12</li> <li>• Program manager and ICSP report that marketing efforts produced the desired results</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Inefficient appliances are removed from the electric grid</li> <li>• Increased customer awareness of Appliance Recycling</li> <li>• Increased participant knowledge of energy efficiency and conservation</li> <li>• Customers are satisfied with the service and satisfaction with PPL Electric Utilities is improved</li> <li>• Energy savings and peak demand reduction accrue from participant households through removal of inefficient appliances</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Achieved 97% satisfaction, determined using participant survey data (exceeding 85% target)</li> <li>• 91% of participants surveyed would recommend Appliance Recycling to others</li> <li>• Contributed 25% of PY13 Residential verified energy savings and 47% of PY13 Residential verified demand reductions savings</li> </ul>

Topics	Logic Model Components/ Plan	Status	PY13 Outcomes
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>• Customers use less energy and have lower energy bills</li> <li>• Fewer inefficient appliances are sold on the secondary market</li> <li>• Fewer appliances go to landfills, reducing environmental impact of refrigerants</li> <li>• Participants engage with more PPL Electric Utilities programs due to their experience with Appliance Recycling</li> <li>• Participants engage in other energy-efficiency behaviors/activities</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	On track to meet in subsequent years	<ul style="list-style-type: none"> <li>• In PY13 (year 1), Appliance Recycling achieved 5% of planned Residential Program Phase IV verified energy savings and 5% of planned system-level Residential verified demand reductions <sup>(1)</sup></li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• The appliance market is transformed (inefficient appliances are no longer available)</li> <li>• Broad market awareness of energy efficiency opportunities and PPL Electric Utilities programs</li> <li>• Improved energy grid resilience and environmental outcomes from properly recycled units</li> </ul>	Unable to assess	<ul style="list-style-type: none"> <li>• Unable to assess at this time</li> </ul>

<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

## 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  
**4,353 MWh/yr**



**PY13 saved  
4,353 MWh/yr**

### PY13 PARTICIPATION



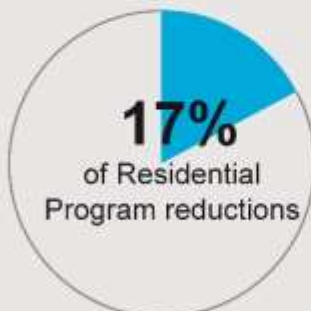
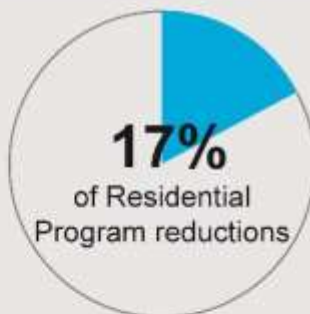
A total of  
**775,814**  
bulbs sold

### BULB TYPE

- 42%** LED candelabra bulbs
- 37%** LED reflector bulbs
- 11%** LED globes
- 10%** LED fixtures

### VERIFIED DEMAND REDUCTIONS

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



**PY13 has  
reductions of  
0.68 MW/yr**

### RETAIL CHANNEL

- 58%** from home improvement stores
- 20%** from mass merchandise stores
- 10%** from membership club stores
- 7%** from hardware stores
- 3%** from other stores
- 2%** from discount stores
- 0%** from lighting and electronics stores

## Appendix H. Evaluation Detail – Efficient Lighting Component

The Efficient Lighting component encourages residential customers to purchase and install specialty LED bulbs by buying down the price of component-qualified ENERGY STAR® LEDs. The component provides upstream incentives to participating manufacturers to discount the prices of a variety of specialty bulbs sold at local retail stores. The component targets residential customers but is available to all PPL Electric Utilities customers and anyone who purchases discounted bulbs from participating retailers.

The ICSP, CLEAResult, manages component operations and provides support to participating retailers and 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

To evaluate the gross impacts of the Efficient Lighting component, Cadmus verified the ENERGY STAR certification of all bulbs sold through the component, derived baseline wattages (one watt per 45 lumens) using ENERGY STAR lumens ratings, adjusted cross-sector sales to conform with the 2021 PA TRM, and calculated energy savings and peak demand reductions using algorithms in the 2021 PA TRM.

#### H.1.1 Gross Impact Methodology and Sampling Approach

Cadmus reviewed data from PPL Electric Utilities’ tracking database to verify energy savings, consistent with planned activities.

The impact evaluation sampling strategy is summarized in Table H-1. Because Cadmus’ approach was to verify the census of the population, that is, bulbs sold, no sampling was used. Impact evaluation activities produced results with ±0.00% precision at 85% confidence.

**Table H-1. PY13 Efficient Lighting Component Gross Impact Evaluation Sample Design**

Stratum	Population Size <sup>(1)</sup>	Sampling Assumptions	Achieved Sample Size	Impact Evaluation Activity
Efficient Lighting	775,814	N/A	Census	Census database review, QA/QC, and <i>ex post</i> adjustments
<sup>(1)</sup> Total number of bulbs sold, per PPL Electric Utilities’ tracking database.				

### ENERGY STAR Verification

Using ENERGY STAR identification numbers or model numbers of every bulb tracked in PPL Electric Utilities’ tracking database, Cadmus confirmed that all bulbs sold through the component met current ENERGY STAR certification criteria.

Cadmus used ENERGY STAR’s Qualified Products List (QPL) to assign efficient wattages and lumens ratings according to each bulb’s model number or unique seven-digit ENERGY STAR identification number. Cadmus then revised each bulb’s baseline wattage to be calculated as a ratio of one watt per 45 lumens in accordance with the 2021 PA TRM.

### Cross-Sector Sales Adjustments

Cadmus identified very slight discrepancies in the application of cross-sector sales (CSS) proportions to the tracking data. The 2021 PA TRM asserts that 7.4% of upstream lighting sales are attributable to small commercial and industrial (C&I) customers. However, the CSS adjustment of 7.4% was not applied consistently across all records in the tracking data, resulting in roughly 187 fewer bulbs attributed to small C&I customers (less than 0.1% of a total 775,814 bulbs). After the correct CSS proportion was applied, the small C&I realization rate increased roughly 0.3 percentage points, while the residential realization rate decreased less than 0.1 percentage points.

#### H.1.2 Gross Impact Results

The Efficient Lighting component reported energy savings of 4,249 MWh/yr, as shown in Table H-2, and demand reduction of 0.61 MW/yr, as shown in Table H-3.

**Table H-2. PY13 Efficient Lighting Component Gross Impact Results for Energy**

Stratum	PYRTD (MWh/yr)	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Efficient Lighting	4,249	102%	N/A	0.00%	4,353
<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

**Table H-3. PY13 Efficient Lighting Component Gross Impact Results for Demand**

Stratum	PYRTD (MW/yr)	Demand Realization Rate <sup>(1) (2)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Efficient Lighting	0.61	102%	N/A	0.00%	0.63	0.68
<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.						
<sup>(2)</sup> Realization rates are applied to verified demand reductions before application of distribution losses. Distribution losses are based on customer sector.						

The slight variation between reported and verified savings (102% realization rate for energy and demand) was due to differences in baseline wattage. Using the 45 lumens/watt baseline, energy savings and demand reduction increased by roughly 104 MWh/yr (2.4%) and 0.015 MW/yr (2.4%), respectively. Cadmus also identified very slight discrepancies in the application of CSS proportions to the tracking data.

## H.2 Net Impact Evaluation

### H.2.1 Net Impact Methodology

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,<sup>54</sup> which discusses the common methods used to determine free

<sup>54</sup> 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.

ridership and spillover. Cadmus conducted interviews with participating retailers, administered by phone, to assess free ridership and spillover for the Efficient Lighting component. Cadmus developed a NTG methodology based on guidance in the Evaluation Framework and in coordination with the SWE. Additional details about methodology are in *Appendix K Net Savings Impact Evaluation*.

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

Table H-4 lists the sampling strategy used to determine net savings for the Efficient Lighting component in PY13. Cadmus conducted nine retailer interviews, of which eight provided usable responses to the NTG questions. Seven interviews were with personnel (owners, managers, or assistant managers) from hardware stores, and one was with regional staff of a prominent home improvement retail chain.

**Table H-4. PY13 Efficient Lighting Component Net Impact Evaluation Sample Design**

Stratum	Stratum Boundaries	Population Size <sup>(1)</sup>	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Number of Records Selected for Sample Frame <sup>(2)</sup>	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample <sup>(3)</sup>
Participating Retailers	Participants	82	0.5	85/15	23	Census	8 <sup>(4)</sup>	100%
<b>Total</b>		<b>82</b>	-	-	<b>23</b>	-	<b>8</b>	<b>100%</b>

<sup>(1)</sup> Population refers to number of unique decision-makers in PY13. There were 82 unique decision-makers representing 172 unique retail locations.

<sup>(2)</sup> Sample frame is a list of participating retailers with physical address information recorded in the PPL Electric Utilities database. Cadmus standardized address information to identify unique retail locations, remove duplicates, and research contact information online.

<sup>(3)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews.

<sup>(4)</sup> One retailer did not respond to free ridership questions and is not included in the NTG analysis.

## Free Ridership

The free ridership analysis compared PY13 sales of LED lighting products to participant retailers' estimates of LED lighting product sales in PY13 in absence of the Efficient Lighting program component. Additional details about methodology are in *Appendix K Net Savings Impact Evaluation*.

Table H-5 summarizes the free ridership scores for each retailer type interviewed and the total Efficient Lighting component.



**Table H-5. PY13 Efficient Lighting Component Free Ridership Scores by Retailer Type**

Stratum	Retailer Type	Number of Respondents	Free Ridership Score	Percent of Analysis Sample Verified Efficient Lighting Component Program Bulbs Sold
Participating Retailers	Hardware & Other	7	57% <sup>(1)</sup>	23%
	Home Improvement	1	95%	77%
<b>Total</b>	-	<b>8</b>	<b>86% <sup>(1)</sup></b>	<b>100%</b>

<sup>(1)</sup> Weighted by verified Efficient Lighting component bulbs sold. This method ensures that respondents who represent retailers that sold a greater number of LEDs through the component have a greater influence on the free ridership estimates than do the respondents who represent retailers that sold fewer LEDs through the component.

*Spillover*

The data collected through the interviews did not provide enough information to reliably quantify spillover. Retailers were either unsure or could not provide quantitative estimates of LED sales from June 2021 through May 2022 that did not go through PPL Electric Utilities’ Efficient Lighting component.

*H.2.2 Net-to-Gross Results*

Table H-6 shows the lift-based NTG ratio result for the participating retailer strata of the Efficient Lighting component.

**Table H-6. PY13 Efficient Lighting Component Lift-Based NTG Ratio Summary**

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio
Participating Retailers	8	86%	0%	0.14

The lift-based NTG ratio is not the final NTG ratio for the Efficient Lighting component. Gross savings are the savings relative to a technical baseline that did not exist in the market during PY13. During PY13, no lamps met the new EISA standard of 45 lumens/watt other than LEDs, which exceed the standard. The market alternatives to LEDs during PY13 were either halogen or incandescent lamps, which are less efficient than the technical baseline prescribed in the 2021 PA TRM, though these products will start to phase out of the market as of September 1, 2022, as enforcement of the EISA backstop rule begins.<sup>55</sup> This results in a counterfactual scenario for a customer who purchased a bulb discounted by the Efficient Lighting component in which the actual difference in energy use (the discounted LED rather than a halogen or incandescent bulb) is greater than the gross savings calculated using the technical baseline prescribed in the 2021 PA TRM.

To account for this scenario, Cadmus calculated an “alternative” gross baseline, comparing Efficient Lighting component lamps against less efficient technologies available during PY13. The calculations mirror those in PY12, prior to the 2021 PA TRM update for Phase IV, which set the technical baseline of 45 lumen/watt.

<sup>55</sup> U.S. Department of Energy. April 26, 2022. *Enforcement Policy Statement—General Service Lamps*. [https://www.energy.gov/sites/default/files/2022-04/GSL\\_EnforcementPolicy\\_4\\_25\\_22.pdf](https://www.energy.gov/sites/default/files/2022-04/GSL_EnforcementPolicy_4_25_22.pdf)

Cadmus applied the lift-based NTG estimate to calculate total net savings. The final NTG ratio for the Efficient Lighting component is equal to the following:

$$Final\ NTGR = \frac{Lift\ based\ NTG\ ratio * Alternative\ gross\ savings}{Gross\ Verified\ Savings}$$

Table H-7 shows the calculation for the final NTG ratio for the Efficient Lighting component.

**Table H-7. PY13 Efficient Lighting Component Final NTG Ratio Summary**

Parameter	Value
Alternative Gross Savings (kWh/yr)	33,798,134
Lift-Based NTGR	14%
Net Savings (kWh/yr)	4,670,379
<b>Final NTGR</b>	<b>107%</b>

### Market Effects or Other Research

Due to the small number of completed interviews, Cadmus benchmarked the lift-based NTG estimate against other recent, comprehensive lighting NTG evaluations of Mid-Atlantic utility programs. Two were selected because they are regionally similar to PPL Electric Utilities’ service area and the evaluations were done using a rigorous, sales data-driven approach to estimating NTG. Cadmus did not adjust the lift-based NTG estimate for the Efficient Lighting component based on the benchmarked studies. The NTG ratios of these benchmarked studies are included in Table H-8 to provide context and confirm that the lift-based NTG ratio of 14% for the Efficient Lighting component is reasonable despite the small number of completed interviews.

**Table H-8. PY13 Efficient Lighting Component NTG Benchmarking**

Study	Study Year	NTG
Mid-Atlantic Utility 1	2020-2021	19%
Mid-Atlantic Utility 2	2021	11%

### H.3 Process Evaluation

Cadmus conducted a process evaluation to gather information about component operations, assess retailer experience and satisfaction regarding the phase-out of general purpose LEDs, assess customer outreach and promotional activities, gather stakeholder feedback and highlight successes and challenges, and inform the logic model review.

The evaluation activities were generally consistent with the planned activities, with some changes to the retailer outreach methodology. Cadmus conducted nine retailer interviews with a target of 23. Seven interviews were conducted with personnel (owners, managers, or assistant managers) from hardware stores, and two interviews were conducted with corporate or regional staff of two prominent home improvement retail chains. .



Cadmus identified an estimated 172 unique retailer addresses in PPL Electric Utilities’ tracking database and attempted to contact each one.<sup>56</sup> For five home improvement and mass merchandise chains, Cadmus was told that stocking decisions for all stores associated with the chain are made at the corporate or regional level, so Cadmus replaced individual retail location contacts with corporate or regional contacts, which reduced the total number of possible contacts.

