
SWE Final Annual Report: Act 129 Program Year 13

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SUBMITTED TO:
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SUBMITTED BY:
NMR Group, Inc.
Demand Side Analytics
Brightline Group
Optimal Energy



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The Phase IV SWE also thanks the staff of the Pennsylvania Public Utility Commission's (PUC's) Bureau of Technical Utility Services (TUS) for their assistance and support in all aspects of the SWE's work during Phase IV, including updating the SWE Evaluation Framework for Phase IV of Act 129 and continuing the refinement of developing efficient processes for the review and approval of Interim Measure Protocols (IMPs) for the Pennsylvania Technical Reference Manual (TRM).

This SWE Phase IV Program Year 13 Final Report presents the findings, conclusions, and recommendations of the Phase IV SWE only and, as such, is not necessarily agreed to by the EDCs or the Commission. The Commission, while not adopting the findings, conclusions, and recommendations contained in this annual report, may consider and adopt some or all of them in appropriate proceedings, such as future updates to the Pennsylvania TRM, Total Resource Cost Test Order, and individual EDC energy efficiency and conservation plan revision proceedings.

Acronyms

ACC	Avoided Costs Calculator
AECs	Alternative Energy Credits
AEPS	Alternative Energy Portfolio Standards
ARCA	Appliance Recycling Centers of America, Inc.
ATE	Average Treatment Effect
ATI	Appliance Turn-In
BRA	Base Residual Auction
C&I	Commercial and Industrial
CAC	Central Air Conditioner
CHP	Combined Heat and Power
CI EMNC	Commercial and Industrial Energy Management and New Construction
CI MF	Master-Metered Multifamily Direct Install
CSP	Conservation Service Provider or Curtailment Service Provider
CV	Coefficient of Variation
DDR	Dispatchable Demand Response
DEER	Database for Energy Efficiency Resources
DLC	Design Lights Consortium
DRIFE	Demand Reduction Induced Pricing Effects
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE&C	Energy Efficiency and Conservation
EEPDR	Energy Efficiency and Peak Demand Reduction
EM&V	Evaluation, Measurement, and Verification
EUL	Effective Useful Life
FCM	Forward Capacity Market
FE	FirstEnergy
FYSATE	First-Year Savings Average Treatment Effect
GNI	Government, Non-Profit, Institutional
GSLs	General Service Lamps
HER	Home Energy Report
HEWs	Home Energy Worksheets
HIM	High Impact Measure
HOU	Hours of Use
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IDI	In-Depth Interview
IMPs	Interim Measure Protocols
IPMVP	International Performance Measurement and Verification Protocol
ISR	In-Service Rate
kW	Kilowatt
kWh	Kilowatt-Hour
LDV	Lagged Dependent Variable
LED	Light-Emitting Diode

LI	Low-Income
LIEEP	Residential LI Energy Efficiency Program
LLF	Line Loss Factor
LMPs	Locational Marginal Prices
LS	Lagged Seasonal
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-Hour
NEF	National Energy Foundation
NPV	Net Present Value
NTG	Net-to-Gross
NTGR	Net-to-Gross Ratio
P4TD	Phase IV to Date
PA PUC	Pennsylvania Public Utility Commission
PSA	Phase IV to Date Preliminary Savings Achieved; equal to VTD + PYRTD
PSA+CO	PSA savings, plus Carryover from Phase III
PY	Program Year: e.g., PY13, from June 1, 2021, to May 31, 2022
PYRTD	Program Year Reported to Date
PYVTD	Program Year Verified to Date
RARP	Residential Appliance Recycling Program
RCT	Randomized Control Trial
RDIP	Residential Downstream Incentives Program
REA	Remote Energy Assessment
RMIP	Residential Midstream Incentive Program
ROB	Replace on Burnout
RTD	Phase IV to Date Reported Gross Savings
RUIP	Residential Upstream Incentive Program
SBDI	Small Business Direct Install
SEEE	Student Energy Efficient Education
SO	Spillover
SSL	Solid State Lighting
SWE	Statewide Evaluator
TRC	Total Resource Cost
TRM	Technical Reference Manual
TUS	Technical Utility Services
VCx	Virtual Commissioning
VTD	Phase IV to Date Verified Gross Savings
WACC	Weighted Average Cost of Capital

Types of Savings

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

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

Reported Gross: Also referred to as *ex ante* (Latin for “beforehand”) savings. The energy and peak demand savings values calculated by the electric distribution company (EDC) or its program implementation conservation service provider (ICSPs) and stored in the program tracking system.

Unverified Reported Gross: The Phase IV Evaluation Framework allows EDCs and the evaluation contractors the flexibility to not evaluate each program every year. If an EE&C program is being evaluated over a multi-year cycle, the reported savings for a program year where evaluated results are not available are characterized as unverified reported gross until the impact evaluation is completed and verified savings can be calculated and reported.

Verified Gross: Also referred to as *ex post* (Latin for “from something done afterward”) gross savings. The energy and peak demand savings estimates reported by the independent evaluation contractor after the gross impact evaluation and associated measurement and verification (M&V) efforts have been completed.

Verified Net: Also referred to as *ex post* net savings. The energy and peak demand savings estimates reported by the independent evaluation contractor after application of the results of the net impact evaluation; typically calculated by multiplying the verified gross savings by a net-to-gross (NTG) ratio.

Annual Savings: Energy and demand savings expressed on an annual basis, or the amount of energy and/or peak demand an EE&C measure or program can be expected to save over the course of a typical year. Annualized savings are noted as MWh/year or MW/year. The Pennsylvania Technical Reference Manual (TRM) provides algorithms and assumptions to calculate annual savings; Act 129 compliance targets for consumption reduction are based on the sum of the annual savings estimates of installed measures or behavior change.

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

Program Year Reported to Date (PYRTD): The reported gross energy and peak demand savings achieved by an EE&C program or portfolio within the current program year. PYRTD values for energy efficiency will always be reported gross savings in a Semi-Annual Report.

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

Phase IV to Date (P4TD): The energy and peak demand savings achieved by an EE&C program or portfolio within Phase IV of Act 129. Reported in several permutations described below:

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

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

Phase IV to Date Preliminary Savings Achieved (PSA): The sum of the verified gross savings (VTD) from previous program years in Phase IV where the impact evaluation is complete plus the reported gross savings from the current program year (PYTD). For PY13, the PSA savings will always equal the PYTD savings because PY13 is the first program year of the phase (no savings will be verified until the PY13 final annual report).

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 II 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.

Executive Summary

Program Year 13 (PY13), June 1, 2021, to May 31, 2022, is the first year of Phase IV of Pennsylvania's Act 129 Energy Efficiency and Conservation (EE&C) program. Phase IV goals were established on an incremental annual basis, meaning that progress toward goals is assessed by summing the annual energy savings of new measure installations in a program year. Over the five-year phase, the seven Electric Distribution Companies (EDCs) subject to Act 129 have a total incremental annual energy savings goal of 4.5 million MWh/year and 809 MW/year of peak demand reductions. Act 129 programs are expected to achieve nearly a 3.1% cumulative reduction in annual electricity use statewide during the five-year phase.

In their PY13 annual reports to the Public Utility Commission (PUC), the seven EDCs claimed a total of 603,806 MWh/year of verified gross energy savings for PY13 (approximately 13% of the statewide Phase IV target) and 99.32 MW of peak demand reductions (approximately 12% of the statewide Phase IV target). The Statewide Evaluator (SWE) performed a detailed review of the research methods, assumptions, and calculations utilized by EDC evaluation contractors to determine verified gross savings for PY13. The SWE audit validated most of the savings calculations. Errors were discovered in some of the verified savings calculations that led to both increases and decreases in the MWh and MW totals, and a net decrease statewide in savings resulting in a revised PY13 gross verified statewide total of 601,700 MWh/year (approximately 13% of the statewide Phase IV target) and 99.03 MW/year of peak demand reductions (approximately 12% of the statewide Phase IV target).

PROGRESS TOWARD PHASE IV ENERGY EFFICIENCY COMPLIANCE TARGETS

Progress toward the individual EDC Phase IV compliance targets to date in verified gross energy savings ranged from 8% (Penelec) to 18% (PECO) (see [Figure 1](#) and [Table 1](#)). Including carryover savings from Phase III, total progress toward Phase IV targets ranged from 22% (Duquesne Light) to 64% (Penn Power). Additional summary tables of progress toward Phase IV targets can be found in [Section 2](#) and [Appendix A.1](#) and the EDC's program-level impacts can be found in [Section 3](#).

Figure 1: P4TD Verified Savings Progress Toward Phase IV Energy Efficiency Compliance Targets, by EDC and Statewide

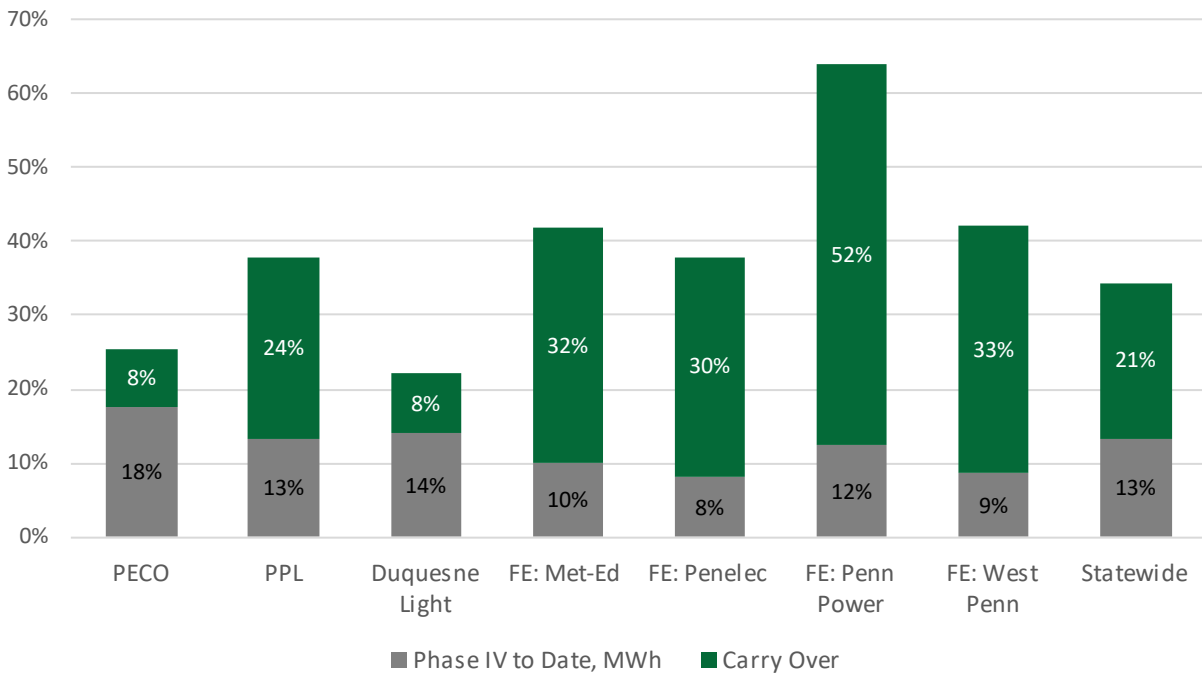


Table 1: Performance Toward Phase IV Energy Efficiency Compliance Targets¹

EDC	PY13 Verified (MWh/yr)	Phase III CO	VTD + CO (MWh/yr)	% of Goal	Phase IV Compliance Target (MWh/yr)
PECO	243,190	106,218	349,408	25%	1,380,837
PPL	167,361	306,275	473,636	38%	1,250,157
Duquesne Light	49,101	28,137	77,238	22%	348,126
FE: Met-Ed	46,455	147,303	193,758	42%	463,215
FE: Penelec	36,021	130,025	166,046	38%	437,676
FE: Penn Power	15,934	66,577	82,511	64%	128,909
FE: West Penn	43,638	168,480	212,118	42%	504,951
Total	601,700	953,015	1,554,715	34%	4,513,871

¹Totals may not equal sum of column or row due to rounding.

Progress Toward Phase IV Low-Income Targets

Each EDC must obtain energy consumption reductions from programs solely directed at low-income (LI) customers or LI-verified participants in multifamily housing programs (see [Table 2](#)). [Figure 2](#) reports EDC P4TD progress toward their targets. Progress toward the LI target ranged from 12% (PPL) to 25% (Penelec and Penn Power) in P4TD verified gross savings and 23% (PECO) to 71% (Penn Power) when Phase III carryover savings are included (EDC totals may not equal the sum of the components of the bar due to rounding).

Figure 2: P4TD Progress Toward Phase IV LI Targets

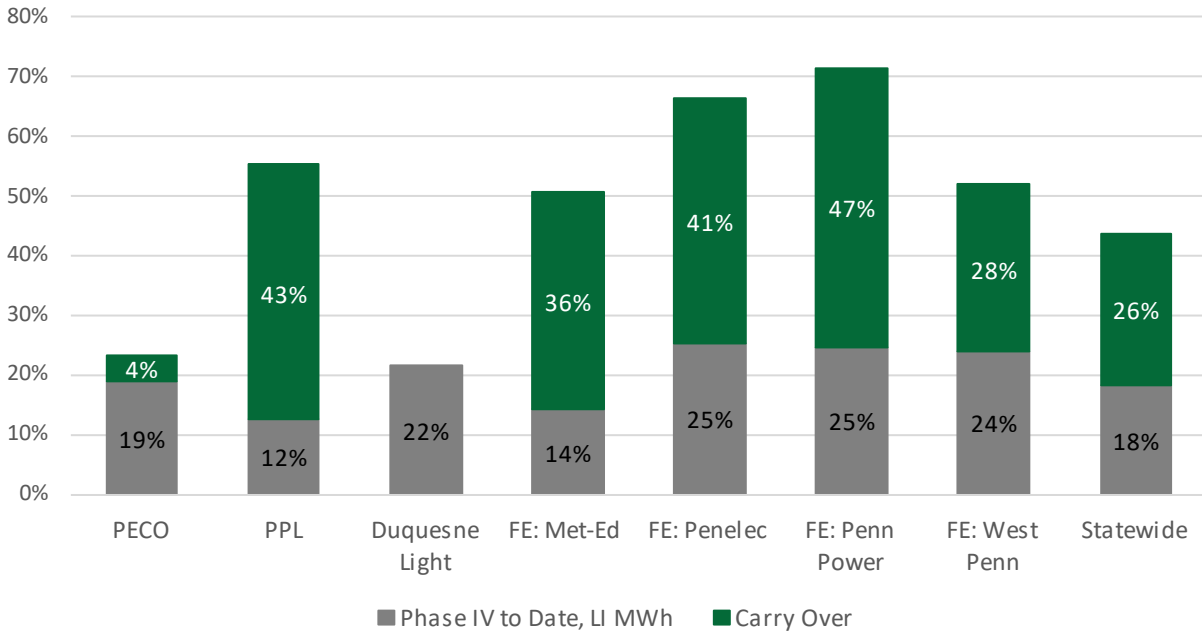


Table 2: Performance Toward Phase IV LI Targets¹

EDC	PY13 LI Verified (MWh.yr)	Phase III CO	VTD + CO (MWh/yr)	% of Goal	Phase IV Compliance Target (MWh/yr)
PECO	15,146	3,452	18,598	23%	80,089
PPL	9,027	31,089	40,116	55%	72,509
Duquesne Light	4,011	-	4,011	22%	18,566
FE: Met-Ed	3,822	9,782	13,604	51%	26,866
FE: Penelec	6,387	10,466	16,853	66%	25,385
FE: Penn Power	1,836	3,504	5,340	71%	7,477
FE: West Penn Power	6,974	8,270	15,243	52%	29,287
Total	47,203	66,563	113,766	44%	260,179

¹ Totals may not equal sum of column or row due to rounding.

Low-Income Measure Proportionality Analysis

The Phase IV Implementation Order also directed EDCs to offer conservation measures to the LI customer segment based on the proportion of electric sales attributable to LI households.¹ This “Low-Income Measure Proportionality” requirement directs each EDC to include in their programs a number of energy efficiency measures for households at or below 150% of the federal poverty

¹ 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. <https://www.puc.pa.gov/pcdocs/1666981.docx>

income guidelines that is proportionate to each EDC’s total LI consumption relative to the total energy usage in the service territory. An LI measure is defined as a measure that is targeted to LI customers and is available at no cost to LI customers. The SWE found that each EDC complied with the LI proportionality requirement in PY13. [Table 3](#) reports the required minimum proportions and results of the SWE’s verification analysis. The SWE’s verification analysis can be found in [Appendix A.2](#).

Table 3: LI Measure Proportionality Targets and SWE Verification Results, PY13

EDC	Proportionate Number of Measures, Target	PY13 Proportionate Number of Measures, Reported	PY13 Proportionate Number of Measures, SWE Verified
PECO	8.80%	69.6%	30.2%
PPL	9.95%	17.0%	15.5%
Duquesne Light	8.40%	14.4%	40.6%
FE: Met-Ed	8.79%	26.0%	17.5%
FE: Penelec	10.23%	26.0%	17.5%
FE: Penn Power	10.64%	26.0%	17.5%
FE: West Penn Power	8.79%	26.0%	17.5%

Phase IV Performance, Multifamily Housing

[Table 4](#) reports the PY13 verified energy savings from multifamily households and low-income multifamily households. Multifamily housing accounts for a range of savings for the residential and low-income customer segments from 2% (Penn Power) to 8% (PECO), while low-income multifamily housing accounts for a range of savings for the low-income segment from 7% (Penn Power) to 24% (PECO).

Table 4: Summary of PY13 Verified Energy Savings for Multifamily Housing by EDC

EDC	PY13 VTD (MWh/yr)	% of PY13 Residential and LI Segments	PY13 VTD, LI Households (MWh/yr)	% of PY13 LI Segment
PECO	6,147	8%	3,041	24%
PPL	2,870	7%	2,049	23%
Duquesne Light	636	5%	636	19%
FE: Met-Ed	554	2%	167	4%
FE: Penelec	691	3%	667	11%
FE: Penn Power	124	2%	124	7%
FE: West Penn Power	1,352	5%	1,351	23%
Statewide	12,373	6%	8,035	18%

PROGRESS TOWARD PHASE IV PEAK DEMAND COMPLIANCE TARGETS

Act 129 defines peak demand savings from energy efficiency as the average expected reduction in electric demand from 2:00 PM to 6:00 PM Eastern Daylight Time (EDT) on non-holiday

weekdays from June to August. The peak demand impacts from energy efficiency in this report are presented at the system level, reflecting adjustments for transmission and distribution losses. Progress toward the individual EDC Phase IV compliance targets to date in verified peak demand savings ranged from 7% (West Penn Power) to 16% (PECO) (Figure 3 and Table 5). Phase III of Act 129 did not have a peak demand reduction target from energy efficiency, so EDCs do not have carryover savings toward this target.

Figure 3: Phase IV EDC Performance Toward Peak Demand Compliance Target

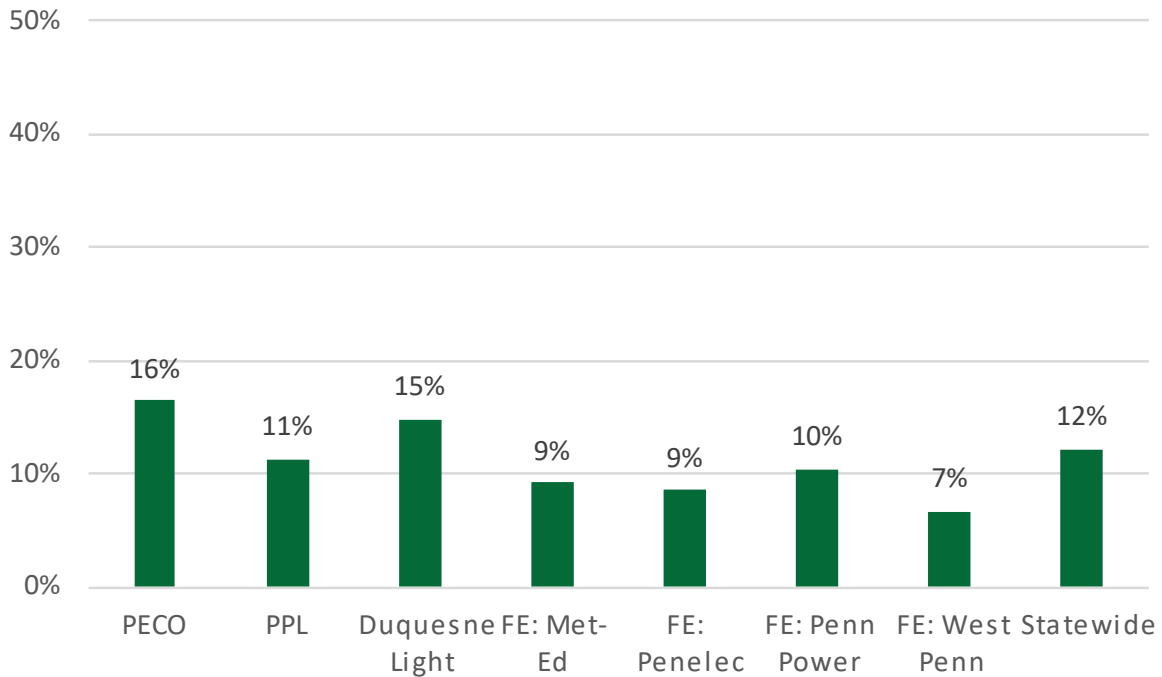


Table 5: Performance Toward Phase IV Peak Demand Compliance Target¹

EDC	VTD (MW/yr)	% of Goal	Phase IV Compliance Target (MW/yr)
PECO	42.11	16%	256
PPL	25.68	11%	229
Duquesne Light	9.45	15%	62
FE: Met-Ed	7.11	9%	76
FE: Penelec	6.94	9%	80
FE: Penn Power	2.10	11%	20
FE: West Penn Power	5.86	7%	86
Total	99.25	12%	809

¹Totals may not equal sum of column or row due to rounding.

Planned FCM Nominations by Program Year and PJM Delivery Year

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 (FCM).² If the resources clear, proceeds flow back to the rate class that generated the Act 129 savings to offset cost recovery via riders. Table 6 summarizes each EDC's PY13 verified gross demand savings and their plans for wholesale recognition of Phase IV peak demand savings by Act 129 program year and PJM delivery year. Duquesne Light intends to nominate EE Resource demand reductions beginning with PJM's Base Residual Auction for delivery year 2025/2026, which is expected to occur in June 2023.

Table 6: Planned FCM Nominations by EDC and PJM Delivery Year for PY13

EDC	PY13 Verified Gross Demand Savings (MW/yr)	Estimated PY13 MW Acquisition for FCM in Delivery Years 2023-2026
PECO	42.11	[10 to 28]
PPL	25.68	1.4
Duquesne Light	9.45	0
FE: Met-Ed	7.11	[2.4 to 4.2]
FE: Penelec	6.94	[2.8 to 4.2]
FE: Penn Power	2.10	[0.8 to 1.2]
FE: West Penn Power	5.86	[2.3 to 4.1]
Statewide	99.25	[19.7 to 43.1]

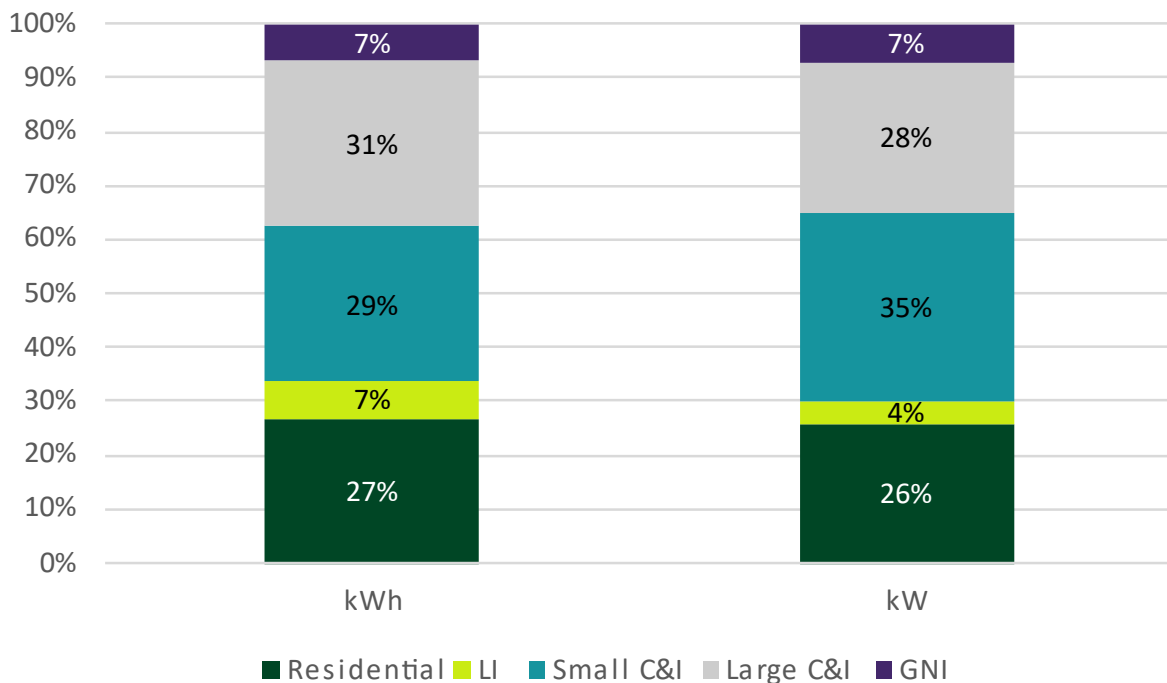
If we assume the midpoint of each EDC's reported range for PY13 nominations, approximately 32% of the peak demand savings acquired by the EDCs in PY13 will be nominated to PJM's FCM.

² <https://www.pjm.com/>

PHASE IV PERFORMANCE BY CUSTOMER SEGMENT

Figure 4 presents the PY13 verified gross savings by customer segment. The residential, small commercial and industrial (C&I), and large C&I segments were defined by EDC tariff, and the LI and government, non-profit, institutional (GNI) segments were defined by statute (66 Pa. C.S. § 2806.1).³ Non-residential customers (small C&I, large C&I, and GNI) accounted for 66% of verified gross kWh savings and 70% of verified gross kW savings in PY13 (the non-residential totals may not equal the sum of the components of the bar due to rounding).

Figure 4: PY13 Verified Gross Savings by Customer Segment, Statewide



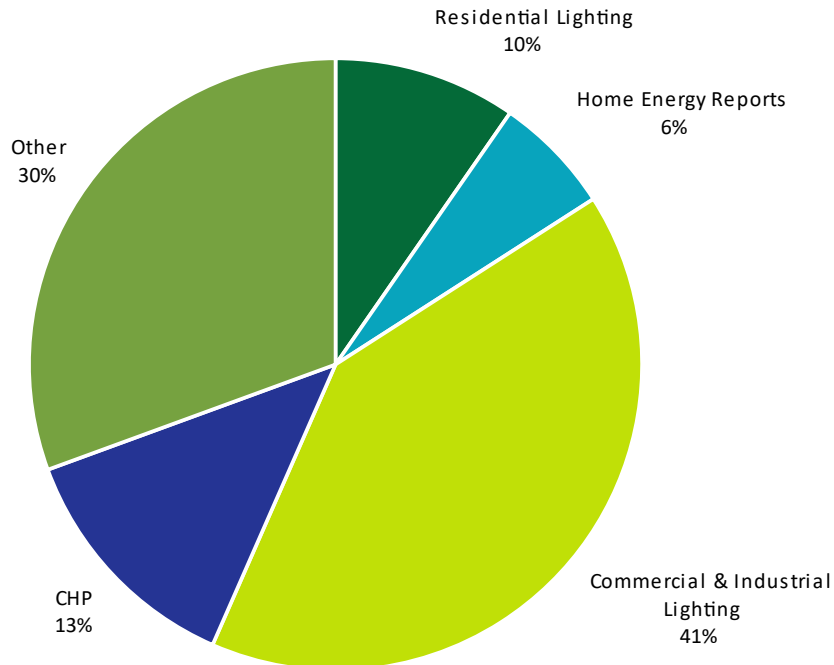
TOP SAVINGS PROGRAM OFFERINGS

The Pennsylvania EDCs support a wide range of energy efficient equipment and technologies in their Phase IV EE&C plans. Figure 5 shows the contribution to PY13 verified gross portfolio MWh savings from lighting, HERs, combined heat and power (CHP), and all other offerings combined. In PY13, lighting, HERs, and CHP accounted for 69% of verified gross energy savings whereas

³ The LI segment is almost entirely a subset of the residential customer class but can include a limited number of LI-qualified residents in master-metered buildings in the small C&I and large C&I sectors. The GNI segment is almost entirely composed of customers who are part of the small C&I or large C&I rate classes but can include a limited number of residential customers.

in Phase III of Act 129 these same measures accounted for nearly 80% of all verified gross energy savings.⁴

Figure 5: Top Savings Program Types in PY13



Forty-one percent of PY13 verified gross energy savings came from non-residential lighting. While changing baselines significantly reduced the savings opportunity from residential lighting, the non-residential sector has been far less affected by code changes. Behavioral HERs also accounted for a reduced share of energy savings compared to prior years. This shift is due, in part, to a change in the TRM measure characterization which disaggregates savings into persistent effects from prior years and incremental first year (compliance) savings. PPL also did not offer a HER program in PY13.

[Appendix J](#) explores each of these core programs in detail. Based on a statewide review, the SWE compares the different ways EDCs delivered these programs in PY13. We also examine the rapidly changing lighting market that EDC programs are working to transform and the implications these market changes have on program delivery.

COST-EFFECTIVENESS SUMMARY

Pennsylvania has adopted the Total Resource Cost (TRC) test as its specified approach to benefit-cost assessment. The TRC test examines cost-effectiveness from the perspective of the

⁴ The total for lighting, HERs, and CHP does not equal the sum of the components of the pie chart due to rounding.

utility, participants, and non-participants. Over time, the Commission customized the Pennsylvania TRC test to reflect the policy priorities of the Commonwealth. In preparation for Phase IV, the PUC issued the 2021 TRC Test Order⁵ to document the methodology and assumptions EDCs should use when calculating the costs and benefits of Phase IV EE&C portfolios.

Table 7 shows the Net Present Value (NPV) costs and benefits for each EDC portfolio in PY13, as well as the TRC ratio (benefits divided by costs). TRC results are presented on both a gross and net savings basis. Per the 2021 TRC Test Order, incremental participant costs and benefits from free riders are excluded from the calculation of the net TRC ratio. The NPV of future energy savings is calculated using a 3% real discount rate (5% nominal discount rate) for all EDCs.⁶ This is a departure from prior phases of Act 129 when each EDC's weighted average cost of capital (WACC) was used to compute the present value of future benefits and costs. On a gross basis, PY13 programs saved the Commonwealth an estimated \$85.9 million (benefits minus costs). On a net basis, statewide savings from PY13 programs are estimated at \$46.9 million.

Table 7: PY13 TRC Test Results by EDC¹

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO	\$143,564	\$146,150	0.98	\$104,246	\$108,329	0.96
PPL	\$122,486	\$66,167	1.85	\$79,029	\$48,139	1.64
Duquesne Light	\$27,484	\$14,901	1.84	\$20,942	\$13,350	1.57
FE: Met-Ed	\$28,227	\$20,914	1.35	\$18,593	\$15,193	1.22
FE: Penelec	\$21,759	\$14,893	1.46	\$17,901	\$12,736	1.41
FE: Penn Power	\$12,906	\$11,981	1.08	\$8,711	\$8,423	1.03
FE: West Penn Power	\$23,227	\$18,739	1.24	\$18,823	\$15,164	1.24
Statewide	\$379,653	\$293,745	1.29	\$268,245	\$221,334	1.21

¹ Totals may not equal sum of column or row due to rounding.

COMPARISON OF SAVINGS AND EXPENDITURES TO PLAN

In preparation for Phase IV, each EDC filed an EE&C plan with detailed projections of program spending, savings, incentive levels, and other key metrics. In the SWE-prepared EDC annual report template, the SWE requested EDCs to compare their actual P4TD expenditures and verified gross energy savings to the EE&C plan projections. Figure 6 compares actual PY13 spending and verified savings to their EE&C plan projections for PY13. Both PPL and Duquesne Light have unverified savings from PY13, which lowers the MWh and MW ratio. Statewide, actual

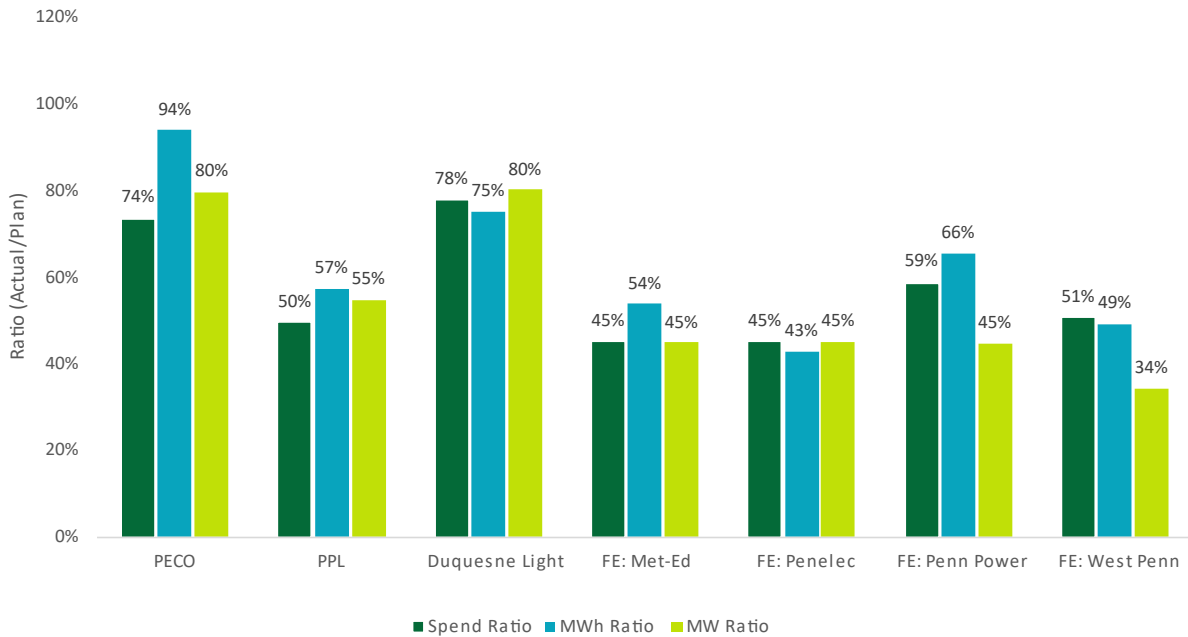
⁵ Pennsylvania Public Utility Commission, *2021 TRC Test Final Order*. From the Public Meeting of December 19, 2019, at Docket No. M-2019-3006868 (*2021 TRC Test Order*). Entered December 19, 2019.

<https://www.puc.pa.gov/pcdocs/1648126.docx>

⁶ 2021 TRC Test Order. Pages 17-21.

PY13 expenditures were 59% of EE&C Plan projections for PY13. The EDCs achieved 67% of the projected energy savings and 60% of the projected peak demand savings for PY13. The EDCs will need to accelerate both their spending and resource acquisition in the remaining years of Phase IV to reach the planned savings totals for the phase.

Figure 6: PY13 Spending and Savings Compared to EE&C Plan



Because of the emphasis on Act 129 goal achievement and the fact that EDC budgets are fixed, acquisition cost is an important metric for EDCs subject to Act 129. Acquisition cost is a performance metric of dollars per first-year kWh (energy) or first-year kW (capacity). [Figure 7](#) compares the projected phase-to-date energy acquisition cost from the Phase IV EE&C plan to actual phase-to-date verified energy acquisition costs. [Figure 8](#) presents the same information for peak demand, or capacity. Statewide, the EDCs are delivering energy savings at a slightly lower cost per kWh than planned and capacity savings at a slightly higher cost per kW than planned. Unverified savings from plan components at PPL and Duquesne Light raise acquisition costs because the costs are incurred but the verified savings are not.

Figure 7: Planned vs. Actual P4TD Energy Acquisition Cost

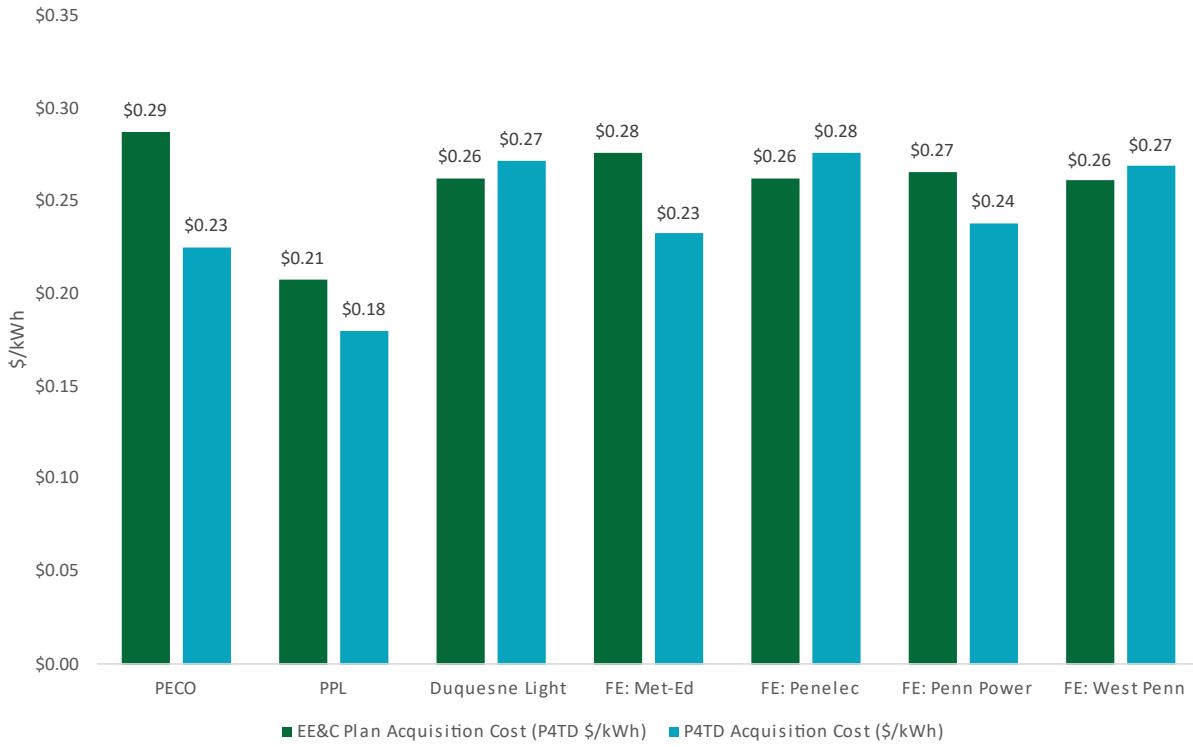
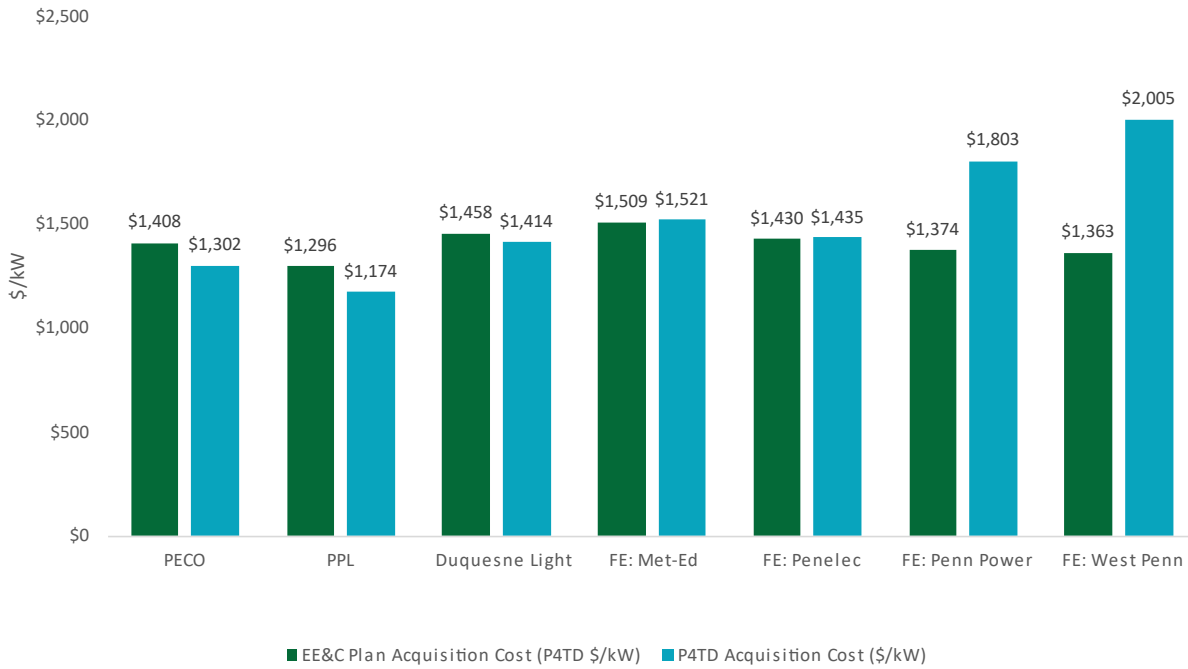


Figure 8: Planned vs. Actual P4TD Capacity Acquisition Cost



Section 2.3 presents the data underlying these figures in table format.

REDUCTION IN EMISSIONS

Electric power generation is a major source of carbon emissions, so the energy conservation programs implemented by the Pennsylvania EDCs have a direct impact on the amount of carbon dioxide produced. Although the Pennsylvania TRC test does not place a monetary value on emission reductions, it is an important benefit to some stakeholders because of links between CO₂ emissions and climate change. Table 8 was compiled using the gross verified first year and lifetime MWh savings in PY13, EDC-specific line loss factors (LLFs), and an average of the 2021 marginal on-peak and off-peak CO₂ emissions rate in PJM’s spring 2022 Emissions Report.⁷

Table 8: PY13 Carbon Dioxide Emission Impacts

Performance Metric	Value
PY13 Verified Gross MWh/yr	601,700
PY13 Verified Gross Lifetime MWh	7,192,040
Weighted Average Measure Life (years)	11.95
Average CO ₂ Emissions Rate (lbs/MWh)	1,063
First-Year Avoided Tons of CO ₂	343,936
Lifetime Avoided Tons of CO ₂	4,109,070

The lifetime emission impacts in Table 8 are calculated using the 2021 CO₂ emission rates and do not include the emissions associated with secondary fossil fuel impacts caused by EE&C measures. If the generation fuel mix in the region becomes cleaner over the life of the measures installed in PY13, the emissions rate would decrease, and the lifetime CO₂ impacts would be lower. If the Act 129 TRC test valued CO₂ emissions at the Biden administration’s interim social cost of carbon – \$46 per short ton – the statewide PY13 gross TRC ratio would increase from the 1.29 value shown in Table 7 to approximately 1.80.

SUMMARY OF SWE FINDINGS

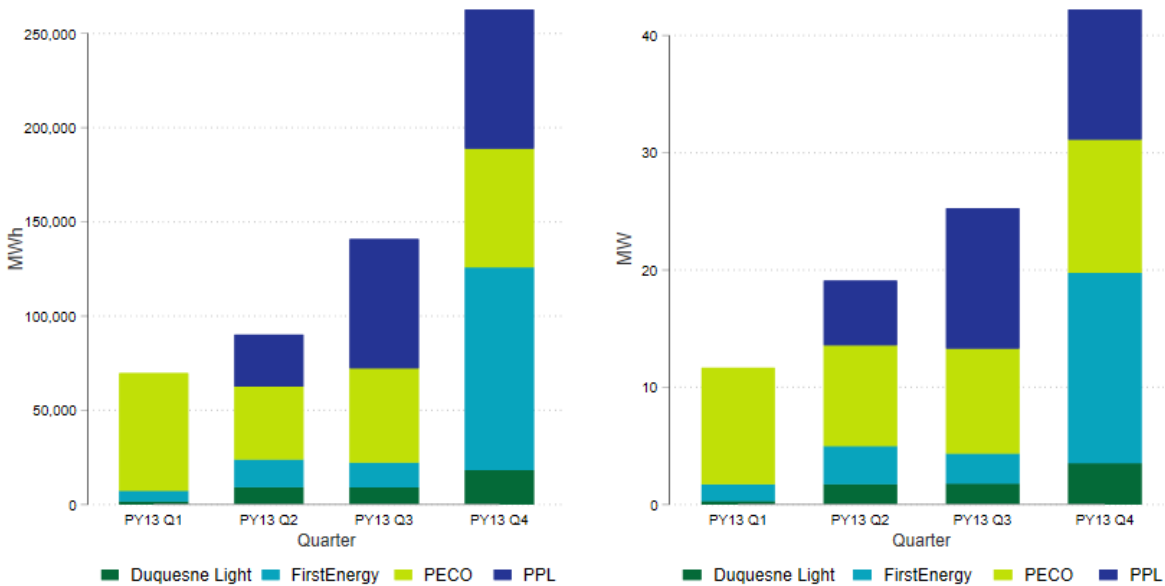
- **Finding:** In general, the EDCs PY13 programs were slow to ramp-up and launch in comparison to their EE&C plans. Verified MWh savings ranged from 43% of planned savings (Penelec) to 94% of planned savings (PECO) while verified MW savings ranged from 34% of planned savings (West Penn Power) to 80% of planned savings (PECO). Statewide, the EDCs reached 67% of planned MWh savings and 60% of planned MW savings. Because of carryover from Phase III, all of the EDCs are on track to reach their Phase IV consumption reduction targets, but they are behind on their peak demand savings, ranging from 7% to 16% of their Phase IV targets.

Factors identified by the EDCs as affecting the lower than planned savings included new program offerings and new Conservation Service Providers (CSPs), inflation, supply chain

⁷ <https://pjm.com/-/media/library/reports-notice/special-reports/2021/2021-emissions-report.ashx>

issues and disruptions, material costs, labor shortages, and lingering COVID-19 hesitation to in-home projects. In addition, PPL and Duquesne Light reported unverified savings in PY13 which should boost verified savings in their PY14 annual reports. Figure 9 shows the breakdown of reported gross energy and peak demand savings by quarter. Savings attributable to HER programs are not included. Approximately 50,000 MWh of Q1 savings came from a single CHP project at PECO. The EDCs' PY13 programs were slow to start but were getting up to speed toward the end of the program year. The PY13 ramp-up pattern mirrors the trajectory observed in PY8 at the start of Phase III.

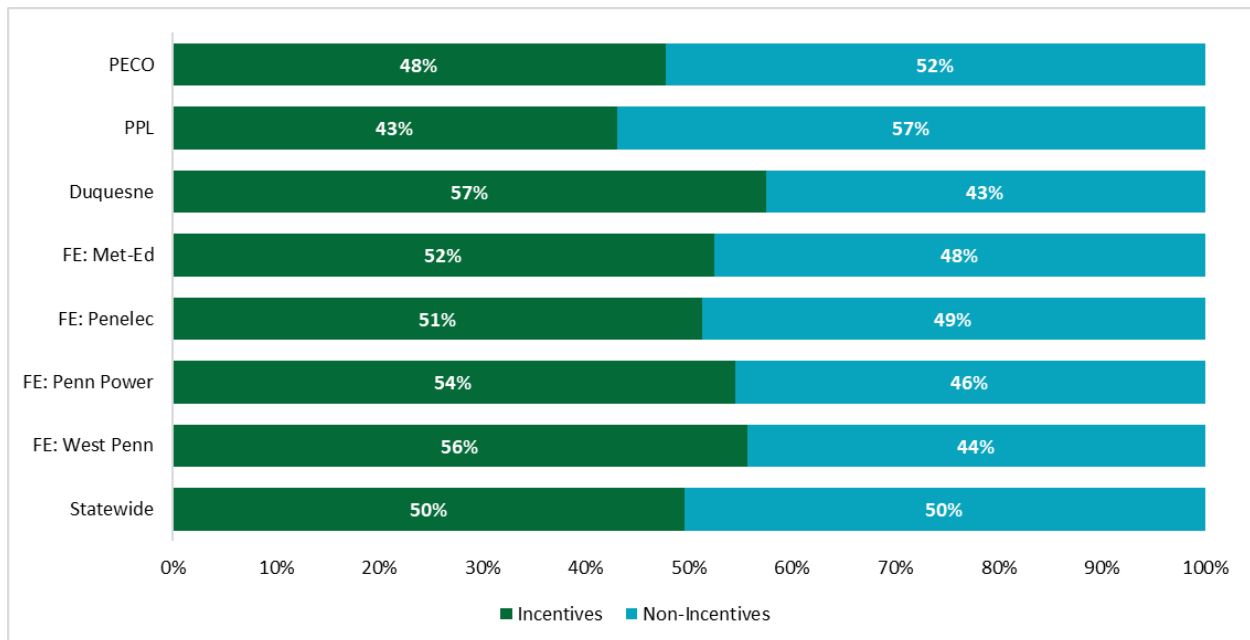
Figure 9: Reported Gross MWh and MW by Quarter



- Finding:** Statewide, there was a big shift in MWh savings toward the non-residential sector in PY13. Non-residential savings accounted for 66% of statewide MWh savings, compared to 49% of savings in Phase III. Non-residential lighting accounted for the bulk of the savings (41% statewide) while CHP was a major contributor with 13% of statewide MWh savings.
- Finding:** Residential Lighting significantly declined from Phase III, accounting for only 10% of statewide MWh savings. During Phase III of Act 129, residential lighting measures accounted for a high of 42% of gross statewide MWh savings to a low of 12% in PY12. While still a top program offering, the quantity of savings from residential lighting is substantially lower than in previous years. For example, PY13 residential lighting savings are equal to 40% of PY12 residential lighting savings and only 14% of PY11 residential lighting savings.
- Finding:** EDC cost categorization is clearly an area of emphasis for the Commission as the Phase IV Implementation Order required that EDCs “submit an EE&C Plan which shows at least 50% of all spending allocated to incentives and less than 50% of all spending allocated

to non-incentive cost categories.”⁸ While this was an EE&C Plan requirement and not an actual program delivery target, the SWE team sees value in reviewing the actual breakdown of expenditures. The statewide share of spending on incentives as a percentage of total EDC expenditures was almost exactly 50% in PY13. Figure 10 shows the division of spending between incentive and non-incentive cost centers by EDC and statewide. PPL showed the lowest percentage of spending on incentives (43%) while Duquesne Light had the highest (57%). Our TRC audit activities found that EDC cost categorization was well-aligned with the directives of the 2021 TRC Test Order in PY13 with respect to energy efficiency kits and directly installed equipment. Administrative costs are generally highest in the first year of a phase due to program design and launch activities.

Figure 10: PY13 Incentive and Non-Incentive Spending by EDC



- Finding:** The accounting methodology for behavioral HERs changed significantly in Phase IV. Instead of assuming all measured savings are incremental first-year savings, the 2021 TRM adopted a multi-year measure life perspective. The assumed persistence of HER impacts comes from a 2018 study by the SWE⁹ which found an average annual decay rate of 31.3%. The EDCs adapted to this new framework in different ways. PPL chose not to run a HER program in PY13. The FirstEnergy EDCs paused their legacy waves and started new HER cohorts. There are no persistence implications for new waves because homes did not receive HERs in prior program years. The EM&V contractor for PECO and Duquesne Light handled the persistence calculations expertly in PY13. The contribution of HERs to EDC energy savings targets was down statewide in PY13 at approximately 6% of all verified gross

⁸ Phase IV Implementation Order. Pages 119-127.

⁹ Addendum to Act 129 Home Energy Report Persistence Study.

https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

MWh. In Phase III of Act 129, HER programs accounted for between 12% and 20% of gross statewide MWh savings annually.

- **Finding:** Phase IV was the first time the Commission required the EDCs to nominate a portion of the peak demand reduction acquired into PJM’s Forward Capacity Market. The strategy varied across EDCs. FirstEnergy and PECO took the most aggressive positions, likely due in part to these companies’ familiarity with energy efficiency nominations from their operating companies elsewhere in the PJM footprint in states where nominations have been required historically. PPL and Duquesne Light took a more conservative approach and plan to nominate a smaller share of the MW acquired in PY13.
- **Finding:** In general, the SWE found that the EDCs’ cost-effectiveness reporting was well documented and aligned with the 2021 TRC Test Order. Gross TRC ratios at the portfolio level ranged widely from 0.98 at PECO to 1.85 at PPL and 1.84 at Duquesne Light. Incremental measure cost is by far the largest TRC cost. [Table 9](#) compares the assumed incremental measure cost per kWh of lifetime savings acquired in PY13.

Table 9: Incremental Measure Cost per Lifetime MWh

EDC	Lifetime MWh	IMC (\$1,000)	IMC per Lifetime MWh
PECO	2,517,930	\$117,523	\$46.67
PPL	2,343,803	\$48,017	\$20.49
Duquesne Light	618,645	\$6,191	\$10.01
FE: Met-Ed	569,089	\$15,517	\$27.27
FE: Penelec	432,826	\$9,808	\$22.66
FE: Penn Power	201,450	\$10,181	\$50.54
FE: West Penn Power	508,298	\$13,296	\$26.16
Statewide	7,192,040	\$220,533	\$30.66

The single largest measure category at all seven EDCs is commercial lighting. PECO, PPL, and Duquesne Light all rely on the SWE Incremental Cost Database¹⁰ for assumptions regarding commercial lighting equipment costs. FirstEnergy uses a mix of actual project costs and Incremental Cost Database assumptions. PPL and Duquesne Light use the Replace on Burnout cost assumptions (efficient equipment cost minus baseline equipment cost) while PECO and FirstEnergy use the Early Replacement vintage (efficient equipment cost plus labor). The PECO and FirstEnergy approach aligns with the savings calculation and measure vintage in the 2021 TRM. The true cost implications of a lighting upgrade to non-residential participants are likely somewhere in between with considerable variation from business to business. The SWE team will work with the EDCs and their evaluation contractors in PY14 to ensure consistent treatment of non-residential costs in future Phase IV TRC modeling.

¹⁰ https://www.puc.pa.gov/media/1316/act129_incremental_cost_database_v4-0.xlsx

- **Finding:** The SWE audit of PY13 TRC models uncovered varying interpretations and implementation of the 2021 TRC Test Order guidance regarding the avoided cost of transmission and distribution capacity. *For Phase IV of Act 129, EDCs are directed to use the avoided T&D values presented in Table 1 and Table 2, escalated for inflation at 2% annually to monetize peak demand reductions from EE&C plan projects completed by participants who take service at secondary voltage. For program participants who take service at primary voltage, only the avoided cost of transmission capacity (Table 1) is applied.*¹¹ Once the SWE flagged this issue, the EDCs and their EM&V contractors responded quickly with updated TRC results which omit the avoided cost of distribution capacity benefits stream for Large C&I participants on primary rates.
 - Although there are no distribution benefits assigned to the grid for these large customers, it's possible that the participating customers experience operation and maintenance (O&M) savings from peak demand reductions on the transformers they maintain behind the meter.
- **Finding:** The Commission's decision to establish Phase IV consumption reduction targets at the meter-level and peak demand reduction targets at the system-level led to some minor confusion in the evaluation processes. The 2021 TRM estimates peak demand reduction at the meter-level and EDC tracking systems also store meter-level impacts. The EDCs and their evaluation contractors were generally diligent about applying line loss factors to scale meter-level reductions to the system level for reporting. However, in a few cases the SWE noted verified savings reported without adjustment for losses and line loss factors being applied a second time in the TRC models. The EDCs and their evaluation contractors were quick to update these calculations once flagged and the SWE expects fewer issues in PY14 once the teams adjust to the new reporting convention for peak demand reductions from energy efficiency.

Recommendations

- The diminished savings opportunity from residential lighting spurred a notable shift in EE&C program activity to the non-residential sector in PY13. The shift does not create an equity issue because Act 129 cost recovery occurs at the class level. However, EDCs and their CSPs should continue to explore new conservation opportunities in the residential sector to ensure a balanced portfolio across customer classes.
- The annual avoided cost review described in [Sections 2.4](#) and [4.7](#) revealed several notable departures from forecast in the actual market conditions for key TRC benefit streams. These included energy and AEPS credits increasing and generation capacity decreasing relative to forecast. The SWE recommends the Commission continue to monitor market conditions and consider a TRC sensitivity analysis at the end of Phase IV if inflation and energy prices remain elevated for an extended period.

¹¹ 2021 TRC Test Order. Pages 45-50.

- Labor shortages and supply chain issues compounded the typical gradual ramp up at the beginning of a new phase. The EDCs and their CSPs should investigate opportunities to help interested participants with the labor component of their projects in addition to upfront equipment cost. Assisting homes and businesses secure qualified contractors could help accelerate project timelines and potentially attract more participation than financial incentives alone.
- The EDCs and their evaluation contractors should remain diligent about applying line loss factors to scale meter-level peak demand reductions to the system level for reporting. The SWE recommends the EDC evaluators work in meter-level savings until results are finalized and convert to system-level for reporting and benefit-cost modeling.
- In some cases, the SWE noted EDC evaluation contractors re-using analysis procedures from Phase III of Act 129 which had not been updated to reflect changes to the 2021 TRM or 2021 TRC Test Order. While the EM&V contractors should absolutely leverage the tools and procedures they have developed over the past decade, it is important to screen for policy or technical changes, particularly in the first year of a new phase.

Section 1 Act 129 and Summary of PUC Orders

1.1 EE&C PROGRAM – PHASE IV IMPLEMENTATION ORDER REQUIREMENTS

Act 129 requires the PUC to establish an EE&C program that includes the following characteristics:

- Adopts an “energy efficiency and conservation program to require electric distribution companies¹² to adopt and implement cost-effective energy efficiency and conservation (EE&C) plans to reduce energy demand and consumption within the service territory of each electric distribution company (EDC) in this commonwealth”¹³
- Adopts additional incremental reductions in consumption if the benefits of the EE&C program exceed its costs
- Evaluates the costs and benefits of the Act 129 EE&C programs in Pennsylvania by November 30, 2013, and every five years thereafter
- Ensures that the EE&C program includes “an evaluation process, including a process to monitor and verify data collection, quality assurance, and results of each plan and the program”¹⁴

Based on findings from the Phase IV Market Potential Study dated February 2020, the PUC determined that the benefits of a Phase IV Act 129 program would exceed its costs, and therefore adopted additional incremental reductions in consumption and peak demand for another EE&C program term of June 1, 2021, through May 31, 2026 (program years thirteen, fourteen, fifteen, sixteen, and seventeen). In its Phase IV Implementation Order, the PUC established targets for those consumption and peak demand reductions (PDRs) for each of the seven EDCs in Pennsylvania; established the standards each plan must meet; and provided guidance on the procedures to be followed for submittal, review, and approval of all aspects of the EDC EE&C plans for Phase IV.¹⁵

1.1.1 EDC Cost Recovery for Act 129 EE&C Programs

Pennsylvania Act 129 allows each EDC to recover all prudent and reasonable costs relating to the provision or management of its EE&C Plan but limits such costs to an amount not to exceed two percent of the EDC’s total annual revenue as of December 31, 2006, excluding LI Usage Reduction Programs established under 52 Pa. Code § 58. 66 Pa. C.S. § 2806.1(g). The cost-

¹² This Act 129 requirement does not apply to EDCs with fewer than 100,000 customers.

¹³ See House Bill No. 2200 of the General Assembly of Pennsylvania, An Act Amending Title 66 (Public Utilities) of the Pennsylvania Consolidated Utilities, October 7, 2008, page 50.

¹⁴ See House Bill No. 2200 of the General Assembly of Pennsylvania, An Act Amending Title 66 (Public Utilities) of the Pennsylvania Consolidated Utilities, October 7, 2008, page 51.

¹⁵ 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.

<https://www.puc.pa.gov/pcdocs/1666981.docx>

recovery mechanism also ensures that approved measures are financed by the customer class that receives the direct energy and conservation benefit of the measure.

The Act also requires that each EDC's plan includes a proposed cost-recovery tariff mechanism, in accordance with 66 Pa. C.S. §1307 (relating to adjustments and sliding scale of rates), to fund all measures and ensure a full and current recovery of prudent and reasonable costs, including administrative costs, as approved by the Commission.

1.1.2 Phase IV Conservation Targets for Each EDC

The PUC's June 2020 Implementation Order explained that it was required to establish electric energy consumption reduction compliance targets for Phase IV of Act 129.¹⁶ In addition, while Phase III had dispatchable demand response (DDR) reduction targets, the Commission excluded DDR targets from Phase IV and replaced them with PDR targets. The final Phase IV Implementation Order stated that the Commission found that the merits of a PDR strategy focused on long-lasting everyday reductions from energy efficiency measures outweigh the features of a design that includes both PDR from EE and DDR. EDCs are also directed to offer an unspecified number of energy efficiency resources into the PJM market. The peak demand impacts from energy efficiency in this report are presented at the system level, reflecting adjustments for transmission and distribution losses.

Table 10 contains portfolio budgets, consumption reduction targets and PDR targets for Phase IV for each of the seven EDCs.

Table 10: Act 129 Phase IV Five-Year Energy Efficiency Reduction Compliance Targets

EDC	Portfolio Budget Allocation (Million \$)	Phase IV Consumption Reduction (MWh.yr)	Phase IV PDR (MW/yr)
PECO	\$427.4	1,380,837	256
PPL	\$307.5	1,250,157	229
Duquesne Light	\$97.7	348,126	62
FE: Met-Ed	\$124.3	463,215	76
FE: Penelec	\$114.9	437,676	80
FE: Penn Power	\$33.3	128,909	20
FE: West Penn Power	\$117.8	504,951	86
Statewide	\$1,222.9	4,513,871	809

1.1.2.1 Standards Each EDC's Phase IV EE&C Plan Must Meet

The PUC requires that each EDC's EE&C plan for Phase IV meet several standards, including the following:

1. EDCs must obtain the given amount of consumption reduction as stated in Table 11 from programs solely directed at low-income customers or low-income-verified participants in multifamily housing programs. Savings from non-low-income programs, such as general

¹⁶ Phase IV Implementation Order at <https://www.puc.pa.gov/pdocs/1666981.docx>

residential programs, will not be counted for compliance. More details about the low-income targets and requirements are provided in [Section 1.1.3](#). Act 129 also includes legislative requirements to include a number of energy efficiency measures for households at or below 150% of the federal poverty income guidelines that is proportionate to each EDC's total low-income consumption relative to the total energy usage in the service territory. The SWE has advised that EDCs should consider the definition of a low-income measure to include a measure that is targeted to low-income customers and is available at no cost to low-income customers.

2. EDCs will be awarded credit for all new, first-year, incremental savings delivered in each year of the phase, as was done in Phase III.
3. EDC plans should be designed to achieve the most lifetime energy savings per expenditure.
4. EDC plans should be designed to achieve at least 15% of the target amount in each program year.
5. EDCs are to include at least one comprehensive program for residential customers and at least one comprehensive program for non-residential customers.
6. EDCs should determine the initial mix and proportion of energy efficiency programs, subject to PUC approval. The PUC expects the EDCs to provide a reasonable mix of energy efficiency programs for all customers. However, each EDC's Phase IV EE&C Plan must ensure that the utility offers each customer class at least one energy efficiency program.
7. EDCs should nominate a portion of the expected peak demand savings in their Phase IV EE&C Plans into PJM's FCM. Cost recovery from the customer class providing the capacity should be adjusted to reflect the proceeds or penalties from this activity.
8. EDCs should report savings achieved for the GNI sector in Phase IV and highlight in their EE&C plans how the GNI sector will be served.
9. EDCs should report savings achieved in multifamily housing, both for the low-income carve-out and for their portfolio of programs.

1.1.3 Low-Income Customer Savings

As noted in [Section 1.1.2.1](#), each EDC Phase IV EE&C Plan must obtain consumption reduction requirements from programs solely directed at low-income customers or low-income-verified participants in multifamily housing programs (see [Table 11](#) for a summary of the low-income carve-out information). Savings from non-low-income programs, such as general residential programs, will not be counted for compliance. Low-income customers are defined as households at or below 150% of the federal poverty income guidelines. As noted in [Section 1.1.4](#), low-income carryover for Phase IV was only permitted if the EDC's entire portfolio had carryover savings and the EDC had low-income specific savings in excess of their Phase III low-income target.

1.1.3.1 Proportionate Number of Measures and Low-Income Savings Targets

Act 129 also includes legislation to ensure that there are specific measures available for and provided to low-income customers. The compliance criteria for this metric are to include a number of energy efficiency measures for households at or below 150% of the federal poverty income guidelines that is proportionate to each EDC's total low-income consumption relative to the total energy usage in the service territory. The SWE has advised that EDCs should consider the definition of a low-income measure to include a measure that is targeted to low-income customers and is available to them at no cost.

Act 129 defines an EE&C measure (in the definitions section; 66 Pa.C.S. 2806.1[m]) as follows:

Energy efficiency and conservation measures.

(1) Technologies, management practices, or other measures employed by retail customers that reduce electricity consumption or demand if all of the following apply:

(i) The technology, practice, or other measure is installed on or after the effective date of this section at the location of a retail customer.

(ii) The technology, practice, or other measure reduces consumption of energy or peak load by the retail customer.

(iii) The cost of the acquisition or installation of the measure is directly incurred in whole or in part by the EDC.

(2) EE&C measures shall include solar or solar photovoltaic panels; energy efficient windows and doors; energy efficient lighting, including exit sign retrofit, high bay fluorescent retrofit, and pedestrian and traffic signal conversion; geothermal heating; insulation; air sealing; reflective roof coatings; energy efficient heating and cooling equipment or systems; and energy efficient appliances; and other technologies, practices, or measures approved by the commission.

The SWE recommends that EDCs refer to the PA TRM when determining the appropriate level of granularity at which to list measures when calculating the "proportionate number of measures." Technologies that are addressed by a single algorithm section in the TRM should not be further subdivided. Measure divisions should be based on equipment types, not differences in equipment efficiency or sizing of the same type of equipment. For example, EDCs should not separate LED bulbs into multiple measures based on wattage. A grouping approach that distinguishes between equipment types but not sizes or efficiency levels should be employed for measures that are not addressed in the PA TRM.

With regard to determining which measures can be classified as specific low-income measures, the legislation states the following:

The plan shall include specific energy efficiency measures for households at or below 150% of the federal poverty income guidelines. The number of measures shall be proportionate to those households' share of the total energy usage in the service territory. The electric distribution company shall coordinate measures under this clause with other programs administered by the commission or another federal or state agency. The expenditures of an electric distribution

company under this clause shall be in addition to expenditures made under 52 Pa. Code Ch. 58 (relating to residential low-income usage reduction programs).

A summary of the low-income carve-out information is provided in [Table 11](#).

Table 11: Act 129 Phase IV Low-Income Carve-Out Information

EDC	Proportionate Number of Measures	2021-2026 Potential Savings (MWh.yr)	Low-Income Savings Target (MWh.yr)
PECO	8.80	1,380,837	80,089
PPL	9.95	1,250,157	72,509
Duquesne Light	8.40	348,126	18,566
FE: Met-Ed	8.79	463,215	26,866
FE: Penelec	10.23	437,676	25,385
FE: Penn Power	10.64	128,909	7,477
FE: West Penn Power	8.79	504,951	29,287
Statewide	-	4,513,871	260,179

1.1.4 Carryover Savings from Phase III

The PUC’s June 2020 Implementation Order specifies that Phase III consumption reductions in excess of an EDC’s Phase III targets can be applied as carryover toward that same EDC’s Phase IV electric consumption reduction targets. Note that only savings achieved in Phase III can count toward carryover. The June 2020 Implementation Order states, “for example, assume an EDC had a Phase III target of 1,000 MWh and had 100 MWh of carryover savings from Phase II. To have carryover into Phase IV, the EDC must have attained over 1,000 MWh in Phase III alone, not including the 100 MWh of Phase II carryover.” Carryover should be determined based on Phase III verified savings (see [Table 1](#) for Phase III carryover for each EDC).

Low-income carve-out savings carryover are only permitted if an EDC has carryover savings for the entire portfolio of programs in Phase III and if the EDC has low-income carve-out savings from Phase III in excess of the Phase III low-income carve-out savings targets (see [Table 2](#) for Phase III low-income carryover for each EDC).

Carryover of Phase III peak demand savings into Phase IV of Act 129 will not be permitted since the nature of the Phase III and Phase IV PDR targets are *inherently different*. Phase III of Act 129 included a PDR target that could only be met with DDR programs. Phase IV of Act 129 includes a PDR target that can only be met with coincident reductions in peak demand from energy efficiency programs. EDCs could not accumulate savings in excess of a Phase III energy efficiency and peak demand reduction (EEPDR) target because no such target existed.

1.1.5 Incremental Annual Accounting

As in Phase III, EDCs will be awarded credit for all new, first-year, incremental savings delivered in each year of the phase. Each program year, the new first-year savings achieved by an EE&C program are added to an EDC’s progress toward compliance. Unlike in Phase I and Phase II of Act 129, whether a measure reaches the end of its expected useful life (EUL) before the end of the phase does not impact compliance savings.

1.1.6 Net-to-Gross Ratio (NTGR)

The PUC's Phase IV Implementation Order specifies that compliance will be based on gross verified savings rather than net savings, and that EDCs will continue to perform Net-to-Gross (NTG) research. Results of the NTG evaluations should be used to inform program modifications and program planning (e.g., program design, modifying program incentive levels, and eligibility requirements), as well as determinations of program cost-effectiveness.

1.1.7 Statewide Evaluator

Act 129 requires the Commission to establish an evaluation process that monitors and verifies data collection, quality assurance, and the results of each EDC EE&C Plan and the program as a whole. See 66 Pa. C.S. § 2806.1(a)(2). While Section 2806.1(b)(1)(i)(C) requires each plan to explain how quality assurance and performance will be measured, verified, and evaluated, it is apparent that Section 2806.1(a)(2) requires the Commission to monitor and verify this data. This evaluation process is to be conducted every year. Each EDC will submit an annual report documenting the effectiveness of its EE&C Plan, energy savings measurement and verification, an evaluation of the cost-effectiveness of expenditures, and any other information the Commission requires. See 66 Pa. C.S. § 2806.1(i)(1).

The Phase IV SWE was selected by the Commission, as in prior phases, to provide credible impact via transparent process evaluations. The SWE provides expertise in evaluations and remains independent from EDC evaluators. The SWE responsibilities include evaluating the EDC programs, identifying whether further cost-effective savings can be obtained in future EE&C programs, developing an updated evaluation framework, conducting annual audits of EDC programs, conducting a market potential study on energy efficiency and a market potential study on DR.

1.1.8 Annual Reporting Requirements

The Phase IV SWE team contract specifies that *“The contractor provide a final annual report on each EDC plan and the program, as a whole, to the Project Officer by November 30. Final Annual Reports will be provided to the Commission by November 30, except for the fifth (final) annual report of the phase which will be rolled into the Final Five-Year Energy Efficiency and Conservation Program Assessment Report. The annual reports may form the basis for Commission annual reports required to be provided to the legislature each year.”*

This report provides detailed information on the findings of the SWE team's audit activities of the Act 129 EE&C programs implemented by seven EDCs in Pennsylvania and reports the status of EDC compliance with Phase IV energy efficiency and peak demand targets

The SWE contract specifies that the Final Annual Reports and the Final Five-Year Report will include, but are not limited to, the following:

- An analysis of each EDCs' plan expenditures and an assessment of the program's expenditures.
- An analysis of each EDCs' protocol for measurement and verification of energy savings attributable to its plan, in accordance with the Commission adopted TRM and approved custom measures.

- An analysis of the cost effectiveness of each EDCs' expenditures in accordance with the Commission adopted Total Resource Cost (TRC) Test Order.
- A review of TRM information and savings values with suggestions for possible revisions and additions.
- A review of the TRC test with suggestions for possible revisions and additions.
- A review of any proposed revisions and updates to EDC plans.

1.2 2021 TRC TEST ORDER

Act 129 requires that the cost-effectiveness of each EDC's EE&C plan be assessed annually to demonstrate its viability. The TRC test, which weighs the net present values of future benefits and costs over the effective life of any given energy efficiency measure, is the standard used to measure cost-effectiveness. The purpose of using a TRC test to evaluate EE&C programs is to track the relationship between the benefits to the Commonwealth and the costs incurred to obtain those benefits. Section 2806.1(m) of Act 129, states that a TRC test be used to determine whether ratepayers received more benefits (in reduced capacity, energy, transmission, and distribution costs) than the implementation costs of the EE&C plans.

Before each prior phase, a TRC Test Order was published to explain how the TRC test process should be applied to Pennsylvania. Each iteration of the TRC Test Order has customized the Act 129 TRC Test by taking in lessons learned from the prior phase to refine the process. The Commission released the 2021 TRC Test Tentative Order at the Public Meeting held on September 19, 2019. After receiving comments and reply comments from stakeholders, the 2021 TRC Test Final Order was adopted at the Public Meeting held on December 19, 2019. Some of the topics addressed in the TRC Test Order include:

- Frequency of review of the TRC test assumptions
- Aggregation level of TRC test results
- Setting a common discount rate for calculation of future benefits and costs
- The methodology for forecasting avoided costs of electric energy, generation capacity, and transmission and distribution capacity.
 - The Commission also released an Avoided Cost Calculator (ACC) to help the EDCs develop their Phase IV avoided cost forecasts.
- Line losses
- Quantifying and monetizing both water and fossil fuel impacts
- Societal benefits
- TRC cost classification
- Treatment of increased fossil fuel consumption due to fuel switching
- Net-to-Gross Issues

1.3 2021 TRM ORDER

First adopted in June 2009, at the beginning of the Act 129 implementation, the Pennsylvania TRM was used to define the savings algorithms and assumptions for individual energy efficiency measures. The Commission charged that the TRM be implemented, maintained, and periodically

updated when need be. For the start of Phase IV an updated TRM was proposed by the 2021 TRM Tentative Order on April 11, 2019. The 2021 TRM Final Order was adopted by the PUC on August 8, 2019. The 2021 TRM was later modified by Secretarial Letter in September 2020 to correct errata, then Tentative and Final 2021 Amendment Orders in October 2020 and February 2021 respectively. The 2021 TRM Amendment Order added peak demand savings protocols for several measures in response to the Commission's decision to establish compliance targets for peak demand reduction from energy efficiency.

In the 2021 TRM Final Order, the Commission set forth several changes intended to improve the accuracy, applicability, and coverage of the TRM. The changes were based partially on recent research, reviews of the TRMs from other states, and the needs and experiences of the EDCs. The other category of changes came from the SWE team's comprehensive review of the 2016 TRM, which identified general improvements to the organization and internal consistency of the manual. The adopted changes focus on improving assumptions for key parameters, algorithms, and deemed savings values, as well as accounting for new codes and standards for residential and non-residential EE&C measures. The adopted changes were intended to make the TRM a more effective and professional tool for validating energy savings and providing support for the Act 129 goals.

Some of the topics covered in the 2021 TRM Order updates are listed below:

- Climate related assumptions
- Consistent taxonomy of C&I building types across measures.
- Updated equivalent full load hour and coincidence factor assumptions for residential HVAC measures
- Adjustments to the definitions of peak and off-peak periods
- Adoption of new Residential and Non-Residential measures
- Removal of some Residential and Non-Residential measures

[Section 4.1](#) discusses recent activities related to the TRM and any updates that were required.

Section 2 Portfolio and Program-Level Savings by Program Year

2.1 SUMMARY OF PY13 ENERGY SAVINGS

2.1.1 Summary of PY13 Energy Savings Statewide and by EDC

Table 12 provides a summary of PY13 reported and verified energy savings by EDC. Realization rates in PY13 ranged from 94% (West Penn Power) to 102% (PECO).

Table 12: Summary of PY13 Reported and Verified Energy Savings by EDC¹

EDC	PY13 Reported (MWh/yr)	PY13 Verified Gross (MWh/yr)	Realization Rate
PECO	238,475	243,190	102.0%
PPL ²	170,005	167,361	98.4%
Duquesne Light ²	47,492	49,101	103.4%
FE: Met-Ed	49,187	46,455	94.4%
FE: Penelec	36,788	36,021	97.9%
FE: Penn Power	16,643	15,934	95.7%
FE: West Penn Power	46,338	43,638	94.2%
Statewide	604,928	601,700	99.5%

¹ Totals may not equal sum of column or row due to rounding.

² Reported savings include unverified savings. The realization rate reported in this table includes the unverified savings as part of the reported savings. The PY13 realization rate will increase slightly in PY14 once the unverified savings are verified.

2.1.2 Summary of PY13 Energy Savings by Sector

Table 13 presents the PY13 verified gross savings by customer segment. The residential, small commercial and industrial (C&I), and large C&I segments were defined by EDC tariff, and the LI and GNI segments were defined by statute (66 Pa. C.S. § 2806.1).¹⁷ Residential customers (including LI customers) accounted for 202,327 MWh of verified gross savings in PY13 (34% of PY13 energy savings) whereas non-residential customers accounted for 399,375 MWh of verified gross savings.

¹⁷ The LI segment is almost entirely a subset of the residential customer class but can include a limited number of LI-qualified residents in master-metered buildings in the small C&I and large C&I sectors. The GNI segment is almost entirely composed of customers who are part of the small C&I or large C&I rate classes but can include a limited number of residential customers.

Table 13: Summary of PY13 Verified Savings by Customer Segment^{1,2}

EDC	Residential (MWh.yr)	LI (MWh.yr)	Small C&I (MWh.yr)	Large C&I (MWh.yr)	GNI (MWh.yr)	Total ² (MWh.yr)
PECO	61,484	12,168	52,141	99,335	18,063	243,190
PPL	30,693	9,027	81,719	29,567	16,354	167,361
Duquesne Light	8,375	3,375	13,354	18,231	5,767	49,101
FE: Met-Ed	19,969	3,762	4,601	17,098	1,025	46,455
FE: Penelec	14,637	5,942	13,204	1,882	356	36,021
FE: Penn Power	5,715	1,716	1,085	7,266	151	15,934
FE: West Penn Power	19,646	5,817	6,862	11,243	71	43,638
Statewide	160,520	41,808	172,965	184,622	41,788	601,700

¹ Does not include carryover savings.

² Totals may not equal sum of column or row due to rounding.

2.1.3 Summary of PY13 Energy Savings for Multifamily Housing

Multifamily savings account for a range of 2% of savings for the residential and low-income customer segments (Penn Power) to 8% (PECO) while low-income multifamily housing accounts for a range of 7% of savings for the low-income segment (Penn Power) to 24% (PECO; see [Table 14](#)).

Table 14: Summary of PY13 Verified Energy Savings for Multifamily Housing by EDC

EDC	PY13 VTD (MWh/yr)	% of PY13 Residential and LI Segments	PY13 VTD, LI Households (MWh/yr)	% of PY13 LI Segment
PECO	6,147	8%	3,041	24%
PPL	2,870	7%	2,049	23%
Duquesne Light	636	5%	636	19%
FE: Met-Ed	554	2%	167	4%
FE: Penelec	691	3%	667	11%
FE: Penn Power	124	2%	124	7%
FE: West Penn Power	1,352	5%	1,351	23%
Statewide	12,373	6%	8,035	18%

2.2 SUMMARY OF PY13 PEAK DEMAND REDUCTIONS

Act 129 defines peak demand savings from energy efficiency as the average expected reduction in electric demand from 2:00 PM to 6:00 PM EDT on non-holiday weekdays from June to August. The peak demand impacts from energy efficiency in this report are presented at the system level, reflecting adjustments for transmission and distribution losses.

2.2.1 Summary of PY13 Peak Demand Reductions Statewide and by EDC

[Table 15](#) provides a summary of PY13 reported and verified peak demand savings by EDC. Realization rates in PY13 ranged from 81% (West Penn Power) to 113% (Duquesne Light).

Table 15: Summary of PY13 Reported and Verified Peak Demand Reduction by EDC

EDC	PY13 Reported (MW/yr)	PY13 Verified Gross (MW/yr)	Realization Rate
PECO	43.24	42.11	97%
PPL	26.66	25.68	96%
Duquesne Light	8.35	9.45	113%
FE: Met-Ed	7.94	7.11	89%
FE: Penelec	7.20	6.94	96%
FE: Penn Power	2.52	2.10	83%
FE: West Penn Power	7.20	5.86	81%
Statewide	103.11	99.25	96%

2.2.2 Summary of PY13 Peak Demand Savings by Sector

Compared to energy savings, non-residential customers account for an even higher percentage of peak demand reductions (70%). Residential customers (including LI customers) accounted for 30% of PY13 peak demand savings (Table 16).