Table H-9 lists the process evaluation sampling strategy. See *Appendix L Survey Bias* for details about Cadmus’ approach to reducing survey bias and contact instructions. See *H.3.3 Other Findings* for further information about retailer interview sample attrition

**Table H-9. PY13 Efficient Lighting 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 <sup>(1)</sup>
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%
Participating Retailers	Participants	Telephone in-depth interview	82 <sup>(2)</sup>	85/15	23	9	73 <sup>(3)</sup>	100%
<b>Component Total</b>			<b>84</b>	<b>-</b>	<b>25</b>	<b>11</b>	<b>75</b>	<b>100%</b>
<sup>(1)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews. <sup>(2)</sup> 82 decision-makers represent 172 unique retail locations. <sup>(3)</sup> Sample frame is a list of participating retailers with physical address information recorded in the PPL Electric Utilities database. Cadmus standardized address information to identify unique retail locations, remove duplicates, and research contact information online. After selecting all unique records (by location and contact), Cadmus removed any records from the population that did not have valid telephone number. See Table H-10 for sample attrition.								

<sup>56</sup> Cadmus manually reviewed all combinations of store name and address in the Efficient Lighting component data and removed any duplicates.

### H.3.1 Program Component Experience

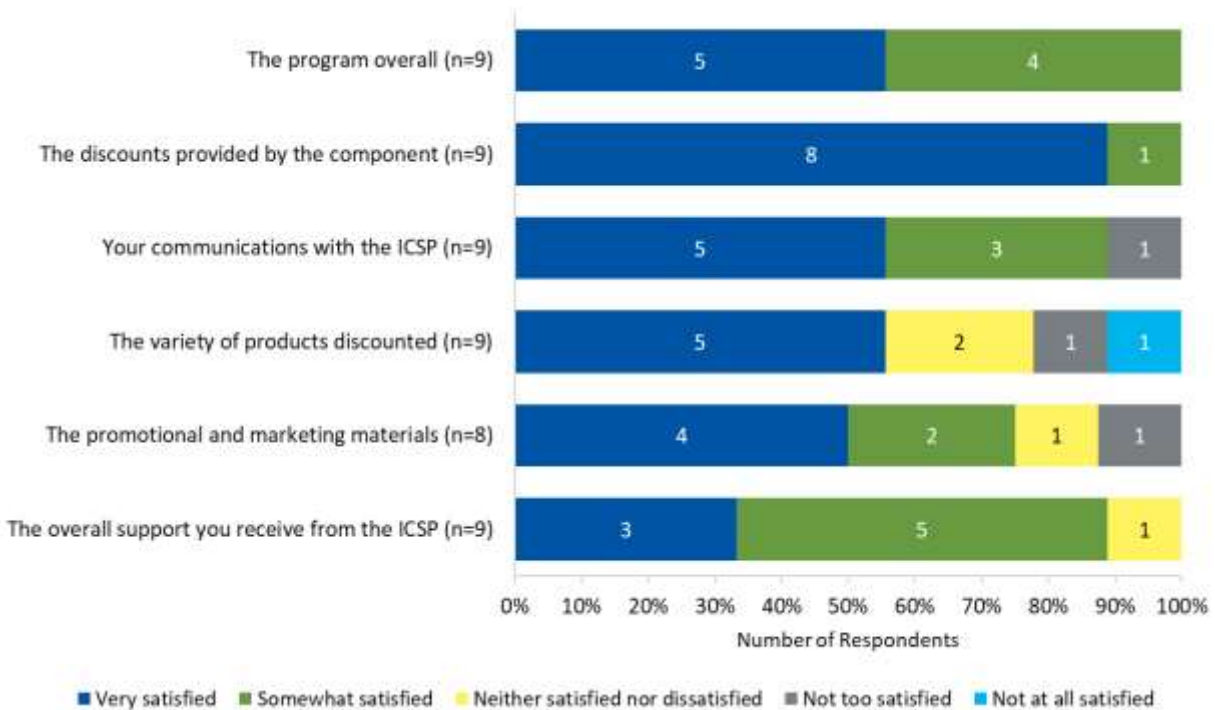
This section characterizes the experiences of retailers who participated in the Efficient Lighting component, including their satisfaction with the component and their perspectives on the component’s impacts on LED stocking practices.

For the two home improvement chains, Cadmus interviewed corporate and regional staff who represented multiple retail locations in PPL Electric Utilities’ service territory. These two chains comprised 58% of specialty LED sales (30% and 28%). The seven hardware stores whose representatives were interviewed by Cadmus comprised roughly 1% of PY13 sales (all hardware stores comprised 7% of sales).

#### Retailer Experience and Satisfaction

Cadmus asked retailer respondents about their satisfaction with elements of the Efficient Lighting component. All were either *very satisfied* (five respondents) or *somewhat satisfied* (four respondents) with the component overall, as shown in Figure H-1. Respondents were satisfied with elements of the component in general and especially with the discounts the component provided.

**Figure H-1. PY13 Efficient Lighting Component Satisfaction**



Source: Survey question, “On a scale of 1 to 5, where 1 means not satisfied at all and 5 very satisfied, how would you rate your satisfaction with...”

Among those less than satisfied with the promotional and marketing materials, respondents for two hardware stores hoped to receive more materials related to the component more consistently from PPL Electric Utilities. One hardware store respondent was less than satisfied with the variety of products

discounted and said the component could provide a greater variety “for all types of customers” the store serves.

Respondents also gave positive ratings for their coordination with the ICSP. These interactions typically took the form of ICSP field staff conducting training sessions with store employees and providing promotional/marketing materials. Hardware stores communicated with ICSP field staff either *occasionally*, e.g., once a month (four respondents), or *rarely*, e.g., once a year (three respondents).

### *Component Influence and EISA Legislation*

When asked what mix of light bulb products their stores stock, hardware store respondents estimated that, on average,<sup>57</sup> LEDs comprise 64% of lighting stock, with three of seven respondents providing estimates as high as 80% to 90%. Other types of bulbs—incandescents (16%), CFLs (9%), and halogens (6%)—trailed far behind.

Specifically for LEDs, hardware store respondents estimated that, on average, general purpose bulbs comprise 43% of LED stock, followed by decorative bulbs (20%), reflectors (12%), and globes (9%). Fixtures comprise 4% of total LEDs and 9% of specialty LEDs, consistent with the component overall (10%) but fewer than the 17% stocked by larger retailers like home improvement stores, according to PPL Electric Utilities tracking data.

One home improvement respondent did not provide stocking estimates but did describe the typical stocking practices. Practices are driven primarily by customer demand, that is, selling products with lighting features that customers tend to favor. In general, the retail chain has sold increasingly more LEDs and fewer CFLs and incandescents. In the respondent’s perspective, customers simply prefer LEDs, irrespective of EISA, and EISA has not meaningfully affected customers’ lighting purchasing decisions. In addition, the retail chain values variety, offering multiple manufacturer options that incorporate unique characteristics and functionality in its products.

Hardware store respondents estimated that less than 30% of the specialty LEDs they sell are incented through the Efficient Lighting component. Respondents for two stores said less than 10% of their specialty LEDs carry incentives from PPL Electric Utilities.

When asked to rate the Efficient Lighting component’s influence on the mix of light bulbs sold at their stores, on a scale of 1 (*not influential at all*) to 5 (*extremely influential*), hardware store respondents provided an average rating of 3.1 (n=7), with three respondents providing ratings of 4 or higher. Price was the most important factor affecting the types of lighting products they stock (n=7), followed closely by variety/availability and ease of selection to fit customers’ needs (n=5).

When asked how LED sales were affected by the Efficient Lighting component’s suspension of incentives in PY12 and reinstatement of incentives in PY13, one hardware store respondent said the reinstatement led to an increase in specialty LED sales from PY12 to PY13. However, the other six respondents thought

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<sup>57</sup> Cadmus calculated the mix of light bulb products as a simple average among responses rather than weighted by total sales for each store.

the absence of incentives in PY12 likely impacted LED sales negatively, but three acknowledged that the COVID-19 pandemic also had a negative impact. Ultimately, these six respondents determined that LED sales, specifically specialty LED sales, were generally unchanged after PPL Electric Utilities reinstated incentives in PY13.

Four hardware store respondents said customers seemed to be aware of the absence of the Efficient Lighting component in PY12 because customers noticed higher prices. In terms of general awareness, respondents estimated that, on average, 64% of customers who purchase discounted LEDs at their stores know that PPL Electric Utilities provided the incentives, with four respondents providing estimates of 80% of customers or higher.

### *H.3.2 Improvement Suggestions*

When asked how PPL Electric Utilities could improve the Efficient Lighting component, one hardware store respondent recommended that PPL Electric Utilities and/or the ICSP provide more communication regarding pricing and incentives to the store's corporate center. Sometimes products ring up a different price than is stated on their tags, and store personnel have to manually override prices to reconcile with the incentives.

Another hardware store respondent asked for more promotional materials as well as more frequent updates regarding any new aspects of the component or when new training becomes available. One home improvement store respondent recommended expanding the number of incented products, suggesting there may be non-incented stock keeping units (SKUs) that fit product eligibility guidelines.

Cadmus also interviewed PPL Electric Utilities and the ICSP to evaluate the success of the Efficient Lighting component in PY13. They said limiting incentives to specialty LEDs affected the number of stores that could participate, as some retailers offered very few of the SKUs eligible to receive incentives, and acknowledged that limiting incentives to multipacks also affected overall component sales.

### *H.3.3 Other Findings*

#### *Survey Participant Profile and Survey Sample Attrition*

Table H-10 lists the total number of records contacted via telephone and the outcome (final disposition) of each record. Additional details on interview methodology are in *Appendix L Survey Bias*.

**Table H-10. PY13 Efficient Lighting Component Sample Attrition**

Description of Outcomes of Retailer Telephone Interviews	Number of Records
<b>Population (number of unique decision-makers)</b>	<b>82 <sup>(1)</sup></b>
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, on "do not contact" list	3
Removed: incomplete or invalid email address or phone number	6
<b>Survey Sample Frame (records attempted)</b>	<b>73</b>
Not reached or non-working: No answer, answering machine, phone busy, did not respond	55
Refused or opted out	4
Not familiar with or aware of Efficient Lighting component	5
<b>Completed Surveys (telephone)</b>	<b>9</b>
<b>Overall Response Rate</b>	<b>12%</b>
<sup>(1)</sup> 82 decision-makers represent 172 unique retail locations.	

*H.3.4 Logic Model*

Cadmus reviewed the logic model in the approved evaluation plan and made updates based on interviews with PPL Electric Utilities and the ICSP and secondary research. The updated logic model is shown in Table H-11.

**Table H-11. PY13 Efficient Lighting Component Logic Model**

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Customers perceive LEDs to be expensive or a luxury purchase</li> <li>• Customers reluctant to replace existing non-LEDs before they have burned out</li> <li>• Customers unfamiliar with or skeptical of LED technology (unreliable, slow to turn on, buzzing, color, mercury)</li> </ul>	<ul style="list-style-type: none"> <li>• ICSP recruits and coordinates with manufacturers and retailers</li> <li>• ICSP negotiates prices for bulk purchases of LEDs</li> <li>• ICSP conducts marketing, outreach, and education about LEDs</li> </ul>	<ul style="list-style-type: none"> <li>• Retailers sell (customers purchase) discounted LEDs</li> <li>• Participating retailer network is diverse and geographically distributed across the PPL Electric Utilities territory</li> <li>• Customers become more informed</li> </ul>	<ul style="list-style-type: none"> <li>• Energy savings accrue from participant households through installation of efficient equipment</li> <li>• Incentives increase LED availability and demand, and decrease prices</li> <li>• In-store signs and point-of-purchase materials increase awareness of and knowledge about energy-efficient lighting technology</li> </ul>	<ul style="list-style-type: none"> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> <li>• Customer satisfaction and familiarity increases uptake</li> <li>• Discounts and uptake drive costs lower due to competition and economies of scale</li> <li>• More effective component evaluation due to continuous evaluation plan feedback</li> </ul>	<ul style="list-style-type: none"> <li>• Customers use LEDs as standard equipment (the lighting market is transformed)</li> <li>• Broad market awareness is created for energy efficiency opportunities and PPL Electric Utilities programs</li> </ul>

Cadmus reviewed the logic model and determined that the Efficient Lighting component is operating as expected. Table H-12 shows the outcome of the logic model review.

**Table H-12. Efficient Lighting Component Logic Model Review**

Topics	Logic Model Components	Status	PY13 Outcomes
<b>Component Activities</b>	<ul style="list-style-type: none"> <li>• ICSP recruits and coordinates with manufacturers and retailers</li> <li>• ICSP negotiates prices for bulk purchases of LEDs</li> <li>• ICSP conducts marketing, outreach, and education about LEDs</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Conducted all activities as planned</li> </ul>
<b>Outputs Produced by Component Activities</b>	<ul style="list-style-type: none"> <li>• Retailers sell (customers purchase) discounted LEDs</li> <li>• Participating retailer network is diverse and geographically distributed across the PPL Electric Utilities territory</li> <li>• Customers become more informed</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• 775,814 specialty LEDs sold in PY13</li> <li>• 172 unique retail locations participated</li> <li>• Retailers confirmed presence of in-store signage provided by ICSP field staff</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Energy savings accrue from participant households through installation of efficient equipment</li> <li>• Incentives increase LED availability and demand, and decrease prices</li> <li>• In-store signs and point-of-purchase materials increase awareness of and knowledge about energy-efficient lighting technology</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>• Contributed 14% to PY13 Residential Program energy savings and 17% of PY13 Residential Program demand reductions</li> <li>• More than \$1.1 million in incentives provided to manufacturers, reducing prices by 25%, using data recorded in PPL Electric Utilities’ tracking database</li> <li>• Per retailer estimates, 64% of customers aware that products they purchased were discounted by PPL Electric Utilities</li> </ul>
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> <li>• Customer satisfaction and familiarity increases uptake</li> <li>• Discounts and uptake drive costs lower due to competition and economies of scale</li> <li>• More effective component evaluation due to continuous evaluation plan feedback</li> </ul>	Monitoring progress	<ul style="list-style-type: none"> <li>• In PY13 (year 1), Efficient Lighting achieved 3% of planned Residential Program Phase IV energy savings and 2% of planned system-level Residential Program Phase IV demand reductions</li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>• Customers use LEDs as standard equipment (the lighting market is transformed)</li> <li>• Broad market awareness is created for energy efficiency opportunities and PPL Electric Utilities programs</li> </ul>	Unable to assess	<ul style="list-style-type: none"> <li>• Unable to assess at this time</li> </ul>





## 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

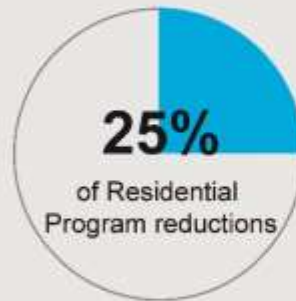
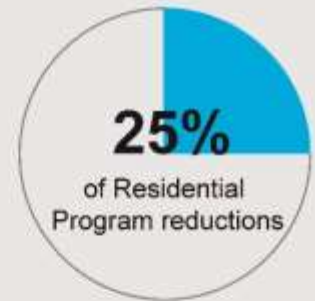
Phase IV has saved 14,689 MWh/yr



PY13 saved 14,689 MWh/yr

### VERIFIED DEMAND REDUCTIONS

Phase IV has reductions of 1.03 MW/yr



PY13 has reductions of 1.03 MW/yr

### PY13 PARTICIPATION

A total of 14,803 received rebates for

7,945 Efficient equipment

5,616 Online marketplace

1,242 New homes

### PARTICIPANT SATISFACTION



88% Satisfied with overall program

94% new homes builders satisfied

90% equipment participants satisfied

80% 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 PY13, the component had three subcomponents: Downstream Equipment, the Online Marketplace, and New Homes. In PY13 PPL Electric Utilities did not report any participants in the Audit and Weatherization or Midstream HVAC subcomponents.

New in PY13, PPL Electric Utilities also offered a free Welcome Kit, redeemable through the Online Marketplace, for new electric customers and a for-purchase kit option, which could be customized to include various energy efficient products such as LEDs, faucet aerators, energy-efficient showerheads, pipe insulation, and weatherization items like weatherstripping and outlet gaskets.

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.

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

### *1.1 Gross Impact Evaluation*

#### *1.1.1 Gross Impact Methodology and Sampling Approach*

Cadmus used findings from desk reviews and a participant survey to evaluate savings from the Downstream Equipment and Online Marketplace subcomponents in PY13. Cadmus did not verify savings for the New Homes subcomponent because of potential changes to TRM guidance that could impact verified savings. Cadmus left these savings as unverified and will verify them in PY14. Additionally, Cadmus did not evaluate savings for the Audit and Weatherization subcomponent because there were no reported savings in PY13. The approach for evaluating Downstream Equipment and Online Marketplace was consistent with the evaluation plan.

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 of the subcomponents.

For the Downstream Equipment subcomponent, Cadmus used a nested stratified random sampling approach, where the sample was stratified by end-use equipment (HVAC, water heating, and appliances). Cadmus first conducted a survey of participants who received a rebate for any of the

measures in the end-use categories, attempting to contact a census of Q2 and Q3 participants.<sup>58</sup> Survey findings contributed to both the process and impact evaluations. Cadmus then selected a random sample of the survey respondents for a desk review. Sample points for this stratum were allocated based on savings.

**Table I-1. Energy Efficient Homes Component Gross Impact Evaluation Sample Design**

Stratum	Sampling Assumptions	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Downstream Equipment	85/15 (Cv=0.50)	23	23	Online survey of a census of participants
		23	28 <sup>(1)</sup> <sup>(2)</sup>	Desk review
Online Marketplace	85/15 (Cv=0.50)	All eligible participants	108 <sup>(3)</sup>	Verification survey (online) and database review

<sup>(1)</sup> HVAC = 19 projects, water heating = 6 projects, appliances = 3 projects  
<sup>(2)</sup> The participant survey was not used for the impact evaluation of water heating end uses because there were no reported savings for heat pump water heaters at the time of the survey.  
<sup>(3)</sup> 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.

For the Online Marketplace subcomponent, Cadmus conducted a database review for all rebated products and used a census-approach for an online participant survey to calculate an in-service rate (ISR) for individual measures. Survey findings also contributed to the process evaluation.

The impact evaluation activities verified energy savings with ±25% precision at 85% confidence and demand reductions with ±15% precision at 85% confidence.

## Ex Post Savings Calculation

### Downstream Equipment and Online Marketplace

Within the strata for which sampling was applied, Cadmus weighted and combined the realization rates for each sampled project into a single, stratum-level realization rate. To calculate *ex post* savings for each stratum, Cadmus applied the sample-derived realization rate for each stratum to the respective population savings. Cadmus then summed *ex post* and *ex ante* kWh savings across strata to calculate component-level realization rates and savings. To calculate the *ex post* savings for each project in the Online Marketplace subcomponent, Cadmus conducted a database review.

Cadmus verified savings in accordance with the PA TRM and relied on inputs from PPL Electric Utilities' participant tracking database, project documentation, third-party sources such as ENERGY STAR, AHRI, and product manufacturer websites, or deemed inputs from the PA TRM, where relevant.

### 1.1.2 Gross Impact Results

Table I-2 shows incentive costs, verified electric savings, and demand reductions by subcomponent.

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<sup>58</sup> PPL Electric Utilities did not report any participants in Q1 and Q4 was not included in the sample frame due to timing.

**Table I-2. PY13 Incentives and Verified Energy Savings and Demand Reductions by Subcomponent**

Parameter	Downstream Equipment	Online Marketplace	New Homes <sup>(1)</sup>	Audit and Weatherization	Total <sup>(2)</sup>
PY13 Participants	7,944	5,616	1,242	-	14,802
PYRTD (MWh/yr)	12,972	1,218	2,933	-	17,124
PYRTD (MW/yr)	0.81	0.11	1.22	-	2.14
PYVTD (MWh/yr)	13,721	968	-	-	14,689
PYVTD (MW/yr)	0.86	0.09	-	-	0.94
System-Level PYVTD (MW/yr)	0.93	0.10	-	-	1.03
PY13 Incentives (\$1000)	\$1,539	\$155	\$783	\$136 <sup>(3)</sup>	\$2,612

<sup>(1)</sup> Cadmus did not evaluate savings for the subcomponent. Savings were left unverified.  
<sup>(2)</sup> Sum of columns may not add up to total column due to rounding.  
<sup>(3)</sup> PPL Electric Utilities paid incentives but did not report participation in PY13 due to delays in tracking system development.

In PY13, the Energy Efficient Homes component reported energy savings of 17,124 MWh/yr, as shown in Table I-3, and demand reduction of 2.14 MW/yr, as shown in Table I-4.

**Table I-3. Energy Efficient Homes Component Gross Impact Results for Energy**

Stratum	PYRTD (MWh/yr)	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Downstream Equipment HVAC	11,545	106%	0.91	31% <sup>(2)</sup>	12,266
Downstream Equipment Water Heating	872	103%	0.02	1%	901
Downstream Equipment Appliances	554	100%	0.00	0%	554
<b>Downstream Subtotal <sup>(3)</sup></b>	<b>12,972</b>	<b>106%</b>	<b>0.89</b>	<b>28%</b>	<b>13,721</b>
Online Marketplace	1,218	79%	0.00	6%	968
<b>Component Subtotal <sup>(3)</sup></b>	<b>14,190</b>	<b>104%</b>	<b>0.00</b>	<b>25%</b>	<b>14,689</b>
Unverified Savings (New Homes)	2,933	-	-	-	-
<b>Total (Verified + Unverified) <sup>(3)</sup></b>	<b>17,124</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>14,689</b>

<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings  
<sup>(2)</sup> Low relative precision for this stratum was due to one outlier project in the sample which had an energy realization rate of 1,027%, due to misreported baseline systems in the reported savings calculation.  
<sup>(3)</sup> Total may not match the sum of rows due to rounding.

**Table I-4. Energy Efficient Homes Component Gross Impact Results for Demand**

Stratum	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System Level PYVTD (MW/yr)
Downstream Equipment HVAC	0.61	107%	0.65	22% <sup>(2)</sup>	0.66	0.71
Downstream Equipment Water Heating	0.05	100%	0.03	2%	0.05	0.05
Downstream Equipment Appliances	0.15	100%	0.00	0%	0.15	0.16
<b>Downstream Subtotal <sup>(3)</sup></b>	<b>0.81</b>	<b>105%</b>	<b>0.52</b>	<b>17%</b>	<b>0.86</b>	<b>0.93</b>

Stratum	PYRTD MW/yr	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PVVT (MW/yr)	System Level PVVT (MW/yr)
Online Marketplace	0.11	80%	0.00	7%	0.09	0.10
<b>Component Subtotal <sup>(3)</sup></b>	<b>0.92</b>	<b>102%</b>	0.00	<b>15%</b>	<b>0.94</b>	1.03
Unverified Savings (New Homes)	1.22	-	-	-	-	-
<b>Total (Verified + Unverified) <sup>(3)</sup></b>	<b>2.14</b>	-	-	-	<b>0.94</b>	<b>1.03</b>
<sup>(1)</sup> 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. <sup>(2)</sup> Low relative precision for this stratum was due to one outlier project in the sample which had a demand realization rate of 380%, due to misreported baseline systems in the reported savings calculation. <sup>(3)</sup> Total may not match the sum of rows due to rounding.						

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

### Downstream Equipment

Energy and demand realization rates for the HVAC end use in the Downstream Equipment subcomponent were slightly higher than 100% due to a difference in reported savings and survey-verified baseline heating and cooling equipment. For one ductless heat pump project, reported savings used a ductless heat pump baseline for heating and cooling, but the verification survey found electric resistance heat and room air conditioner baseline equipment, which resulted in higher verified savings. This resulted in the project also having a realization rate higher than the average (above 1,000%), which increased variance and impacted overall precision. Cadmus removed this project to test the sensitivity of the precision and found that relative precision improves from 21% for the component to 16% with this outlier removed.

Six ductless heat pump projects also reported a lower heating capacity than was verified with the desk review, which slightly increased the realization rates for energy.

### Online Marketplace

Energy and demand realization rates for the Online Marketplace subcomponent were lower than 100% primarily due to low ISRs, in particular for outlet gaskets, advanced power strips, LEDs in the Welcome Kit, and stand-alone smart thermostats. Cadmus calculated ISRs using an online survey of an attempted census of participants at the time of the survey field period. For measures that did not receive enough responses, Cadmus applied historical program ISRs.

For many Welcome Kit measures, *ex ante* savings relied on the PA TRM default installation rates or on historical installation rates where applicable, whereas *ex post* savings used updated PY13 survey data.

The smart thermostat ISR of 56% in PY13 was lower than in PY12 (83%) and PY11 (66%). This product represents 37% of the energy savings and 42% of demand reductions for the Online Marketplace subcomponent, so the ISR had a large impact on the overall realization rate. Of the 22 respondents who did not install their smart thermostat, the most common reason was compatibility issues with their

HVAC system (eight respondents). Other reasons were not having time (five respondents), installation challenges (four respondents), product damage or product not working (two respondents), dissatisfaction with product quality or performance (one respondent), or receiving an incorrect product or giving the product as a gift (one respondent each).<sup>59</sup>

Table I-5 lists the *ex ante* and *ex post* ISRs for each Online Marketplace product—as a stand-alone purchase or as a product in the Welcome Kit—along with the difference. The Welcome Kit represents 60% of the Online Marketplace’s energy savings and 52% of demand reductions; the low ISRs for several kit measures substantially reduced overall realization rates.

**Table I-5. Online Marketplace In-Service Rates**

Measure Category	<i>Ex Ante</i> ISR	<i>Ex Post</i> ISR	Difference
<b>Stand-Alone Purchases</b>			
Advanced Power Strip	86%	77%	-9%
Dehumidifier	100%	100%	0%
Lighting	92%	100%	+8%
Lighting Control	100%	100%	0%
Pipe Insulation	62%	62%	0%
Smart Thermostat	75%	56%	-19%
Weatherstripping	72%	59%	-13%
<b>Welcome Kits</b>			
Advanced Power Strip	86%	63%	-23%
Bathroom Aerator	28%	26%	-2%
Kitchen Aerator	28%	37%	+9%
LED Nightlight	20%	60%	+40%
Lighting	92%	52%	-40%
Outlet Gasket	62%	21%	-41%
Pipe Insulation	62%	26%	-36%
Showerhead	35%	39%	+4%

## I.2 Net Impact Evaluation

### I.2.1 Net Impact Methodology

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,<sup>60</sup> which discusses the common methods used to determine free ridership and spillover. Cadmus used self-report surveys, administered online, to assess free ridership and spillover for the Downstream Equipment subcomponent. Cadmus conducted primary research to

<sup>59</sup> Not all respondents who did not install the smart thermostat provided the reason why.

<sup>60</sup> 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.

assess free ridership and spillover for New Homes but because the savings were left unverified, we will include the analysis and methodology in the PY14 report when savings are verified.

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

Table I-6 lists the methods and sampling strategy used to determine net savings for the Energy Efficient Homes component in PY13.

**Table I-6. Energy Efficient Homes Component Net Impact Evaluation Sample Design**

Stratum	Evaluation year	Stratum Boundaries	Population Size	Achieved Sample Size	NTG Activity
Downstream Equipment – Refrigerator	PY13	Participants (Customers)	1,499	76 <sup>(1)</sup>	Participant online survey
Downstream Equipment – Dehumidifier	PY13		1,017	57 <sup>(1)</sup>	
Downstream Equipment – Central Air Conditioner (CAC)	PY13		919	32 <sup>(1)</sup>	
Downstream Equipment – Air-Source Heat Pump (ASHP)	PY13		909	47 <sup>(1)</sup>	
Downstream Equipment – Ductless Heat Pump (DHP)	PY13		2,105	70 <sup>(1)</sup>	
Downstream Equipment - Smart Thermostat	PY13		951	25 <sup>(1)</sup>	
Downstream Equipment – Other	PY13		161	9 <sup>(1)</sup>	
<b>Program Total</b>			<b>7,561</b>	<b>316</b>	
<sup>(1)</sup> Achieved sample size is based on number of survey respondents answering the first free ridership question C1 to C6, “Which of the following would have happened if you had not received the \$[Field-REBATE] to purchase your [MEASURE]?” and answering at least of one of the questions from C7a to C7b, “Please rate the following items on how much influence each item had on your decision to purchase the [MEASURE]. Please use a scale from 1 to 5, 1 meaning no influence, and 5 meaning the item was extremely influential in your decision. C7a. The discount for the [MEASURE], C7b. PPL Electric Utilities’ information about energy efficiency.					

**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-7 summarizes the intention, influence, and free ridership scores for each stratum.

**Table I-7. Energy Efficient Homes Component Intention, Influence, and Free Ridership Score by Stratum**

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Downstream Equipment – Refrigerator	76	41%	15%	56%
Downstream Equipment – Dehumidifier	57	36%	16%	52%
Downstream Equipment – Central Air Conditioner (CAC)	32	36%	18%	54%
Downstream Equipment – Air-Source Heat Pump (ASHP)	47	38%	21%	59%
Downstream Equipment – Ductless Heat Pump (DHP)	70	33%	20%	53%
Downstream Equipment - Smart Thermostat	25	28%	19%	47%
Downstream Equipment – Other	9	17%	3%	20%

*Spillover*

Table I-8 lists the quantity of spillover energy-efficient equipment types that the respondents for the efficient equipment stratum categories attributed to PPL Electric Utilities. The table also lists the per-unit energy savings and source of the estimated energy savings used in the spillover analyses.