Table 16: Summary of PY13 Verified Peak Demand Reduction by Customer Segment^{1,2}

EDC	Residential (MW/yr)	LI (MW/yr)	Small C&I (MW/yr)	Large C&I (MW/yr)	GNI (MW/yr)	Total ² (MW/yr)
PECO	11.12	1.15	11.14	15.37	3.35	42.11
PPL	3.80	1.02	14.07	4.08	2.71	25.68
Duquesne Light	1.05	0.34	3.74	3.31	0.99	9.45
FE: Met-Ed	3.31	0.50	0.78	2.34	0.17	7.11
FE: Penelec	2.25	0.64	3.71	0.31	0.03	6.94
FE: Penn Power	0.94	0.18	0.14	0.82	0.02	2.10
FE: West Penn Power	2.97	0.59	1.06	1.23	0.01	5.86
Statewide	25.44	4.42	34.64	27.47	7.28	99.25

¹ Does not include carryover savings.

² Totals may not equal sum of column or row due to rounding.

2.3 COMPARISON OF PY13 EXPENDITURES AND APPROVED EE&C PLAN BUDGET ESTIMATES

Table 17 provides an overview of the EDC's planned and actual expenditures for EE&C programs in PY13. In PY13, all EDCs spent less than their approved budget. This could be due in part to delays in ramping up Phase IV program designs, processes, and Implementation CSPs as well as lingering impacts of the COVID-19 pandemic.

Table 17: Comparison of PY13 Statewide Energy Efficiency Budgets and Expenditures¹

EDC	Actual PY13 Expenditures (\$1000)	Approved Budget for PY13 (\$1000)	Difference Between Actual and EE&C Plan	Percent Difference from EE&C Plan
PECO	\$54,820	\$74,460	(\$19,640)	-26%
PPL	\$30,161	\$60,824	(\$30,663)	-50%
Duquesne Light	\$13,359	\$17,156	(\$3,797)	-22%
FE: Met-Ed	\$10,808	\$23,850	(\$13,042)	-55%
FE: Penelec	\$9,959	\$22,018	(\$12,059)	-55%
FE: Penn Power	\$3,795	\$6,459	(\$2,664)	-41%
FE: West Penn Power	\$11,742	\$23,166	(\$11,424)	-49%
Statewide	\$134,644	\$227,933	(\$93,289)	-41%

¹Totals may not match EE&C plan totals due to rounding.

Table 18 provides an overview of the EDC's planned and actual energy acquisition costs in PY13 and Table 19 presents the same comparison for PY13 capacity savings.

Table 18: Planned Versus Actual Energy Acquisition Costs in PY13

EDC	PY13 Verified Savings (MWh/yr)	Forecasted PY13 Acquisition Cost per First-Year kWh Saved	Actual PY13 Acquisition Cost per First-Year kWh Saved	Percent Change from Forecasted Acquisition Cost
PECO	243,190	\$0.29	\$0.22	-22%
PPL	167,361	\$0.21	\$0.18	-13%
Duquesne Light	49,101	\$0.26	\$0.27	4%
FE: Met-Ed	46,455	\$0.28	\$0.23	-16%
FE: Penelec	36,021	\$0.26	\$0.28	5%
FE: Penn Power	15,934	\$0.27	\$0.24	-10%
FE: West Penn Power	43,638	\$0.26	\$0.27	3%
Statewide	601,700	\$0.25	\$0.22	-12%

Table 19: Planned Versus Capacity Acquisition Costs in PY13

EDC	PY13 Verified Savings (MW/yr)	Forecasted PY13 Acquisition Cost per First-Year kW Saved	Actual PY13 Acquisition Cost per First-Year kW Saved	Percent Change from Forecasted Acquisition Cost
PECO	42.1	\$1,408	\$1,302	-8%
PPL	25.7	\$1,296	\$1,174	-9%
Duquesne Light	9.5	\$1,458	\$1,414	-3%
FE: Met-Ed	7.1	\$1,509	\$1,521	1%
FE: Penelec	6.9	\$1,430	\$1,435	0%
FE: Penn Power	2.1	\$1,374	\$1,803	31%
FE: West Penn Power	5.9	\$1,363	\$2,005	47%
Statewide	99.2	\$1,386	\$1,357	-2%

2.4 COST-EFFECTIVENESS SUMMARY

Pennsylvania utilizes the Total Resource Cost (TRC) test for all benefit-cost analysis. The TRC test examines cost-effectiveness from the perspective of the utility, participants, and non-participants. Over time, the Commission has customized the Pennsylvania TRC Test to reflect the policy priorities of the Commonwealth. In preparation for Phase IV, the PUC issued the 2021 TRC Test Order¹⁸ to document the methodology and assumptions EDCs should use when calculating the costs and benefits of Phase IV EE&C portfolios. Figure 11 shows the breakdown of total TRC benefits and costs across all EDCs in PY13. The comparison of Total Gross Net Present Value (NPV) TRC Benefits to Total Gross NPV TRC Costs is the statewide TRC ratio, which was 1.29 in PY13. The red coloring for fossil fuel impacts indicates negative benefits, or increased fossil fuel consumption. Fossil fuel increases from the interactive effects of LED lighting on space heating systems and the additional fuel required to power CHP systems.

¹⁸ Pennsylvania Public Utility Commission, *2021 TRC Test Final Order*. From the Public Meeting of December 19, 2019, at Docket No. M-2019-3006868 (*2021 TRC Test Order*). Entered December 19, 2019. <https://www.puc.pa.gov/pcdocs/1648126.docx>

Figure 11: PY13 Statewide TRC Breakdown

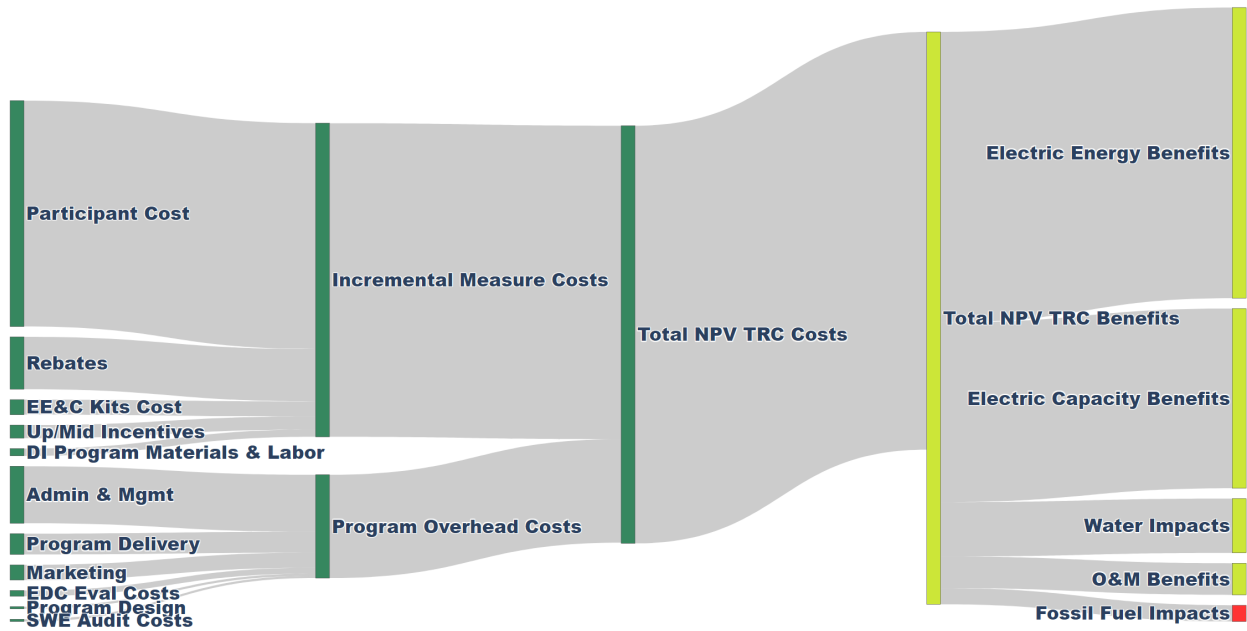


Table 20 shows the NPV costs and benefits for each EDC portfolio in PY13, as well as the TRC ratio (benefits divided by costs). TRC results are presented on both a gross and net savings basis. Per the 2021 TRC Test Order, incremental participant costs and benefits from free riders are excluded from the calculation of the net TRC ratio. The NPV of future energy savings is calculated using a 3% real discount rate (5% nominal discount rate) for all EDCs.¹⁹ This is a departure from prior phases of Act 129 when each EDC’s weighted average cost of capital (WACC) was used to compute the present value of future benefits and costs. On a gross basis, PY13 programs saved the Commonwealth an estimated \$85.9 million (benefits minus costs). On a net basis, statewide savings from PY13 programs are estimated at \$46.9 million.

¹⁹ 2021 TRC Test Order. Pages 17-21.

Table 20: PY13 TRC Test Results by EDC¹

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO	\$143,564	\$146,150	0.98	\$104,246	\$108,329	0.96
PPL	\$122,486	\$66,167	1.85	\$79,029	\$48,139	1.64
Duquesne Light	\$27,484	\$14,901	1.84	\$20,942	\$13,350	1.57
FE: Met-Ed	\$28,227	\$20,914	1.35	\$18,593	\$15,193	1.22
FE: Penelec	\$21,759	\$14,893	1.46	\$17,901	\$12,736	1.41
FE: Penn Power	\$12,906	\$11,981	1.08	\$8,711	\$8,423	1.03
FE: West Penn Power	\$23,227	\$18,739	1.24	\$18,823	\$15,164	1.24
Statewide	\$379,653	\$293,745	1.29	\$268,245	\$221,334	1.21

¹ Totals may not equal sum of column or row due to rounding.

Finally, [Table 21](#) presents a summary of statewide portfolio finances on a gross basis. The incremental cost of efficient equipment is the largest cost category. In PY13, EDC incentives covered 28% of incremental measures costs and participants paid the other 72%. Water benefits accounted for over 10% of TRC benefits in PY13 thanks to a significant uptake of low-flow showerheads and faucet aerator measures. The PY13 statewide TRC Ratio was 1.29 with net benefits (benefits minus costs) of almost \$86 million.

Table 21: Summary of Statewide Portfolio Finances

Row #	Cost Category*	PY13 (\$1000)	
1	IMCs	\$220,533	
2	Rebates to Participants and Trade Allies	\$36,796	
3	Upstream / Midstream Incentives	\$9,248	
4	Material Cost for Self-Install Programs (EE&C Kits)	\$10,586	
5	Direct Installation Program Materials and Labor	\$5,090	
6	Participant Costs (Row 1 minus the sum of Rows 2 through 5)	\$158,813	
		EDC	CSP
7	Program Design	\$887	\$665
8	Administration and Management	\$27,403	\$12,701
9	Marketing	\$7,262	\$3,433
10	Program Delivery	\$210	\$14,426
11	EDC Evaluation Costs	\$4,083	
12	SWE Audit Costs	\$1,584	
13	Program Overhead Costs (Sum of rows 7 through 12)	\$72,653	
14	Total NPV TRC Costs (Sum of rows 1 and 13)	\$293,745	
15	Total NPV Lifetime Electric Energy Benefits	\$204,371	
16	Total NPV Lifetime Electric Capacity Benefits	\$126,332	
17	Total NPV Lifetime O&M Benefits	\$22,222	
18	Total NPV Lifetime Fossil Fuel Impacts	-\$11,433	
19	Total NPV Lifetime Water Impacts	\$38,162	
20	Total NPV TRC Benefits (Sum of rows 15 through 19)	\$379,653	
21	Statewide TRC Ratio (Row 20 divided by Row 14)	1.29	

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

2.4.1 Summary of the Alternative Energy Portfolio Standards Costs

The 2021 TRC Test Order²⁰ directed the Phase IV SWE to include a summary of the Alternative Energy Portfolio Standards (AEPS) costs in its Annual Report and to produce a comparison of how these costs have changed over time. What follows is a brief introduction to the AEPS values, how they are used, and their historic fluctuations. At this time, however, the SWE does not recommend any mid-cycle update to the Phase IV AEPS avoided cost projections as they remain a very small component of the larger avoided energy costs.

²⁰ From the Public Meeting of December 19, 2019, at Docket No. M-2019-3006868. Entered December 19, 2019. <https://www.puc.pa.gov/pdocs/1648126.docx>

Alternative Energy Portfolio Standards Costs are electric cost adders included to reflect the cost of purchasing Alternative Energy Credits (AECs) as required by the AEPS Act²¹. The AECs are categorized into three tiers: Non-Solar Tier I, Tier II and Solar. The AEPS Act requires that AECs be purchased in a fixed percentage of EDC retail sales each year. EDCs must procure 10% of their retail MWh sales as Tier II credits, 8% of retail MWh sales as Non-Solar Tier I credits and 0.5% as Solar credits. Since EDC EE&C Plans reduce electric sales, they reduce the number of AECs an EDC must purchase.

In the Act 129 Phase IV Avoided Energy and Capacity Cost Calculator²², AEPS avoided costs are a benefit as any reduction in retail sales associated with energy efficiency will decrease the total number of credits required to be procured. To simplify modeling, a single, weighted, AEPS cost was constructed. The total cost to purchase these credits to offset 1,000 MWh of retail sales is \$834 in nominal dollars, which amounts to \$4.51/credit and \$0.83/MWh.

The SWE was instructed to investigate AEPS cost changes and provide a recommendation on whether these values should be updated. To assess the degree to which AEPS costs fluctuate over time, the SWE collected historic²³ and current AEPS bid and offer prices and constructed the cost per MWh and per credit from 2008 onwards. Using current Marex Spectron prices, the weighted average cost of the AECs is \$18.18 per credit, or \$3.36 per MWh. Compared to the values originally included in the 2021 TRC Test Final Order and Phase IV ACC, the current value of credits is up by a factor of four. However, when looking at the historical trend, three things are clear. First, the AEPS cost incorporated in 2019 represented a time when prices were at a historic low. Second, there has always been fluctuation in AEPS prices, and third, the current prices are in line with a trend toward increased AEPS costs over the last four years. This increase has roots in policy changes that originated in the amending of the AEPS Act by Act 40²⁴ of 2017 and Act 114²⁵ of 2020. Act 40 requires that Solar AECs come from solar facilities within the Commonwealth while Act 114 implements the same location requirement for Tier II credits.

In line with these findings, the SWE recommends that no changes be made to the current AEPS price used to calculate TRC benefits at this time. While AEPS costs are increasing, they still represent a small fraction of the overall avoided costs and therefore do not warrant a mid-cycle update.

2.4.2 Annual Comparison of Phase IV Avoided Costs with Actual Market Conditions

Section B.1 of the 2021 TRC Test Final Order called for a single forecast of avoided costs to be used in Phase IV EE&C Plans and EDC Annual Reports. The Industrials²⁶ commented that EDCs

²¹ See 73 P.S. §§ 1648.1–1648.8 and 66 Pa. C.S. § 2814. See also 52 Pa. Code §§ 75.1–75.72.

²² <https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/total-resource-cost-test/>

²³ See AEPS Act Historical Pricing reports at <https://www.pennaeps.com/reports/>.

²⁴ See PA Act 40 of 2017, Section 2804

²⁵ See PA Act 114 of 2020, Section 1799.10-E

²⁶ The Met-Ed Industrial Users Group, the Penelec Industrial Customer Alliance, the Philadelphia Area Industrial Energy Users Group, the PP&L Industrial Customer Alliance, the West Penn Power Industrial Intervenors, and the Pennsylvania Energy Consumer Alliance

should use actual experienced market prices rather than forecasted prices in annual and phase reporting. PA-EEFA²⁷ comments recommended an annual review of market conditions by the SWE to assess whether an update to the avoided costs forecast was warranted. The Commission agreed and directed the SWE “to include in its Final Annual Reports a comparison of forecasted avoided costs of electricity to load weighted real time locational marginal prices (LMPs) for each EDC service area.” According to the 2021 TRC Test Order, the Commission may reconsider the appropriateness of a static forecast of avoided costs or make changes in the methodology currently used to develop the avoided costs forecast based on the results of this exercise.

The original Phase IV forecasted avoided costs were developed in the summer of 2020, at the height of the COVID-19 pandemic. During this time, the energy markets were facing low prices and uncertainty about the future regarding the pandemic. In summer 2022, the first review of avoided costs was undertaken by the SWE. Using LMP data from PJM’s DataMiner2, it was determined that, in every costing period, the forecasted avoided costs had been underpredicted in comparison to experienced prices. The largest divergence from predictions was seen in the shoulder months.

A review of the avoided cost of generating capacity forecasts was conducted in parallel to the review of forecasted avoided energy costs. In contrast, the most recent clearing prices for generation capacity were lower than forecasted for all EDCs. While the forecasted avoided cost of energy has led to understated avoided energy benefits, the forecasted avoided cost of capacity has overstated the value of peak savings in the near term.

No forecast model is perfect and there will always be some difference between forecasted and actual market conditions. When combining forecasts for multiple resources, however, differences should be expected to even out unless there is a systematic bias in the forecast. This is indeed the observation for the energy and capacity market forecasts versus actual values which nearly balanced each other out in our sensitivity analysis. Long-term forecasts also predicted the current high prices of energy to fall in the coming years, closer to the levels originally forecasted.

The SWE team cautions against an update to Phase IV avoided costs based on short-term departures between market conditions and the forecast. If long-term fuel projections stop showing a return to traditional levels, or if actual capacity prices cease to offset the impact on total TRC benefits, the Commission may want to consider a mid-phase update to Phase IV avoided costs.

²⁷ Green and Healthy Homes Initiative, Housing Alliance of Pennsylvania, Keystone Energy Efficiency Alliance, Natural Resources Defense Council, National Housing Trust, Pennsylvania Utility Law Project, and Regional Housing Legal Services (collectively, the Pennsylvania Energy Efficiency for All Coalition (PA-EEFA))

Section 3 Portfolio and Program-Level Savings by EDC

This chapter provides a summary of the portfolio and program-level energy impacts, peak demand impacts, DR performance, and Total Resource Cost (TRC) benefit-cost ratios for each EDC.

Table 22 presents a statewide overview of PY13 savings.

Table 22: Summary of Statewide PY13 Impacts: Gross and Net Annual and Lifetime Savings

Savings Category	Statewide Total
PY13 Reported Gross Savings (MWh/yr)	604,928
PY13 Verified Gross Savings (MWh/yr)	601,700
PY13 Net Savings (MWh/yr)	419,934
PY13 Gross Lifetime Savings (MWh)	7,192,040
PY13 Net Lifetime Savings (MWh)	4,871,611

3.1 PECO

3.1.1 Impact Evaluation

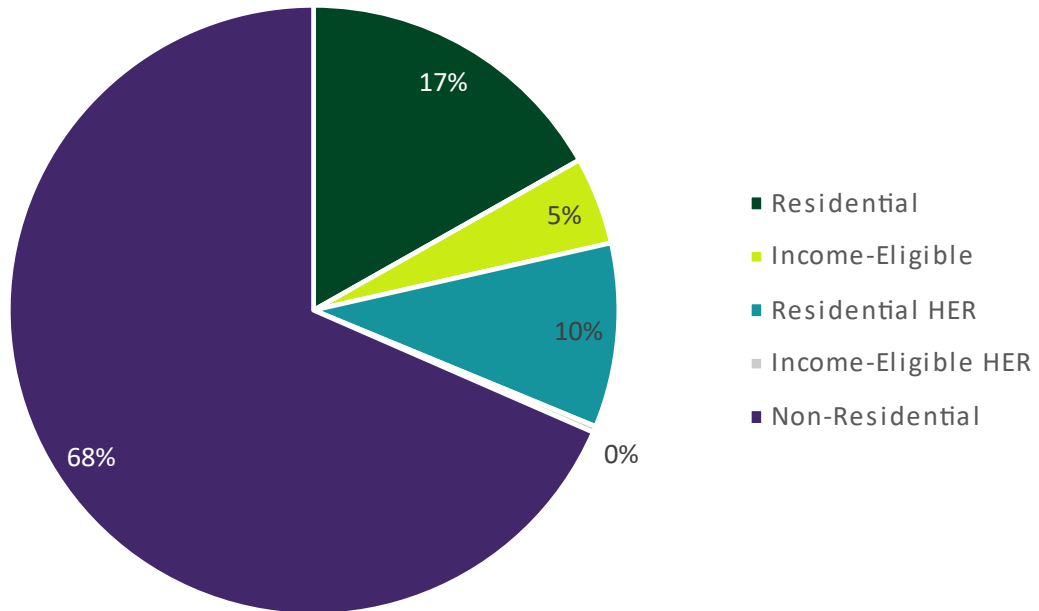
Table 23 summarizes PECO's energy impacts by program for PY13. Over two-thirds of the savings (68%) are attributable to the Non-Residential Program while the Residential Program accounted for 17% of verified savings in PY13 (see Figure 12).

Table 23: PY13 Incremental Annual Energy Savings by Program (MWh/Year) – PECO

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Residential	42,009	97%	40,863	0.68	27,872
Income-Eligible	15,969	71%	11,310	1.00	11,310
Residential HER	23,789	100%	23,781	1.00	23,781
Income-Eligible HER	793	100%	795	1.00	795
Non-Residential	155,915	107%	166,440	0.64	106,507
Portfolio Total¹	238,475	102%	243,190	0.70	170,265

¹ Totals may not equal sum of column or row due to rounding.

Figure 12: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – PECO



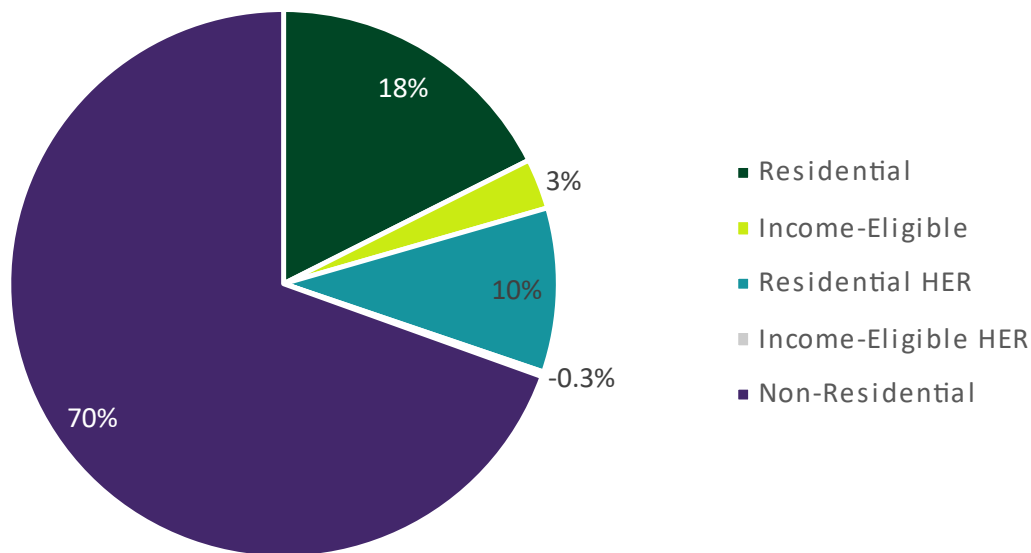
A summary of the peak demand impacts by energy efficiency program for PY13 are presented in Table 24 and Figure 13.

Table 24: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year) – PECO

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Residential	7.64	97%	7.44	0.68	5.13
Income-Eligible	1.81	75%	1.27	1.00	1.27
Residential HER	3.87	106%	4.10	1.00	4.10
Income-Eligible HER	0.13	-91%	-0.12	1.00	-0.12
Non-Residential	29.78	99%	29.43	0.65	19.09
Portfolio Total¹	43.24	97%	42.11	0.70	29

¹ Totals may not equal sum of column or row due to rounding.

Figure 13: Percent of Portfolio PY13VTD Gross Peak Demand Savings, by Program – PECO



3.1.2 Cost-Effectiveness

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 elsewhere 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.

Figure 14 shows the breakdown of total TRC benefits and costs for PECO in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 0.98 in PY13. The red coloring for fossil fuel impacts indicates negative benefits, or increased fossil fuel consumption. Fossil fuel increases from the interactive effects of LED lighting on space heating systems and the additional fuel required to power CHP systems.

Figure 14: PY13 PECO TRC Breakdown

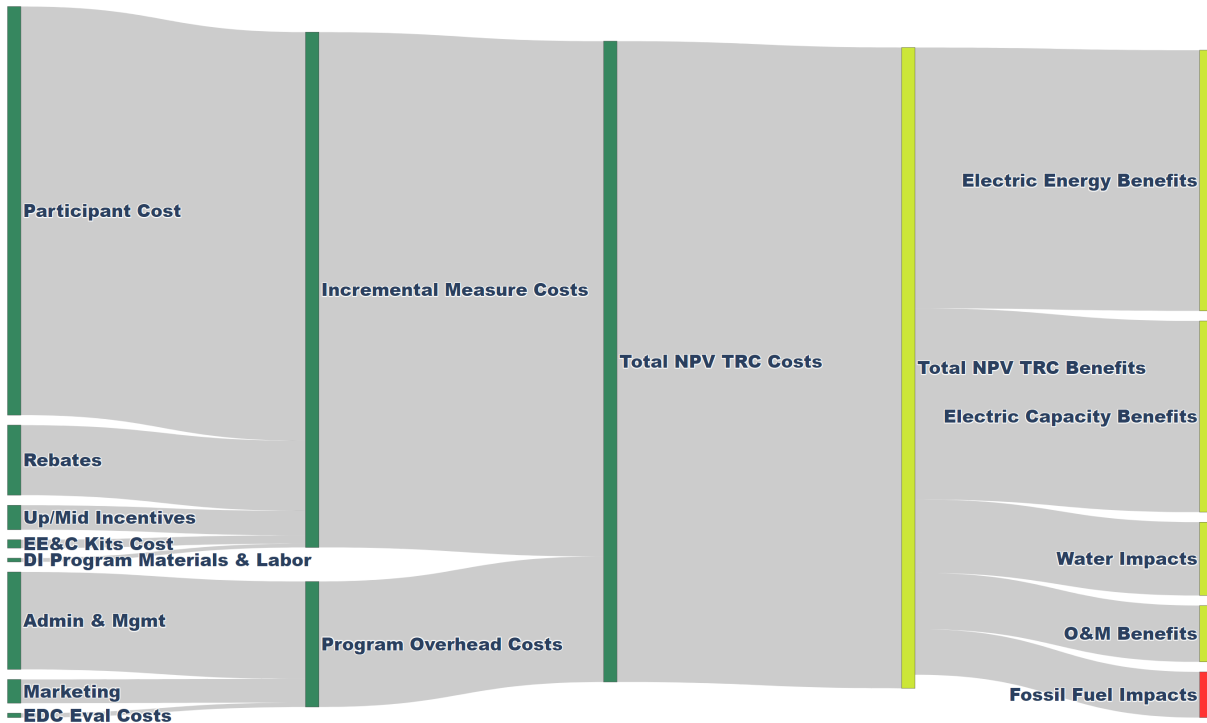


Table 25 shows the TRC ratios by program and for the portfolio. The benefits in Table 25 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 25: PY13 Gross TRC Ratios by Program (\$1,000) – PECO

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Income Eligible Energy Efficiency	\$21,895	\$5,731	3.82	\$16,164
Income Eligible Home Energy Report	\$1	\$60	0.01	(\$59)
Residential Energy Efficiency	\$40,166	\$38,217	1.05	\$1,950
Residential Home Energy Reports	\$2,409	\$1,418	1.70	\$991
Residential Total	\$64,472	\$45,425	1.42	\$19,047
Non-Residential Energy Efficiency	\$79,092	\$90,252	0.88	(\$11,159)
Non-Residential Total	\$79,092	\$90,252	0.88	(\$11,159)
Cross-cutting	\$0	\$10,473	N/A	(\$10,473)
Portfolio Total¹	\$143,564	\$146,150	0.98	(\$2,585)

¹ Totals may not equal sum of column or row due to rounding.

3.1.3 Process Evaluation

Guidehouse reported on PY13 process evaluations for the following PECO programs and target market segments (Table 26).

Table 26: PECO PY13 Process Evaluations Conducted for Program Components

Programs and Program Components	
Residential Program ²⁸	Non-Residential Program ²⁹
	Midstream Rebates
Residential Home Energy Reports Program	
Home Energy Reports	Income-Eligible Program ³⁰
Income-Eligible Home Energy Reports Program	
Home Energy Reports	

For PY13, Guidehouse conducted and reported on full process evaluations for a total of three components within the PECO residential, residential home energy reports, income-eligible, income-eligible home energy reports, and non-residential programs. From these evaluations, it produced a total of four process evaluation findings that resulted in four process recommendations, all of which were under consideration. A key cross-program finding was program satisfaction from participants and distributors. Participant satisfaction information was collected for the Residential Home Energy Reports Program and the Income-Eligible Home Energy Reports Program. To rate participant satisfaction, Guidehouse used a scale of 0 to 10 with 0 representing “extremely dissatisfied” and 10 representing “extremely satisfied.” The average, participant satisfaction score for the Residential Home Energy Reports Program overall was 7.6 out of 10 and the average participant satisfaction score for the Income-Eligible Home Energy Reports Program overall was 7.2 out of 10. Satisfaction information was also collected from distributors in one non-residential program component, with an average distributor satisfaction score of 7 out of 10 for the Midstream Rebates component of the program overall.

For the *PECO Residential Home Energy Reports Program*, the PY13 process evaluation produced two findings that resulted in two recommendations. The two recommendations are under consideration by the program. A key program finding was on program satisfaction from participating customer surveys, which were conducted for the Residential Home Energy Reports Program. Participants provided an average satisfaction rating of 7.6 out of 10 for the program

²⁸ As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Rebates and Marketplace, the In-Home Assessments (Single-Family), the Multifamily, Appliance Recycling, or New Construction components in PY13 for the Residential Program.

²⁹ As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Downstream Rebates, the New Construction, or the Small Business Direct Install components in PY13 for the Non-Residential Program.

³⁰ As described in the Phase IV Evaluation Plan updated for PY13 and approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Single-Family, the Multifamily, the Appliance Recycling, or the Long-Term Savings components in PY13 for the Income-Eligible Program.

overall. Findings for this program addressed other topics beyond satisfaction, including the following:³¹

- Perceived usefulness of various report components
- Perceived accuracy of various report components
- Awareness of energy-saving tips provided in the reports
- Perceived relevance of energy-saving tips provided in the reports

For the *PECO Income-Eligible Home Energy Reports Program*, the PY13 process evaluation produced two findings that resulted in two recommendations. The two recommendations are under consideration by the program. A key program finding was on program satisfaction from participating customer surveys, which were conducted for the Income-Eligible Home Energy Reports Program. Participants provided an average satisfaction rating of 7.2 out of 10 for the program overall. Findings for this program addressed other topics beyond satisfaction, including the following:³²

- Perceived usefulness of various report components
- Perceived accuracy of various report components
- Awareness of energy-saving tips provided in the reports
- Perceived relevance of energy-saving tips provided in the reports

For the *PECO Non-Residential EE Program*, the PY13 process evaluation of the Midstream Rebate component did not include any process findings that led to recommendations. A key program finding was on program satisfaction from participating distributor surveys. Distributors provided an average satisfaction rating of 7 out of 10 with the Midstream Rebate Component of the Non-Residential EE Program overall.

Component-specific findings for the Midstream Rebate Component addressed other topics beyond satisfaction, including the following:³³

- Ease of participating in the program
- Likelihood to recommend the program
- Additional feedback about the program
- Influence of the COVID-19 pandemic on distributors' ability to stock program-qualified fixtures

3.1.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the PECO PY13 Annual Report and the supporting detail provided by PECO's evaluation contractor. The detailed audit findings can be found in [Appendix B](#).

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PECO's PY13 Annual Report to the tracking data provided to the

³¹ The PECO annual report provides further detail regarding these topics.

³² The PECO annual report provides further detail regarding these topics.

³³ The PECO annual report provides further detail regarding these topics.

SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings, reported MW savings, and incentives. We were unable to replicate participant counts exactly using the tracking data, but we did not expect to be able to do so.

- The SWE conducted a project file review for a sample of PECO’s residential and income-eligible components in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, Guidehouse estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and applied historic NTG according to the approved EM&V plan.
- For the process evaluations, Guidehouse completed all the PY13 activities detailed in the approved evaluation plan and sampling memos, and the reporting followed the SWE guidelines. The process evaluation discussion was succinct and highlighted findings that should be of value to PECO and its CSPs.
- PECO’s Phase IV EM&V Plan created a new intermediate savings quantity between reported and verified gross referred to as “adjusted database savings.” The adjusted database savings are computed for every program component annually, even in program years when no impact evaluation is conducted. In PY13, the adjusted database savings were virtually identical to the reported gross savings for many programs. This speaks to the robustness of PECO’s program tracking system. The incorporation of this interim step into the rollup and calculation of verified savings was not well documented in the PY13 annual data request response. The SWE discussed the challenges with Guidehouse and Guidehouse will improve its documentation in PY14.
- Beginning in PY13, behavioral HER savings were adjusted to remove persistent impacts from HERs issued in previous program years. PECO had separate waves with one, two, and three plus years of treatment, each of which required different calculations, and Guidehouse applied the new Phase IV guidelines exactly for each.
- PECO enhanced its methodology to estimate peak demand savings from HERs in PY13. Peak demand savings are now measured as the difference in usage between treatment and control groups from 2:00 PM to 6:00 PM on non-holiday weekdays in June, July, and August. Guidehouse implemented the new method appropriately. PECO may have seen greater savings with an earlier start date for its newest waves; however, this wave made up a large percentage of total participants and a majority of energy savings, but participants did not begin receiving HERs until June 27, 2021, at the earliest.
- For the Rebates and Marketplace Components of the Residential Program, Guidehouse conducted impact evaluations that estimated verified savings and realization rates for a sample of projects, stratified by measure, that incorporated data from surveys of participants. However, the SWE team found the evaluated components difficult to verify because the adjusted database savings and verified savings were mislabeled in several files. In addition, the verified savings and realization rates for the sample varied slightly in the Guidehouse analysis files. Further, while the approved PECO evaluation plan specified engineering desk reviews (as well as participant surveys) as part of the impact

evaluation activities, Guidehouse relied on a combination of TRM default values, EDC-provided data, and participant surveys.³⁴ The SWE recommends that future engineering reviews of sampled programs include verification of measure characteristics in EDC-provided data when measure model numbers or ENERGY STAR IDs are provided.

- PECO had the lowest portfolio TRC ratio of the seven EDCs subject to Act 129 in PY13. The marginal portfolio result was driven largely by two factors from the non-residential program.
 - A single CHP project accounted for approximately one-third of non-residential savings in PY13. While the project delivered a large amount of compliance savings with limited investment of program budget, the economics from a TRC standpoint were modest at approximately 0.75. Without this CHP project, PECO's non-residential program and portfolio show a gross TRC ratio greater than 1.0.
 - PECO assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The PECO cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

3.2 PPL

3.2.1 Impact Evaluation

A summary of energy impacts by program for PY13 is presented in [Table 27](#). Over three quarters of the savings (76%) are attributable to the Non-Residential Energy Efficiency Program, which comprises two distinct program components – Efficient Equipment and Custom (see [Figure 15](#)). The program is designed to give customers the option to save electricity across lighting and non-lighting end-uses including those measure that are not covered by other programs. Given this comprehensive approach, the program has a much wider reach and higher participation than other programs in the portfolio.

³⁴ In response to the SWE's inquiry about engineering reviews and independent verification of measure characteristics, Guidehouse provided more details on their review. Guidehouse generally relies on the measure characteristics in the tracking data and deemed TRM assumptions where specified. Early in the program year Guidehouse reviewed the CSP's methodology for measure characteristics (e.g., ENERGY STAR database for most products, AHRI database for HVAC, and manufacturer specifications as needed if there are any gaps). For program components with evaluation samples, Guidehouse reviewed the measure characteristics but did not independently verify them.

Table 27: PY13 Incremental Annual Energy Savings by Program (MWh/Year)* – PPL

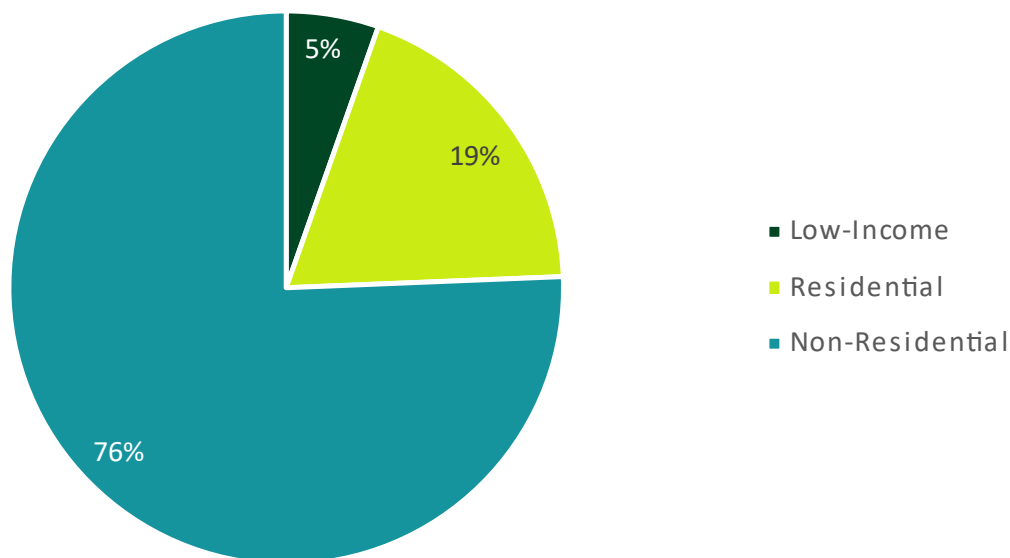
Program	PYRTD (MWh/yr) ²	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Low-Income	11,840	0.76	9,027	1.00	9,027
Residential	35,008	0.91	31,737	0.68	21,476
Non-Residential	123,157	1.03	126,597	0.58	73,230
Portfolio Total¹	170,005	0.98	167,361	0.62	103,733

¹ Totals may not equal sum of column or row due to rounding.

² Reported savings include unverified savings

Note that the PYRTD includes a total of 6,084 unverified savings that will be verified in PY14, including 3,048 MWh for the Non-Residential program, 103 MWh for the Low-Income program, and 2,933 MWh for the Residential program.

Figure 15: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – PPL



A summary of the peak demand impacts by energy efficiency program for PY13 are presented in Table 28 and Figure 16.

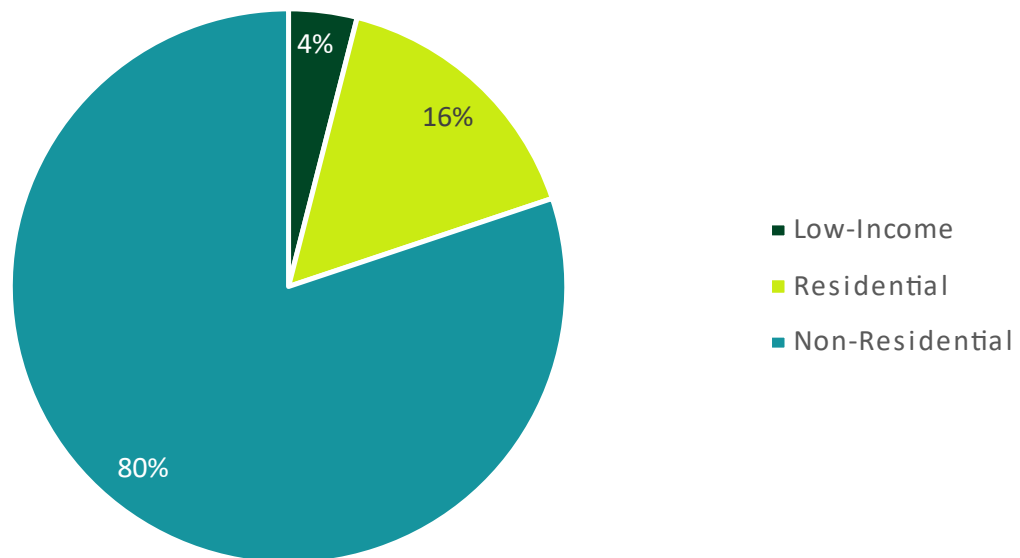
Table 28: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year)* – PPL

Program	PYRTD (MW/yr) ²	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Low-Income	1.29	79%	1.02	1.00	1.02
Residential	5.00	82%	4.08	0.69	2.81
Non-Residential	20.37	101%	20.58	0.57	11.66
Portfolio Total¹	26.66	96%	25.68	0.60	15.49

¹ Totals may not equal sum of column or row due to rounding.

² Reported savings include unverified savings

Figure 16: Percent of Portfolio PY13VTD Peak Demand Savings, by Program – PPL



3.2.2 Cost-Effectiveness

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 elsewhere 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.

Figure 17 shows the breakdown of total TRC benefits and costs for PPL in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.85 in PY13.

Figure 17: PY13 PPL TRC Breakdown

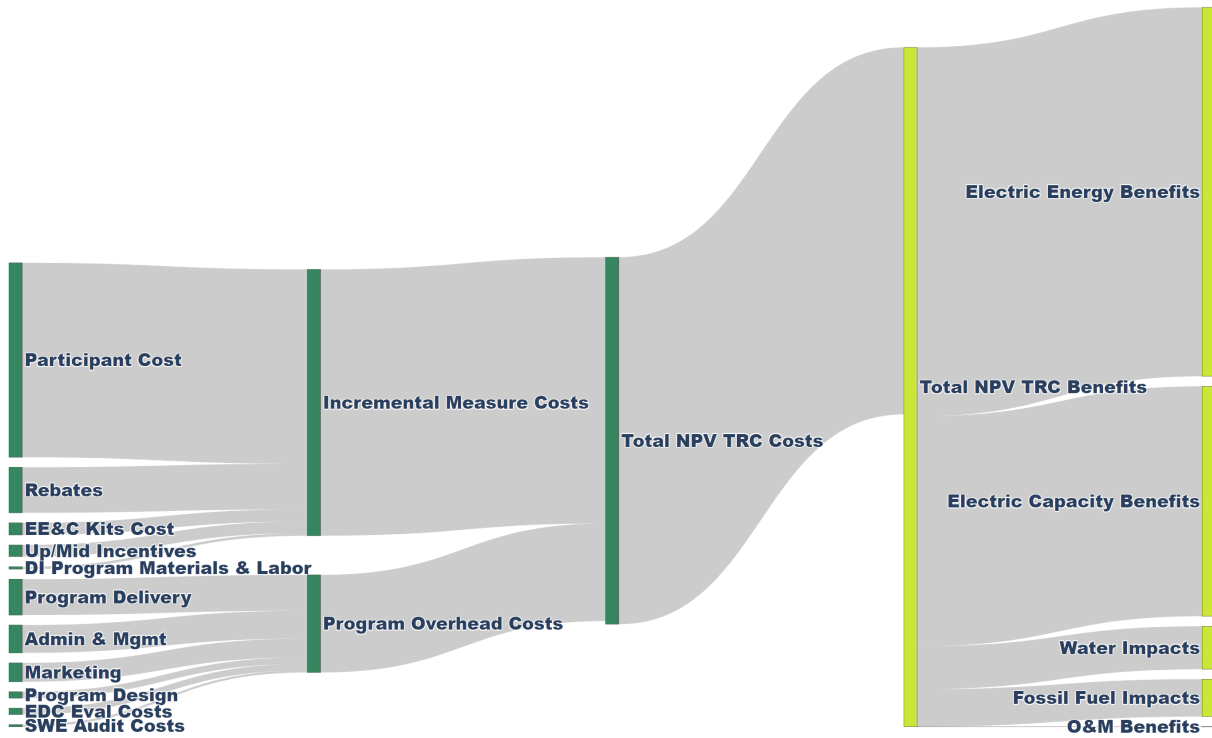


Table 29 shows the TRC ratios by program component and for the portfolio. The benefits in Table 29 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 29: PY13 Gross TRC Ratios by Program (\$1,000) – PPL

Program Components	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Low-Income	\$6,748	\$5,215	1.29	\$1,533
Appliance Recycling	\$2,340	\$1,577	1.48	\$763
Efficient Lighting	\$3,058	\$1,153	2.65	\$1,905
Energy Efficient Homes	\$12,303	\$11,548	1.07	\$755
Student Energy Efficient Education	\$6,505	\$663	9.81	\$5,842
Residential Total	\$30,954	\$20,157	1.54	\$10,797
Custom	\$22,903	\$10,704	2.14	\$12,199
Efficient Equipment	\$68,630	\$28,905	2.37	\$39,725
Non-Residential Total	\$91,533	\$39,609	2.31	\$51,924
Cross-cutting	\$0	\$6,400	N/A	(\$6,400)
Portfolio Total	\$122,486	\$66,167	1.85	\$56,319

¹ Totals may not equal sum of column or row due to rounding.

3.2.3 Process Evaluation

Cadmus reported on PY13 process evaluations for the following PPL programs and program components (Table 30).

Table 30: PPL PY13 Process Evaluations Conducted for Program Components

Programs and Program Components	
Residential Program ³⁵	Non-Residential Program ³⁶
Appliance Recycling	Efficient Equipment (downstream)
Efficient Lighting	Custom
Energy Efficient Homes - New Homes	
Energy Efficient Homes - Online Marketplace	Low-Income (LI) Program ³⁷
Energy Efficient Homes - Equipment (downstream)	Remote Energy Assessment (REA)
Student Energy Efficient Education	Welcome Kits

For PY13, Cadmus conducted and reported on full process evaluations for a total of ten components and subcomponents within the PPL residential, non-residential, and LI programs. The Residential Program has four components (Appliance Recycling, Efficient Lighting, Energy Efficient Homes, and Student Energy Efficient Education). Additionally, the Energy Efficient Homes component within the Residential Program has five distinct sub-components (New Homes, Audit and Weatherization, Online Marketplace, Downstream Equipment, and Midstream Equipment) with separate evaluations. The Non-Residential Program has two components (Efficient Equipment and Custom) with separate evaluations. Additionally, the Efficient Equipment component within the Non-Residential program has two distinct sub-components (Downstream and Midstream). The LI Program has three components (REA, Direct Install, and Welcome Kits) with separate evaluations. These evaluations generated a total of three process evaluation conclusions, which resulted in three recommendations, two of which have been implemented and one of which is under consideration.³⁸ A key cross-program finding was on program satisfaction from participants, retailers, builders, and participating teachers and students. Participant

³⁵ For the Residential Program, the Audit and Weatherization sub-component of the Energy Efficient Homes component and the Equipment (midstream) sub-component of Energy Efficient Homes component are not included because process evaluations were not completed for these sub-components in PY13. A process evaluation was planned for the Audit and Weatherization sub-component in PY13 but it was not completed because PPL did not report any participants in this sub-component.

³⁶ For the Non-Residential Program, the Midstream sub-component is not included because a full process evaluation was not completed in PY13. Please note that both the Downstream and Midstream sub-components include both non-lighting and lighting participation pathways. A limited process evaluation was performed for the Midstream lighting subcomponent (logic model review).

³⁷ For the LI Program, the Direct Install component is not included because a process evaluation was not completed for this component in PY13. Though the evaluation plan targeted 36 completed surveys for Direct Install participants, there was only one direct install appointment completed at the time of the survey fielding. Therefore, Cadmus did not complete a participant survey with the Direct Install participants and instead targeted additional completes for REA participants.

³⁸ There are additional findings and recommendations in the PY13 report; however, this section reports only findings and recommendations that were specifically related to the process evaluation.

satisfaction information was collected for three residential program components (Appliance Recycling, Energy Efficient Homes, and Student Energy Efficient Education), two Non-Residential program components (Efficient Equipment and Custom), and two residential LI program components (REA and Welcome Kits). On average, across all participant surveys, 83% of residential and LI participants and 93% of non-residential participants were satisfied with the programs or program measures overall.³⁹ Satisfaction information was also collected for retailers in one residential program component, with an average of 100% satisfaction for retailers active with the Efficient Lighting component. Satisfaction information was also collected from builders in one residential program, with an average of 94% satisfaction for builders active with the New Homes sub-component of the Energy Efficient Homes component.

For the *PPL Residential Program*, the PY13 process evaluation provided a total of two conclusions and two recommendations. One of the recommendations has been implemented and one of the recommendations is under consideration. A key cross-program finding was on program satisfaction from participant, retailer, builder, and participating student and teacher surveys. The evaluation conducted a participant survey for the Appliance Recycling component, a retailer survey for the Efficient Lighting component, a builder survey for the New Homes sub-component of the Energy Efficient Home component, a participant survey for the Online Marketplace sub-component of the Efficient Home component, a participant survey for the Downstream Equipment subcomponent of the Efficient Homes component, and participating teacher and student surveys for the Student Energy Efficient Education component. On average, 88% of the participants (including participating customers, teachers, and students), 100% of the retailers, and 94% of the builders were satisfied with the program overall. Findings for this program addressed other topics beyond satisfaction, including the following:⁴⁰

- Ease of participation
- Perspectives on the component's impacts on stocking practices
- Perspectives on impacts of the EISA legislation
- Insights about the residential new construction market and installation of high-efficiency equipment
- Drivers of program component satisfaction
- Opinions about PPL
- Likelihood to recommend the program component
- Program improvement suggestions

For the *PPL Non-Residential Program*, the PY13 process evaluation did not include any process conclusions that led to recommendations. A key cross-program finding was on program satisfaction from participant surveys. The evaluation conducted participant surveys for the Downstream Non-Lighting sub-component of the Efficient Equipment component, the Downstream Lighting sub-component of the Efficient Equipment component, and the Custom

³⁹ Weighted by the number of PY13 participants in each program.

⁴⁰ The PPL annual report provides further detail regarding these topics.

component. On average, 93% of the participants were satisfied with the program overall. Findings for this program addressed other topics beyond satisfaction, including the following:⁴¹

- Ease of participation
- Drivers of program component satisfaction
- Opinions about PPL
- Likelihood to recommend the program component
- Program improvement suggestions

For the *PPL Residential LI Program*, the PY13 process evaluation provided a total of one process conclusion and one process recommendation. The recommendation has been implemented. A key cross-program finding was program satisfaction from participant surveys. The evaluation conducted a participant survey for the REA component and a participant survey for the Welcome Kits component. On average, 83% of the participants were satisfied with the program overall. Findings for this program addressed other topics beyond satisfaction, including the following:⁴²

- Ease of participation
- Drivers of program component satisfaction
- Opinions about PPL
- Likelihood to recommend the program component
- Program improvement suggestions

3.2.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the PPL PY13 Annual Report and the supporting detail provided by PPL's evaluation contractor. The detailed audit findings can be found in [Appendix C](#).

- PPL had one the highest portfolio TRC ratios of the seven EDCs subject to Act 129 in PY13. The portfolio result was driven largely by the performance of the non-residential program, which had a gross TRC ratio of 2.31. However, the TRC audit noted that PPL assumes a replace-on-burnout perspective (efficient equipment cost minus baseline equipment cost) when assigning incremental measure cost to most commercial lighting measures. The PPL cost perspective is inconsistent with the perspective used to estimate energy and demand savings and leads to an upward bias in the TRC results. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14, since it is by far the largest measure category statewide.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PPL's PY`3 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings, reported MW savings, and participant counts. We

⁴¹ The PPL annual report provides further detail regarding these topics.

⁴² The PPL annual report provides further detail regarding these topics.

were unable to replicate incentives exactly using the tracking data, but we did not expect to be able to do so.

- The SWE conducted a project file review for a sample of PPL's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, Cadmus estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and the approved EM&V plan.
- For the process evaluations, Cadmus completed all the PY13 activities detailed in the approved evaluation plan and sampling memos, and the reporting followed the SWE guidelines. The process evaluation discussion was succinct and highlighted findings that should be of value to PPL and its CSPs.

3.3 DUQUESNE LIGHT

3.3.1 Impact Evaluation

A summary of energy impacts by program for PY13 is presented in [Table 31](#). Seventy-six percent of the savings are attributable to non-residential programs such as the Commercial Large Business Solutions (21% of PY13 energy savings; see [Figure 18](#)). The Residential Behavioral accounted for the largest share of residential savings (11% of PY13 portfolio savings).

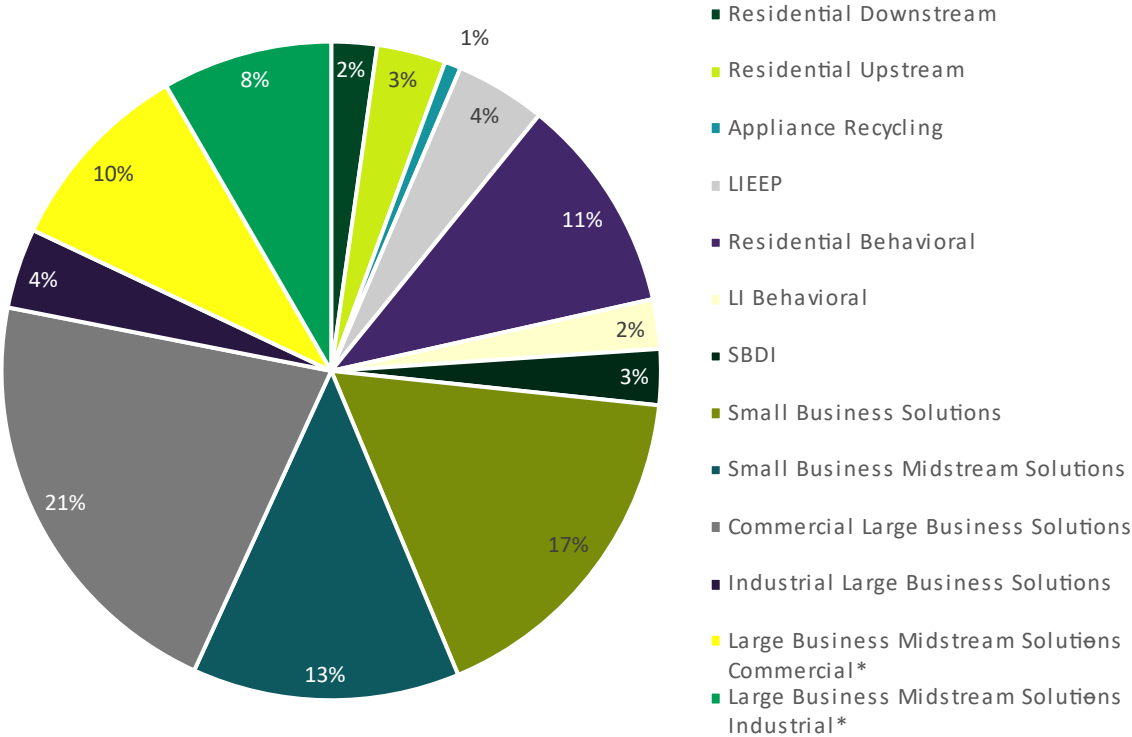
Table 31: PY13 Incremental Annual Energy Savings by Program (MWh/Year)¹ – Duquesne Light

Program	PYRTD (MWh/yr) ²	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Residential Downstream Incentives	1,533	72%	1,099	68%	749
Residential Midstream Incentives	N/A	N/A	N/A	N/A	N/A
Residential Upstream Incentives	1,381	120%	1,659	65%	1,083
Residential Appliance Recycling	347	113%	391	47%	183
Low Income Energy Efficiency (LIEEP)	2,534	86%	2,179	100%	2,179
Residential Behavioral Savings	5,137	102%	5,227	100%	5,227
LI Residential Behavioral	931	128%	1,196	100%	1,196
Small Business Direct Install (SBDI)	1,298	103%	1,343	99%	1,333
Small Business Solutions	6,134	136%	8,369	79%	6,591
Small Business Midstream Solutions ²	10,665	60%	6,438	72%	4,635
Small Business Virtual Commissioning	N/A	N/A	N/A	N/A	N/A
Commercial Large Business Solutions	9,189	114%	10,442	79%	8,224
Industrial Large Business Solutions	2,142	90%	1,933	61%	1,175
Large Business Midstream Solutions – Commercial ²	3,359	141%	4,727	72%	3,403
Large Business Midstream Solutions – Industrial ²	2,841	144%	4,098	72%	2,950
Large Business Virtual Commissioning	N/A	N/A	N/A	N/A	N/A
Portfolio Total	47,492	103%	49,101	79%	38,929

¹ Totals may not equal sum of column or row due to rounding.

² Reported savings include unverified savings

Figure 18: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – Duquesne Light



A summary of the peak demand impacts by energy efficiency program for PY13 are presented in [Table 32](#) and [Figure 19](#).

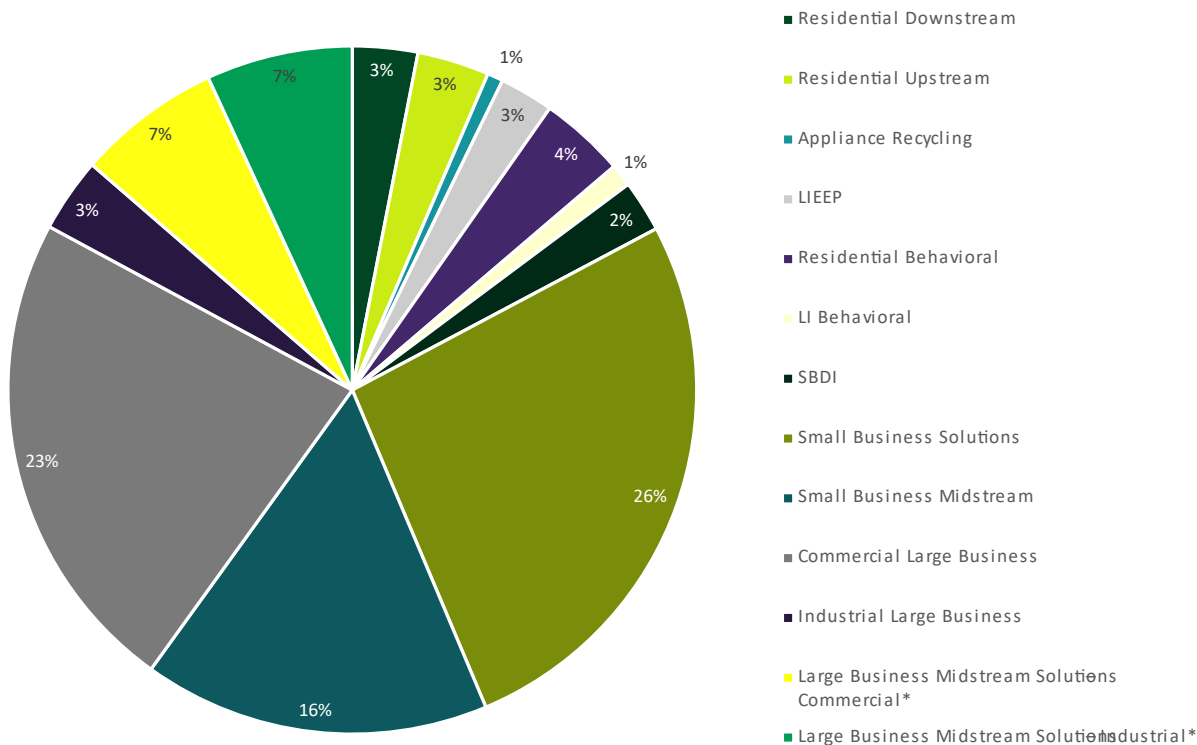
Table 32: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year) – Duquesne Light¹

Program	PYRTD (MW/yr) ²	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Residential Downstream Incentives	0.3	96%	0.29	68%	0.19
Residential Midstream Incentives	N/A	N/A	0	N/A	0
Residential Upstream Incentives	0.24	131%	0.32	65%	0.24
Residential Appliance Recycling	0.07	112%	0.07	47%	0.03
Low Income Energy Efficiency	0.27	88%	0.24	100%	0.24
Residential Behavioral Savings	0.4	94%	0.38	100%	0.38
LI Residential Behavioral	0.03	280%	0.1	100%	0.1
Small Business Direct Install	0.21	109%	0.23	99%	0.22
Small Business Solutions	1.25	199%	2.5	79%	1.97
Small Business Midstream Solutions ²	2.13	72%	1.54	72%	1.11
Small Business Virtual Commissioning	N/A	N/A	0	N/A	0
Commercial Large Business Solutions	1.82	119%	2.17	79%	1.71
Industrial Large Business Solutions	0.35	95%	0.33	61%	0.2
Large Business Midstream Solutions – Commercial ²	0.62	102%	0.64	72%	0.46
Large Business Midstream Solutions – Industrial ²	0.65	100%	0.65	72%	0.47
Large Business Virtual Commissioning	N/A	N/A	0	N/A	0
Portfolio Total	8.35	113%	9.45	79%	7.32

¹ Totals may not equal sum of column or row due to rounding.

² Reported savings include a total of 0.73 MW of unverified savings

Figure 19: Percent of Portfolio PY13VTD Peak Demand Savings, by Program – Duquesne Light



3.3.2 Cost-Effectiveness

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 elsewhere 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.

Figure 20 shows the breakdown of total TRC benefits and costs for Duquesne Light in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.84 in PY13. The red coloring for fossil fuel impacts indicates negative benefits, or increased fossil fuel consumption. Fossil fuel increases from the interactive effects of LED lighting on space heating systems.

Figure 20: PY13 Duquesne Light TRC Breakdown

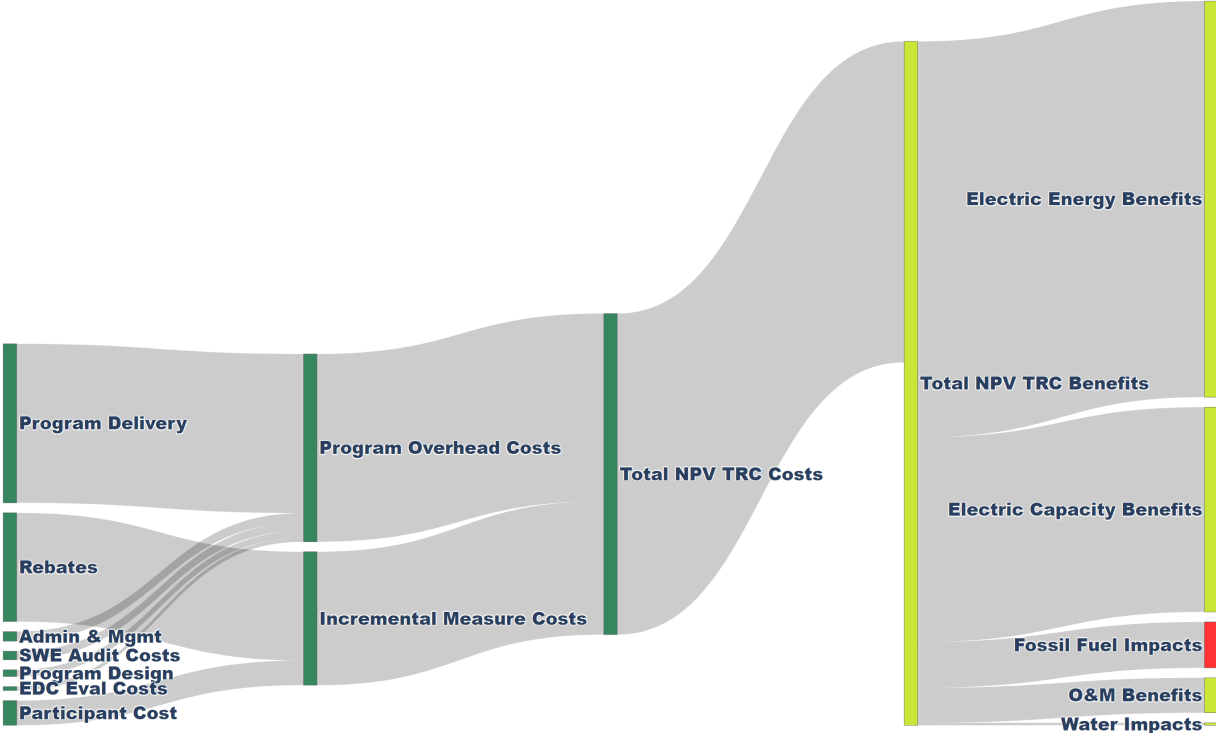


Table 33 shows the TRC ratios by program and for the portfolio. The benefits in Table 33 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 33: PY13 Gross TRC Ratios by Program (\$1,000) – Duquesne Light¹

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Appliance Recycling	\$85	\$803	0.11	(\$718)
Residential Downstream Incentives	\$589	\$1,025	0.57	(\$436)
Residential Midstream Incentives	\$0	\$74	0.00	(\$74)
Residential Upstream Incentives	\$916	\$1,033	0.89	(\$117)
Residential Behavioral Energy Efficiency	\$294	\$576	0.51	(\$282)
Low Income Energy Efficiency	\$562	\$1,243	0.45	(\$681)
Low Income Behavioral Efficiency	\$71	\$127	0.56	(\$56)
Residential Total	\$2,517	\$4,881	0.44	(\$2,364)
Small Business Direct Install	\$856	\$701	1.22	\$156
Small Business Solutions	\$6,335	\$1,583	4.00	\$4,753
Small Business Midstream Solutions	\$4,648	\$2,672	1.74	\$1,976
Small Business Virtual Commissioning	\$0	\$65	0.00	(\$65)
Large Commercial Business Solutions	\$6,853	\$2,504	2.74	\$4,349
Large Commercial Business Midstream Solutions	\$2,789	\$1,134	2.46	\$1,656
Large Commercial Business Virtual Commissioning	\$0	\$45	0.00	(\$45)
Large Industrial Business Solutions	\$1,121	\$633	1.77	\$488
Large Industrial Business Midstream Solutions	\$2,364	\$652	3.62	\$1,712
Large Industrial Business Virtual Commissioning	\$0	\$32	0.00	(\$32)
Non-Residential Total	\$24,967	\$10,020	2.49	\$14,947
Cross-cutting	N/A	N/A	N/A	N/A
Portfolio Total	\$27,484	\$14,901	1.84	\$12,583

¹Totals may not equal sum of column or row due to rounding.

3.3.3 Process Evaluation

Guidehouse reported on PY13 process evaluations for the following Duquesne Light programs.

Table 34: Duquesne Light PY13 Process Evaluations Conducted for Program Components

Programs and Program Components	
Residential Programs ⁴³	C&I Programs ⁴⁴
Residential Downstream Incentives Program - Downstream Rebate	
Residential Downstream Incentives Program - Energy Efficiency Education	

Guidehouse reported on one PY13 process evaluation for the Duquesne Light Residential Downstream Incentives Program (RDIP).⁴⁵

The PY13 process evaluation of the RDIP generated a total of 15 findings and nine recommendations. Eleven of the findings and seven of the recommendations pertain to the Downstream Rebate component; two of the recommendations were accepted, and five are under consideration. Four of the findings and two of the recommendations pertain to the Energy Efficiency Education component; one recommendation was accepted, and one is under consideration.

A key finding of the PY13 process evaluation was overall program satisfaction from surveys of participants in the two RDIP components. Satisfaction ranged from 68% of respondents for the Downstream Rebate component to 95% of respondents for the Energy Efficiency Education component.⁴⁶ The overall satisfaction rate, weighted by the number of participants, is 80%.

The process evaluation focused on the following areas:

- Program awareness
- Program influence
- Program satisfaction

⁴³ As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not conduct PY13 process evaluations for the Residential Midstream Incentive Program (RMIP), the Residential Upstream Incentive Program (RUIP), the Residential Appliance Recycling Program, the Residential Behavioral Program, the Low-Income Energy Efficiency Program, and the Low Income Residential Behavioral Program.

⁴⁴ As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not conduct PY13 process evaluations for the Small Business Solutions Program, the Small Business Midstream Program, the Small Business Virtual Commissioning Program, The Large Business Solutions Program, the Large Business Midstream Program, and the Large Business Virtual Commissioning Program.

⁴⁵ Guidehouse began a process evaluation of the Small Business Direct Install (SBDI) Program which was part of the PY13 EMV Plan including an online survey of program participants. However, due to significantly lower program participation than expected, Guidehouse was unable to collect enough responses to generate statistically defensible estimates and therefore plans to extend the online participant surveys into PY14 and will report on process evaluation results and recommendations in PY14. During sample design stages the team estimated 60 unique participants for this program with a target of 23 completed surveys. Guidehouse received 4 completed surveys from the SBDI program's participants.

⁴⁶ The Residential Downstream Incentives Program (RDIP) includes three components: customers who received rebates for purchasing and installing energy efficient equipment (Rebate), customers who received a comprehensive energy efficiency audit (Audit), and students and teachers who participate in a K-12 Energy Efficiency Education program (Education).

- Program barriers and challenges
- Opportunities for improvement

3.3.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the Duquesne Light PY13 Annual Report, and the supporting detail provided by Duquesne Light's evaluation contractor. The detailed audit findings can be found in [Appendix D](#).

- Duquesne Light had one the highest portfolio TRC ratios of the seven EDCs subject to Act 129 in PY13. The portfolio result was driven largely by the performance of the non-residential program, which had a gross TRC ratio of 2.49. However, the TRC audit noted that Duquesne Light assumes a replace-on-burnout perspective (efficient equipment cost minus baseline equipment cost) when assigning incremental measure cost to most commercial lighting measures. The Duquesne Light cost perspective is inconsistent with the perspective used to estimate energy and demand savings for most measures and leads to an upward bias in the TRC results. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
- The SWE conducted a project file review for a sample of Duquesne Light's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, Guidehouse estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, Guidehouse completed all the PY13 activities detailed in the approved evaluation plan and sampling memos, and the reporting followed the SWE guidelines. The process evaluation discussion was succinct and highlighted findings that should be of value to Duquesne Light and its CSPs.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Duquesne Light's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. A subset of records from four programs were omitted from the PY13Q4 tracking data request response. The SWE confirmed the missing data with Guidehouse and was able to reconcile these differences by referencing the verification data in the TRC model. After receiving an updated cumulative tracking data file, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- For Duquesne Light's Large C&I programs, line losses were applied inconsistently to peak demand savings between the TRC model and the annual report tables. The issue centers around which accounts should receive a line loss factor of 1.0081 versus a 1.0741 system weighted average. The 1.0081 factor comes from the high voltage primary service rate class, which consists of just 12 accounts that take service at 69 kV. Duquesne Light's Large C&I EE&C programs serve accounts with peak demand above 300 kW, which is a

much broader set of customers. Once the inconsistency was identified, the SWE discussed the issue with Duquesne Light and determined that the treatment of line losses in the TRC model was consistent with line losses on Duquesne Light's system. Once parties aligned on the issue, Guidehouse provided the SWE with revised estimates of verified gross and net peak demand savings, and those are the values presented in this report.

- In PY13, high voltage primary service accounts contributed almost no energy and demand savings. However, historically these large industrial accounts have completed some of the largest and most complex projects in Duquesne Light's EE&C portfolio. Guidehouse and Duquesne Light will need to work out a process to differentiate line loss factors for reporting within the Large C&I programs.
- The SWE found several transcription errors in program-level savings, realization rates and NTG ratios in the summary tables included in Chapter 2 of the Duquesne Light PY13 Annual Report. In addition, the SWE found several inconsistent NTG values reported in the summary table in Chapter 2 compared to the NTG ratios the program specific chapters. The SWE alerted Guidehouse to the issue, who confirmed the correct values.

3.4 FIRSTENERGY: METROPOLITAN EDISON COMPANY

3.4.1 Impact Evaluation

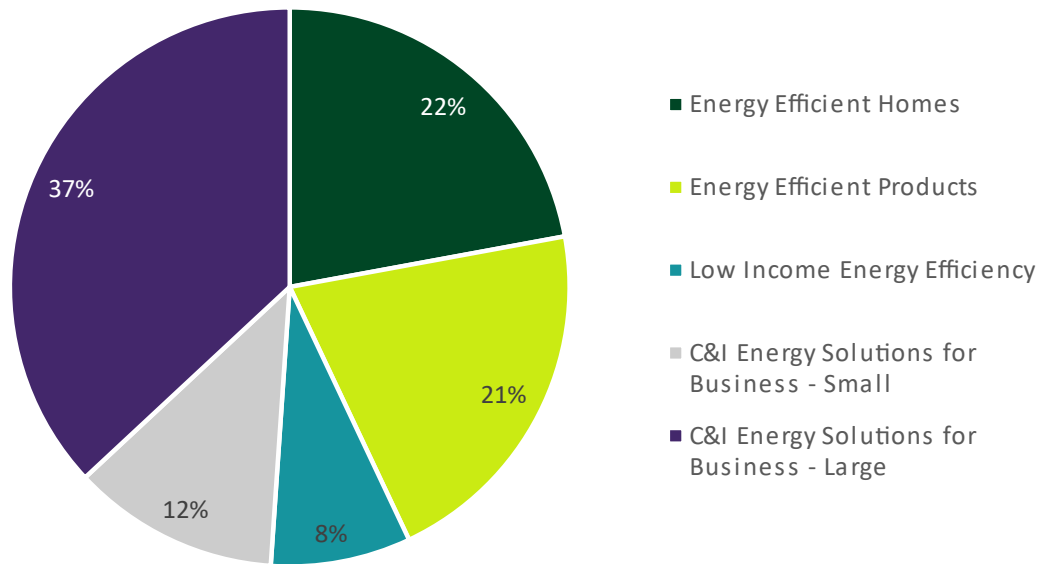
A summary of energy impacts by program for PY13 is presented in [Table 35](#). Forty-nine percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximate 43% of savings are attributable to the two market-rate residential programs ([Figure 21](#)).

Table 35: PY13 Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed¹

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	14,005	73%	10,266	0.83	8,485
Energy Efficient Products	9,299	104%	9,703	0.44	4,252
Low Income Energy Efficiency	4,060	93%	3,762	1.00	3,762
C&I Energy Solutions for Business - Small	5,243	106%	5,562	0.63	3,491
C&I Energy Solutions for Business - Large	16,579	104%	17,162	0.56	9,630
Portfolio Total	49,187	94%	46,455	0.64	29,620

¹ Totals may not equal sum of column or row due to rounding.

Figure 21: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – Met-Ed



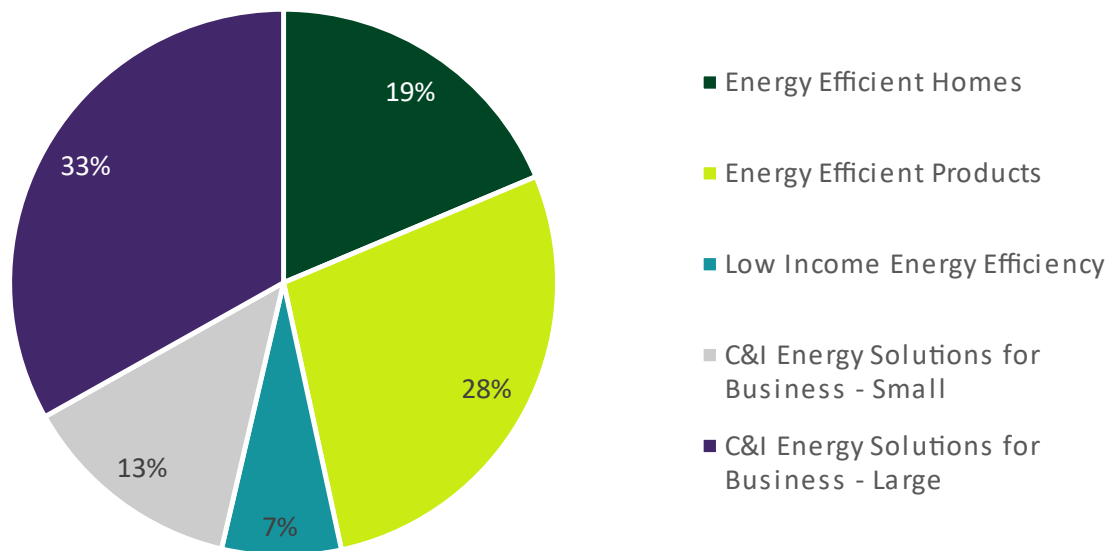
A summary of the peak demand impacts by energy efficiency program for PY13 are presented in Table 36 and Figure 22.

Table 36: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year) – Met-Ed¹

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	2.19	61%	1.33	0.78	1.03
Energy Efficient Products	1.94	102%	1.99	0.43	0.86
Low Income Energy Efficiency	0.54	93%	0.50	1.00	0.50
C&I Energy Solutions for Business - Small	0.96	98%	0.94	0.63	0.59
C&I Energy Solutions for Business - Large	2.32	101%	2.36	0.57	1.34
Portfolio Total	7.94	89%	7.11	0.61	4.32

¹ Totals may not equal sum of column or row due to rounding.

Figure 22: Percent of Portfolio PY13VTD Peak Demand Savings, by Program – Met-Ed



3.4.2 Cost-Effectiveness

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 elsewhere 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.

Figure 23 shows the breakdown of total TRC benefits and costs for Met-Ed in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.35 in PY13. The red coloring for fossil fuel impacts indicates negative benefits, or increased fossil fuel consumption. Fossil fuel increases from the interactive effects of LED lighting on space heating systems.

Figure 23: PY13 Met-Ed TRC Breakdown

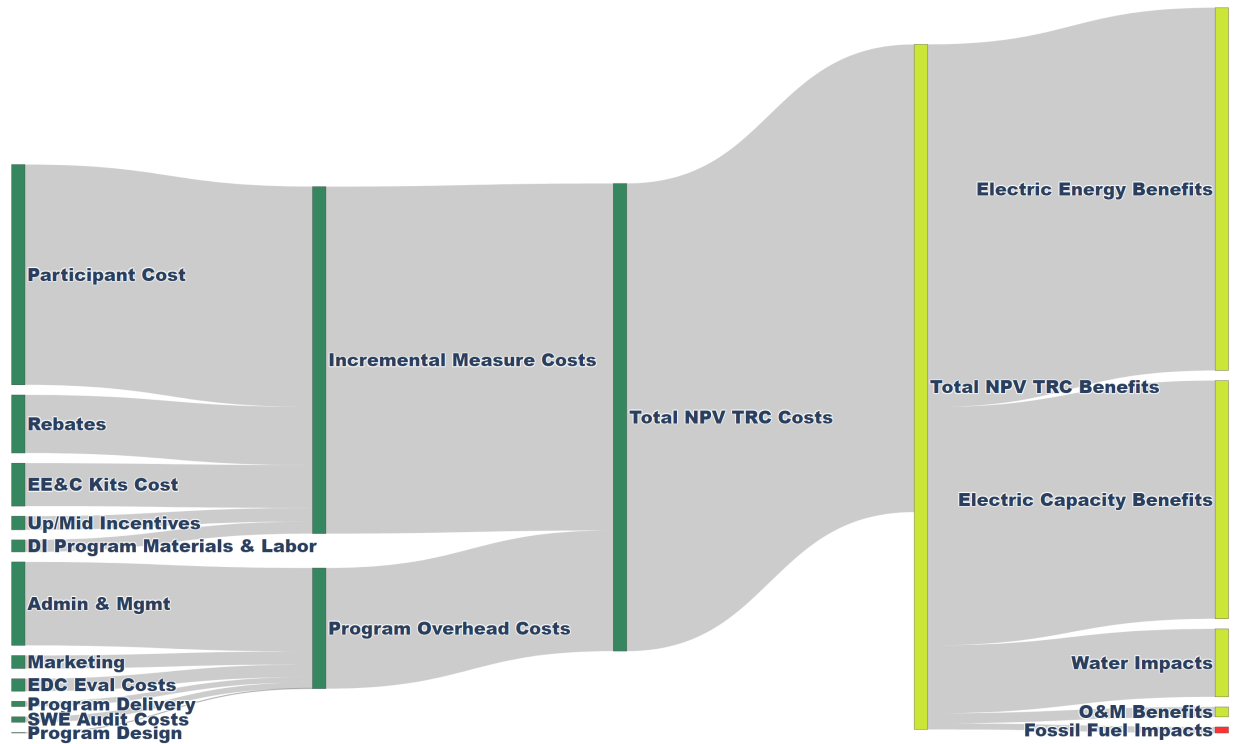


Table 37 shows the TRC ratios by program and for the portfolio. The benefits in Table 37 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 37: PY13 Gross TRC Ratios by Program (\$1,000) – Met-Ed¹

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$8,093	\$4,467	1.81	3,627
Energy Efficient Products	\$4,772	\$5,032	0.95	(\$260)
Low Income Energy Efficiency	\$2,393	\$1,710	1.40	\$683
Residential Total	\$15,259	\$11,209	1.36	\$4,050
C&I Energy Solutions for Business - Small	\$4,039	\$3,339	1.21	\$700
C&I Energy Solutions for Business - Large	\$8,929	\$6,366	1.40	\$2,563
Non-Residential Total	\$12,968	\$9,705	1.34	\$3,263
Cross-cutting	N/A	N/A	N/A	N/A
Portfolio Total	\$28,227	\$20,914	1.35	\$7,313

¹ Totals may not equal sum of column or row due to rounding.

3.4.3 Process Evaluation

Four EDCs – Met-Ed, Penelec, Penn Power, and West Penn Power – operate an identical set of energy efficiency programs. Since the evaluation contractor, ADM, together with its process evaluation subcontractor, Tetra Tech, took unified process evaluation approaches to these

programs across the four EDCs, the annual reports of the four EDCs report identical information about the process evaluation. ADM/Tetra Tech reported on PY13 process evaluation activities for all FirstEnergy Utilities programs (Table 38).