**Table I-8. Energy Efficient Homes Component Spillover Products and Savings for Refrigerator, Dehumidifier, CAC, DHP, ASHP, Smart Thermostat, and Other Equipment Categories**

Spillover Product	Downstream Equipment Respondent Quantity <sup>(1)</sup>	Per-Unit Savings (kWh/yr)	Savings Source
Air Conditioning Equipment	2 <sup>(2)</sup>	333.9	PY13 PPL Electric Utilities Gross Verified Savings
Air Source Heat Pump	1 <sup>(2)</sup>	1,156.9	PY13 PPL Electric Utilities Gross Verified Savings
Clothes Washer	10 <sup>(3)</sup>	95.0	2021 PA TRM
Ductless Heat Pump	1	1,796.8	PY13 PPL Electric Utilities Gross Verified Savings
Dishwasher	9 <sup>(2)</sup>	22.8	2021 PA TRM
Freezer	2	27.0	2021 PA TRM
Refrigerator	9 <sup>(4)</sup>	54.3	PY13 PPL Electric Utilities Gross Verified Savings
Smart Thermostat	2	530.9	PY13 PPL Electric Utilities Gross Verified Savings

<sup>(1)</sup> Refrigerator, Dehumidifier, Central Air Conditioner, DHP, ASHP, Smart Thermostat, and Other.  
<sup>(2)</sup> 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."  
<sup>(3)</sup> 50% of per-unit savings kWh/yr applied to two units due to a maximum PPL Electric Utilities influence rating of three.  
<sup>(4)</sup> 50% of per-unit savings kWh/yr applied to three units due to a maximum PPL Electric Utilities influence rating of three.

Table I-9 shows the spillover results for the PY13 evaluated equipment categories of the downstream equipment stratum group of the Energy Efficient Homes component.

**Table I-9. Energy Efficient Homes Component Spillover Calculation for Refrigerator, Dehumidifier, CAC, DHP, ASHP, Smart Thermostat, and Other Equipment Categories**

Variable	Variable Description	Downstream Equipment (Refrigerator, Dehumidifier, Central Air Conditioner, DHP, ASHP, Smart Thermostat, and Other)	Source
A	Survey Sample Size (n)	316	Survey Data
B	Total Survey Sample Spillover kWh/yr Savings	5,448	Survey Data/Engineering Estimates
C	Average SO kWh/yr Savings Per Survey Respondent	17.2	Variable B ÷ Variable A
D	Program Participant Population	7,561 <sup>(1)</sup>	Program Tracking Data
E	SO kWh/yr Savings Extrapolated to the Participant Population	130,356	Variable C × Variable D
F	Evaluated Program Population kWh/yr Savings	12,820,139	Evaluated Gross Impact Analysis
G	Spillover Percentage Estimate	1%	Variable E ÷ Variable F

<sup>(1)</sup> 7,561 unique participants.

### 1.3 Net-to-Gross Results

Table I-10 shows the downstream equipment stratum free ridership, spillover, and NTG ratios by equipment category. For NTG in PY13, Cadmus surveyed all downstream equipment categories except for HPWH. The NTG estimate for HPWH is from PY12.

**Table I-10. Energy Efficient Homes Component – Downstream Equipment Stratum Net Impact Evaluation Results**

Equipment Category	PYVTD kWh/yr	Evaluation Year	Free Ridership (%) <sup>(1)</sup>	Spillover (%)	NTG Ratio
Refrigerator	81,401	PY13	56%	1%	0.45
Dehumidifier	228,770	PY13	52%	1%	0.49
Central Air Conditioner	323,181	PY13	54%	1%	0.47
ASHP	1,321,686	PY13	59%	1%	0.42
DHP	10,116,044	PY13	53%	1%	0.48
HPWH	559,583	PY12	23%	1%	0.78
Smart Thermostat	504,875	PY13	47%	1%	0.54
Other <sup>(4)</sup>	585,766	PY13	20%	1%	0.81
<b>Stratum Total <sup>(2) (3)</sup></b>	<b>13,721,307</b>	<b>-</b>	<b>51%</b>	<b>1%</b>	<b>0.50</b>

<sup>(1)</sup> These 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.

<sup>(2)</sup> Equipment- level free ridership, spillover, and NTG estimates were weighted by the product’s verified kWh/yr component population savings to arrive at the downstream equipment stratum NTG ratio of 0.50.

<sup>(3)</sup> May not match due to rounding.

<sup>(4)</sup> Other includes pool pumps and fuel switching equipment.



Table I-11 shows the NTG ratio results for the online marketplace and downstream equipment strata of the Energy Efficient Homes component. The overall Energy Efficient Homes component NTG ratio of 0.52 is heavily weighted towards the downstream equipment stratum NTG ratio of 0.50, as the downstream equipment stratum represents 93% of the Energy Efficient Homes component verified gross population energy savings.

**Table I-11. Energy Efficient Homes Component NTG Ratio Summary**

Stratum	PYVTD kWh/yr	Evaluation Year	Free Ridership (%) <sup>(1)</sup>	Spillover (%)	NTG Ratio
Online Marketplace	968,114	PY11	25%	0%	0.75
Downstream Equipment	13,721,307	PY13	51%	1%	0.50
<b>Program Total <sup>(2) (3)</sup></b>	<b>14,689,420</b>	-	<b>49%</b>	<b>1%</b>	<b>0.52</b>

<sup>(1)</sup> 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.

<sup>(2)</sup> The stratum-level free ridership, spillover, and NTG ratio estimates were weighted by the stratum’s verified kWh/yr component population savings to arrive at the final Energy Efficient Homes component NTG ratio of 0.52.

<sup>(3)</sup> Total may not match sum of rows due to rounding.

### *I.4 Process Evaluation*

Cadmus conducted a full process evaluation of the Energy Efficient Homes component using data collected through the online participant survey and interviews with staff from PPL Electric Utilities, the ICSP, the ICSP’s subcontractors, and builders. The research objectives for the process evaluation were to assess participant satisfaction, review component changes and performance, assess component design and market actor experience, review the logic model, and make recommendations for improvement.

Table I-12 shows the sampling strategy for the process evaluation. The results from the participant survey produced a measure of program 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 except for the Audit and Weatherization subcomponents. The Energy Efficient Homes component did not report participation or savings for any audits or weatherization measures in PY13, so Cadmus did not conduct a survey or complete any other evaluation activities for the subcomponent.

**Table I-12. 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 <sup>(1)</sup>	Percent of Sample Frame Contacted to Achieve Sample <sup>(2)</sup>
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%
Program Participants	New Home Builders	Telephone in-depth interview	66	85/15	Up to 18	16	66	100%
	Downstream Equipment	Online survey	4,894 <sup>(3)</sup>	85/15	All eligible	304 <sup>(4)</sup>	3,937	100%
	Online Marketplace	Online survey	3,104 <sup>(3)</sup>	85/15	All eligible	94 <sup>(4)</sup>	2,782	100%
<b>Program Total</b>			<b>8,067</b>	-	-	<b>417</b>	<b>6,788</b>	<b>100%</b>
<p><sup>(1)</sup> 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 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.</p> <p><sup>(2)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews.</p> <p><sup>(3)</sup> Number of participants in the PPL Electric Utilities' tracking database at the time of the PY13 survey which occurred before the end of the program year.</p> <p><sup>(4)</sup> 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.</p>								

A total of 398 respondents—304 in the Downstream Equipment and 94 in the Online Marketplace subcomponent—completed the online survey in April through May 2022.

Cadmus interviewed 16 builders of a total 66 unique building firms that participated in the New Homes subcomponent in PY13. Cadmus attempted to contact a census of, that is, all builders with projects during Q2 and Q3 and reached 16 who were willing to participate in an interview.

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 each question, even if they did not complete the survey.

### 1.4.1 Program Component Experience

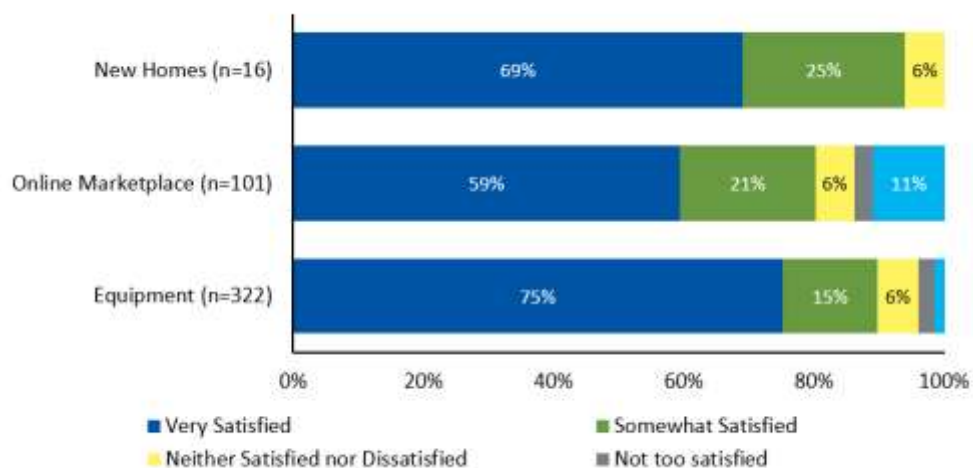
Downstream Equipment, Online Marketplace, and New Homes respondents rated satisfaction with their experience with different aspects of these subcomponents. Survey respondents in the Downstream Equipment and Online Marketplace subcomponents also provided insights about their satisfaction ratings as well as a rating of their likelihood to recommend the Energy Efficient Homes component and the effect of their participation on their opinion of PPL Electric Utilities.

Builders participating in the New Homes subcomponent provided insights about the residential new construction market and installation of high-efficiency equipment.

### 1.4.2 Program Satisfaction and Customer Effort

Across the three subcomponents, nearly all participants were satisfied with their experience in the Energy Efficient Homes component (Figure I-1), with 88% overall satisfaction (as measured by responses of *very* or *somewhat satisfied*).

**Figure I-1. PY13 Overall Satisfaction with Energy Efficient Homes by Subcomponent**



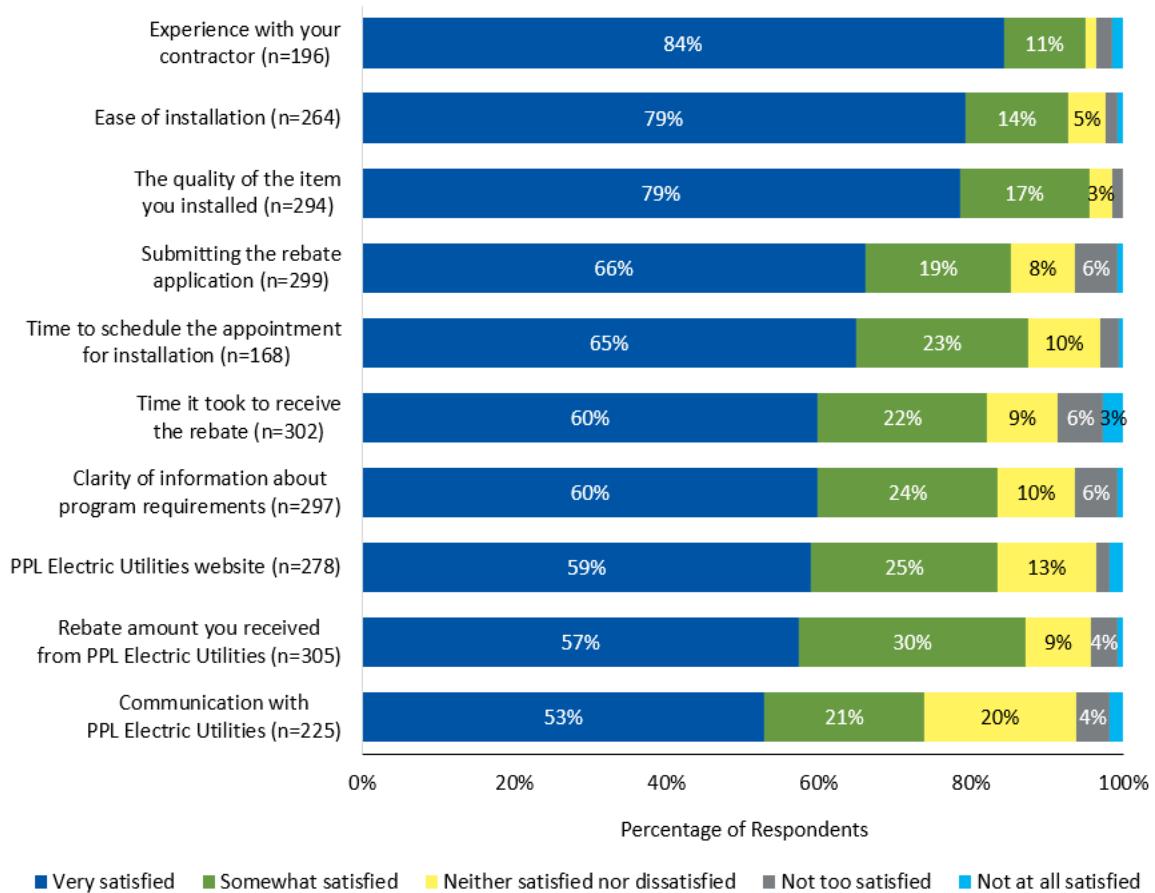
Source: Downstream Equipment, Online Marketplace, and New Home builder participant survey/guide Question, “Thinking about your overall experience with the PPL Electric Utilities [program], how would you rate your satisfaction?” Totals may not sum due to rounding. Due to rounding the sum of *very* and *somewhat satisfied* shown here may not match the totals in the infographic. Sample sizes reflect partially completed surveys.

### Downstream Equipment

When asked about various elements of the program delivery, Downstream Equipment respondents said they were *very* or *somewhat satisfied* with each program element at least 74% of the time (Figure I-2). Respondents were most satisfied with the experience with their contractor, with 95% (n=196) indicating they were *very* or *somewhat satisfied*.

When asked how easy it was to participate in this rebate program, 85% (n=322) said the process was *very easy* (56%) or *easy* (29%).

**Figure I-2. PY13 Satisfaction with Elements of the Downstream Equipment Subcomponent**



Source: Participant survey, Question F1, “The following questions are about your satisfaction with the components from the PPL Electric Utilities program: experience with your contractor, ease of installation, the quality of the item you installed, time to schedule the appointment for installation, 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, submitting the rebate application.”