Table 38: FirstEnergy PY13 Process Evaluations Conducted for Program Components

Programs and Program Components	
Energy Efficient Homes ⁴⁷	Energy Efficient Products ⁴⁸
LI Energy Efficiency ⁴⁹	C&I Energy Efficiency Solutions-Small ⁵⁰
C&I Energy Efficiency Solutions-Large ⁵¹	

For PY13, ADM/Tetra Tech completed a full process evaluation and reported on the Appliance Recycling component of the Energy Efficient Products program within the Met-Ed residential sector. This evaluation generated a total of six process evaluation findings, which resulted in three recommendations, all of which were accepted. To rate participant satisfaction, ADM/Tetra Tech used a scale of 1 to 5, with 1 representing “very dissatisfied” and 5 representing “very satisfied.” Key findings of the process evaluation were the mean satisfaction scores for the overall program and individual program components which ranged from 4.4 to 4.8 (on a scale where 1 was *very dissatisfied* and 5 was *very satisfied*). The average participant satisfaction score for Met-Ed respondents was 4.8 out of 5. Eighty percent of Met-Ed respondents reported they were *very satisfied* with the program overall.

3.4.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE’s audit of the Met-Ed PY13 Annual Report and the supporting detail provided by Met-Ed’s evaluation contractor. The detailed audit findings can be found in Appendix E.

- Met-Ed’s non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.34 but showed a TRC ratio far lower than PPL and Duquesne Light despite a similar set of measure offerings. A key driver of the difference is incremental cost assumptions for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to

⁴⁷ In PY13, ADM/Tetra Tech conducted initial process evaluation activities of in-depth interviews with program administrators and implementors for Home Energy Reports, the School Education Program, In-Home Audits, New Homes, the Multifamily Program, and Behavioral Online Audits. These IDIs will be part of the process evaluation, which is due to be completed in PY14.

⁴⁸ In PY13, ADM/Tetra Tech conducted a process evaluation of the Appliance Recycling component and IDIs with program administrators and implementors for Appliances and HVAC.

⁴⁹ In PY13, ADM/Tetra Tech conducted initial process evaluation activities of in-depth interviews with program administrators and implementors which will be part of the process evaluation, due to be completed in PY14.

⁵⁰ In PY13, ADM/Tetra tech conducted in-depth interviews with program administrators and implementors.

⁵¹ In PY13, ADM/Tetra tech conducted in-depth interviews with program administrators and implementors.

estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

- The SWE conducted a project file review for a sample of Met-Ed's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Met-Ed's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- Met-Ed initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (3.5% of MWh) compared to Phase III. HERs accounted for approximately 5% of Met-Ed's progress toward its low-income compliance target in PY13. Because the cohorts launched after the summer, Met-Ed claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and ADM was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.
 - The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.

3.5 FIRSTENERGY: PENNSYLVANIA ELECTRIC COMPANY

3.5.1 Impact Evaluation

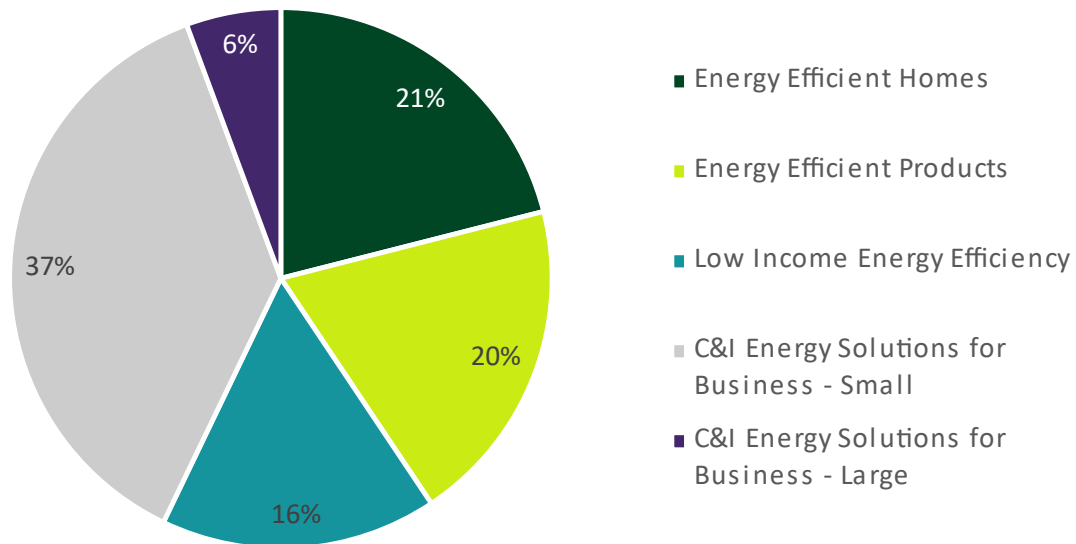
A summary of energy impacts by program for PY13 is presented in Table 39. Forty-three percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximate 41% of savings are attributable to the two market-rate residential programs (see Figure 24).

Table 39: PY13 Incremental Annual Energy Savings by Program (MWh/Year) – Penelec¹

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	8,407	90%	7,573	0.84	6,335
Energy Efficient Products	6,483	109%	7,064	0.59	4,169
Low Income Energy Efficiency	5,920	100%	5,942	1.00	5,942
C&I Energy Solutions for Business - Small	13,829	97%	13,407	0.87	11,610
C&I Energy Solutions for Business - Large	2,149	95%	2,035	0.78	1,593
Portfolio Total	36,788	98%	36,021	0.82	29,649

¹ Totals may not equal sum of column or row due to rounding.

Figure 24: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – Penelec



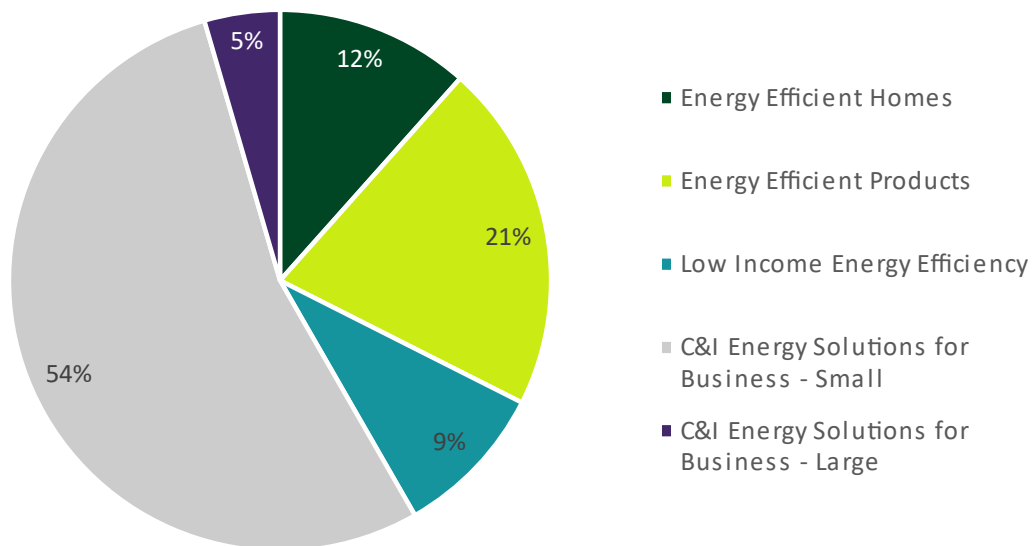
A summary of the peak demand impacts by energy efficiency program for PY13 are presented in Table 40 and Figure 25.

Table 40: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year) – Penelec¹

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	0.86	93%	0.80	0.82	0.66
Energy Efficient Products	1.38	105%	1.45	0.59	0.86
Low Income Energy Efficiency	0.74	87%	0.64	1.00	0.64
C&I Energy Solutions for Business - Small	3.86	97%	3.73	0.88	3.27
C&I Energy Solutions for Business - Large	0.36	86%	0.31	0.78	0.24
Portfolio Total	7.20	96%	6.94	0.82	5.68

¹ Totals may not equal sum of column or row due to rounding.

Figure 25: Percent of Portfolio PY13VTD Peak Demand Savings, by Program – Penelec



3.5.2 Cost-Effectiveness

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 elsewhere 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.

Figure 26 shows the breakdown of total TRC benefits and costs for Penelec in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.46 in PY13. The red coloring for fossil fuel impacts indicates negative benefits, or increased fossil fuel consumption. Fossil fuel increases from the interactive effects of LED lighting on space heating systems and the additional fuel required to power CHP systems.

Figure 26: PY13 Penelec TRC Breakdown

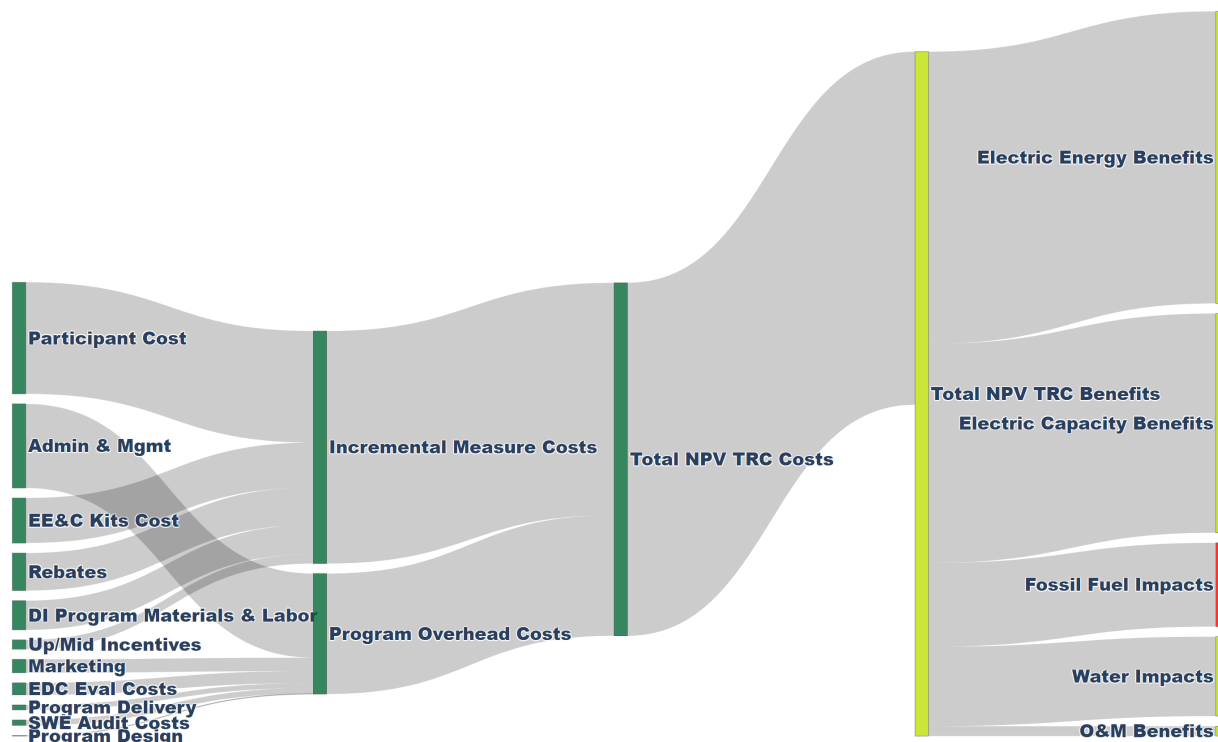


Table 41 shows the TRC ratios by program and for the portfolio. The benefits in Table 41 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 41: PY13 Gross TRC Ratios by Program (\$1,000) – Penelec¹

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$6,353	\$2,198	2.89	\$4,156
Energy Efficient Products	\$3,280	\$3,935	0.83	(\$656)
Low Income Energy Efficiency	\$3,052	\$2,308	1.32	\$744
Residential Total	\$12,685	\$8,441	1.50	\$4,244
C&I Energy Solutions for Business - Small	\$7,926	\$5,201	1.52	\$2,726
C&I Energy Solutions for Business - Large	\$1,147	\$1,251	0.92	(\$104)
Non-Residential Total	\$9,074	\$6,452	1.41	\$2,622
Cross-cutting	N/A	N/A	N/A	N/A
Portfolio Total	\$21,759	\$14,893	1.46	\$6,866

¹ Totals may not equal sum of column or row due to rounding.

3.5.3 Process Evaluation

FirstEnergy’s evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to the programs across the four FirstEnergy EDCs, including Penelec, so the annual evaluation report of the four FirstEnergy EDCs reports identical information about the process evaluation. ADM/Tetra Tech reported on PY13 process evaluation activities for the FirstEnergy Utilities programs ([Table 38](#)).

For PY13, ADM/Tetra Tech completed a full process evaluation and reported on the Appliance Recycling component of the Energy Efficient Products program within the Penelec residential sector. To rate participant satisfaction, ADM/Tetra Tech used a scale of 1 to 5 with 1 representing “very dissatisfied” and 5 representing “very satisfied.” The average participant satisfaction score for Penelec respondents was 4.6 out of 5. Seventy-eight percent of Penelec respondents reported they were *very satisfied* with the program overall.

3.5.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE’s audit of the Penelec PY13 Annual Report and the supporting detail provided by Penelec’s evaluation contractor. The detailed audit findings can be found in [Appendix F](#).

- Penelec’s non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.41 but showed a TRC ratio far lower than PPL and Duquesne Light despite similar a set of measure offerings. A key driver of the difference is incremental cost assumptions for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

- The SWE conducted a project file review for a sample of Penelec’s residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.
- Penelec initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (2.3% of MWh) compared to Phase III. HERs accounted for approximately 10% of Penelec’s progress toward its low-income compliance target in PY13. Because the cohorts launched after the summer, Penelec claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and ADM was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.
 - The SWE team found that ADM’s HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penelec’s PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.

3.6 FIRSTENERGY: PENNSYLVANIA POWER COMPANY

3.6.1 Impact Evaluation

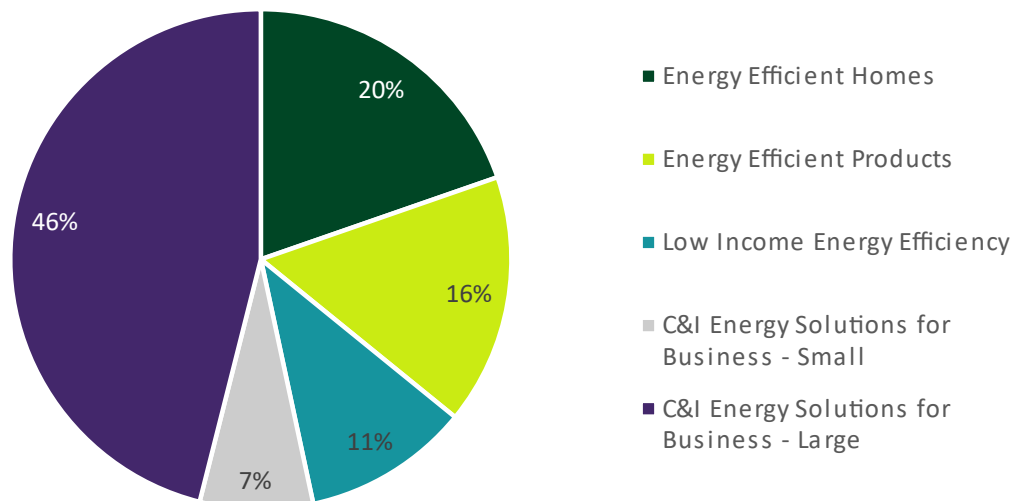
A summary of energy impacts by program for PY13 is presented in Table 42. Fifty-three percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximate 36% of savings are attributable to the two market-rate residential programs (see Figure 27).

Table 42: PY13 Incremental Annual Energy Savings by Program (MWh/Year) – Penn Power¹

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	3,913	80%	3,135	0.85	2,657
Energy Efficient Products	2,548	101%	2,580	0.43	1,111
Low Income Energy Efficiency	1,738	99%	1,716	1.00	1,716
C&I Energy Solutions for Business - Small	1,150	101%	1,162	0.82	951
C&I Energy Solutions for Business - Large	7,293	101%	7,340	0.64	4,709
Portfolio Total	16,643	96%	15,934	0.70	11,144

¹ Totals may not equal sum of column or row due to rounding.

Figure 27: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – Penn Power



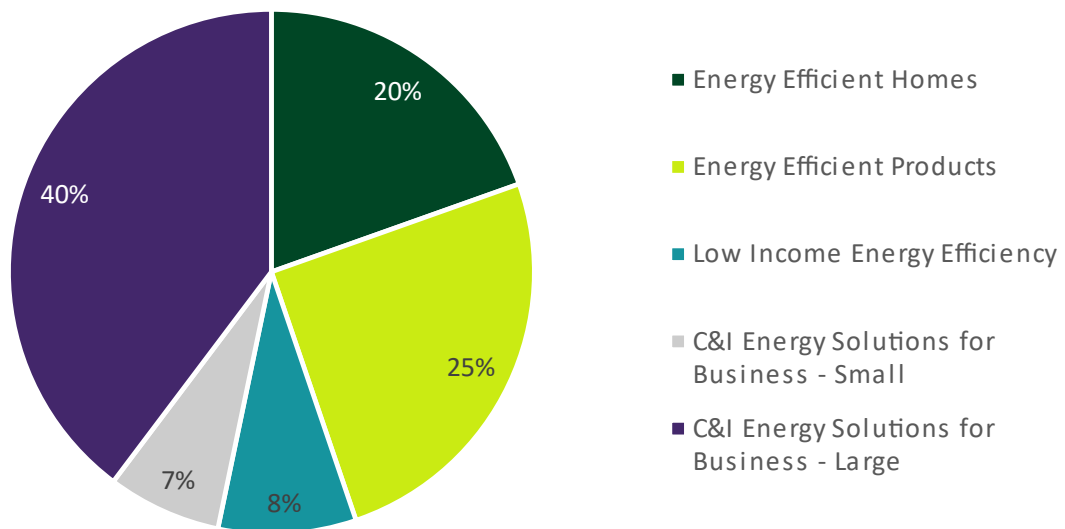
A summary of the peak demand impacts by energy efficiency program for PY13 are presented in Table 43.

Table 43: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year) – Penn Power¹

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	0.75	55%	0.41	0.78	0.32
Energy Efficient Products	0.52	102%	0.53	0.43	0.23
Low Income Energy Efficiency	0.23	77%	0.18	1.00	0.18
C&I Energy Solutions for Business - Small	0.17	86%	0.15	0.81	0.12
C&I Energy Solutions for Business - Large	0.84	99%	0.84	0.65	0.54
Portfolio Total	2.52	83%	2.10	0.66	1.39

¹ Totals may not equal sum of column or row due to rounding.

Figure 28: Percent of Portfolio PY13VTD Peak Demand Savings, by Program – Penn Power



3.6.2 Cost-Effectiveness

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 elsewhere 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.

Figure 29 shows the breakdown of total TRC benefits and costs for Penn Power in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.08 in PY13.

Figure 29: PY13 Penn Power TRC Breakdown

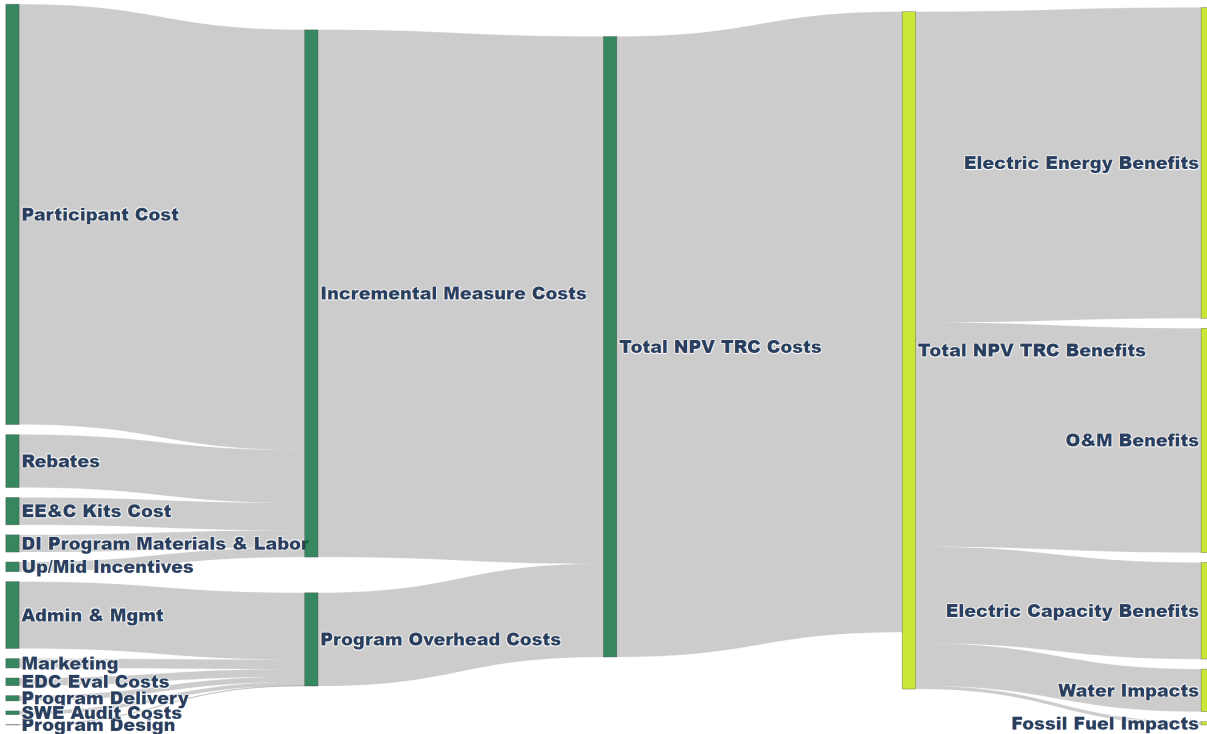


Table 44 shows the TRC ratios by program and for the portfolio. The benefits in Table 44 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 44: PY13 Gross TRC Ratios by Program (\$1,000) – Penn Power¹

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$2,146	\$1,609	1.33	\$537
Energy Efficient Products	\$1,240	\$1,290	0.96	(\$50)
Low Income Energy Efficiency	\$797	\$704	1.13	\$93
Residential Total	\$4,183	\$3,604	1.16	\$580
C&I Energy Solutions for Business - Small	\$654	\$783	0.84	(\$129)
C&I Energy Solutions for Business - Large	\$8,069	\$7,594	1.06	\$475
Non-Residential Total	\$8,723	\$8,378	1.04	\$345
Cross-cutting	N/A	N/A	N/A	N/A
Portfolio Total	\$12,906	\$11,981	1.08	\$925

¹ Totals may not equal sum of column or row due to rounding.

3.6.3 Process Evaluation

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to the programs across the four FirstEnergy EDCs, including Penn Power, so the annual evaluation report of the four FirstEnergy EDCs reports identical information about the process evaluation. ADM/Tetra Tech reported on PY13 process evaluation activities for the FirstEnergy Utilities programs ([Table 38](#)).

For PY13, ADM/Tetra Tech completed a full process evaluation and reported on the Appliance Recycling component of the Energy Efficient Products program within the Penn Power residential sector. To rate participant satisfaction, ADM/Tetra Tech used a scale of 1 to 5 with 1 representing "very dissatisfied" and 5 representing "very satisfied." The average participant satisfaction score for Penn Power respondents was 4.5 out of 5. Seventy-one percent of Penn Power respondents reported they were *very satisfied* with the program overall.

3.6.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the Penn Power PY13 Annual Report and the supporting detail provided by Penn Power's evaluation contractor. The detailed audit findings can be found in [Appendix G](#).

- The SWE conducted a project file review for a sample of Penn Power's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.
- Penn Power's non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.04 but showed a TRC ratio far lower than PPL and Duquesne Light despite similar a set of measure offerings. A key driver of the difference is incremental cost assumptions for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
- Penn Power initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (5.5% of MWh) compared to Phase III. HERs accounted for approximately 15% of Penn Power's progress toward its

low-income compliance target in PY13. Because the cohorts launched after the summer, Penn Power claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and ADM was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.

- The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penn Power's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.
- The SWE found several transcription errors in program component level NTG ratios for Penn Power in the summary tables included in chapter 2 of the FirstEnergy PY13 Annual Report. The NTG values reported in the program specific chapters and appendices were accurate, however. ADM was extremely responsive when the SWE pointed out the reporting errors and provided corrections to the SWE.

3.7 FIRSTENERGY: WEST PENN POWER

3.7.1 Impact Evaluation

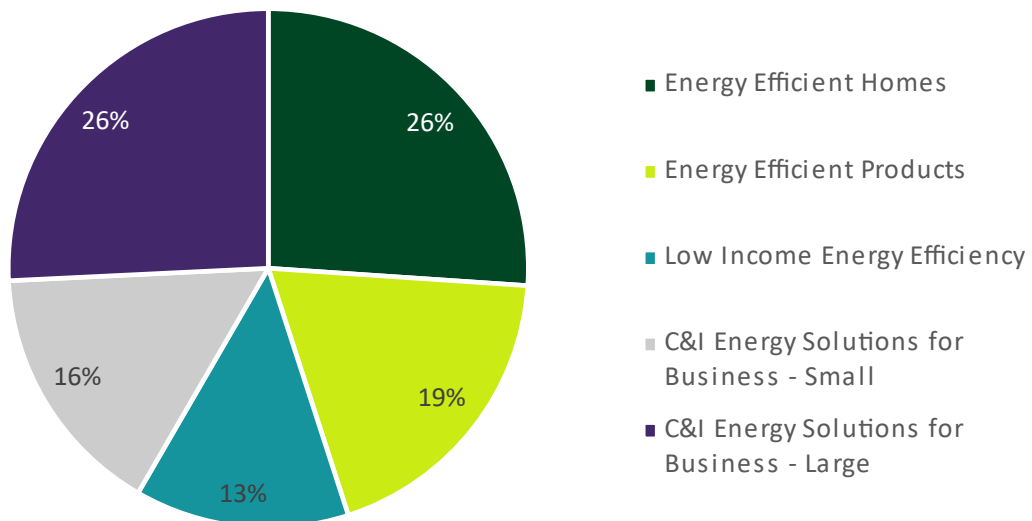
A summary of energy impacts by program for PY13 is presented in [Table 45](#). Forty-two percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximate 45% of savings are attributable to the two market-rate residential programs (see [Figure 30](#)).

Table 45: PY13 Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power¹

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	14,685	77%	11,375	1.04	11,791
Energy Efficient Products	7,794	106%	8,270	0.61	5,075
Low Income Energy Efficiency	5,398	108%	5,817	1.00	5,817
C&I Energy Solutions for Business - Small	7,268	95%	6,933	0.72	4,957
C&I Energy Solutions for Business - Large	11,194	100%	11,243	0.61	6,826
Portfolio Total	46,338	94%	43,638	0.79	34,466

¹ Totals may not equal sum of column or row due to rounding.

Figure 30: Percent of Portfolio PY13VTD Gross Energy Savings, by Program – West Penn Power



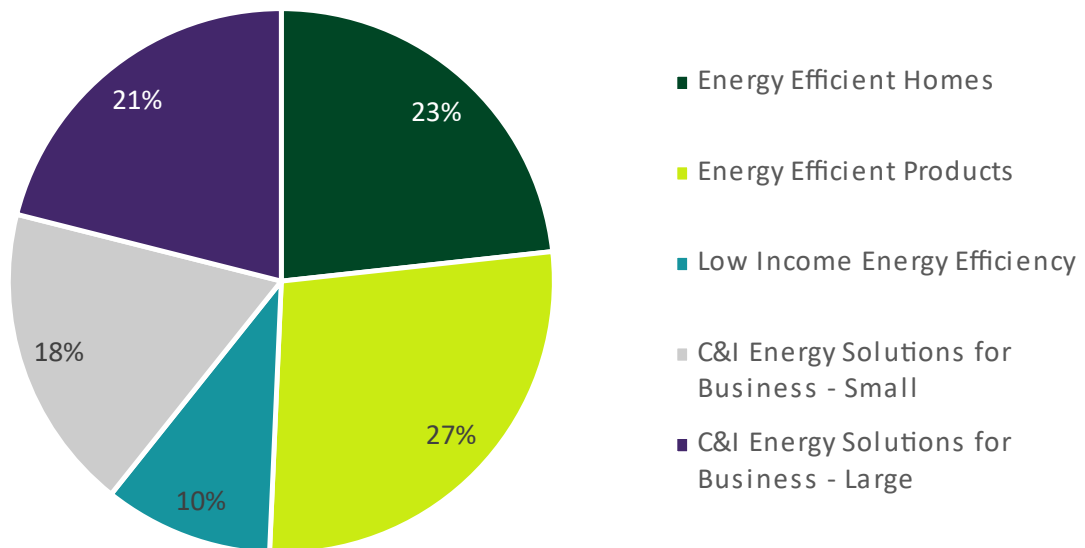
A summary of the peak demand impacts by energy efficiency program for PY13 are presented in Table 46 and Figure 31.

Table 46: PY13 Peak Demand Savings by Energy Efficiency Program (MW/Year) – West Penn Power¹

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	2.26	60%	1.36	1.00	1.36
Energy Efficient Products	1.60	101%	1.61	0.62	0.99
Low Income Energy Efficiency	0.80	73%	0.59	1.00	0.59
C&I Energy Solutions for Business - Small	1.22	87%	1.07	0.71	0.76
C&I Energy Solutions for Business - Large	1.31	94%	1.23	0.61	0.75
Portfolio Total	7.20	81%	5.86	0.76	4.45

¹ Totals may not equal sum of column or row due to rounding.

Figure 31: Percent of Portfolio PY13VTD Peak Demand Savings, by Program – West Penn Power



3.7.2 Cost-Effectiveness

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 elsewhere 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.

Figure 32 shows the breakdown of total TRC benefits and costs for West Penn Power in PY13. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.24 in PY13. The red coloring for fossil fuel impacts indicates negative benefits, or increased fossil fuel consumption. Fossil fuel increases from the interactive effects of LED lighting on space heating systems.

Figure 32: PY13 West Penn Power TRC Breakdown

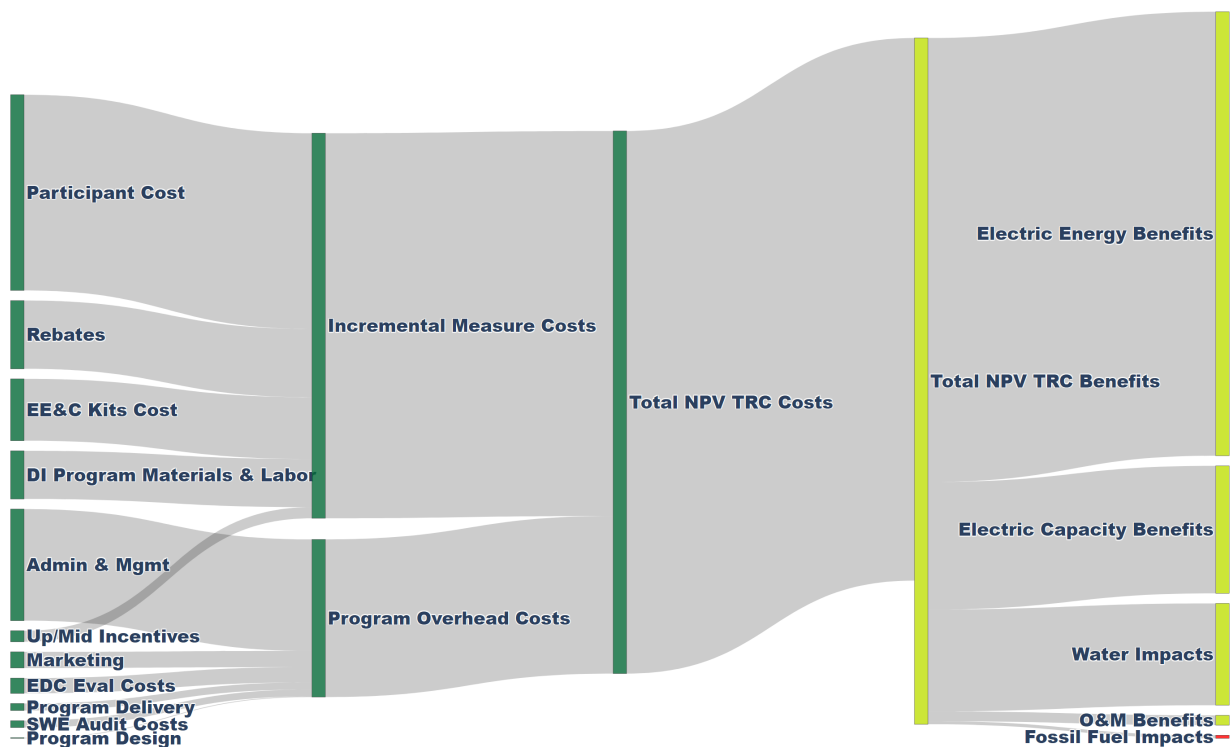


Table 47 shows the TRC ratios by program and for the portfolio. The benefits in Table 47 were calculated using gross verified impacts. Costs and benefits are expressed in 2021 dollars.

Table 47: PY13 Gross TRC Ratios by Program (\$1,000) – West Penn Power¹

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$7,546	\$4,440	1.70	3,106
Energy Efficient Products	\$3,328	\$4,550	0.73	(\$1,222)
Low Income Energy Efficiency	\$2,673	\$1,730	1.54	\$943
Residential Total	\$13,547	\$10,720	1.26	\$2,827
C&I Energy Solutions for Business - Small	\$4,075	\$4,245	0.96	(\$170)
C&I Energy Solutions for Business - Large	\$5,605	\$3,774	1.49	\$1,831
Non-Residential Total	\$9,680	\$8,019	1.21	\$1,661
Cross-cutting	N/A	N/A	N/A	N/A
Portfolio Total	\$23,227	\$18,739	1.24	\$4,488

¹ Totals may not equal sum of column or row due to rounding.

3.7.3 Process Evaluation

FirstEnergy’s evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to the programs across the four FirstEnergy EDCs, including West Penn Power, so the annual evaluation report of the four FirstEnergy EDCs reports identical information about the process evaluation. ADM/Tetra Tech reported on PY13 process evaluation activities for the FirstEnergy Utilities programs ([Table 38](#)).

For PY13, ADM/Tetra Tech completed a full process evaluation and reported on the Appliance Recycling component of the Energy Efficient Products program within the West Penn Power residential sector. To rate participant satisfaction, ADM/Tetra Tech used a scale of 1 to 5 with 1 representing “very dissatisfied” and 5 representing “very satisfied.” The average participant satisfaction score for West Penn Power respondents was 4.6 out of 5. Seventy-six percent of West Penn Power respondents reported they were *very satisfied* with the program overall.

3.7.4 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE’s audit of the West Penn Power PY13 Annual Report and the supporting detail provided by West Penn Power’s evaluation contractor. The detailed audit findings can be found in [Appendix H](#).

- The SWE conducted a project file review for a sample of West Penn Power’s residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process

evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.

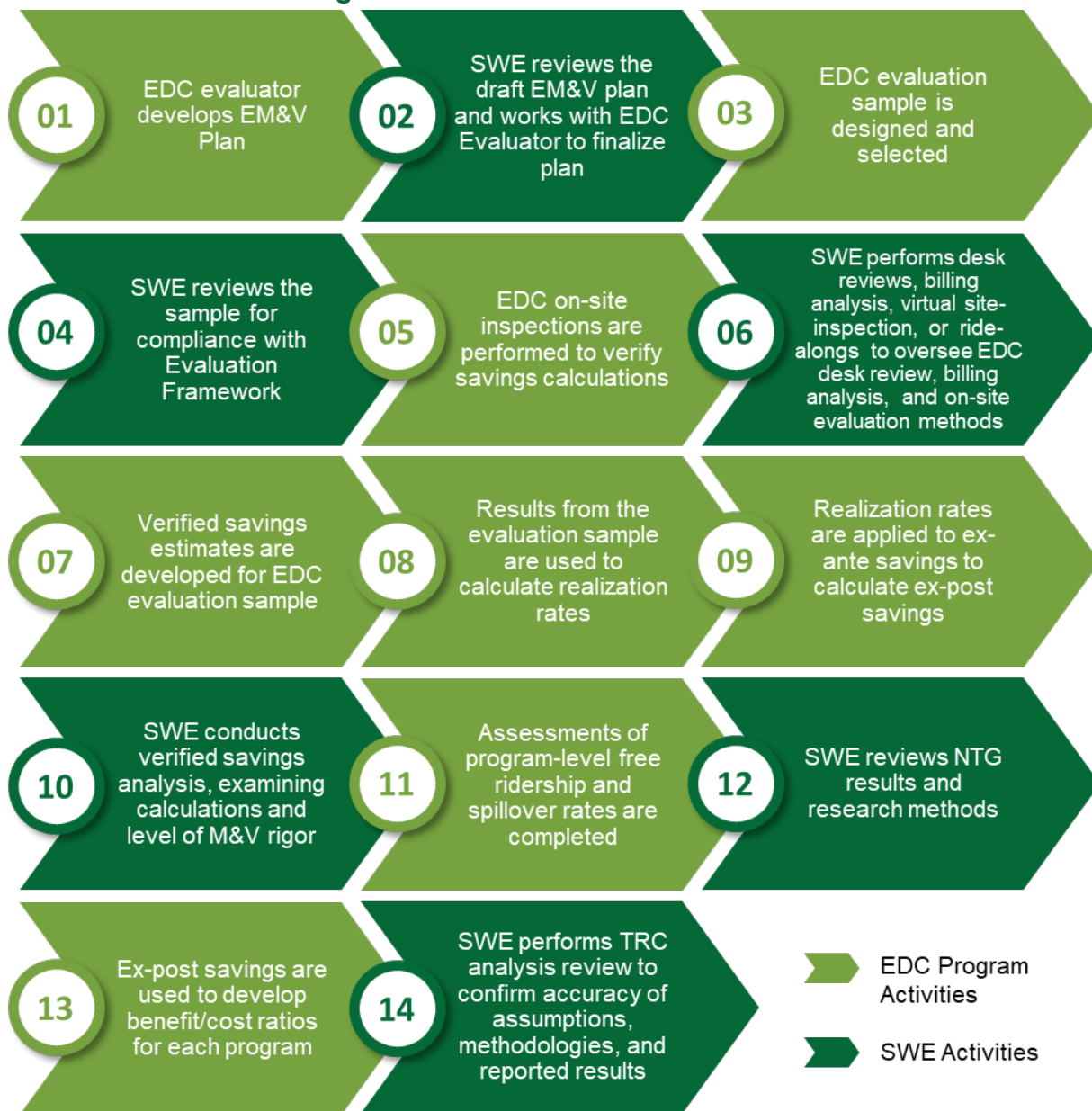
- West Penn Power's non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.21 but showed a TRC ratio far lower than PPL and Duquesne Light despite similar a set of measure offerings. A key driver of the difference is incremental cost assumptions for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
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 - The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in West Penn Power's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.
- The SWE found several transcription errors in program component level NTG ratios for West Penn Power in the summary tables included in chapter 2 of the FirstEnergy PY13 Annual Report. However, the NTG values reported in the program specific chapters and

appendices were accurate. ADM was extremely responsive when the SWE pointed out the reporting errors and provided corrections to the SWE.

Section 4 Cross-Cutting SWE Activities

This section presents a summary of the audit and cross-cutting activities conducted by the SWE during PY13, including a review/audit of EDC program delivery mechanisms and all evaluation processes and results submitted by each EDC's evaluation contractor. The SWE uses the audit activity findings, which parallel the EDC evaluation activities, to assess the quality and validity of the EDC reported gross, verified gross, and verified net savings estimates; process evaluation findings and recommendations; and benefit/cost ratios. For example, [Figure 33](#) shows the C&I sector specific SWE audit activities and their correspondence to the evaluation steps.

Figure 33: The SWE Audit Activities⁵²



⁵² The figure shows both gross and net components of the C&I audit process, including the TRC audit approach

4.1 TECHNICAL REFERENCE MANUAL (TRM)

While the formal proceedings associated with the 2021 TRM concluded before the start of Phase IV of Act 129, the SWE team continued to work with the EDCs and their EM&V contractors to refine and expand the library of measure characterizations used to claim and report EE&C Plan performance. The following sections summarize the key efforts during PY13.

4.1.1 TRM Interim Measure Protocols (IMPs)

As described in the Evaluation Framework, IMPs are used for measures that do not exist in the TRM, or to expand the applicability of an existing TRM protocol. IMPs serve as a holding ground before a protocol is fully integrated into the TRM. The SWE maintains a catalog of IMPs, showing their effective dates on the SWE SharePoint site for EDCs to use to claim reported savings, and for evaluators to follow when determining verified savings. The database of IMPs provides a list of new/revised measure protocols that should be included in subsequent TRM updates. A total of 30 IMPs were developed, reviewed, and approved to be effective during PY13 ([Table 48](#)). Measure expansion to address midstream delivery was a common theme during PY13 as several EDCs' Phase IV EE&C Plans called for midstream delivery of non-lighting technologies.

Table 48: IMPs Approved During PY13

TRM Section Number	IMP Name
2.2.1	Res High Efficiency Equipment for Midstream Delivery: ASHP, CAC, PTAC, PTHP
2.2.2	Cold Climate Heat Pumps
2.4.3	Appliance Recycling - mini-fridges
2.4.5 & 2.4.6	Residential Ventless ENERGY STAR Dryers IMP
2.7.1	Multifamily New Construction
3.1.1	Lighting Improvements
3.1.4	Midstream Exit Signs
3.1.7	Lighting Midstream
3.2.1 & 3.2.4	Non-Res HVAC Systems Midstream Delivery Option
3.7.1	ENERGY STAR Ice Machines
3.7.10	ENERGY STAR Commercial Griddle for Midstream Delivery
3.7.4	ENERGY STAR Electric Steam Cooker for Midstream Delivery
3.7.5	ENERGY STAR Combination Oven for Midstream Delivery
3.7.6	ENERGY STAR Commercial Convection Oven for Midstream Delivery
3.7.7	ENERGY STAR Commercial Fryer for Midstream Delivery
3.7.8	ENERGY STAR Commercial Hot Food Holding Cabinet for Midstream Delivery
3.7.9	ENERGY STAR Commercial Dishwasher for Midstream Delivery
4.1.3	High-Efficiency Ventilation Fans with and without Thermostats
4.1.4	Heat Reclaimers Midstream
4.1.5	High Volume Low Speed Fans Midstream
4.1.6	Livestock Waterer Midstream
4.1.7	VSD Controller on dairy vacuum pumps Midstream
NA	ENERGY STAR Uninterruptible Power Supplies
NA	Demand Control Ventilation
NA	Advanced Rooftop Controls
NA	HVAC Tune-up, C&I customers
NA	C&I Smart Thermostat
NA	Chilled Water Pipe Insulation
NA	Domestic Hot Water Pipe Insulation
NA	ENERGY STAR Bathroom Exhaust Fan

4.1.2 TRM Codes and Standards Review

The Phase IV Energy Efficiency and Conservation (EE&C) Implementation Order and 2021 TRM Final Order directs the SWE to provide an annual recommendation to the Commission regarding potential updates to the 2021 TRM based on changes to codes, standards, and ENERGY STAR specifications since the 2021 TRM was adopted. [Figure 34](#) summarizes the process.

Figure 34: Process and Schedule for Code Change Updates to the 2021 TRM

Estimated Date	Action
March 15	SWE memo analyzing impact of code or standards changes will be delivered to TUS.
April 15	TUS will determine if an update is warranted.
July 1	Codes and standards must be in effect by this date.
July	Tentative TRM Order and Manual on Public Meeting Agenda.
August - September	Comment and review process.
November	Final TRM Order and Manual on Public Meeting Agenda.

In March 2022, the SWE team delivered a memo to TUS summarizing the SWE's research into changes to codes, standards, and ENERGY STAR specifications since the development of the 2021 TRM in 2018-2019. The memo also estimated the direction and magnitude (in MWh) of the changes to Phase IV savings for PY15-PY17 should the Commission choose to pursue an update to the 2021 TRM, effective June 1, 2023, based on any impacted parameters in effect by July 1, 2022.⁵³ The research uncovered 18 affected measures and the overall impact on Phase IV EE&C plans was limited (~1%). Based on the limited effect on aggregate plan savings, TUS determined it was not necessary to move forward with a formal TRM Order and update to the Manual. Instead, TUS directed the SWE to develop and issue a series of guidance memos summarizing the changes and recommending that the EDCs consider updating their savings calculations and reported savings to reflect the changes. While the EDCs can elect to follow the 2021 TRM, the guidance memos will reflect best practices and are what TUS and the SWE consider to be reasonable updates to the EDC's EE&C plans.

The SWE subsequently expanded the scope of our initial March 2022 codes and standards review to capture updates to codes and standards going into effect on or before June 1, 2023, as Section 1.8 of the 2021 TRM allows new eligibility requirements to take effect at the start of the next consecutive program year.⁵⁴ Notable new codes and standards updates include federal standards that pertain to the efficacy requirements for screw-based general service lamps (GSLs), which are effective July 25, 2022, and new federal standards and ENERGY STAR specifications for central air conditioners (CAC) and heat pumps, which are effective January 1, 2023.

Table 49 summarizes the 20 Codes and Standards Guidance Memos. Individual memos describing the detailed changes and revised measure characterizations and include the following:

- A summary of the change to codes or standards that necessitated an update to the measure parameters.
- A detailed description of the changes to the measure characterization

⁵³ The SWE's estimates of projected MWh savings by measure come from the EDCs' Phase IV EE&C Plans

⁵⁴ The 2021 Technical Reference Manual (Volume 1, General Information), at Docket Number M-2019-3006867. Adopted at the August 8, 2019 Public Meeting <https://www.puc.pa.gov/pcdocs/1692530.docx>

- A clean copy of the TRM measure characterization which EDCs, their CSPs, and EM&V contractors are encouraged to follow beginning in PY15.
- Discussion of any associated IMP implications. For example, if a measure has a midstream IMP counterpart, the memo will discuss the changes to the IMP and link the reader to an updated version of the IMP.

Table 49: Codes and Standards Guidance Memos

TRM Measure #	TRM Measure Name	Type of Change
2.1.1	ENERGY STAR Lighting	Change to Federal Standard
2.2.1	High Efficiency Equipment: ASHP, CAC, GSHP, PTAC, PTHP	Change to Federal Standard and ES Standard
2.2.2	High Efficiency Equipment: Ductless Heat Pumps with Midstream Delivery Option	Change to Federal Standard and ES Standard
2.3.1	Heat Pump Water Heaters	Changes to ES standard
2.3.3	Fuel Switching: Electric Resistance to Fossil Fuel Water Heater	Change to ES standard
2.4.9	ENERGY STAR Dehumidifiers	Change to ES standard
2.4.12	ENERGY STAR Air Purifiers	Changes to federal minimum and ES standards
2.7.1	Residential New Construction	Change to ES standard
2.7.2	ENERGY STAR Manufactured Homes	Change to Federal Standard
2.8.1	Variable Speed Pool Pumps	New federally regulated equipment class, and new ES standards
3.1.2	New Construction Lighting	IECC 2018 reduces interior and exterior lighting power allowances
3.1.7	Lighting Improvements for Midstream Delivery Programs	Change to Federal Standard for General Service
3.2.4	Ductless Mini-Split Heat Pumps - Commercial < 5.4 tons	Change to ES Standard
3.4.1	Heat Pump Water Heaters	ENERGY STAR qualification update changes default efficient case UEF
3.4.2	Low Flow Pre-Rinse Sprayers for Retrofit Programs and Time of Sale Programs	Federal standard increases baseline flow rate.
3.4.3	Fuel Switching: Electric Resistance Water Heaters to Gas/Propane	Change to ES Standard
3.5.1	ENERGY STAR Refrigeration/Freezer Cases	Change to ES standard
3.7.5	ENERGY STAR Combination Oven	Change to ES standard
3.7.6	ENERGY STAR Commercial Convection Oven	Change to ES standard
3.7.9	ENERGY STAR Commercial Dishwasher	Change to ES standard

4.1.3 TRM Question Tracker and Guidance Memos

The SWE maintains a central repository of clarifying questions posted by the EDCs and EDC evaluators and responses from the SWE. The SWE addressed 58 questions about TRM algorithms and protocols during PY13. In some cases, the SWE issued guidance memos to provide more detailed guidance on a TRM-related topic. The SWE issued six guidance memos during PY13 on the following topics:

- The eligibility requirements for solid state lighting (SSL) rebated under Act 129 programs in Guidance for Solid State Lighting due to new and DLC Technical Requirements (Version 5.1)
- Errata corrections to 2021 TRM section 2.2.9 (Duct Sealing & Duct Insulation)
- Errata corrections to 2021 TRM section 2.4.1 (ENERGY STAR Refrigerators)
- Guidance to 2021 TRM section 2.4.3 (Refrigerator / Freezer Recycling with and without Replacement) that included errata corrections and clarifying a term in the energy savings algorithm
- Errata corrections to 2021 TRM section 3.1.7 (Lighting Improvements for Midstream Delivery Programs)
- Errata corrections to incorrect table cross-references in Volume 2 of the 2021 TRM

4.2 EM&V PLAN REVIEW AND APPROVAL

EDC evaluation contractors are required to prepare and submit a detailed evaluation plan to the SWE each program year. The intent of the evaluation plan is to document the research objectives and data collection activities for each program within the EDC portfolio. Evaluation plans are expected to generally align with the guidance provided by the SWE in the Pennsylvania Evaluation Framework to ensure consistency in evaluation practices across EDCs. Evaluation contractors were directed to discuss reported savings, the gross impact evaluation, NTG analysis, process evaluation, sampling statistics and uncertainty, cost-effectiveness evaluation activities, frequency of evaluation, and outcomes separately.

One of the main differences between Phase IV and previous phases, from an EM&V perspective, is the frequency of evaluation. During prior phases, every program was generally evaluated in every program year. Prior to Phase IV EDCs and their evaluators were given the opportunity to set an evaluation schedule that would allow for deeper investigations and meet the shortened, more streamlined, reporting timelines. Process evaluations should still be conducted at least once per phase as well as gross impacts. In years when verification activities do not occur, savings will either be deemed unverified or a previous year's verification rate can be applied in order to yield the verified savings number. Six main criteria were used to determine evaluation cadence:

- **Amount of energy and demand savings** - Programs with larger expected savings warrant more frequent evaluation.
- **Expected EM&V costs** – Programs that require less intensive data gathering techniques can be evaluated more often at a lower cost than those that require more intensive methods.
- **Program continuity/discontinuity** – New initiatives or those that undergo significant changes from year-to-year warrant more frequent evaluation than those that remain unchanged with constant realization rates.
- **Market or technology continuity/discontinuity** – Changes in market or energy efficiency standards warrants more frequent evaluation

- **Uniformity of measures** – If the efficiency measures offered by a program change from year to year more frequent evaluation may be warranted
- **Underperforming expectations** – Realization rates below expected levels which may be indicative of program issues warrant more frequent evaluations

First drafts of the PY13 EM&V plan were due before September 30, 2021. The SWE reviewed the revised PY13 draft evaluation plans and provided suggestions and requests for clarification. EDC evaluation contractors addressed the feedback and prepared revised plans for review and approval. The EDC-specific appendices of this report each include an “EM&V Plan Review” section that documents the evaluation plan review and approval process for PY13.

4.3 SAMPLE DESIGN REVIEW

Verified savings estimates for most programs, or program components, are based on a sample of projects selected from the full population. Because every project is not evaluated, there is a possibility that the sample is not representative of the full population. The level of uncertainty depends on how large the sample is, and the degree to which the reported savings and verified savings align. The amount of sampling error (margin of error) is represented by the relative precision of the verified savings. For example, if a project has verified savings of 1,000 MWh/year with a relative precision of $\pm 5\%$ at the 85% confidence level, then there is an 85% chance that the true value of savings for the population is between 950 MWh/year and 1,050 MWh/year. All programs that rely on sampling to calculate verified savings must include the relative precision to quantify the sampling uncertainty.

The Phase IV Evaluation Framework allows a maximum level of sampling uncertainty of $\pm 15\%$ at 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. In its annual data request to the EDCs and their EM&V contractors, the SWE requests a table for each initiative which lists the stratum assignment, reported savings, and verified savings for each evaluated project along with a unique identifier that allows the sampled units to be merged with the initiative population. The SWE team then uses this information to independently replicate the energy and peak demand realization rates and associated relative precision.

This exercise serves to validate the expansion of evaluation findings in the sample to the initiative, program, and population level. It also informs future sample design reviews because the sample size required to achieve $\pm 15\%$ relative precision at the 85% confidence level is a function of the variability between reported and verified savings. Initiatives with high variance may require larger sample sizes in the following program year. Initiatives which exhibit low variance may require smaller sample sizes during future impact evaluations.

4.4 TRACKING DATA REVIEW

After each quarter, EDCs provide responses to a standing request for program implementation data. This request includes a full extract from the program tracking system of records listing the reported gross kWh, kW, measure type, rebate amount, participant information, and relevant dates for all transactions in the quarter. Data for behavioral Home Energy Reports is not included in the quarterly tracking data. For Phase IV, the SWE designed a standard file specification for this response to allow for consolidation of data across EDCs.

The tracking data review task is a straightforward task, where the SWE aggregates the very granular tracking records to the program and portfolio level and compares these calculated totals with the reported gross kWh, kW, participation, and incentive totals reported by EDCs in their semi-annual and final annual reports to the PUC. The intent of this exercise is to confirm that the high-level program totals are supported by detailed records for each of the thousands of measure transactions. This independent validation of reported gross program impacts also ensures that the tracking records archived by the SWE, a foundation of other audit activities, are consistent with the EDC's records.

4.5 PROJECT FILE REVIEWS

In addition to the tracking data review, the SWE conducts a review of a sample of EDC project and program files, cross-checking actual program files, receipts, invoices, and work orders against their corresponding database entries to verify that the EDCs have reported program data correctly and consistently.⁵⁵ The SWE cross-checks actual program files, receipts, invoices, and work orders against their corresponding database entries to verify that the EDCs have reported program data correctly and consistently. This “project file review” is designed to audit the accuracy of the savings values stored in the EDC tracking system and to confirm that the EDCs' calculations were performed in accordance with the current TRM. The uploaded project files include project savings calculation workbooks, specification sheets for equipment installed, invoices, customer incentive agreements, and post-inspection forms. Through these reviews, the SWE verifies that the equipment quantities, efficiency levels, and savings values recorded in project files and the program tracking database are consistent.

4.6 VERIFIED SAVINGS AUDIT

The SWE conducts a detailed review of data collection, estimation methods, and calculations used by the EDC evaluation contractors to calculate verified gross and verified net savings. Following the submission of their annual reports, EDC evaluation contractors are required to submit the supporting work products for audit. EDC evaluation contractors are also encouraged

⁵⁵ The SWE also conducts a database review through which the SWE attempts to verify that EDCs are using the correct values and algorithms from the Pennsylvania TRM in their savings calculations. For deemed measures, the SWE reviews whether the EDC used the correct deemed savings value. For partially deemed measures, the SWE used the values from the EDC database to independently calculate savings and verify them against the savings reported by the EDC.

to submit their supporting work products for early review, before the EDC Annual Report is submitted to the PUC. These datasets and calculation workbooks, along with the EDC annual reports, are the basis for the SWE verified savings audit. Based on the results of the verified savings audit, the SWE makes one of the three recommendations to the PUC for a given initiative:

1. The SWE agrees with the verified savings calculations and results and suggests the PUC count the reported total toward EDC compliance targets.
2. The SWE discovered an error in the calculation or disagrees with the assumptions used to estimate savings, and the SWE quantifies different verified savings. If the magnitude of the error is greater than 5% of savings at the portfolio level, EDCs refile their annual report to correct the error. If the magnitude of the error is less than 5% of savings, EDCs are expected to update their phase-to-date verified savings going forward.
3. The SWE discovered an error or disagrees with an assumption with negligible impact at the portfolio level. This report provides guidance on correcting the issue on a going-forward basis.

4.7 AD HOC TASKS

The SWE team's contract provides for ad hoc support of Commission staff on various technical matters as needed. The following sections describe two tasks requested by stakeholders in comments to the 2021 TRC Test Order and completed by the SWE during PY13.

4.7.1 Annual Avoided Costs Review

Section B.1 of 2021 TRC Test Final Order called for a single forecast of avoided costs to be used in Phase IV EE&C Plans and EDC Annual Reports. The Industrials⁵⁶ commented that EDCs should use actual experienced market prices rather than forecasted prices in annual and phase reporting. PA-EEFA⁵⁷ comments recommended an annual review of market conditions by the SWE to assess whether an update to the avoided costs forecast was warranted. The Commission agreed and directed the SWE *“to include in its Final Annual Reports a comparison of forecasted avoided costs of electricity to load weighted real time locational marginal prices (LMPs) for each EDC service area.”* According to the 2021 TRC Test Order, the Commission may reconsider the appropriateness of a static forecast of avoided costs or make changes in the methodology currently used to develop the avoided costs forecast based on the results of this exercise.

The Phase III SWE developed a new Avoided Cost Calculator (ACC)⁵⁸ to standardize the process by which EDCs developed avoided costs for Phase IV. A 20-year period with six distinct periods

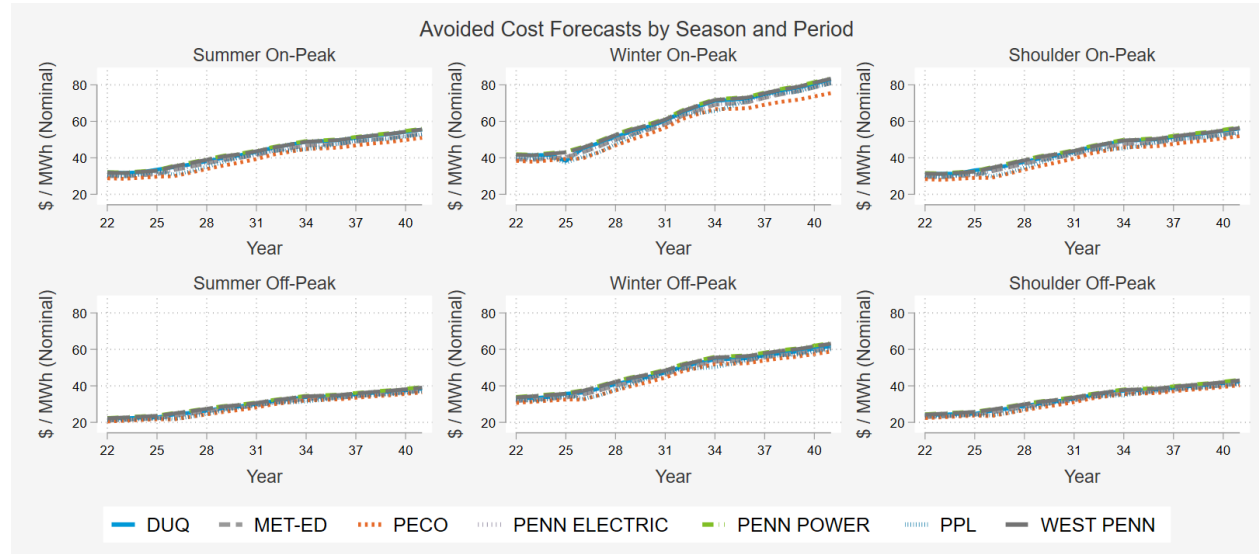
⁵⁶ The Met-Ed Industrial Users Group, the Penelec Industrial Customer Alliance, the Philadelphia Area Industrial Energy Users Group, the PP&L Industrial Customer Alliance, the West Penn Power Industrial Intervenors, and the Pennsylvania Energy Consumer Alliance

⁵⁷ Green and Healthy Homes Initiative, Housing Alliance of Pennsylvania, Keystone Energy Efficiency Alliance, Natural Resources Defense Council, National Housing Trust, Pennsylvania Utility Law Project, and Regional Housing Legal Services (collectively, the Pennsylvania Energy Efficiency for All Coalition (PA-EEFA))

⁵⁸ Avoided Cost Calculator. From the Public meeting of December 19, 2019, at Docket No. M-2019-3006868. Entered December 19, 2019. <https://www.puc.pa.gov/pcdocs/1648144.xlsx>

per year (winter, summer, and shoulder seasons with on and off-peaks) is used for the 2021 TRC Test Order. Figure 35 shows the 20-year avoided costs forecast for Phase IV, by EDC and costing period.

Figure 35: Phase IV Forecasted Avoided Costs



The avoided cost of energy is particularly important for Pennsylvania because of the relatively limited set of TRC benefits called for the 2021 TRC Test Order. In many states, the value of CO₂ emissions embedded in energy production is a larger benefits stream than the cost of the energy itself. Pennsylvania does not monetize avoided emissions, recognize Demand Reduction Induced Pricing Effects (DRIPLE), or claim non-energy benefits like neighboring states so TRC ratios are lean to begin with and particularly susceptible to assumptions regarding the marginal cost of energy being saved.

Draft Phase IV EE&C plans were due in November 2020. Therefore, EDCs developed avoided cost forecasts in summer 2020, not long after the beginning of the COVID-19 pandemic. To compare the forecast to actual marginal energy costs for each EDC, the SWE gathered hourly load and total real-time LMP for all bus locations for PY13 (6/1/2021 – 5/31/2022) from PJM’s Data Miner 2 tool.⁵⁹ To find a load-weighted average LMP by season and period, the following method for each EDC, season and period was used: the load for a given hour (MW_i) was multiplied by the mean LMP price for that hour. Mean LMP price for an hour is found by averaging the LMP price from n pricing nodes for each hour and EDC, then divided by the total number of hours in that period of the season. The products are then summed together and divided by the number of hours in the period.

⁵⁹ PJM Data Miner 2. Accessed June 1, 2022. <https://dataminer2.pjm.com/>

$$\frac{1}{h} \cdot \sum_{i=1}^h MW_i \cdot \left(\frac{1}{n} \cdot \sum_{j=1}^n LMP_j \right)$$

The forecasted PY13 avoided cost of energy was underestimated for each EDC in each period across PY13 when compared to actual marginal energy costs. Forecasts are never perfect, but the size of the differences is surprising for the initial year of a forecast. In the PJM region, and in most other locations in the United States, wholesale electricity prices are highly correlated with the price of natural gas since marginal generating units are typically natural gas power plants. Fuel costs are volatile and affected by a variety of factors, political and natural, making the exercise of predicting such costs difficult and inexact. The first segment of the avoided cost forecast relies on electricity futures from summer 2020, as the prompt month for NYMEX futures was established three months prior to the filing date (November 2020). Summer 2020 was the height of the COVID-19 pandemic and forward energy prices – already low pre-pandemic - reflect the reduced demand at the time.

Since that time, fuel prices have rebounded beyond pre-pandemic levels. PY13 began in June 2021 as the costs began to rise. Some factors that have affected prices throughout PY13 were unforeseen, such as the war in Ukraine beginning in February 2022 sharply affecting supply and demand for energy, irregularly high inflation, and foreign demand for liquefied natural gas. Average monthly LMP can be seen in Figure 36, where the shaded regions represent the different seasons.

Figure 36: Average LMP by Month

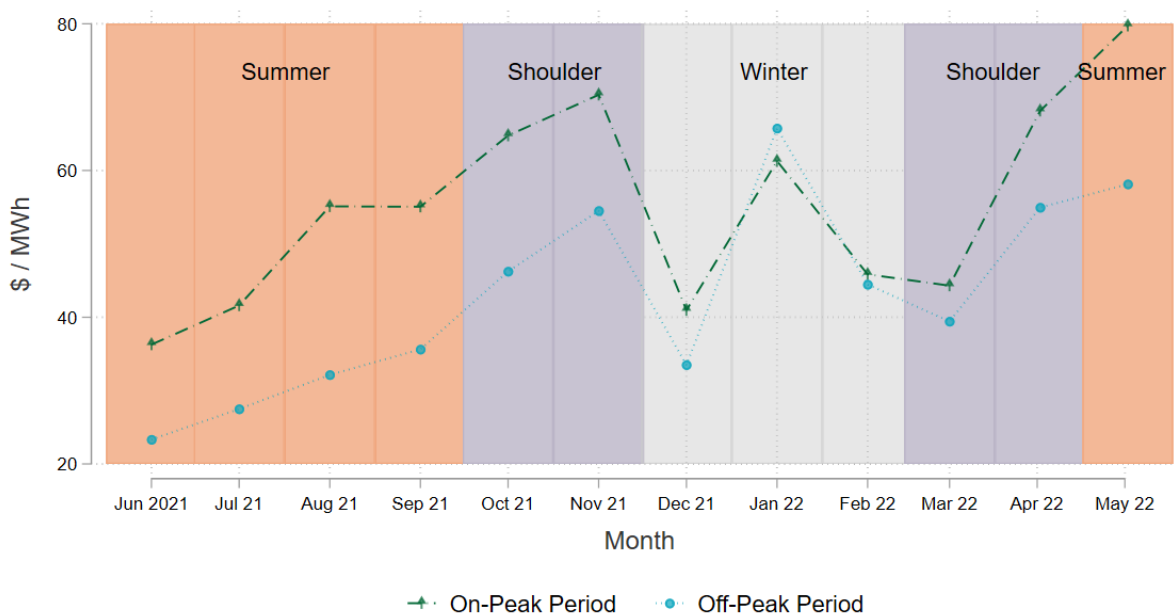


Table 50 presents the PY13 results by EDC, season, and period, including the percent difference from the forecasted avoided costs of PY13 to the real-time LMP weighted average.

Table 50: Load-Weighted Average LMPs by Season and Period for PY13

Season	Period	Forecasted Avoided Cost	Load-Weighted Average LMP	Percent Difference
Shoulder	Off-Peak	\$23.34	\$47.66	104%
	On-Peak	\$29.93	\$58.92	97%
Summer	Off-Peak	\$21.29	\$36.71	72%
	On-Peak	\$30.38	\$51.21	69%
Winter	Off-Peak	\$32.24	\$55.16	71%
	On-Peak	\$40.03	\$50.64	27%

PJM conducted the Base Residual Auction (BRA) for the 2022 – 2023 (PY14) and 2023 – 2024 (PY15) delivery years since the EDCs developed their avoided cost forecasts for Phase IV of Act 129. The BRA sets the price of generation capacity, by zone, in the PJM footprint. Unlike our review of market conditions for energy, actual capacity clearing prices were lower than the Phase IV forecasts. Capacity clearing prices for the 2021 – 2022 (PY13) delivery year were known and used in Phase IV, but the remainder of the Phase IV forecast relies on the average of the three most recent auction results. [Table 51](#) compares the forecasted and actual zoning clearing price for generation capacity, by EDC.

Table 51: Forecast versus Actual Generation Capacity (\$/kW-year)

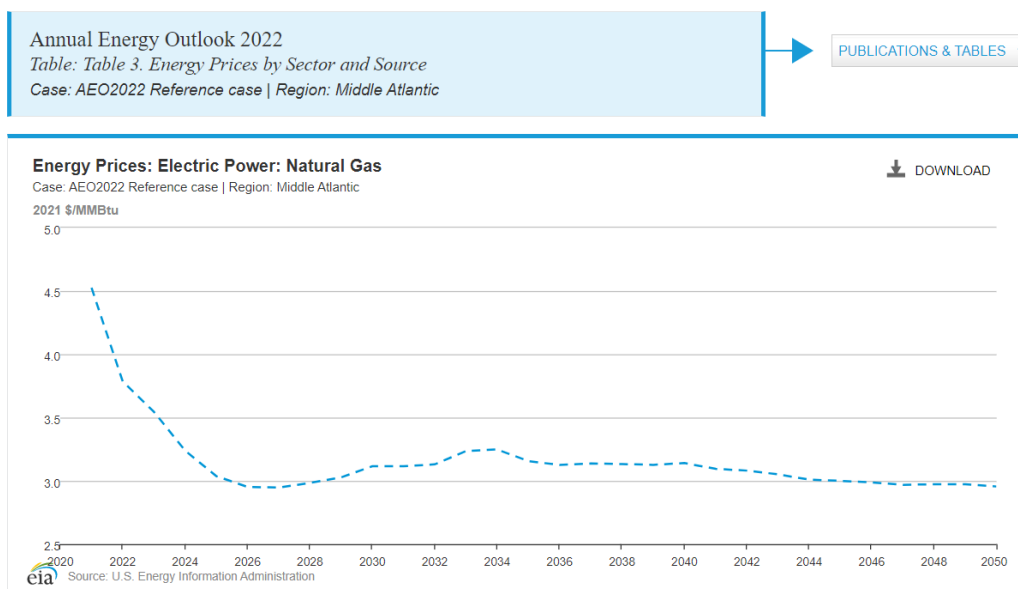
EDC	PY14 ACC	PY14 BRA	PY14 Percent Difference	PY15 ACC	PY15 BRA	PY15 Percent Difference
PECO	\$60.73	\$35.79	-70%	\$61.94	\$18.10	-242%
PPL	\$41.70	\$35.19	-18%	\$42.54	\$18.14	-135%
Duquesne Light	\$40.16	\$18.28	-120%	\$40.96	\$12.48	-228%
FE: Met-Ed	\$53.16	\$35.19	-51%	\$54.23	\$18.14	-199%
FE: Penelec	\$53.16	\$35.19	-51%	\$53.23	\$18.14	-193%
FE: Penn Power	\$65.06	\$18.28	-256%	\$66.36	\$12.48	-432%
FE: West Penn Power	\$53.16	\$18.28	-51%	\$54.23	\$12.48	-335%

Phase IV avoided costs were developed at the height of a global pandemic when wholesale prices were at historic lows. In the two years since, wholesale prices have swung widely in the opposite direction, creating a gap between forecast and actual marginal energy costs during PY13. There is a certain amount of uncertainty expected for any long-term forecast. The Phase IV avoided cost of energy forecast for PY13 proved to underestimate the value of saved energy relative to actual market conditions. The practical implication of this outcome is that PY13 TRC ratios based on EE&C Plan avoided costs will understate the avoided energy benefits of short-lived measures like

Home Energy Reports. In contrast, the Phase IV avoided costs of demand forecast for PY14 and PY15 over-estimated the value of reduced peak demand relative to market conditions. There will always be some amount of difference between forecasted and actual market conditions because no forecast model is perfect. When combining forecasts for multiple resources, however, the differences should be expected to even out unless there is a systematic bias in the forecast. This is indeed the observation for the energy and capacity market forecasts versus actual values which nearly balanced each other out in a sensitivity analysis conducted by the SWE.

Despite the magnitude of differences in short-term forecasted and actual avoided energy costs, it is important to remember that energy efficiency is a long-term investment, and the forecast is a long-term projection. [Figure 37](#) shows the US Energy Information Administration's (EIA's) projections of wholesale natural gas prices for the electric power sector in the Mid-Atlantic region. The EIA projection predicts a return to more normal levels in 2024 – 2025. If this projected trend is accurate, the Phase IV avoided costs forecast should fall back in line with actual market conditions.

Figure 37: Energy Information Administration Gas Price Projections (\$2021)



The SWE team cautions against an update to Phase IV avoided costs based on short-term departures between market conditions and the forecast. As shown in [Figure 35](#), the Phase IV avoided costs forecast begins to grow in the mid-2020s from its initially low levels. If long-term fuel projections stop showing a return to traditional levels, or if actual capacity prices cease to offset the impact on total TRC benefits, the Commission may want to consider a mid-phase update to Phase IV avoided costs.

4.7.2 Summary of Alternative Energy Portfolio Standards Costs

Per the 2021 TRC Test Order⁶⁰, the Phase IV SWE was directed to include a summary of the Alternative Energy Portfolio Standards (AEPS) costs to produce a comparison of how these costs have changed over time. What follows is a brief introduction to the AEPS values, how they are used, and their historic fluctuations. Currently, however, the SWE does not recommend any mid-cycle update to the AEPS costs as they remain a very small component of the larger avoided energy costs.

Alternative Energy Portfolio Standards Costs are electric cost adders included to reflect the cost of purchasing Alternative Energy Credits (AECs) as required by the AEPS Act⁶¹. The AECs are categorized into three tiers: Non-Solar Tier I, Tier II and Solar, with their eligible credit sources listed in Table 52.

Table 52: Energy Sources Eligible for Alternative Energy Credits

Tier I	Tier II	Solar
Out-of-Commonwealth Solar PV	Distributed Generation Systems	In-Commonwealth Solar PV
Biologically Derived Methane Gas	Demand Side Management	
Biomass Energy	Generation using Pulping Process By-Products	
Coal Mine Methane	Large-Scale Hydropower	
Fuel Cells	Municipal Solid Waste	
Geothermal Energy	Waste Coal	
Low-Impact Hydropower		
Solar Thermal		
Wind Power		

The AEPS Act requires that AECs be purchased in a fixed percentage of EDC retail sales each year. EDCs must procure 10% of their retail MWh sales as Tier II credits, 8% of retail MWh sales as Non-Solar Tier I credits and 0.5% as Solar credits.

In the PA Act 129 Phase IV Avoided Energy and Capacity Cost Calculator⁶², AEPS avoided costs are a benefit as any reduction in retail sales associated with energy efficiency will decrease the total number of credits required to be procured. To simplify modeling, a single, weighted, AEPS

⁶⁰ From the Public meeting of December 19, 2019, at Docket No. M-2019-3006868. Entered December 19, 2019. <https://www.puc.pa.gov/pcdocs/1648126.docx>

⁶¹ See 73 P.S. §§ 1648.1–1648.8 and 66 Pa. C.S. § 2814. See also 52 Pa. Code §§ 75.1–75.72.

⁶² <https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/total-resource-cost-test/>

cost is constructed. The procedure for producing the weighted average price is shown in [Table 53](#), which shows the AEPS costs currently in the Act 129 Phase IV TRC Test ACC.

Table 53: AEPS Cost Weighted Average Example

Metric	Unit	2019 TRC Credit Type		
		Solar	Tier I	Tier II
Average Bid Price	\$/Credit	\$50.00	\$6.10	\$0.45
Average Offer Price	\$/Credit	\$60.00	\$6.50	\$0.65
Average Price	\$/Credit	\$55.00	\$6.30	\$0.55
Required Credits as % of Retail Sales	%	0.50%	8%	10%
Required Credits by Tier	Credits/1,000MWh	5	80	100
Total Cost per Credit Type	\$/1,000MWh	\$275.00	\$504.00	\$55.00
Total Cost	\$/1,000MWh	\$275 + \$504 + \$55 = \$834		
Total Credits	Credits/1,000MWh	5 + 80 + 100 = 185		
Weighted Average Price	\$/Credit	\$834/185 = \$4.51		
Weighted Average Price	\$/MWh	\$834/1,000 = \$0.83		

The average price per credit is constructed using Marex Spectron⁶³ data on AEPS bid and offer prices in 2021. For every 1,000MWh of retail energy sales, five Solar credits, 80 Tier I credits and 100 Tier II credits must be purchased. This amounts to a total cost per credit type of \$275, \$504, and \$55, respectively. The total cost to purchase these 185 credits is \$834 in nominal dollars, which amounts to \$4.51/credit and \$0.83/MWh.

The SWE was instructed to investigate AEPS cost changes and provide a recommendation on whether these values should be updated. To assess the degree to which AEPS costs fluctuate over time, the SWE collected historic⁶⁴ and current AEPS bid and offer prices and constructed the cost per MWh and per credit from 2008 onwards using the same methodology as described in [Table 53](#). The results are shown in [Table 54](#).

⁶³ Marex Spectron is a United Kingdom-based broker of financial instruments and provider of market data services across the metals, agricultural and energy markets. See <https://www.marexspectron.com/about-us>.

⁶⁴ See AEPS Act Historical Pricing reports at <https://www.pennaeps.com/reports/>.

Table 54: Historic AEPS Costs

Year	Solar	Tier I	Tier II	Cost per MWh	Cost per Credit
2008	\$230.00	\$4.48	\$0.66	\$1.57	\$8.51
2009	\$260.19	\$3.65	\$0.36	\$1.63	\$8.81
2010	\$325.00	\$4.77	\$0.32	\$2.04	\$11.02
2011	\$247.82	\$3.94	\$0.22	\$1.58	\$8.52
2012	\$180.39	\$5.23	\$0.17	\$1.34	\$7.23
2013	\$109.23	\$8.31	\$0.22	\$1.23	\$6.66
2014	\$94.39	\$9.78	\$0.13	\$1.27	\$6.85
2015	\$78.62	\$12.51	\$0.12	\$1.41	\$7.60
2016	\$62.06	\$14.56	\$0.10	\$1.49	\$8.03
2017	\$55.20	\$12.16	\$0.16	\$1.26	\$6.84
2018	\$31.31	\$10.15	\$0.22	\$0.99	\$5.35
2019	\$31.58	\$6.41	\$0.31	\$0.70	\$3.79
2020	\$37.00	\$7.87	\$1.92	\$1.01	\$5.44
2021	\$38.24	\$10.62	\$5.76	\$1.62	\$8.74
2022	\$41.45	\$17.68	\$10.86	\$2.71	\$14.64
2021 TRC Test Order	\$55.00	\$6.30	\$0.55	\$0.83	\$4.51
Current	\$44.00	\$24.30	\$12.00	\$3.36	\$18.18

Using current Marex Spectron prices, the weighted average cost of the AECs is \$18.18 per credit, or \$3.36 per MWh. Compared to the values originally included in the ACC, the current value of credits is up by a factor of four. However, when looking at the historical trend, three things are clear. First, the AEPS cost incorporated in 2019 represented a time when prices were at a historic low. Second, there has always been fluctuation in AEPS prices, and third, the current prices are in line with a trend toward increased AEPS cost over the last four years. This increase has roots in policy changes that originated in the amending of the AEPS Act by Act 40⁶⁵ of 2017 and Act 114⁶⁶ of 2020. Act 40 requires that Solar AECs come from solar facilities within the Commonwealth while Act 114 implements the same location requirement for Tier II credits. In line with these findings, the SWE recommends that no changes be made to the current AEPS price in the ACC at this time. While AEPS costs are increasing, they still represent a small fraction of the overall avoided costs and therefore do not warrant a mid-cycle update.

⁶⁵ See PA Act 40 of 2017, Section 2804

⁶⁶ See PA Act 114 of 2020, Section 1799.10-E

Section 5 PY13 Findings, Conclusions, and Recommendations

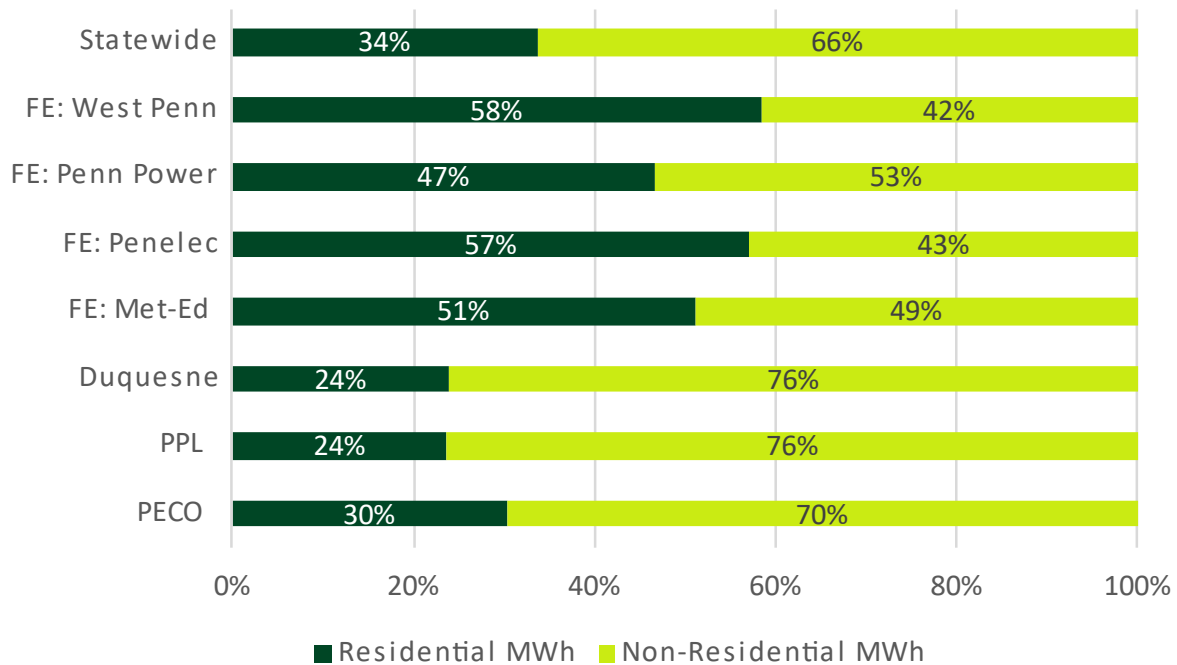
5.1 FINDINGS & RECOMMENDATIONS

The SWE conducted a review/audit of EDC program delivery mechanisms, tracking data, project and program files and provides the following key findings and recommendations:

5.1.1 Program Delivery

- Progress toward the individual EDC Phase IV compliance targets to date in verified gross energy savings ranged from 8% (Penelec) to 18% (PECO). Including carryover savings from Phase III, total progress toward Phase IV targets ranged from 22% (Duquesne Light) to 64% (Penn Power).
- Progress toward the LI target ranged from 12% (PPL) to 25% (Penelec and Penn Power) in P4TD verified gross savings and 23% (PECO) to 71% (Penn Power) when Phase III carryover savings are included.
- Progress toward the individual EDC Phase IV compliance targets to date in verified peak demand savings ranged from 7% (West Penn Power) to 16% (PECO).
- Labor shortages and supply chain issues compounded the typical gradual ramp up at the beginning of a new phase. At the beginning of any new phase EDCs must design marketing and application collateral to reflect new program designs, orient new CSPs, and refine program tracking practices. The Phase IV Implementation Order also specifies that Phase IV funds can only be used for measures installed and commercially operable after June 1, 2021, so any phase will have a slow first quarter due to the time it takes the program to fully process projects after installation. Staffing challenges in the trades led to efficient equipment sitting idle at some facilities for months waiting for contractor availability for installation. In other cases, projects were delayed due to atypically long lead times for equipment components. Lingering waves of the COVID-19 pandemic compounded project timelines and businesses responded to changing conditions across PY13. Participation and claimed savings picked up in the third and fourth quarters of PY13 and the EDCs and their CSPs appear to be on track for a strong PY14.
- Statewide, there was a big shift in MWh savings toward the non-residential sector in PY13. Non-residential savings accounted for 66% of statewide MWh savings in PY13 (Figure 38), compared to 49% of savings in Phase III. Non-residential lighting accounted for the bulk of the savings (41% statewide) while CHP was a major contributor with 13% of statewide MWh savings.

Figure 38: Share of Residential and Non-Residential PY13 Verified Gross MWh Savings by EDC and Statewide



- Residential Lighting significantly declined in PY13 compared to Phase III, accounting for 10% of statewide MWh savings. During Phase III of Act 129, residential lighting measures accounted for a high of 42% of gross statewide MWh savings to a low of 12% in PY12 (note that two EDCs did not offer upstream lighting programs in PY12). While still a top program offering, the quantity of savings from residential lighting is substantially lower than in previous years. For example, PY13 savings are equal to 40% of PY12 residential lighting savings and only 14% of PY11 residential lighting savings.
- In addition to the significantly reduced contribution from residential lighting, the contribution of HERs to EDC energy savings targets was down statewide in PY13 at approximately 6% of all verified gross MWh. In Phase III of Act 129, HER programs accounted for between 12% and 20% of gross statewide MWh savings annually. The accounting methodology for behavioral Home Energy Reports changed significantly in Phase IV. Instead of assuming all measured savings are incremental first-year savings, the 2021 TRM adopted a multi-year measure life perspective. The EDCs adapted to this new framework in different ways. PPL chose not to run a HER program in PY13. The FirstEnergy EDCs paused their legacy waves and started new HER cohorts, which have no persistence implications for new waves because homes did not receive HERs in prior program years. The EM&V contractor for PECO and Duquesne Light handled the persistence calculations expertly in PY13. The six EDCs that launched new cohorts in PY13 all started them after the beginning of the program year. The mid-year launch led to reduced energy savings compared to a full year of exposure, but a significant reduction in

peak demand savings since the Act 129 peak demand window falls during the first three months of the program (June – August). Duquesne Light and FirstEnergy each launched new waves in October, so those waves contributed no PY13 peak demand savings.

5.1.2 Evaluation

The Pennsylvania EDCs and their evaluation contractors conducted a significant volume of verification and program design research in PY13. Some of the key findings and recommendations from their research – and the SWE audit activities – included the following:

- The EDC evaluations of HER programs showed good attention to detail in PY13. The accounting method for HER programs changed in PY13 with the introduction of a HER protocol in the 2021 TRM and the transition to a multi-year measure life perspective. Under the new accounting method, verified gross savings from prior program years are inputs to the PY13 incremental annual impact calculation for legacy cohorts. PPL did not offer a HER program in PY13, and the FirstEnergy EDCs only delivered HERs to new cohorts, so they did not need to separate incremental impacts from persistent impacts. Duquesne Light and PECO's evaluation contractors successfully followed the 2021 TRM guidelines for estimating the persistent impacts of previous years of HER exposure. PECO and Duquesne Light also increased the level of rigor of their HER peak demand savings analysis in PY13 compared to Phase III in response to the Commission's decision to establish a peak demand reduction compliance target.
- Two EDCs claimed unverified reported gross savings for PY13. 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. In addition to program components that were planned to be unverified for PY13, Duquesne Light had 3,808 MWh of unverified savings from Business Midstream Lighting projects where the program-supported lighting equipment had not yet been installed when the sites were contacted for verification. PPL and Duquesne Light handled unverified savings slightly differently in their realization rate calculations. PPL omitted the unverified savings from the denominator while Duquesne Light did not. Either approach is reasonable, but for consistency the SWE uses the Duquesne Lighting approach in this report and includes all reported savings in the denominator of our realization rates.
- The Commission's decision to establish Phase IV peak demand reduction targets at the system-level led to some minor confusion in the evaluation processes. The 2021 TRM estimates peak demand reduction at the meter-level and EDC tracking systems also store meter-level impacts. The EDCs and their evaluation contractors were generally diligent about applying line loss factors to scale meter-level reductions to the system level for reporting. However, in a few cases, the SWE noted verified savings reported without adjustment for losses and line loss factors being applied a second time in the TRC models. The EDCs and their evaluation contractors were quick to update these calculations once

flagged and the SWE expects fewer issues in PY14 once the teams adjust to the new reporting convention for peak demand reductions from energy efficiency.

- The annual avoided cost review described in Sections 2.4 and 4.7 revealed some notable departures from forecast in the actual market conditions for key TRC benefit streams. The avoided cost of electricity and natural gas has increased significantly since the EDCs developed their avoided cost forecasts in summer 2020. The war in Ukraine is a key driver of the recent escalation in wholesale energy prices. The value of AEPS credits has also increased since the 2021 TRC Test Order established the value of avoided AEPS compliance costs for Phase IV. Increases in energy and AEPS compliance costs have been offset to some extent by lower than forecasted generation capacity prices in PJM's two most recent Base Residual Auctions. The TRC Test looks at benefits over the 15-year life of an EE&C Plan and only one year of actual market conditions are now known. The SWE does not recommend an update of avoided costs at this time, but it will be important to monitor market conditions and potentially adjust if energy prices remain elevated for an extended period.
- The SWE's review of verified savings for residential and non-residential programs for all EDC's found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and were generally accurate.
- Overall, the EDC evaluators estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework.
- Overall, the EDC evaluators conducted process evaluations consistent with the Phase IV Evaluation Plan and with the approved EM&V plans. Participant satisfaction was high across all EDCs for residential, low-income, and C&I customers. Table 55 provides an overview of the PY13 process evaluations conducted by each EDC.

Table 55: PY13 Process Evaluations by EDC: Percent of Participating Customers Satisfied

EDC	# of PY13 Programs & Components Evaluated	% of Satisfied Residential & LI Customers*	% of Satisfied C&I Customers*
PECO	3	73.9%	100%
PPL	10	83%	93%
Duquesne Light	2	80%	-
FirstEnergy EDCs**	-	77%	-

* Average across all programs for which participant surveys were conducted. Average is weighted by number of PY13 participants in each program. Percent satisfied defined as ratings of seven to ten on a scale from zero to ten for PECO and Duquesne Light and ratings of satisfied or very satisfied for PPL and the FirstEnergy EDCs.

** The four FirstEnergy EDCs (Met-Ed, Penelec, Penn Power, and West Penn Power) operate an identical set of five programs. The evaluation contractor took unified process evaluation approaches to these programs and reported process evaluation results across all four EDCs.

Appendix A Summary of EDC Performance Against Portfolio Targets & Cross-Cutting Findings

The following tables provide a summary of progress toward the individual EDC Phase IV compliance targets in PY13 and comparison of EDC and SWE verified savings.

A.1 EDC PERFORMANCE AGAINST PORTFOLIO TARGETS

Table 56: Summary of PY13 Verified Energy Savings and Phase IV Portfolio Targets¹

EDC	Phase IV Compliance Target (MWh/yr)		PY13 Verified Gross Savings (MWh.yr)	
	Overall	LI	Overall	LI
PECO	1,380,837	80,089	243,190	15,146
PPL	1,250,157	72,509	167,361	9,027
Duquesne Light	348,126	18,566	49,101	4,011
FE: Met-Ed	463,215	26,866	46,455	3,822
FE: Penelec	437,676	25,385	36,021	6,387
FE: Penn Power	128,909	7,477	15,934	1,836
FE: West Penn Power	504,951	29,287	43,638	6,974
Statewide	4,513,871	260,179	601,700	47,203

¹Totals may not equal sum of column or row due to rounding.

Table 57: Comparison of EDC and SWE PY13 Verified Energy Savings¹

EDC	PY13 EDC Verified Gross Savings (MWh/yr)		PY13 SWE Verified Gross Savings (MWh.yr)	
	Overall	LI	Overall	LI
PECO	243,870	15,902	243,190	15,146
PPL	168,786	10,449	167,361	9,027
Duquesne Light	49,101	4,011	49,101	4,011
FE: Met-Ed	46,455	3,822	46,455	3,822
FE: Penelec	36,021	6,387	36,021	6,387
FE: Penn Power	15,934	1,836	15,934	1,836
FE: West Penn Power	43,638	6,974	43,638	6,974
Statewide	603,806	49,381	601,700	47,203

¹Totals may not equal sum of column or row due to rounding.

Table 58: Summary of PY13 Verified Peak Demand Savings and Phase IV Portfolio Targets¹

EDC	Phase IV Compliance Target (MW/yr)	PY13 SWE Verified (MW/yr)
PECO	256	42.11
PPL	229	25.68
Duquesne Light	62	9.45
FE: Met-Ed	76	7.11
FE: Penelec	80	6.94
FE: Penn Power	20	2.10
FE: West Penn Power	86	5.86
Statewide	809	99.25

¹Totals may not equal sum of column or row due to rounding.

Table 59: Comparison of EDC and SWE PY13 Verified Peak Demand Savings¹

EDC	PY13 EDC Verified (MW/yr)	PY13 SWE Verified (MW/yr)
PECO	42.22	42.11
PPL	25.89	25.68
Duquesne Light	9.21	9.45
FE: Met-Ed	7.11	7.11
FE: Penelec	6.94	6.94
FE: Penn Power	2.10	2.10
FE: West Penn Power	5.86	5.86
Statewide	99.32	99.25

¹Totals may not equal sum of column or row due to rounding.

A.2 LOW-INCOME MEASURE PROPORTIONALITY ANALYSIS

As noted in the [Low-Income Measure Proportionality Analysis](#) section of the Executive Summary, the Phase IV Implementation Order directed the EDCs to offer conservation measures to the LI customer segment based on the proportion of electric sales attributable to LI households.⁶⁷ This “Low-Income Measure Proportionality” requirement directs each EDC to include in their programs a number of energy efficiency measures for households at or below 150% of the federal poverty income guidelines that is proportionate to each EDC’s total LI consumption relative to the total energy usage in the service territory. An LI measure is defined as a measure that is targeted to LI customers and is available at no cost to LI customers

The SWE found that each EDC complied with the LI proportionality requirement

[Table 60](#) reports the required minimum proportions and results of the SWE’s verification analysis.

⁶⁷ 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.
<https://www.puc.pa.gov/pcdocs/1666981.docx>

Table 60: LI Measure Proportionality Targets and SWE Verification Results

EDC	Proportionate Number of Measures, Target	PY13 Proportionate Number of Measures, Reported	PY13 Proportionate Number of Measures, SWE Verified
PECO	8.80%	69.6%	30.2%
PPL	9.95%	17.0%	15.5%
Duquesne Light	8.40%	14.4%	40.6%
FE: Met-Ed	8.79%	26.0%	17.5%
FE: Penelec	10.23%	26.0%	17.5%
FE: Penn Power	10.64%	26.0%	17.5%
FE: West Penn Power	8.79%	26.0%	17.5%

A.2.1 Matching Measures to TRM Algorithms Subheading

EDCs reported compliance with the proportionate number of measures targeted in their individual PY13 Annual Reports and provided supporting lists of measures from their Phase IV EE&C plans and classifications of measures to the SWE. However, upon analysis of the EDC measure classifications, the SWE found some inconsistencies in how EDCs defined measures. In the Phase IV evaluation Framework, the SWE advised EDCs to differentiate measures at the same granularity as algorithms in the TRM: “Technologies that are addressed by a single algorithm section in the TRM should not be further subdivided. Measure divisions should be based on equipment types, not differences in equipment efficiency or sizing of the same type of equipment. For example, EDCs should not separate LED bulbs into multiple measures based on wattage. A grouping approach that distinguishes between equipment types but not sizes or efficiency levels should be employed for measures that are not addressed in the PA TRM.”⁶⁸

The SWE matched measures as reported by the EDCs to TRM algorithm sections. Doing so identified when (1) multiple EDC-reported measures should be considered a single measure because they corresponded with a single algorithm section, or (2) a single EDC-reported measure could possibly be split into multiple measures because the TRM algorithm section covered multiple types of equipment, such as *Section 2.2.1 (High Efficiency Equipment: ASHP, CAC, GSHP, PTAC, PTHP)*.⁶⁹

A few challenges, described below, complicated the matching effort.

- **Matching measures to TRM algorithms:** The PECO and Duquesne Light evaluations did not match measures to 2021 TRM, which was the primary reason for the discrepancy between the EDC reported and SWE verified measure proportionality.

⁶⁸ Evaluation Framework for Pennsylvania Act 129 Phase IV Energy Efficiency and Conservation Programs. https://www.puc.pa.gov/media/1584/swe-phaseiv_evaluation_framework071621.pdf

⁶⁹ See Volume 2 (Residential Measures) of the 2021 Technical Reference Manual at Docket No. M-2019-3006867. Adopted at the February 4, 2021 Public Meeting. <https://www.puc.pa.gov/pdocs/1692531.docx>

- **Definition of *algorithm section*:** *Algorithm section* is not always clear-cut definition. Some subsections of the TRM have a single algorithm, which can easily be considered a single algorithm section. Other subsections have multiple algorithms split by text headings but without any additional numbering. This occurs in *Section 2.2.1 Electric HVAC* of the TRM, which has different algorithms for different types of equipment. In these instances, each type of equipment with a unique algorithm was considered an individual algorithm section (e.g., *Section 2.2.1* has four algorithm sections). Still, other sections have multiple text headings but the algorithms under each heading are functionally identical. This occurs in *Section 2.4.1 ENERGY STAR Refrigerators*, which has headings for “ENERGY STAR Refrigerator” and “ENERGY STAR Most Efficient Refrigerator.” The headings have identical equations except for different labeling for the variable representing the efficiency of the “new” refrigerator and should be considered a single measure.
- **Ambiguous measure names:** The EDCs provided comprehensive lists of their conservation measures; however, measure terminology varied across EDCs. In some cases, measure names had to be interpreted and matched to a TRM algorithm section by the SWE or identified as technologies or measures distinct from the TRM (for example, custom measures).

When multiple EDC-reported measures were combined to match a single algorithm section in the TRM, the final measure was considered LI if it included any EDC-reported, LI-qualified measures.

A.2.2 Common Themes

There were some measure types that at least some EDCs consistently characterized at different granularities than reflected in the TRM. Those measures are discussed below.

- **Residential and Commercial Lighting:** The TRM includes a section each for residential (2.1.1) and commercial (3.1.1) efficient lamps and fixtures. The algorithm for both sections is a straightforward algorithm that calculates the difference between baseline and new wattage regardless of bulb type and location. However, some EDCs split out measures by bulb type and location. The analysis used in this report combines these measures into one section each for residential and commercial sectors to be consistent with the SWE recommendation.
- **“Most Efficient” Appliances:** As discussed above, some TRM sections, such as 2.4.1 *ENERGY STAR Refrigerators*, include two different algorithms that are functionally the same and should be considered a single measure.
- **Ceiling/Attic, Wall, Floor and Rim Joist Insulation:** The TRM has one algorithm section, 2.6.3, that addresses ceiling/attic, wall, floor, and rim joist insulation. Some EDCs reported these as separate measures but do not have their own savings algorithms. In the SWE’s analysis, these measures are deemed as part of the *Section 2.6.3* algorithm.
- **Smart Power Strips:** The TRM has two algorithm sections for “Smart Strips” to accommodate two different tiers of smart strip technology. A few EDCs only include a single measure for smart strips. If the EDCs provide both Tier 1 and Tier 2 smart strips, then two measures should be considered. When EDCs specified the Tier 1 and Tier 2

measures separately, the analysis counts them separately. When EDCs did not specify, the analysis only counts a single measure.

- **Refrigerator/Freezer Replacement and Recycling:** Section 2.4.3 in the TRM encapsulates all refrigerators and freezers with replacement (replacing an inefficient appliance that has remaining working life with a more efficient model) and recycling (removing an inefficient appliance and preventing it from being used again with or without replacing it). Some EDCs counted this as just a single measure, while others broke out the measure by freezer/refrigerator and early replacement/recycling. While the TRM does not have different algorithm sections with separate headings for freezers and refrigerators, the inputs for each measure are substantially different. Given these differences, the SWE analysis treats them as four separate measures.
- **Double Counting Measures:** The SWE guides the EDCs to count measures that are offered both as LI (meaning the customer incurs none of the measure cost and is a LI customer) and non-LI (meaning the customer incurs some of the measure cost and/or is not a LI customer) twice in the denominator of the compliance equation. Some EDCs followed this guidance and others did not. The SWE analysis sought to identify EDC-reported measures that should be double counted and incorporated the double counting into its overall measure counts for each EDC.

A.2.3 Results

Every EDC complied with the LI proportionality requirement. Matching EDC reported measures to the TRM algorithm resulted in lower levels of compliance than reported for six of the seven EDCs.

A.2.3.1 PECO

PECO reported that 69.6% of its 115 conservation measures qualified as LI measures, which surpasses its 8.4% requirement. By the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, IMPs, and non-TRM measures, 30.2% qualify as LI measures. The reduction in compliance is largely attributable to PECO's measures not being matched to TRM algorithms. Matching measures to the TRM and double counting the proper measures resulted in 86 total measures and 26 low-income measures.

A.2.3.2 PPL

PPL reported that 17% of its 47 conservation measures qualified as LI measures, which surpasses its 8.8% requirement. According to the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, IMPs, and non-TRM measures, 15.5% qualify as LI measures. The reduction in compliance is largely attributable to the SWE identifying distinct measures within the same TRM algorithm section, such as refrigerator and freezer recycling. Matching measures to the TRM and double counting the proper measures resulted in 58 total measures and nine low-income measures.

A.2.3.3 Duquesne Light

Duquesne Light reported that 14.4% of its 194 conservation measures qualified as LI measures, which surpasses its 10% requirement. According to the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, IMPs, and non-TRM measures, 40.6% qualify as LI measures. The increase in compliance is largely attributable to Duquesne Light's measures not being matched to TRM algorithms. Matching measures to the TRM and double counting the proper measures resulted in 64 total measures and 26 low-income measures.

A.2.3.4 FirstEnergy Companies

The FirstEnergy EDCs were all assessed as a group since their measure counts are identical. The FirstEnergy companies reported that 26% of its 128 conservation measures qualified as LI measures, which surpasses the FirstEnergy requirement which ranges from 8.8% (Met-Ed and West Penn Power) to 10.6% (Penn Power). According to the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, IMPs, and non-TRM measures, 17.5% qualify as LI measures. The reduction in compliance is largely attributable to the SWE identifying distinct measures within the same TRM algorithm section, such as refrigerator and freezer recycling. Matching measures to the TRM and double counting the proper measures resulted in 171 total measures and 30 low-income measures.

A.3 NTG

Overall, the EDCs estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework. The EDCs made the NTG input data, NTG calculators, and NTG estimation syntax available to the SWE, allowing for a complete audit of the reported values.

Appendix B PECO PY13 Audit Detail

B.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework; followed proper custom site-specific Measurement and Verification (M&V) activities; applied TRM protocols correctly. The SWE made minor recommendations to Guidehouse regarding specific aspects of some impact analyses, resulting in less than 1% difference in final savings values. The SWE's feedback was provided to the evaluator with sufficient time for PECO to include all suggested changes in their annual report.
- The SWE closely reviewed a large CHP project, which accounted for about one-third of non-residential savings in PY13. Guidehouse used trended measurements collected at the facility to determine the project's verified savings, and the SWE's review of Guidehouse's analysis confirmed all energy streams were correctly accounted for, including parasitic loads.
- The SWE's review of verified savings for residential components, which include income-eligible programs, found that, overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE found minor errors for a few individual measures that were cumulatively less than 0.3% of verified portfolio savings.
- For the Rebates and Marketplace Components of the Residential Program, Guidehouse conducted impact evaluations that estimated verified savings and realization rates for a sample of projects, stratified by measure, that incorporated data from surveys of participants. However, the SWE team found the evaluated components difficult to verify because the adjusted database savings and verified savings were mislabeled in several files. In addition, the verified savings and realization rates for the sample varied slightly in the Guidehouse analysis files. The approved PECO evaluation plan specified engineering desk reviews (as well as participant surveys) as part of the impact evaluation activities, Guidehouse relied on a combination of TRM default values, EDC-provided data, and participant surveys. For the EDC-provided data, Guidehouse reviewed the CSP's methodology for incorporating measure characteristics (e.g., ENERGY STAR database for most products, AHRI database for HVAC, and manufacturer specifications as needed). For the program components with evaluation samples, Guidehouse reviewed the measure characteristics but did not independently verify them. The SWE recommends that future engineering reviews of sampled programs include verification of measure characteristics in EDC-provided data when measure model numbers or ENERGY STAR IDs are provided.
- PECO's Phase IV EM&V Plan created a new intermediate savings quantity between reported and verified gross savings referred to as "adjusted database savings." The adjusted database savings are computed for every program component annually, even in program years when no impact evaluation was conducted. In PY13, the adjusted database savings were virtually identical to the reported gross savings for non-residential programs but led to some material changes in the residential sector. The incorporation of this interim step into the rollup and calculation of verified savings was not well documented in the

PY13 annual data request response. The SWE discussed the challenges with Guidehouse and Guidehouse will improve its documentation in PY14.

- PECO had the lowest portfolio TRC ratio of the seven EDCs subject to Act 129 in PY13. The marginal portfolio result was driven largely by two factors from the non-residential program.
 - While the CHP project referenced above delivered a large amount of compliance savings with limited investment of program budget, the economics from a TRC standpoint were modest at approximately 0.75. Without this CHP project, PECO's non-residential program and portfolio show a gross TRC ratio greater than 1.0.
 - PECO assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The PECO cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PECO's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings, reported MW savings, and incentives. We were unable to replicate participant counts exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE noted only a few minor discrepancies.
- The SWE conducted a project file review for a sample of PECO's residential and income-eligible components in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, Guidehouse estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and applied historic NTG according to the approved EM&V plan.
- For the process evaluations, Guidehouse completed all the PY13 activities detailed in the approved evaluation plan and sampling memos, and the reporting followed the SWE guidelines. The process evaluation discussion was succinct and highlighted findings that should be of value to PECO and its CSPs.

B.2 EM&V PLAN REVIEWS

PECO's evaluation contractor, Guidehouse, first submitted a Phase IV EM&V plan matrix in late August 2021. The summary focused on plans for three sectors: Residential, Income-Eligible, and Non-Residential. In September 2021, the first draft of the full evaluation plan was submitted in document form. After several rounds of comments from the SWE and revisions by Guidehouse, the final evaluation plan was approved by the SWE in mid-January 2022. The peak demand savings approach for HERs was left open in the approved EM&V plan. In March 2022,

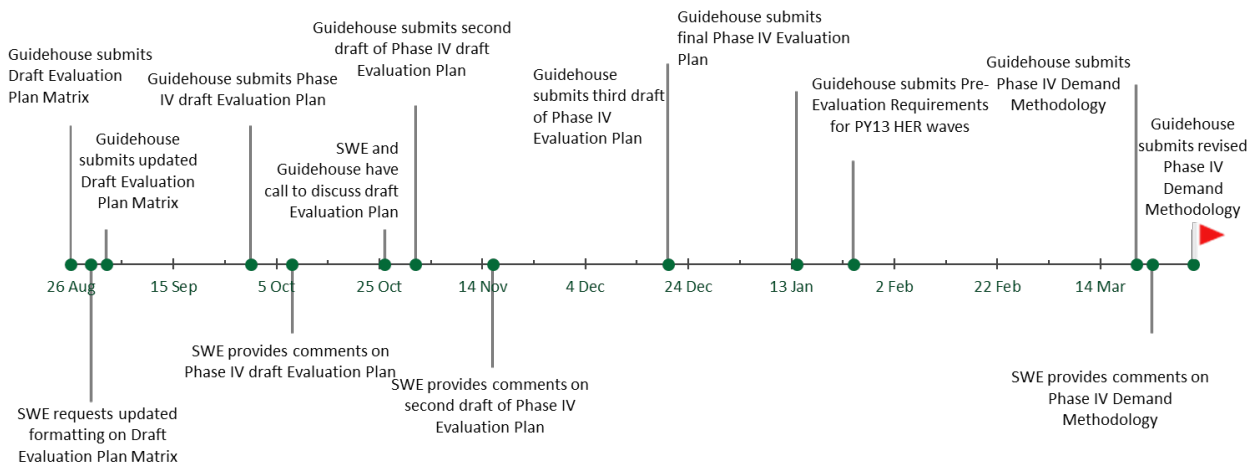
Guidehouse submitted a memo outlining the Demand Methodology for Phase IV HER impacts. The HER peak demand methods memo received comment and was finalized by the end of March. The Phase IV EM&V plan discussed sampling approaches in a general sense but included no specifics. Instead, Guidehouse submitted standalone PY13 sample design memos to the SWE once they had observed participation levels for several quarters. The SWE reviewed and approved the PY13 sample design memos upon receipt. [Appendix B.3](#) provides additional detail on PY13 impact evaluation sample designs.

The following list highlights key topics of discussion between Guidehouse and the SWE as PECO's Phase IV EM&V plan matured from a high-level matrix to a detailed plan:

- Which program components will receive an impact evaluation in which program years and the proposed approach for claiming verified savings in program years when no new impact evaluation happens.
- The purpose and output of the 'tracking database analysis' as it relates to Act 129 reporting in years when an impact evaluation is conducted and program years when no impact evaluation is planned.
- The impact evaluation in question when the EM&V plan calls for a historic realization rate in PY13.
- Expected data availability and evaluation methods for program components with a midstream delivery model.
- Interplay between Act 129 EM&V efforts and the required M&V for energy efficiency resources nominated to PJM's Forward Capacity Market.
- The expected files that will be available for "engineering desk review" for different program components.
- The timing and data collection approaches for various process and net-to-gross evaluation activities.
- Peak demand savings methodology for behavioral Home Energy Reports

[Figure 39](#) shows the review timeline of correspondence between Guidehouse and the SWE team to finalize the Phase IV EM&V plan.

Figure 39: PECO Evaluation Plan Review Timeline 2021-2022



As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. [Table 61](#) shows which PECO programs produced verified impacts in PY13, and which will use historic realizations rates, while waiting until PY14 to verify current phase results.

Table 61: PY13 PECO Program Impact Evaluation Summary

Program	Component	Delivery Channel	PY13 Impacts
Residential	Rebates and Marketplace	Downstream	Verified
		Trade ally and Distributor Network	Verified
		Point of Purchase	Verified
		Marketplace	Verified
	Appliance Recycling	N/A	Verified using PY12 verification rate
	In-Home Assessments	N/A	Verified using PY11 verification ratio from the Whole Home program
	New Construction	N/A	Verified
	Multifamily	N/A	Verified using PY10 verification ratio
Residential HER	HER	N/A	Verified
Income-Eligible	Single-Family	All	Verified using PY12 verification ratio from the Whole Home program
	Appliance Recycling	N/A	Verified using PY12 verification rate
	Long-Term Savings	All	Verified using PY12 verification ratio from the Whole Home program
Income-Eligible HER	HER	N/A	Verified
Non-Residential	Downstream Rebates	N/A	Verified
	Midstream Rebates	N/A	Verified
	New Construction	N/A	Verified
	Small Business Direct Install	N/a	Verified using PY11 verification ratio from the Whole Building program

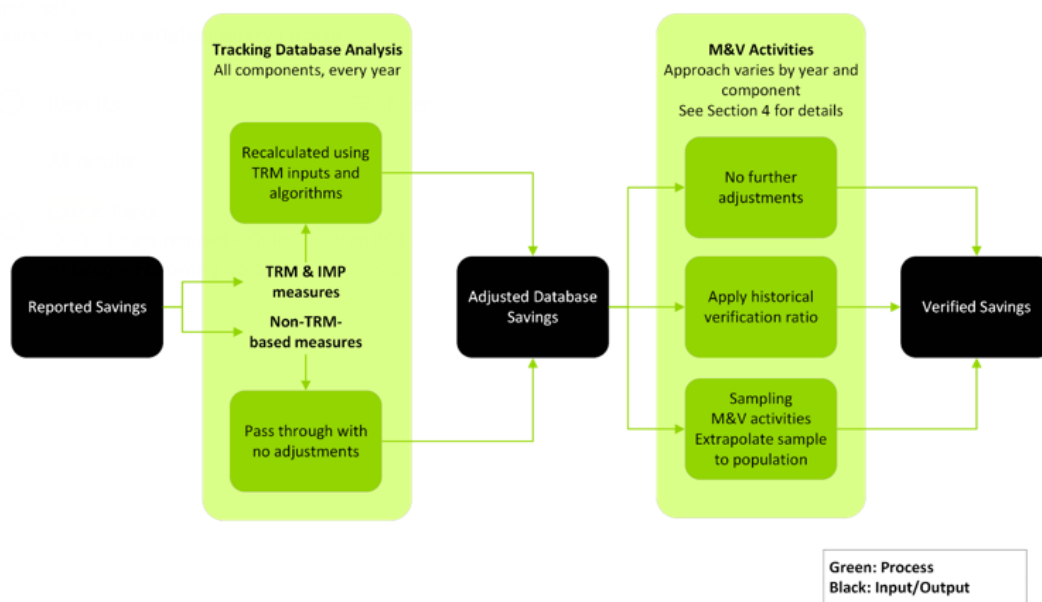
In addition to the evaluation plans, the SWE also reviewed and provided comments on draft surveys and interview guides for the applicable components.

B.3 SAMPLE DESIGN REVIEW

Of the seven EDCs subject to Act 129, PECO had the most complex sample design and expansion process in PY13. PECO's evaluation contractor Guidehouse implemented an intermediary step of tracking database adjustment to correct for any systematic issues in the reported savings. The output of this intermediate step serves as the denominator of a "verification ratio" when sampling is done and is what the results of prior sample findings are applied to in years where the EM&V Plan calls for a historic realization rate.

Figure 40 documents the two-step process by which Guidehouse verified PY13 impacts, taken from the PECO Phase IV EM&V plan.

Figure 40: Phase IV Savings Verification Process



In PY13, adjusted database savings values were only slightly different from the reported savings for most C&I programs. For residential programs, the database adjustments were more significant. For example, the Income-Eligible Single-Family component saw an approximately 20% reduction in MWh from reported savings to adjusted database savings.

The SWE recommends that if three savings values (reported, adjusted database, and verified) are to be used in the verification process in PY14 and beyond, Guidehouse should include all three quantities in the sample rollup files they provide to the SWE in the annual data request response. Specifically, the outputs of the database review need to be included in the response to item #5 of the SWE annual data request. In PY13, the data provided to the SWE had these fields spread across different files without solid unique identifiers for merging. This made it cumbersome for SWE auditors to replicate the two-step verification process and reproduce the verified gross savings values for PY13. The SWE also encountered conflicting values across files which should align.

The Phase IV Evaluation Framework established a maximum allowable level of sampling uncertainty of $\pm 15\%$ at 85% confidence level for each “initiative.” This ensures uncertainty introduced by sampling is capped at a certain acceptable level. For Phase IV of Act 129, the SWE established precision requirements at the initiative level instead of by program. This aids EDCs like PECO who define EE&C programs broadly but have specific offerings grouped more logically for evaluation purposes. PECO denotes the initiative level with the term “component.” Within some components, multiple strata are used to ensure robust sampling. The Guidehouse evaluation activities for PECO were broken down by program (residential or non-residential) and component (Rebates and New Construction) and reported in the PECO PY13 Annual Report by component. Samples were devised to meet the 85/15 sampling requirement for each program component. [Table 62](#) shows the relative precision of the energy savings for each component

evaluated in PY13. The SWE reproduced the precision values in Table 62 with the project-level sample dispositions furnished in response to the SWE annual data request. Note that program components which relied on historic realization rates have been omitted. Behavioral programs, which have no uncertainty associated with sampling, have also been omitted.

Table 62: Relative Precision of PY13 Impacts by Component at the 85% Confidence Level

Program	Component	Relative Precision (Energy)	Relative Precision (Demand)
Residential	Rebates and Marketplace	0.3%	1%
	New Construction	2%	3%
Non-Residential	Downstream	6%	11%
	Midstream	11%	11%
	New Construction	7%	13%

After clarifying the two-step database adjustment process with Guidehouse, the SWE was able to largely replicate the reported relative precision values using sample rollups and tracking data provided in response to the annual data request.

Not all components rely on sampling to estimate verified savings. For the Residential HER and Income-Eligible HER programs, the impact evaluation relies on a statistical billing analysis of all participants, so there is no uncertainty associated with sampling. The precision requirements for the behavioral program are unique, with the Phase IV Evaluation Framework requiring the component-level verification to achieve an absolute precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). This requirement for program design is less stringent than the sampling requirement (described above) that programs annually achieve $\pm 15\%$ relative precision at the 85% confidence level. Standard precision requirements are not reasonable expectations for behavioral programs because the size of the average effect is typically much smaller, and all estimation error is captured as opposed to sampling error only. The HER analysis examines the program's entire population, a census evaluation, and the reported precision values reflect the error of the regression analysis estimate rather than a sampling uncertainty. PECO reports impacts and the associated uncertainty by cohort and month, with overall program totals comfortably below the threshold.

B.4 REPORTED GROSS SAVINGS AUDITS

B.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the savings, participation counts, and incentives reported in PECO's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)
- Participation counts

- Incentive dollars

The SWE leveraged PECO's Q1-Q4 tracking data to audit these values. Note that the SWE does not receive the full tracking data set, but a subset of the full tracking data set tailored to our PY13 quarterly data request. Also note that HER programs are not audited using the tracking data, thus they are not included in the tables or totals in the following sections. The SWE's findings regarding the behavioral component of PECO's Residential Energy Efficiency Program can be found in [Appendix B.5.1.3](#).

[Table 63](#) summarizes our findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the values in PECO's PY13 Annual Report and "No" otherwise. The tracking data supports the Annual Report for all programs.

Table 63: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Energy Efficiency Program	42,009	42,009	Yes*
Residential Income-Eligible Program	15,969	15,969	Yes*
Non-Residential Energy Efficiency Program	155,915	155,915	Yes
Portfolio Total	213,893	213,893	Yes*

*The Residential Energy Efficiency Programs have HER components not represented in this table.

[Table 64](#) summarizes the SWE's findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. Like with reported gross energy savings, the tracking data supports the PECO PY13 Annual Report value exactly for all programs.

Table 64: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Residential Energy Efficiency Program	7.64	7.64	Yes*
Residential Income-Eligible Program	1.81	1.81	Yes*
Non-Residential Energy Efficiency Program	29.78	29.78	Yes
Portfolio Total	39.23	39.23	Yes*

*The Residential Energy Efficiency Programs have HER components not represented in this table.

Table 65 shows participation counts for each of PECO's programs. For all three programs, the SWE calculated directionally similar counts via the tracking data and a supplemental file. The portfolio totals, though not exactly equal, line up well: 55,365 in the PECO PY13 Annual Report and 55,318 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with PECO and their evaluation contractors to understand the Phase IV business rules around counting participants for different program components.

Table 65: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Residential Energy Efficiency Program	40,937	40,764	No*
Residential Income-Eligible Program	11,456	11,800	No*
Non-Residential Energy Efficiency Program	2,972	2,754	No
Portfolio Total	55,365	55,318	No*

*The Residential Energy Efficiency Programs have HER components not represented in this table.

Finally, Table 66 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE was able to replicate incentives shown in PECO's PY13 Annual Report for all programs after including Giveaway Costs as incentives.

Table 66: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Residential Energy Efficiency Program	5,725	5,725	Yes
Residential Income-Eligible Program	4,153	4,153	Yes
Non-Residential Energy Efficiency Program	16,316	16,316	Yes
Portfolio Total	\$26,194	\$26,194	Yes

B.4.2 Project File Reviews

B.4.2.1 Residential

The SWE conducted a project file review for a sample of PECO's residential and income-eligible components in PY13 as part of the reported savings (i.e., ex-ante) review. The project file documentation was provided by PECO, the program implementors, and the evaluation contractor, Guidehouse, in response to the SWE's standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms.

Table 67 presents a summary of SWE's residential project file reviews. Project files were found to match most of the tracking data, with some exceptions.

Table 67: PECO Residential Project File Review Summary

Program	Component	Number of files reviewed	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data? ¹
Residential EE Program	In-Home Assessment	12	✓	✓	✓	✓
Residential EE Program	Rebates and Marketplace	12	✓	✓	✓	✓
Residential EE Program	Appliance Recycling	13	✓	✓	✓	✓
Residential EE Program	Residential New Construction	32	✓	✓	✓	✓
Residential EE Program	Multifamily	8	✓	✓	✓	✓
Income-Eligible EE Program	Single-Family Income Eligible	15	✓	✓	✓	✓
Income-Eligible EE Program	Appliance Recycling	9	✓	✓	✓	✓
Income-Eligible EE Program	Long-Term Savings	3	✓	✓	✓	✓

¹ It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential program. Below is a summary of the SWE's review of the Residential EE Program and Income-Eligible EE Program project file packages and program tracking data.

Residential EE Program: In-home Assessment

The SWE was provided with PECO energy assessment reports, which were compared to the program tracking data spreadsheet. The SWE determined that project files matched the tracking data for the residential in-home assessment projects for Q2, Q3, and Q4. There were no quarterly submissions for the in-home assessment projects in Q1.

Residential EE Program: Rebates and Marketplace

The project file documentation that was provided for the rebates and marketplace component included images of receipts, contractor invoices, ENERGY STAR certificates, and AHRI certificates. The SWE determined that project files matched the tracking data for the residential rebates and marketplace projects for Q2, Q3, and Q4. There were no quarterly submissions for the Rebate and Marketplace components in Q1.

Residential and Income-Eligible EE Program: Appliance Recycling Component

The project file documentation that was provided for the appliance recycling component included electronic data collection, signature forms, and some pictures. Signature forms specified number of units, unit type, location, brand, model, color, age, size, amps, defrost setting, and driver notes. Signature forms were provided for Q1, Q2, and Q4. Photos were captured in some instances but not in others. The data in the project files matched the program tracking data. However, Q3 consisted of one word document with a screengrab of the data collection software tool after the data for the project documentation was added. These often showed a picture of the recycled appliance, but generally no nameplates were captured. The SWE was not able to verify that the correct inputs were used for age and size without nameplate photos or model and serial number data.

The SWE reviewed projects from the Income-Eligible EE Program appliance recycling component in tandem with the Residential EE Program review.

Residential EE Program: New Construction Component

The SWE was provided with a sample of project files for individual projects, which were compared to the program tracking data spreadsheet. In all reviewed cases, project files consisted of REM/Rate file, an image of the REM/Rate PECO savings report, and an image of the REM/Rate PECO HERS report. The SWE observed three cases where the percent savings over the baseline reported in the REM/Rate certificate differed from the program tracking data but did not observe discrepancies in the reported savings. The reported savings also included savings from lighting and appliance end-uses. In addition, one REM/Rate model was not able to open due to an error in the file.

Residential EE Program: Multifamily

The SWE was provided with contractor invoices and data collection form spreadsheets for individual projects, which were compared to the program tracking data spreadsheet. The SWE determined that project files matched the tracking data for the residential multifamily projects for Q1 and Q4. However, there were no project files provided for Q2 and Q3 despite there being project records present in the program tracking data.

Income-Eligible EE Program: Single-Family Income Eligible

The SWE reviewed project documentation which included invoices for batch giveaways and direct installation data collection form spreadsheets. The SWE found that the files uploaded on a quarterly basis were not consistent among quarters, for example Q1 only included audit files and Q2 only consisted of giveaway records. The SWE did not observe any major discrepancies during

the file review but did observe some cases where rebate amounts were included in the project invoices but not in the program tracking data.

Income-Eligible EE Program: Long Term Savings

The SWE was provided with two contractor invoices and a contractor incentive application for individual projects, which were compared to the program tracking data spreadsheet. The SWE determined that project files matched the tracking data for the income eligible long-term savings components projects for Q4. The SWE did not review project files for Q2 and Q3 because of low participation project counts for those quarters. There were no quarterly submissions for the long-term savings projects in Q1.

B.4.2.2 Non-Residential

The SWE reviewed a sample of PECO’s Downstream, Midstream, and Small Business Direct Install (SBDI) projects for PY13 using the project documentation provided by the evaluation contractor in response to the SWE’s standing quarterly data request. The project file packages included savings calculation worksheets, rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. Most of the reviewed project file packages included all documentation requested and were well organized, allowing for a comprehensive review of the forty-one projects sampled.

Table 68 presents an overview of the results of the SWE’s C&I project file reviews. The SWE noted a handful of instances where the project tracking documentation did not match the provided calculation workbooks and/or project files. These noted inconsistencies generally reflect minor impacts on reported savings values.

Table 68: PECO PY13 C&I Project File Review

Program	Segment	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?
Downstream	Large C&I	7	✓	4/7	✓	✓	✓
Downstream	Small C&I	6	✓	4/6	✓	✓	✓
Midstream	--	2	✓	✓	✓	✓	✓
SBDI	Small C&I	2	✓	✓	✓	✓	✓

B.5 VERIFIED GROSS SAVINGS AUDITS

B.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of PECO's portfolio of residential programs. PECO's portfolio of residential programs consists of the following components: Appliance Recycling, Rebates and Marketplace, In-Home Assessments, Multifamily (includes income-eligible multifamily), and Residential n=New Construction. In addition, the SWE's audit covered the Income-Eligible Program which includes the following components: Single-family, Appliance Recycling, and Long-term Savings. Note that the SWE reports the residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

Table 69 provides a summary of the evaluation and M&V approaches used by PECO in their PY13 verified savings calculations.

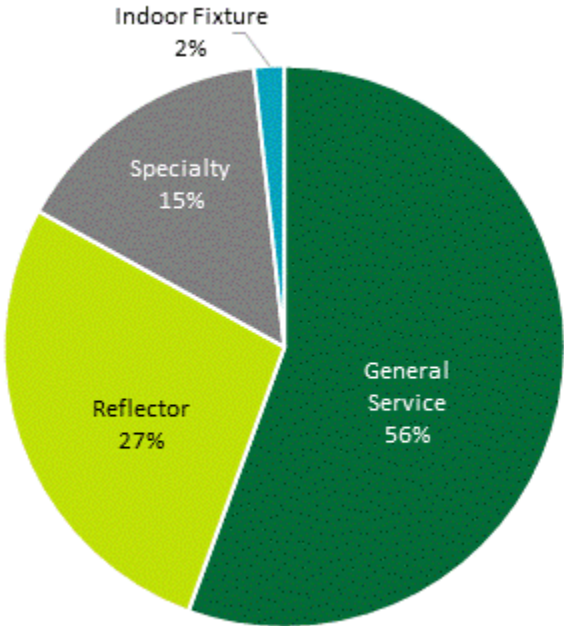
Table 69: Residential and LI Impact Evaluation Activities - PECO

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis	Historic Realization Rate
Residential Program					
Appliance Recycling	-	-	✓	-	✓
Rebates and Marketplace	✓	-	✓	-	
Residential In-Home Assessments	-	-	✓	-	✓
Multifamily (includes income eligible)	-	-	✓	-	✓
New Construction	-	-	✓	-	
Income-Eligible Program					
Single-family	-	-	✓	-	✓
Appliance Recycling	-	-	✓	-	✓
Long-Term Savings	-	-	✓	-	✓
^a The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.					

B.5.1.1 Upstream Stream Lighting & Cross-Sector Sales

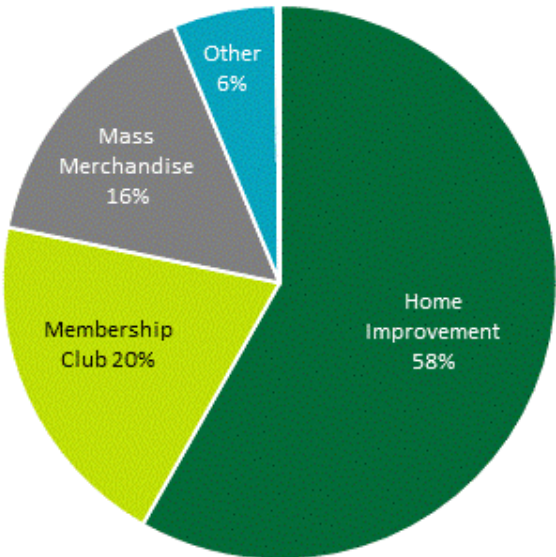
Customers purchased over 1.6 million efficient light bulbs and fixtures through PECO's PY13 upstream lighting program. Figure 41 displays the distribution of sales by product type. Over one-half (56%) were general service lamps, followed by reflectors (27%), specialty bulbs (15%), and indoor fixtures (2%).

Figure 41: PECO PY13 Upstream Lighting Sales by Product Type



Over one-half (58%) of PECO’s PY13 upstream light bulbs and fixtures were sold through home improvement stores, followed by membership clubs (20%) and mass merchandise stores (16%, Figure 42).

Figure 42: PECO PY13 Upstream Lighting Sales by Retail Channel



Audit Findings

The SWE reviewed the data in PECO's tracking system to verify that Guidehouse used the appropriate values and algorithms from the 2021 TRM to calculate verified gross savings. Although the team identified some minor discrepancies (described in the review below), the SWE generally agrees with Guidehouse's verified gross savings for upstream lighting but has adjusted verified savings for the errors detailed below.

The SWE observed 558 unique lighting model numbers in the PY13 tracking system and was able to verify that 549 are ENERGY STAR certified. The SWE compared the product descriptions, lumens, and wattages in the tracking system to those in the ENERGY STAR certified products lists and found that they aligned for 482 models. The team confirmed that Guidehouse used the appropriate algorithms to calculate kWh and kW savings and the correct baseline wattages, ISR, HOU, interactive effects, and coincidence factors in the calculations. For many of the cases in which lumens and/or wattages did not align between the tracking system and the ENERGY STAR certified products lists, neither did the ENERGY STAR ID. In addition, there were six models in the tracking system that were each linked to two ENERGY STAR IDs. After correcting the lumens and wattages for models that did not match those in the ENERGY STAR certified products lists the SWE determined that verified savings were underestimated by 79 MWh. The impact of the discrepancies the SWE identified on portfolio-level savings is negligible.

Cross-Sector Sales

Guidehouse did not conduct cross-sector sales research in PY13 but applied the TRM default cross-sector sales rate of 7.4%.

Recommendations

The SWE makes the following recommendation based on its review:

- Verify ENERGY STAR IDs in the ENERGY STAR certified products lists by model number. Update any incorrect ENERGY STAR IDs and ensure there are no duplicates.

B.5.1.2 Residential Non-Lighting

The SWE's review of verified savings for residential non-lighting components, which include income-eligible programs, found that, overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE found minor errors for a few individual measures that were cumulatively less than 0.3% of verified portfolio savings.

Appliance recycling

The SWE reviewed the Appliance Recycling component recycles old appliances, such as refrigerators and freezers. Guidehouse conducted a tracking database analysis of the PY13 tracking data, and adjusted savings to conform to the TRM guidelines before applying the PY12 verification ratio. The SWE confirmed that the savings values were correctly calculated and reported for both residential and income eligible Appliance Recycling components.

Rebates and Marketplace

The Rebates and Marketplace component of the Residential program includes rebates for lighting, HVAC, appliances, and other energy-saving devices such as smart power strips. There are four

delivery channels within Rebates and Marketplace: Downstream, Trade Ally and Distributor Network, Marketplace, and Point of Purchase. The Guidehouse evaluation team conducted survey-based verification of a sample of projects for three of the four delivery channels: Downstream, Trade Ally and Distributor Network, and Marketplace.

The SWE audit of the three sampled Rebates and Marketplace components included ECM Circulation Fans, ENERGY STAR air purifiers, ENERGY STAR clothes dryers, ENERGY STAR clothes washers, ENERGY STAR dehumidifiers, ENERGY STAR refrigerators, ENERGY STAR room air conditioners, heat pump water heaters, air-source heat pumps, central A/C, variable speed pool pumps, advanced power strips, smart thermostats, ENERGY STAR lighting, and ductless mini-split heat pumps. The SWE determined that the savings were calculated in accordance with TRM protocols and incorporated the measure verification data from the evaluation surveys. The SWE noted minor discrepancies between the verified savings for the sampled projects in the evaluation sample file and the rollup file and alerted Guidehouse to the discrepancies. Guidehouse informed the SWE that the discrepancies were due to the rollup file including savings from installed measures not included in the survey for a couple of respondents.

Residential In-home Assessments

The Residential In-home Assessments component provides in-home or virtual assessments and comprehensive audits to educate customers, install efficient measures, and identify potentially larger opportunities (like insulation and air sealing). Measures included: ENERGY STAR lighting, LED nightlights, advanced power strips, low-flow showerheads, water heater temperature setbacks, water heater pipe insulation, HVAC maintenance, insulation, and air-sealing. Guidehouse conducted a tracking database analysis of the PY13 data to confirm the measure savings adhered to the TRM protocols and then applied a PY11 verification ratio to determine verified savings. The SWE confirmed that the tracking data review applied the correct default values and EDC collected data to the TRM algorithms before applying the PY11 verification ratio.

Residential New Construction

The New Construction component supports the construction of more Energy Efficient Homes compared to those that were built to code. Guidehouse conducted a review of a sample of homes for the PY13 verified savings. They reviewed project files, performed building energy modeling simulations, and calculated gross demand impacts using TRM algorithms. Guidehouse provided the analysis to the SWE in advance of the PY13 annual reporting and was able to correct observed inconsistencies between verified demand values in the impact analysis file and the sample rollup file prior to drafting the PECO PY13 Annual Report. The SWE confirmed that the demand values were corrected in the PY13 report.

Residential and Income-eligible Multifamily

The Residential Multifamily component of the Residential and Income-eligible EE programs provides analysis, direct install measures, and larger, investment-level upgrades to improve the energy efficiency of multifamily buildings, both in-unit and in common areas. The program covers market-rate and income-eligible customers and has a commercial savings component. The evaluator, Guidehouse, conducted a tracking data review using a combination of TRM defaults and data included in the tracking data. The evaluator then applied a historical realization rate from

PY10, based on the approved EM&V plan. The SWE found that the savings recreated using TRM defaults and EDC tracked data were conducted correctly before applying the PY12 verification ratio.

Single Family (Income-Eligible)

The Single-Family component of the Income-Eligible EE Program enables income-eligible customers to improve the energy efficiency of their homes through home energy check-ups (in-person and virtual), direct install measures, and giveaway measures. Guidehouse conducted a tracking database analysis of the PY13 tracking data. After adjusting reported savings for any instances in which savings estimates did not conform with TRM guidelines, Guidehouse applied the PY12 verification ratio. The SWE reviewed the tracking database analysis and confirmed that savings had been calculated correctly in accordance with TRM guidelines for most measures. Exceptions included faucet aerators, connected thermostats, ENERGY STAR lighting, LED nightlights, and thermostatic shower restriction valves. For kit-delivered faucet aerators, kitchen location was assumed rather than unknown location, overstating verified savings. For around 10% of connected thermostats for which EDC gathered HSPF was not available, a value other than the TRM default HSPF was used to calculate savings. In addition, the baseline wattages for around 20% of LED nightlights were unreasonably high for nightlights (15 to 100 watts). For ENERGY STAR lighting, the SWE found that the efficient lumens and/or wattages used to calculate savings differed from those listed in the ENERGY STAR certified products lists for six models. Lastly, the SWE observed that thermostatic shower restriction valve calculations for a handful of single-family homes utilized the multifamily TRM default input for household size.

Long-Term Savings (Income-Eligible)

The Long-Term Savings component is implemented as an overlay service through the Single-Family component to encourage the installation of long-term, comprehensive measures, including insulation, air sealing, duct sealing, ducted and ductless air source heat pumps, air conditioners, thermostats, and heat pump water heaters. Guidehouse conducted a tracking database analysis of the PY13 tracking data. After adjusting reported savings for any instances in which savings estimates did not conform with TRM guidelines, Guidehouse applied the PY12 verification ratio. The SWE reviewed the tracking database analysis and confirmed that savings had been calculated correctly in accordance with TRM guidelines for all measures.

B.5.1.3 Behavior

Approximately 10% of the PY13 verified gross energy savings listed in PECO's PY13 Annual Report came from Home Energy Reports issued to over 560,000 households. For PY13, the program provided 24,576 MWh in energy savings with 795 MWh accruing to low-income households. Behavioral Home Energy Reports account for 5% of PECO's progress toward its low-income compliance target in PY13. The program also generated 3.69 MW of meter-level peak demand savings and 3.98 MW of system-level peak demand savings toward PECO's Phase IV PDR target.

PECO's Residential Market Rate and Income-Eligible HER programs consist of 7 waves, with later waves further subdivided into smaller groups. Waves 4 and 5 were not active in PY13, so

they were not evaluated in PY13. [Table 70](#) shows the average number of active households by wave and group during PY13, rounded to the nearest hundred:

Table 70: PECO HER Waves Summary

Wave	Wave Start Date	Treatment Group Homes	Control Group Homes
1	Aug 1, 2013	21,400	13,800
2	May 1, 2014	27,900	11,800
3	Jun 1, 2015	48,400	15,000
6 - Dual Fuel	Jul 28, 2019	14,100	3,800
6 - Electric	Jul 28, 2019	4,600	11,900
7 - Dual Fuel	Jun 27, 2021	99,600	24,800
7 - Has Email	Jun 27, 2021	213,600	17,300
7 - Income Eligible	Jun 27, 2021	20,600	11,900
7 - No Email	Jun 27, 2021	85,000	19,800

Wave 7 participants began receiving home energy reports June 27, 2021. The wave is divided into four groups by customer type, as shown in [Table 70](#). The combined Wave 7 treatment groups account for 79% of the PECO customers currently receiving HERs. Oracle is the implementation CSP for all waves of the program, including the new Wave 7 groups.

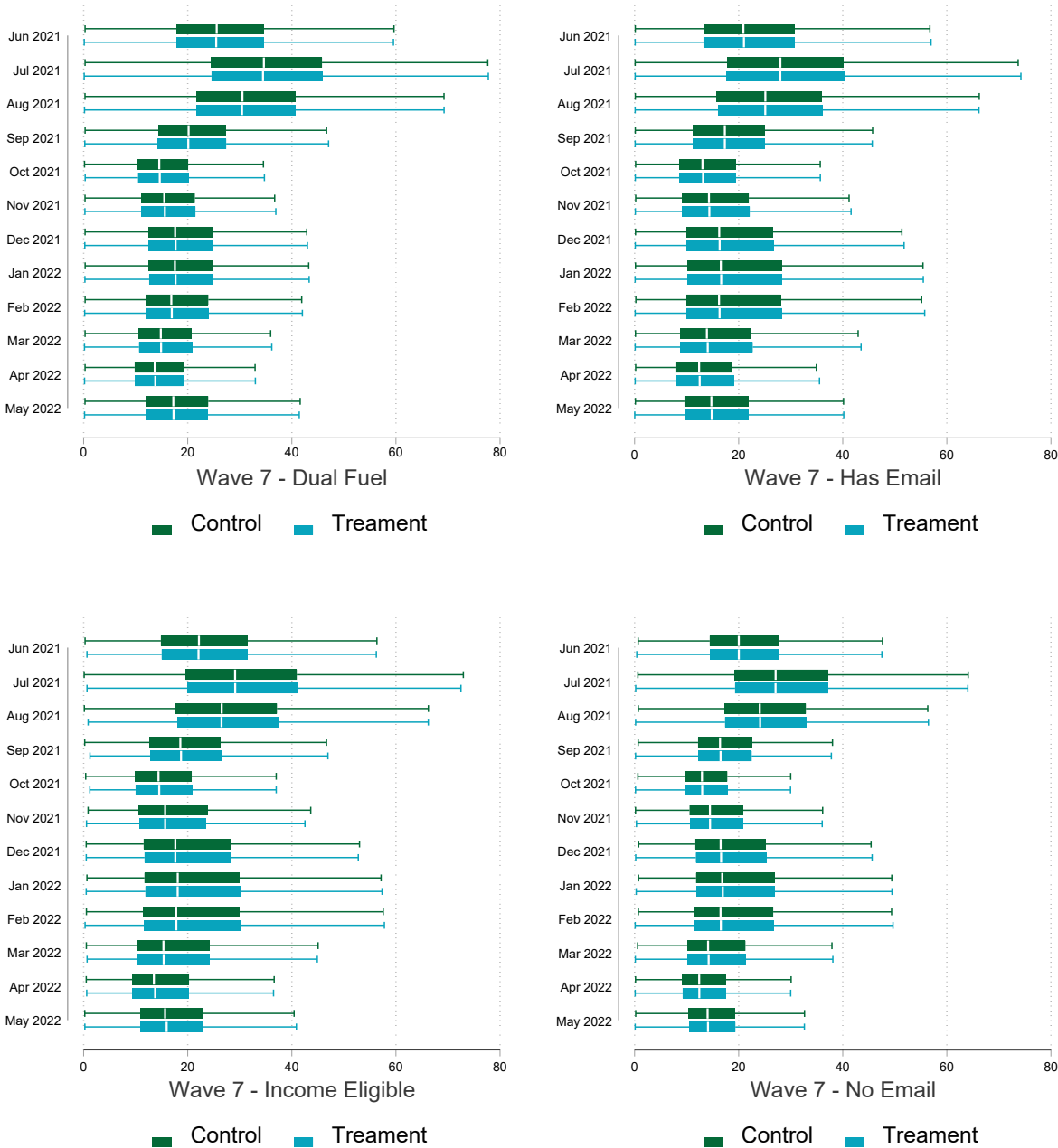
Pre-Treatment Equivalence of Treatment & Control Groups

All waves in PECO's HER programs are organized as randomized control trials (RCTs). Oracle first identified eligible customers for each wave, then randomly assigned each to either receive home energy reports (the treatment group) or not (the control group). Sub-groups in Waves 6 and 7 were designated by customer characteristics after the initial random assignment. To validate Oracle's random assignment of customers to receive HERs, pre-treatment energy-use patterns are compared across the treatment and control groups. Similar pre-treatment usage for treatment and control group customers through Wave 6 have been reported previously.

For Wave 7, Guidehouse confirmed that pre-treatment energy-use patterns were similar across treatment and control groups. All four groups in Wave 7 show no significant differences in energy use in the 12 months prior to June 2021, when the first HERs were issued. The SWE confirmed this result using a random-effects model with indicators for treatment and months as explanatory variables. There was essentially no difference in energy use between the treatment and control groups in the pre-treatment period: The treatment indicator's impact was estimated to be zero, with a very high p-value.

[Figure 43](#) shows energy use patterns for treatment and control groups in each of the Wave 7 groups for 12 months prior to the program start date. The distributions of usage for treatment and control groups do not show any consistent differences.

Figure 43: Average Daily Usage by Month in Pre-Treatment Period (kWh)



Energy Impact Estimates

The SWE was able to confirm all energy savings estimates. Using data prepared by Guidehouse, estimates were replicated exactly, and estimates using data prepared by the SWE were very similar. Guidehouse estimated the average daily impact of HERs on energy use with a lagged-dependent-variable (LDV) regression model. The model estimates the effect of HER exposure in PY13 while controlling for a customer’s usage during the same calendar month before treatment began. Daily HER impacts were estimated separately for each month, then multiplied by the

number of participants and days to produce monthly estimates. These monthly totals are aggregated across PY13 in [Table 71](#) below.

Dual Participation

Home Energy Reports promote participation in additional PECO EE&C offerings such as ENERGY STAR appliances, efficient lighting, HVAC etc. To the extent that treatment group households participate in these programs more frequently, gross savings estimates capture impacts of both the HERs as well as the other programs. Since these other programs claim savings separate from PECO's HER programs, their impacts must be removed to avoid double-counting. As shown in [Table 71](#), HER savings estimates are reduced to account for the difference in program participation observed between the treatment and control groups. For PY13, estimated gross savings before adjusting for dual participation was roughly 55,000 MWh. Of this, 4,600 MWh can be attributed to other upstream or downstream programs.

Table 71: PY13 Energy Savings from Home Energy Reports (MWh/yr)

Wave	Gross Savings	Downstream Dual Participation	Upstream Dual Participation	Persistence	PY13 Incremental Savings
1	6,344	638	171	3,824	1,711
2	12,096	1,307	324	5,900	4,565
3	18,245	996	518	12,734	3,997
6 - Dual Fuel	1,463	72	31	824	536
6 - Electric	3,905	204	83	2,264	1,354
7 - Dual Fuel	3,671	65	27	-	3,579
7 - Has Email	6,503	104	48	-	6,351
7 - Income Eligible	807	6	6	-	795
7 - No Email	1,736	47	13	-	1,676
Total	54,771	3,440	1,221	25,546	24,576

Persistence

Some PECO customers have been receiving Home Energy Reports for multiple years, with impacts persisting, to some degree, from HERs sent in earlier years. Starting in PY13, these impacts from previous years must be subtracted from savings estimates to yield *incremental first-year savings*, the impact attributable to HER program efforts in the current program year only. Act 129 compliance goals are based on first-year incremental savings.

As shown in [Table 72](#), more than half of gross savings in Waves 1, 2, 3, and 6 are attributable to persistent impacts from previous years' HERs. Guidehouse thus calculated PECO's first-year

savings as PY13 savings (net of uplift) minus estimated impacts from the previous 3 program years, with impacts from previous years assumed to decay at a rate of 31.3% for up to 3 years.⁷⁰

Following the 2021 TRM, for the first two years of HER exposure, persistence is assumed to be zero and the *first-year savings average treatment effect* (FYSATE) simply equals the average treatment effect (ATE). PECO’s Wave 7 groups, which began in PY13, thus have no persistent impacts removed.

For waves receiving HERs for 2 years or more, the FYSATE is calculated as the ATE minus the decayed impacts from each of the previous three program years:

$$FYSATE_y = ATE_y - \sum_{x=1}^{x=i-2} FYSATE_{y-x} - FYSATE_{y-x} * Decay * (X - 0.5)$$

where *FYSATE_y* is the average daily savings attributable to HERs in the current year *y* and *FYSATE_{y-x}* is the average daily savings attributable to HERs delivered in an earlier year *y - x*. Year *i* is first year of HER exposure, up to a maximum of 5 (since waves in years 1 and 2 of treatment are not included in these calculations) and *x* indicates one to a maximum of three previous years.

Persistent impacts of HERs on each wave of PECO participants are shown in Table 72. Any impacts before PY10 are assumed to have decayed to zero. Wave 6 participants are in their third year of treatment and thus only have two previous years’ impacts to subtract. Daily impacts are multiplied by participants and days to yield the total persistent savings shown in Table 72.

Table 72: Persistent Impacts from PY10 – PY12, Average Daily Savings (kWh)

Wave	Persistent Impact from PY12	Persistent Impact from PY11	Persistent Impact from PY10	Total
1	0.344	0.104	0.042	0.489
2	0.310	0.178	0.091	0.578
3	0.456	0.195	0.071	0.721
6 - Dual Fuel	0.492	0.257	-	0.492
6 - Electric	0.440	0.241	-	0.439

The SWE team found that Guidehouse accurately estimated persistent savings for each wave following TRM specifications. Guidehouse provided the SWE team with estimated impacts from all previous years. These were used to calculate first-year savings for the earliest program years,

⁷⁰ Addendum to Act 129 Home Energy Report Persistence Study. November 2018. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

with the estimates carried forward to calculate the FYSATE for program years 10-12. FYSATE estimates were then used in the formula above to calculate persistence for each wave.

Low-Income Participants

For PY13, PECO identified Income-Eligible customers within the Wave 7 treatment and control groups. Impacts from the Wave 7: Income Eligible cohort count directly toward PECO's Phase IV low-income target. 22,000 Wave 7 participants were income-eligible (5% of participants), with total savings of 795 MWh ([Table 73](#)). These made up over 6% of the Wave 7 savings, all of which are incremental, first-year savings.

Table 73: PY13 First-Year Savings by Income Groups

Income Group	Incremental Savings (MWh/yr)
Wave 7: Market Rate (combined)	11,606
Wave 7: Income-Eligible	795
Total	12,401

Peak Demand Impacts

For PY13, peak-demand savings from HERs were estimated with hourly meter data. Peak periods were defined as hours from 2:00 PM to 6:00 PM on non-holiday weekdays from June to August. Since hourly data for the pre-treatment period was not available for all customers, peak demand impacts were measured by comparing treatment and control-group customers in PY13 only (summer 2021). Treatment/control groups were randomly assigned in each wave and had equivalent usage patterns before they began receiving HERs, so these comparisons are valid.

Guidehouse estimated the impact of HERs on peak hourly usage separately in June, July, and August 2021 while controlling for average hourly usage in each month. [Table 74](#) shows the results.

Table 74: PY13 Peak Demand Savings by Month (Meter-Level MW)

Wave	June 2021	July 2021	August 2021	PY13 Average
1	0.19	0.24	0.25	0.23
2	0.66	0.65	0.79	0.70
3	0.55	0.56	0.51	0.54
6 - Dual Fuel	0.04	0.03	-0.01	0.02
6 - Electric	0.06	0.07	0.06	0.06
7 - Dual Fuel	0.10	0.58	0.84	0.51
7 - Has Email	1.37	1.95	2.29	1.87
7 - Income Eligible	- 0.18	- 0.16	0.02	-0.11
7 - No Email	- 0.23	- 0.14	0.03	-0.11
Total	2.57	3.78	4.77	3.69

For older waves (through Wave 6), PY13 estimates will be applied to savings in future years, while Wave 7 estimates will apply to PY13 only. PECO chose to estimate demand impacts for June 2021, so all peak periods in that month were considered treated for estimation purposes even though the first HERs were not sent until June 27. The SWE largely replicated Guidehouse's estimated peak demand savings for all waves. SWE estimates were directionally similar and not statistically different from Guidehouse estimates. Small differences in the point estimates resulted from a difference in handling of extremely small and large meter reads.

Conclusion

Guidehouse's data management and reporting processes for two behavioral Home Energy Report programs are clear and repeatable. The SWE was able to replicate savings estimates using the modeling procedures laid out in PECO's Phase IV EM&V Plan for both energy and peak demand savings. First-year incremental savings (net of uplift and persistent impacts) were also verified. Overall, the SWE agrees with the PY13 savings reported by Guidehouse for PECO's Residential Market Rate and Income-Eligible HER programs.

B.5.2 Non-Residential Audit Activities

B.5.2.1 Downstream

The Downstream component operates under the Municipal Lighting, Small C&I, and Large C&I programs comprising 87% of PECO's Non-Residential reported energy savings. The 769 participants contributed to nearly 3,000 rebated projects. Guidehouse derived a sample of 33 projects from the Large and Small C&I programs and allocated them to multiple strata based on project type and size.

Of the nine (9) projects evaluated under the Small C&I segment, eight (8) included lighting or lighting control retrofits and one (1) custom project. Of the 24 projects evaluated under the Large C&I component segment, 19 included lighting or lighting control retrofits, four (4) were classified as custom, and one (1) is classified as motors and drives. A single combined heat and power (CHP) project included in the Custom category under the Large C&I program represents 38% of reported peak demand savings and 48% of reported energy savings.

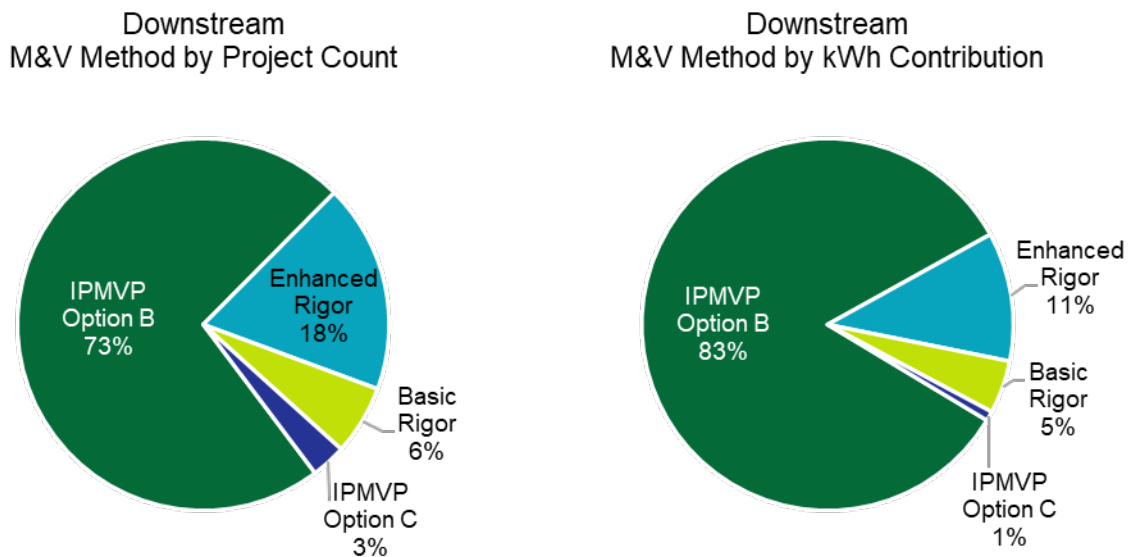
The SWE attended Guidehouse's site visits for four of the sampled projects and conducted desk reviews for an additional eight projects.

Guidehouse conducted desk reviews for all projects in the evaluation sample. The desk reviews used project applications, project-specific analysis files and associated calculation sheets, measure invoices, measure specification sheets, construction plans, and other construction documents provided by PECO. Guidehouse supplemented desk reviews with phone verification, on-site verification, and metering. Most sampled projects from the Downstream component achieved realization rates for both demand and energy within 20% of the expected values. Three (3) of the projects had verified energy savings values above 120% of the reported values, while three (3) of the projects fell below 80% of reported values. Guidehouse observed the following conditions that resulted in adjustments to reported savings:

- Control types, HVAC system types, and HOU were revised for lighting projects based on site-specific data and customer reviews.
- Peak period definitions were updated in two (2) retro commissioning projects which impacts peak demand savings.
- CHP system availability and capacity during peak times was adjusted based on trend data analysis to a lower value than reported.

Figure 44 displays the share of M&V methods performed under the Downstream component. IPMVP methods accounted for 84% of the evaluated savings, and only represented 8% of projects.

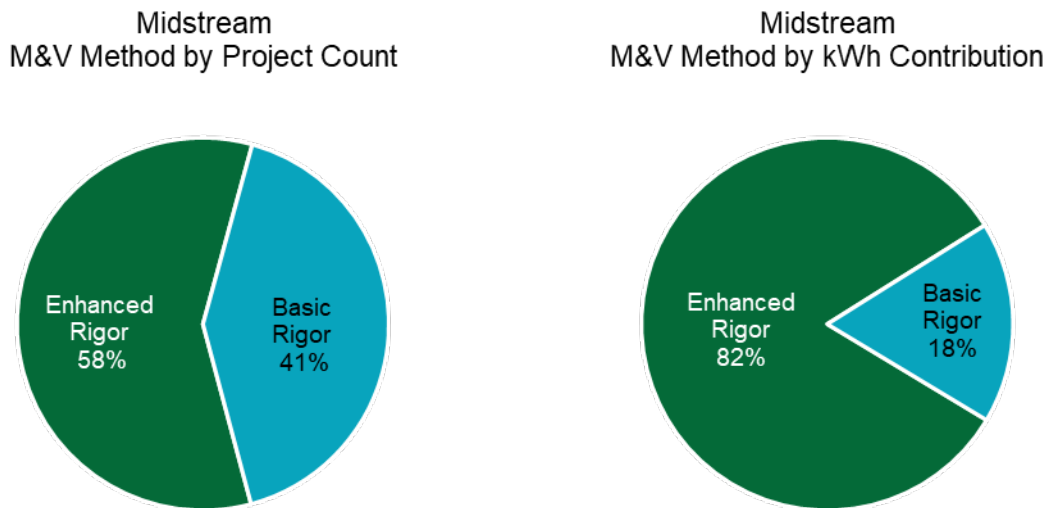
Figure 44: Summary of PECO's PY13 Downstream Component M&V Methods



B.5.2.2 Midstream

The Midstream component operates under the Municipal Lighting, Small C&I, and Large C&I programs. The Municipal Lighting segment represents less than 1% of the energy savings for this program. Guidehouse sampled 78 participants from this program that includes 43 phone interviews, 33 desk reviews, and two (2) on-site verifications.

Figure 45: Summary of PECO's PY13 Midstream M&V Methods



B.5.2.3 Small Business Direct Install

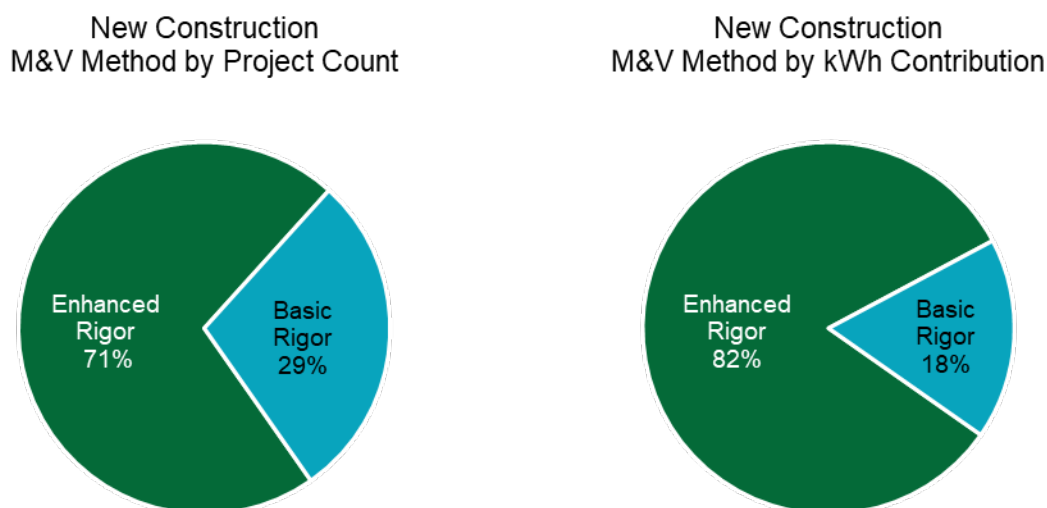
The Small Business Direct Install component contributed approximately 3% of reported savings to PECO's non-residential portfolio. This program operates under both the Large and Small C&I

programs. Guidehouse did not evaluate any projects from this component in PY13 and applied the realization rates from PY11 for energy and demand for PY13 gross savings.

B.5.2.4 New Construction

The Non-Residential New Construction segment represented approximately 3% of PECO’s reported energy savings and 3% of PECO’s peak demand savings portfolios. Guidehouse sampled 14 projects from this component in PY13 that includes ten phone interviews and four desk reviews.

Figure 46: Summary of PECO’s PY13 New Construction M&V Methods



B.5.2.5 Verified Savings Audits

The SWE audited the activities above through a detailed audit of Guidehouse’s evaluation work for a sample of their evaluated projects. The SWE audit for Guidehouse in PY13 included review of 12 projects, encompassing the following activities:

- 9 Field and Analysis Engineers observed
- 6 measure types reviewed
- 4 Ride-Alongs conducted, 1 in person and 3 virtual
- 38% of Verified Non-Res Energy Savings reviewed
- 25% of Verified Non-Res Demand Savings reviewed

Table 75 provides the overall results of the SWE Verified Savings Audit for C&I projects:

Table 75: PECO C&I Verified Savings Audit Results

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
12	58,973,787	100.3%	7,377	100.3%

Overall, the SWE agreed with the calculation methods utilized by PECO's evaluation contractors. The savings calculations and accompanying reports were easy to follow and showed evidence that the TRM was utilized by the contractor for appropriate measures. The SWE agreed with most of the engineering decisions made by the evaluators for custom calculations. Changes to energy and demand savings calculations were suggested by the SWE for two projects. For one custom project, the SWE proposed modifications to the regression model used to determine annualized energy and demand savings. The SWE also proposed a correction to lighting control savings factors for some measures within one midstream lighting project. The SWE's proposed modifications resulted in increased energy savings in both cases.

B.6 NTG

Table 76 lists PECO's PY13 NTG results across all programs. Details concerning the methods and data used to estimate NTG values are in Appendices B.6.1 and B.6.2.

Table 76: Summary of PECO's PY13 NTG Results

Program Name	Component	NTG
Residential	Rebates and Marketplace	0.61
Residential	Appliance Recycling	0.53
Residential	In-Home Assessment	1.15
Residential	New Construction	0.92
Residential	Multifamily	0.87
Residential	Multifamily Income-Eligible	1.0
Residential	HER	1.0
Low-Income	HER	1.0
Low-Income	Single-Family	1.0
Low-Income	Appliance Recycling	1.0
Low-Income	Long-Term Savings	1.0
Non-Residential	Downstream	0.63
Non-Residential	Midstream	0.69
Non-Residential	Small Business Direct Install	0.88
Non-Residential	New Construction	0.38
Portfolio Total		0.70

B.6.1 Residential Programs

The PECO Phase IV evaluation plan stated that there would be no new residential NTG research for PY13. The NTG values, data and estimation methods for the Rebates and Marketplace, Appliance Recycling, In-Home Assessment, New Construction and Multifamily programs are

taken from evaluations conducted during Phase III and have been validated by the SWE (Table 77).

Table 77: Summary of PECO's PY13 Residential NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Rebates and Marketplace	N/A	N/A	N/A	N/A	0.61
Appliance Recycling	N/A	N/A	N/A	N/A	0.53
In-Home Assessment	N/A	N/A	N/A	N/A	1.15
New Construction	N/A	N/A	N/A	N/A	0.92
Multifamily	N/A	N/A	N/A	N/A	0.87
Multifamily Income-Eligible	Low-income	N/A	N/A	N/A	1.0
HER	RCT	N/A	N/A	N/A	1.0
Residential Total					0.73

B.6.2 C&I Energy Efficiency Programs

The PECO Phase IV evaluation plan stated that the Non-Residential Midstream Rebates would be the only NTG analysis conducted for PY13. Guidehouse conducted and completed the NTG analysis for the Non-Residential Midstream Rebates program for PY13, consistent with the evaluation plan (Table 78).

The C&I Downstream, Small Business Direct Install and New Construction program NTG values were taken from evaluations conducted during Phase III and have been validated by the SWE.

Table 78: Summary of PECO's PY13 C&I NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Downstream	N/A	N/A	N/A	N/A	0.63
Midstream	Participant Interviews	5	31%	0%	0.69
Small Business Direct Install	N/A	N/A	N/A	N/A	0.88
New Construction	N/A	N/A	N/A	N/A	0.38
C&I Total					0.70

B.7 TRC

Table 79 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for PECO's PY13 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the PECO PY13 Annual Report. Like Phase III, PECO's Income Eligible Energy Efficiency program was the most cost-effective program in PY13 for PECO. Residential Energy Efficiency and Residential Home Energy Reports were also cost-effective at both the gross and net levels. Income Eligible Home Energy Reports

and Non-Residential Energy Efficiency, however, both had TRC ratios below 1, meaning that they were not cost-effective in PY13.