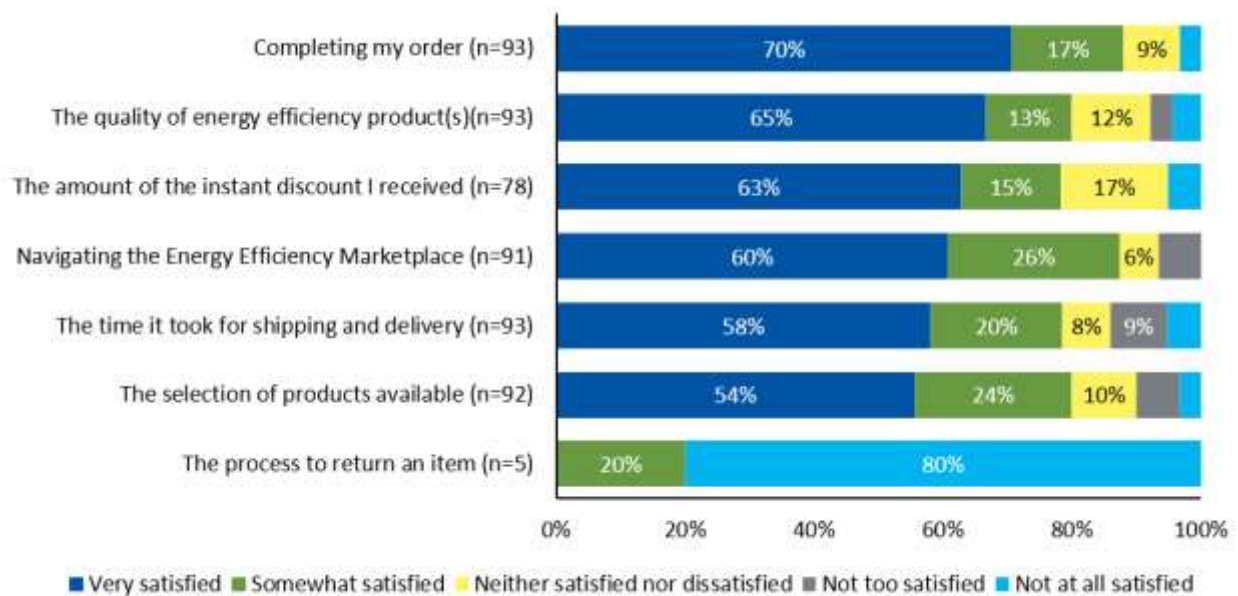
Totals may not sum due to rounding.

### Online Marketplace

Participants shopping at PPL Electric Utilities’ Online Marketplace for energy-efficient products had a positive experience. When asked how easy it was to place an order on the Online Marketplace, 89% (n=101) reported the process was *very easy* (60%) or *easy* (29%).

As shown in Figure I-3, most Online Marketplace respondents said that they were either *very* or *somewhat satisfied* with various aspects of their online shopping and purchasing experience with one exception. Respondents were most satisfied with completing an order (87%, n=93) and navigating the marketplace (86%, n=91). Only five respondents returned their purchase, and four said they were *not at all satisfied* with the process.

**Figure I-3. PY13 Satisfaction with Elements of the Online Marketplace Subcomponent**



Source: Participant survey, Question E1, “Thinking about the program, please indicate how satisfied you are with each element of your experience: the process to return an item, the amount of the instant discount I received, the time it took for shipping and delivery, completing my order, the selection of product available, the quality of energy efficiency product(s) I ordered, navigating the Energy Efficiency Marketplace to find the products I wanted.” Totals may not sum due to rounding.

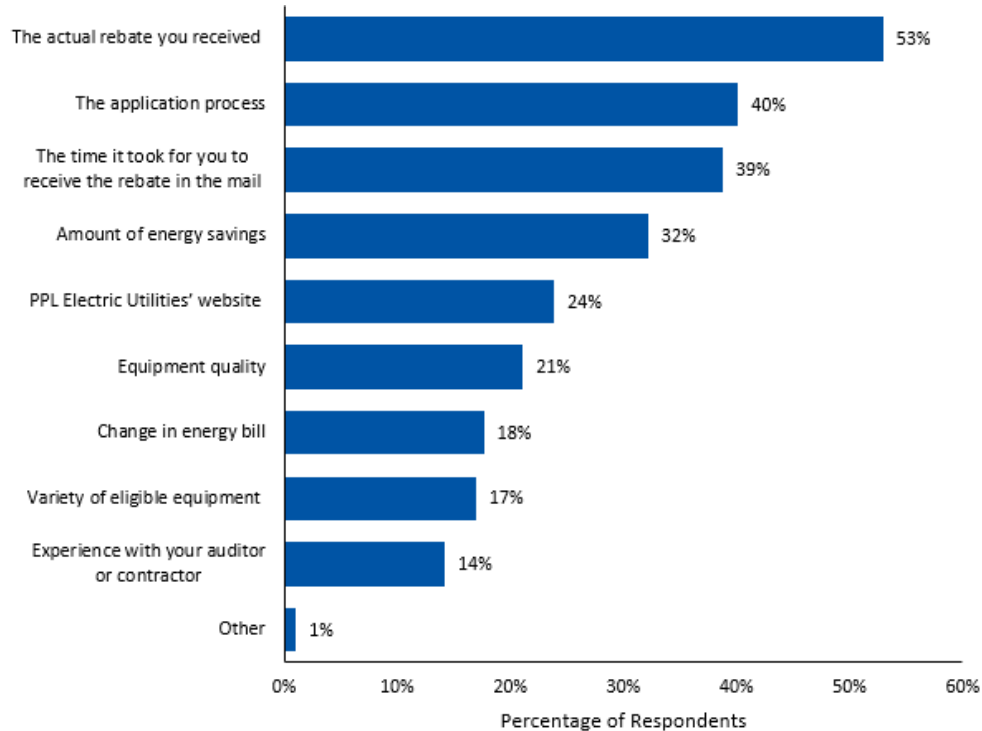
Free Welcome Kits, a new offering on the Online Marketplace for new PPL Electric Utilities customers in PY13, were very well received. Respondents said they were *very* or *somewhat satisfied* with their overall experience 89% of the time (n=53).

Respondents who purchased a smart thermostat (n=44) were *very* or *somewhat satisfied* 66% of the time, likely due to issues with installation. As noted in *I.1.2 Gross Impact Results*, the installation rate for smart thermostats was low, at 56% (compared with 83% in PY12 and 66% in PY11). Of the 22 respondents who did not install the smart thermostat, most cited incompatibility with their HVAC system or difficulty installing, despite prominent instructions on how to check thermostat compatibility on the Online Marketplace website. The majority of smart thermostat purchasers (79%, n=44) said they either did not read or did not recall reading the smart thermostat buyers guide, also available on the Online Marketplace website. Those who did read the guide said it was helpful.

*Drivers of Program Component Satisfaction*

To better understand what drives satisfaction, the survey asked participants of the Downstream Equipment and Online Marketplace subcomponents what factor or factors led to their satisfaction rating. In Downstream Equipment, shown in Figure I-4, of 289 respondents who rated their satisfaction with the component as *very* or *somewhat satisfied*, top drivers of high satisfaction were the rebates (53%), application process, (40%), and time it took to receive the rebate in the mail (39%). Respondents could cite multiple factors, so percentages add to over 100%.

**Figure I-4. Downstream Equipment Drivers of High Satisfaction**



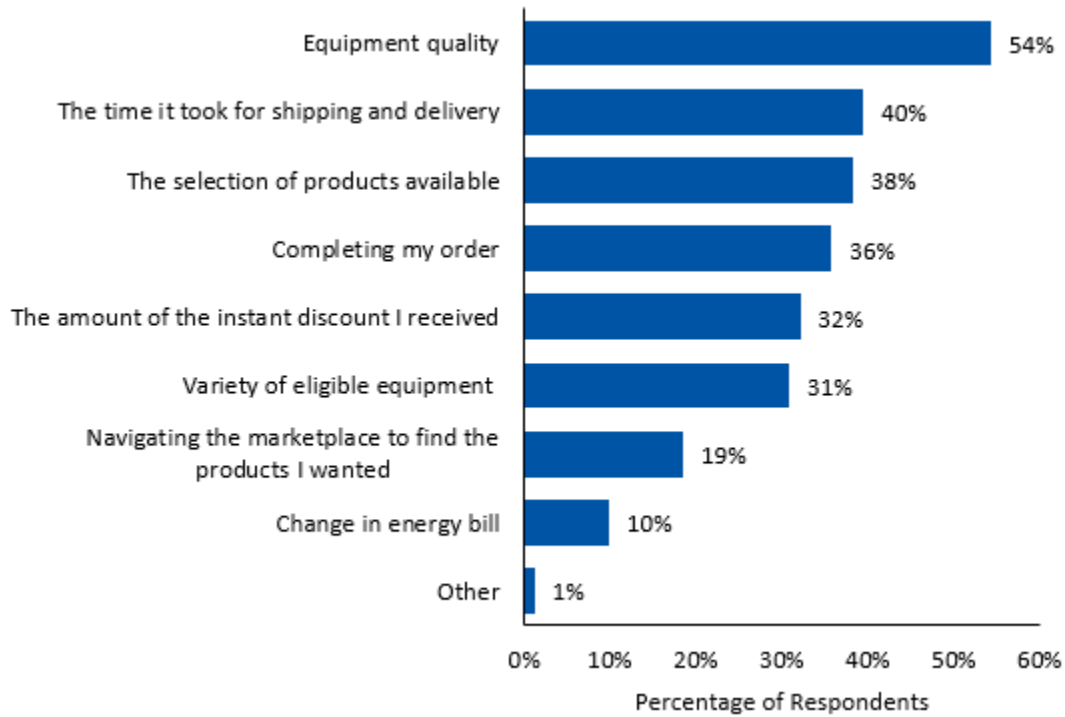
Source: Participant survey, Question E2, “What factor(s) most affected the overall experience rating you gave?” (n=289; multiple responses allowed) Analysis reflects respondents who rated their overall satisfaction with the component *very* or *somewhat satisfied*.

For the 33 Downstream Equipment respondents (10%; n=322) who were *neither satisfied nor dissatisfied, not too satisfied, or not at all satisfied* with their overall experience with the rebate offering, reasons were also the application process (36%), rebate they received (24%), and time it took to receive the rebate in the mail (24%).

For the Online Marketplace respondents (n=81), top drivers of high satisfaction were equipment quality (54%), the time it took for shipping and delivery (40%), and the selection of products available (38%), as shown in Figure I-5. The findings indicate that customers value a positive shopping experience and product quality more than the discounts, though price was one major reason most customers chose to shop on the Online Marketplace (74% said price was *very important* in their decision, n=47).

For the 20 respondents who were *not too* or *not at all satisfied* with their overall experience with the Online Marketplace (15 smart thermostat purchasers and five Welcome Kit recipients), top drivers for the low rating were related to customer support and difficulties with installation (35%), shipping time (30%), or product quality (25%).

**Figure I-5. Online Marketplace Drivers of High Satisfaction**



Source: Participant survey, Question D2, “What factor(s) most affected the overall experience rating you gave?” (n=81; 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 Downstream Equipment and Online Marketplace subcomponents had an impact on how customers view PPL Electric Utilities. About half of the respondents—54% of Downstream Equipment respondents (n=318) and 46% of Online Marketplace respondents (n=101)—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—78% of Downstream Equipment respondents (n=318) and 65% of Online Marketplace users (n=102).<sup>61</sup>

<sup>61</sup> 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.

## *Builder Satisfaction and Market Insights*

Nearly all builders (15 of 16 respondents) were satisfied with their experience with the New Homes subcomponent, and one was *neither satisfied nor dissatisfied*.

Cadmus asked builders if they had experienced any challenges, including any issues meeting program standards, scheduling HERS raters, or receiving rebate checks. Thirteen builders said they had had no issues with the New Homes subcomponent at all.

Three builders mentioned the following issues related to getting their homes rated:

- Achieving desired air leakage results
- Scheduling enough time for HERS rater to complete all tests and calculations
- Scheduling re-inspections for issues discovered by the HERS rater

Two builders said they experienced a delay receiving their rebate check. In one case, issues with the program software prevented the builder from registering a project, and this issue was resolved. In the other case, the builder said the HERS rater waited to submit information to PPL Electric Utilities, which delayed the rebate process. A third builder said it was challenging to evaluate project profits and, in turn, plan for upcoming projects when it takes 60 to 90 days to receive the rebate check.

## **Marketing and Awareness**

Of the 16 builders interviewed, 12 said all of the homes their company built in the PPL Electric Utilities territory received a program rebate, which means 75% of respondents built exclusively to program standards. The four respondents who did not build all of their homes to program-eligible standards cited custom situations and homeowner preferences.

HERS raters play an important role in raising awareness of the program and encouraging builders to participate. Four of 16 builders credit their HERS rater for their program participation.

Ten builders said they actively advertise program participation when selling their homes. Two of these reported using PPL Electric Utilities branded materials, either on their website or with a sticker at the site. Other non-PPL Electric Utilities-branded marketing methods included sales brochures, homeowner closing packets, electrical panel stickers, and word of mouth. Of 16 builders, only four believed realtors were aware of the New Homes subcomponent, five did not believe realtors were aware, and seven were unsure.

## **Residential Construction Market Insights and Energy Efficiency**

All 16 builder respondents agreed that the region is experiencing a housing inventory shortage, but 11 expected the real estate market to slow down in the next year. Builders also reported impacts to their business due to COVID-19, and all cited challenges such as supply chain issues, increased material costs, and, to a lesser extent, labor shortages. Respondents said the cost of materials has gone up for all supplies and is unpredictable, making it difficult for builders to price homes and provide affordable housing with a reasonable profit margin.



Several builders discussed challenges of building affordable homes as material costs increase and code requirements become stricter. Even so, none predict that the market for energy-efficient homes will slow down. Two builders said code requirements were the driving factor for continuing to build energy-efficient homes, and five said they were seeing an increase in customer demand for energy-efficient homes.

Seven builders said the New Homes subcomponent had impacted their company’s selection of energy-efficient equipment and building shell products, though three of these said these decisions were simultaneously affected by stricter code requirements. The list of efficiency upgrades spurred by program participation includes bathroom exhaust fans, LED lighting, air sealing, and installation of heat pump systems. Two specifically mentioned installing more heat pump HVAC and water heater systems to maximize efficiency. One builder said 40% of the HVAC systems the company installs are heat pumps and that no barriers related to these systems have been experienced.

One builder stated, “We compared two spec homes built in the same subdivision. The first home finished was listed for \$323,000. We listed the second home this month for \$490,000. They were the same model, floor plan, etc. There were no differences, so that increase is purely due to increased lumber and product costs.”