Table 79: Summary of PECO's PY13 TRC Results

Program Name	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Income Eligible Energy Efficiency	\$21,895	\$5,731	3.82	\$21,895	\$5,731	3.82
Income Eligible Home Energy Reports	\$1	\$59	0.01	\$1	\$59	0.01
Non-Residential Energy Efficiency	\$79,092	\$90,252	0.88	\$50,619	\$61,409	0.82
Residential Energy Efficiency	\$40,166	\$38,217	1.05	\$29,322	\$29,238	1.00
Residential Home Energy Reports	\$2,409	\$1,418	1.70	\$2,409	\$1,418	1.70
Common Portfolio Costs	N/A	\$10,473	N/A	N/A	\$10,473	N/A
Portfolio Total	\$143,564	\$146,150	0.98	\$104,246	\$108,329	0.96

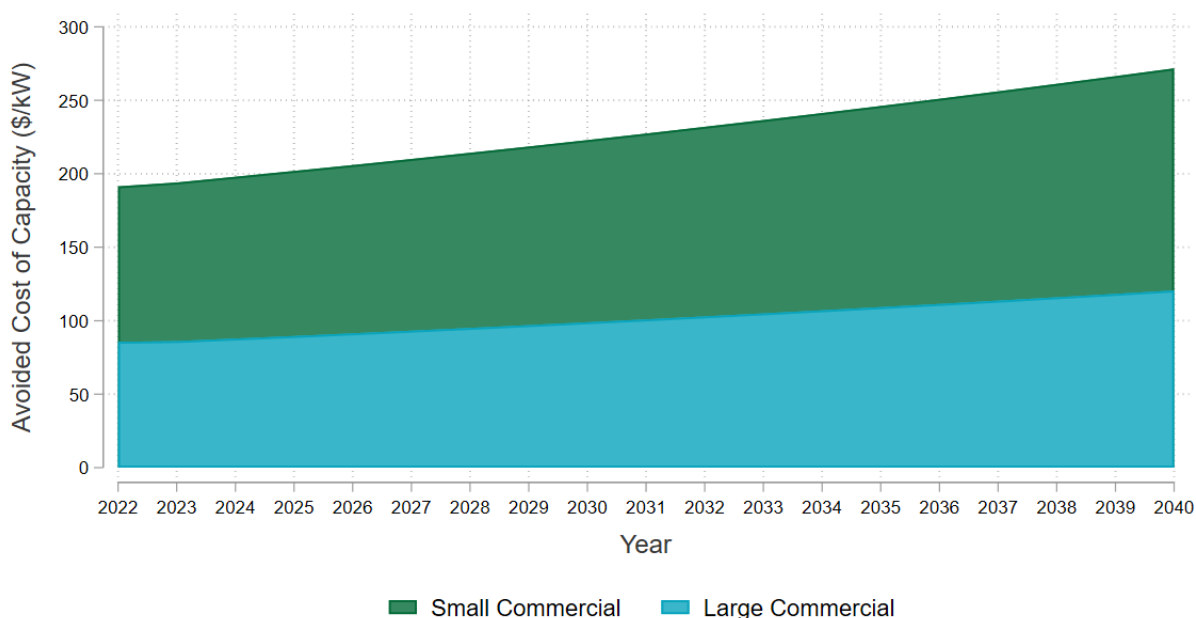
Three of PECO's five programs were found to be cost-effective, using net and gross savings, in PY13 led by the Income Eligible Energy Efficiency program. In PY13, water saving measures were the most impactful measures for the Low-Income EE program that drove the most savings. Two of PECO's programs were not cost-effective, using net or gross savings. Income Eligible Home Energy Reports had a TRC ratio of 0.01. This was due to small amounts of energy savings and negative demand savings in the first year of the cohort. Non-Residential Energy Efficiency had a gross TRC ratio of 0.88 in PY13. A combined heat and power project was a major contributor to this result. The project costs made up more than a third of the total program costs with a gross TRC ratio of 0.75. If the CHP project were excluded from the TRC calculations, then the Non-Residential Energy Efficiency Program would pass.

B.7.1 Notes from the TRC Model Review

The PY13 TRC model was developed by Guidehouse using the Analytica software. Below is a summary of the assumptions and inputs verified by the SWE.

- The PY13 TRC model used a nominal discount rate of 5.0%, which matches PECO's Phase IV EE&C plan. In the 2021 TRC Test Order, the Commission directed all EDCs to use a common discount rate rather than their own weighted average cost of capital.
- In Phase IV, HER cohorts, after their initial year, have a "decay" of 31.3% applied to future years of savings, up the EUL of those savings. The SWE found that this new method was correctly applied to savings in the Residential Home Energy Report program.

- In the Commercial Lighting Sector, PECO consistently applied the benefits and incremental costs of Early Replacement to all measures. This aligns with the definitions in Table 6 of the 2021 TRC Test Order.
- A line loss factor (LLF) of 1.0799 was used for energy and demand savings in the residential and non-residential sectors, which is consistent with the 2021 TRM.
- Measure lives were reported at the measure-level. The SWE spot-checked the measure life assumptions in the PY13 TRC model and found them to be consistent with the 2021 TRM.
- The SWE checked measure quantities against the quarterly data request responses used to populate our statewide tracking database and found them to be consistent.
- The PY13 TRC model was based on verified savings, so Guidehouse adjusted program impacts by an applicable realization rate prior to importing them into the model. The SWE confirmed that energy and demand realization rates reflected in the TRC model inputs are consistent with the impact evaluation results reported in PECO's PY13 Annual Report.
- The application of the NTG results in the calculation of net TRC Benefits and costs were handled consistently with the 2021 TRC Test Order directive for Phase IV. All NTG ratios in the TRC model inputs were consistent with PECO's PY13 Annual Report.
- In PY13, Guidehouse and PECO broke out Non-Electric Benefits into O&M Benefits and Fossil Fuel/Water Benefits in accordance with the Phase IV Annual Report template. Consistent with the 2021 TRC Test Order, the model treats all fossil fuel impacts as TRC Benefits whether they are positive or negative.
- In PY13, the Low-Income Energy Efficiency program had the highest TRC ratio at 3.82. This was mostly driven by water conservation benefits. If the water conservation benefits were not included in the TRC test, then the ratio for Low-Income Energy Efficiency program would have only just been over 1 at 1.17. Benefits from water savings in this program were more than 4 times higher than savings from energy.
 - It was found that the incorrect savings numbers were used to calculate the benefits for the faucet aerators from kits in the Low-Income Eligible Energy Efficiency program. If the correct numbers had been included in the TRC test, then the Low-Income EE program would have had a TRC ratio of 3.02 and PECO would have overall had an overall TRC ratio of 0.95. This change will be reflected in the Phase IV to date financials report put out by PECO.
- The PY13 TRC Model uses the avoided costs of energy approved in the PECO's Phase IV EE&C Plan and avoided capacity costs spelled out in the 2021 TRC Test Order. The SWE was able to independently replicate the calculation of all TRC Benefits.
 - As shown in [Figure 47](#) PECO used a lower avoided cost of capacity for the Large Commercial Summer Peak Demand to reflect a lack of distribution capacity benefits in the Large Commercial sector where customers take service at primary voltage.

Figure 47: PECO Avoided Cost of Capacity Forecast (\$/kW-year)

B.8 PROCESS

B.8.1 Residential Program

The Residential Program is made up of five components, shown below:

- Rebates and Marketplace⁷¹ (no process evaluation in PY13)
- In-Home Assessments (Single-Family) (no process evaluation in PY13)
- Multifamily (no process evaluation in PY13)
- Appliance Recycling (no process evaluation in PY13)
- New Construction (no process evaluation in PY13)

B.8.1.1 Rebates and Marketplace Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.1.2 In-Home Assessments (Single-Family) Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

⁷¹ For the Rebates and Marketplace component, there are multiple delivery channels to receive product rebates: Downstream, Trade Ally and Distributor Network, Marketplace, and Point of Purchase

B.8.1.3 Multifamily Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.1.4 Appliance Recycling Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.1.5 New Construction Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.2 Residential Home Energy Reports Program

For PY13, Guidehouse reported on a process evaluation for the Residential Home Energy Reports Program.

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed utility and implementation staff, and surveyed participants. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, perceived accuracy of various report components, awareness of energy-saving tips provided in the reports, and areas of strength and improvement.

Summary of the Process Evaluation Findings

Guidehouse employed several data-collection methods to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, conducted an online survey with 358 participating customers associated with the market rate waves of the Residential Home Energy Reports Program and of these responses, 228 were not flagged as Income-Eligible (IE) participants. Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, two key process findings emerged:

- Respondents rated the accuracy of the neighbor comparison in the HERs as 6.0 out of 10 (scale of 0 to 10, where 0 is “extremely inaccurate” and 10 is “extremely accurate”). Respondents who rated accuracy lower than 7 were asked why they provided that score. Many respondents mentioned differences in household size and occupancy, as well as different household needs as reasons the comparison may not be accurate.
- When asked if they recall specific energy-saving tips from the HERs, 38% of market-rate customers said yes. Respondents who confirmed recalling suggestions from the report most often recalled adjusting the temperature/thermostat in the home to save energy (26%). Seventy-one percent of customers who reported recalling energy-saving tips indicated they find tips from the HERs relevant.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY13 activities listed in the evaluation plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted 160 completes and achieved a total of 358 completed surveys from the market rate waves.⁷²

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY13 Annual Report included descriptions of the methods, summary of findings, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations. The report included sufficient detail for the SWE (and other readers) to assess the methods, findings, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

B.8.3 Income-Eligible Program

The Income-Eligible Program is made up of four components, shown below:

- Single-Family (no process evaluation in PY13)
- Multifamily (no process evaluation in PY13)
- Appliance Recycling (no process evaluation in PY13)
- Long-Term Savings (no process evaluation in PY13)

B.8.3.1 Single-Family Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.3.2 Multifamily Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.3.3 Appliance Recycling Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

⁷² Guidehouse created target survey completion goals based on strata and an IE flag that was provided by the implementer, Oracle, to collect data from a representative sample. Guidehouse presented survey results by participant wave; one wave targeted Income-Eligible (IE) customers only while all other waves targeted market-rate customers. Note that the sample stratification described in the report differs from this participant wave distinction used to conduct analysis and present results, as customers with an IE flag could have been included in any wave. Guidehouse presented results of the 358 responses from market-rate waves for the Residential Home Energy Reports Program and presented results of the 88 responses from the one wave that targeted IE customers specifically.

B.8.3.4 Long-Term Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.4 Income-Eligible Home Energy Reports Program

For PY13, Guidehouse reported on a process evaluation for the Income-Eligible Home Energy Reports Program.

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed utility and implementation staff, and surveyed participants. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, perceived accuracy of various report components, awareness of energy-saving tips provided in the reports, and areas of strength and improvement.

Summary of the Process Evaluation Findings

Guidehouse employed several data-collection methods to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, conducted an online survey with 88 participating customers associated with the Income-Eligible (IE) survey wave for the Home Energy Reports Program.⁷³ Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, two key process findings emerged:

- Respondents rated the accuracy of the neighbor comparison in the HERs as 5.4 out of 10 (scale of 0 to 10, where 0 is “extremely inaccurate” and 10 is “extremely accurate”). Respondents who rated accuracy lower than 7 were asked why they provided that score. Many respondents mentioned differences in household size and occupancy, as well as different household needs as reasons the comparison may not be accurate.
- When asked if they recall specific energy-saving tips from the HERs, 33% of IE customers said yes. Respondents who confirmed recalling suggestions from the report most often recalled unplugging or turning off electronics or lights that are not in use (24%). Eighty-six percent of customers who reported recalling energy-saving tips indicated they find tips from the HERs relevant.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY13 activities listed in the evaluation plan.

⁷³ Note that 218 respondents were flagged as IE by the program implementer, Oracle. IE customers could have been included in any wave of the survey. The sample targets were based on a combination of strata and IE flag, to collect data from a representative sample. Only one survey wave specifically targeted IE customers and is considered the Income-Eligible Home Energy Reports Program. From this wave, 88 survey responses were achieved

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted 140 completes from IE customers and achieved a total of 218 completed surveys from IE customers. For the IE wave specifically, 88 completed surveys were achieved.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY13 Annual Report included descriptions of the methods, summary of findings, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations. The report included sufficient detail for the SWE (and other readers) to assess the methods, findings, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

B.8.5 Non-Residential Program

The Non-Residential Program is made up of four components, shown below:

- Downstream Rebates (no process evaluation in PY13)
- Midstream Rebates
- New Construction (no process evaluation in PY13)
- Small Business Direct Install (no process evaluation in PY13)

B.8.5.1 Downstream Rebate Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.5.2 Midstream Rebate Component

Summary of the Process Evaluation Findings

Guidehouse relied on several data sources to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and interviewed five participating distributors on a small selection of process questions during the NTG distributor telephone interviews. Guidehouse also reviewed the participation tracking databases and other program materials. No key process findings or recommendations resulted from these data.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY13 activities listed in the evaluation plan and as outlined in the Distributor Interview Guide. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated details describing the sampling strategy (but not a table summarizing the sampling

strategy). The SWE recommends including a table summarizing the sample strategy and achieved samples for all process evaluations in future annual reports.

The evaluation plan sampling memo identified that a census-based approach would be used to contact the distributors, with 14 completed interviews anticipated. The evaluator achieved a total of 5 completed interviews for a 23% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY13 Annual Report included descriptions of the methods, summary of findings, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process-related findings or recommendations for this program component. The report included sufficient detail for the SWE (and other readers) to assess the methods, findings, and recommendations.

Overall, the process evaluation discussion was generally succinct and highlighted findings that should be of value to the administrator and implementer.

B.8.5.3 New Construction Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

B.8.5.4 Small Business Direct Install Component

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff.

Appendix C PPL PY13 Audit Detail

C.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework; followed proper custom site-specific M&V activities; the TRM protocols are applied correctly and are generally accurate.
- The SWE's review of verified savings for PPL's Residential and Low-Income programs, found that, overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE found errors (detailed below) for a few individual measures that were cumulatively less than 0.75% of verified portfolio savings
- The SWE reviewed PPL's Residential and Low-Income programs and found a few discrepancies in the calculation of measure-level savings. The SWE observed that for the Remote Energy Assistance (REA) component of the Low-Income Program, for some lighting measures, the verified savings calculations did not correctly apply EDC gathered data or TRM defaults in absence of data to inform baseline wattages for ENERGY STAR lighting. The demand impacts for HPWH's included interactive heat effects, a variable not included in the TRM algorithm, resulting a slightly underestimating peak demand savings. The SWE also notes that lighting sold through the online marketplace could be installed in small businesses, which have greater savings potential. Therefore, excluding cross-sector sales produced a more conservative estimate for savings for these measures.
- For the Residential Program, the SWE notes that ductless heat pumps were a very successful measure in PY13, accounting for 32% of all savings for the Residential Program (and 6% of PY13 portfolio savings).
- PPL had one the highest portfolio TRC ratios of the seven EDCs subject to Act 129 in PY13. The portfolio result was driven largely by the performance of the non-residential program, which had a gross TRC ratio of 2.31. However, the TRC audit noted that PPL assumes a replace-on-burnout perspective (efficient equipment cost minus baseline equipment cost) when assigning incremental measure cost to most commercial lighting measures. The PPL cost perspective is inconsistent with the perspective used to estimate energy and demand savings and leads to an upward bias in the TRC results. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PPL's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings, reported MW savings, and participant counts. We were unable to replicate incentives exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE noted only a few minor discrepancies.

- The SWE conducted a project file review for a sample of PPL’s residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data. While the photographs were included for the Appliance Recycling component, Cadmus and PPL should work with the CSP to take clearer pictures and to capture the nameplate (e.g., model number and serial number).
- Overall, Cadmus estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and the approved EM&V plan.
- For the process evaluations, Cadmus completed all the PY13 activities detailed in the approved evaluation plan and sampling memos, and the reporting followed the SWE guidelines. The process evaluation discussion was succinct and highlighted findings that should be of value to PPL and its CSPs.

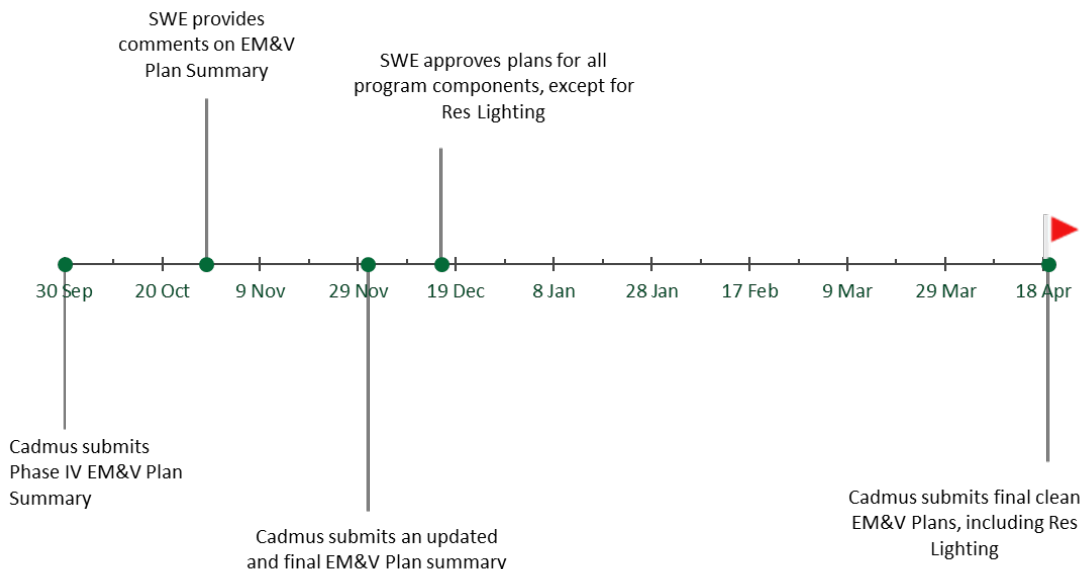
C.2 EM&V PLAN REVIEWS

Cadmus, PPL’s evaluation contractor, first submitted a Phase IV EM&V plan summary in late September 2021. The summary included plans for residential, non-residential, and low-income sectors. Cadmus also submitted individual plans for each component that allowed for SWE feedback on a component-by-component basis. All draft plans only required a single set of comments from the SWE before they were submitted for final approval. The topics identified in the following bullets required some discussion and plan updates.

- The net savings approach for Residential Energy Efficient Lighting
- Frequency of survey analysis for the Student Energy Efficiency Education component
- Timing of interviews and other data collection activities relative to upcoming changes to codes and standards.
- Clarification on using the updated UMP for the net impact evaluation of the appliance recycling component
- Database review of program tracking data for the low-income program evaluation

Figure 48 shows the review timeline of correspondence between Cadmus and the SWE team to finalize the Phase IV EM&V plan.

Figure 48: PPL Evaluation Plan Review Timeline 2021-2022



As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. [Table 80](#) shows which PPL programs produced verified impacts in PY13, and which will wait until PY14 to verify results. A two-year sample size will be used to verify results in PY14. Three components in [Table 80](#) are the source of 6,084 MWh and 1.79 MW of unverified savings reported by PPL in its PY13 Annual Report.

Table 80: PY13 PPL Program Impact Evaluation Summary

Program	Component	Delivery Channel	PY13 Impacts
Non-Residential Program	Custom	Large	Verified
		Small	Unverified until PY14
		CHP	Verified
	Equipment	Downstream	Verified
		Midstream	Unverified until PY14*
	Lighting	Downstream	Verified
Midstream		Verified	
Low-Income Program	All strata	All strata	Verified **
Residential Program	Appliance Recycling	Refrigerators	Verified
		Freezers	Verified
		Room AC's and dehumidifiers	Verified
	Energy Efficient Home	Audit and Weatherization	Unverified until PY14*
		Midstream Equipment	Unverified until PY14*
		Downstream Equipment	Verified
		Online Marketplace	Verified
		New Homes	Unverified until PY14
	Efficient Lighting	Lighting	Verified
	Student Energy Efficiency Education	All strata	Verified
*There was no participation in Midstream Equipment or Audit and Weatherization in PY13			
** In-home assessments were unverified due to timing, as data were not available until the Q3 surveys			

In addition to the evaluation plans, the SWE also reviewed and provided comments on draft surveys, interview guides, and stakeholder guides for the applicable components. These documents covered components and delivery channels in the Non-Residential, Low-Income, and Residential programs.

C.3 SAMPLE DESIGN REVIEW

The Phase IV Evaluation Framework established a maximum level of sampling uncertainty of ±15% at 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. PPL’s energy efficiency portfolio consists of three programs, organized by sector. Each program consists of several “components”, each broken down into strata made up of projects made up of similar measures and sizes of savings. PPL designed their strata sample sizes to meet the minimum

85/15 requirement as outlined in their SWE-approved EM&V plan. PPL provided the SWE with their energy and demand gross impact realization rates along with the relative precision of their savings estimates for each stratum. The SWE conducted a review of realization rate and relative precision calculations provided by PPL and confirmed that all components except for Energy Efficient Home met the 85/15 requirement outlined in the Phase IV Evaluation Framework. [Table 81](#) shows the relative precision of energy and demand savings estimates by PPL program component.

Table 81: Relative Precision of PY13 Impacts by Component at the 85% Confidence Level

Program	Component	Relative Precision (Energy)	Relative Precision (Demand)
Non-Residential Program	Custom	0.0%	0.0%
	Efficient Equipment (Lighting)	7.2%	6.7%
	Efficient Equipment (Equipment)	3.8%	3.2%
Low-Income Program	All evaluated strata	3.1%	3.3%
Residential Program	Appliance Recycling	8.3%	6.0%
	Energy Efficient Home	25.1%	14.9%
	Efficient Lighting	0.0%	0.0%
	Student Energy Efficiency Education	2.8%	2.9%

In the PPL PY13 Annual Report, Cadmus addressed the missed $\pm 15\%$ threshold for relative precision for the Energy Efficient Home component's PY13 energy savings. This was due to one outlier project having a realization rate of over 1,000 percent, causing increased variance and reduced precision of savings estimates. Each of the other program components comfortably satisfied the 85/15 requirement in PY13 for both energy and demand. The SWE found Cadmus's sample rollup worksheets to be well organized and consistent with industry practice, although in the Appliance Recycling rollup there was a negative relative precision calculation and a negative error ratio for the Refrigerators and Freezers stratum. However, this did not affect the component-level calculations, as the SWE's independent rollup calculations also yielded $\pm 8.3\%$ (energy) and 6.0% (demand) relative precision at the 85% confidence level.

C.4 REPORTED GROSS SAVINGS AUDITS

C.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in PPL's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)

- Participation counts
- Incentive dollars

The SWE leveraged Appendix A of PPL’s Q1-Q4 tracking data to audit these values. Note that the PPL’s Appendix A to the quarterly tracking data responses is a subset of the full tracking data set (which PPL provides in Appendix Z of their quarterly data submissions.) This subset is used in creating the statewide tracking database, as it is tailored to the SWE’s PY13 quarterly data request. Any references to “tracking data” herein refer to tracking data in PPL’s Appendix A, not the tracking data in PPL’s Appendix Z.

Table 82 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in the PPL PY13 Annual Report and “No” otherwise. The tracking data supports PPL’s PY13 Annual Report for all programs.

Table 82: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Non-Residential	123,157	123,157	Yes
Low-Income	11,840	11,840	Yes
Residential	35,008	35,008	Yes
Portfolio Total	170,005	170,005	Yes

Table 83 summarizes the SWE’s findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. Like with reported gross energy savings, the tracking data supports PPL’s PY13 Annual Report value exactly for all programs.

Table 83: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Non-Residential	20.37	20.37	Yes
Low-Income	1.29	1.29	Yes
Residential	5.00	5.00	Yes
Portfolio Total	26.66	26.66	Yes

Table 84 summarizes the SWE's findings regarding program participation. The SWE was able to replicate participant counts perfectly for all programs. The portfolio totals are exactly equal: 852,940 in the PPL PY13 Annual Report and 852,940 in the tracking data.

Table 84: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Non-Residential	5,317	5,317	Yes
Low-Income	25,682	25,682	Yes
Residential	821,941	821,941	Yes
Portfolio Total	852,940	852,940	Yes

Finally, Table 85 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in PPL's PY13 Annual Report. The Annual Report incentives are neither equal nor directionally similar within any given program. Note that PPL expressed to the SWE that the rebate amounts in the tracking data will generally never exactly equal the incentive dollars in their reports because the PPL PY13 Annual Report values are pulled from a financial system as opposed to program tracking data.

Table 85: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Non-Residential	\$6,346	\$9,460	No
Low-Income	\$2,174	\$1,504	No
Residential	\$4,446	\$6,336	No
Portfolio Total	\$12,966	\$17,298	No

C.4.2 Project File Reviews

C.4.2.1 Residential

The SWE conducted a project file review for a sample of PPL's residential and low-income solutions in PY13 as part of the reported savings (i.e., ex-ante) review. The project file

documentation was provided by PPL, the program implementors, and the evaluation contractor, Cadmus, in response to the SWE’s standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. The sampled project file packages included the majority of the documentation requested. For the sample files that were provided, a sample key and sample memo was included that allowed for consistent matching between files and the tracking data.

Table 86 presents a summary of the SWE’s residential project file reviews.

Table 86: PPL Residential Project File Review Summary

Program	Solution	Number of files reviewed	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data? ¹
Appliance Recycling	n/a	25	✓	✓	✓	✓ ¹
Energy Efficient Homes	New Homes	20	✓	✓	✓	✓
Energy Efficient Homes	Downstream Equipment	20	✓	✓	✓	✓
Energy Efficient Homes	Online Market Place	11	✓	✓	✓	✓

¹ It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As outlined above, the requested number of project files and supporting details were submitted for the residential program. All the program measures used default or EDC collected data as outlined in the EM&V plan. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Appliance Recycling Program

The SWE located the Appliance Recycling project files within the tracking database. The quarterly data report noted that the Appliance Recycling program had no participants during the first quarter of PY13. The SWE observed a few instances where the project documentation included multiple recycled appliances and required looking beyond the project ID provided to the account number to identify all appliances included in the documentation. The SWE observed one case in which the project file did not match the tracking data. In this one case the project file indicated two refrigerators, while the tracking data listed only one refrigerator. The SWE attempted to look up the second refrigerator but was unable to find it within the tracking data. While there were no additional discrepancies between the tracking database and the project files reviewed, the

photographs for all 25 of the projects provided by the CSP do not clearly capture the nameplates of the recycled equipment. Additionally, four project files did not include a photo of the appliance being recycled. Consequently, the SWE could not independently confirm the values in the tracking data.

Energy Efficient Homes: New Homes

The SWE observed most of the sample files were conducted in v16.2.3 of the REM/Rate software,⁷⁴ which was the most recent version of the software at the start of PY13, though a few projects applied prior versions. The SWE ran the sample files with the REM/Rate version used for reported savings. The SWE found that the savings provided in the REM/Rate file matched the reported savings in the tracking data.

Energy Efficient Homes: Downstream Equipment

Invoices were provided quarterly samples of project documentation for downstream equipment. The SWE found that the project file documentation matched the tracking data.

Energy Efficient Homes: Online Market Place

A review of the sampled files did not reveal any discrepancies; however, the SWE notes that some project files that were submitted online included a limited amount of documentation to verify.

C.4.2.2 Non-Residential

The SWE reviewed a sample of PPL's Efficient Equipment projects for PY13 using the project documentation provided by the evaluation contractor in response to the SWE's standing quarterly data request. The project file packages included savings calculation worksheets, rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. Most of the reviewed project file packages included all documentation requested and were well organized, allowing for a comprehensive review of the forty-one projects sampled.

Table 87 presents an overview of the results of the SWE's C&I project file reviews. The SWE noted a handful of instances where the project tracking documentation did not match the provided calculation workbooks and/or project files. These noted inconsistencies generally reflect minor impacts on reported savings values.

⁷⁴ <https://www.remrate.com/>

Table 87: PPL PY13 C&I Project File Review Summary

Program	Segment	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?
Efficient Equipment	Lighting - Downstream	15	✓	✓	✓	✓	✓
Efficient Equipment	Lighting - Midstream	12	11/12	✓	✓	✓	✓
Efficient Equipment	Non-Lighting	14	✓	✓	13/14	✓	✓

C.5 VERIFIED GROSS SAVINGS AUDITS

C.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of PPL's portfolio of residential and LI programs. PPL's portfolio of residential and LI programs includes the following: Appliance Recycling, Energy Efficient Homes, Efficient Lighting, and Student Energy Efficient Education program components. The Low-Income Program consists of: Remote Energy Assessments, Direct Install, and Welcome Kits. Note that the SWE reports the residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

[Table 88](#) provides a summary of the EM&V approaches used by Cadmus in their PY13 verified savings calculations. The SWE discovered some discrepancies for a few residential and low-income program measures.

Table 88: Residential and LI Impact Evaluation Activities - PPL

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Residential Program				
Downstream Equipment	✓	-	✓	-
Online Marketplace	✓	-	✓	-
Student Energy Efficient Education (SEEE)	✓	-	✓	-
New Homes ^b	-	-	-	-
Audit and Weatherization ^c	-	-	-	-
Midstream HVAC ^d	-	-	-	-
Low-Income Program				
Remote Energy Assessment	✓	-	✓	-
In-Home Assessments ^e	-	-	-	-
Welcome Kits	-	-	✓	-

^a The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.

^b Savings were not verified for the New Homes subprogram in PY13 due to potential changes to TRM guidance and plans to verify these savings in PY14.

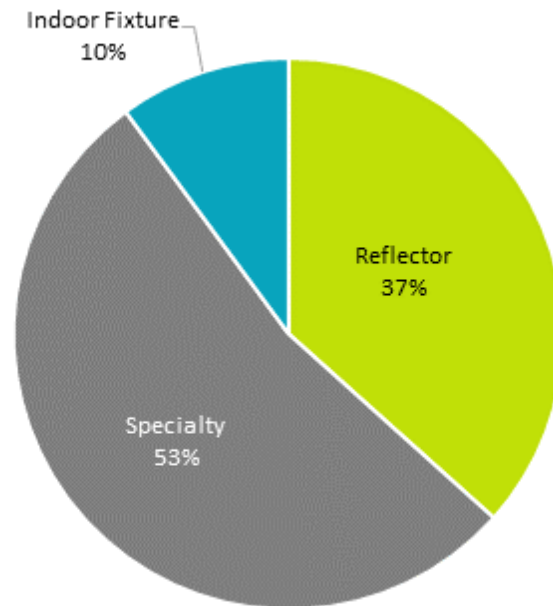
^c Was not evaluated in PY13 due to lack of participation.

^d Midstream HVAC is on a two-year evaluation cycle and will be evaluated in PY14.

^e In-home Assessments were not verified in PY13.

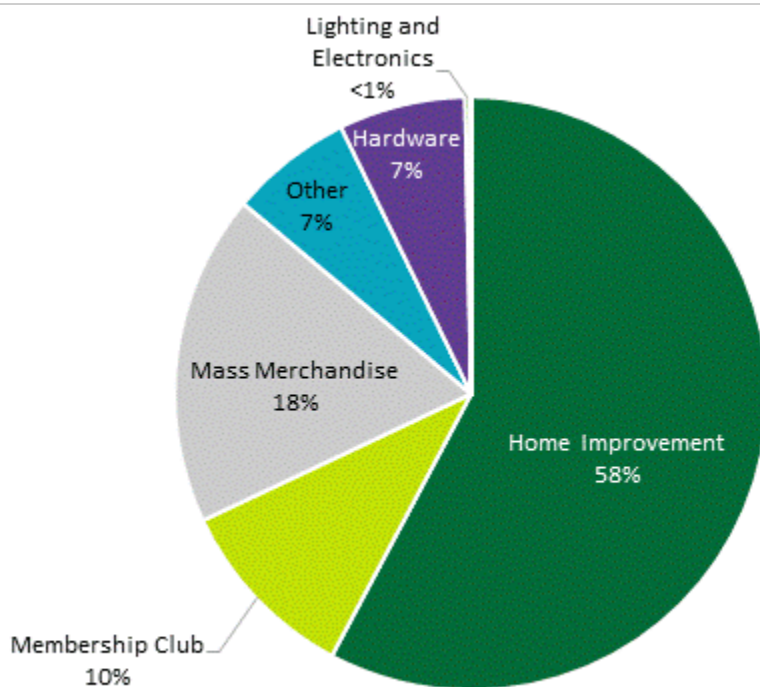
C.5.1.1 Upstream Lighting and Cross-Sector Sales

Customers purchased over 775,000 efficient light bulbs and fixtures through PPL's PY13 upstream lighting program. Figure 49 displays the distribution of sales by product type. Over one-half (53%) were specialty bulbs, followed by reflectors (37%) and indoor fixtures (10%).

Figure 49: PPL PY13 Upstream Lighting Sales by Product Type

Over one-half (58%) of PPL's PY13 upstream light bulbs were sold through home improvement stores. Mass merchandise stores and membership clubs were the next most common retail channels for lighting equipment, accounting for 18% and 10% of sales, respectively (Figure 50).

Figure 50: PPL PY13 Upstream Lighting Sales by Retail Channel



Audit Findings

Cadmus provided the PY13 impact analysis for PPL's upstream lighting before the PPL PY13 Annual Report was submitted to the PUC. This allowed time for the SWE to conduct its audit and provide Cadmus with feedback before the report was submitted. Cadmus was able to adjust for some, but not all of this feedback prior to submitting the PPL PY13 Annual Report. The outstanding items were lumens and/or wattages did not align between the tracking system and the ENERGY STAR qualified products lists for a few models, and the use of 365.25 days/year as instructed in the 2016 TRM as opposed to the revised 365 days/year from the 2021 TRM. The impact of these discrepancies on portfolio-level savings is negligible.

Cross-Sector Sales

Cadmus did not conduct cross-sector sales research in PY13 but applied the TRM default cross-sector sales rate of 7.4%.

Recommendations

The SWE makes the following recommendation based on its review:

- Use 365 days/year (instead of 365.25 days/year) in accordance with the 2021 TRM.

C.5.1.2 Residential Non-Lighting

The SWE's review of verified savings for residential non-lighting solutions, which include LI programs, found that, overall, the verified savings followed proper TRM protocols, and the verified

savings are accurate. The SWE found errors (detailed below) for a few individual measures that were cumulatively less than 0.75% of verified portfolio savings

Residential Program: Energy Efficient Homes

The Energy Efficient Homes component of PPL's Residential Program provides downstream incentives for high-efficiency equipment such as HVAC equipment, water heaters, and appliances. In PY13 Cadmus conducted desk reviews for a sample of measures and a survey to gather in-service rates and other savings inputs. The SWE confirmed that the correct TRM default values were used when EDC gathered inputs were not available. In addition, the SWE determined that verified gross savings had been calculated correctly using the TRM algorithms for most measures. The one exception is that peak demand savings calculations for heat pump water heaters erroneously included an interactive effect for heating. This heating interactive effect appears in the TRM algorithm for electricity savings, but not for peak demand savings. The SWE notes that ductless heat pumps were a very successful measure in PY13, accounting for 32% of all savings for the Residential Program (and 6% of PY13 portfolio savings).

The Energy Efficient Homes component also provides instant discounts on Energy Efficient Products via an Online Marketplace. These include connected thermostats, dehumidifiers, smart strips, lighting, weatherstripping, and kits. PY13 evaluation activities for the Online Marketplace included a database review and participant survey. The SWE determined that verified gross savings had been calculated correctly in accordance with TRM guidelines. The SWE notes that verified savings for lighting sold through the Online Marketplace did not include cross-sector savings estimates. It is feasible that some lighting purchased through the Online Marketplace could be installed in small businesses, and lighting installed in businesses tends to have higher hours of use and therefore greater savings. The SWE recommends including cross-sector savings estimates in Online Marketplace lighting sales.

Residential Program: Student Energy Efficient Education (SEEE)

PPL's evaluator, Cadmus, conducted a survey of the SEEE component of PPL's Residential Program to assess verified savings. This component provides three types of energy savings kits to classrooms in the service territory. While the contents of each kit vary, the measures include showerheads, aerators, LED nightlights, advanced power strips, furnace whistles, outlet gaskets, DHW pipe wrap, and weatherstripping. The SWE found that the savings calculations applied the correct TRM default values and survey results to calculate verified savings. The SWE also confirmed that the participation counts, verified savings, and realization rates aligned between the impact analysis and the PPL PY13 Annual Report.

Residential Program: New Homes

The New Homes component of PPL's Residential Program was not evaluated in PY13 due to potential changes in TRM guidelines for calculating peak demand savings for residential new construction. The evaluator, Cadmus, indicated that PY13 new home projects would be verified during the PY14 evaluation.

Residential Program: Audits and Weatherization

The Audits and Weatherization component of PPL's Residential Program was not evaluated in PY13 due to lack of participation.

Residential Program: Midstream HVAC

The Midstream HVAC component of PPL's Residential Program was not evaluated in PY13 but will be in PY14 based on the approved EM&V plan for PPL.

Low-Income Program

The Low-Income Program offers services to income-qualified customers in single-family homes, master- and individually metered multifamily units, and manufactured homes. The Low-Income program offers services such as: HVAC, lighting, weatherization, water-saving and heating, appliances, appliance recycling, and home health and safety. These services are offered through welcome kits, remote energy assessments, and in-home assessments. However, the in-home assessment component of the program was not evaluated in PY13. For the Remote Energy Assessment, the CSP sends a custom kit to each participant after the assessment, which is determined from opportunities identified during the remote assessment.

The SWE reviewed the remote energy assessment and welcome kit components of the Low-Income Program. The evaluator, Cadmus, conducted a census review of the welcome kits. The SWE did not find any discrepancies for the welcome kits and found that the kits correctly applied TRM defaults to the population savings.

The evaluation of the remote energy assessments included a tracking data review combined with a review of the recordings from the remote assessments for a sample of projects. The SWE observed that the values used for baseline wattages were, in some cases, using incorrect baseline values. Cadmus outlined in their EM&V plan that in instances where the baseline bulb type was unknown, that the 2021 TRM baseline wattage would be used, however baseline wattages for halogen bulbs were often used. The SWE updated the baseline wattages for unknown bulb types to the 2021 TRM baseline and attempted to recalculate program-level savings based on the updated realization rates calculated from the sampled projects for each stratum. During this process, the SWE also observed some inconsistencies in strata-designations between the sample calculations and the verified savings documentation. The SWE updated the strata to align with the final strata designation to estimate the impact of the error. The SWE estimated a reduction of nearly 1,422 MWh and 0.1 MW in verified savings based on the correction.

C.5.2 Non-Residential Audit Activities

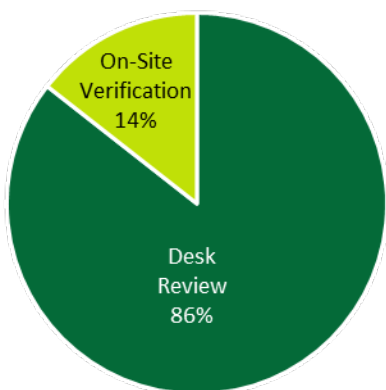
The SWE conducted various review and audit activities for PPL's energy efficiency programs. These activities included a review of the evaluation efforts and an audit of the savings verification completed by PPL's evaluation contractor, Cadmus. The remainder of this section presents the SWE's findings from these activities.

Figure 51 provides a summary of the evaluation activities and M&V approaches utilized by PPL's evaluation contractor in their PY13 verified savings calculations summarized by total project counts and evaluated savings. For PY13, PPL's evaluation contractor completed site visits to 14%

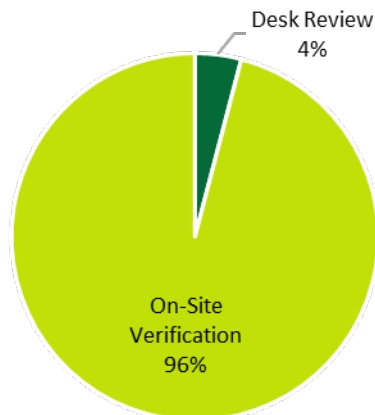
of projects. Due to COVID-19, some of these site-visits were virtual site-visits for which Cadmus conducted a video conference with the customer and the customer provided supplemental pictures to verify project specific information. In assessing savings, enhanced M&V techniques (IPMVP Options A, B, C, and D) were employed for the majority (81%) of total energy savings reviewed. Basic evaluation rigor (desk reviews, and on-site verification) was employed for non-residential Efficient Equipment (Lighting and Non-Lighting) projects and Midstream Lighting projects. Figure 51 provides a summary of the share of projects, which underwent Cadmus' evaluation activities by quantity of projects and evaluated savings. Figure 51 also displays the share of projects which were reviewed using basic rigor methods and IPMVP methods.

Figure 51: Summary of PPL's C&I Evaluation Activities

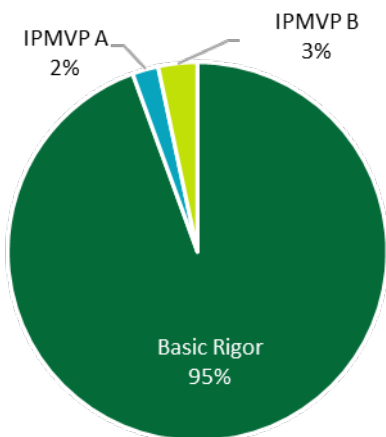
Evaluation Activity by Project Count



Evaluation Activity by kWh Contribution



M&V Method by Project Count



M&V Method by kWh Contribution

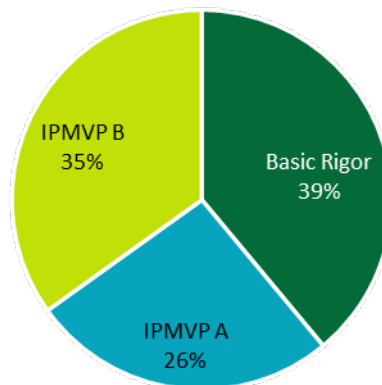


Table 89 provides a summary of the evaluation activities and M&V approaches PPL's evaluation contractor used across strata for all projects stratified by program.

Table 89: Summary of PPL's PY13 C&I Evaluation Activities by Program

Program / Strata	Sample Quantity	Realization Rate	Desk Review	On-Site Verification
Non-Res Efficient Equipment Program	13	85%	9	4
Downstream - HVAC	5	107%	4	1
Downstream - refrigeration and other	8	81%	5	3
Non-Residential Lighting Program	72	108%	68	4
Midstream	32	139%	32	-
Downstream (<120K kWh/year)	16	96%	16	-
Downstream (120-750K kWh/yr)	16	101%	15	1
Downstream threshold (>750K kWh/yr)	8	101%	5	3
Custom Program	5	105%	0	5
Large	3	100%	-	3
Small (unverified)	0	-	-	-
CHP	2	100%	-	2
Total	90	103%	77	13

The SWE's review of verified savings for non-residential programs found that, overall, the verified savings methods were aligned with the Evaluation Framework. Cadmus followed proper custom site-specific M&V protocols, applied TRM protocols correctly, and the verified savings are generally accurate. The following program sections describe the SWE's audit of the verified savings methodology for non-residential programs in further detail.

C.5.2.1 Non-Residential Efficient Equipment Program

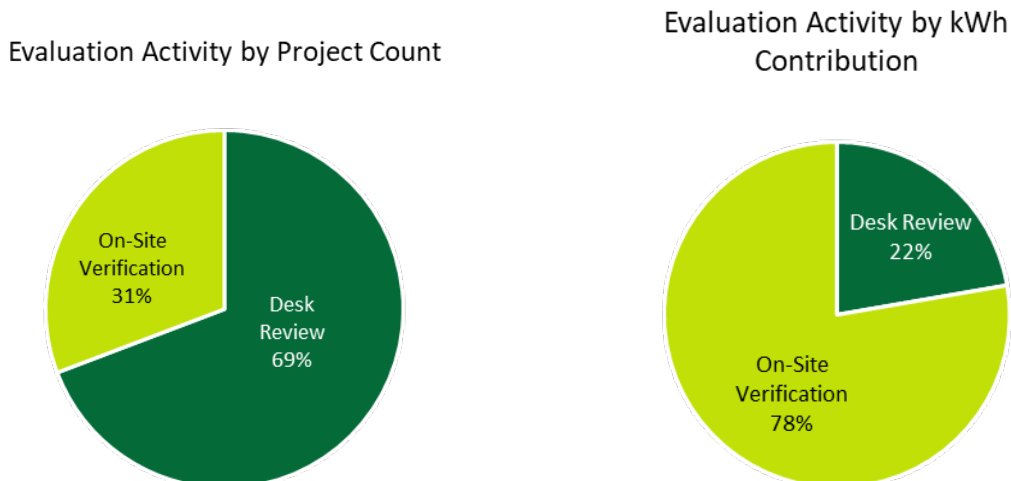
The PY13 evaluation sampling plan was designed to meet 90% confidence and $\pm 10\%$ precision (90/10) for the lighting stratum and of 85% confidence and 15% precision (85/15) for the equipment stratum. The program met both relative precision targets for energy and demand for efficient equipment. All sampled non-lighting equipment projects were evaluated at a basic level of rigor (9 by desk review and 4 virtual site visits).

In summary, the strata and substrata for the Non-Residential Efficient Equipment program were as follows:

- Non-Lighting Equipment
 - Downstream - HVAC
 - Downstream – refrigeration and other

As shown in Figure 52, PPL's evaluation contractor verified approximately 69% of projects via desk reviews and the rest of projects via on-site verification.

Figure 52: Summary of PPL's PY13 Efficient Equipment Program Evaluation Activities (Non-Lighting)



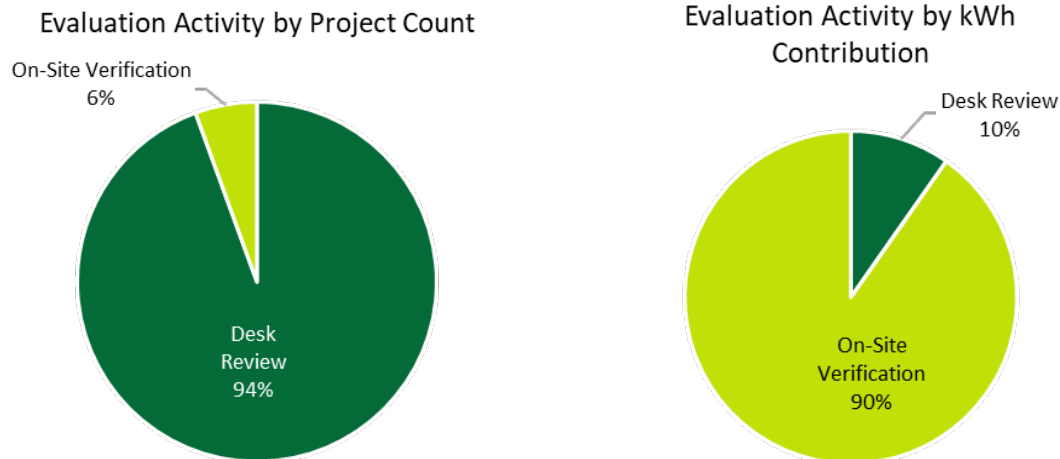
C.5.2.2 Non-Residential Efficient Lighting Program

In PY13, Cadmus grouped the efficient lighting projects into downstream and midstream stratum. The PY13 evaluation sampling plan was designed to meet 90% confidence and $\pm 10\%$ precision (90/10) for the lighting stratum. The program met both relative precision targets for energy and demand for lighting projects. During the audit of the non-residential midstream lighting program, the SWE found that PPL's evaluation contractor used an appropriate M&V approach for a sample of PY13 projects. Cadmus conducted four virtual site visits and 36 desk audits to evaluate 40 total downstream projects (eight of these desk reviews involved phone interviews). Cadmus conducted desk reviews for all 32 midstream lighting projects. The sample was stratified by reported annual energy savings to estimate realization rates, verified savings, and relative precision. The lighting strata are listed below.

- Downstream (>750 MWh/yr)
- Downstream (120-750 MWh/yr)
- Downstream (<120 MWh/yr)
- Midstream

As shown in [Figure 53](#), PPL's evaluation contractor verified approximately 94% of projects via desk reviews and the rest of projects via on-site verification.

Figure 53: Summary of PPL's PY13 Efficient Equipment Program Evaluation Activities (Lighting)



C.5.2.3 Non-Residential Custom Program

The SWE found that the evaluation contractor defined projects in three strata:

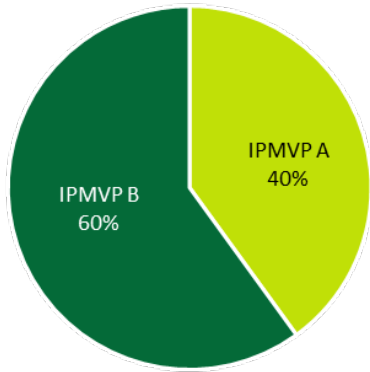
- Large (expected energy savings greater than 2,000,000 kWh/yr. or high level of uncertainty)
- Small (expected energy savings below 2,000,000 kWh/yr.)
- CHP

Cadmus evaluated all sampled projects, verifying savings at a high level of rigor, using approaches described in the IPMVP.

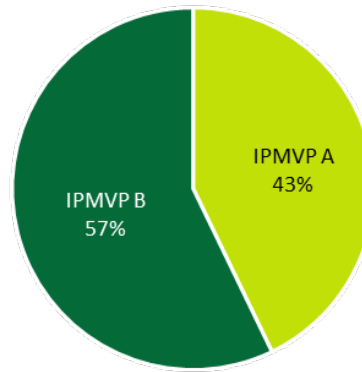
The large project and CHP project verification strata were a census of the participation population, with Cadmus conducting pre- and post-retrofit M&V so that TRM guidelines are met, and the reported values are corrected to match evaluated results. Therefore, the projects in these strata achieved realization rates of 100%. Cadmus randomly selected projects to include in the small project stratum. However, the 31 projects assigned to the small stratum were not verified in PY13. Instead, they will be included in the small stratum sample and evaluated in PY14. Cadmus prepared SSMVPs for each project and then conducted post-installation inspections and verified savings. In the CHP stratum, production data was collected for three to six months to determine electricity generation, parasitic loads, useful heat recovery from the CHP, and net gas usage (CHP gas consumption less gas usage offset by heat recovery). IPMVP Option A and B were used to calculate the first-year energy savings for the CHP project. [Figure 54](#) provides a summary of the quantity and annual energy savings contribution of the custom projects reviewed by Cadmus for each level of rigor. IPMVP Options A and B encompass 100% of the evaluated energy savings in PY13.

Figure 54: Summary of PPL’s PY13 Custom Program M&V Methods

M&V Method by Project Count



M&V Method by kWh Contribution



C.5.2.4 Verified Savings Audits

The SWE audited the activities above through a detailed audit of Cadmus’ evaluation work for a sample of their evaluated projects. The SWE audit for Cadmus’ in PY13 included review of thirteen (13) projects, encompassing the following activities:

- 5 Field and Analysis Engineers observed
- 5 Measure Types reviewed
- 5 Ride-Alongs conducted
- 21% of Verified Non-Res Energy Savings reviewed
- 16% of Verified Non-Res Demand Savings reviewed

Table 90 provides the overall results of the SWE Verified Savings Audit for C&I projects.

Table 90: PPL C&I Verified Savings Audit Results

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
13	26,757,153	99.9%	3,038	99.9%

Overall, the SWE agreed with the calculation methods utilized by PPL’s evaluation contractors. The savings calculations and accompanying reports were easy to follow and showed evidence that the TRM was utilized by the contractor for appropriate measures. The SWE agreed with most of the engineering decisions made by the evaluators for custom calculations. Changes to energy and demand savings calculations were suggested by the SWE for only one Efficient Equipment – Lighting Improvements project. For that project, the SWE revised the reported hours of use, coincident factor, and the lamp quantity. The SWE’s proposed modifications resulted in marginally (1%) lower energy savings.

C.6 NTG

Table 91 lists PPL's PY13 NTG results across all programs. Details concerning the methods and data used to estimate NTG values are in sections C.6.1 and C.6.2.

Table 91: Summary of PPL's PY13 NTG Results

Program Name	Component	NTG
Residential	Appliance Recycling	0.56
Residential	Efficient Lighting	1.07
Residential	Energy Efficient Homes	0.52
Residential	Student Energy Efficient Education	1.0
Low-Income	Low-Income	1.0
Non-Residential	Custom	0.22
Non-Residential	Efficient Equipment	0.73
Portfolio Total		0.62

C.6.1 Residential Programs

Cadmus planned and conducted PY13 residential program NTG estimation for Appliance Recycling, Efficient Lighting and Energy Efficient Homes. Appliance Recycling NTG was conducted for refrigerators and freezers as room ac and dehumidifiers are only eligible for program pick-up if bundled with a refrigerator or freezer pickup. Appliance recycling NTG was estimated to be 0.56 using a decision tree approach on data collected through a self-report survey with 318 program participants. Efficient Lighting NTG was estimated to be 1.07 and is based on data collected from eight retailer interviews. Cadmus utilized a counterfactual gross program savings to estimate Efficient Lighting NTG to adequately deal with current retailer lighting stock not matching up with the 2021 TRM lighting energy baseline.⁷⁵ To account for this inconsistency Cadmus applied a NTG ratio of 0.14, calculated using the common method as described in the SWE Phase IV Evaluation Framework, to an alternative gross savings figure (using the PY13 baseline of 45 lumen/watt) and then divided by the actual gross verified savings resulting in a NTG of 1.07. The Energy Efficient Homes NTG was estimated by weighting two program strata NTG by PY13 gross savings. New data were collected for the downstream equipment stratum NTG (0.50) which was combined with the PY11 online marketplace stratum NTG (0.75). Over 90% of the PY13 of the Energy Efficient Homes program savings came from the downstream equipment strata so the overall program NTG of 0.52 was heavily weighted to that strata's NTG. Cadmus assigned an NTG of 1 to Student Energy Efficient Education program, reasoning that there is no free-ridership or spillover possible for this program (Table 92).

The SWE reviewed PPL's Phase IV EMV Plan, all surveys, analyses code and data used to estimate NTG and have found that they have correctly employed NTG methodology recommended in the Phase IV Evaluation Framework.

Table 92: Summary of PPL's PY13 Residential NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Appliance Recycling	Self-report surveys	318	45%	1%	0.56
Efficient Lighting	Retailer interviews	8	N/A	N/A	1.07
Energy Efficient Homes	Self-report surveys	316	49%	1%	0.52
Student Energy Efficient Education	N/A	0	0%	0%	1.0
Program Total	N/A		N/A	N/A	0.68

C.6.2 C&I Energy Efficiency Programs

PY13 C&I program NTG estimation was planned and conducted for the C&I Custom and Efficient Equipment (Non-Lighting and Lighting strata only) programs (Table 93). The PY13 Efficient Equipment data was applied to the common formula to estimate free-ridership and NTG but could not be utilized to estimate spillover and resulted in a Non-Lighting NTG of 0.67 and a Lighting

⁷⁵ During PY13, no non-LED lamps met the new EISA standard and 2021 TRM baseline of 45 lumens/watt.

NTG of 0.77. The Midstream Lighting NTG was estimated previously for PY11. C&I Custom NTG (0.22) was calculated using survey data from two PY13 participants (40% of the total program participants).

The SWE reviewed PPL's Phase IV EMV Plan, all surveys, analyses code and data used to estimate NTG and have found that they have correctly employed NTG methodology recommended in the Phase IV Evaluation Framework. The SWE does suggest that PPL attempt to collect a larger number of survey participants from the Efficient Equipment program to estimate NTG in future efforts.

Table 93: Summary of PPL's PY13 C&I NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Custom	Self-report surveys	2	78%	0%	0.22
Efficient Equipment Non-Lighting	Self-report surveys	2	33%	0%	0.67
Efficient Equipment Lighting	Self-report surveys	8	23%	0%	0.77
Midstream Lighting	N/A	0	38%	0%	0.62
Program Total	N/A		N/A	N/A	0.58

C.7 TRC

Table 94 shows the high-level TRC Test results for PPL in PY13 at the program level. The table shows benefits and costs, both gross and net, for each program component in the PPL portfolio and overall, as well as the resultant TRC Ratios. The components may not add up to the totals due to rounding.

Table 94: Summary of PPL's PY13 TRC Results

Program Component	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Custom	\$22,903	\$10,704	2.14	\$5,039	\$3,894	1.29
Efficient Equipment	\$68,630	\$28,905	2.37	\$49,696	\$21,957	2.26
Low-Income	\$6,748	\$5,215	1.29	\$6,748	\$5,215	1.29
Appliance Recycling	\$2,340	\$1,577	1.48	\$1,310	\$1,577	0.83
Efficient Lighting	\$3,058	\$1,153	2.65	\$3,272	\$1,153	2.84
Energy Efficient Home	\$12,303	\$11,548	1.07	\$6,460	\$7,278	0.89
Student Energy Efficient Education	\$6,505	\$663	9.81	\$6,505	\$663	9.81
Common Portfolio costs	N/A	\$6,400	N/A	N/A	\$6,400	N/A
Portfolio Total	\$122,486	\$66,167	1.85	\$79,029	\$48,139	1.64

PY13 TRC test results showed that every program was cost-effective in gross terms, while all but Appliance Recycling and Energy Efficient Home were cost-effective on a net basis. The non-residential sectors accounted for 75% of the total TRC Gross Benefits in PY13. The Residential program with the highest individual Gross TRC benefits was Student Energy Efficient Education at 9.81. This was mostly driven by the low costs associated with the program. The Non-Residential program with the highest Gross TRC ratio was the Efficient Equipment program component at 2.37. This program also had the largest amount of Gross TRC benefits of any PPL program in PY13.

C.7.1 Notes from the TRC Model Review

The PY13 TRC model was developed by Cadmus for PPL. Below is a summary of the assumptions and inputs verified by the SWE.

- The SWE used the granular TRC measure impacts and assumptions to independently recreate the PY13 electric energy and capacity benefits. This exercise replicated the electric benefits at the program level almost perfectly. The slight differences can be attributed to rounding.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Non-Electric Benefits. The SWE was able to recreate the PY13 fossil fuel benefits through a similar process as described for the electric benefits. The derivation of these non-electric impacts was well-documented in PY13 with supporting workbooks for each program.
- Review of the TRC model finds that PPL correctly applied the 2021 TRC Test Order nominal discount rate of 5.0%. In Phase IV the PUC directed all EDCs to use a common discount rate rather than their own weighted average costs of capital as had been done in previous phases.
- The correct line-loss multipliers of 1.042 for Large C&I applications and 1.0875 otherwise were used for all measures. An initial review of the model by the SWE flagged that the avoided distribution capacity costs were inadvertently applied to Large C&I peak demand impacts. Once flagged, the Cadmus team was able to quickly update the measure mapping and share updated TRC results. All TRC results in this report only include the avoided cost of transmission capacity for Large C&I customers per the directives of the 2021 TRC Test Order.
- The SWE team found that PPL was inconsistent with respect to measure vintage used for calculating savings/benefits and incremental measure costs for prescriptive commercial lighting measures. The savings and associated benefits were calculated using the early replacement vintage per the 2021 TRM. The incremental costs, however, assume a replacement on burnout vintage. In the future, the SWE team recommends using the same measure vintage to calculate both the benefits and incremental costs of all measures.
 - Table 6 of the 2021 TRC Test Order is a useful reference table of Act 129 measure vintage types and lays out the savings and cost perspective for each. As a rule, savings and incremental measure costs should always follow the same measure vintage.

- The SWE found, through spot checking, that EULs were correctly applied from the 2021 TRM. In the past PPL applied EULs inconsistently in some minor cases, but it was found that all those cases were handled appropriately in PY13.

C.8 PROCESS

C.8.1 Residential Program

The Residential Program is made up of the following components and sub-components, shown below:

- Appliance Recycling component
- Efficient Lighting component
- Energy Efficient Homes component
 - New Homes sub-component
 - Audit and Weatherization sub-component (no process evaluation in PY13)
 - Online Marketplace sub-component
 - Downstream Equipment sub-component
 - Midstream Equipment sub-component (no process evaluation in PY13)
- Student Energy Efficient Education component

Table 95 summarizes program component or sub-component satisfaction for the Residential Program.

Table 95: PPL PY13 Program Satisfaction Summary- Residential Program

Program Component / Sub-component	Population	% Satisfied
Appliance Recycling	Participants	97%
Efficient Lighting	Retailers	100%
Energy Efficient Home - New Homes	Builders	94%
Energy Efficient Homes - Online Marketplace	Participants	80%
Energy Efficient Homes - Equipment (downstream)	Participants	90%
Student Energy Efficient Education	Students	80%
Student Energy Efficient Education	Teachers	100%

C.8.1.1 Appliance Recycling

Summary of Process Evaluation Results

For the process evaluation of this program component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed participants. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP staff and from secondary research. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included the effectiveness of program administration, implementation, and delivery; ease of participation; customer sub-component program satisfaction, drivers of program sub-component satisfaction; opinions about PPL;

likelihood to recommend the program sub-component, and recommendations. Based on these data, the following key process findings emerged:

- A large majority of PY13 responding participants (97%) said they were satisfied with the Appliance Recycling component overall.
- A large majority of PY13 responding participants (97%) said it was easy to participate in the Appliance Recycling component.
- The main driver for high participant satisfaction with the Appliance Recycling component was the collection process (when the contractor picks up the appliances), mentioned by 72% of satisfied PY13 responding participants.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted 140 participant survey responses and achieved a total of 344 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations. There was one recommendation that followed from the process evaluation and that applied to all residential program components; the recommendation has been implemented. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

C.8.1.2 Efficient Lighting

Summary of Process Evaluation Results

For the process evaluation of this program component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed retailers. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; retailer program component satisfaction, drivers of program component satisfaction; perspectives on the component's impacts on stocking practices, perspectives on impacts of the EISA legislation, and recommendations. Based on these data, the following key process findings emerged:

- 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 very

satisfied, and 1 of 9 said they were somewhat satisfied 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.

- 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%).
- In PY13, PPL provided incentives exclusively for multi-packs and no single bulbs. Although the component sold 43% more specialty LEDs per month on average in PY13 compared to PY11,⁷⁶ monthly average energy savings decreased by 83% because of lower baseline wattages due to the EISA backstop provision.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were generally consistent with the Phase IV Evaluation Plan with some changes to the retailer outreach methodology. Cadmus conducted nine retailer interviews with a target of 23. For some 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. The reason for this change to the Phase IV Evaluation Plan was clearly explained by Cadmus in the final report.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations. There was one recommendation that followed from the process evaluation and that applied to all residential program components; the recommendation has been implemented. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

⁷⁶ 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.

C.8.1.3 Energy Efficient Homes

Summary of Process Evaluation Results

For the process evaluation of this program component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed builders and customers. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; ease of participation; customer program component satisfaction, drivers of program component satisfaction; insights about the residential new construction market and installation of high-efficiency equipment, opinions about PPL; likelihood to recommend the program sub-component, and recommendations. Based on these data, the following key process findings emerged:

- Builders and customers were satisfied with the Energy Efficient Homes offering; 88% indicated that they were satisfied with the component overall.
- 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).
- 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).

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan, with one exception. The Energy Efficient Homes component did not report participation or savings for any audits or weatherization measures in PY13, so evaluator did not conduct a survey or complete any other evaluation activities for the Audit and Weatherization sub-component. The reason for this change to the Phase IV Evaluation Plan was clearly explained by Cadmus in the final report.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted up to 18 builder survey responses and all eligible Online Marketplace participant survey responses and Downstream Equipment participant survey responses. It achieved a total of 16 builder survey responses, 94 Online Marketplace participant survey responses, and 304 Downstream Equipment participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations. There was one recommendation that followed from the process evaluation and that applied to all residential program components; the recommendation has been

implemented. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

C.8.1.4 Student Energy Efficient Education

Summary of Process Evaluation Results

For the process evaluation of this program component, Cadmus reviewed program documents and data, PPL and ICSP program managers, and surveyed participants. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; student and teacher program component satisfaction; teacher feedback, and recommendations. Based on these data, the following key process findings emerged:

- Overall, 80% of PY13 responding participants gave positive ratings of the Student Energy Efficient Education component (80% very satisfied or somewhat satisfied for students, and 100% excellent or good 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.
- Cadmus observed that the question wording and response scale for gauging satisfaction with the program varied between student and teacher participant types.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted all eligible student and teacher survey responses. It achieved a total of 14,794 student survey responses and 135 teacher survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations. There were two recommendations that followed from the process evaluation. One of the recommendations applied to all residential program components; this recommendation has been implemented. The second recommendation applied specifically to this component; this recommendation is under consideration. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

C.8.2 Non-Residential Program

The Non-Residential Program is made up of the following components and sub-components, shown below:

- Efficient Equipment component
 - Downstream sub-component, including lighting and non-lighting
 - Midstream sub-component, including non-lighting (no process evaluation in PY13) and lighting (limited process evaluation in PY13)
- Custom component

Table 96 summarizes program component or sub-component satisfaction for the Non-Residential Program.

Table 96: PPL PY13 Program Satisfaction Summary- Non-Residential Program

Program Component / Sub-component	Population	% Satisfied
Efficient Equipment (downstream)	Participants	93%
Custom	Participants	100%

C.8.2.1 Efficient Equipment (Downstream)

Summary of Process Evaluation Results

For the process evaluation of this program sub-component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed participants. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation and delivery; ease of participation; customer program satisfaction, drivers of program sub-component satisfaction; opinions about PPL; likelihood to recommend the program sub-component, and recommendations. Based on these data, the following key process findings emerged:

- Most of the PY13 responding participants (93%) indicated that they were satisfied with the PPL Efficient Equipment downstream program.
- A majority (88%) of the PY13 responding participants indicated that it was easy to participate in the PPL Efficient Equipment downstream program.
- The rebate amount was the main driver for high satisfaction among the PY13 responding participants.
- Two of five PY13 responding participants said that they needed more clarity on the rebate and how the program works, and one respondent suggested increasing the rebate amount.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan although the targeted number of participant survey completes was not reached.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted 23 non-lighting participant survey responses and 69 lighting participant survey responses. It achieved a total of three non-lighting participant survey responses and 25 lighting participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY13 for this sub-component. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

C.8.2.2 Efficient Equipment (Midstream)

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff for the Efficient Equipment Midstream Non-Lighting sub-component. No process evaluation was conducted in PY13 beyond interviews with program and implementation staff and a logic model review for the Efficient Equipment Midstream Lighting sub-component.

C.8.2.3 Custom

Summary of Process Evaluation Results

For the process evaluation of this program component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed participants. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; the influence of the contractor or design engineer on project design; customer program satisfaction, drivers of program component satisfaction; opinions about PPL; likelihood to recommend the program component; and recommendations. Based on this data, four key process findings emerged:

- Two out of three PY13 responding participants indicated that they were very satisfied with the PPL Custom rebate program, while the other respondent said that they were somewhat satisfied (n=3).
- A majority (two of three) of the PY13 responding participants indicated that it was easy to participate in the Custom program.

- Communication with PPL and CLEAResult was a common driver for high satisfaction among PY13 responding participants.
- One out of three PY13 responding participants 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.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted a census of custom participant survey responses and achieved a total of three participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY13 for this component. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

C.8.3 Low-Income Program

The Low-Income Program is made up of the following components and sub-components, shown below:

- Low Income Assessment component
 - Remote Energy Assessment (REA) sub-component
 - Direct Install sub-component (no process evaluation in PY13)
 - Welcome Kits sub-component

Table 97 summarizes program component or sub-component satisfaction for the LI Program.

Table 97: PPL PY13 Program Satisfaction Summary- LI Program

Program Component / Sub-component	Population	% Satisfied
Low-Income Assessment - Remote Energy Assessment (REA)	Participants	85%
Low-Income Assessment - Welcome Kits	Participants	80%

C.8.3.1 Remote Energy Assessment (REA)

For the process evaluation of this program sub-component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed participants.

Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; ease of participation; customer program satisfaction, drivers of program sub-component satisfaction; opinions about PPL; likelihood to recommend the program sub-component, and recommendations. Based on these data, the following key process findings emerged:

- Cadmus found that 85% of PY13 REA responding participants (76% very satisfied and 9% somewhat satisfied; n=106) were satisfied with the program overall.
- Eighty-nine percent (n=105) of PY13 REA responding participants found it very easy or easy to participate in the program.
- The most common reason PY13 REA responding participants were very or somewhat satisfied with the program sub-component was reduced energy bills.
- Of 102 PY13 REA responding participants, 68% said their opinion of PPL 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.
- Overall, 78% (n=96) of PY13 REA responding participants were likely to recommend the program to a friend, family member, or colleague.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan, with one exception. 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 increased the REA participant survey completion target to 60 completes from the original 24 planned survey completes identified in the Phase IV Evaluation Plan. The reason for this change to the Phase IV Evaluation Plan was clearly explained by Cadmus in the final report.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted 60 participant survey responses and achieved a total of 87 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY13 for this sub-component. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

C.8.3.2 Direct Install

No process evaluation was conducted in PY13 beyond interviews with program and implementation staff. Though the original evaluation plan targeted 36 completed surveys for Direct Install participants, there was only one direct install appointment completed at the time of the survey fielding. Therefore, Cadmus did not complete a participant survey with the Direct Install participants and instead targeted additional completes for REA participants.

C.8.3.3 Welcome Kits

For the process evaluation of this program sub-component, Cadmus reviewed program documents and data, interviewed PPL and ICSP program managers, and surveyed participants. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL and ICSP and from secondary research. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included the effectiveness of program administration, implementation, and delivery; ease of participation; customer program satisfaction, drivers of program sub-component satisfaction; opinions about PPL; likelihood to recommend the program sub-component, and recommendations. Based on these data, the following key process findings emerged:

- Cadmus found that 80% of responding welcome kit recipients (70% very satisfied and 10% somewhat satisfied; n=30;) were satisfied with the program overall.
- Eighty-six percent (n=30) of responding PY13 welcome kit recipients found it very easy or easy to participate in the program.
- The most common reason responding PY13 welcome kit recipients were very or somewhat satisfied with the program sub-component was reduced energy bills.
- Of 28 PY13 welcome kit recipient survey respondents, 67% said their opinion of PPL had improved after participating in the Low-Income Program, 19% said their opinion had not changed, and 15% (four respondents) said their opinion decreased. 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, 65% (n=27) of PY13 welcome kit recipient survey respondents were likely to recommend the program to a friend, family member, or colleague.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluation targeted 23 participant survey responses and achieved a total of 26 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY13 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations. There was one recommendation that followed from the process evaluation; the recommendation has been implemented. The report included sufficient detail for the SWE (and other readers) to assess the methods, conclusions, and recommendations.

Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer.

Appendix D Duquesne Light PY13 Audit Detail

D.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework; followed proper custom site-specific M&V activities; applied TRM protocols correctly; and are generally accurate. The SWE made minor recommendations to Guidehouse regarding specific aspects of some impact analyses, resulting in less than 1% difference in final savings values. The SWE's feedback was provided to the evaluator with sufficient time for Duquesne Light to include all suggested changes in their PY13 Annual Report.
- For Duquesne Light's Large C&I programs, line losses were applied inconsistently to peak demand savings between the TRC model and the Duquesne Light PY13 Annual Report tables. The issue centers around which accounts should receive a line loss factor of 1.0081 versus a 1.0741 system weighted average. The 1.0081 factor comes from the high voltage primary service rate class, which consists of just 12 accounts that take service at 69 kV. Duquesne Light's Large C&I EE&C programs serve accounts with peak demand above 300 kW, which is a much broader set of customers. Once the inconsistency was identified, the SWE discussed the issue with Duquesne Light and determined that the treatment of line losses in the TRC model was consistent with line losses on Duquesne Light's system. Once parties aligned on the issue, Guidehouse provided the SWE with revised estimates of verified gross and net peak demand savings, and those are the values presented in this report.
 - In PY13, high voltage primary service accounts contributed almost no energy and demand savings. However, historically these large industrial accounts have completed some of the largest and most complex projects in Duquesne Light's EE&C portfolio. Guidehouse and Duquesne Light will need to work out a process to differentiate line loss factors for reporting within the Large C&I programs.
- Duquesne Light provided their Residential and Low Income verified savings analyses prior to drafting their Duquesne Light PY13 Annual Report. This allowed the SWE to conduct an early review and had ample time and opportunity to discuss any questions, potential discrepancies, and review updated results that were directly incorporated into the Duquesne Light PY13 Annual Report. In addition, the verified savings analyses were well organized, and included the documentation required to conduct verified savings checks from the measure-level all the way to program-level savings.
- Duquesne Light had one of the highest portfolio TRC ratios of the seven EDCs subject to Act 129 in PY13. The portfolio result was driven largely by the performance of the non-residential program, which had a gross TRC ratio of 2.49. However, the TRC audit noted that Duquesne Light assumes a replace-on-burnout perspective (efficient equipment cost minus baseline equipment cost) when assigning incremental measure cost to most commercial lighting measures. The Duquesne Light cost perspective is inconsistent with the perspective used to estimate energy and demand savings for most measures and leads to an upward bias in the TRC results. The SWE will work with the EDCs and their

evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Duquesne Light's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. A subset of records from four programs were omitted from the PY13Q4 tracking data request response. The SWE confirmed the missing data with Guidehouse and was able to reconcile these differences by referencing the verification data in the TRC model. After receiving an updated cumulative tracking data file, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE noted only a few minor discrepancies.
- The SWE conducted a project file review for a sample of Duquesne Light's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data. The SWE notes that photographs for appliance recycling were not provided, but data such as size and age were included in the tracking data.
- The SWE found several transcription errors in program-level savings, realization rates and NTG ratios in the summary tables included in Chapter 2 of the Duquesne Light PY13 Annual Report. In addition, the SWE found several inconsistent NTG values reported in the summary table in Chapter 2 compared to the NTG ratios in the program specific chapters. The SWE alerted Guidehouse to the issue and Guidehouse confirmed which were the correct values.
- Overall, Guidehouse estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, Guidehouse completed all the PY13 activities detailed in the approved evaluation plan and sampling memos, and the reporting followed the SWE guidelines. The process evaluation discussion was succinct and highlighted findings that should be of value to Duquesne Light and its CSPs.

D.2 EM&V PLAN REVIEWS

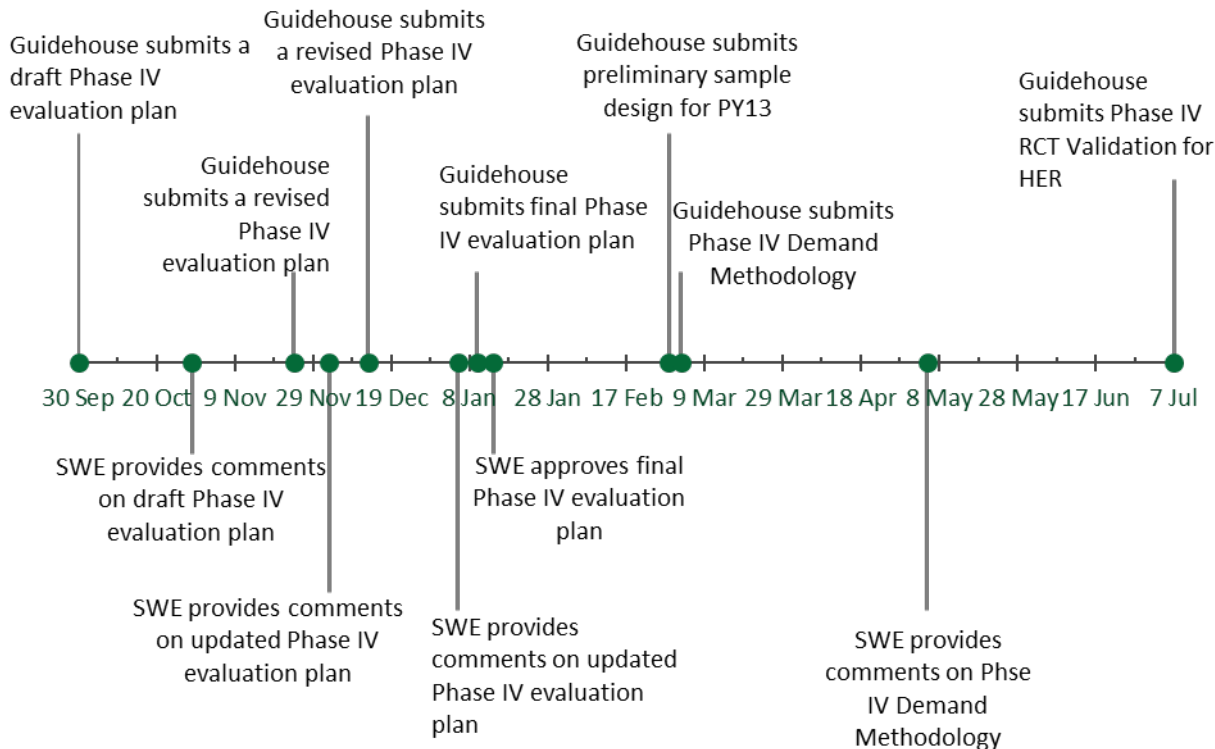
Duquesne Light's evaluation contractor, Guidehouse, submitted a draft Phase IV EM&V plan summary in late September 2021. The plan described the impact and process evaluation data collection tasks and methods for programs across the residential, small/medium C&I, and large C&I sectors. After several rounds of comment from the SWE and revisions by Guidehouse, the final evaluation plan was approved by the SWE in early January 2022. The Phase IV EM&V only described sampling approaches in a general sense, so Guidehouse submitted supplemental sampling design memos for its PY13 evaluation of the residential and non-residential programs. The peak demand savings method for behavioral programs was left open in the approved Phase IV EM&V Plan so Guidehouse issued a supplemental memorandum in early March 2022. These received comments from the SWE in late March. In July 2022 Guidehouse submitted a memo to

the SWE validating the RCT design of three new behavioral Home Energy Report cohorts. The SWE brought some of the following points to Guidehouse during revision of the plans:

- Request to clarify which programs receive an impact evaluation for which program years of Phase IV and whether savings will be left unverified or claimed using historic realization rates in years when no new impact evaluation is scheduled.
- The mechanics of rolling samples when an impact evaluation examines verified savings across more than one Act 129 program year.
- The impact evaluation methodology for Duquesne Light's Small and Large Virtual Commissioning program. This offering relies on advanced billing analysis techniques rather than TRM characterizations, so the SWE team requested a more detailed description of the methods.
- Plans to separate low-income savings from market rate residential savings for behavioral Home Energy Report programs. The final approach to this issue is quite simple – savings from the two low-income cohorts will be claimed toward the Phase IV low-income compliance target and savings from the four market rate cohorts will not.
- Verification methods by program and measure type (phone surveys, in-person site visits, virtual site visits, desk review of project documentation etc.)
- Expected data availability and evaluation methods for programs with a midstream delivery model.

Figure 55 shows the review timeline of correspondence between Guidehouse and the SWE team to finalize the Phase IV EM&V plan.

Figure 55: Duquesne Light Evaluation Plan Review Timeline 2021-2022



As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. [Table 98](#) shows which Duquesne Light programs produced verified impacts in PY13, and which will wait until PY14 to verify results. A two-year sample size will be used to verify results in PY14. Those that use a two-year rolling sample should use verified impacts in each year starting in PY14. Several programs also used historic realization rates in PY13. In future years of the phase, current verification rates will be produced.

Table 98: PY13 Duquesne Light Program Impact Evaluation Summary

Sector	Program	PY13 Impacts
Residential	Upstream Incentives	Verified
	Midstream Incentives	No activity in PY13
	Downstream Incentives	Verified
	Appliance Recycling	Verified
	Residential Behavioral	Verified
Low-Income	Low-Income Behavioral	Verified
Small C&I	Low-Income Energy Efficiency	Verified using historic realization rates from PY10 and PY11
	Small Business Direct-Install	Verified using a PY12 realization rate. Sampled for a two-year impact evaluation.
	Small Business Solutions	Verified using PY12 historic realization rates. Sampled for a two-year impact evaluation.
	Small Business Midstream	*Verified
Large C&I	Small Virtual Commissioning	**Unverified until PY14
	Large Business Solutions	Verified using PY12 historic realization rates. Sampled for a two-year impact evaluation.
	Large Business Midstream	*Verified
	Large Virtual Commissioning	**Unverified until PY14

* A subset of the Small and Large Business Midstream savings for PY13 were left unverified because the program-supported equipment had not yet been installed. These sites will be revisited in PY14, and the savings will be verified if the equipment has been installed.

**Small Business and Large Virtual Commissioning had no participation in PY13

In addition to the evaluation plans, the SWE also reviewed and provided comments on draft surveys and interview guides for the applicable delivery channels.

D.3 SAMPLE DESIGN REVIEW

The Phase IV Evaluation Framework allows a maximum level of sampling uncertainty of $\pm 15\%$ at 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. Duquesne Light’s energy efficiency portfolio consists of multiple programs which serve multiple sectors. [Table 99](#) shows the reported relative precision of savings estimates by sector and program. Initiatives verified using historic realization rates are omitted from the table. Behavioral programs that do not have uncertainty associated with sampling are also omitted from the table.

Table 99: Relative Precision of PY13 Impacts by Component at the 85% Confidence Level

Sector	Program/Initiative	Relative Precision (Energy)	Relative Precision (Demand)
Residential Program	Upstream Incentives	0.0%	0.0%
	Downstream Incentives	0.1%	0.3%
	Appliance Recycling	7.5%	6.9%
Cross-cutting	Business Midstream	14.2%	9.5%

In addition to reporting relative precision by program, Guidehouse also reported relative precision at an aggregated initiative level. For PY13 Guidehouse grouped similar programs into two evaluation initiatives, Business Midstream Solutions and Large Business Solutions. Large Business Solutions met the 85/15 precision requirement for energy and demand impacts with historic impact evaluation results and Business Midstream Solutions met the 85/15 precision requirement with PY13 verification activities. The SWE was able to replicate the relative precision figures provided by Guidehouse using standard rollup procedures.