Cadmus asked the builders how their company decides which energy-efficient products and shell products to install. Builders listed three prominent factors—energy efficiency (seven respondents), customer preferences (five respondents), and cost (two respondents). Builders also mentioned regularly pursuing high-efficiency HVAC systems, LED lighting, and ENERGY STAR appliances. Four builders said their standard practice is to select all energy-efficient equipment and shell products.

When asked which types of efficient equipment or strategies the builders were less likely to pursue, there was less agreement. One builder said the company avoids tankless water heaters. Another avoided heat pump water heaters, and this was the only builder to mention issues with heat pump technology. Two builders sometimes install less efficient appliances based on customer selections. One builder specifically mentioned avoiding Nest smart thermostats because customers often have issues and call the builder for help.

### *Improvement Suggestions*

Cadmus asked survey and interview respondents what PPL Electric Utilities could do to improve the Energy Efficient Homes component. Most respondents did not have a suggestion.

For the Downstream Equipment subcomponent, 90 respondents (28%; n=322) made a suggestion and, of these, 33 respondents suggested simplifying the application process or improving customer service and communication about the application. Relatedly, another eight of the 90 respondents asked that PPL Electric Utilities clarify the eligibility guidelines for qualifying products or equipment. Other suggestions encouraged PPL Electric Utilities to offer more rebates (11 respondents), increase the rebate amount (17 respondents), or advertise more so more people are aware of the offerings (ten respondents).

For the Online Marketplace subcomponent, suggested improvements fell into the following categories:

- Expand product selection and improve product quality (nine respondents)
- Implement faster shipping and returns (six respondents)
- Improve smart thermostat compatibility guidelines and general installation instructions (six respondents)
- Improve website and customer service (five respondents)
- Allow kits to be customized (three respondents)

Respondents said they wanted to see more smart home devices, solar battery home devices (such as chargers or lamps), and lighting options on the Online Marketplace.

For the New Homes subcomponent, six of 16 builders said they would like to see higher rebates offered. One of these builders specifically mentioned that increasing incentives would help “to keep up with the costs related to the code continuing to get stricter.” Three builders asked that marketing materials be more readily available. One of these builders specifically mentioned the benefit of an option to incorporate the company logo on PPL Electric Utilities-branded material.

When asked, half the builders expressed interest in attending virtual group training led by industry experts about such topics as maximizing program rebates (seven builders), heat pump water heaters (six builders), marketing energy-efficient homes (five builders), and eliminating air leakage and methods for improving blower door test results (one builder).

### *1.4.3 Other Findings*

#### *Participant Profile and Survey Sample Attrition*

##### **Equipment and Online Marketplace**

The PY13 surveys collected demographic information about participants in the Energy Efficient Homes component.<sup>62</sup> Respondents had the following characteristics:

- Lived in a single-family detached residence (81%; n=397)
- Had an average household size of 2.2 people (n=369)
- Averaged 67 years of age (n=334)
- Had completed some college education or more (81%; n=388)
- Had an annual household income of \$50,000 or greater (69%; n= 261)

Table I-13 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 Survey Bias*.

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<sup>62</sup> Includes data on Online Marketplace and Downstream Equipment.

**Table I-13. Energy Efficient Homes Sample Table**

Description of Outcomes of Online Participant Survey	Number of Records	
	Equipment	Online Marketplace
<b>Population (number of unique jobs)</b>	<b>4,894</b>	<b>3,104</b>
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	216	230
Removed: incomplete or invalid email address or phone number	741	92
<b>Survey Sample Frame (records attempted)</b>	<b>3,937</b>	<b>2,782</b>
Not reached or non-working: Opted out, email returned (bounce back), did not respond	3,567	2,658
Partially completed survey	66	30
<b>Completed Surveys (online)</b>	<b>304</b>	<b>94</b>
<b>Overall Response Rate</b>	<b>8%</b>	<b>3%</b>

**New Homes**

Of the 16 builders interviewed, eleven said their company has participated in the program for five years or less. In the past year, seven builders had less than 10 homes that received a rebate, seven had between 10 and 100 homes that received a rebate, and two received rebates for over 100 homes.

Table I-14 lists the total number of records contacted via the telephone interview and the outcome (final disposition) of each record.

**Table I-14. New Homes Subcomponent Sample Attrition Table**

Description of Outcomes of Telephone Interview	Number of Records
<b>Population (number of builders)</b>	<b>66</b>
<b>Survey Sample Frame (records attempted)</b>	<b>66</b>
Not reached: no answer, voicemail, phone busy, out of office response, did not respond	34
No-show for scheduled interview	4
Declined interview	12
<b>Completed Interviews (telephone)</b>	<b>16</b>
<b>Overall Response Rate</b>	<b>24%</b>

*1.4.4 Logic Model*

Cadmus reviewed the component’s logic model and made updates based on interviews with the program managers from PPL Electric Utilities and the ICSP and secondary research. The updated logic mode is shown in Table I-15.

**Table I-15. Energy Efficient Homes Program Component Logic Model**

Barriers	Program Activities	Outputs Produced by Program Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Cost of energy saving equipment and efficient home building practices</li> <li>• Lack of knowledge about energy-efficient technology or where to purchase</li> <li>• Difficulty with or lack of knowledge about installing equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Engage contractors, distributors, home builders, and energy auditors to support customers in purchasing and installing energy-efficient equipment and building newly constructed energy-efficient homes</li> <li>• Offer downstream, midstream, and upstream rebates and discounts for qualified products</li> <li>• Promote energy efficient products and rebates through marketing activities directed at residential customers and market actors</li> <li>• Operate an Online Marketplace for customers to purchase discounted energy efficient products</li> </ul>	<ul style="list-style-type: none"> <li>• Qualified products are purchased, installed by customers and market actors</li> <li>• Home builders and raters participate in the program to build new efficient homes due to rebates and program support</li> <li>• Program tracking data and participant data are collected and maintained for evaluability, market research, and cross-marketing opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Energy savings and peak demand reduction accrue from participant households through installation of efficient equipment and efficient new homes</li> <li>• Increased program awareness among customers and market actors</li> <li>• Increased participant knowledge of energy efficiency and conservation</li> <li>• High customer satisfaction with program experience and satisfaction with PPL Electric Utilities is improved</li> </ul>	<ul style="list-style-type: none"> <li>• PPL Electric Utilities is trusted resource for energy efficiency information and products (via online storefront)</li> <li>• Participants engage in other energy efficiency behaviors/activities and participate in additional programs</li> <li>• Energy and peak demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Broad market awareness of energy efficiency opportunities and PPL Electric Utilities programs</li> <li>• Participants engage in word-of-mouth marketing to others related to the program</li> <li>• Improved energy grid resilience</li> <li>• Increasing PPL Electric Utilities’ knowledge and experience operating this type of program</li> </ul>

Cadmus reviewed the logic model and determined that the Energy Efficient Homes component is operating as expected. Table I-16 shows the outcome of the logic model review, based on indicators that are within the scope of the evaluation.

**Table I-16. Energy Efficient Homes Component Logic Model Review**

Topics	Logic Model Components/ Goal	Status	PY13 Outcomes
<b>Program Activities</b>	<ul style="list-style-type: none"> <li>Engage contractors, distributors, home builders, and energy auditors to support customers in purchasing and installing energy-efficient equipment and building newly constructed energy-efficient homes</li> <li>Offer rebates and discounts for qualified products</li> <li>Promote energy-efficient products and available rebates through marketing activities directed at residential customers and market actors</li> <li>Operate a virtual storefront for customers to purchase discounted energy-efficient products</li> </ul>	Completed	<ul style="list-style-type: none"> <li>Conducted all activities as planned. Midstream rebates will be offered in PY14.</li> </ul>
<b>Outputs Produced by Program Activities</b>	<ul style="list-style-type: none"> <li>Qualified products are purchased, installed by customers and market actors</li> <li>Home builders and raters participate in the program to build new efficient homes due to rebates and program support</li> <li>Program tracking data and participant data are collected</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>The program operated as planned and has sufficient participation from customers, builders, and home raters to meet Phase IV goals</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>Energy savings and peak demand reduction accrue from participant households through installation of efficient equipment and efficient new homes</li> <li>Increased program awareness</li> <li>Increased participant knowledge of energy efficiency and conservation</li> <li>High customer satisfaction with program experience and satisfaction with PPL Electric Utilities is improved</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>Contributed 46% to PY13 Residential verified energy savings and 25% of PY13 Residential verified demand reductions</li> <li>Achieved 88% satisfaction among participating customers and builders vs 85% goal.</li> </ul>
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>PPL Electric Utilities is trusted resource for energy efficiency information and products (via online storefront)</li> <li>Participants engage in other energy-efficiency behaviors/activities and participate in additional programs</li> <li>Energy and peak demand savings accrue and contribute to PPL Electric Utilities planned savings and regulatory requirements</li> </ul>	On track to meet in subsequent years	<ul style="list-style-type: none"> <li>In PY13 (Year 1), EE Homes achieved 9% of planned Residential Phase IV energy savings and 3% of planned Residential Phase IV system-level demand reductions<sup>(1)</sup></li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>Broad market awareness of energy efficiency opportunities and PPL Electric Utilities programs</li> <li>Participants engage in word-of-mouth marketing to others related to the program</li> <li>Improved energy grid resilience</li> <li>Increasing PPL Electric Utilities' knowledge and experience operating this type of program</li> </ul>	Unable to assess	<ul style="list-style-type: none"> <li>Unable to assess at this time</li> </ul>

<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

## 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

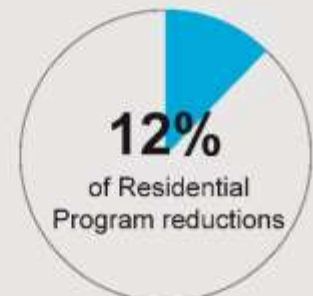
Phase IV  
has saved  
**4,797 MWh/yr**



**PY13** saved  
**4,797 MWh/yr**

### VERIFIED DEMAND REDUCTIONS

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



**PY13** has  
reductions of  
**0.47 MW/yr**

### PY13 PARTICIPATION



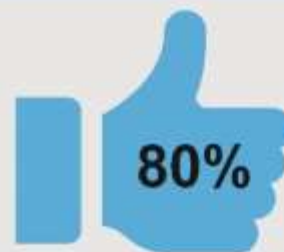
A total of **20,015** participants

**5,027** Bright Kids (2<sup>nd</sup> – 3<sup>rd</sup> grades)

**10,007** Take Action (5<sup>th</sup> – 7<sup>th</sup> grades)

**4,981** Innovation (9<sup>th</sup> – 12<sup>th</sup> grades)

### PARTICIPANT SATISFACTION



Satisfied with  
overall program

**100%** Teachers

**87%** Bright Kids (2<sup>nd</sup> – 3<sup>rd</sup> grades)

**80%** Take Action (5<sup>th</sup> – 7<sup>th</sup> grades)

**74%** Innovation (9<sup>th</sup> – 12<sup>th</sup> 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 program 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 response to disruptions to in-person school during the 2021-2022 school year, PY13 activities extended into February of 2022.

In Phase IV, the SEEE component includes more implementer involvement during the presentations compared to the end of Phase III when in-person presentations had to be curtailed. The component has also continued to offer virtual presentations. In PY13, an energy educator attended each presentation, whether virtual or in-person. In Phase IV, the SEEE component also offers a different selection of items in the energy-savings kits.

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.

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 SEEE component provides kits to students in three cohorts:

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

Table J-1 shows the kit items by cohort. New in PY13 are furnace filter whistles, weatherstripping, hot water pipe insulation, and outlet gaskets in the Take Action and Innovation cohorts.

Each kit distributed is counted as a participant and is recorded in the ICSP's database and PPL Electric Utilities' tracking database with an identifier for school, classroom, and teacher. PPL Electric Utilities did not collect or record utility account numbers of classroom students who received a kit.

**Table J-1. Energy-Savings Items by Cohort**

Cohort	Kit Items
Bright Kids	LED nightlight, Tier 1 advanced power strip
Take Action <sup>(1)</sup>	LED nightlight, kitchen aerator, showerhead, Tier 1 advanced power strip, furnace filter whistle, weatherstripping (17 ft), hot water pipe insulation (3 ft), 10 outlet gaskets, energy education
Innovation <sup>(1)</sup>	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, energy education
<sup>(1)</sup> These cohorts also received education that included instructions for setting back water heater temperatures.	

CLEARresult, PPL Electric Utilities’ residential 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 program components by the Pennsylvania Department of Education, and assembling the kits. In PY13, EFI became the vendor responsible for 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 support, evaluation, and data management.

### J.1 Gross Impact Evaluation

#### J.1.1 Gross Impact Methodology and Sampling Approach

Cadmus conducted the PY13 impact evaluation for the SEEE component using PY13 survey data gathered through paper and online HEWs to estimate savings for all items in the kits.

Cadmus calculated verified savings using the PA TRM algorithms for outlet gaskets, weatherstripping, and furnace whistles, whereas *ex ante* savings weighted the default savings from the PA TRM’s Table 2-119 Default Annual Energy Savings by climate zones and electric saturation.

The impact evaluation sampling strategy is summarized in Table J-2. Cadmus used a census approach and stratified by education-level cohorts. The impact evaluation verified energy and demand savings with 2.76% and 2.90% relative precision, respectively, both with 85% confidence.

Because the items in the kits differ for each cohort, Cadmus computed cohort-level metrics. To calculate cohort-level *ex post* savings, Cadmus applied the cohort-level realization rates to cohort-level *ex ante* savings. Taking the sum of cohort-level *ex post* savings, Cadmus estimated the component-level *ex post* savings.



**Table J-2. Student Energy Efficient Education Component Gross Impact Evaluation Sample Design**

Stratum	Reported Population Size <sup>(1)</sup>	Sampling Assumptions <sup>(2)</sup>	Achieved Sample Size <sup>(3)</sup>	Impact Evaluation Activity
Bright Kids 2 <sup>nd</sup> – 3 <sup>rd</sup> grades	5,027	N/A	3,673	PY13 paper and online HEWs
Take Action 5 <sup>th</sup> – 7 <sup>th</sup> grades	10,007	N/A	7,767	PY13 paper and online HEWs
Innovation 9 <sup>th</sup> – 12 <sup>th</sup> grades	4,981	N/A	3,354	PY13 paper and online HEWs
<b>Component Total</b>	<b>20,015</b>	<b>N/A</b>	<b>14,794</b>	<b>N/A</b>

<sup>(1)</sup> Population size is based on number of kits distributed according to PPL Electric Utilities’ participant tracking database.  
<sup>(2)</sup> Because this component’s evaluation plan did not include sampling, Cv and targeted precision are not meaningful for planned assumptions.  
<sup>(3)</sup> Achieved sample size is based on number of HEWs included in the HEW data file from the ICSP and does not match the total in PPL Electric Utilities’ participant tracking database.