Not all programs rely on sampling to estimate verified savings. For the Residential Behavioral Savings program, the impact evaluation relies on a statistical billing analysis of all participants, so there is no uncertainty associated with sampling. The precision requirements for the behavioral program are unique, with the Phase IV Evaluation Framework requiring the solution-level verification achieve an absolute precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). This requirement for program design is less stringent than the sampling requirement, described above, that programs annually achieve $\pm 15\%$ relative precision at the 85% confidence level. Standard precision requirements are not reasonable expectations for behavioral programs because the size of the average effect is typically much smaller, and all estimation error is captured as opposed to sampling error only. The SWE reviewed the design of Duquesne Light's behavioral offerings and found the treatment and control group sizes were adequate to achieve ± 0.5 absolute precision at the 95% confidence level in aggregate.

D.4 REPORTED GROSS SAVINGS AUDITS

D.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Duquesne Light's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)
- Participation counts
- Incentive dollars

The SWE leveraged Duquesne Light's Q1-Q4 tracking data to audit these values. Note that the SWE does not receive the full tracking data set, rather a subset of the full tracking data set tailored

to our quarterly data request. A subset of records from four programs were omitted from the PY13Q4 tracking data request response. The SWE confirmed the missing data with Guidehouse and was able to reconcile these differences by referencing the verification data in the TRC model. Also note that HER programs are not audited using the tracking data, thus they are not included in the tables or totals in the following sections. The SWE's findings regarding Duquesne Light's Residential and Low-Income Behavioral Savings programs can be found in [Appendix D.5.1.3](#).

[Table 100](#) summarizes our findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the values in Duquesne Light's PY13 Annual Report and "No" otherwise. After receiving an updated cumulative tracking data file, the SWE was able to replicate the values reported by Duquesne Light.

Table 100: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Downstream Incentives	1,533	1,533	Yes
Residential Midstream Incentives	0	0	Yes
Residential Upstream Incentives	1,381	1,381	Yes
Residential Appliance Recycling	347	347	Yes
Low Income Energy Efficiency	2,534	2,534	Yes
Small Business Direct Install	1,298	1,298	Yes
Small Business Solutions	6,134	6,134	Yes
Small Business Midstream Solutions	10,665	10,665	Yes
Small Business Virtual Commissioning	0	0	Yes
Commercial Large Business Solutions	9,189	9,189	Yes
Industrial Large Business Solutions	2,142	2,142	Yes
Large Business Midstream Solutions – Commercial	3,359	3,359	Yes
Large Business Midstream Solutions – Industrial	2,841	2,841	Yes
Large Business Virtual Commissioning	0	0	Yes
Portfolio Total	41,423	41,423	Yes

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Downstream Incentives	1,533	1,533	Yes
Residential Midstream Incentives	0	0	Yes
Residential Upstream Incentives	1,381	1,381	Yes
Residential Appliance Recycling	347	347	Yes
Low Income Energy Efficiency	2,534	2,534	Yes
Small Business Direct Install	1,298	1,298	Yes
Small Business Solutions	6,134	6,134	Yes
Small Business Midstream Solutions	10,665	10,665	Yes
Small Business Virtual Commissioning	0	0	Yes
Commercial Large Business Solutions	9,189	9,189	Yes
Industrial Large Business Solutions	2,142	2,142	Yes
Large Business Midstream Solutions – Commercial	3,359	3,359	Yes
Large Business Midstream Solutions – Industrial	2,841	2,841	Yes
Large Business Virtual Commissioning	0	0	Yes
Portfolio Total	41,423	41,423	Yes*

*The Residential and LIEEPs have HER components that are not represented in this table.

Table 101 summarizes the SWE's findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. After receiving an updated cumulative tracking data file, we were able to replicate the values reported by Duquesne Light.

Table 101: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Residential Downstream Incentives	0.30	0.30	Yes
Residential Midstream Incentives	0	0	Yes
Residential Upstream Incentives	0.24	0.24	Yes
Residential Appliance Recycling	0.07	0.07	Yes
Low Income Energy Efficiency	0.27	0.27	Yes
Small Business Direct Install	0.21	0.21	Yes
Small Business Solutions	1.25	1.25	Yes
Small Business Midstream Solutions	2.13	2.13	Yes
Small Business Virtual Commissioning	0	0	Yes
Commercial Large Business Solutions	1.82	1.82	Yes
Industrial Large Business Solutions	0.35	0.35	Yes
Large Business Midstream Solutions – Commercial	0.62	0.62	Yes
Large Business Midstream Solutions – Industrial	0.65	0.65	Yes
Large Business Virtual Commissioning	0	0	Yes
Portfolio Total	7.92	7.92	Yes*
*The Residential and LIEEPs have HER components that are not represented in this table			

Table 102 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for all programs. The portfolio totals, though not exactly equal, line up well: 10,314 in the Duquesne Light PY13 Annual Report and 10,162 in the tracking data.

Table 102: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Residential Downstream Incentives	4,648	4,649	Yes
Residential Midstream Incentives	0	0	Yes
Residential Upstream Incentives	0	0	Yes
Residential Appliance Recycling	545	429	No
Low Income Energy Efficiency	4,211	4,211	Yes
Small Business Direct Install	41	40	Yes
Small Business Solutions	191	170	No
Small Business Midstream Solutions	488	483	No
Small Business Virtual Commissioning	0	0	Yes
Commercial Large Business Solutions	49	41	No
Industrial Large Business Solutions	13	11	No
Large Business Midstream Solutions – Commercial	89	89	Yes
Large Business Midstream Solutions – Industrial	39	39	Yes
Large Business Virtual Commissioning	0	0	Yes
Portfolio Total	10,314	10,162	No*

*The Residential and LIEEPs have HER components that are not represented in this table.

Finally, Table 103 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in Duquesne Light's PY13 Annual Report. The SWE was able to exactly replicate incentive dollars for several programs. For the remaining programs, the SWE calculated directionally similar values using the tracking data. The portfolio totals are also directionally similar: \$5,045,000 in the Duquesne Light PY13 Annual Report and \$4,724,000 in the tracking data. The SWE acknowledges that these differences exist because the Annual Report values are pulled from a financial system as opposed to program tracking data. For this reason, the SWE does not view the differences as an issue.

Table 103: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Residential Downstream Incentives	\$11	\$11	Yes
Residential Midstream Incentives	\$0	\$0	Yes
Residential Upstream Incentives	\$178	\$178	Yes
Residential Appliance Recycling	\$30	\$27	No
Low Income Energy Efficiency	\$975	\$901	No
Small Business Direct Install	\$361	\$361	Yes
Small Business Solutions	\$451	\$415	No
Small Business Midstream Solutions	\$1,502	\$1,485	No
Small Business Virtual Commissioning	\$0	\$0	Yes
Commercial Large Business Solutions	\$645	\$458	No
Industrial Large Business Solutions	\$83	\$79	No
Large Business Midstream Solutions – Commercial	\$439	\$439	Yes
Large Business Midstream Solutions – Industrial	\$370	\$370	Yes
Large Business Virtual Commissioning	\$0	\$0	Yes
Portfolio Total	\$5,045	\$4,724	No

D.4.2 Project File Reviews

D.4.2.1 Residential

The SWE conducted a project file review for a sample of Duquesne Light's residential programs in PY13 as part of the reported savings (i.e., ex-ante) review. The project file documentation was provided by Duquesne Light, the program implementors, and the evaluation contractor, Guidehouse, in response to the SWE's standing quarterly data request. The project file packages included rebate applications, equipment invoices, and post-inspection forms. The sampled project file packages included most of the documentation requested.

Table 104 presents a summary of SWE's residential project file reviews. Project files were found to match most of the tracking data, with some exceptions.

Table 104: Duquesne Light PY13 Residential Project File Review

Program	Sub Program	Number of Files Reviewed	Did EDC provide project files?	Are most of the requested files included?	Are the projects easily located in the tracking data?	Does the data in the files match the tracking data? ¹
Residential Incentives	Downstream Rebates, EE Education	15	✓	✓	✓	✓
Residential Recycling	Appliance	11	✓	✓	✓	✓
Residential Incentive ²	Midstream	-	-	-	-	-
Residential Incentive	Upstream Lighting, Appliances	11	✓	✓	X	X
Low Income Efficiency	Energy	35	✓	✓	✓	✓

¹ It should be noted that while the data typically matches, minor discrepancies were found and are detailed in the paragraphs below.

² The Residential Midstream Incentive program was not evaluated, and no savings were claimed in PY13.

As detailed above, the requested number of project files and supporting details were submitted for the residential program. Below is a summary of the SWE's review of the project file packages and quarterly tracking data.

Overall, the SWE found that tracking data matched the measures and quantities in project documentation. Occasionally an invoice was missing for a particular unit; however, this was a minor issue, and such units were often documented elsewhere. Overall, the SWE was impressed with the thoroughness of the documentation provided for Duquesne Light residential and low-income programs.

Residential Downstream Incentives

The Residential Downstream Incentives program had project files containing invoices on purchased LED lighting, refrigerators, dehumidifiers, thermostats, heat pumps, and other energy efficient equipment. The SWE verified that the reviewed project files matched the measures and quantities in the tracking data. There were multiple instances where the reported energy savings for refrigerators was found to be lower than the default savings, but data was not provided to explain the lower reported savings. There were also two instances where the project files did not clearly indicate the provided rebate.

Residential Appliance Recycling

The Residential Appliance Recycling program had light participation in PY13. A list of refrigerators and freezers that were recycled, along with the associated dates, addresses, rebates paid, ages, and sizes were provided. However, there were no photographs or documents to verify these data. Duquesne Light was extremely proactive, informing the SWE that there had been an issue with the CSP providing photographs of recycled appliances and that the issue had been resolved. Beginning with the data request response for Q1 of PY14, photographs of recycled appliances were provided and an initial review indicated the model numbers and serial numbers were clear and legible.

Residential Midstream Incentive

There was no participation in PY13 and therefore not part of the project file review.

Residential Upstream Incentive

The Residential Upstream Incentive program had project files containing purchase receipts and rebate invoices for various LED lighting. These files do not contain project numbers or similar designations that would aid in matching the purchases with their respective entries within the tracking data.

Low Income Energy Efficiency

The Low Income Energy Efficiency program had project files containing invoices on purchased LED lighting, faucet aerators, showerheads, smart strips, and other energy efficient equipment. The SWE verified that the reviewed project files mostly matched the measures and quantities in the tracking data, with a few exceptions. In addition, the SWE reviewed assumptions used in reported savings calculations. The program tracking data listed the measure life for nightlights as 15 years, but according to the TRM the measure life for nightlights is 8 years. The program tracking data also listed energy savings that were approximately five times higher than the default values provided by the TRM, but the SWE could not verify whether other EDC collected data was being used in the calculation. The SWE observed the reported savings for smart strips use TRM defaults but found one instance where the project file documentation and tracking data inconsistently reported whether it was a Tier 1 or Tier 2 strip.

D.4.2.2 Non-Residential

The SWE reviewed a sample of Duquesne Light's Small C&I, Large C&I, and Industrial C&I projects for PY13 using the project documentation provided by the evaluation contractor in response to the SWE's standing quarterly data request. The project file packages included savings calculation worksheets, rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. Most of the reviewed project file packages included all documentation requested and were well organized, allowing for a comprehensive review of the forty-one projects sampled.

Table 105 presents an overview of the results of the SWE's C&I project file reviews. The SWE noted a handful of instances where the project tracking documentation did not match the provided calculation workbooks and/or project files. These noted inconsistencies generally reflect minor impacts on reported savings values.

Table 105: Duquesne Light PY13 C&I Project File Review Summary

Program	Sub-Program	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
Large C&I	Large Commercial Business Solutions	9	✓	8/9	8/9	✓	✓	-
Large C&I	Large Commercial Midstream Solutions	1	✓	✓	✓	✓	0/1	-
Large C&I	Large Industrial Business Solutions	5	✓	✓	✓	✓	✓	-
Large C&I	Large Industrial Midstream Solutions	1	✓	0/1	0/1	✓	✓	-
Small C&I	SBDI	5	✓	4/5	4/5	✓	✓	-
Small C&I	Small Commercial Business Solutions	15	14/15	✓	13/15	✓	✓	-

A few project discrepancies are described below by program.

- **Large Commercial Business Solutions**
 - For one project, inconsistencies were observed between the invoices, savings calculations, and tracking data.
- **Large Commercial Midstream Solutions**
 - For one project, the TRM algorithm for midstream savings was misapplied.
- **Large Industrial Midstream Solutions**
 - For one project, the TRM algorithm for midstream savings was misapplied, and inconsistencies in fixture quantities were noted between invoice and savings calculations.
- **Small Business Direct Install (SBDI) Solutions**
 - For one project, inconsistencies were observed between the invoices, savings calculations, and tracking data.
- **Small Commercial Business Solutions**
 - Minor inconsistencies in lamp types and quantities was noted between invoices and savings calculations for three projects.

Despite the minor issues discussed with the above project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

D.5 VERIFIED GROSS SAVINGS AUDITS

D.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of Duquesne Light's portfolio of residential programs. Duquesne Light's portfolio of residential programs consists of the following programs: Residential Downstream Incentives Program (RDIP), Residential Appliance Recycling Program (RARP), Residential Behavioral Program, Residential Midstream Incentive Program (RMIP), Residential Upstream Incentive Program (RIUP) and the Residential LI Energy Efficiency Program (LIEEP). Note that the SWE reports the residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

Table 106 provides a summary of the evaluation and M&V approaches used by Duquesne Light in their PY13 verified savings calculations.

Table 106: Residential Program Evaluation Activities – Duquesne Light Company

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis	Applied Historic RR
RDIP (Rebates)	-	-	✓	-	-
RDIP (EE Education)	-	-	✓	-	-
RARP	✓	-	✓	-	-
RMIP ^b	-	-	-	-	-
RIUP (lighting)	-	-	✓	-	-
RIUP (appliances)	-	-	✓	-	-
LI Energy Efficiency Program (LIEEP)	-	-	-	-	✓
Residential Behavior	-	-	-	✓	-

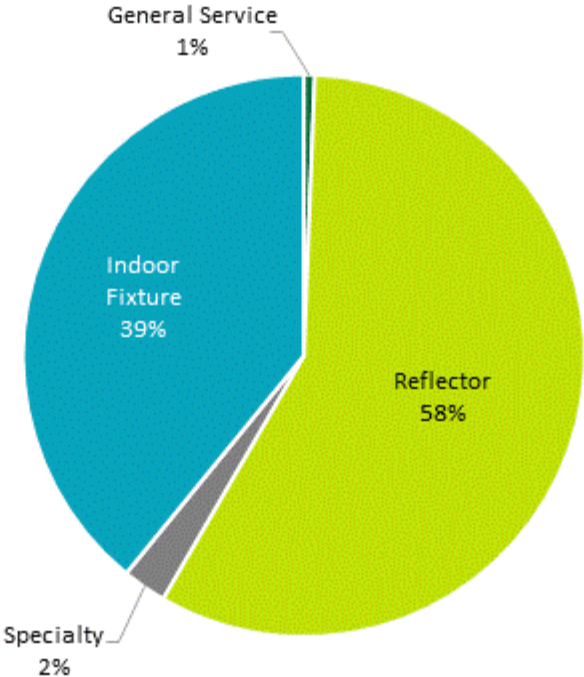
^a The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.

^b The Residential Midstream Incentive program was not evaluated, and no savings were claimed in PY13.

D.5.1.1 Upstream Lighting and Cross-Sector Sales

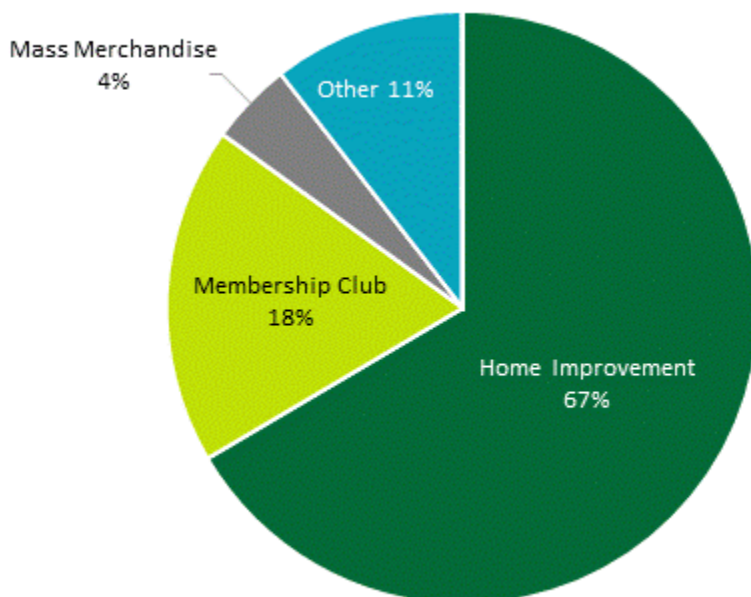
Customers purchased over 105,000 efficient light bulbs and fixtures through Duquesne Light's PY13 upstream lighting program. Figure 56 displays the distribution of sales by product type. Most sales were either reflectors (58%) or indoor fixtures (39%).

Figure 56: Duquesne Light PY13 Upstream Lighting Sales by Product Type



Two-thirds (67%) of Duquesne Light's PY13 upstream light bulbs were sold through home improvement stores. Membership clubs were the next most common retail channels for lighting equipment, accounting nearly one-fifth (18%) of sales (Figure 57).

Figure 57: Duquesne Light PY13 Upstream Lighting Sales by Retail Channel



Audit Findings

Guidehouse provided the PY13 impact analysis for Duquesne Light's upstream lighting before the Duquesne Light PY13 Annual Report was submitted to the PUC. This allowed time for the SWE to conduct its audit, provide Guidehouse with feedback, and for Guidehouse to adjust the analysis based on this feedback. The SWE agrees with Guidehouse's verified gross savings for upstream lighting.

Cross-Sector Sales

Guidehouse did not conduct cross-sector sales research in PY13 but applied the TRM default cross-sector sales rate of 7.4%.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY13 upstream lighting analysis.

D.5.1.2 Residential Non-Lighting

The SWE's review of verified savings for residential non-lighting programs found that, overall, the verified savings followed proper TRM protocols and that the verified savings are accurate. The SWE review includes descriptions of the measures within each program and reviewed evaluation activities. No discrepancies were observed.

Residential Downstream Incentive Program (RDIP)

The SWE audited both components – rebates and energy efficiency education kits – of the RDIP. The rebate component comprised of ENERGY STAR dehumidifiers, ENERGY STAR refrigerators, connected thermostats, and heat pump water heaters. The kit portion of RDIP comprises energy efficiency kits that include weatherization items such as outlet gaskets and weather stripping, DHW pipe wrap, advanced power strips, aerators, and showerheads.

The SWE conducted an early review of these programs and worked with the evaluation team to correct any observed discrepancies in the savings calculations. The SWE found that the sample sizes and participation counts matched what was reported in the Duquesne Light PY13 Annual Report, and that verified savings and realization rates for rebated measures were correct.

Residential Appliance Recycling Program

The Residential Appliance Recycling program covers the recycling of older model refrigerators, freezers, room air conditioners, and dehumidifiers.

Guidehouse again provided the PY13 impact analysis for the Residential Appliance Recycling program early. This afforded the SWE ample time to conduct its audit. Following the approved PY13 Evaluation Plan, Guidehouse conducted a survey with a sample of participants and reviewed the program tracking data to verify measure eligibility and determine realization rates. The SWE verified the savings calculations and realization rate were correct.

Residential Midstream Incentive Program

There was no activity in the Residential Midstream Incentives Program in PY13.

Residential Upstream Incentive Program

The Residential Upstream Incentive Program offers incentives for qualified energy efficient lighting and appliances at the time of sale. The evaluation contractors, Guidehouse, conducted a tracking data review to verify that savings calculations and the inputs were in accordance with the PA TRM for both appliances and LED measures. The SWE confirmed that the verified savings values were in accordance with the TRM and did not observe any discrepancies with calculation and applications of realization rates.

LI Energy Efficiency Program

Duquesne Light offers LI customers no-cost energy audit and a range of directly installed energy saving measures. Per the evaluation plan, the LIEEP program applied PY10 and PY11 RRs at the stratum level for PY13. The SWE confirmed that the reported savings aligned with the 2021 TRM. In addition, the SWE confirmed the application of these RRs were done at the stratum level and that the verified savings were accurate.

D.5.1.3 Behavior

Approximately 13% of Duquesne Light's verified gross energy savings for PY13 came from Home Energy Reports issued to approximately 200,000 residential and residential-LI households. 35% of Duquesne Light's progress toward its low-income target in PY13 came from HERs. Duquesne Light's behavioral portfolio consists of six different waves, or cohorts, of homes.

Table 107 summarizes the average number of active households during PY13 by cohort. Duquesne Light has four market rate cohorts which began receiving HERs in 2012, 2015, and 2021 and two cohorts targeting low-income households which began receiving HERs in 2015 and 2021. The new 2021 cohorts include a trial of digital HER delivery and traditional non-digital delivery.

Table 107: Duquesne Light HER Cohort Summary

Wave	First HER Mailing	Treatment Group Homes	Control Group Homes
2012 Market Rate	Jul 2012	12,424	32,622
2015 Market Rate	Mar 2015	33,200	12,086
2015 Low Income	Mar 2015	8,230	4,111
2021 Low Income	Oct 2021	12,368	9,224
2021 Digital	Oct 2021	72,237	19,250
2021 Non-Digital	Oct 2021	67,985	19,439

The program ICSP Oracle implemented each of the six waves as a randomized control trial (RCT) where the eligible households were identified and then randomly assigned to either a treatment or control group. Following randomization, Guidehouse conducted statistical tests on the pre-treatment energy usage patterns to confirm equivalence between the treatment and control groups.

RCT Validation

The SWE team also conducted an audit of randomization soundness and pre-treatment equivalence for the three new cohorts introduced in PY13. The SWE team ran a simple fixed effects regression on month and the treatment indicator variable using pre-treatment data and found the coefficient on the treatment term to be statistically insignificant for all three cohorts. The SWE team also ran a t-test of pre-period usage by treatment status for each cohort and found all differences in usage to be statistically insignificant. The SWE team conducted all pre-equivalence checks on both the raw billing data and prepared data from Guidehouse. Figure 58, Figure 59, and Figure 60 compare the monthly distribution of daily kWh usage for the treatment and control groups of each of the new PY13 cohorts. These visuals reinforce the finding that pre-treatment usage patterns are extremely similar between the treatment and control groups of each new cohort.

Figure 58: Pre-Treatment Equivalence (2021 Low Income)

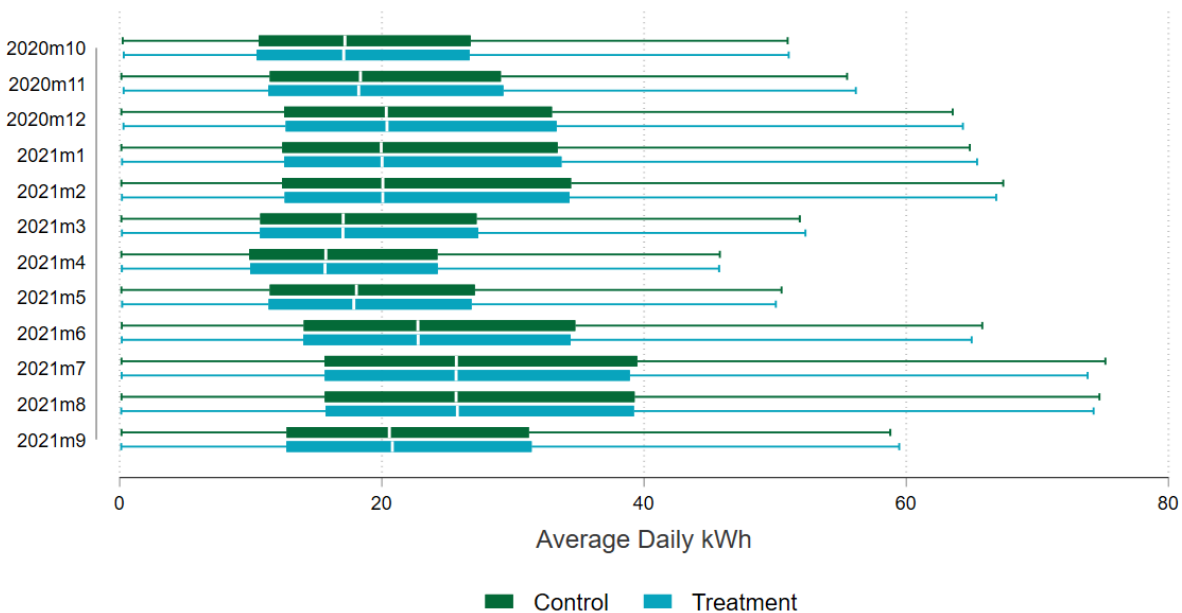


Figure 59: Pre-Treatment Equivalence (2021 Digital)

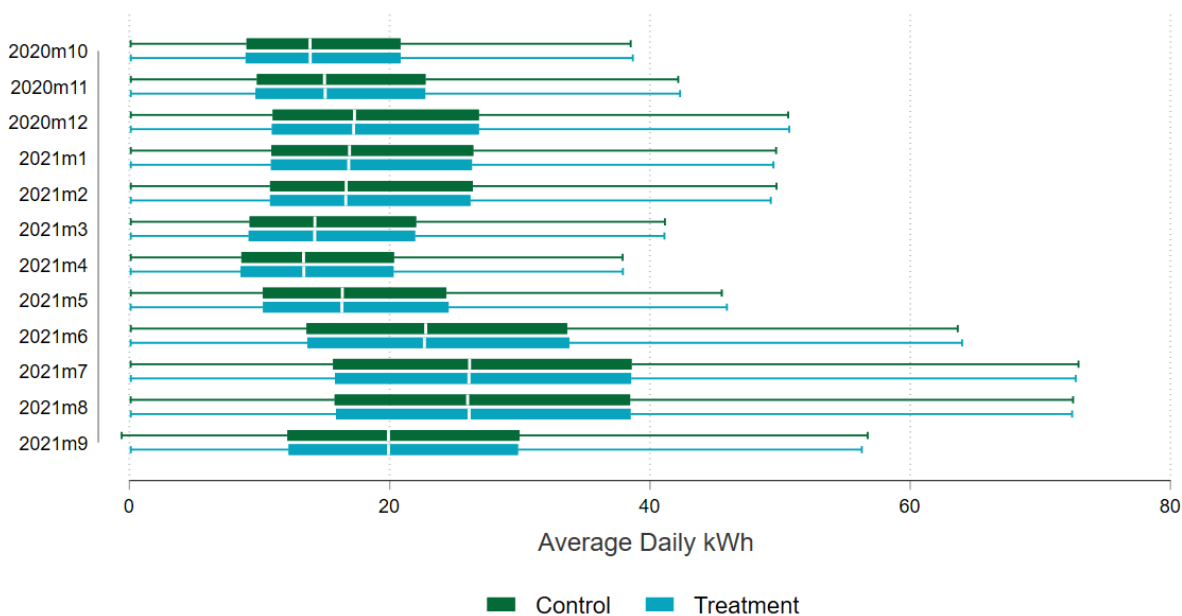
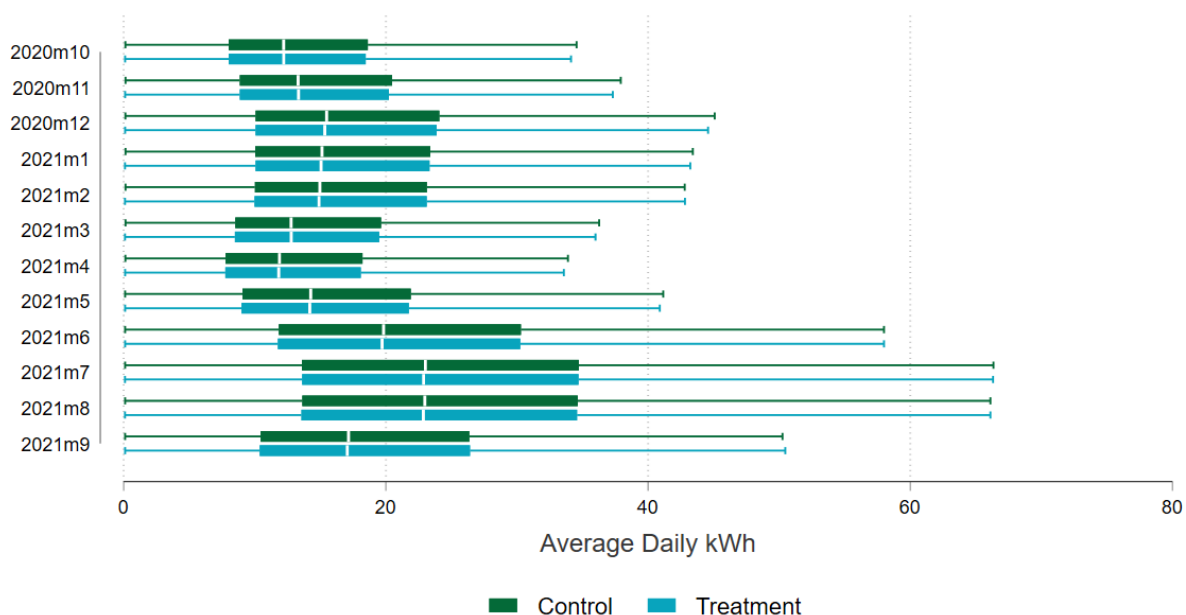


Figure 60: Pre-Treatment Equivalence (2021 Non-Digital)



Data Preparation

The SWE team received both raw billing data and calendarized billing data in response to its annual data request. To ensure the validity of the data preparation methods used by Guidehouse, the SWE team conducted their own preparation of the raw data. Guidehouse used a lagged dependent variable (LDV) regression model for the PY13 impact analysis as called for in the Duquesne Light PY13 EM&V plan, and the model matches the specification in the EM&V plan exactly. The SWE team first used Guidehouse's prepared data and regression specification and replicated exactly the regression coefficients reported by Guidehouse in their PY13 HER results. Then the SWE replicated the PY13 monthly gross savings for each cohort using data prepared by the SWE, and any differences were negligible.

Participant Counts

Guidehouse obtains active customer counts by first taking the original customer data and removing accounts that are flagged as inactive prior to the start of the program year. If an account has multiple inactive dates, then the most recent date is considered. If one of the inactive dates is marked as 'NA' then that customer is considered active. The SWE team validated Guidehouse's enrollment counts by performing a similar counting method on the raw, non-calendarized billing data. Customers are considered active through the end of the month that they received their last bill. For example, if a customer received their last bill in the middle of August 2021, they would be counted in June, July, and August 2021, but not in September or any month following. The SWE team's final customer counts matched Guidehouse's counts within 0.1 percent for each month and each cohort.

Impacts

The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match Guidehouse's estimates. [Table 108](#) shows the aggregate PY13 pre-adjustment gross MWh savings by wave. Gross savings were largest for the 2015 Market Rate Wave. However, after netting out dual participation savings and persistent savings from prior program years, the 2021 Digital Wave showed the largest incremental savings (in part due to all savings being counted as first-year savings).

Table 108: PY13 HER Energy Savings

Wave	Gross Savings (MWh/yr)	Downstream Dual Participation (MWh/yr)	Upstream Dual Participation (MWh/yr)	Persistence (MWh/yr)	Incremental Savings (MWh/yr)
2012 Market Rate	2,946	523	73	1,419	931
2015 Market Rate	4,505	1,541	89	1,924	951
2015 Low Income	1,726	270	44	924	489
2021 Low Income	712	0	5	0	707
2021 Digital	2,887	11	22	0	2,855
2021 Non-Digital	499	5	4	0	490
Total	13,275	2,350	237	4,267	6,422

Dual Participation

In [Table 108](#), gross savings before adjusting for dual participation were 13,275 MWh. It is important to note that Home Energy Reports advertise other Duquesne Light residential EE&C programs and measures such as ENERGY STAR appliances, efficient lighting, HVAC etc. To the extent that treatment group households participate in these programs more frequently than control group homes, the incremental savings is captured in the regression estimates for the HER analysis. To avoid double-counting, the HER savings are reduced to account for the incremental program participation observed in the treatment group compared to the control group.

Persistence

PY13 saw the introduction of a new framework for separating persisting savings from previous program years from incremental savings attributable to the treatment in the current program year. The 2021 TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific

research⁷⁷ on the persistent effects of behavioral energy efficiency treatment in the years after discontinuing treatment. Since Act 129 compliance goals are based on first-year incremental savings, these persistent impacts are subtracted from the measured savings to estimate incremental first-year savings (those directly due to the current program year of treatment).

For the first two years of HER exposure, persistence is assumed to be zero and the first-year savings average treatment effect (FYSATE) simply equals the average treatment effect (ATE). For years three and beyond of HER exposure, the FYSATE is calculated with the following formula from the 2021 TRM. For year *i* of HER exposure:

$$FYSATE_y = ATE_y - \sum_{x=1}^{x=i-2} FYSATE_{y-x} - FYSATE_{y-x} * Decay * (X - 0.5)$$

$$\Delta kWh_y = FYSATE_y * Treatment\ Accounts_y * Days_y$$

Where FYSATE_y is the average daily savings attributable to HERs delivered in the current year (Y) and FYSATE_{y-x} is the average daily savings attributable to HERs delivered in an earlier year Y-X.

The SWE team found that Guidehouse correctly modeled persistence in accordance with TRM specifications. Guidehouse provided the SWE team with detailed manual calculations of persistence for the three legacy Duquesne Light cohorts, which the SWE team verified matched TRM accounting rules. Impacts from previous program years used in persistence calculations were also confirmed to match previous annual reports. Table 109 displays persistence and first-year savings and their respective percentage of PY13 total dual-participation-adjusted savings. First-year savings make up a significant portion of PY13 total savings because there are no persistent savings from prior years for the three cohorts that launched in 2021.

Table 109: PY13 HER Persistence and First-Year Savings

Component	Savings (MWh/yr)	Percent of PY13 Total
Persistence from Prior Years	4,267	40%
PY13 First-Year Savings	6,422	60%
Total	10,689	100%

Low-Income

Beginning in PY13, Duquesne Light declared each cohort to be exclusively low-income or market rate. This simplifies the accounting of savings toward the Phase IV low-income target. Table 110 gives the breakdown of total HER first-year savings by sector.

⁷⁷ Addendum to Act 129 Home Energy Report Persistence Study. November 2018. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

Table 110: PY13 HER First-Year Savings by Sector

Sector	PY13 MWh
Market Rate	5,227
Low-Income	1,196
Total	6,422

Peak Demand Impacts

In the Duquesne Light Phase IV EM&V Plan, Guidehouse chose to estimate peak demand savings from HERs via a peak demand multiplier. This method of evaluating demand impacts is a departure from previous years, where the MWh savings were simply allocated evenly across each hour of the year. The selected approach corresponds to option #3 in section 6.1.6 of the Phase IV Evaluation Framework. Guidehouse calculated the Phase IV peak demand multiplier from five years of reference residential 8760 load shapes supplied by the ICSP. The peak demand multiplier was calculated as follows:

- AMI data for residential customers in Duquesne Light service territory was used to create an average 8760 load shape for the years from 2017 through 2021.
- The ratio of average annual load for all hours and days of the year over average summer peak load (per the TRM-defined peak period) was calculated for each of the years from 2017 through 2021.
- The 5-year average ratio was then used as the peak demand multiplier for determining Phase IV HER peak demand impacts.

The Phase IV Duquesne Light peak demand multiplier is 1.63.

Incremental peak demand savings only apply to the three cohorts that were active during June-August 2021 and are calculated as follows for HER in PY13:

$$\text{Incremental Peak Demand Savings} = \frac{2,370 \text{ MWh}}{8,760 \text{ hours}} * 1.63 = 0.44 \text{ MW}$$

Since Phase IV peak demand reduction goals were established at the system-level, the peak demand savings also need to be scaled up for line losses. Duquesne Light's residential line loss factor for Phase IV is 1.0741.

Conclusion

The transition from Phase III to Phase IV of Act 129 saw several key updates to the EM&V procedures for behavioral Home Energy Reports. These included a new persistence perspective and accounting paradigm and increased methodological rigor for peak demand impacts. The SWE team found that Guidehouse handled these changes well and their evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.

D.5.2 Non-Residential Audit Activities

The SWE conducted various review and audit activities for Duquesne Light's programs. These activities included a review of the evaluation efforts and an audit of the savings verification completed by Duquesne Light's evaluation contractor, Guidehouse. The remainder of this section presents the SWE's findings from these activities.

Guidehouse used various approaches to verify the gross impact estimates for each non-residential program. This section discusses the results of the SWE's review of Guidehouse's approach in applying various levels of rigor to assessing and estimating project impacts from their evaluation sample. The SWE completed this review based on evaluation sample population extracts provided by Guidehouse, which detailed how each sampled project was evaluated regarding evaluation activity and the level of rigor applied.

Table 111 outlines the evaluation activities by project count for each of Duquesne Light's non-residential programs, along with the evaluation realization rates.

Table 111: Duquesne Light Evaluation Activities by Project Count

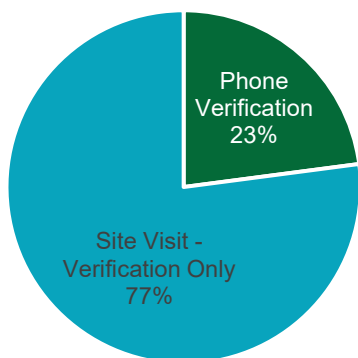
Program / Strata	Sample Quantity (PY12/PY13)	RR-Energy	RR-Demand	Desk Review	Phone Interview	On-Site Verification
Large Business Solutions	8			0	2	6
Commercial - Large	2	113%	96%	0	0	2
Commercial - Medium	3	106%	109%	0	1	2
Commercial - Small	1	144%	216%	0	1	0
Industrial - Large	1	99%	75%	0	0	1
Industrial - Medium	1	79%	106%	0	0	1
Small Business Solutions	2			0	1	1
Small Business Solutions - Medium	1	106%	109%	0	0	1
Small Business Solutions - Small	1	144%	216%	0	1	0
Midstream Business Solutions	38			0	8	30
Large Business Midstream Solutions - Large	5	154%	98%	0	0	5
Large Business Midstream Solutions - Medium	6	128%	100%	0	2	4
Large Business Midstream Solutions - Small	14	158%	124%	0	3	11
Small Business Midstream Solutions - Large	3	40%	24%	0	0	3
Small Business Midstream Solutions - Medium	6	63%	86%	0	0	6
Small Business Midstream Solutions - Small	4	91%	115%	0	3	1
Small Commercial Direct Install	-	103%	109%	-	-	-
Total	48			0	11	37

Figure 61 provides a summary of the evaluation activities and M&V approaches utilized by Duquesne Light’s evaluation contractor in their PY13 verified savings calculations. Guidehouse conducted site verification for approximately 77% of the PY13 evaluation sample, and this is most pronounced from the perspective of verified savings. However, most of these site visits encompassed verification only.

The SWE’s review of verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and that the verified savings are generally accurate. The following subsections outline the evaluation activities for each of Duquesne Light’s non-residential programs in PY13.

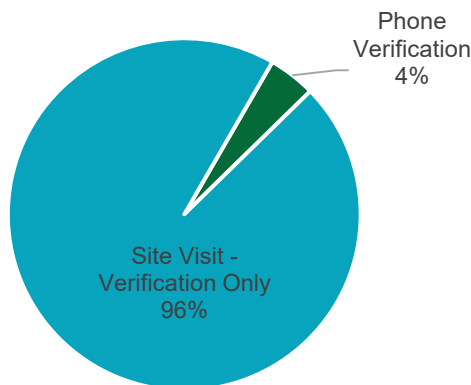
Figure 61: Summary of Duquesne Light’s C&I Evaluation Activities

Evaluation Activity by Project Count



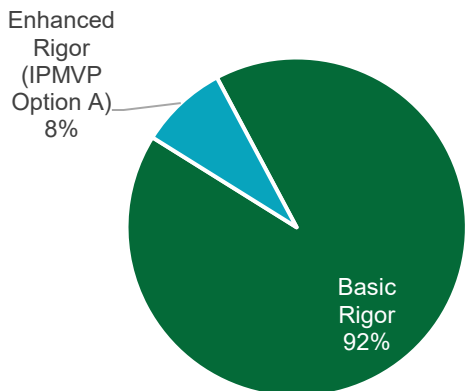
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Evaluation Activity by kWh Contribution



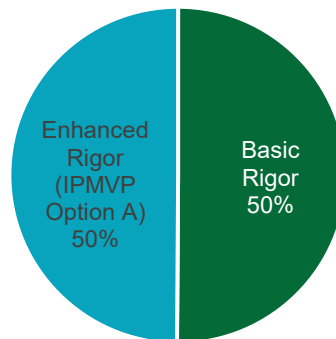
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Level of Rigor by Project Count



■ Basic Rigor ■ Enhanced Rigor (IPMVP Option A)

Level of Rigor by kWh Contribution



■ Basic Rigor ■ Enhanced Rigor (IPMVP Option A)

D.5.2.1 Small and Large Business Solutions

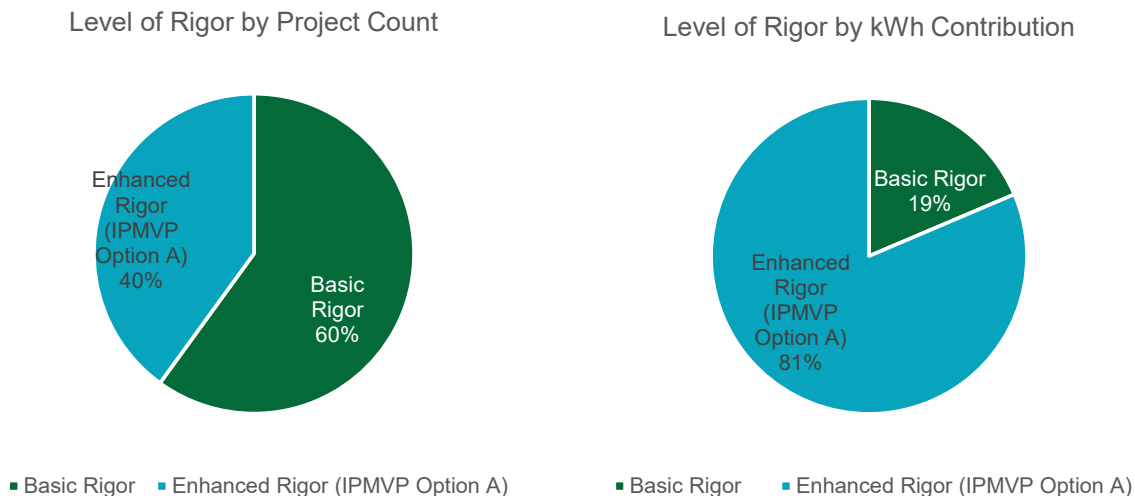
These programs offer rebates to offset the higher cost of high efficiency equipment compared to standard efficiency equipment. Program incentives promote customer indifference to the higher cost of high efficiency equipment and increase customer adoption of high efficiency equipment. The programs' primary objective is to provide C&I customers an expedited, quantifiable, and simple-to-understand incentive offering that helps them save energy and money. This program is filed as two programs in Duquesne Light's Phase IV—one as a small C&I program and one as a large C&I program. The two programs are marketed together as one program from the customers' perspective.

Although they share a common structure, the Large Business Solutions program targets C&I customers having annual demand savings greater than or equal to 300 kW, whereas the Small Business Solutions program targets C&I customers having annual demand less than 300 kW. The Small and Large Building Solutions programs will employ targeted customer engagement channels to assist customers to overcome unique, segment specific barriers to energy efficiency program participation. Both programs offer two core participation tracks: prescriptive and custom. The prescriptive track offers a simplified method on pre-defined measures without requiring complex analysis and will generally include deemed and partially deemed measures from the TRM. The custom track makes it possible to include more complex, site-specific measures and projects in the programs. Custom projects must be able to show specific and verifiable energy savings and costs using TRM protocols.

These programs are projected to account for approximately 47% of the utility's Phase IV savings. The realization rate for all three of its predecessor programs (Commercial Energy Program, Industrial Energy Program, and Express Efficiency) have been consistently close to 100% during Phase III. Similar to other nonresidential programs, the Small and Large Business Solutions programs were evaluated on a specified schedule.

Figure 62 provides a summary of the M&V approaches utilized by Duquesne Light's evaluation contractor in their PY13 verified savings calculations. Guidehouse employed Enhanced Rigor – IPMVP Option A for approximately 81% of the PY13 verified savings in this solution.

Figure 62: Summary of Duquesne Light’s PY13 Small and Large Downstream Business Solutions Evaluation Activities



D.5.2.2 Small and Large Business Midstream Solutions

The Non-Residential Midstream Lighting program delivers utility incentives to end-use customers via C&I product distributors or manufacturers. End-use customers, property/facility managers, and installation contractors acting on behalf of C&I end-use customers may purchase qualified products from a participating distributor. This program is filed as two programs in Duquesne Light’s Phase IV—one as a small C&I program and one as a large C&I program. However, to the customer and distributor there is only one program.

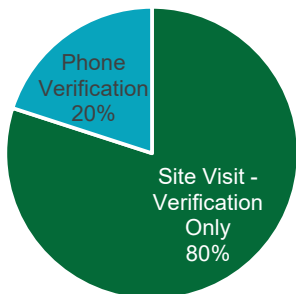
At the start of Phase IV, this program was expected to include only lighting measures, similar to the Midstream Lighting program in Phase III. In the phase’s later program years, other measures (HVAC, refrigeration, and food service equipment) may be added to the program.

These measures will require additional evaluation to determine savings impacts as they are added to the program, and the evaluation plan will be adjusted to reflect these changes.

Figure 63 provides a summary of evaluation activities performed by Guidehouse in PY13 for evaluating midstream projects. Site visits for 80% of large midstream projects, and 76% of small midstream projects were performed. In both programs, site visits were conducted accounting for approximately 98% of verified savings. Most of these site visits encompassed verification only.

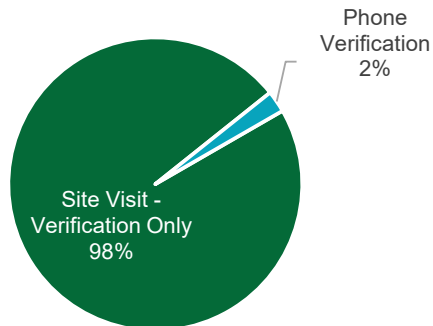
Figure 63: Summary of Duquesne Light’s PY13 Midstream Lighting Program Evaluation Activities

Evaluation Activity by Project Count for Large Business Midstream Solutions



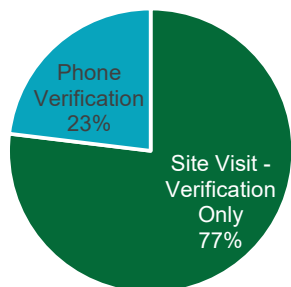
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Evaluation Activity by kWh Contribution for Large Business Midstream Solutions



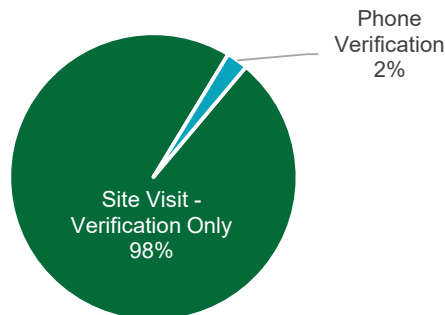
■ Site Visit - Verification Only ■ Phone Verification

Evaluation Activity by Project Count for Small Business Midstream Solutions



■ Site Visit - Verification Only ■ Phone Verification

Evaluation Activity by kWh Contribution for Small Business Midstream Solutions



■ Site Visit - Verification Only ■ Phone Verification

D.5.2.3 Small Business Direct Install

Realization rates from Phase III were applied to the SBDI program for PY13. Several aspects of the SBDI program in PY13 were unique and will not continue in later program years. For example, six projects were self-install school projects formerly classed as the PAPP program. Since this initiative will not continue, Guidehouse applied the results of the PY12 evaluation to this stratum. Going forward, Guidehouse will evaluate SBDI projects from PY13 and PY14 as a single evaluation effort to ensure representativeness of the sample.

D.5.2.4 Virtual Commissioning

The Virtual Commissioning program was not active in PY13.

D.5.2.5 Verified Savings Audits

The SWE audited the activities above through a detailed audit of Guidehouse's evaluation work for a sample of their evaluated projects. The SWE audit for Guidehouse's evaluation for Duquesne Lighting in PY13 included review of eight (8) projects, encompassing the following activities:

- 3 Field and Analysis Engineers were observed
- 2 Measure Types were observed
- 2 In-Person ride-alongs were conducted
- 14% of Verified Energy Savings reviewed
- 9% of Verified Demand Savings reviewed

Table 112 provides an overview of the SWE milestones for the verified savings audit review of evaluated Duquesne Light projects.

Table 112: Duquesne Light Verified Savings Audit Review Milestones

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
8	5,357,562	99%	706	99%

Overall, the SWE found that Duquesne Light's evaluation contractor demonstrated general adherence to the TRM for prescriptive measures. The overall energy and demand savings attainment percentages of Duquesne Light's reviewed projects were 99% for both energy and demand savings. For two projects, the SWE proposed minor modifications to lighting analyses which were accepted by the evaluator.

D.6 NTG

Table 113 lists Duquesne Light's PY13 NTG as listed in the Duquesne Light PY13 Annual Report. Details concerning the methods and data used to estimate NTG values are in sections D.6.1 and D.6.2.

Table 113: Summary of Duquesne Light's PY13 NTG Results

Program Name	Component	NTG
Residential	Downstream Incentives	0.68 ¹
Residential	Midstream Incentives	N/A
Residential	Upstream Incentives	0.65
Residential	Appliance Recycling	0.47
Residential	HER Total	1.0
Low-Income	Low-Income	1.0
Non-Residential	Small Business Direct-Install	0.99
Non-Residential	Small Business Solutions	0.79
Non-Residential	Small Business Midstream Solutions	0.72 ¹
Non-Residential	Small Business Virtual Commissioning	N/A
Non-Residential	Commercial – Large Business Solutions	0.79
Non-Residential	Industrial – Large Business Solutions	0.61
Non-Residential	Commercial - Large Business Midstream Solutions	0.72 ¹
Non-Residential	Industrial – Large Business Midstream Solutions	0.72 ¹
Non-Residential	Large Business Virtual Commissioning	N/A
Portfolio Total		0.79

¹ The Duquesne Light PY13 Annual Report reviewed by the SWE for the SWE Final Annual Report included several NTG values reported in the impact evaluation summary table (Table 2-4) that were not consistent with values reported in program specific sections of the report. Duquesne Light's evaluator, Guidehouse, was able to confirm the correct NTG values for the SWE.

D.6.1 Residential Programs

Guidehouse planned for and enacted NTG research for the Downstream Incentives program (Table 114). The SWE reviewed the survey, data, and worksheet that informed the NTG estimation and found that all methods were consistent with the recommended NTG methodology outlined in the Phase IV Evaluation Framework. The HERs program NTG was assigned a value of 1.0, in accordance with the Phase IV Evaluation Framework, as the random control trial (RCT) design of the program eliminates the need for NTG analysis because the control group does everything the treatment group would have done and the estimated savings are technically net savings. The Upstream Incentives and Appliance Recycling NTG values are from previous evaluations.

Table 114: Summary of Duquesne Light's PY13 Residential NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Downstream Incentives - Rebates	Self-report surveys	59	37%	19%	0.82
Midstream Incentives	N/A	N/A	N/A	N/A	N/A
Upstream Incentives	N/A	N/A	N/A	N/A	0.65
Appliance Recycling	N/A	N/A	N/A	N/A	0.47
HER Total	RCT	N/A	0%	0%	1.0
Portfolio Total					0.64

D.6.2 C&I Energy Efficiency Programs

Guidehouse planned and enacted NTG research and estimation for the Small Business Midstream Solutions, Commercial Large Business Midstream Solutions, and Industrial Large Business Midstream Solutions programs (Table 115). NTG data was collected through participating distributor interviews with 13 of 31 Business Midstream Solutions participants using a question battery and NTG estimation formula that is consistent with the methods recommended in the Phase IV Evaluation Framework. Guidehouse attempted to collect data for a NTG evaluation of the Small Business Direct Install program but was unable to garner enough participation to estimate a NTG that satisfied statistical rigor and will continue to collect data to estimate NTG in PY14. Small Business Solutions, Commercial Large Business Solutions, and Industrial Large Business Solutions program NTG values are from previous years evaluations.

Table 115: Summary of Duquesne Light's PY13 C&I NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Small Business Direct-Install	N/A	N/A	N/A	N/A	0.99
Small Business Solutions	N/A	N/A	N/A	N/A	0.79
Small Business Midstream Solutions	Participating distributor interviews	13	28%	0%	0.72
Small Business Virtual Commissioning	N/A	N/A	N/A	N/A	N/A
Commercial – Large Business Solutions	N/A	N/A	N/A	N/A	0.79
Industrial – Large Business Solutions	N/A	N/A	N/A	N/A	0.61
Commercial - Large Business Midstream Solutions	Participating distributor interviews	13	28%	0%	0.72
Industrial – Large Business Midstream Solutions	Participating distributor interviews	13	28%	0%	0.72
Large Business Virtual Commissioning	N/A	N/A	N/A	N/A	N/A
Portfolio Total					0.76

D.7 TRC

Table 116 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Duquesne Light's PY13 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the Duquesne Light PY13 Annual Report and the model itself was well-organized and documented. There was no participation in the Small or Large Business Virtual Commissioning (VCx) programs in PY13, and therefore these programs were not evaluated. Pursuant to the 2021 TRC Test Order directive for Phase IV, the nominal discount rate is now 5% and no longer tied to WACC. All else being equal, a lower discount rate improves the TRC ratio.

Table 116: Summary of Duquesne Light's PY13 TRC Results

Program	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Appliance Recycling	\$85	\$803	0.11	\$40	\$801	0.05
Res Downstream Incentives	\$589	\$1,025	0.57	\$401	\$1,001	0.40
Res Midstream Incentives	\$0	\$74	0.00	\$0	\$74	0.00
Res Upstream Lighting	\$916	\$1,033	0.89	\$598	\$816	0.73
Res Behavioral EE	\$294	\$576	0.51	\$294	\$576	0.51
Low Income Energy Efficiency	\$562	\$1,243	0.45	\$562	\$1,243	0.45
Low Income Behavioral EE	\$71	\$127	0.56	\$71	\$127	0.56
Small Business Direct Install	\$856	\$701	1.22	\$850	\$698	1.22
Small Business Downstream	\$6,335	\$1,583	4.00	\$4,989	\$1,378	3.62
Small Business Midstream	\$4,648	\$2,672	1.74	\$3,346	\$2,196	1.52
Small Business VCx	\$0	\$65	0.00	\$0	\$65	0.00
Large Commercial Downstream	\$6,853	\$2,504	2.74	\$5,397	\$2,228	2.42
Large Commercial Midstream	\$2,789	\$1,134	2.46	\$2,008	\$938	2.14
Large Commercial VCx	\$0	\$45	0.00	\$0	\$45	0.00
Large Industrial Downstream	\$1,121	\$633	1.77	\$681	\$580	1.17
Large Industrial Midstream	\$2,364	\$652	3.62	\$1,702	\$553	3.08
Large Industrial VCx	\$0	\$32	0.00	\$0	\$32	0.00
Portfolio Total¹	\$27,484	\$14,901	1.84	\$20,942	\$13,350	1.57

¹Rows may not sum to totals due to rounding

Seven of Duquesne Light's 17 EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. The same seven programs were found to be cost-effective using net verified savings. The non-residential sectors accounted for 90% of the total TRC Gross

Benefits in PY13. None of the Residential programs were found to be cost-effective using gross verified savings, due in large part to high program delivery costs. The Non-Residential program with the highest Gross TRC ratio was the Small Business Downstream program component at 4.00. The Large Commercial Downstream program had the largest amount of Gross TRC benefits of any Duquesne Light program in PY13.

D.7.1 Notes from the TRC Model Review

The PY13 TRC model organized program costs, measure impacts, and avoided costs in a comprehensive calculation workbook. Below is a summary of the assumptions and inputs verified by the SWE.

- The PY13 TRC model used a nominal discount rate of 5.0%, which matches Duquesne Light's Phase IV EE&C plan. In the 2021 TRC Test Order, the Commission directed all EDCs to use a common discount rate rather than their own weighted average cost of capital.
- Realization rates for energy and demand impacts were applied to the program impacts in the TRC model, which were based on reported gross savings values, to calculate verified gross savings.
- Duquesne Light relies on the SWE Incremental Cost Database for assumptions regarding commercial lighting equipment costs. In the PY13 TRC model, the SWE found Duquesne Light assumes a replace-on-burnout perspective (efficient equipment cost minus baseline equipment cost) when assigning incremental measure cost to most commercial lighting measures. The Duquesne Light cost perspective is inconsistent with the perspective used to estimate energy and demand savings for most measures and leads to an upward bias in the TRC results. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
- The calculation of NTG using free-ridership and spillover, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the 2021 TRC Test Order directive for Phase IV. The TRC model followed the protocol pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.
- The correct line-loss multiplier of 1.0741 was used for all Residential and Small C&I measures. A line-loss multiplier of 1.0081 was applied to savings from participants that take high-voltage service (69 kV). Duquesne Light only has 12 accounts on its High Voltage Primary Service tariff and in PY13 these accounts only completed two tiny projects.
- The Duquesne Light TRC model is well-equipped to handle the distinction between primary service and secondary service with respect to line losses and stores two separate arrays of meter-level avoided energy costs. For PY14, the SWE recommends Duquesne Light update the "high voltage" avoided costs to omit the avoided cost of distribution capacity per the Commission's guidance in Section B.7 of the 2021 TRC Test Order. This setup issue had virtually no impact on the PY13 results because these sites served at primary voltage accounted for only 0.01% of peak demand savings. However, the 12 large

industrial accounts served at primary voltage have historically completed some of the largest projects at Duquesne Light so this issue could apply to a far larger share of verified MW savings in future program years.

- The SWE found that the cost categories were handled correctly in the TRC model. Participant incentives were not considered TRC costs, while administrative costs, incremental costs, and kits were incorporated as costs.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Fossil Fuel Impacts and Total NPV Lifetime Water Impacts. The SWE verified that the savings were accounted for in accordance with 2021 TRC Test Order. The TRC model includes no fuel switching measures offered in PY13, which correctly reflects Duquesne Light's program offerings to date in Phase IV. The TRC model claimed over 11 million gallons per year of water saving, which translates to approximately \$113,000 in NPV lifetime avoided costs.
- The SWE verified the ex-ante demand and capacity savings were accurate in the TRC model when compared to the Quarterly Tracking Data reported by Duquesne Light.

D.8 PROCESS

D.8.1 Residential Programs

Duquesne Light operates seven residential energy efficiency programs: the Residential Downstream Incentive Program (RDIP), the Residential Midstream Incentive Program (RMIP), the Residential Upstream Incentive Program (RUIP), the Residential Appliance Recycling Program, the Residential Behavioral Program, the Residential Low-Income Energy Efficiency Program, and the Residential Low Income Behavioral Program.

For PY13, Guidehouse conducted process evaluation activities for one Duquesne Light residential program, the RDIP.

For the PY13 process evaluation of the RDIP, Guidehouse interviewed the Duquesne Light program manager and the CSP, and reviewed program materials that were provided by Duquesne Light. Guidehouse also conducted on-line surveys with program participants of the rebate and energy efficiency education components.

For the RDIP, the SWE provides a summary of the process evaluation findings and the SWE's audit of those findings.

D.8.1.1 Residential Downstream Incentives Program (RDIP)

Summary of Process Evaluation Findings

The Duquesne Light RDIP includes incentives for energy efficiency products, such as ENERGY STAR appliances; high efficiency heating, cooling, and water heating equipment; and other products. There are three components of the program: customers who received rebates for purchasing and installing energy efficient equipment (Rebate), customers who received a comprehensive energy efficiency audit (Audit), and students and teachers who participate in a K-12 Energy Efficiency Education program (Education).

Guidehouse's PY13 process evaluation activities for RDIP addressed two components of the program: the rebates and education.⁷⁸ The process evaluation for the RDIP in PY13 included online participant surveys for the two components and interviews with program managers and the CSP.

Key findings for the rebates program component centered on awareness and satisfaction. Regarding awareness, the findings included the following:

- The most common source of program awareness is the Duquesne Light website, where 64% of the respondents learned about the Program.
- A majority of survey respondents (84%) reported that they would look for additional energy efficiency information directly on Duquesne Light's website.
- Among the respondents who learned about the program through the website, 66% were very or extremely influenced in their decision to participate by the website.
- Only 5% of participants learned about the program through energy equipment vendors, retail store staff or sales representatives, 2% through Home Energy Reports (HERs) and none through installation contractors. These sources were more important in past evaluations.
- Email advertisements are starting to play a role in increasing customer awareness in PY13, with 7% of participants reporting they learned about the program through email advertisements from Duquesne Light.
- Among participants who learned about the program through the email advertisements, 75% were very or extremely influenced in their decision to participate.
- When asked how Duquesne Light could get more customers to participate in the rebate program, 31% of respondents suggested to increase advertising.

Regarding satisfaction, the findings included the following:

- Among survey respondents, 68% reported high satisfaction with the rebate program and 78% reported high satisfaction with the level of service provided by Duquesne Light (ratings of 7 or higher on a 0 to 10 scale).
- A slight majority of survey respondents (56%) reported high satisfaction with the amount of time it took to receive the rebate.
- A slight majority of respondents (51%) reported being satisfied with the eligible products included in the program.

The most frequent suggestion for improving the program was to offer more products, mentioned by 69% of respondents.

Key findings for the education program component also centered on program awareness and satisfaction. Regarding awareness, the findings included the following:

⁷⁸ The audit component did not see participation in PY13

- The most common sources of program awareness were participants' coworkers (48%), email outreach from a National Energy Foundation (NEF) representative (36%), and presentations performed at the participant's school (23%).
- NEF played a significant role in raising awareness among teachers and other professionals in schools about this program, where 45% of respondents stated that NEF reached out to them directly via email, phone, or in-person.

Regarding satisfaction, the findings included the following:

- Participants reported very high satisfaction with the Energy Efficiency Education Program (95% of respondents rated the program 7 or higher).
- All survey respondents reported that the program was either very effective or somewhat effective at educating students on energy efficiency, with 82% reporting the program was very effective.

The overall satisfaction rate for the RDIP, weighted by the number of survey participants, is 78%.

Summary of Process Evaluation Audit

The process evaluation of RDIP appears to have been generally consistent with the Phase IV evaluation plan. The PY13 residential sampling plan targeted 82 participant surveys (38 for the rebate program, 44 for the education program). The target was met for the education program and exceeded for the rebate program with 59 survey respondents in total for that component.

Nine recommendations follow the process evaluation: eight for the rebate program and one for the education program. Three of the rebate program recommendations were accepted and five are under consideration. The education program recommendation was accepted.

D.8.1.2 Residential Midstream Incentives Program

Guidehouse did not conduct process evaluation research for the Residential Midstream Incentives Program in PY13 and plans to complete it in PY14.

D.8.1.3 Residential Upstream Incentives Program

Guidehouse did not conduct process evaluation research for the Residential Upstream Incentives Program in PY13 and plans to complete it in PY14.

D.8.1.4 Residential Appliance Recycling Program

Guidehouse did not conduct process evaluation research for the Residential Appliance Recycling Program in PY13 and plans to complete it in PY15.

D.8.1.5 Residential Behavioral Program

Guidehouse did not conduct process evaluation research for the Residential Behavioral Program in PY13 and plans to complete it in PY15.

D.8.1.6 Residential Low-Income Energy Efficiency Program

Guidehouse did not conduct process evaluation research for the Residential Low-Income Energy Efficiency Program in PY13 and plans to complete it in PY14.

D.8.1.7 Residential Low-Income Behavioral Program

Guidehouse did not conduct process evaluation research for the Residential Low-Income Behavioral Program in PY13 and plans to complete it in PY15.

D.8.2 C&I Programs

Duquesne Light operates seven C&I energy efficiency programs: the Small Business Direct Install (SBDI) Program, the Small Business Solutions Program, the Small Business Midstream Solutions Program, the Small Business Virtual Commissioning Program, the Large Business Solutions Program, the Large Business Midstream Solutions Program, and the Large Business Virtual Commissioning Program.

For PY13, Guidehouse began but did not complete process evaluation activities for one Duquesne Light C&I program, the Small Business Direct Install Program.

D.8.2.1 Small Business Direct Install Program

Guidehouse began a process evaluation of the SBDI Program which was part of the PY13 EM&V Plan. This research focused on program awareness, satisfaction, and barriers to participation. The evaluation team interviewed the program manager and the CSP. The process evaluation also included an online survey of program participants to obtain feedback about their experiences with the program delivery processes and opportunities for program improvement. However, due to significantly lower program participation than expected, Guidehouse was unable to collect enough responses to generate statistically defensible estimates. During sample design stages, the Guidehouse team estimated 60 unique participants for this program with a target of 23 completed surveys. Guidehouse received four completed surveys from the program's participants and therefore plans to extend the online participant surveys into PY14 and will report on process evaluation results and recommendations in PY14.

D.8.2.2 Small Business Solutions Program

Guidehouse did not conduct process evaluation research for the Small Business Solutions Program in PY13 and plans to complete it in PY14.

D.8.2.3 Small Business Midstream Solutions Program

Guidehouse did not conduct process evaluation for the Small Business Midstream Solutions Program in PY13 and plans to complete it in PY15.

D.8.2.4 Small Business Virtual Commissioning Program

Guidehouse did not conduct process evaluation for the Small Business Virtual Commissioning Program in PY13 and plans to complete it in PY15.

D.8.2.5 Large Business Solutions Program

Guidehouse did not conduct process evaluation research for the Large Business Solutions Program in PY13 and plans to complete it in PY14.

D.8.2.6 Large Business Midstream Solutions Program

Guidehouse did not conduct process evaluation for the Large Business Midstream Solutions Program in PY13 and plans to complete it in PY15.

D.8.2.7 Large Business Virtual Commissioning Program

Guidehouse did not conduct process evaluation for the Large Business Virtual Commissioning Program in PY13 and plans to complete it in PY15.

Appendix E FirstEnergy: Metropolitan Edison Company PY13 Audit Detail

E.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, and were generally accurate. The SWE made recommendations to FirstEnergy's evaluation contractor, ADM Associates (ADM), regarding specific aspects of some impact analyses, resulting in less than 5% difference in final savings values. The SWE's feedback was provided to the evaluator with sufficient time for Met-Ed to include all suggested changes in the Met-Ed PY13 Annual Report.
- Met-Ed provided their Residential and Low Income verified savings analyses prior to drafting the Met-Ed PY13 Annual Report. This allowed the SWE to conduct an early review and had ample time and opportunity to discuss any questions, potential discrepancies, and review updated results that could be directly incorporated into the Met-Ed PY13 Annual Report. In addition, the verified savings analyses were well organized, and included the documentation required to conduct verified savings checks from the measure-level all the way to program-level savings.
- Met-Ed initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (3.5% of MWh) compared to Phase III. HERs accounted for approximately 5% of Met-Ed's progress toward its low-income compliance target in PY13. Because the cohorts launched after the summer, Met-Ed claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and ADM was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.
 - The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand

reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.

- Met-Ed's non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.34 but showed a TRC ratio far lower than PPL and Duquesne Light despite similar a similar set of measure offerings. A key driver of the difference is incremental cost assumptions for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Met-Ed's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE only noted a few minor discrepancies.
- The SWE conducted a project file review for a sample of Met-Ed's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.

E.2 EM&V PLAN REVIEWS

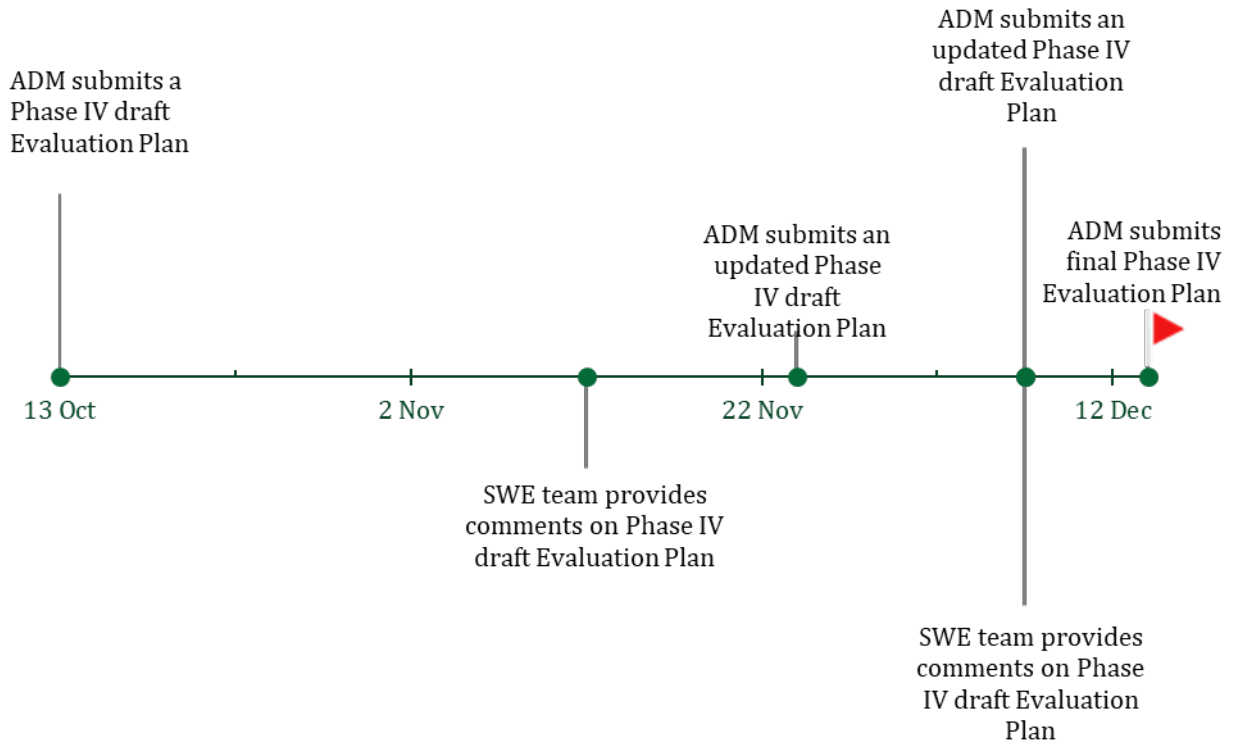
ADM first submitted a draft Phase IV EM&V plan on October 13, 2021. The plan was organized by sector and detailed the gross impact, net impact, and process evaluation activities by program. After several rounds of comments from the SWE and revisions by ADM, the final evaluation plan was approved by the SWE in mid-December 2021. The SWE brought some of the following points to ADM during revision of the plans:

- Impact evaluation activities for PY17. The initial plan called for annual impact evaluations in PY13-PY16 with PY17 relying almost entirely on historic realization rates. The SWE and ADM ultimately agreed on staggering the historic realization rates across PY16 and PY17.
- The baseline wattage for LED lamps in energy efficiency kits.

- The expected types of measures and impact evaluation techniques for the CI Energy Management and New Construction sampling initiative.
- How to disentangle HER impacts from the Online Audit subprogram impact estimates.
- Peak demand savings methodology for behavioral Home Energy Reports.

Figure 64 shows the review timeline of correspondence between ADM and the SWE team to finalize the Phase IV EM&V plan.

Figure 64: Met-Ed Evaluation Plan Review Timeline 2021-2022



As discussed in Section 4.2, each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. Met-Ed’s Phase IV EM&V Plan, however, called for development of verified gross impacts for all program components in PY13. Met-Ed will not use historic realization rates until PY15.

Table 117 shows all Met-Ed program components and indicates that verified impacts were developed for each in PY13.

Table 117: PY13 Met-Ed Impact Evaluation Summary

Sector	Components	PY13 Impacts
Residential	EE Kits	Verified
	Home Energy Reports	Verified
	Midstream	Verified
	New Homes	Verified
	Downstream HVAC	Verified
	LI Direct Install	Verified
	On-Line Audit	Verified
	Downstream Appliances	Verified
	LI - Home Energy Reports	Verified
	Smart Thermostats	Verified
	Audit and DI	Verified
	Online Audit	Verified
	Cross-Cutting	Appliance Recycling
Multifamily		Verified
C&I	Custom	Verified
	Prescriptive	Verified
	Energy Management and New Construction	Verified

In addition to the evaluation plans, the SWE also reviewed and provided comments on draft survey instruments in April 2022 for multiple programs.

E.3 SAMPLE DESIGN REVIEW

The Phase IV Evaluation Framework establishes a maximum level of sampling uncertainty of $\pm 15\%$ at 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. This change was implemented specifically for EDCs like Met-Ed, who define EE&C programs broadly, but have specific offerings that are a more logical grouping for evaluation purposes due to program delivery channel or supported technology.

Met-Ed’s EE&C portfolio consists of five programs: Energy Efficient Homes, Energy Efficient Products, Low Income Energy Efficiency, C&I Energy Solutions for Business – Large, and C&I Energy Solutions for Business – Small. The SWE performed its annual sample design review at the initiative level, which sometimes span multiple programs or sectors. In response to the annual

data request, FirstEnergy's EM&V contractor provided the SWE with a sample disposition for each initiative detailing the project-level ex-ante and ex-post savings for each unit in the samples.

Table 118 shows the relative precision of PY13 energy and demand impacts by component at the 85% confidence level. Note that the Online Audit program, which had zero reported savings for PY13, is omitted.

Table 118: Relative Precision of PY13 Impacts by Program Component at the 85% Confidence Level

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	10.0%	9.9%
	LI - EE Kits	19.5%	19.7%
	Midstream	0.0%	0.0%
	New Homes & Smart Thermostats	14.7%	14.7%
	HVAC	10.4%	9.3%
	LI - Direct Install	7.7%	7.7%
	Downstream Appliances	9.4%	9.7%
	Audit and DI	5.7%	2.6%
Cross-Cutting	Appliance Recycling	5.9%	7.2%
	Multifamily	0.0%	0.0%
C&I	Custom	0.0%	0.0%
	Prescriptive	10.1%	10.1%
	Energy Management and New Construction	10.3%	10.5%

The Residential Midstream, Non-Residential Custom, and Multifamily components have a relative precision of $\pm 0\%$. ADM evaluated all projects undertaken in those programs in PY13, so there is no sampling uncertainty.

ADM established in their Phase IV evaluation plan submitted to the SWE that they would use an assumed coefficient of variation derived from past program years for initial sample design. However, ADM also used these planning coefficients of variation to calculate and report initiative-level relative precision. For the C&I Prescriptive initiative, ADM designed its PY13 sample using a coefficient of variation of 0.4. The Phase IV EM&V plan notes that 0.4 was a deliberately conservative estimate of the expected coefficient of variation, which the SWE team found to be true for PY13. The SWE team replicated the C&I Prescriptive rollup instead using observed coefficients of variation and found the relative precision of savings estimates to be lower than the reported figures of 10.1% for energy and 10.1% for demand. The SWE team recommends that ADM use manual variance calculations in place of planning coefficients of variation in their PY14 report to yield more accurate estimates of relative precision. Although the SWE still recommends leaving a hedge to guarantee that the $\pm 15\%$ relative precision threshold is met, ADM might be able to use fewer sample points than they did in PY13 for certain initiatives with low coefficients of variation.

The Behavioral Modification subprogram provides HERs to residential customers in the Met-Ed service territory. The subprogram is divided between market rate residential customers and LI customers, and each is administered as an RCT. Participants are enrolled in experimental cohorts and a monthly billing analysis regression is used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase IV Evaluation Framework requiring the solution-level verification to achieve an absolute precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 119](#) shows the absolute precision of PY13 Behavioral Modification impacts at the 95% confidence level.

Table 119: Absolute Precision of PY13 Impacts for Behavioral Modification Programs at the 95% Confidence Level

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.27%
Behavioral Modification (LI)	0.36%

E.4 REPORTED GROSS SAVINGS AUDITS

E.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Met-Ed's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)
- Participation counts
- Incentive dollars

The SWE leveraged Met-Ed's Q1-Q4 tracking data to audit these values. Note that the SWE does not receive the full tracking data set, but a subset of the full tracking data set tailored to our PY13 quarterly data request. Also note that HER programs are not audited using the tracking data, thus they are not included in the tables or totals in the following sections. The SWE's findings regarding the HER components of the Energy Efficient Homes and LIEEP can be found in [Appendix E.5.1.2](#).

Table 120 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in Met-Ed’s PY13 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by Met-Ed.

Table 120: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	11,961	11,961	Yes*
Energy Efficient Products	9,299	9,299	Yes
Low Income Energy Efficiency	3,678	3,678	Yes*
C&I Energy Solutions for Business - Small	5,243	5,243	Yes
C&I Energy Solutions for Business - Large	16,579	16,579	Yes
Portfolio Total	46,760	46,760	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 121 summarizes the SWE’s findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. Like with reported gross energy savings, the tracking data supports the Annual Report value exactly for all programs.

Table 121: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	1.95	1.95	Yes*
Energy Efficient Products	1.94	1.94	Yes
Low Income Energy Efficiency	0.49	0.49	Yes*
C&I Energy Solutions for Business - Small	0.96	0.96	Yes
C&I Energy Solutions for Business - Large	2.32	2.32	Yes
Portfolio Total	7.66	7.66	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 122 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for all programs. The portfolio totals, though not exactly equal, line up well: 87,629 in the Met-Ed PY13 Annual Report and 80,734 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with the EDCs and their evaluation contractors to understand the Phase IV business rules around counting participants for different program components.

Table 122: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	55,455	47,682	No*
Energy Efficient Products	20,842	22,977	No
Low Income Energy Efficiency	11,158	9,927	No*
C&I Energy Solutions for Business - Small	157	134	No
C&I Energy Solutions for Business - Large	17	14	No
Portfolio Total	87,629	80,734	No*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 123 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in Met-Ed's PY13 Annual Report. The SWE was able to exactly replicate incentive dollars for the Low-Income Energy Efficiency and C&I Energy Solutions for Business – Large programs. For the other three programs, the SWE calculated directionally similar values using the tracking data. For these five programs, the totals are also directionally similar: \$5,664,000 in the Annual Report and \$5,641,000 in the tracking data.

Table 123: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$2,223	\$2,211	No
Energy Efficient Products	\$1,248	\$1,264	No
Low Income Energy Efficiency	\$989	\$990	Yes
C&I Energy Solutions for Business - Small	\$584	\$556	No
C&I Energy Solutions for Business - Large	\$620	\$620	Yes
Portfolio Total	\$5,664	\$5,641	No

E.4.2 Project File Reviews

E.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of Met-Ed's residential project files for PY13 using the project file documentation provided by Met-Ed, the program implementors, and the evaluation contractor, ADM. This is in response to the SWE's standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. Most of the project file packages that were uploaded included a majority of the documentation requested.

Table 124 presents a summary of SWE's residential project file reviews.

Table 124: Met-Ed PY13 Project File Review Summary

Program	Sub Program	Number of files reviewed ¹	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data? ²
EE Homes Program	Direct Install	7	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	4	✓	✓	✓	✓
EE Homes Program	Multifamily	4	✓	✓	✓	✓
EE Homes Program	New Homes	16	✓	✓	✓	✓
EE Products Programs	Appliances	13	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	8	✓	✓	X	✓
EE Products Programs	HVAC	17	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	12	✓	✓	✓	✓
LIEEP	Appliances	4	✓	✓	✓	✓
LIEEP	Appliance Turn In	10	✓	✓	✓	✓
LIEEP	Direct Install	12	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all FirstEnergy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Energy Efficient Homes Program: Direct Install

Invoices along with customer applications were provided for Met-Ed's direct install component. A review of the sampled files did not reveal any discrepancies. No project files were submitted in Q1 or Q2, however, and participation was limited per the tracking data and Met-Ed PY13 Annual Report. The SWE notes that the information provided within each project matched the tracking database.

Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. Documentations for these programs were only supplied in Q4, however the SWE notes that the majority of activity for the component occurred in the final two months of PY13. The documentation included invoices and specification sheets for each kit by EDC, however the tracking database only provides information at the kit-level. The SWE verified the reported kit-level savings aligned with spec sheet values, and confirmed the date and quantity aligned with the tracking data.

For the school education kits, the documentation included invoices and specification sheets for each kit by the EDC at the individual level. The SWE was able to confirm the total orders for all FirstEnergy EDCs. The SWE was unable to confirm specific instances of kit delivery with the tracking data due to project documentation consisting of batch invoices. However, the SWE was able to verify that the reported savings for an individual kit aligned with the kit contents.

Energy Efficient Homes Program: Multifamily

The SWE did not review any Met-Ed multifamily project files in PY13 due to no participation or claimed savings.