### J.1.2 Gross Impact Results

In PY13, the SEEE component reported energy savings of 5,704 MWh/yr, as shown in Table J-3, and demand reductions of 0.49 MW/yr, as shown in Table J-4.

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

Stratum	PYRTD MWh/yr	Energy Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio <sup>(2)</sup>	Relative Precision at 85% C.L.	PYVTD (MWh/yr)
Bright Kids	473	95%	0.09	1%	448
Take Action	3,475	74%	0.20	2%	2,557
Innovation	1,756	102%	0.46	7%	1,792
<b>Component Total <sup>(3)</sup></b>	<b>5,704</b>	<b>84%</b>	<b>0.49</b>	<b>3%</b>	<b>4,797</b>

<sup>(1)</sup> Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.  
<sup>(2)</sup> Although this evaluation did not include sampling, Cv and precision can be calculated from the actual number of responses from the home energy worksheets (HEWs) in the kits and the evaluation forms given to teachers.  
<sup>(3)</sup> 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	Demand Realization Rate <sup>(1)</sup>	Sample Cv or Error Ratio <sup>(2)</sup>	Relative Precision at 85% C.L.	PYVTD (MW/yr)	System-Level PYVTD (MW/yr)
Bright Kids	0.05	90%	0.09	1%	0.04	0.04
Take Action	0.29	78%	0.20	2%	0.23	0.25
Innovation	0.15	110%	0.47	7%	0.17	0.18
<b>Component Total <sup>(2)</sup></b>	<b>0.49</b>	<b>89%</b>	<b>0.51</b>	<b>3%</b>	<b>0.43</b>	<b>0.47</b>

<sup>(1)</sup> 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.  
<sup>(2)</sup> Although this evaluation did not include sampling, Cv and precision can be calculated from the actual number of responses from the home energy worksheets (HEWs) in the kits and the evaluation forms given to teachers.  
<sup>(3)</sup> Total may not match the sum of rows due to rounding.

In PY13, verified savings were lower than reported savings due primarily to differences in installation rates between what was used to calculate reported and verified savings.

The following factors contributed to the 84% overall energy realization rate and 89% demand realization rate for the SEEE component:<sup>63</sup>

- Cadmus found the lowest installation rates in the largest cohort, Take Action, which reduced the overall realization rate.
- Cadmus found a low installation rate for outlet gaskets for the Take Action and Innovation cohorts. Reported savings assumed an average installation rate of 6.2 gaskets per kit. On average, 2.5 gaskets were installed per kit in the Take Action cohort and 3.2 gaskets were installed per kit for the Innovation cohort.
- Cadmus used an electric cooling saturation of 57% from HEW responses, which was lower than the reported savings calculation, which used a cooling saturation of 83%. This difference in cooling equipment saturation reduced demand reduction realization rates for outlet gaskets and weatherstripping.
- For weatherstripping, peak demand savings were reported for only 10 feet of weatherstripping, but the kit included 17 feet of weatherstripping. Cadmus calculated verified savings at 17 feet, for an overall realization rate of 68% for energy savings and 66% for peak demand savings. Despite revising the length to 17 feet, the realization rate for weatherstripping was still less than 100% due to low installation rates in Take Action and Innovation cohorts and the correction of the electric cooling saturation rate (described in the previous bullet).
- For furnace whistles, Cadmus calculated installation rates of 19% for Take Action and 29% for Innovation, which resulted in realization rates higher than 100%. *Ex ante* savings used the default installation rate of 15% from the PA TRM. Cadmus also calculated higher verified savings for participants whose home has a heat pump. Both factors contributed to high energy realization rates for this measure of 144% for Take Action and 204% for Innovation.
- For hot water pipe insulation, Cadmus calculated installation rates of 30% for Take Action and 43% for Innovation, compared with an assumed installation rate of 62% for reported savings. This led to low realization rates of 42% for Take Action and 71% for Innovation.
- Results for showerheads and water heater setback differed between the Take Action and Innovation cohorts. For Take Action, *ex post* installation rates for both items were equal to or lower than *ex ante* installation rates, while for Innovation, *ex post* installation rates for both items were higher than *ex ante* installation rates. This resulted in energy realization rates of 85% for showerheads and 62% for water heater setback for Take Action and 125% for showerheads and 119% for water heater setback for Innovation.

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<sup>63</sup> The overall demand realization rates were higher than the overall energy realization rates due to differences in each measure's contribution to energy and demand savings. For example, nightlights do not contribute any demand savings; therefore, they had no impact on the demand realization rates.

### J.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 (NTG) ratio of 1.0.

### J.3 Process Evaluation

In PY13, Cadmus conducted a process evaluation of the SEEE component to assess student participant satisfaction, teacher satisfaction, inform the logic model review, 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 home energy worksheets (HEWs) produced a measure of component satisfaction with ±0.54% precision at 85% confidence.

**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 <sup>(1)</sup>
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	3	N/A <sup>(2)</sup>	Up to 3	3	N/A	100%
Students	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered paper and online HEWs	20,015	N/A <sup>(2)</sup>	All surveys returned	14,794 <sup>(3)</sup>	All eligible	100% <sup>(2)</sup>
Teachers	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered Teacher evaluation forms	723 <sup>(4)</sup>	N/A <sup>(2)</sup>	All surveys returned	135	All eligible	100%
<b>Component Total</b>			<b>20,741</b>	-	-	<b>14,932</b>	-	-

<sup>(1)</sup> Percent contacted means the percentage of the sample frame contacted to complete surveys/interviews.

<sup>(2)</sup> Because this component’s evaluation did not include sampling, Cv and target precision are not meaningful.

<sup>(3)</sup> 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.

<sup>(4)</sup> Quantity reflects the number of unique teachers.

### J.3.1 Participant Satisfaction

Students and teachers participate in the SEEE component by receiving kits, presentations, and curriculum. Overall, 80% of participants were satisfied with their experience with the SEEE component in PY13, as shown in Table J-6. Though teachers were more satisfied than students, student experience comprises the majority of the satisfaction score due to the overall number of students who are reached and the corresponding number of surveys returned.

**Table J-6 PY13 Satisfaction for the SEEE Component**

Stratum	Overall Satisfaction
<b>Overall Satisfaction</b>	<b>80%</b>
Students (n=14,794)	80% <sup>(1)</sup>
Teachers (n=135)	100% <sup>(2)</sup>
<sup>(1)</sup> As measured by a rating of <i>very</i> or <i>somewhat satisfied</i>	
<sup>(2)</sup> As measured by a rating of <i>excellent</i> or <i>good</i>	

The ICSP’s subcontractor, NEF, includes a satisfaction question on the HEW and on the evaluation form distributed to participating teachers. Overall satisfaction was measured via a five-point rating scale for students (*very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, not very satisfied, or not at all satisfied*) and a four-point rating scale for teachers (*excellent, good, fair, or poor*). Questions were worded slightly differently on the two forms. To calculate satisfaction, Cadmus used the top two rating tiers for each, consistent with other Residential Program components.

To improve the consistency of measuring participant satisfaction, the ICSP and NEF are in the process of aligning the wording of questions and the rating scales for PY14.

### Student Satisfaction

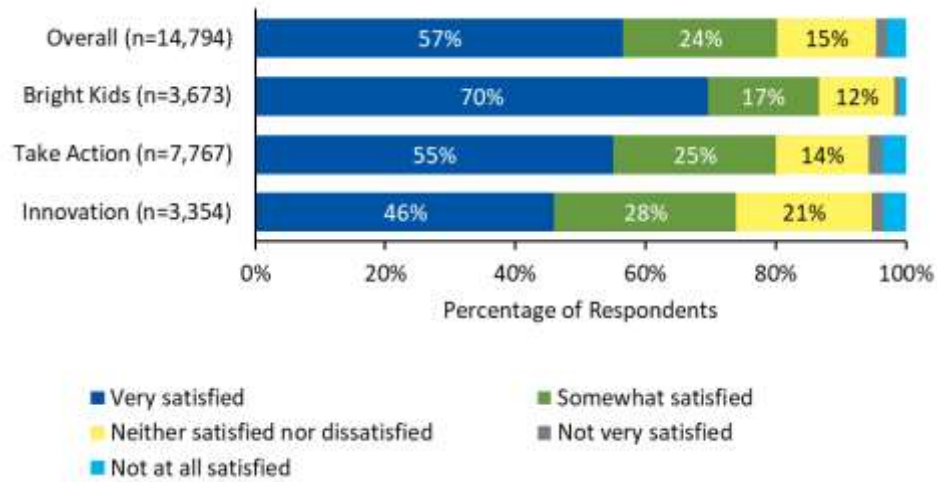
Student participants completed HEWs, either online or on paper forms that teachers could copy and distribute.

A majority of student participants (74%; n=14,794) completed HEWs and answered the satisfaction question. Figure J-1 summarizes the results by cohort. Of the students who responded to the question, 80% said they were *very satisfied* (57%) or *somewhat satisfied* (24%) with the component overall.<sup>64</sup>

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<sup>64</sup> Using a higher precision than presented in Figure J-1, the sum of *very satisfied* (56.55%) and *somewhat satisfied* (23.71%) adds to 80%.

**Figure J-1. PY13 Participating Student Satisfaction with Student Energy Efficient Education Component Overall by Cohort**



Home Energy Worksheet Q8 (*Bright Kids*), Q24 (*Take Action*), and Q23 (*Innovation*):

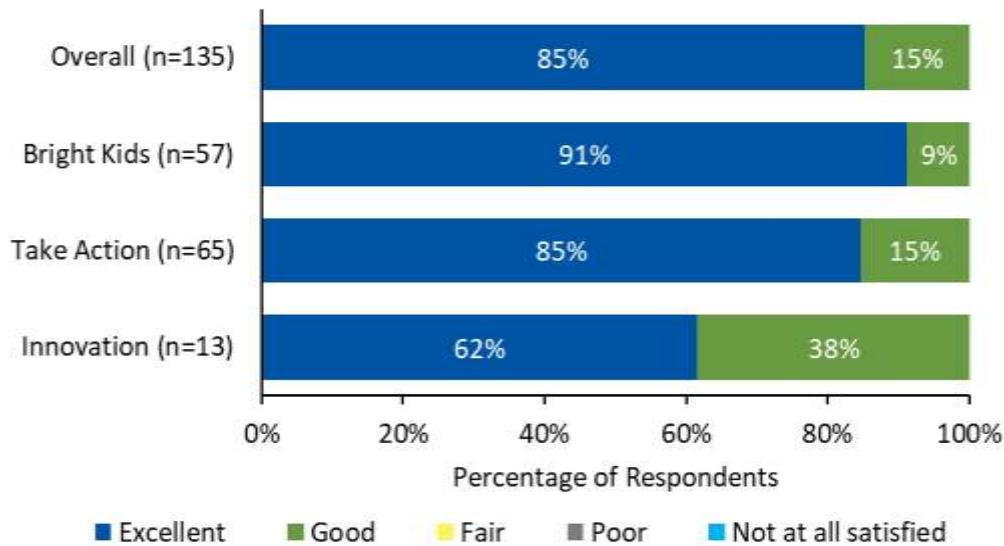
“Please rate your overall satisfaction with the Think! Energy program.” Total may not sum to 100% due to rounding. Sum of *very* and *somewhat satisfied* may not match percentage reported on infographic due to rounding.

### Teacher Satisfaction

After participating in the teacher’s classroom presentation, NEF asked teachers to rate delivery of the SEEE component. Of 723 participating teachers in PY13, 19% (135 teachers) completed evaluation forms and provided a rating.

Figure J-2 summarizes the results of teacher satisfaction. All teachers who responded to the survey rated the component as either *excellent* (85%) or *good* (15%). Teachers of the Bright Kids and Take Action cohorts rated their impression of the component as *excellent* (91% and 85%, respectively) more often than did teachers of the Innovation cohort (62%).

**Figure J-2. PY13 Participating Teacher Satisfaction with Student Energy Efficient Education Component Overall**



Teacher Evaluation Q5 (n=135): “Please share your impression of Think! Energy Program overall.”

### Teacher Feedback

Feedback was overwhelmingly positive for the component among teachers. Participating teachers wrote about how the component successfully engaged students in learning and in applying their new knowledge:

- “... The program was educational and appropriate for 2<sup>nd</sup> grade and the energy efficiency [kits] were a great take-home for parents.”
- “I would tell others that it's informative and worth having presented to your students.”
- “It is a wonderful, educational, and student friendly program. My students absolutely LOVE this program.”
- “I would recommend it. Students, even 8<sup>th</sup> graders, were engaged and participating. I made a big deal of the contents of the bag and some students expressed that they were going to use some of the materials.”
- “Thanks again for all you do to promote saving energy in these 5<sup>th</sup> graders. It definitely plants the seeds of knowledge that they might not necessarily get at home or during the school day!”

“The program [is] fun and motivates students to really start thinking about energy conservation, building background for science lessons on electricity and conservation. The kids love the goodies, which vary from year to year. They were so excited to take home the power strips this year...”

### Suggestions for Improvement

In their evaluation forms, participating teachers suggested improving the interactivity of the presentation, particularly with allowing kids a chance to participate or move and adding video or visuals

and said they missed receiving the LED light bulbs that had been distributed in prior years. They otherwise appreciated the current selection of kit items:

- “Fifth graders were getting a little restless by the end of the presentation. The information was GREAT. The kits were AMAZING. The program could be improved by adding some more movement to the presentation. :)” [Take Action]
  - “Presentation is good, but would be better if it were more interactive for this age group.” [Take Action]
  - “It's wonderful—why not consider a video or other technology piece to build background or check in 3 months or once the seasons change.” [Take Action]
  - “Our school is a special case, but more support for English learners would have gone a long way (i.e. materials in Spanish, subtitles). Having the surveys in multiple language, both online and on paper. Linking videos to YouTube give more translation and captioning options.” [Take Action]
  - “My students loved everything in the bag they received, we did miss the lightbulbs because they lasted so long.” [Take Action]
  - “This program keeps getting better, although we miss the LED light bulbs that came in kits in the past.” [Innovation]
- “The content was GREAT. It was a LONG time for students to stay seated and silent. I would recommend having them do several ‘turn and talk to a partner’ to process what they heard AND/OR having them get up and move around...” [Bright Kids]

### *J.3.2 Other Findings*

#### *Survey Participant Profile*

The PY13 HEWs collected demographic information about participants in the SEEE component. Respondents had the following characteristics:

- Lived in a single-family detached residence (80%; n=14,822)
- Had an average household size of 4.6 people (n=14,936)

*J.3.3 Logic Model*

Cadmus reviewed the logic model created in Phase III and made updates for Phase IV based on interviews with the program managers from PPL Electric Utilities and the ICSP and secondary research. The updated logic mode is shown in Table J-7.