Energy Efficient Homes Program: New Homes

A review of the sampled files did not reveal any discrepancies between the project files and the tracking database. However, the SWE notes that reported savings for Q1 were unverifiable as the project files only contained REM/Rate reports rather than the REM/Rate building energy models, which are used to confirm that the reported savings values match the tracking data.

Energy Efficient Products Program: Appliances

The SWE observed two small discrepancies between the project files and the program tracking data. Both cases pertained to the capacity of the appliance being different and smaller than what appeared in the tracking database. One refrigerator was listed as 28 cubic feet in the invoice yet appeared as 14.8 cubic feet in the tracking database and the second refrigerator appeared as 20 cubic feet in the project files but was listed as 24 cubic feet in the tracking database.

Energy Efficient Products Program: Appliance Recycling

The SWE was initially unable to match the photographs provided with the project documentation to the tracking data for Q1, Q3, and Q4 due to unclear identifying information between the project files and tracking data.⁷⁹ The photos provided for Q2 were directly tied to a project number which was corroborated with the tracking data information. The SWE also notes that the quality of the photographs does not consistently and clearly capture the nameplate information of the recycled equipment but notes that quality of the photographs improved over the course of PY13. ADM included a useful analysis illustrating the improvement in photo quality and inclusion of verifiable nameplate or model number information. The other project documentation allowed the SWE to confirm the count of recycled appliances for each sampled project, however these counts were only provided in an Excel database with an electronic customer signature.

Energy Efficient Products Program: HVAC

The HVAC project files included AHRI certifications, invoices for equipment registration and rebate application forms. The SWE observed various discrepancies between the data provided and the database. The SWE observed in two cases where the AHRI data for a central air conditioner did not match the tracking data provided. For these two cases, the AHRI data listed a lower EER and SEER than what is in the tracking database. In another instance these values were missing from the tracking data all together.

Alongside, the SWE observed the same discrepancy as previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular variable. In the tracking data, capacity was displayed as a singular *ton's* variable.⁸⁰ That being said, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data.

Starting in PY9, ADM worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations. Most project requests did not include an AHRI certificate, which prevented verification of tracking data measures.

Energy Efficient Products Program: Midstream Appliances

The Midstream Appliance project files included invoices which listed out quantities, appliances, and the total cost. Many of the invoices in the data request were designated an EDC but spanned all four EDCs in the tracking data. In addition, these files spanned multiple quarters, so a full reconciliation of quantities did not always match when reviewing the quarterly data uploads of program tracking data. In these instances, the SWE was unable to verify total FirstEnergy and

⁷⁹ ADM provided the SWE with detailed information on how to corroborate the appliance recycling pictures with the program tracking data, and the SWE confirmed the photographs could be tied back to the program tracking data.

⁸⁰ For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

individual EDC quantities. However, ADM was able to confirm that invoice quantities matched when looking at full year tracking data.

Low-Income Energy Efficiency Program: Appliances

The SWE did not review any Met-Ed LI Appliance project files in PY13 due to low participation and claimed savings.

Low-Income Energy Efficiency Program: Appliance Turn-In

The SWE review of LI Appliance Turn-In files is summarized in the appliance recycling subsection above.

Low-Income Energy Efficiency Program: New Homes

The SWE review of LI New Homes files is summarized in the New Homes subsection above.

Low-Income Energy Efficiency Program: Direct Install

The project documentation for the LI Direct Install mostly matched the quarterly tracking data. Some accounts had multiple tracking data entries that did not correspond to the project file invoice. The SWE observed one case where the project files included only the tracking information for the lighting but did not contain any information regarding the appliances. The SWE also noted the tracking data failed to include Tier 1 smart strips associated with one project.

Low-Income Energy Efficiency Program: Kits

The SWE review of LI kit files is summarized in the energy efficient kits subsection above.

Energy Efficient (EE) Products Program: Upstream Electronics

The FirstEnergy companies did not offer the Upstream Electronics component of the EE products program in PY13.

E.4.2.2 Non-Residential

As part of its audit process, the SWE conducts a review of ex-ante savings values and methodologies. This review involves assessing specific ICSP project files for a sample of Met-Ed's non-residential programs in PY13. Throughout the program year, Met-Ed, program implementors, and the evaluation contractor provide project documentation on a quarterly basis to the SWE for review. The project documentation typically includes program rebate applications and approvals, invoices for installed equipment, equipment specification or "cut" sheets, post-inspection forms, and calculation workbooks. The SWE reviews these documents for completeness and consistency. The SWE also compares the data points in the documentation against the program tracking database to ensure values such as savings, rebate amounts, installation, approval, and invoice dates align.

Overall, the SWE found that the project files were organized, complete, and accurate. [Table 125](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 125: Met-Ed PY13 C&I Project File Review Summary

Program	Sub-Program	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program – Large	Custom - LCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Large	Lighting - LCI	3	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	Lighting - SCI	5	✓	4/5	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	Multifamily - SCI	1	0/1	0/1	0/1	0/1	✓	-
C&I Energy Solutions for Business Program – Small	Energy Management - SCI	2	0/2	✓	0/2	0/2	0/2	-

The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were estimated. However, the SWE did note that some files were missing for the Multifamily and Energy Management projects reviewed. In addition to these general issues, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **Lighting – SCI**
 - The rebate amount in the calculator for one project did not match the rebate listed in the tracking data
- **Multifamily – SCI**
 - Missing invoice and calculator
 - The overall project energy and demand savings did not match the tracking data
- **Energy Management – SCI**
 - Missing calculator to verify project details (i.e., HOU, quantities and wattages) and to match demand savings with tracking data

Despite minor issues with some project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

E.5 VERIFIED GROSS SAVINGS AUDITS

E.5.1 Residential Audit Activities

This section presents a summary of the SWE’s audit of the verified gross savings of the Met-Ed portfolio of residential programs. Met-Ed’s portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy Efficient Homes Initiative, the Energy Efficient Products Initiative, and the LI Energy Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings into the three following sections: upstream lighting, residential non-lighting, and behavior.

The SWE identified the evaluation activities used to verify savings for the residential programs. [Table 126](#) provides a summary of the evaluation and M&V approaches used by Met-Ed in their PY13 verified savings calculations.

Table 126: Residential Program Evaluation Activities – Met-Ed

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Energy Efficient Homes				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
Energy Efficient Products				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
Low-Income Energy Efficiency Program				
LI Direct Install	-	✓	✓	✓
LI Appliance Turn-in	✓	-	✓	-
LI Appliances	✓	-	✓	-
LI New Homes	-	✓	✓	-
LI Kits	✓	-	✓	-

E.5.1.1 Residential Non-HER

The SWE's review of verified savings for residential non-lighting programs found that, generally, the verified savings followed proper TRM protocols and that the verified savings are accurate. However, the SWE did observe a discrepancy in the kits and appliance program components that led to an underreporting of verified demand savings.

Energy Efficient Homes Program and LIEEP: Energy Efficient and School Education Kits

The SWE reviewed both the energy efficient kits and the school kits subprograms. The SWE worked with ADM to correct any observed discrepancies prior to the filing of the FirstEnergy PY13 Annual Report. The SWE reviewed that the savings calculations were in accordance with the TRM and that the survey results were correctly applied to calculate the program-level realization rates. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that

participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes the review and results also cover the low-income energy efficient and education kit program components.

Energy Efficient Homes Program and LIEEP: New Homes

The SWE worked with evaluation contractor, ADM, to resolve any discrepancies in the evaluated savings prior to annual reporting. ADM conducted a QA/QC of REM/Rate energy models, confirming model entries were accurate with on-site data. The SWE confirmed the verified savings were in accordance with TRM protocols, including the application of demand savings. In addition, the SWE confirmed the realization rates were correctly applied to calculate program-level savings.

The SWE notes that the review also covered the LIEEP New Homes program component.

Energy Efficient Homes Program and LIEEP: Direct Install

The Direct Install subcomponent of the EE Homes program includes both weatherization and non-weatherization measures. There were no weatherization projects conducted for Met-Ed in PY13. The SWE reviewed the non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included lighting, nightlights, advanced power strips, connected thermostats, and water heater setbacks.

The SWE also reviewed the LIEEP Direct Install subcomponent, which provides LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE confirmed these measures also applied the correct TRM algorithms to calculate verified savings.

The SWE also confirmed the application of realization rates, participation counts, and the verified savings were accurate in the PY13 report.

Energy Efficient Products Program and LIEEP: Appliances

ADM used a combination of verification surveys, invoice and application reviews, and applied EDC collected data, such as efficiency and capacity data, to program tracking data inputs when deemed appropriate by the TRM. The appliance component includes measures such as: refrigerators, freezers, clothes washers and dryers, dehumidifiers, dishwashers, window ACs, HPWHs, and connected thermostats. The SWE was able to conduct an early review and confirmed that the savings values were correctly calculated using the TRM protocols. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the Met-Ed PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes that the appendix for this component includes a list of the variables for each appliance, and where the data source came from. This was a helpful addition for the review process.

The SWE notes that the review also covered the LIEEP Appliances program component.

Energy Efficient Products Program and LIEEP: Appliance Recycling

The SWE performed audits on all measures included in the LI and non-LI Appliance Turn-In (ATI) programs, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

Energy Efficient Homes Program: Multifamily

There were no reported savings or projects for Met-Ed in PY13 for the Multifamily subcomponent.

Energy Efficient Products Program: HVAC

The SWE conducted an early review of the HVAC component. The SWE determined that ADM, applied survey results and model-specific values appropriately. The SWE confirmed the participation counts, realization rates, and verified savings aligned with the annual report.

Energy Efficient Products Program: Midstream Appliances

The SWE conducted an early review of the Midstream Appliances component. ADM’s evaluation included a full review of the program tracking data and aligning savings estimates with the TRM and product specific data. The SWE did not observe any discrepancies with the application of the TRM algorithms, or the application of EDC gathered data. The SWE confirmed participation counts, realization rates, and verified savings were reported accurately.

Energy Efficient Products Program: Upstream Electronics

The FirstEnergy companies did not offer the Upstream Electronics component of the EE products program in PY13.

E.5.1.2 Behavior

Home Energy Reports were issued to around 46,000 residential and residential-LI households in PY13. Five percent of Met-Ed’s progress toward its low-income target in PY13 came from HERs. Met-Ed’s behavioral portfolio consists of two different waves, or cohorts, of homes. Both cohorts were launched during PY13 and one of them targets low-income households. [Table 127](#) summarizes the average number of active households during PY13 by cohort.

Table 127: Met-Ed HER Cohort Summary

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	32,684	11,287
2021 Low-Income	9/30/2021	11,718	10,666

The program ICSP Oracle implemented both cohorts as a randomized control trial (RCT) where the eligible households were identified and then randomly assigned to either a treatment or control group. Following randomization, ADM conducted statistical tests on the pre-treatment energy usage patterns to confirm equivalence between the treatment and control groups.

RCT Validation

The SWE team conducted an audit of randomization soundness and pre-treatment equivalence for the two cohorts introduced in PY13. The SWE team ran a simple fixed effects regression model using the pre-treatment data with indicator variables for each month and for the treatment. During the pre-treatment period, we'd expect the "treatment" indicator variable to be statistically insignificant, as the treatment effect is only expected after HER delivery begins. Indeed, we found the treatment indicator variable to be statistically insignificant for both cohorts. The SWE team also ran a t-test of pre-period usage by treatment status for each cohort and found all differences in usage to be statistically insignificant. [Figure 65](#) and [Figure 66](#) display the monthly distribution of daily kWh usage for the treatment and control groups of each of the cohorts. These visuals reinforce the finding that pre-treatment usage patterns are extremely similar between the treatment and control groups of each cohort.

Figure 65: Pre-Treatment Equivalence, Residential Cohort

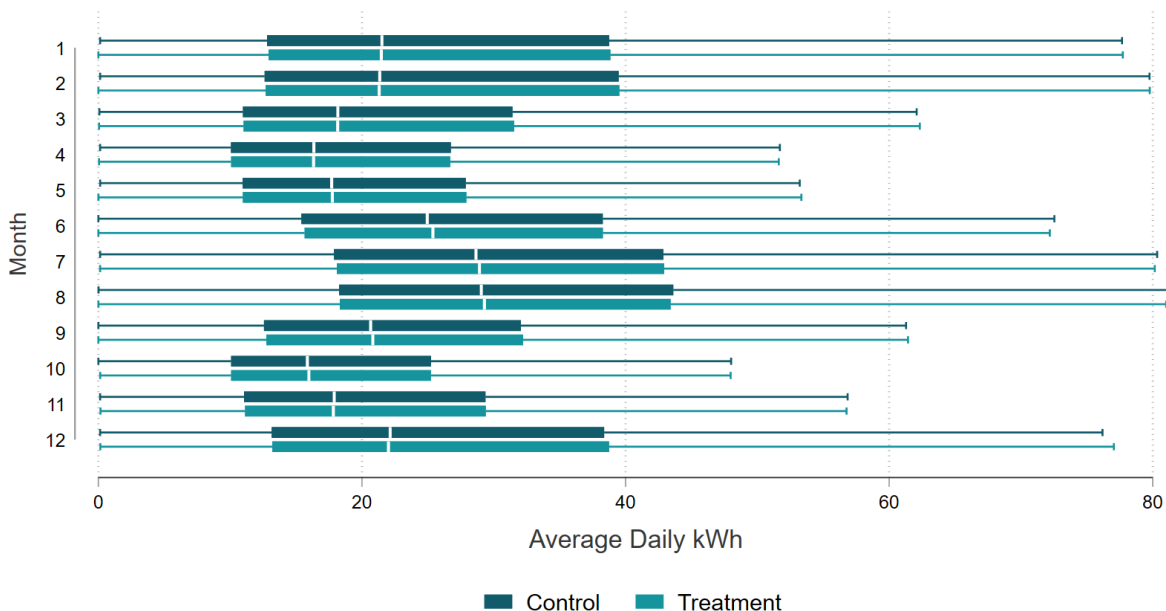
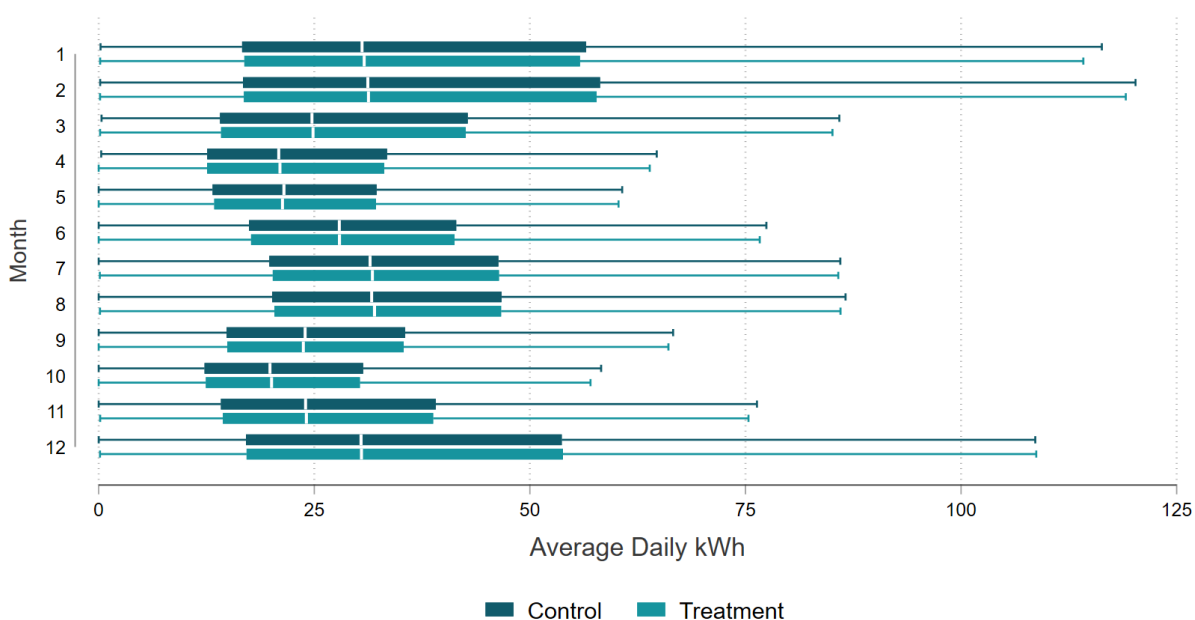


Figure 66: Pre-Treatment Equivalence, Low-Income Cohort



Data Preparation

The SWE team received interval data from ADM at three different levels: hourly, daily, and monthly. The monthly data is the primary input in the estimation of HER impacts. The SWE team independently checked the aggregation of the daily data to the monthly level, and we found the calculations to be sound (and we also found the distribution of monthly kWh to be reasonable). ADM used a lagged seasonal (LS) regression model for the PY13 impact analysis as called for in

the Met-Ed PY13 EM&V plan. The LS model contains three lag variables: one for average usage during the pre-treatment period (all months), one for average summer usage during the pre-treatment period, and one for average winter usage during the pre-treatment period. The SWE team was able to replicate the three lagged variables calculated by ADM.

Participant Counts

ADM obtains active customer counts for each month by tallying up the number of accounts that have hourly interval data for the month. Only active accounts where HER delivery has begun are included in these calculations. An inconsequential number of accounts were not counted because they were placed in both the control group and treatment group, or they had multiple treatment starting dates. A larger number of accounts (3.4% of the total treatment accounts) were not included in the counts because Oracle never began HER delivery to these homes or due to pre-start date attrition.

The SWE team validated ADM enrollment counts by performing a similar counting method on the hourly interval data. Customers are considered active through the end of the month that they last have interval data. For example, if a customer's final AMI record is from February 15th, the customer would be included in the count for February but not in March or any month following. The SWE team's final customer counts matched ADM's counts within 0.1 percent for each month and each cohort.

Customers that did not have 12 months of pre-treatment data were not included in the impact estimation (because the lagged seasonal variables for these customers could not be calculated), but they were included in the customer counts.

Impacts

By month, the daily impact estimates are plotted in [Figure 67](#) (residential) and [Figure 68](#) (low-income). Notably, June through September are not included in the figure. This is because HER delivery did not begin until October. For each cohort, [Table 128](#) shows the average of the PY13 monthly impact estimates (across the eight active months). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.18 kWh per day, on average, during PY13. The SWE was able to replicate ADM's impact estimate for each cohort/month combination.

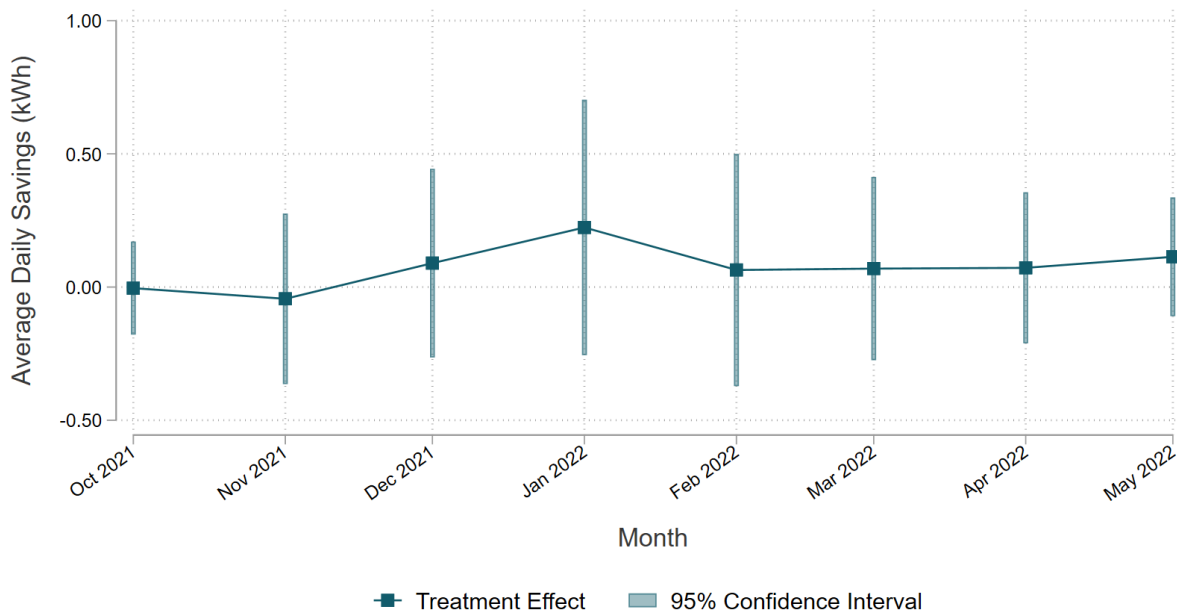
Table 128: Met-Ed HER Impact Estimates

Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.18
2021 Low-Income	0.07

Figure 67: Average Daily Savings (kWh) by Month, Residential Cohort



Figure 68: Average Daily Savings (kWh) by Month, Low-Income Cohort



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 129](#) shows the aggregate PY13 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, which are discussed in greater detail later, and the PY13 incremental gross savings estimate.

Table 129: PY13 HER Energy Savings

Cohort	Gross Savings (MWh/yr)	Downstream Dual Participation (MWh/yr)	Upstream Dual Participation (MWh/yr)	Persistence (MWh/yr)	Incremental Savings (MWh/yr)
2021 Residential	1,436	1	0	0	1,436
2021 Low-Income	209	12	0	0	197
Total	1,646	13	0	0	1,633

Dual Participation

In [Table 129](#), gross savings before adjusting for dual participation were 1,646 MWh. It is important to note that Home Energy Reports advertise other Met-Ed residential EE&C programs and measures such as ENERGY STAR appliances, water heaters, HVAC etc. To the extent that treatment group households participate in these programs more frequently than control group homes, the incremental savings is captured in the regression estimates for the HER analysis. To avoid double-counting, the HER savings are reduced to account for the incremental program participation observed in the treatment group compared to the control group.

Regarding upstream dual participation, note that Met-Ed did not offer an upstream lighting program in PY13. The Upstream Electronics component of the Energy Efficient Products Program was not offered in PY13 either. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

Persistence

PY13 saw the introduction of a new framework for separating persisting savings from previous program years from incremental savings attributable to the treatment in the current program year. The 2021 TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research⁸¹ on the persistent effects of behavioral energy efficiency treatment in the years after discontinuing treatment. Since Act 129 compliance goals are based on first-year incremental savings, these persistent impacts are subtracted from the measured savings to estimate incremental first-year savings (those directly due to the current program year of treatment). Because both PY13 Met-Ed waves were launched during PY13, all savings are first-year savings. Separating persisting savings from incremental savings was not necessary.

⁸¹ Addendum to Act 129 Home Energy Report Persistence Study. November 2018. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

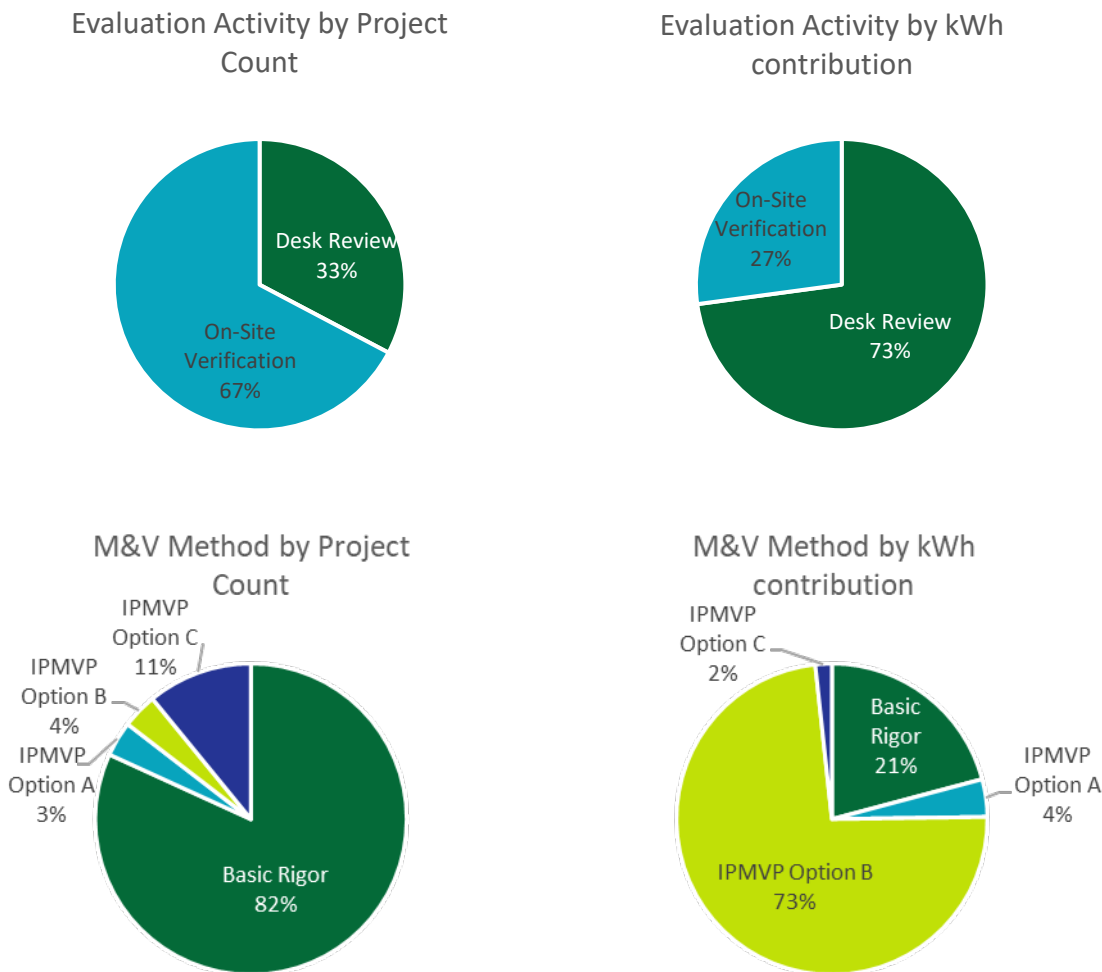
Peak Demand Impacts

The 2021 TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 PM to 6:00 PM Eastern Daylight Time on non-holiday weekdays during June, July, and August. Because HER delivery did not begin until the fall, there were no peak demand impacts in PY13.

E.5.2 Non-Residential Audit Activities

Figure 69 provides a summary of the evaluation activities and M&V approaches utilized by ADM in their PY13 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY13, Met-Ed’s evaluation contractor completed site visits to 67% of evaluated projects, and these projects represented 27% of total evaluated energy savings. In total, 37 site visits were completed. IPMVP Options A, B, and C were employed for 79% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 21% of the total evaluated savings, including the majority of prescriptive projects and most energy management projects.

Figure 69: Summary of Met-Ed’s C&I Evaluation Activities



Met-Ed's evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Met-Ed's C&I programs are assigned to one of four evaluation initiatives, as Met-Ed's programs target specific sectors of C&I customers, but offerings are often identical across the programs. Table 130 provides a summary of the evaluation activities Met-Ed's evaluation contractor used across strata for all projects by initiative.

Table 130: Summary of Met-Ed's PY13 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
Appliance Recycling	-	103%	99%	-	-
Custom	8	100%	100%	7	1
Custom – C	2	100%	100%	1	1
Custom – 1	6	100%	100%	6	-
Prescriptive	26	118%	105%	8	18
Downstream Lighting -	-	-	-	-	-
Downstream Lighting - 2	11	121%	108%	0	11
Downstream Lighting - 1	11	105%	95%	6	5
Downstream Non-Lighting	2	100%	101%	2	-
Midstream Lighting	2	87%	67%	-	2
Midstream Non-Lighting	-	-	-	-	-
EMNC	18	84%	82%	2	16
EMNC	1	85%	44%	1	-
Building Tune-Ups	17	84%	83%	1	16
Multifamily	3	49%	43%	1	2
TOTAL	55			18	37

The SWE's review of verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and are generally accurate. The following sections describe the SWE's audit of the verified savings methodology for non-residential programs in further detail.

E.5.2.1 Appliance Recycling Initiative

In PY13, projects in Met-Ed’s Appliance Recycling Sub-Initiative were evaluated through a review of tracking and reporting data. The gross energy and demand realization rates for each evaluation stratum were taken to be the realization rates from the broader initiative-level evaluation which included the residential and low-income residential components.

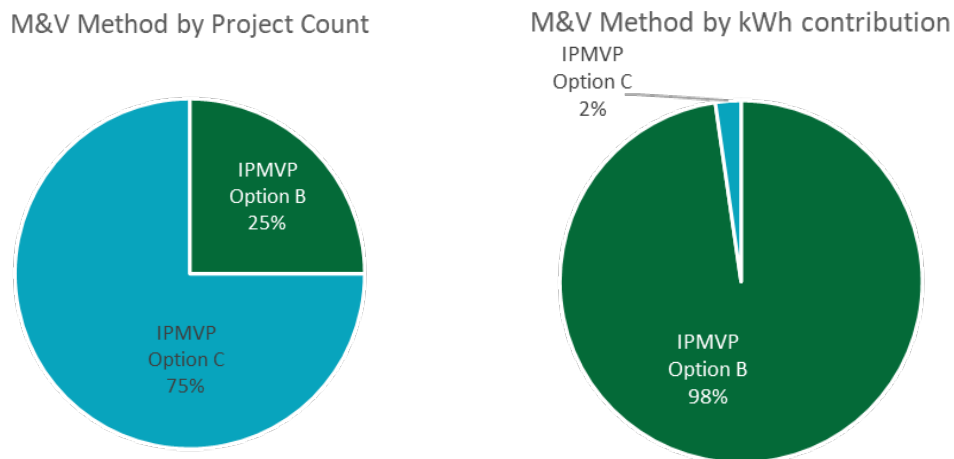
E.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews and/or IPMVP evaluation methods for all sampled projects. No site visits were conducted for PY13 custom sampled projects. The evaluation was satisfactorily conducted through desk reviews for all projects using data provided by the customer (EMS data, billing data, etc.).

Met-Ed’s evaluation contractor employed two strata for projects in the Custom initiative. The largest projects, with ex-ante savings estimates of 500 MWh or more, are separated into a “certainty” stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

The distribution of rigor across the sample strata is in keeping with Table 14 of the Phase IV Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. Enhanced rigor methods were employed to evaluate all projects, with IPMVP Option C selected as the primary enhanced M&V method for 75% of evaluated custom projects, as shown in [Figure 70](#).

Figure 70: Summary of Met-Ed’s C&I Custom Program M&V Methods



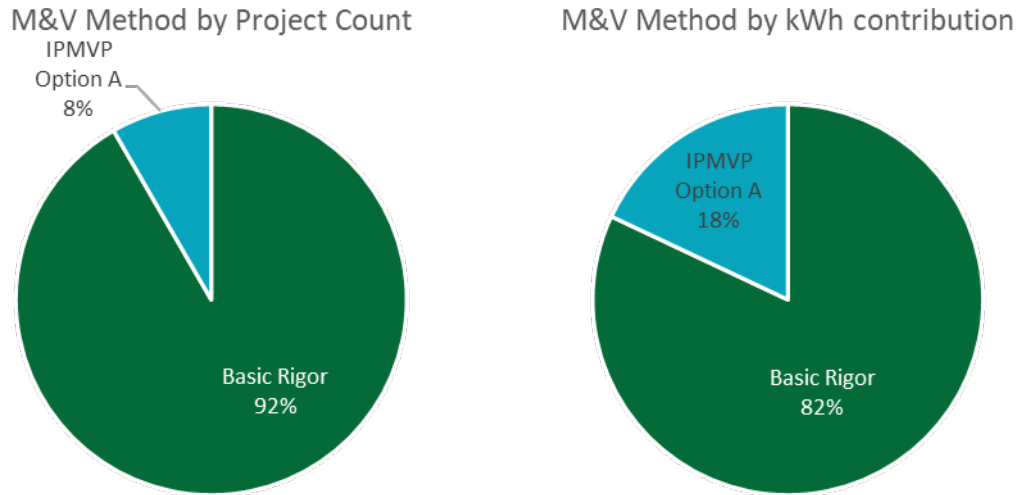
E.5.2.3 Prescriptive Initiative

Evaluation activities for this initiative include desk reviews for most projects and primary data collection of lighting hours of use for medium and high savings projects. TRM deemed hours of operation were applied in basic rigor desk reviews for low savings projects. All sampled projects undergo a full documentation review prior to site visits, and site-specific M&V plans are developed for most.

Met-Ed's evaluation contractor employed three strata for projects in the Prescriptive initiative. The largest projects, with ex-ante savings estimates of 750 MWh or more, are separated into a "Downstream - Certainty" stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

Basic Rigor was employed for 92% of evaluated projects in this initiative with the remaining projects using IPMVP Option A, as seen in [Figure 71](#) below.

Figure 71: Summary of Met-Ed's C&I Prescriptive Program M&V Methods



E.5.2.4 Commercial and Industrial Energy Management and New Construction Initiative (CI EMNC)

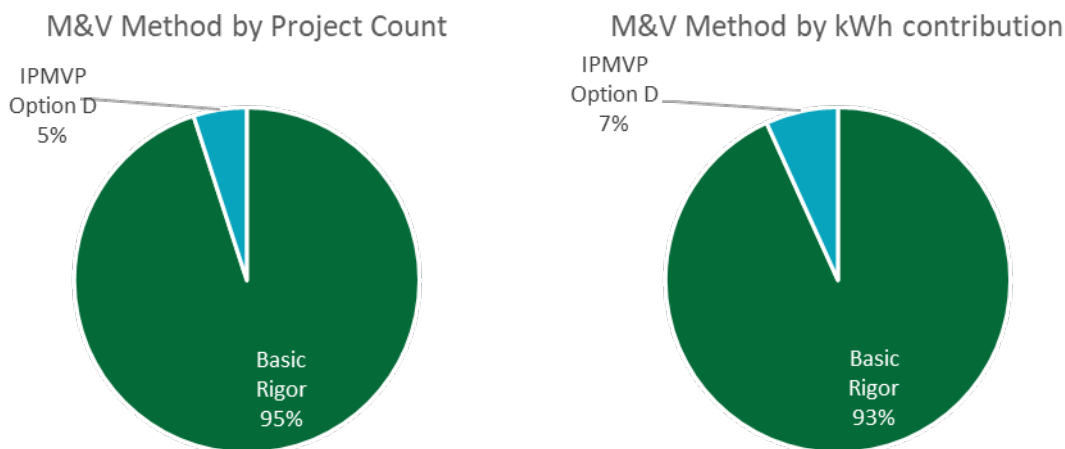
The CI EMNC Initiative has five subcomponents, but only two were active in PY13: Building Tune-Up and New Construction.

Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Basic rigor M&V methods were applied to these projects, incorporating TRM algorithms and reconciliations of invoices with equipment specification sheets.

Projects in the New Construction strata were evaluated using IPMVP Option D, which included review of baseline and as-built simulation models developed in the implementer's custom simulation tool.

Basic Rigor was employed for 95% of evaluated projects in this initiative with the remaining projects using IPMVP Option D, as seen in [Figure 72](#) below.

Figure 72: Summary of Met-Ed’s CI EMNC Program M&V Methods



E.5.2.5 Master-Metered Multifamily Direct Install Initiative

All sampled projects in the CI MF initiative were evaluated using basic rigor desk reviews, with on-site inspections conducted for about one-third of the sample. The desk review process included reconciliation of invoices and re-calculation of reported savings using TRM algorithms.

E.5.2.6 Verified Savings Audits

The SWE audited the activities above through a detailed audit of ADM’s evaluation work for a sample of their evaluated projects. The SWE audit for ADM’s Met-Ed evaluation in PY13 included review of seven (7) projects, encompassing the following activities:

SWE Audit activities for PY13 encompassed the following metrics.

- 4 Field and Analysis Engineers were observed
- 4 Measure Types were observed
- 2 In-Person Ride-Alongs conducted
- 64% of Verified Energy Savings reviewed
- 51% of Verified Demand Savings reviewed

Table 131 provides an overview of the SWE milestones for the verified savings audit review of evaluated Met-Ed projects.

Table 131: Met-Ed Verified Savings Audit Review Milestones

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
7	14,500,142	96%	1,682	100%

Overall, the SWE found that Met-Ed’s evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods for custom measures. For projects observed during ride-along site visits, the SWE proposed changes to

lighting hours of use for some lighting equipment based on statements made by the site contact. ADM and the SWE agreed on revisions to the initial evaluation results to reflect the operational conditions observed on-site, which yielded an overall energy attainment percentage of 96% for the SWE's audited sample. No changes were proposed for demand savings estimates, so the demand savings attainment percentage was 100%.

E.6 NTG

Table 132 lists Met-Ed's PY13 NTG results across all programs. Details concerning the methods and data used to estimate NTG values are in sections E.6.1 and E.6.2.

Table 132: Summary of Met-Ed's PY13 NTG Results

Program Name	Component	NTG
Energy Efficient Homes	EE Kits	0.82
Energy Efficient Homes	Home Energy Reports	1.0
Energy Efficient Homes	Direct Install	0.95
Energy Efficient Homes	New Homes	0.73
Energy Efficient Homes	Multifamily	0.81
Energy Efficient Homes	Online Audits	1.0
Energy Efficient Products	Appliance Recycling	0.39
Energy Efficient Products	Upstream Electronics	0.58
Energy Efficient Products	HVAC	0.51
Energy Efficient Products	Appliances	0.50
Energy Efficient Products	Midstream Appliances	0.47
Low-Income	Appliances	1.0
Low-Income	Appliances Turn-In	1.0
Low-Income	Direct Install	1.0
Low-Income	Home Energy Reports	1.0
Low-Income	Kits	1.0
Low-Income	New Homes	1.0
Low-Income	Online Audits	1.0
C&I Solutions for Business Programs - Small and Large	Prescriptive	0.63
C&I Solutions for Business Programs - Small and Large	Custom	0.54
C&I Solutions for Business Programs - Small and Large	EMNC	0.63
C&I Solutions for Business Programs - Small and Large	Multifamily	1.0
C&I Solutions for Business Programs - Small and Large	Appliance Recycling	0.39

E.6.1 Residential Programs

ADM planned and enacted NTG research for the residential Appliance Recycling program for PY13 (Table 133). ADM utilized participant surveys to estimate free-ridership and NTG reasoning that spillover estimation was not necessary since the Appliance Recycling program does not lead to installation of Energy Efficient Products. ADM utilized a free-ridership battery of questions that was consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation (excluding spillover).

All other residential programs utilized NTG values estimated, and SWE verified during Phase III with the exception of the Home Energy Report Program. The Home Energy Report program NTG

was assigned a value of 1.0, in accordance with the Phase IV Evaluation Framework. The random control trial (RCT) design of the program eliminates the need for NTG analysis because the control group does everything the treatment group would have done and the estimated savings are technically net savings.

Table 133: Summary of Met-Ed’s PY13 Residential NTG Results

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
EE Kits	N/A	N/A	21%	3%	0.82
Home Energy Reports	RCT	N/A	0%	0%	1.0
Direct Install	N/A	N/A	19%	14%	0.95
New Homes	N/A	N/A	27%	0%	0.73
Multifamily	N/A	N/A	19%	0%	0.81
Online Audits	N/A	N/A	0%	0%	1.0
Appliance Recycling	Self-Report Survey	139	61%	0%	0.39
Upstream Electronics	N/A	N/A	N/A	N/A	0.58
HVAC	N/A	N/A	50%	1%	0.51
Appliances	N/A	N/A	53%	3%	0.50
Midstream Appliances	N/A	N/A	53%	0%	0.47

E.6.2 C&I Energy Efficiency Programs

ADM did not conduct any new NTG research for C&I programs in PY13 (Table 134). They applied NTG values from Phase III NTG evaluations that have been verified by SWE during Phase III. ADM did apply the residential Appliance Recycling PY13 NTG to the C&I Appliance Recycling program and assigned a NTG value of 1 to the C&I Multifamily program as it is a low-income program.

Table 134: Summary of Met-Ed’s PY13 C&I NTG Results

Program Components	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	N/A	N/A	37%	1%	0.63
Custom	N/A	N/A	46%	0%	0.54
EMNC	N/A	N/A	38%	0%	0.62
Multifamily	N/A	N/A	N/A	N/A	1.0
Appliance Recycling	N/A	N/A	61%	0%	0.39

E.7 TRC

Table 135 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Met-Ed’s PY13 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY13 annual report and the model itself was well-organized and documented.

The program designs presented in FirstEnergy's Phase IV EE&C Plan are organized into the following sectors: (1) Residential; (2) Residential Low-Income; (3) Small Commercial and Industrial; and (4) Large Commercial and Industrial. The number of programs within these sectors decreased from nine in Phase III to five in Phase IV in part due to the exclusion of dispatchable demand response from Phase IV. The Appliance Turn-In Program is now a component of the Energy Efficient Products Program.

Both gross and net TRC ratios increased from PY12, with the largest increase occurring in the Low-Income Energy Efficiency program and the only decrease occurring in the C&I Energy Solutions for Business - Small program. Pursuant to the 2021 TRC Test Order directive for Phase IV, the nominal discount rate is now 5% and no longer tied to WACC. All else being equal, a lower discount rate improves the TRC ratio.

Table 135: Summary of Met-Ed's PY13 TRC Results

Program Name	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Energy Efficient Homes	\$8,093	\$4,467	1.81	\$6,454	\$3,683	1.75
Energy Efficient Products	\$4,772	\$5,032	0.95	\$2,185	\$3,145	0.69
Low Income Energy Efficiency	\$2,393	\$1,710	1.40	\$2,393	\$1,710	1.40
C&I Energy Solutions for Business - Small	\$4,039	\$3,339	1.21	\$2,544	\$2,549	1.00
C&I Energy Solutions for Business - Large	\$8,929	\$6,366	1.40	\$5,016	\$4,106	1.22
Portfolio Total	\$28,227	\$20,914	1.35	\$18,593	\$15,193	1.22

Four of Met-Ed's five EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. The same four programs were found to be cost-effective using net verified savings. The Energy Efficient Products program was not cost-effective on a gross or net verified basis, in part due to the high incremental costs relative to energy savings for ENERGY STAR appliances like clothes dryers and dishwashers.

E.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- Met-Ed's annual electric energy savings are calculated and allocated by season (summer, winter, and shoulder) and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is consistent with the on-peak hours defined in the 2021 TRM (Monday – Friday 7AM to 11PM). The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions. The SWE also verified the correct avoided costs from Met-Ed's EE&C Plan were used in the TRC model. The

TRC model accurately collapsed the 8,760 hourly load shapes into single annual weighted-average values used in the energy benefits calculations.

- To calculate the avoided cost of natural gas, Met-Ed used a three-segment approach outlined in the 2021 TRC Test Order. The SWE verified the TRC Model correctly applied the EE&C Plan avoided costs to estimate TRC benefits.
- Pursuant to the 2021 TRC Test Order, the SWE verified Met-Ed used a nominal discount rate of 5% to calculate the net present value of future program benefits. This discount rate is consistent with their EE&C plan and the 2021 TRC Test Order. Line loss adjustment factors varied by sector. Residential (1.0945), Small C&I (1.072) and Large C&I (1.072).
- The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the Database for Energy Efficiency Resources (DEER), company assumptions, and actual project costs as gathered from the PY13 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent with Met-Ed's EE&C plan.
 - For non-residential lighting measures, Met-Ed consistently applied the benefits and incremental costs of Early Replacement to all measures. This aligns with the definitions in Table 6 of the 2021 TRC Test Order and the measure vintage in the 2021 TRM.
- Realization rates for energy and demand impacts were applied to the reported gross program impacts in the TRC model to calculate verified gross savings.
- The calculation of NTG using free-ridership and spillover, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the 2021 TRC Test Order directive for Phase IV. The TRC model followed the protocol pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.
- The SWE found that the cost categories were handled correctly in the TRC model. Participant incentives were not considered TRC costs, while administrative costs, incremental costs, and kits were incorporated as costs.
- The SWE verified the ex-ante demand and capacity savings were accurate in the TRC model by comparing them to the Quarterly Tracking Data reported by Met-Ed.
- According to the Phase IV Evaluation Framework, low-income measures are required to be provided at no cost to the participants. At first glance, it appears that Met-Ed's low-income programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the Low-Income Energy Efficiency Program (Table 62 in FirstEnergy's PY13 Annual Report). However, in their Phase IV EE&C Plan, Met-Ed explains that these costs are only being allocated to landlords and owners of low-income properties, rather than the low-income customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Fossil Fuel Impacts and Total NPV Lifetime Water Impacts. The SWE verified

that the savings were accounted for in accordance with the 2021 TRC Test Order. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative benefit rather than a TRC cost. The TRC model claimed nearly 23 million gallons per year of water saving, which translates to approximately \$3,040,000 in NPV lifetime avoided costs.

E.8 PROCESS

Four EDCs – Met-Ed, Penn Power, Penelec, and West Penn Power – operate an identical set of energy efficiency programs. Since ADM, together with its process evaluation subcontractor, Tetra Tech, took unified process evaluation approaches to these programs across the four EDCs, the annual reports of the four EDCs report identical information about the process evaluation. Therefore, the SWE's audit summary described in this section pertains to all four FirstEnergy utilities. Sample sizes are noted under each EDC.

E.8.1 Residential Programs

There are three residential programs: Energy Efficient Products, Energy Efficient Homes, and Low-Income Energy Efficiency Program, and each program has multiple components. For PY13, ADM/Tetra Tech completed a process evaluation of a component of the Energy Efficient Products Program, Appliance Recycling.

E.8.1.1 Energy Efficient Products Program

For PY13, ADM/Tetra Tech conducted process evaluations for one of four program components of the Energy Efficient Products Program: Appliance Recycling. The Appliance Recycling program process evaluation consisted of program staff and implementer interviews as well as surveys of randomly selected participating customers. The surveys focused on program awareness and customer satisfaction. The evaluators reported on the following key findings:

- *FirstEnergy program staff report that the program is running well.* The relationship with the Appliance Recycling Centers of America, Inc. (ARCA), the conservation service provider (CSP), is effective, with good communication, timely and accurate reporting, and high customer satisfaction. The program had to shut down for three months due to the COVID-19 pandemic but successfully transitioned processes to accommodate contactless pickups.
- *ARCA reports the program has successfully transitioned into Phase IV.* ARCA believes the working relationship with FirstEnergy is excellent. ARCA offers customers both in-person and contactless pickup services and provides weekly and monthly updates to FirstEnergy. To improve implementation, ARCA is continuing efforts to partner with retailers to talk and provide information about the Appliance Recycling program when customers are buying new appliances.
- *The program is searching for additional ways to recycle more units in bulk.* The program is in the process of developing a midstream offering; this effort would involve working with retailers to recycle several used units at once. The program also works with hotels, apartment complexes, and universities to recycle units, including room air conditioners.

- *Bill inserts continue to be the most common source of program information.* In PY13, 49 percent of respondents indicated bill inserts as a source of program information, consistent with prior evaluations. Email from the EDC was the second most common source of program awareness mentioned by 17 percent of respondents.
- *Program satisfaction remains high.* Mean satisfaction scores for the overall program and individual program components ranged from 4.4 to 4.8 (on a scale where 1 was *very dissatisfied* and 5 was *very satisfied*). Seventy-seven percent of respondents reported they were *very satisfied* with the program overall, down slightly from 79 percent in PY10. Of the customers who expressed *dissatisfaction* (82 out of 570), pickup cancelation and scheduling were the most common reasons.
- *Most customers were able to purchase their preferred replacement equipment.* The evaluation team wanted to understand if the delays in the supply chain due to the COVID-19 pandemic had any impact on customers replacing their recycled units and if they could purchase the equipment they preferred. Most customers (over 85 percent) said they were able to buy their preferred equipment; for those customers who did not, the cost was the driving factor. Additionally, customers tended to purchase equipment with fewer features than their preferred model if their preferred model was unavailable.

Summary of Process Evaluation Audit

The process evaluation of the Appliance Recycling component appears to have been generally consistent with the Phase IIV evaluation plan. The PY13 residential sampling plan targeted 139 participant surveys with Met-Ed customers; the target was exceeded with 151 completed surveys. The SWE notes that the PY13 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

E.8.1.2 Energy Efficient Homes Program

No initiatives within the Energy Efficient Homes Program were scheduled for process evaluation reporting in PY13. However, several program elements are scheduled for reporting in PY14, and Tetra Tech has conducted initial process evaluation activities such as interviews with program managers and implementers for the following components:

- Behavioral
- School Education Program
- In-home Audits
- New Homes
- Multifamily Program
- Behavioral On-line Audits

E.8.1.3 Residential Low-Income Program

Apart from Appliance Recycling, no initiatives within the Residential Low-Income Program were scheduled for process evaluation reporting in PY13. However, several program elements are scheduled for reporting in PY14, and Tetra Tech has conducted initial process evaluation activities such as interviews with program managers and implementers for the following components:

- Downstream Appliances
- Weatherization (Direct Installation)
- Home Energy Reports
- School Education Program
- New Homes
- Behavioral On-line Audits

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan. The evaluation targeted 420 participant survey responses and achieved a total of 570 participant survey responses across all four FirstEnergy EDCs.

E.8.2 C&I Programs

There are two C&I programs: Energy Solutions for Business-Small and Energy Solutions for Business-Large. No process evaluations were completed in PY13, but Tetra Tech conducted semi-structured interviews with program managers and implementers. Process evaluation activities in PY13 focused on understanding the program design, any changes in design or implementation in Phase IV, and to identify researchable issues for the upcoming process evaluation effort. Most practical aspects of the programs are managed as one general effort rather than distinct programs, so the interviews covered both programs.

Appendix F FirstEnergy: Pennsylvania Electric Company PY13 Audit Detail

F.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, and were generally accurate.
- Penelec provided their Residential and Low Income verified savings analyses prior to drafting their annual reports. This allowed the SWE to conduct an early review and had ample time and opportunity to discuss any questions, potential discrepancies, and review updated results that could be directly incorporated into the PY13 annual report for the FirstEnergy companies. In addition, the verified savings analyses were well organized, and included the documentation required to conduct verified savings checks from the measure-level all the way to program-level savings.
- Penelec initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (2.3% of MWh) compared to Phase III. HERs accounted for approximately 10% of Penelec's progress toward its low-income compliance target in PY13. Because the cohorts launched after the summer, Penelec claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and FirstEnergy's evaluation contractor, ADM Associates (ADM) was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.
 - The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.
- Penelec's non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.41 but showed a TRC ratio far lower than PPL and Duquesne Light despite a similar set of measure offerings. A key driver of the difference is incremental cost assumptions for

non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penelec's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE only noted a few minor discrepancies.
- The SWE conducted a project file review for a sample of Penelec's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.

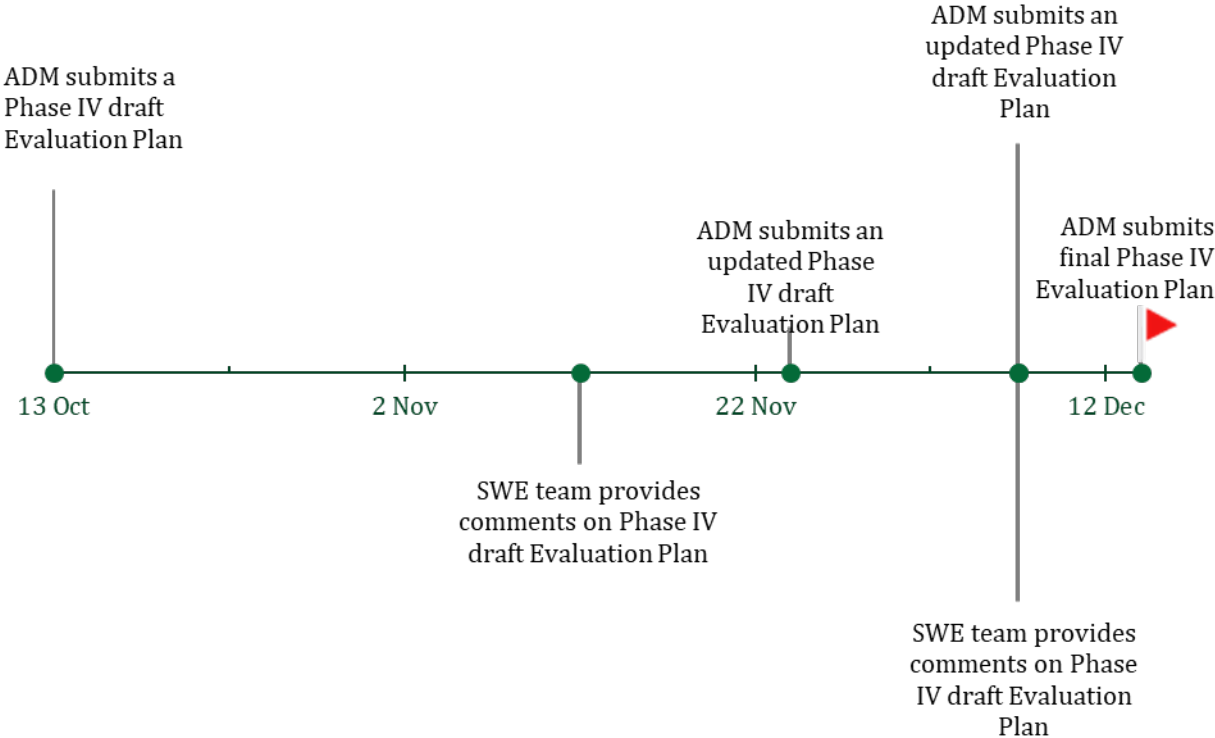
F.2 EM&V PLAN REVIEWS

ADM first submitted a draft Phase IV EM&V plan on October 13, 2021. The plan was organized by sector detailed the gross impact, net impact, and process evaluation activities by program. After several rounds of comments from the SWE and revisions by ADM, the final evaluation plan was approved by the SWE in mid-December 2021. The SWE brought some of the following points to ADM during revision of the plans:

- Impact evaluation activities for PY17. The initial plan called for annual impact evaluations in PY13-PY16 with PY17 relying almost entirely on historic realization rates. The SWE and ADM ultimately agreed on staggering the historic realization rates across PY16 and PY17.
- The baseline wattage for LED lamps in energy efficiency kits.
- The expected types of measures and impact evaluation techniques for the CI Energy Management and New Construction sampling initiative.
- How to disentangle HER impacts from the Online Audit subprogram impact estimates.
- Peak demand savings methodology for behavioral Home Energy Reports.

Figure 73 shows the review timeline of correspondence between ADM and the SWE team to finalize the Phase IV EM&V plan.

Figure 73: Penelec Evaluation Plan Review Timeline 2021-2022



As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. Penelec, however, will evaluate verified gross impacts for all programs in PY13. Penelec will not use historic realization rates until PY15 and PY17. [Table 136](#) shows all Penelec programs, which produced verified impacts in PY13.

Table 136: PY13 Penelec Program Impact Evaluation Summary

Sector	Components	PY13 Impacts
Residential	EE Kits	Verified
	Home Energy Reports	Verified
	Midstream	Verified
	New Homes	Verified
	Downstream HVAC	Verified
	LI Direct Install	Verified
	On-Line Audit	Verified
	Downstream Appliances	Verified
	LI - Home Energy Reports	Verified
	Smart Thermostats	Verified
	Audit and DI	Verified
	Online Audit	Verified
Cross-Cutting	Appliance Recycling	Verified
	Multifamily	Verified
C&I	Custom	Verified
	Lighting Downstream	Verified
	Lighting Midstream	Verified
	Energy Management and New Construction	Verified
	Prescriptive Non-Lighting Downstream	Verified
	Prescriptive Non-Lighting Midstream	Verified

In addition to the evaluation plans, the SWE also reviewed and provided comments on draft survey instruments in April 2022 for multiple programs.

F.3 SAMPLE DESIGN REVIEW

The Phase IV Evaluation Framework establishes a maximum level of sampling uncertainty of $\pm 15\%$ at the 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. This change was implemented specifically for EDCs like Penelec, who define EE&C programs broadly, but have specific offerings that are a more logical grouping for evaluation purposes due to program delivery channel or supported technology.

Penelec's EE&C portfolio consists of five programs: Energy Efficient Homes, Energy Efficient Products, Low Income Energy Efficiency, C&I Energy Solutions for Business – Large, and C&I Energy Solutions for Business – Small. The SWE performed its annual sample design review at the initiative level, which sometimes span multiple programs or sectors. In response to the annual data request, FirstEnergy's EM&V contractor provided the SWE with a sample disposition for each initiative detailing the project-level ex-ante and ex-post savings for each unit in the samples.

Table 137 shows the relative precision of PY13 energy and demand impacts by component at the 85% confidence level. Note that the Online Audit program, which had zero reported savings and demand impacts for PY13, is omitted.

Table 137: Relative Precision of PY13 Impacts by Program Component at the 85% Confidence Level

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	11.5%	11.5%
	LI - EE Kits	15.6%	15.9%
	Midstream	0.0%	0.0%
	New Homes & Smart Thermostats	9.7%	9.7%
	HVAC	12.2%	11.2%
	LI - Direct Install	8.1%	8.2%
	Downstream Appliances	8.9%	9.5%
	Audit and DI	0.0%	0.0%
Cross-Cutting	Appliance Recycling	5.7%	6.1%
	Multifamily	8.6%	8.4%
C&I	Custom	0.4%	0.2%
	Prescriptive	14.3%	14.0%
	Energy Management and New Construction	10.3%	10.0%

The Residential Midstream and Audit and Direct Install components have a relative precision of $\pm 0\%$. ADM evaluated all projects undertaken in those programs in PY13, so there is no sampling uncertainty.

ADM established in their Phase IV evaluation plan submitted to the SWE that they would use an assumed coefficient of variation derived from past program years for initial sample design. However, ADM also used these planning coefficients of variation to calculate and report initiative-level relative precision. For the C&I Prescriptive initiative, ADM designed its PY13 sample using a coefficient of variation of 0.4. The Phase IV EM&V plan notes that 0.4 was a deliberately conservative estimate of the expected coefficient of variation, which the SWE team found to be true for PY13. The SWE team replicated the C&I Prescriptive rollup instead using observed coefficients of variation and found the relative precision of savings estimates to be lower than the reported figures of 14.3% for energy and 14.0% for demand. The SWE team recommends that ADM use manual variance calculations in place of planning coefficients of variation in their PY14 report to yield more accurate estimates of relative precision. Although the SWE still recommends

leaving a hedge to guarantee that the $\pm 15\%$ relative precision threshold is met, ADM might be able to use fewer sample points than they did in PY13 for certain initiatives with low coefficients of variation.

The Behavioral Modification subprogram provides HERs to residential customers in the Penelec service territory. The subprogram is divided between market rate residential customers and LI customers, and each is administered as an RCT. Participants are enrolled in experimental cohorts and a monthly billing analysis regression is used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral programs are unique, with the Phase IV Evaluation Framework requiring the solution-level verification achieve an absolute precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 138](#) shows the absolute precision of PY13 Behavioral Modification impacts at the 95% confidence level.

Table 138: Absolute Precision of PY13 Impacts for Behavioral Modification Programs at the 95% Confidence Level

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.33%
Behavioral Modification (LI)	0.42%

F.4 REPORTED GROSS SAVINGS AUDITS

F.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Penelec's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)
- Participation counts
- Incentive dollars

The SWE leveraged Penelec's Q1-Q4 tracking data to audit these values. Note that the SWE does not receive the full tracking data set, rather a subset of the full tracking data set tailored to our PY13 quarterly data request. Also note that HER programs are not audited using the tracking data, thus they are not included in the tables or totals in the following sections. The SWE's findings regarding the HER components of Penelec's Energy Efficient Homes and LIEEP can be found in [Appendix F.5.1.2](#).

Table 139 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in Penelec’s PY13 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by Penelec.

Table 139: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	8,407	8,407	Yes*
Energy Efficient Products	6,483	6,483	Yes
Low Income Energy Efficiency	5,920	5,920	Yes*
C&I Energy Solutions for Business - Small	13,829	13,829	Yes
C&I Energy Solutions for Business - Large	2,149	2,149	Yes
Portfolio Total	36,788	36,788	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 140 summarizes the SWE’s findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. Like with reported gross energy savings, the tracking data supports the Penelec PY13 Annual Report value exactly for all programs.

Table 140: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	0.81	0.81	Yes*
Energy Efficient Products	1.38	1.38	Yes
Low Income Energy Efficiency	0.59	0.59	Yes*
C&I Energy Solutions for Business - Small	3.86	3.86	Yes
C&I Energy Solutions for Business - Large	0.36	0.36	Yes
Portfolio Total	7.00	7.00	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 141 summarizes the SWE’s findings regarding program participation. The SWE was able to calculate directionally similar participation counts for all programs. The portfolio totals, though not exactly equal, line up well: 78,900 in the Penelec PY13 Annual Report and 71,311 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with the EDCs and their evaluation contractors to understand the Phase IV business rules around counting participants for different program components

Table 141: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	44,414	39,711	No*
Energy Efficient Products	16,464	17,851	No
Low Income Energy Efficiency	17,842	13,582	No*
C&I Energy Solutions for Business - Small	166	156	No
C&I Energy Solutions for Business - Large	14	11	No
Portfolio Total	78,900	71,311	No*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 142 summarizes the SWE’s comparison of incentive dollars listed in program tracking data to the program totals in Penelec’s PY13 Annual Report. The SWE was able to exactly replicate incentive dollars for the Energy Efficient Homes, Low Income Energy Efficiency, and C&I Energy Solutions for Business – Large programs. For the other two programs, the SWE calculated directionally similar values using the tracking data. For these five programs, the totals are also directionally similar: \$5,104,000 in the Annual Report and \$5,076,000 in the tracking data.

Table 142: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$1,368	\$1,369	Yes
Energy Efficient Products	\$772	\$788	No
Low Income Energy Efficiency	\$1,504	\$1,504	Yes
C&I Energy Solutions for Business - Small	\$1,280	\$1,236	No
C&I Energy Solutions for Business - Large	\$180	\$180	Yes
Portfolio Total	\$5,104	\$5,076	No

F.4.2 Project File Reviews

F.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample Penelec's residential project files for PY13 using the project file documentation provided by Penelec, the program implementors, and ADM. This is in response to the SWE's standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. Most of the project file packages that were uploaded included a majority of the documentation requested.

Table 143 presents a summary of SWE's residential project file reviews.

Table 143: Penelec PY13 Residential Project File Review Summary

Program	Sub Program	Number of files reviewed ¹	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data? ²
EE Homes Program	Direct Install	7	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	4	✓	✓	✓	✓
EE Homes Program	Multifamily	4	✓	✓	✓	✓
EE Homes Program	New Homes	16	✓	✓	✓	✓
EE Products Programs	Appliances	13	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	8	✓	✓	X	✓
EE Products Programs	HVAC	17	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	12	✓	✓	✓	✓
LIEEP	Appliances	4	✓	✓	✓	✓
LIEEP	Appliance Turn In	10	✓	✓	✓	✓
LIEEP	Direct Install	12	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all FirstEnergy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Energy Efficient Homes Program: Direct Install

Invoices along with customer applications were provided for Penelec's direct install component. A review of the sampled files did not reveal any discrepancies. No project files were submitted in Q1, Q2, or Q3. However, Penelec's participation was limited per the tracking data and PY13 annual report. The SWE notes that the information provided within each project matched the tracking database.

Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. Documentations for these components were only supplied in Q4, however the SWE notes that the majority of activity for the components occurred in the final two months of PY13. The documentation included invoices and specification sheets for each kit by EDC, however the tracking database only provides information at the kit-level. The SWE verified the reported kit-level savings aligned with spec sheet values, and confirmed the date and quantity aligned with the tracking data.

For the school education kits, the documentation included invoices and specification sheets for each kit by the EDC at the individual level. The SWE was able to confirm the total orders for all FirstEnergy EDCs. The SWE was unable to confirm specific instances of kit delivery with the tracking data due to project documentation consisting of batch invoices. However, the SWE was able to verify that the reported savings for an individual kit aligned with the kit contents.

Energy Efficient Homes Program: Multifamily

Project files contained program applications, invoices, and landlord agreements. No project files were submitted for Q1, Q2, or Q4 however Penelec had limited participation per the tracking data and PY13 annual report. All information in project files matched the tracking database.

Energy Efficient Homes Program: New Homes

A review of the sampled files did not reveal any discrepancies between the project files and the tracking database. However, the SWE notes that reported savings for Q1 were unverifiable as the project files only contained REM/Rate reports rather than the REM/Rate building energy models, which are used to confirm that the reported savings values match the tracking data.

Energy Efficient Products Program: Appliances

The SWE observed two small discrepancies between the project files and the program tracking data. In one project file the capacity of the appliance was different and smaller than what appeared in the tracking database. The refrigerator was listed as 38 cubic feet in the invoice yet appeared as 14.8 cubic feet in the tracking database. Additionally in that same project file, the tracking data was missing the model number. In another project file, the provided invoice listed a heat pump that was missing from tracking data.

Energy Efficient Products Program: Appliance Recycling

The SWE was initially unable to match the photographs provided with the project documentation to the tracking data for Q1, Q3, and Q4 due to unclear identifying information between the project files and tracking data.⁸² The photos provided for Q2 were directly tied to a project number which was corroborated with the tracking data information. The SWE also notes that the quality of the photographs does not consistently and clearly capture the nameplate information of the recycled equipment but notes that quality of the photographs improved over the course of PY13. ADM included a useful analysis illustrating the improvement in photo quality and inclusion of verifiable nameplate or model number information. The other project documentation allowed the SWE to confirm the count of recycled appliances for each sampled project, however these counts were only provided in an Excel database with an electronic customer signature.

Energy Efficient Products Program: HVAC

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. Project files mostly matched the tracking data. In one instance tracking data was missing a thermostat included in the project file invoice.

The SWE observed the same discrepancy as previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular variable. In the tracking data, capacity was displayed as a singular *tons* variable.⁸³ That being said, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data.

Starting in PY9, ADM worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations. Most project requests did not include an AHRI certificate, which prevented verification of tracking data measures.

Energy Efficient Products Program: Midstream Appliances

The Midstream Appliance project files included invoices which listed out quantities, appliances, and the total cost. Many of the invoices were designated an EDC but spanned all four EDCs in the tracking data. In addition, these files spanned multiple quarters, so a full reconciliation of quantities did not always match when reviewing the quarterly data uploads of program tracking data. In these instances, the SWE was unable to verify total FirstEnergy and individual EDC quantities. However, ADM was able to confirm that invoice quantities matched when looking at full year tracking data.

⁸² ADM provided the SWE with detailed information on how to corroborate the appliance recycling pictures with the program tracking data, and the SWE confirmed the photographs could be tied back to the program tracking data.

⁸³ For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

Low-Income Energy Efficiency Program: Appliances

The SWE observed no discrepancies between project files and tracking data. Project files included application rebate forms and quantity, size, and recreated savings all matched tracking data. No project files were submitted in Q1 or Q2 however participation was limited per the program tracking data.

Low-Income Energy Efficiency Program: Appliance Turn-In

The SWE review of LI Appliance Turn-In files is summarized in the appliance recycling subsection above.

Low-Income Energy Efficiency Program: Kits

The SWE review of LI kit files is summarized in the energy efficient kits subsection above.

Low-Income Energy Efficiency Program: New Homes

The SWE review of LI New Homes files is summarized in the New Homes subsection above.

Low-Income Energy Efficiency Program: Direct Install

The project documentation for the LI Direct Install mostly matched the quarterly tracking data. Some accounts had multiple tracking data entries that did not correspond to the project file invoice. The SWE observed one case where the project files included a freezer, but the tracking data listed the freezer as a “test” and provided no savings.

F.4.2.2 Non-Residential

As part of its audit process, the SWE conducted a review of ex-ante savings. This review involved assessing specific project files for a sample of Penelec’s non-residential programs in PY13. Project file documentation was provided each quarter of the program year by Penelec, the program implementors, and the evaluation contractor to the SWE. Project documentation provided typically includes program rebate applications and approvals, letters of attestation, invoices for installed equipment, equipment specification or cut sheets, post-inspection forms, and calculation workbooks. The SWE reviewed these documents for completeness and consistency. The SWE also compared the data points in the documentation against the program tracking database to ensure values such as savings, rebate amounts, installation, approval, and invoice dates align.

Project files were generally well organized, complete, and accurate. [Table 144](#) presents an overview of the results of the SWE’s C&I project file reviews.

Table 144: Penelec PY13 C&I Project File Review Summary

Program	Sub-Program	Number of Project Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations ?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate ?
C&I Energy Solutions for Business Program - Small	Custom - SCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Small	Food Service	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program - Large	Lighting - LCI	2	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program - Small	Lighting - SCI	2	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program - Small	Multifamily - SCI	4	1/4	0/4	2/4	1/4	✓	-
C&I Energy Solutions for Business Program - Small	Energy Management - SCI	2	0/2	1/2	0/2	0/2	1/2	-

The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were estimated. However, the SWE did note a few issues with missing documentation for the Multifamily and Energy Management projects reviewed. In addition to these general observations, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **Multifamily - SCI**
 - Missing calculators to check calculated savings with tracking data
 - For one project, the 16 cu. Ft. refrigerator measure was listed in the tracker, but the actual refrigerator installed was a 17 cu Ft.
 - For one project, the savings values did not match the tracking data – double counting savings from LED exit signs.
- **Energy Management - SCI**
 - For one project, the calculator was missing to verify project details (i.e., HOUs, quantities and wattages) and to match demand savings with tracking data
 - For a second project, the invoice was missing to verify quantities

Despite minor issues with some locked calculation workbooks and other small discrepancies, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

F.5 VERIFIED GROSS SAVINGS AUDITS

F.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the Penelec portfolio of residential programs. Penelec's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy Efficient Homes Initiative, the Energy Efficient Products Initiative, and the LI Energy Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings into the three following sections: upstream lighting, residential non-lighting, and behavior.

The SWE identified the evaluation activities used to verify savings for the residential programs. [Table 145](#) provides a summary of the evaluation and M&V approaches used by Penelec in their PY13 verified savings calculations.

Table 145: Residential Program Evaluation Activities - Penelec

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Energy Efficient Homes				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
Energy Efficient Products				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
Low-Income Energy Efficiency Program				
LI Direct Install	-	✓	✓	✓
LI Appliance Turn-in	✓	-	✓	-
LI Appliances	✓	-	✓	-
LI New Homes	-	✓	✓	-
LI Kits	✓	-	✓	-

F.5.1.1 Residential Non-HER

The SWE's review of verified savings for residential non-lighting programs found that, generally, the verified savings followed proper TRM protocols and that the verified savings are accurate. However, the SWE did observe a discrepancy in the kits and appliance program components that led to an underreporting of verified demand savings.

Energy Efficient Homes Program and LIEEP: Energy Efficient and School Education Kits

The SWE reviewed both the energy efficient kits and the school kits subprograms. The SWE worked with ADM to correct any observed discrepancies prior to the filing of the FirstEnergy annual report. The SWE reviewed that the savings calculations were in accordance with the TRM and that the survey results were correctly applied to calculate the program-level realization rates. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the Penelec PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that

participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes the review and results also cover the low-income energy efficient and education kit program components.

Energy Efficient Homes Program and LIEEP: New Homes

The SWE worked with ADM to resolve any discrepancies in the evaluated savings prior to annual reporting. ADM conducted a QA/QC of REM/Rate energy models, confirming model entries were accurate with on-site data. The SWE confirmed the verified savings were in accordance with TRM protocols, including the application of demand savings. In addition, the SWE confirmed the realization rates were correctly applied to calculate program-level savings.

The SWE notes that the review also covered the LIEEP New Homes program component.

Energy Efficient Homes Program and LIEEP: Direct Install

The Direct Install subcomponent of the EE Homes program includes both weatherization and non-weatherization measures. There were no weatherization projects conducted for Penelec in PY13. The SWE reviewed the non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included lighting, nightlights, advanced power strips, connected thermostats, and water heater setbacks.

The SWE also reviewed the LIEEP Direct Install subcomponent, which provides LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE confirmed these measures also applied the correct TRM algorithms to calculate verified savings.

The SWE also confirmed the application of realization rates, participation counts, and the verified savings were accurate in the PY13 report .

Energy Efficient Products Program and LIEEP: Appliances

ADM used a combination of verification surveys, invoice and application reviews, and applied EDC collected data, such as efficiency and capacity data, to program tracking data inputs when deemed appropriate by the TRM. The appliance component includes measures such as: refrigerators, freezers, clothes washers and dryers, dehumidifiers, dishwashers, window ACs, HPWHs, and connected thermostats. The SWE was able to conduct an early review and confirmed that the savings values were correctly calculated using the TRM protocols. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the Penelec PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes that the appendix for this component includes a list of the variables for each appliance, and where the data source came from. This was a helpful addition for the review process.

The SWE notes that the review also covered the LIEEP Appliances program component.

Energy Efficient Products Program and LIEEP: Appliance Recycling

The SWE performed audits on all measures included in the LI and non-LI Appliance Turn-In (ATI) programs, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

Energy Efficient Homes Program: Multifamily

The SWE reviewed the Multifamily subcomponent of the EE Homes program for FirstEnergy. The Multifamily subcomponent directly installed ENERGY STAR lighting, LED night lights, and advanced power strips in residential multifamily units. The SWE observed that the savings were calculated in accordance with the TRM. The SWE also confirmed that the participation counts, realization rates, and total savings were correct.

Energy Efficient Products Program: HVAC

The SWE conducted an early review of the HVAC component. The SWE determined that ADM applied survey results and model-specific values appropriately. The SWE confirmed the participation counts, realization rates, and verified savings aligned with the annual report.

Energy Efficient Products Program: Midstream Appliances

The SWE conducted an early review of the Midstream Appliances component. ADM's evaluation included a full review of the program tracking data and aligning savings estimates with the TRM and product specific data. The SWE did not observe any discrepancies with the application of the TRM algorithms, or the application of EDC gathered data. The SWE confirmed participation counts, realization rates, and verified savings were reported accurately.

Energy Efficient Products Program: Upstream Electronics

The FirstEnergy companies did not offer the Upstream Electronics component of the EE products program in PY13.

F.5.1.2 Behavior

Home Energy Reports were issued to around 30,000 residential and residential-LI households in PY13. 10% of Penelec's progress toward its low-income target in PY13 came from HERs. Penelec's behavioral portfolio consists of two different waves, or cohorts, of homes. Both cohorts were launched during PY13 and one of them targets low-income households. [Table 146](#) summarizes the average number of active households during PY13 by cohort.

Table 146: Penelec HER Cohort Summary

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	18,218	11,145
2021 Low-Income	9/30/2021	11,036	10,450

The program ICSP Oracle implemented both cohorts as a randomized control trial (RCT) where the eligible households were identified and then randomly assigned to either a treatment or control group. Following randomization, ADM conducted statistical tests on the pre-treatment energy usage patterns to confirm equivalence between the treatment and control groups.

RCT Validation

The SWE team conducted an audit of randomization soundness and pre-treatment equivalence for the two cohorts introduced in PY13. The SWE team ran a simple fixed effects regression model using the pre-treatment data with indicator variables for each month and for the treatment. During the pre-treatment period, we'd expect the "treatment" indicator variable to be statistically insignificant, as the treatment effect is only expected after HER delivery begins. Indeed, we found the treatment indicator variable to be statistically insignificant for both cohorts. The SWE team also ran a t-test of pre-period usage by treatment status for each cohort and found all differences in usage to be statistically insignificant. [Figure 74](#) and [Figure 75](#) display the monthly distribution of daily kWh usage for the treatment and control groups of each of the cohorts. These visuals reinforce the finding that pre-treatment usage patterns are extremely similar between the treatment and control groups of each cohort.

Figure 74: Pre-Treatment Equivalence, Residential Cohort

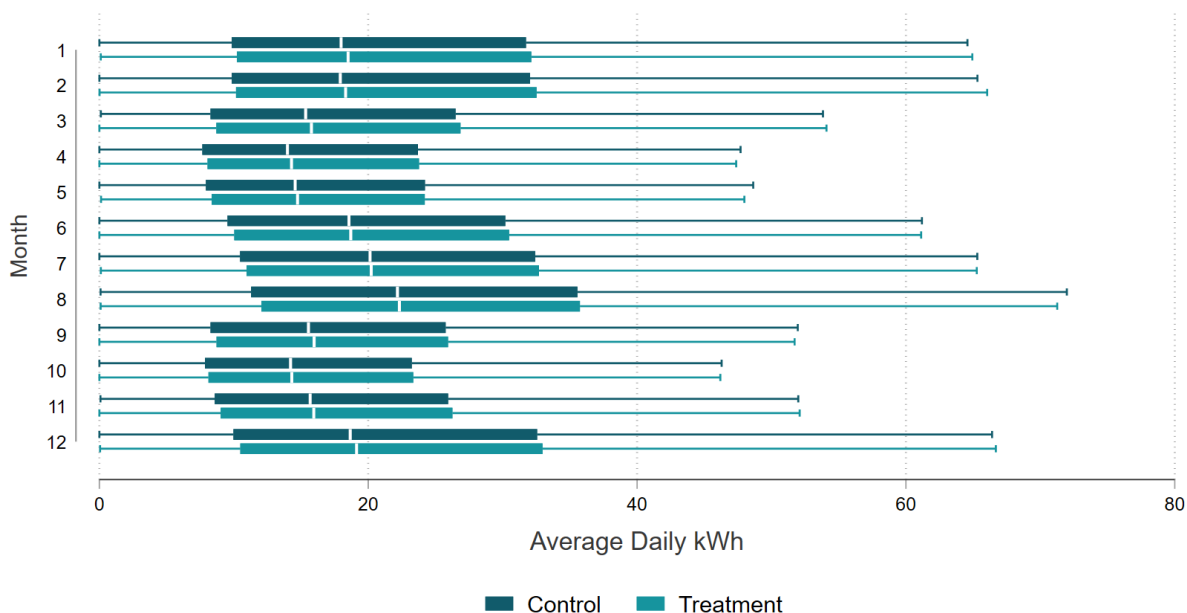
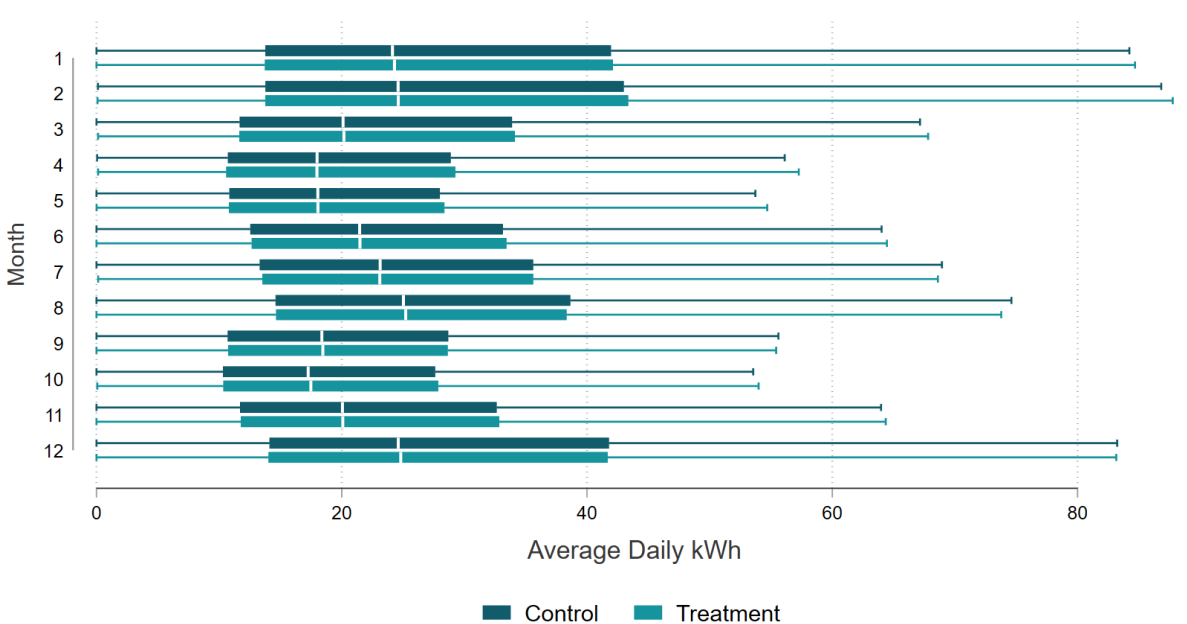


Figure 75: Pre-Treatment Equivalence, Low-Income Cohort



Data Preparation

The SWE team received interval data from ADM at three different levels: hourly, daily, and monthly. The monthly data is the primary input in the estimation of HER impacts. The SWE team independently checked the aggregation of the daily data to the monthly level, and we found the calculations to be sound (and we also found the distribution of monthly kWh to be reasonable). ADM used a lagged seasonal (LS) regression model for the PY13 impact analysis as called for in

the Penelec PY13 EM&V plan. The LS model contains three lag variables: one for average usage during the pre-treatment period (all months), one for average summer usage during the pre-treatment period, and one for average winter usage during the pre-treatment period. The SWE team was able to replicate the three lagged variables calculated by ADM.