**Table J-7. Student Energy Efficient Education Component Logic Model**

Barriers	Component Activities	Outputs Produced by Component Activities	Short-Term Outcomes	Intermediate Outcomes	Long-Term Outcomes
<ul style="list-style-type: none"> <li>• Lack of environmental and energy curriculum resources in schools</li> <li>• Low awareness about energy, energy efficiency, and water efficiency among school-aged children</li> <li>• Limited access to energy efficient household products</li> </ul>	<ul style="list-style-type: none"> <li>• Recruit participating schools/teachers/classrooms</li> <li>• Conduct energy efficiency education for primary, intermediate, and secondary students</li> <li>• Provide free kits containing energy efficient items</li> <li>• Provide HEWs to participating students and evaluation forms to teachers</li> </ul>	<ul style="list-style-type: none"> <li>• Teachers enrolled</li> <li>• Participants received:                             <ul style="list-style-type: none"> <li>▪ Kit items, customized according to grade level</li> <li>▪ Energy education</li> </ul> </li> <li>• HEWs and teacher evaluation forms collected</li> </ul>	<ul style="list-style-type: none"> <li>• Increased participant knowledge of energy efficiency and conservation</li> <li>• Participants install provided energy efficiency items and engage in energy-saving behaviors</li> <li>• Participating students and teachers are satisfied with the component</li> <li>• Energy savings accrue from participant households through installation of energy efficient items</li> </ul>	<ul style="list-style-type: none"> <li>• Energy and demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> <li>• Participants see lower energy bills</li> <li>• Participants engage in other energy efficiency behaviors and activities and participate in additional components</li> </ul>	<ul style="list-style-type: none"> <li>• Improved energy grid resilience</li> <li>• Increasing PPL Electric Utilities’ knowledge and experience operating this type of component</li> </ul>



Cadmus reviewed the logic model and determined that the Student Energy Efficient Education program component is operating as expected. Table J-8 shows the outcome of the logic model review.

**Table J-8. Student Energy Efficient Education Component Logic Model Review**

Topics	Logic Model Components/ Plan	Status	PY13 Outcomes
<b>Component Activities</b>	<ul style="list-style-type: none"> <li>Recruit participating schools/teachers/classrooms</li> <li>Conduct energy efficiency education for primary, intermediate, and secondary students</li> <li>Provide free kits containing energy efficient items</li> <li>Provide HEWs to participating students and evaluation forms to teachers</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>Conducted all activities as planned</li> <li>Added back in-person presentations</li> <li>Distributed kits with new product updates</li> </ul>
<b>Outputs Produced by Component Activities</b>	<ul style="list-style-type: none"> <li>Teachers enrolled</li> <li>Participants received:                             <ul style="list-style-type: none"> <li>Kit products, customized according to grade level</li> <li>Energy education</li> </ul> </li> <li>HEWs and teacher evaluation forms collected</li> </ul>	Achieved	<ul style="list-style-type: none"> <li>723 teachers participated</li> <li>83% of participating students completed HEWs and 19% of participating teachers completed evaluation forms</li> <li>Students received energy education</li> </ul>
<b>Short-Term Outcomes</b>	<ul style="list-style-type: none"> <li>Increased participant knowledge of energy efficiency and conservation</li> <li>Participants install provided energy efficiency products and engage in energy-saving behaviors</li> <li>Participating students and teachers are satisfied with the component</li> <li>Energy savings accrue from participant households through installation of efficient equipment</li> </ul>	Partially achieved	<ul style="list-style-type: none"> <li>Participating teachers said that the component improved their students' knowledge of energy efficiency</li> <li>Installation rates ranged from 19.4% to 86.6% across products and cohorts</li> <li>Achieved 80% satisfaction among participating students and 100% positive ratings among participating teachers (satisfaction goal: 85%)</li> <li>Contributed 15% to PY13 Residential Program verified energy savings and 12% to PY13 Residential Program verified demand reductions</li> </ul>
<b>Intermediate Outcomes</b>	<ul style="list-style-type: none"> <li>Energy and demand savings accrue and contribute to PPL Electric Utilities savings plan and regulatory requirements</li> <li>Participants see lower energy bills</li> <li>Participants engage in other energy-efficiency behaviors/activities and participate in additional components</li> </ul>	On track to meet in subsequent years	<ul style="list-style-type: none"> <li>In PY13 (year 1), SEEE component achieved 3% of planned Residential Program Phase IV energy savings and 1% of planned system-level Residential Program demand reductions <sup>(1)</sup></li> </ul>
<b>Long-Term Outcomes</b>	<ul style="list-style-type: none"> <li>Improved energy grid resilience</li> <li>Increasing PPL Electric Utilities' knowledge and experience operating this type of component</li> </ul>	Unable to assess	<ul style="list-style-type: none"> <li>Unable to assess at this time</li> </ul>

<sup>(1)</sup> PPL Electric Utilities Corporation. Revised May 24, 2021. *Energy Efficiency and Conservation Plan Act 129 Phase IV*. Docket No. M-2020-3020824.

## 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,<sup>65</sup> 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. Non-Residential scores are weighted by *ex post* gross kWh/yr savings.

#### Intention Score

Cadmus assessed intention by asking questions to determine how the participant’s decisions would have differed in the absence of the program. For example, the survey asked the following key questions to determine how the residential respondent’s decisions or the business organization’s project-related decisions would have differed in the absence of a program:

- “Which of the following would have happened if you had not received the rebate for \$[REBATE AMOUNT] from PPL Electric Utilities for the [MEASURE OR C\_MEASURE] project?”
- “By how much would you have reduced the size, scope, or efficiency?”
- “How likely is it that [you/your organization] would have paid the full cost to install the same quantity and efficiency of that equipment at the same time you conducted this project?”

Cadmus used the responses to determine a participant’s final intention score, which was multiplied by the participant’s respective *ex post* kWh/yr savings to calculate intention-based free rider savings.

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<sup>65</sup> 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,<sup>66</sup> Cadmus estimated spillover. To estimate spillover, surveys included questions to determine whether participants installed specific additional high-efficiency products and, if so, whether participation in the program was important to their decision. Additional high-efficiency product purchases counted toward spillover only if the customer did not receive a rebate and the program had been important to the decision to purchase and install the products. Typically, the data collected through the surveys do not provide enough information to reliably quantify spillover; therefore, spillover is reported qualitatively.

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.

## *K.2 Efficient Lighting Component NTG Methodology*

The section discusses the NTG methodology for the Efficient Lighting component of the Residential Program.

### *K.2.1 Efficient Lighting Component Free Ridership Methodology*

The free ridership analysis compared 2021 sales of LED lighting products to participant retailers’ estimated LED lighting product sales in absence of the Efficient Lighting program component. The evaluation team conducted interviews with participating retailers to obtain the estimates.

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<sup>66</sup> 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.

Natural occurring free ridership was estimated from lighting type-specific answers to the following questions:

E1. Let’s discuss how many specialty LEDs were sold at your retail locations in PPL Electric Utilities Efficient Lighting service territory from June 2021 through May 2022, when PPL Electric Utilities reintroduced incentives for specialty LEDs. According to our records, **[RETAILER NAME]** sold **[PROGRAM SALES]** **[LIGHTING TYPE]** LEDs that went through the PPL Electric Utilities Efficient Lighting program.

Thinking about stores in PPL Electric Utilities’ territory, did you sell any **[LIGHTING TYPE]** LEDs from June 2021 through May 2022 that didn’t go through PPL Electric Utilities’ Efficient Lighting program? **[If ‘YES’ ASK HOW MANY UNITS; RECORD FOR EACH LIGHTING TYPE; IF CAN’T GIVE AN EXACT ANSWER TRY TO GET A RANGE; RESPONSE VALUE=“2021 NON-PROGRAM SALES” VARIABLE FOR A GIVEN [LIGHTING TYPE]]**

E2. What is your best estimate of the proportion of **[LIGHTING TYPE]** LED sales would have occurred from June 2021 through December 2021 if the PPL Electric Utilities’ Efficient Lighting program had not existed? **[ENTER INTO TABLE BELOW]**

A retailer’s **total LED sales** for a lighting type = **[2021 PROGRAM SALES] + [2021 NON-PROGRAM SALES]**

Retailers were either unsure or could not provide quantitative estimates of LED sales from June 2021 through May 2022 that did not go through PPL Electric Utilities’ Efficient Lighting program, resulting in a **[2021 NON-PROGRAM SALES]** equal to zero for each retailer.

Cadmus multiplied the retailer reported proportion of sales that would have occurred without the program, by lighting type, by the retailer’s LED sales at the stores they represent to arrive at a weighted average proportion of sales that would have occurred without the Efficient Lighting component for each **retailer type**.<sup>67</sup> Cadmus determined **natural occurring free ridership units** associated with a retailer type by multiplying the weighted average proportion of sales that would have occurred without the Efficient Lighting component for a **retailer type** by the **total LED sales** associated with the retailer chains that were interviewed. Cadmus did not estimate lighting type specific free ridership component estimates due to small analysis sample sizes.

The following equation illustrates the **natural occurring free ridership units** calculation:

$$\begin{aligned}
 & \textit{Natural Occuring Free Ridership Units} \\
 & \quad = \textit{Weighted Average Retailer Type Proportion Sold Without Component} \\
 & \quad * \textit{Total LED Units Sold}
 \end{aligned}$$

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<sup>67</sup> One retailer did not provide estimates at the bulb type level, so Cadmus applied a single estimate of the proportion of bulbs that would have sold absent the program to all sales through that retailer.

The participant retailers were asked the following question to assess the influence the Efficient Lighting program component had on program-qualifying sales that retailers report would not have occurred if the program did not exist:

E3. Next, using a scale from 1 to 5, with 1 meaning “not influential at all” and 5 meaning “extremely influential,” please rate how influential participating in the PPL Electric Utilities’ Efficient Lighting program has been on your specialty LED sales in PPL Electric Utilities’ territory from June 2021 through May 2022 for the following lighting products.

Cadmus multiplied the retailer reported influence rating, by lighting type, by the retailer’s LED sales at the stores they represent to arrive at a weighted average influence rating for each **retailer type**, which determined a lift free ridership score for each **retailer type**, shown in Table K-1. Cadmus then multiplied the weighted average lift free ridership score for a **retailer type** by the component-qualifying sales that retailers reported would not have occurred if the Efficient Lighting component didn’t exist to estimate **lift free ridership units** for each **retailer type**.

**Table K-1. Lift Free Ridership Scoring**

Influence Rating	Lift Free Ridership Score
1 - Not at all influential	100%
2	75%
3	50%
4	25%
5 – Extremely influential	0%

The following equation illustrates the **lift free ridership units** calculation:

*Lift Free Ridership Units*

= *Weighted Average Lift Free Ridership Score*

\* *Retailer reported LED sales that would not have occurred if the program didn't exist*

The sum of the **natural occurring free ridership units** and **lift free ridership units** divided by a retailer type’s total LED sales equals the lighting type-specific free ridership ratio for a **retailer type**:

*Free Ridership Ratio (Retailer Type specific)*

$$= \frac{\text{Natural occurring Free Ridership units} + \text{Lift Free Ridership units}}{\text{Verified Component Units Sold}}$$

Overall program **retailer type**-specific free ridership ratios are the summation of the retailers’ natural occurring and lift free ridership units divided by summation of the retailers’ total component sales:

*Overall Program Free Ridership Ratio (Lighting Type specific)*

$$= \frac{\sum(\text{Natural occurring Free Ridership Units, Lift Free Ridership units})}{\sum \text{Verified Component Units Sold}}$$

Cadmus estimated an overall Efficient Lighting component free ridership estimate by weighting the **retailer type**-specific free ridership estimates by verified Efficient Lighting component bulbs sold in PY13 by the retailer chains interviewed.

Table K-2 summarizes the free ridership components and scores for each retailer type interviewed and the total Efficient Lighting component.

**Table K-2. PY13 Efficient Lighting Component Free Ridership Score by Retailer Type**

Stratum	Retailer Type	Respondents	Verified Program Units Sold (A)	Natural FR Units (B)	Lift FR Units (C)	Free Ridership Score ((B+C)/A)	Percent of Analysis Sample Verified Efficient Lighting Component Units Sold
Participating Retailers	Hardware & Other	7	43,003	18,543	6,115	57% <sup>(1)</sup>	23%
	Home Improvement	1	140,643	126,579	7,032	95%	77%
<b>Total</b>		<b>8</b>	<b>183,646</b>	<b>145,122</b>	<b>13,147</b>	<b>86% <sup>(1)</sup></b>	<b>100%</b>

<sup>(1)</sup> Weighted by verified Efficient Lighting component bulbs sold. This method ensures that respondents who sold a greater number of LEDs through the component have a greater influence on the free ridership estimates than do the respondents who sold fewer LEDs through the component.

### K.2.2 Participant Spillover Methodology

To assess participant spillover, the evaluation team asked participating retailers if they sold any additional unrebated program-qualifying specialty lighting from June 2021 through December 2021 because of Efficient Lighting program influence. Cadmus planned to estimate program spillover unit sales by subtracting the sum of the natural occurring free ridership units, lift free ridership units, and verified program units sold from the total LED units sales.

Interviewed retailers were either unsure or could not provide quantitative estimates of LED sales from June 2021 through May 2022 that did not go through PPL Electric Utilities’ Efficient Lighting component. The data collected through the surveys did not provide enough information to reliably quantify spillover, and the participants spillover estimate is 0%.

### K.2.3 Lift-based Net-to-Gross

Cadmus calculated overall Efficient Lighting component lift-based NTG ratio by combining the free ridership and participant spillover estimates using the following formula:

$$\text{Lift – based NTG Ratio} = 1 - \text{Free Ridership} + \text{Participant Spillover}$$

Table K-3 shows the NTG ratio results for the participating retailer strata of the Efficient Lighting component.

**Table K-3. PY13 Efficient Lighting Component Lift-Based NTG Ratio Summary**

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Participating Retailers	8	86%	0%	14%	15% <sup>(1)</sup>

<sup>(1)</sup> At 85% confidence interval.

## 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 PY13.

### *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 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.<sup>68</sup>

### 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.<sup>69</sup>

### 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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<sup>68</sup> 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.

<sup>69</sup> SWE. *Guidance on the Inclusion of Fossil Fuel and H<sub>2</sub>O Benefits in the TRC Test*. March 25, 2018.