Participant Counts

ADM obtains active customer counts for each month by tallying up the number of accounts that have hourly interval data for the month. Only active accounts where HER delivery has begun are included in these calculations. An inconsequential number of accounts were not counted for other reasons (placed in both the control group and treatment group or multiple treatment starting dates). A larger number of accounts (5.5% of the total treatment accounts) were not included in the counts because Oracle never began HER delivery to these homes or due to pre-start date attrition.

The SWE team validated ADM enrollment counts by performing a similar counting method on the hourly interval data. Customers are considered active through the end of the month that they last have interval data. For example, if a customer's final AMI record is from February 15th, the customer would be included in the count for February but not in March or any month following. The SWE team's final customer counts matched ADM's counts within 0.1 percent for each month and each cohort.

Customers that did not have 12 months of pre-treatment data were not included in the impact estimation (because the lagged variables for these customers could not be calculated), but they were included in the customer counts.

Impacts

By month, the daily impact estimates are plotted in [Figure 76](#) (residential) and [Figure 77](#) (low-income). Notably, June through September are not included in the figure. This is because HER delivery did not begin until October. For each cohort, [Table 147](#) shows the average of the PY13 monthly impact estimates (across the eight active months). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.05 kWh per day, on average, during PY13. The SWE was able to replicate ADM's impact estimate for each cohort/month combination.

Table 147: Penelec HER Impact Estimates

Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.05
2021 Low-Income	0.24

Figure 76: Average Daily Savings (kWh) by Month, Residential Cohort

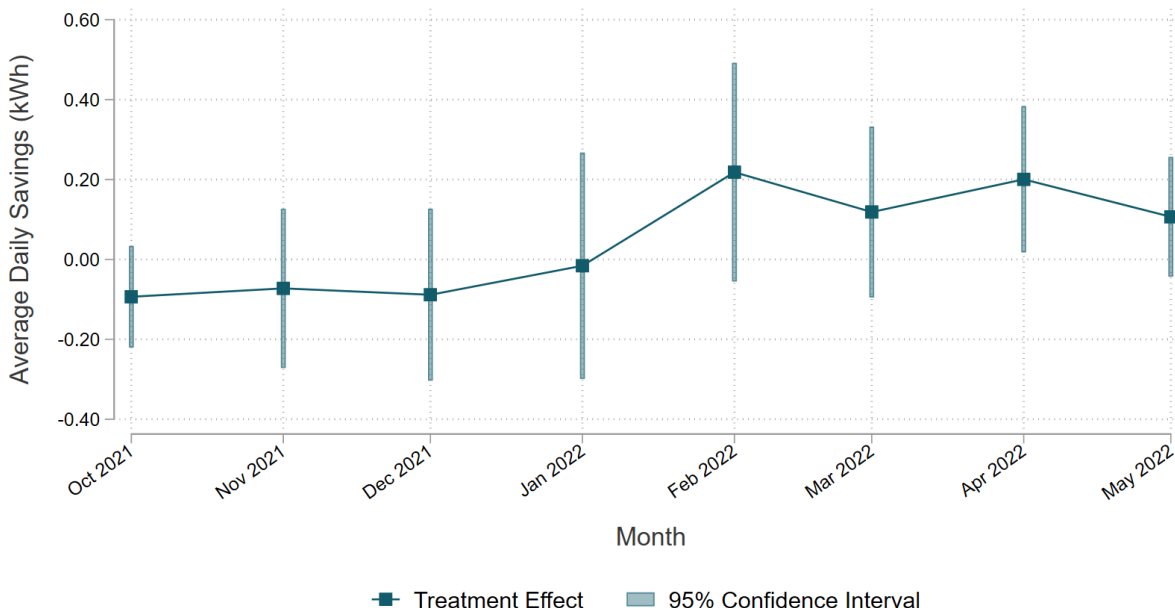
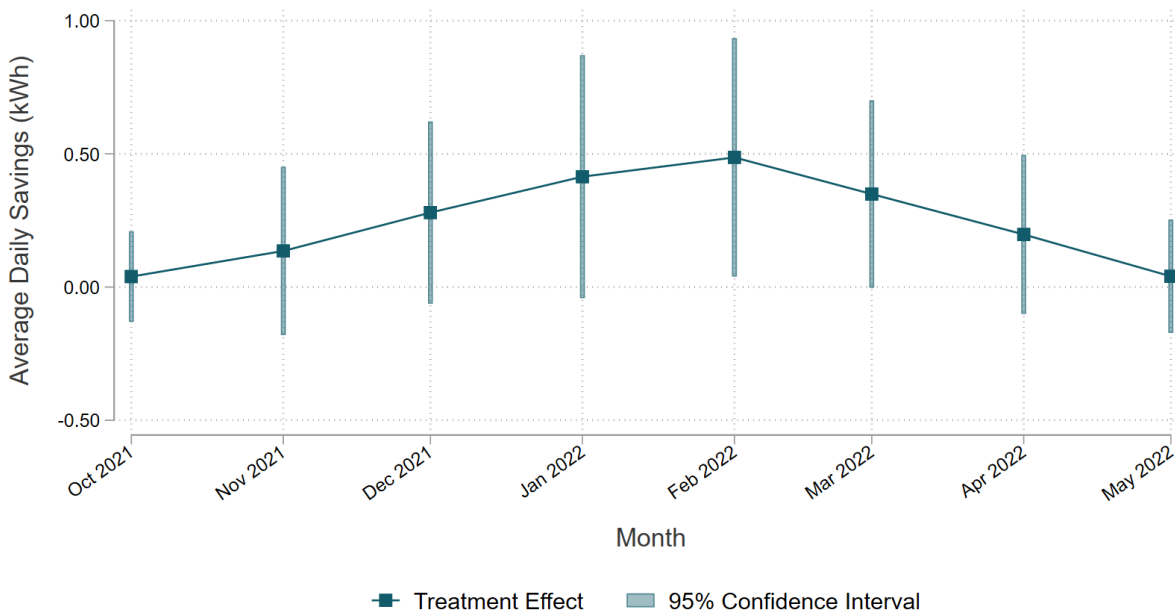


Figure 77: Average Daily Savings (kWh) by Month, Low-Income Cohort



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 148](#) shows the aggregate PY13 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, which are discussed in greater detail later, and the PY13 incremental gross savings estimate.

Table 148: PY13 HER Energy Savings

Cohort	Gross Savings (MWh/yr)	Downstream Dual Participation (MWh/yr)	Upstream Dual Participation (MWh/yr)	Persistence (MWh/yr)	Incremental Savings (MWh/yr)
2021 Residential	199	10	0	0	189
2021 Low-Income	640	-5	0	0	645
Total	839	5	0	0	834

Dual Participation

In [Table 148](#), gross savings before adjusting for dual participation were 839 MWh. It is important to note that Home Energy Reports advertise other Penelec residential EE&C programs and measures such as ENERGY STAR appliances, water heaters, HVAC etc. To the extent that treatment group households participate in these programs more frequently than control group homes, the incremental savings is captured in the regression estimates for the HER analysis. To avoid double-counting, the HER savings are reduced to account for the incremental program participation observed in the treatment group compared to the control group.

Regarding upstream dual participation, note that Penelec did not offer an upstream lighting program in PY13. The Upstream Electronics component of the Energy Efficient Products Program was not offered in PY13 either. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

Persistence

PY13 saw the introduction of a new framework for separating persisting savings from previous program years from incremental savings attributable to the treatment in the current program year. The 2021 TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research⁸⁴ on the persistent effects of behavioral energy efficiency treatment in the years after discontinuing treatment. Since Act 129 compliance goals are based on first-year incremental savings, these persistent impacts are subtracted from the measured savings to estimate incremental first-year savings (those directly due to the current program year of treatment). Because both PY13 Penelec waves were launched during PY13, all savings are first-year savings. Separating persisting savings from incremental savings was not necessary.

⁸⁴ Addendum to Act 129 Home Energy Report Persistence Study. November 2018. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

Peak Demand Impacts

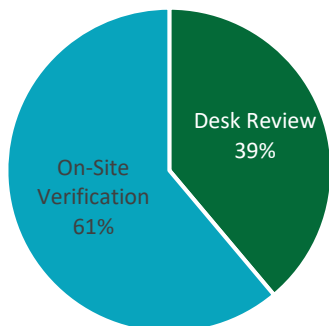
The 2021 TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 PM to 6:00 PM Eastern Daylight Time on non-holiday weekdays during June, July, and August. Because HER delivery did not begin until the fall, there were no peak demand impacts in PY13.

F.5.2 Non-Residential Audit Activities

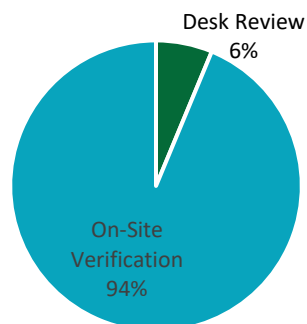
Figure 78 provides a summary of the evaluation activities and M&V approaches utilized by Penelec's evaluation contractor, ADM, in their PY13 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY13, Penelec's evaluation contractor completed site visits to 82% of evaluated projects, and these projects represented 84% of total evaluated energy savings. In total, 33 site visits were completed. IPMVP Options A, B, C, and D were employed for 92% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 8% of the total evaluated savings, including majority of prescriptive projects and most energy management projects.

Figure 78: Summary of Penelec’s C&I Evaluation Activities

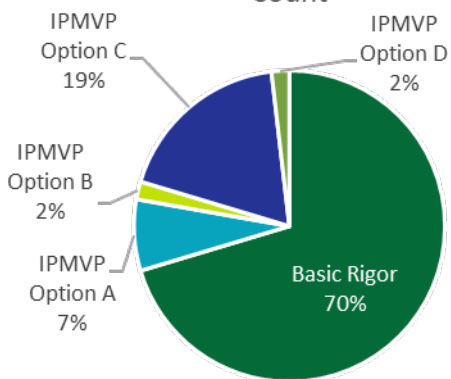
Evaluation Activity by Project Count



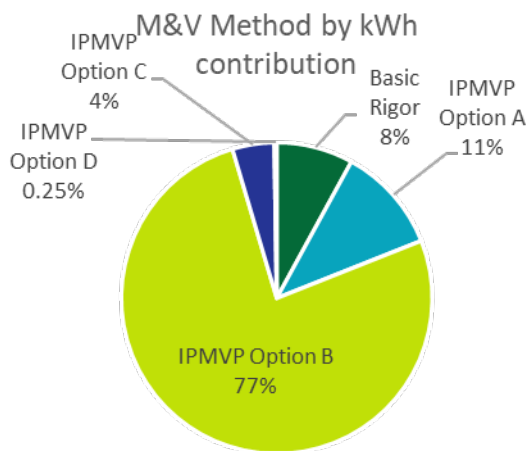
Evaluation Activity by kWh contribution



M&V Method by Project Count



M&V Method by kWh contribution



Penelec’s evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Penelec’s C&I programs are assigned to one of four evaluation initiatives, as Penelec’s programs target specific sectors of C&I customers, but offerings are often identical across the programs. [Table 149](#) provides a summary of the evaluation activities Penelec’s evaluation contractor used across strata for all projects by initiative.

Table 149: Summary of Penelec’s PY13 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
Appliance Recycling	-	108%	104%	-	-
Custom	11	100%	100%	10	1
Custom – C	1	100%	100%	-	1
Custom – 1	10	100%	100%	10	-
Prescriptive	18	95%	86%	3	15
Downstream Lighting - C	-	-	-	-	-
Downstream Lighting - 2	4	100%	88%	-	4
Downstream Lighting - 1	8	90%	84%	-	8
Downstream Non-Lighting	2	81%	100%	2	-
Midstream Lighting	3	90%	79%	-	3
Midstream Non-Lighting	1	34%	34%	1	-
EMNC	16	86%	75%	6	19
EMNC	1	100%	100%	1	-
Building Tune-Ups	15	86%	74%	5	10
Multifamily	9	72%	70%	2	7
TOTAL	54			21	33

The SWE’s review of verified savings for non-residential programs found that, overall, the verified savings estimation was aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and that the verified savings are generally accurate. The following sections describe the SWE’s audit of the verified savings methodology for non-residential programs in further detail.

F.5.2.1 Appliance Recycling Initiative

In PY13, projects in Penelec’s Appliance Recycling Sub-Initiative were evaluated through a review of tracking and reporting data. The gross energy and demand realization rates for each evaluation stratum were taken to be the realization rates from the broader initiative-level evaluation which included the residential and low-income residential components.

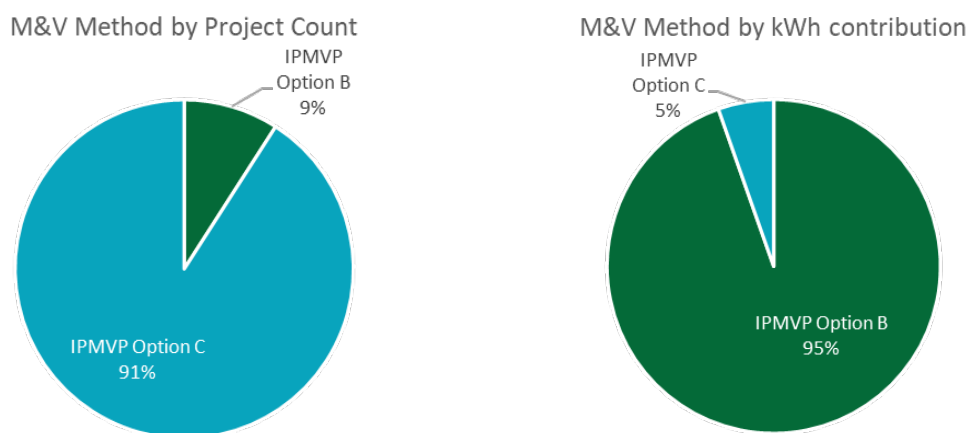
F.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews and/or IPMVP evaluation methods for all sampled projects. No site visits were conducted for PY13 custom sampled projects. The evaluation was satisfactorily conducted through desk reviews for all projects using data provided by the customer (EMS data, billing data, etc.).

Penelec's evaluation contractor employed two strata for projects in the Custom initiative. The largest projects, with ex-ante savings estimates of 500 MWh or more, are separated into a "certainty" stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

The distribution of rigor across the sample strata is in keeping with Table 14 of the Phase IV Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. Enhanced rigor methods were employed to evaluate all projects, with IPMVP Option C selected as the primary enhanced M&V method for 91% of evaluated custom projects, as shown in [Figure 79](#).

Figure 79: Summary of Penelec's C&I Custom Program M&V Methods



F.5.2.3 Prescriptive Initiative

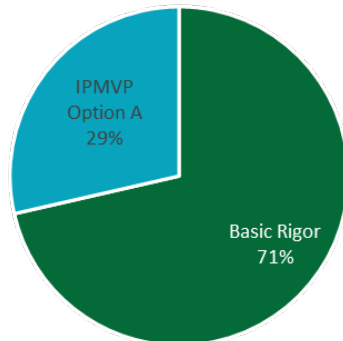
Evaluation activities for this initiative include desk reviews for most projects and primary data collection of lighting hours of use for medium and high savings projects. TRM deemed hours of operation were applied in basic rigor desk reviews for low savings projects. All sampled projects undergo a full documentation review prior to site visits, and site-specific M&V plans are developed for most.

Penelec's evaluation contractor employed three strata for projects in the Prescriptive initiative. The largest projects, with ex-ante savings estimates of 750 MWh or more, are separated into a "Downstream - Certainty" stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

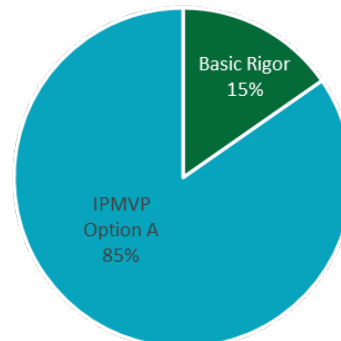
Basic Rigor was employed for 71% of evaluated projects in this initiative with the remaining projects using IPMVP Option A, as seen in [Figure 80](#) below.

Figure 80: Summary of Penelec’s C&I Prescriptive Program M&V Methods

M&V Method by Project Count



M&V Method by kWh contribution



F.5.2.4 Commercial and Industrial Energy Management and New Construction Initiative (CI EMNC)

The CI EMNC Initiative has five subcomponents, but only two were active in PY13: Building Tune-Up and New Construction.

Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Basic rigor M&V methods were applied to these projects, incorporating TRM algorithms and reconciliations of invoices with equipment specification sheets.

Projects in the New Construction strata were evaluated using IPMVP Option D, which included review of baseline and as-built simulation models developed in the implementer’s custom simulation tool.

Basic Rigor was employed for 100% of evaluated projects in this initiative for Met-Ed.

F.5.2.5 Master-Metered Multifamily Direct Install Initiative

All sampled projects in the CI MF initiative were evaluated using basic rigor desk reviews, with on-site inspections conducted for about one-third of the sample. The desk review process included reconciliation of invoices and re-calculation of reported savings using TRM algorithms.

F.5.2.6 Verified Savings Audits

The SWE audited the activities above through a detailed audit of ADM’s evaluation work for a sample of their evaluated projects. The SWE audit for ADM’s Penelec evaluation in PY13 included review of nine (9) projects, encompassing the following activities:

- 5 Field and Analysis Engineers were observed
- 4 Measure Types were observed
- 4 In-Person Ride-Alongs conducted
- 62% of Verified Energy Savings reviewed

- 58% of Verified Demand Savings reviewed

Table 150 provides an overview of the SWE milestones for the verified savings audit review of evaluated Penelec's projects.

Table 150: Penelec Verified Savings Audit Review Milestones

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
9	9,553,952	100%	2,361	100%

Overall, the SWE found that Penelec's evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods for custom measures. The overall energy and demand savings attainment percentages of Penelec's reviewed projects were 100% for both energy and demand savings.

F.6 NTG

Table 151 lists Penelec's PY13 NTG results across all programs. Details concerning the methods and data used to estimate NTG values are in sections F.6.1 and F.6.2.

Table 151: Summary of Penelec PY13 NTG Results

Program Name	Component	NTG
Energy Efficient Homes	EE Kits	0.84
Energy Efficient Homes	Home Energy Reports	1.0
Energy Efficient Homes	Direct Install	1.03
Energy Efficient Homes	New Homes	0.73
Energy Efficient Homes	Multifamily	0.84
Energy Efficient Homes	Online Audits	1.0
Energy Efficient Products	Appliance Recycling	0.65
Energy Efficient Products	Upstream Electronics	0.58
Energy Efficient Products	HVAC	0.52
Energy Efficient Products	Appliances	0.60
Energy Efficient Products	Midstream Appliances	0.53
Low-Income	Appliances	1.0
Low-Income	Appliances Turn-In	1.0
Low-Income	Direct Install	1.0
Low-Income	Home Energy Reports	1.0
Low-Income	Kits	1.0
Low-Income	New Homes	1.0
Low-Income	Online Audits	1.0
C&I Solutions for Business Programs - Small and Large	Prescriptive	0.78
C&I Solutions for Business Programs - Small and Large	Custom	0.89
C&I Solutions for Business Programs - Small and Large	EMNC	0.75
C&I Solutions for Business Programs - Small and Large	Multifamily	1.0
C&I Solutions for Business Programs - Small and Large	Appliance Recycling	0.65

F.6.1 Residential Programs

ADM planned and enacted NTG research for the residential Appliance Recycling program for PY13 (Table 152). ADM utilized participant surveys to estimate free-ridership and NTG reasoning that spillover was not necessary since the Appliance Recycling program does not lead to installation of Energy Efficient Products. ADM utilized a free-ridership battery of questions that was consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation (excluding spillover).

All other residential programs utilized NTG values estimated, and SWE verified during Phase III with the exception of the Home Energy Report Program. The Home Energy Report program NTG was assigned a value of 1.0, in accordance with the Phase IV Evaluation Framework. The random control trial (RCT) design of the program eliminates the need for NTG analysis because the control

group does everything the treatment group would have done and the estimated savings are technically net savings.

Table 152: Summary of Penelec's PY13 Residential NTG Results

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
EE Kits	N/A	N/A	21%	4%	0.84
Home Energy Reports	RCT	N/A	0%	0%	1.0
Direct Install	N/A	N/A	16%	19%	1.03
New Homes	N/A	N/A	27%	0%	0.73
Multifamily	N/A	N/A	16%	0%	0.84
Online Audits	N/A	N/A	0%	0%	1.0
Appliance Recycling	Self-Report Survey	165	35%	0%	0.65
Upstream Electronics	N/A	N/A	N/A	N/A	0.58
HVAC	N/A	N/A	49%	1%	0.52
Appliances	N/A	N/A	47%	7%	0.60
Midstream Appliances	N/A	N/A	47%	0%	0.53

F.6.2 C&I Energy Efficiency Programs

ADM did not conduct any new NTG research for C&I programs in PY13 (Table 153). They applied NTG values from Phase III NTG evaluations that have been verified by SWE during Phase III. ADM did apply the residential Appliance Recycling PY13 NTG to the C&I Appliance Recycling program and assigned a NTG value of 1 to the C&I Multifamily program as it is a low-income program.

Table 153: Summary of Penelec's PY13 C&I NTG Results

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	N/A	N/A	25%	3%	0.78
Custom	N/A	N/A	11%	0%	0.89
EMNC	N/A	N/A	25%	0%	0.75
Multifamily	N/A	N/A	N/A	N/A	1.0
Appliance Recycling	N/A	N/A	47%	0%	0.53

F.7 TRC

Table 154 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Penelec's PY13 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY13 annual report and the model itself was well-organized and documented.

The program designs presented in FirstEnergy's Phase IV EE&C Plan are organized into the following sectors: (1) Residential; (2) Residential Low-Income; (3) Small Commercial and Industrial; and (4) Large Commercial and Industrial. The number of programs within these sectors decreased from nine in Phase III to five in Phase IV in part due to the exclusion of dispatchable demand response from Phase IV. The Appliance Turn-In Program is now a component of the Energy Efficient Products Program.

Both gross and net TRC ratios increased from PY12, with the largest increase occurring in the Low-Income Energy Efficiency program and the only decreases occurring in the Energy Efficient Products and C&I Energy Solutions for Business - Large programs. Pursuant to the 2021 TRC Test Order directive for Phase IV, the nominal discount rate is now 5% and no longer tied to WACC. All else being equal, a lower discount rate improves the TRC ratio.

Table 154: Summary of Penelec's PY13 TRC Results

Program Name	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Energy Efficient Homes	\$6,353	\$2,198	2.89	\$5,284	\$2,021	2.61
Energy Efficient Products	\$3,280	\$3,935	0.83	\$1,859	\$2,625	0.71
Low Income Energy Efficiency	\$3,052	\$2,308	1.32	\$3,052	\$2,308	1.32
C&I Energy Solutions for Business - Small	\$7,926	\$5,201	1.52	\$6,807	\$4,632	1.47
C&I Energy Solutions for Business - Large	\$1,147	\$1,251	0.92	\$898	\$1,149	0.78
Portfolio Total	\$21,759	\$14,893	1.46	\$17,901	\$12,736	1.41

Three of Penelec's five EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. The same three programs were found to be cost-effective using net verified savings. The Energy Efficient Products and C&I Energy Solutions for Business - Large programs were not cost-effective on a gross verified or net verified basis. The Energy Efficient Products program was not cost-effective in part due to the high incremental costs relative to energy savings for ENERGY STAR appliances like clothes dryers and dishwashers.

F.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- Penelec’s annual electric energy savings are calculated and allocated by season (summer, winter, and shoulder) and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is consistent with the on-peak hours defined in the 2021 TRM (Monday – Friday 7AM to 11PM). The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions. The SWE also verified the correct avoided costs from Penelec’s EE&C Plan were used in the TRC Model. The TRC Model accurately collapsed the 8,760 hourly load shapes into single annual weighted-average values used in the energy benefit calculations.
- Penelec had the highest PY13 TRC ratio of the four FirstEnergy companies, in part due to higher capacity avoided costs than Penn Power or West Penn Power.
- To calculate the avoided cost of natural gas, Penelec used a three-segment approach outlined in the 2021 TRC Test Order. The SWE verified the TRC Model correctly applied the avoided costs to estimate TRC benefits.
- Pursuant to the 2021 TRC Test Order, the SWE verified Penelec used a nominal discount rate of 5% to calculate the net present value of future program benefits. This discount rate is consistent with their EE&C plan. Line loss adjustment factors varied by sector. Residential (1.0945), Small C&I (1.072) and Large C&I (1.072).

The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the Database for Energy Efficiency Resources (DEER), company assumptions, and actual project costs as gathered from the PY13 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent with Penelec’s EE&C plan.

- For non-residential lighting measures, Penelec consistently applied the benefits and incremental costs of Early Replacement to all measures. This aligns with the definitions in Table 6 of the 2021 TRC Test Order and the measure vintage in the 2021 TRM.
- Realization rates for energy and demand impacts were applied to the reported gross program impacts in the TRC model to calculate verified gross savings.
- The calculation of NTG using free-ridership and spillover, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the 2021 TRC Test Order directive for Phase IV. The TRC model followed the protocol pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.
- The SWE found that the cost categories were handled correctly in the TRC model. Participant incentives were not considered TRC costs, while administrative costs, incremental costs, and kits were incorporated as costs.

- The SWE verified the ex-ante demand and capacity savings were accurate in the TRC model by comparing to the Quarterly Tracking Data reported by Penelec.
- According to the Phase IV Evaluation Framework, low-income measures are required to be provided at no cost to the participants. At first glance, it appears that Penelec's low-income programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the Low-Income Energy Efficiency Program (Table 63 in FirstEnergy's PY13 Annual Report). However, in their Phase IV EE&C Plan, Penelec explains that these costs are only being allocated to landlords and owners of low-income properties, rather than the low-income customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Fossil Fuel Impacts and Total NPV Lifetime Water Impacts. The SWE verified that the savings were accounted for in accordance with 2021 TRC Test Order. Penelec correctly reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative benefit rather than a program cost. The TRC model claimed over 26 million gallons per year of water saving, which translates to approximately \$3,352,000 in NPV lifetime avoided costs.

F.8 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to the programs across the four FirstEnergy EDCs, including Penelec, so the annual evaluation report of the four FirstEnergy EDCs reports identical information about the process evaluation. Therefore, [Appendix E.8](#) of the SWE's PY13 Final Annual Report, described previously for Met-Ed, applies to all four FirstEnergy utilities, including Penelec. The customer survey for the Appliance Recycling component set a goal of completions by 123 Penelec customers; the target was exceeded with 177 completions.

Appendix G FirstEnergy: Pennsylvania Power Company PY13 Audit Detail

G.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, and were generally accurate.
- Penn Power provided their Residential and Low Income verified savings analyses prior to drafting their annual reports. This allowed the SWE to conduct an early review and had ample time and opportunity to discuss any questions, potential discrepancies, and review updated results that could be directly incorporated into the PY13 annual report for the FirstEnergy companies. In addition, the verified savings analyses were well organized, and included the documentation required to conduct verified savings checks from the measure-level all the way to program-level savings.
- Penn Power initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (5.5% of MWh) compared to Phase III. HERs accounted for approximately 15% of Penn Power's progress toward its low-income compliance target in PY13. Because the cohorts launched after the summer, Penn Power claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and FirstEnergy's evaluation contractor, ADM Associates (ADM), was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.
 - The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.
- Penn Power's non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.04 but showed a TRC ratio far lower than PPL and Duquesne Light despite similar a set of measure offerings. A key driver of the difference is incremental cost assumptions

for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penn Power's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE only noted a few minor discrepancies.
- The SWE conducted a project file review for a sample of Penn Power's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.
- The SWE found several transcription errors in program component level NTG ratios for Penn Power in the summary tables included in Chapter 2 of the FirstEnergy PY13 Annual Report. The NTG values reported in the program specific chapters and appendices were accurate, however. ADM was extremely responsive when the SWE pointed out the reporting errors and provided corrections to the SWE.

G.2 EM&V PLAN REVIEWS

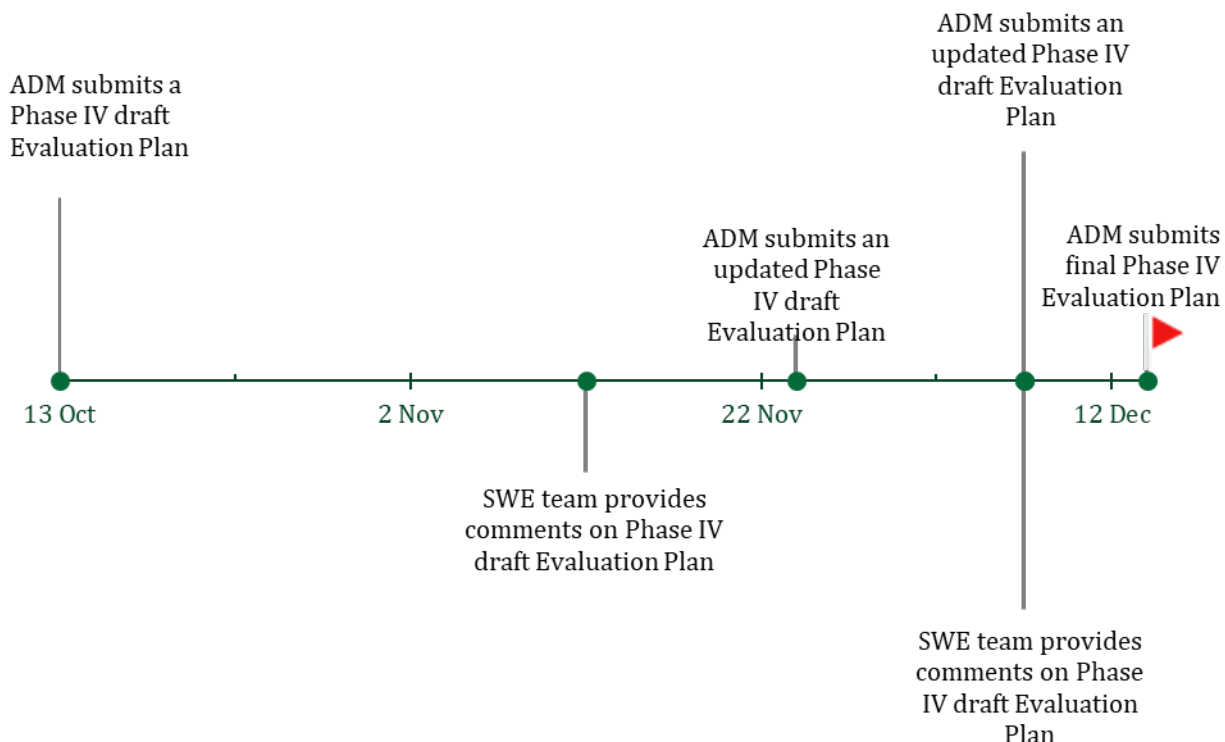
ADM first submitted a draft Phase IV EM&V plan on October 13, 2021. The plan was organized by sector detailed the gross impact, net impact, and process evaluation activities by program. After several rounds of comment from the SWE and revisions by ADM, the final evaluation plan was approved by the SWE in mid-December 2021. The SWE brought some of the following points to ADM during revision of the plans:

- Impact evaluation activities for PY17. The initial plan called for annual impact evaluations in PY13-PY16 with PY17 relying almost entirely on historic realization rates. The SWE and ADM ultimately agreed on staggering the historic realization rates across PY16 and PY17.
- The baseline wattage for LED lamps in energy efficiency kits.

- The expected types of measures and impact evaluation techniques for the CI Energy Management and New Construction sampling initiative.
- How to disentangle HER impacts from the Online Audit subprogram impact estimates.
- Peak demand savings methodology for behavioral Home Energy Reports.

Figure 81 shows the review timeline of correspondence between ADM and the SWE team to finalize the Phase IV EM&V plan.

Figure 81: Penn Power Evaluation Plan Review Timeline 2021-2022



As discussed in Section 4.2, each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. Penn Power, however, will evaluate verified gross impacts for all programs in PY13. Penn Power will not use historic realization rates until PY15 and PY17. Table 155 shows all Penn Power programs, which produced verified impacts in PY13.

Table 155: PY13 Penn Power Program Impact Evaluation Summary

Sector	Components	PY13 Impacts
Residential	EE Kits	Verified
	Home Energy Reports	Verified
	Midstream	Verified
	New Homes	Verified
	Downstream HVAC	Verified
	LI Direct Install	Verified
	On-Line Audit	Verified
	Downstream Appliances	Verified
	LI - Home Energy Reports	Verified
	Smart Thermostats	Verified
	Audit and DI	Verified
Cross-Cutting	Appliance Recycling	Verified
	Multifamily	Verified
C&I	Custom	Verified
	Lighting Downstream	Verified
	Lighting Midstream	Verified
	Energy Management and New Construction	Verified
	Prescriptive Non-Lighting Downstream	Verified
	Prescriptive Non-Lighting Midstream	Verified

In addition to the evaluation plans, the SWE also reviewed and provided comments on draft survey instruments in April 2022 for multiple programs.

G.3 SAMPLE DESIGN REVIEW

The Phase IV Evaluation Framework establishes a maximum level of sampling uncertainty of $\pm 15\%$ at the 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. This change was implemented specifically for EDCs like Penn Power, who define EE&C programs broadly, but have specific offerings that are a more logical grouping for evaluation purposes due to program delivery channel or supported technology.

Penn Power’s EE&C portfolio consists of five programs: Energy Efficient Homes, Energy Efficient Products, Low Income Energy Efficiency, C&I Energy Solutions for Business – Large, and C&I Energy Solutions for Business – Small. The SWE performed its annual sample design review at the initiative level, which sometimes span multiple programs or sectors. In response to the annual

data request, FirstEnergy's EM&V contractor provided the SWE with a sample disposition for each initiative detailing the project-level ex-ante and ex-post savings for each unit in the samples.

Table 156 shows the relative precision of PY13 energy and demand impacts by component at the 85% confidence level. Note that the Online Audit program, which had zero reported savings and demand impacts for PY13, is omitted.

Table 156: Relative Precision of PY13 Impacts by Program Component at the 85% Confidence Level

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	15.4%	14.8%
	LI - EE Kits	15.6%	15.5%
	Midstream	0.0%	0.0%
	New Homes & Smart Thermostats	13.6%	13.6%
	HVAC	14.0%	13.7%
	LI - Direct Install	9.6%	9.6%
	Downstream Appliances	11.7%	12.5%
	Audit and DI	0.0%	0.0%
Cross-Cutting	Appliance Recycling	8.2%	7.6%
	Multifamily	10.0%	10.5%
C&I	Custom	1.9%	2.3%
	Prescriptive	8.6%	9.5%
	Energy Management and New Construction	10.5%	10.5%

The Residential Midstream and Audit and Direct Install components have a relative precision of $\pm 0\%$. ADM evaluated all projects undertaken in those programs in PY13, so there is no sampling uncertainty.

ADM established in their Phase IV evaluation plan submitted to the SWE that they would use an assumed coefficient of variation derived from past program years for initial sample design. However, ADM also used these planning coefficients of variation to calculate and report initiative-level relative precision. For the C&I Prescriptive initiative, ADM designed its PY13 sample using a coefficient of variation of 0.4. The Phase IV EM&V plan notes that 0.4 was a deliberately conservative estimate of the expected coefficient of variation, which the SWE team found to be true for PY13. The SWE team replicated the C&I Prescriptive rollup instead using observed coefficients of variation and found the relative precision of savings estimates to be lower than the reported figures of 8.6% for energy and 9.5% for demand. The SWE team recommends that ADM use manual variance calculations in place of planning coefficients of variation in their PY14 report to yield more accurate estimates of relative precision. Although the SWE still recommends leaving a hedge to guarantee that the $\pm 15\%$ relative precision threshold is met, ADM might be able to use fewer sample points than they did in PY13 for certain initiatives with low coefficients of variation.

The Behavioral Modification subprogram provides HERs to residential customers in the Penn Power service territory. The subprogram is divided between market rate residential customers

and LI customers, and each is administered as an RCT. Participants are enrolled in experimental cohorts and a monthly billing analysis regression is used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase IV Evaluation Framework requiring the solution-level verification achieve an absolute precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 157](#) shows the absolute precision of PY13 Behavioral Modification impacts at the 95% confidence level.

Table 157: Absolute Precision of PY13 Impacts for Behavioral Modification Programs at the 95% Confidence Level

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.28%
Behavioral Modification (LI)	0.51%

Penn Power did not meet the absolute precision threshold of $\pm 0.5\%$ for the low-income wave of their Behavioral Modification program in PY13.

G.4 REPORTED GROSS SAVINGS AUDITS

G.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Penn Power's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)
- Participation counts
- Incentive dollars

The SWE leveraged Penn Power's Q1-Q4 tracking data to audit these values. Note that the SWE does not receive the full tracking data set, rather a subset of the full tracking data set tailored to our PY13 quarterly data request. Also note that HER programs are not audited using the tracking data, thus they are not included in the tables or totals in the following sections. The SWE's findings regarding the HER components of the Energy Efficient Homes and LIEEP can be found in [Appendix G.5.1.2](#).

Table 158 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in Penn Power’s PY13 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by Penn Power.

Table 158: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	3,117	3,117	Yes*
Energy Efficient Products	2,548	2,548	Yes
Low Income Energy Efficiency	1,470	1,470	Yes*
C&I Energy Solutions for Business - Small	1,150	1,150	Yes
C&I Energy Solutions for Business - Large	7,293	7,293	Yes
Portfolio Total	15,579	15,579	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 159 summarizes the SWE’s findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. Like with reported gross energy savings, the tracking data supports the Penn Power PY13 Annual Report value exactly for all programs.

Table 159: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	0.63	0.63	Yes*
Energy Efficient Products	0.52	0.52	Yes
Low Income Energy Efficiency	0.18	0.18	Yes*
C&I Energy Solutions for Business - Small	0.17	0.17	Yes
C&I Energy Solutions for Business - Large	0.84	0.84	Yes
Portfolio Total	2.34	2.34	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 160 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for all programs. The portfolio totals, though not exactly equal, line up well: 25,295 in the Penn Power PY13 Annual Report and 22,354 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with the EDCs and their evaluation contractors to understand the Phase IV business rules around counting participants for different program components.

Table 160: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	13,606	11,905	No*
Energy Efficient Products	7,208	7,623	No
Low Income Energy Efficiency	4,412	2,765	No*
C&I Energy Solutions for Business - Small	61	56	No
C&I Energy Solutions for Business - Large	8	5	No
Portfolio Total	25,295	22,354	No*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 161 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in Penn Power's PY13 Annual Report. The SWE was able to exactly replicate incentive dollars for all programs except Energy Efficient Homes. The totals are nearly identical at the portfolio level: \$2,066,000 in the Annual Report and \$2,058,000 in the tracking data.

Table 161: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$612	\$603	No
Energy Efficient Products	\$343	\$344	Yes
Low Income Energy Efficiency	\$411	\$411	Yes
C&I Energy Solutions for Business - Small	\$240	\$240	Yes
C&I Energy Solutions for Business - Large	\$460	\$460	Yes
Portfolio Total	\$2,066	\$2,058	No

G.4.2 Project File Reviews

G.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of Penn Power's residential project files for PY13 using the project file documentation

provided by Penn Power, the program implementors, and ADM. This is in response to the SWE's standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms.

Table 162 presents a summary of SWE's residential project file reviews.

Table 162: Penn Power PY13 Residential Project File Review

Program	Sub Program	Number of files reviewed ¹	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data? ²
EE Homes Program	Direct Install	7	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	4	✓	✓	✓	✓
EE Homes Program	Multifamily	4	-	-	-	-
EE Homes Program	New Homes	16	✓	✓	✓	✓
EE Products Programs	Appliances	13	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	8	✓	✓	X	✓
EE Products Programs	HVAC	17	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	12	✓	✓	✓	✓
LIEEP	Appliances	4	-	-	-	-
LIEEP	Appliance Turn In	10	✓	✓	✓	✓
LIEEP	Direct Install	12	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all FirstEnergy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Energy Efficient Homes Program: Direct Install

Invoices along with customer applications were provided for Penn Power's direct install component. A review of the sampled files did not reveal any discrepancies. No project files were submitted in Q1 and Q2 however participation was limited per the tracking data and PY13 annual report. The SWE notes that the information provided within each project matched the tracking database.

Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. Documentation for these programs were only supplied in Q4, however the SWE notes that the majority of activity for the component occurred in the final two months of PY13. The documentation included invoices and specification sheets for each kit by EDC, however the tracking database only provides information at the kit-level. The SWE verified the reported kit-level savings aligned with spec sheet values, and confirmed the date and quantity aligned with the tracking data.

For the school education kits, the documentation included invoices and specification sheets for each kit by the EDC at the individual level. The SWE was able to confirm the total orders for all FirstEnergy EDCs. The SWE was unable to confirm specific instances of kit delivery with the tracking data due to project documentation consisting of batch invoices. However, the SWE was able to verify that the reported savings for an individual kit aligned with the kit contents.

Energy Efficient Homes Program: Multifamily

The SWE did not review any Penn Power multifamily project files in PY13 due to no participation or claimed savings.

Energy Efficient Homes Program: New Homes

A review of the sampled files did not reveal any discrepancies between the project files and the tracking database. However, the SWE notes that reported savings for Q1 were unverifiable as the project files only contained REM/Rate reports rather than the REM/Rate building energy models, which are used to confirm that the reported savings values match the tracking data.

Energy Efficient Products Program: Appliances

The SWE observed a small discrepancy between the project files and the program tracking data. In one project file the capacity of the appliance was different and smaller than what appeared in the tracking database. The refrigerator was listed as 20 cubic feet in the invoice yet appeared as 24 cubic feet in the tracking database. Additionally in that same project file, the tracking data was missing the model number. However, in all other SWE reviewed project files all data matched the tracking data.

Energy Efficient Products Program: Appliance Recycling

The SWE was initially unable to match the photographs provided with the project documentation to the tracking data for Q1, Q3, and Q4 due to unclear identifying information between the project

files and tracking data.⁸⁵ The photos provided for Q2 were directly tied to a project number which was corroborated with the tracking data information. The SWE also notes that the quality of the photographs does not consistently and clearly capture the nameplate information of the recycled equipment but notes that quality of the photographs improved over the course of PY13. ADM included a useful analysis illustrating the improvement in photo quality and inclusion of verifiable nameplate or model number information. The SWE observed a couple inconsistencies in the Q2 project documentation and the tracking data. One instance where the tracking data was missing a dehumidifier in the sample file, but no additional photographs were supplied to verify which count was correct. In another case, one sampled project was missing two appliances in the tracking data.

Energy Efficient Products Program: HVAC

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. Project files mostly matched the tracking data. In one instance tracking data was missing a thermostat included in the project file invoice.

The SWE observed the same discrepancy as previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular variable. In the tracking data, capacity was displayed as a singular *tons* variable.⁸⁶ That being said, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data.

Starting in PY9, ADM worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations. Most project requests did not include an AHRI certificate, which prevented verification of tracking data measures.

Energy Efficient Products Program: Midstream Appliances

The Midstream Appliance project files included invoices which listed out quantities, appliances, and the total cost. Many of the invoices in the data request were designated an EDC but spanned all four EDCs in the tracking data. In addition, these files spanned multiple quarters, so a full reconciliation of quantities did not always match when reviewing the quarterly data uploads of program tracking data. In these instances, the SWE was unable to verify total FirstEnergy and individual EDC quantities. However, ADM was able to confirm that invoice quantities matched when looking at full year tracking data.

⁸⁵ ADM provided the SWE with detailed information on how to corroborate the appliance recycling pictures with the program tracking data, and the SWE confirmed the photographs could be tied back to the program tracking data.

⁸⁶ For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

Low-Income Energy Efficiency Program: Appliances

The SWE did not receive project files for appliances, though the SWE notes there was low program activity.

Low-Income Energy Efficiency Program: Appliance Turn-In

The SWE review of LI Appliance Turn-In files is summarized in the appliance recycling subsection above.

Low-Income Energy Efficiency Program: Kits

The SWE review of LI kit files is summarized in the energy efficient kits subsection above.

Low-Income Energy Efficiency Program: New Homes

The SWE review of LI New Homes files is summarized in the New Homes subsection above.

Low-Income Energy Efficiency Program: Direct Install

The project documentation for the LI Direct Install mostly matched the quarterly tracking data. Some accounts had multiple tracking data entries that did not correspond to the project file invoice. The SWE observed one case where the tracking data listed an additional seven nightlights that were not listed in the project documentation. All other information was consistent.

G.4.2.2 Non-Residential

As part of its audit process, the SWE conducts a review of ex-ante savings. This review involves assessing specific project files for a sample of Penn Power's non-residential programs in PY13. Project file documentation is provided each quarter of the program year by Penn Power, the program implementors, and the evaluation contractor to the SWE. Project documentation provided typically includes program rebate applications and approvals, letters of attestation, invoices for installed equipment, equipment specification or "cut" sheets, post-inspection forms, and calculation workbooks. The SWE reviews these documents for completeness and consistency. The SWE also compares the data points in the documentation against the program tracking database to ensure values such as savings, rebate amounts, installation, approval, and invoice dates align.

Of the 12 project files reviewed, the majority were generally well organized, complete, and accurate. [Table 163](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 163: Penn Power PY13 C&I Project File Review Summary

Program	Sub-Program	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program - Large	Custom - LCI	2	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Small	Custom - SCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Small	Lighting - SCI	4	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program - Small	Multifamily - SCI	1	0/1	0/1	0/1	0/1	-	✓
C&I Energy Solutions for Business Program - Small	Energy Management - SCI	4	2/4	3/4	2/4	2/4	2/4	-

The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were estimated. However, the SWE did note some missing documentation for Multifamily and Energy Management projects reviewed. In addition to these general observations, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **Multifamily – SCI**
 - Missing document to match calculated savings with tracking data
 - Quantities not included in the invoice
- **Energy Management – SCI**
 - For two projects, the calculator was missing to verify project details (i.e., HOU's, quantities and wattages) and to match demand savings with tracking data
 - For two different projects, the DLC wattages were not used for two fixture types.

Despite the minor issues discussed with the above project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

G.5 VERIFIED GROSS SAVINGS AUDITS

G.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the Penn Power portfolio of residential programs. Penn Power's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy Efficient Homes Initiative, the Energy Efficient Products Initiative, and the LI Energy Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings into the three following sections: upstream lighting, residential non-lighting, and behavior.

The SWE identified the evaluation activities used to verify savings for the residential programs. [Table 164](#) provides a summary of the evaluation and M&V approaches used by Penn Power in their PY13 verified savings calculations.

Table 164: Residential Program Evaluation Activities – Penn Power

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Energy Efficient Homes				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
Energy Efficient Products				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
Low-Income Energy Efficiency Program				
LI Direct Install	-	✓	✓	✓
LI Appliance Turn-in	✓	-	✓	-
LI Appliances	✓	-	✓	-
LI New Homes	-	✓	✓	-
LI Kits	✓	-	✓	-

G.5.1.1 Residential Non-HER

The SWE's review of verified savings for residential non-lighting programs found that, generally, the verified savings followed proper TRM protocols and that the verified savings are accurate. However, the SWE did observe a discrepancy in the kits and appliance program components that led to an underreporting of verified demand savings.

Energy Efficient Homes Program and LIEEP: Energy Efficient and School Education Kits

The SWE reviewed both the energy efficient kits and the school kits subprograms. The SWE worked with ADM to correct any observed discrepancies prior to the filing of the FirstEnergy annual report. The SWE reviewed that the savings calculations were in accordance with the TRM and that the survey results were correctly applied to calculate the program-level realization rates. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the Penn Power PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that

participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes the review and results also cover the low-income energy efficient and education kit program components.

Energy Efficient Homes Program and LIEEP: New Homes

The SWE worked with ADM to resolve any discrepancies in the evaluated savings prior to annual reporting. ADM conducted a QA/QC of REM/Rate energy models, confirming model entries were accurate with on-site data. The SWE confirmed the verified savings were in accordance with TRM protocols, including the application of demand savings. In addition, the SWE confirmed the realization rates were correctly applied to calculate program-level savings.

The SWE notes that the review also covered the LIEEP New Homes program component.

Energy Efficient Homes Program and LIEEP: Direct Install

The Direct Install subcomponent of the EE Homes program includes both weatherization and non-weatherization measures. There was only one weatherization project completed for Penn Power in PY13. The SWE reviewed the non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included lighting, nightlights, advanced power strips, connected thermostats, and water heater setbacks.

The SWE also reviewed the LIEEP Direct Install subcomponent, which provides LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE confirmed these measures also applied the correct TRM algorithms to calculate verified savings.

The SWE also confirmed the application of realization rates, participation counts, and the verified savings were accurate in the PY13 report.

Energy Efficient Products Program and LIEEP: Appliances

ADM used a combination of verification surveys, invoice and application reviews, and applied EDC collected data, such as efficiency and capacity data, to program tracking data inputs when deemed appropriate by the TRM. The appliance component includes measures such as: refrigerators, freezers, clothes washers and dryers, dehumidifiers, dishwashers, window ACs, HPWHs, and connected thermostats. The SWE was able to conduct an early review and confirmed that the savings values were correctly calculated using the TRM protocols. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the Penn Power PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes that the appendix for this component includes a list of the variables for each appliance, and where the data source came from. This was a helpful addition for the review process.

The SWE notes that the review also covered the LIEEP Appliances program component.

Energy Efficient Products Program and LIEEP: Appliance Recycling

The SWE performed audits on all measures included in the LI and non-LI Appliance Turn-In (ATI) programs, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

Energy Efficient Homes Program: Multifamily

There were no reported savings or projects for Penn Power in PY13 for the Multifamily subcomponent.

Energy Efficient Products Program: HVAC

The SWE conducted an early review of the HVAC component. The SWE determined that ADM applied survey results and model-specific values appropriately. The SWE confirmed the participation counts, realization rates, and verified savings aligned with the annual report.

Energy Efficient Products Program: Midstream Appliances

The SWE conducted an early review of the Midstream Appliances component. ADM’s evaluation included a full review of the program tracking data and aligning savings estimates with the TRM and product specific data. The SWE did not observe any discrepancies with the application of the TRM algorithms, or the application of EDC gathered data. The SWE confirmed participation counts, realization rates, and verified savings were reported accurately.

Energy Efficient Products Program: Upstream Electronics

The FirstEnergy companies did not offer the Upstream Electronics component of the EE products program in PY13.

G.5.1.2 Behavior

Home Energy Reports were issued to around 25,000 residential and residential-LI households in PY13. 15% of Penn Power’s progress toward its low-income target in PY13 came from HERs. Penn Power’s behavioral portfolio consists of two different waves, or cohorts, of homes. Both cohorts were launched during PY13 and one of them targets low-income households. [Table 165](#) summarizes the average number of active households during PY13 by cohort.

Table 165: Penn Power HER Cohort Summary

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	17,709	11,295
2021 Low-Income	9/30/2021	6,143	6,193

The program ICSP Oracle implemented both cohorts as a randomized control trial (RCT) where the eligible households were identified and then randomly assigned to either a treatment or control

group. Following randomization, ADM conducted statistical tests on the pre-treatment energy usage patterns to confirm equivalence between the treatment and control groups.

RCT Validation

The SWE team conducted an audit of randomization soundness and pre-treatment equivalence for the two cohorts introduced in PY13. The SWE team ran a simple fixed effects regression model using the pre-treatment data with indicator variables for each month and for the treatment. During the pre-treatment period, we'd expect the "treatment" indicator variable to be statistically insignificant, as the treatment effect is only expected after HER delivery begins. Indeed, we found the treatment indicator variable to be statistically insignificant for both cohorts. The SWE team also ran a t-test of pre-period usage by treatment status for each cohort and found all differences in usage to be statistically insignificant. [Figure 82](#) and [Figure 83](#) display the monthly distribution of daily kWh usage for the treatment and control groups of each of the cohorts. These visuals reinforce the finding that pre-treatment usage patterns are extremely similar between the treatment and control groups of each cohort.

Figure 82: Pre-Treatment Equivalence, Residential Cohort

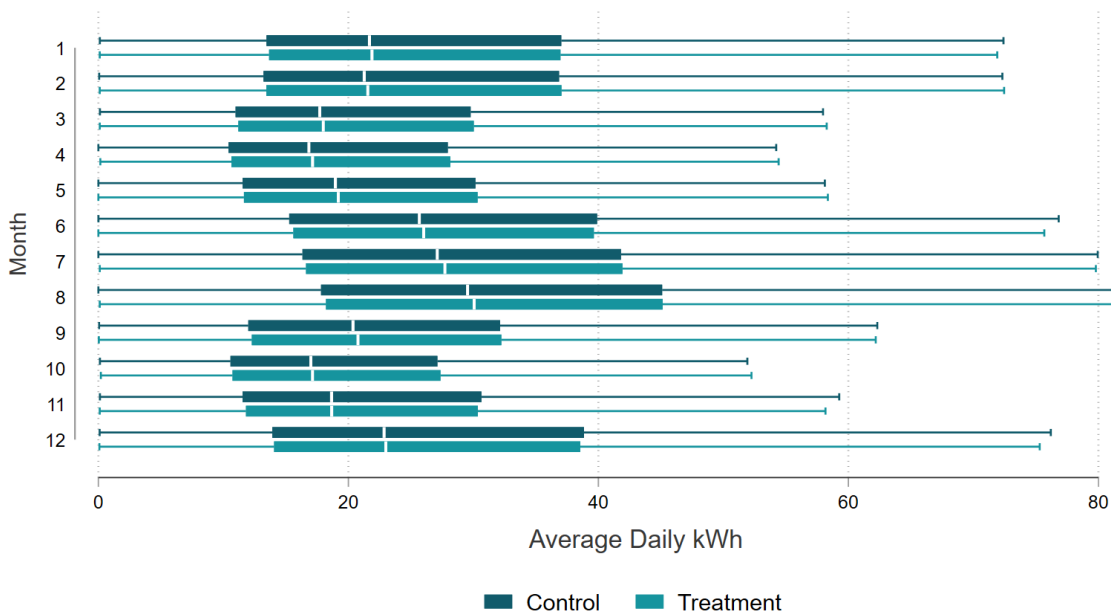
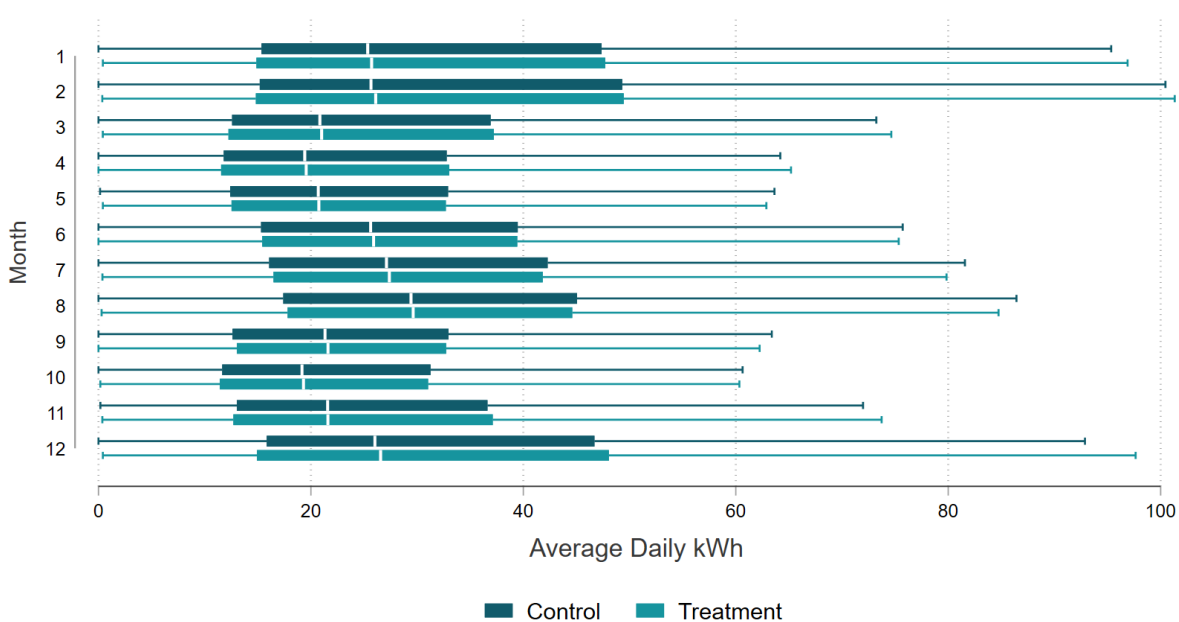


Figure 83: Pre-Treatment Equivalence, Low-Income Cohort



Data Preparation

The SWE team received interval data from ADM at three different levels: hourly, daily, and monthly. The monthly data is the primary input in the estimation of HER impacts. The SWE team independently checked the aggregation of the daily data to the monthly level, and we found the calculations to be sound (and we also found the distribution of monthly kWh to be reasonable). ADM used a lagged seasonal (LS) regression model for the PY13 impact analysis as called for in

the Penn Power PY13 EM&V plan. The LS model contains three lag variables: one for average usage during the pre-treatment period (all months), one for average summer usage during the pre-treatment period, and one for average winter usage during the pre-treatment period. The SWE team was able to replicate the three lagged variables calculated by ADM.

Participant Counts

ADM obtains active customer counts for each month by tallying up the number of accounts that have hourly interval data for the month. Only active accounts where HER delivery has begun are included in these calculations. An inconsequential number of accounts were not counted for other reasons (placed in both the control group and treatment group or multiple treatment starting dates). A larger number of accounts (4.1% of the total treatment accounts) were not included in the counts because Oracle never began HER delivery to these homes or due to pre-start date attrition.

The SWE team validated ADM enrollment counts by performing a similar counting method on the hourly interval data. Customers are considered active through the end of the month that they last have interval data. For example, if a customer's final AMI record is from February 15th, the customer would be included in the count for February but not in March or any month following. The SWE team's final customer counts matched ADM's counts within 0.1 percent for each month and each cohort.

Customers that did not have 12 months of pre-treatment data were not included in the impact estimation (because the lagged variables for these customers could not be calculated), but they were included in the customer counts.

Impacts

By month, the daily impact estimates are plotted in [Figure 84](#) (residential) and [Figure 85](#) (low-income). Notably, June through September are not included in the figure. This is because HER delivery did not begin until October. For each cohort, [Table 166](#) shows the average of the PY13 monthly impact estimates (across the eight active months). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.14 kWh per day, on average, during PY13. The SWE was able to replicate ADM's impact estimate for each cohort/month combination.

Table 166: Penn Power HER Impact Estimates

Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.14
2021 Low-Income	0.19

Figure 84: Average Daily Savings (kWh) by Month, Residential Cohort

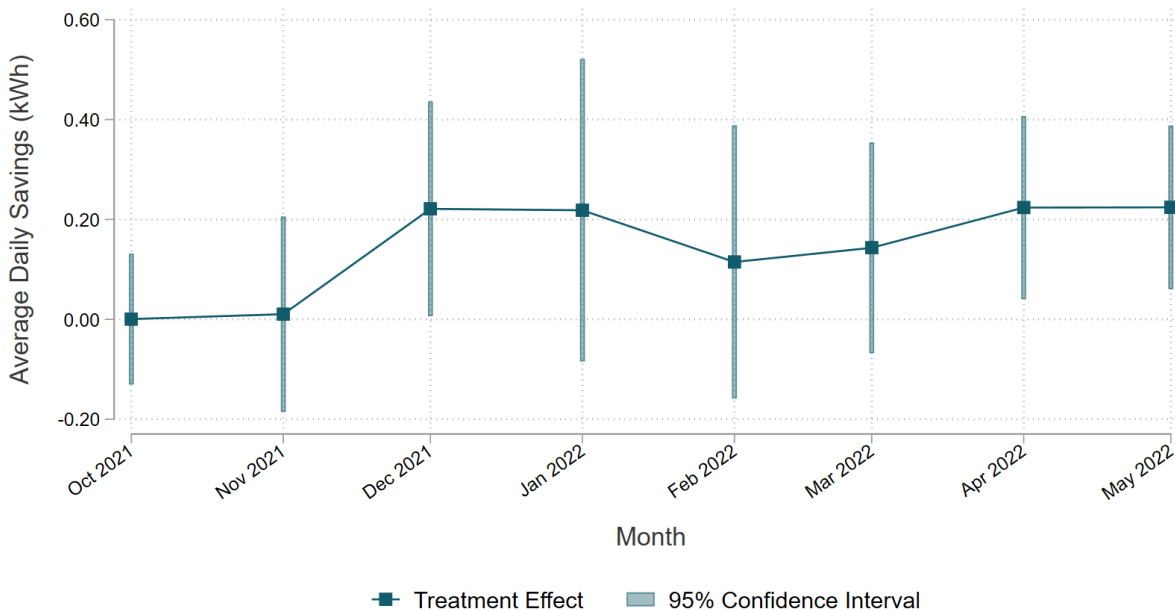
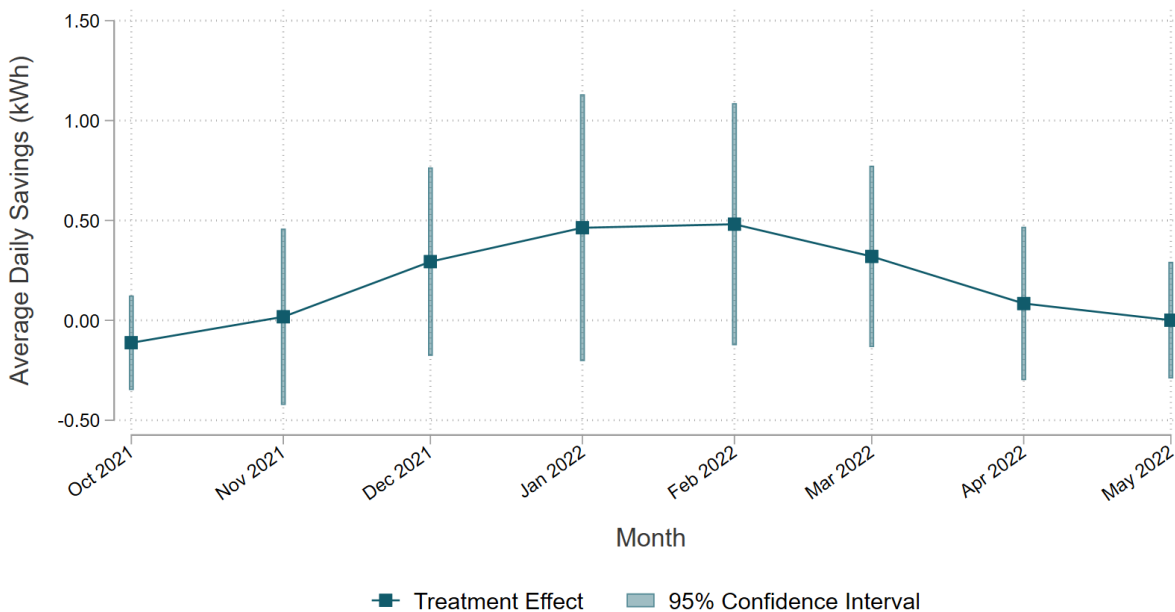


Figure 85: Average Daily Savings (kWh) by Month, Low-Income Cohort



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 167](#) shows the aggregate PY13 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, which are discussed in greater detail later, and the PY13 incremental gross savings estimate.

Table 167: PY13 HER Energy Savings

Cohort	Gross Savings (MWh/yr)	Downstream Dual Participation (MWh/yr)	Upstream Dual Participation (MWh/yr)	Persistence (MWh/yr)	Incremental Savings (MWh/yr)
2021 Residential	619	17	0	0	602
2021 Low-Income	274	-2	0	0	275
Total	893	15	0	0	877

Dual Participation

In [Table 167](#), gross savings before adjusting for dual participation were 893 MWh. It is important to note that Home Energy Reports advertise other Penn Power residential EE&C programs and measures such as ENERGY STAR appliances, water heaters, HVAC etc. To the extent that treatment group households participate in these programs more frequently than control group homes, the incremental savings is captured in the regression estimates for the HER analysis. To avoid double-counting, the HER savings are reduced to account for the incremental program participation observed in the treatment group compared to the control group.

Regarding upstream dual participation, note that Penn Power did not offer an upstream lighting program in PY13. The Upstream Electronics component of the Energy Efficient Products Program was not offered in PY13 either. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

Persistence

PY13 saw the introduction of a new framework for separating persisting savings from previous program years from incremental savings attributable to the treatment in the current program year. The 2021 TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research⁸⁷ on the persistent effects of behavioral energy efficiency treatment in the years after discontinuing treatment. Since Act 129 compliance goals are based on first-year incremental savings, these persistent impacts are subtracted from the measured savings to estimate incremental first-year savings (those directly due to the current program year of treatment). Because both PY13 Penn Power waves were launched during PY13, all savings are first-year savings. Separating persisting savings was not necessary.

Peak Demand Impacts

The 2021 TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 PM to 6:00 PM. Eastern Daylight Time on non-holiday weekdays during June, July, and

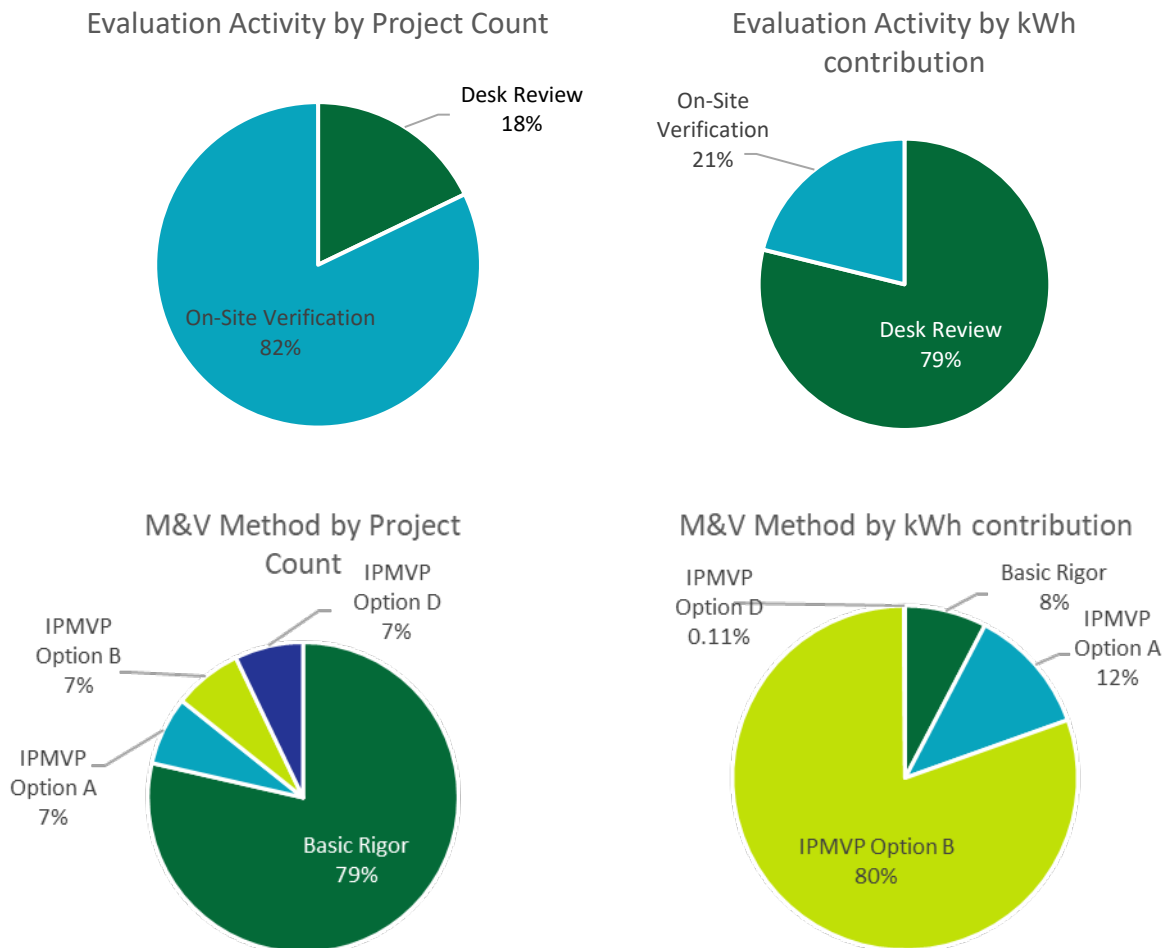
⁸⁷ Addendum to Act 129 Home Energy Report Persistence Study. November 2018. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

August. Because HER delivery did not begin until the fall, there were no peak demand impacts in PY13.

G.5.2 Non-Residential Audit Activities

Figure 86 provides a summary of the evaluation activities and M&V approaches utilized by ADM in their PY13 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY13, Penn Power’s evaluation contractor completed site visits to 82% of evaluated projects, and these projects represented 21% of total evaluated energy savings. In total, 23 site visits were completed. IPMVP Options A, B, and D were employed for 92% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 8% of the total evaluated savings, including majority of prescriptive projects and most energy management projects.

Figure 86: Summary of Penn Power’s C&I Evaluation Activities



Penn Power’s evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Penn Power’s C&I programs are assigned to one of four evaluation initiatives, as Penn Power’s programs target specific sectors of C&I customers, but offerings are often

identical across the programs. Table 168 provides a summary of the evaluation activities Penn Power's evaluation contractor used across strata for all projects by initiative.

Table 168: Summary of Penn Power's PY13 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
Appliance Recycling	-	95%	92%	-	-
Custom	2	100%	100%	1	1
Custom – C	1	100%	100%	-	1
Custom – 1	1	101%	99%	1	-
Prescriptive	10	105%	97%	1	9
Downstream Lighting - C	-	-	-	-	-
Downstream Lighting - 2	2	110%	91%	-	2
Downstream Lighting - 1	7	98%	104%	-	7
Downstream Non-Lighting	1	100%	101%	1	-
Midstream Lighting	-	-	-	-	-
Midstream Non-Lighting	-	-	-	-	-
EMNC	10	99%	63%	3	7
EMNC	-	-	-	-	-
Building Tune-Ups	10	99%	63%	3	7
Multifamily	6	90%	95%	-	6
TOTAL	28			5	23

The SWE's review of verified savings for non-residential programs found that, overall, the verified savings estimation was aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and that the verified savings are generally accurate. The following sections describe the SWE's audit of the verified savings methodology for non-residential programs in further detail.

G.5.2.1 Appliance Recycling Initiative

In PY13, projects in Penn Power's Appliance Recycling Sub-Initiative were evaluated through a review of tracking and reporting data. The gross energy and demand realization rates for each evaluation stratum were taken to be the realization rates from the broader initiative-level evaluation which included the residential and low-income residential components.

G.5.2.2 Custom Initiative

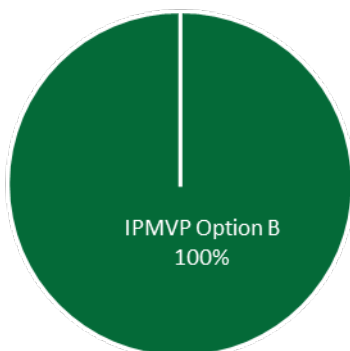
Evaluation activities for this initiative include desk review or site visit and IPMVP evaluation methods for all sampled projects.

Penn Power’s evaluation contractor employed two strata for projects in the Custom initiative. The largest projects, with ex-ante savings estimates of 500 MWh or more, are separated into a “certainty” stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

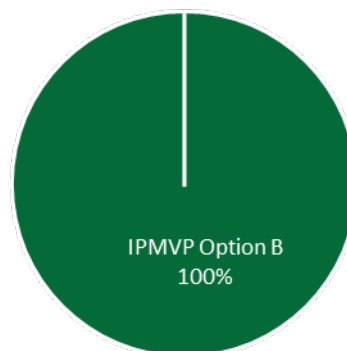
The distribution of rigor across the sample strata is in keeping with Table 14 of the Phase IV Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. Enhanced rigor methods were employed to evaluate all projects, with IPMVP Option B selected as the primary enhanced M&V method for all evaluated custom projects, as shown in [Figure 87](#).

Figure 87: Summary of Penn Power’s C&I Custom Program M&V Methods

M&V Method by Project Count



M&V Method by kWh contribution



G.5.2.3 Prescriptive Initiative

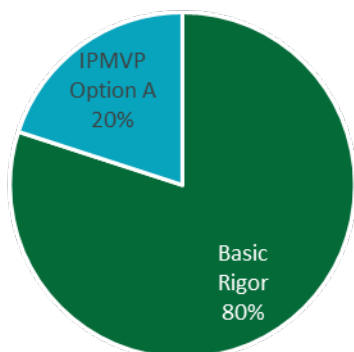
Evaluation activities for this initiative include desk reviews for most projects and primary data collection of lighting hours of use for medium and high savings projects. TRM deemed hours of operation were applied in basic rigor desk reviews for low savings projects. All sampled projects undergo a full documentation review prior to site visits, and site-specific M&V plans are developed for most.

Penn Power’s evaluation contractor employed three strata for projects in the Prescriptive initiative. The largest projects, with ex-ante savings estimates of 750 MWh or more, are separated into a “Downstream - Certainty” stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

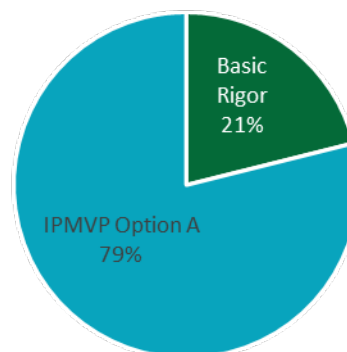
Basic Rigor was employed for 80% of evaluated projects in this initiative with the remaining projects using IPMVP Option A, as seen in [Figure 88](#) below.

Figure 88: Summary of Penn Power’s C&I Prescriptive Program M&V Methods

M&V Method by Project Count



M&V Method by kWh contribution



G.5.2.4 Commercial and Industrial Energy Management and New Construction Initiative (CI EMNC)

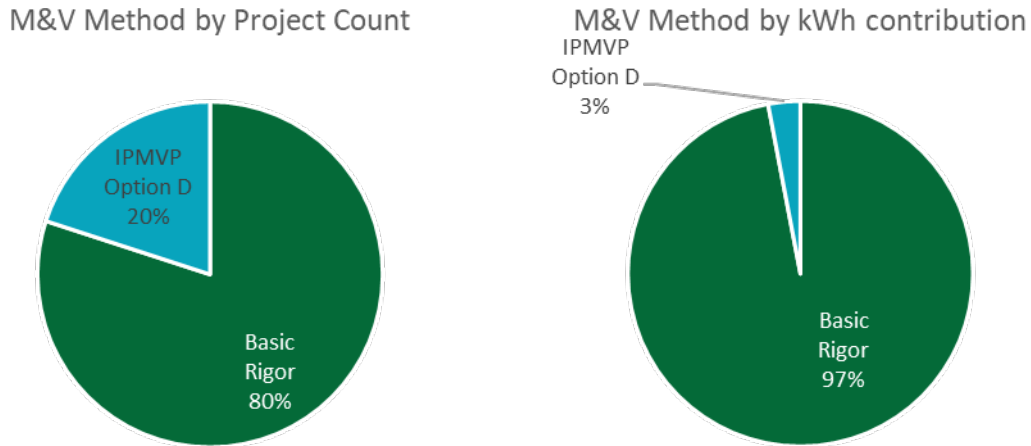
The CI EMNC Initiative has five subcomponents, but only two were active in PY13: Building Tune-Up and New Construction.

Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Basic rigor M&V methods were applied to these projects, incorporating TRM algorithms and reconciliations of invoices with equipment specification sheets.

Projects in the New Construction strata were evaluated using IPMVP Option D, which included review of baseline and as-built simulation models developed in the implementer’s custom simulation tool.

Basic Rigor was employed for 88% of evaluated projects in this initiative with the remaining projects using IPMVP Option D, as seen in [Figure 89](#) below.

Figure 89: Summary of Penn Power’s CI EMNC Program M&V Methods



G.5.2.5 Master-Metered Multifamily Direct Install Initiative

All sampled projects in the CI MF initiative were evaluated using basic rigor desk reviews, with on-site inspections conducted for about one-third of the sample. The desk review process included reconciliation of invoices and re-calculation of reported savings using TRM algorithms.

G.5.2.6 Verified Savings Audits

The SWE audited the activities above through a detailed audit of ADM’s evaluation work for a sample of their evaluated projects. The SWE audit for ADM’s Penn Power evaluation in PY13 included review of four (4) projects, encompassing the following activities:

- 4 Field and Analysis Engineers were observed
- 4 Measure Types were observed
- 77% of Verified Energy Savings reviewed
- 69% of Verified Demand Savings reviewed

Table 169 provides an overview of the SWE milestones for the verified savings audit review of evaluated Penn Power’s projects.

Table 169: Penn Power Verified Savings Audit Review Milestones

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
4	6,538,079	100%	678.54	100%

Overall, the SWE found that Penn Power’s evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods for custom measures. The overall energy and demand savings attainment percentages of Penn Power’s reviewed projects were 100% for both energy and demand savings.

G.6 NTG

Table 170 lists Penn Power's PY13 NTG results across all programs. Details concerning the methods and data used to estimate NTG values are in sections G.6.1 and G.6.2. The values in the NTG tables are taken from the FirstEnergy PY13 Annual Report program specific sections and appendices.⁸⁸

Table 170: Penn Power PY13 NTG Results

Program Name	Component	NTG
Energy Efficient Homes	EE Kits	0.84
Energy Efficient Homes	Home Energy Reports	1.0
Energy Efficient Homes	Direct Install	1.0
Energy Efficient Homes	New Homes	0.73
Energy Efficient Homes	Multifamily	1.0
Energy Efficient Homes	Online Audits	1.0
Energy Efficient Products	Appliance Recycling	0.38
Energy Efficient Products	Upstream Electronics	0.58
Energy Efficient Products	HVAC	0.55
Energy Efficient Products	Appliances	0.56
Energy Efficient Products	Midstream Appliances	0.44
Low-Income	Appliances	1.0
Low-Income	Appliances Turn-In	1.0
Low-Income	Direct Install	1.0
Low-Income	Home Energy Reports	1.0
Low-Income	Kits	1.0
Low-Income	New Homes	1.0
Low-Income	Online Audits	1.0
C&I Solutions for Business Programs - Small and Large	Prescriptive	0.80
C&I Solutions for Business Programs - Small and Large	Custom	0.62
C&I Solutions for Business Programs - Small and Large	EMNC	0.80
C&I Solutions for Business Programs - Small and Large	Multifamily	1.0
C&I Solutions for Business Programs - Small and Large	Appliance Recycling	0.38

⁸⁸ The FirstEnergy PY13 Annual Report reviewed by the SWE for the SWE Final Annual Report included several NTG values reported in the impact evaluation summary table in Chapter 2 of the report (Table 12) that were not consistent with the value reported in program specific sections and appendices of the report. ADM was able to confirm the correct NTG values to the SWE

G.6.1 Residential Programs

ADM planned and enacted NTG research for the residential Appliance Recycling program for PY13. ADM utilized participant surveys to estimate free-ridership and NTG reasoning that spillover was not necessary since the Appliance Recycling program does not lead to installation of Energy Efficient Products (Table 171). ADM utilized a free-ridership battery of questions that was consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation (excluding spillover).

All other residential programs utilized NTG values estimated, and SWE verified during Phase III with the exception of the Home Energy Report Program. The Home Energy Report program NTG was assigned a value of 1.0, in accordance with the Phase IV Evaluation Framework. The random control trial (RCT) design of the program eliminates the need for NTG analysis because the control group does everything the treatment group would have done and the estimated savings are technically net savings. The Multifamily program NTG was originally reported as 1.00 but was corrected to 0.81 by ADM when the SWE noted that the program component had a free ridership rate of 19%.

Table 171: Summary of Penn Power’s PY13 Residential NTG Results

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
EE Kits	N/A	N/A	27%	11%	0.84
Home Energy Reports	RCT	N/A	0%	0%	1.0
Direct Install	N/A	N/A	19%	20%	1.0
New Homes	N/A	N/A	27%	0%	0.73
Multifamily	N/A	N/A	19%	0%	0.81
Online Audits	N/A	N/A	0%	0%	1.0
Appliance Recycling	Self-Report Survey	86	62%	0%	0.38
Upstream Electronics	N/A	N/A	N/A	N/A	0.58
HVAC	N/A	N/A	53%	8%	0.55
Appliances	N/A	N/A	56%	12%	0.56
Midstream Appliances	N/A	N/A	56%	0%	0.44

G.6.2 C&I Energy Efficiency Programs

ADM did not conduct any new NTG research for C&I programs in PY13. They applied NTG values from Phase III NTG evaluations that have been verified by SWE during Phase III. ADM did apply the residential Appliance Recycling PY13 NTG to the C&I Appliance Recycling program and assigned a NTG value of 1 to the C&I Multifamily program as it is a low-income program (Table 172).

Table 172: Summary of Penn Power's PY13 C&I NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	N/A	N/A	20%	1%	0.80
Custom	N/A	N/A	38%	0%	0.62
EMNC	N/A	N/A	20%	0%	0.80
Multifamily	N/A	N/A	N/A	N/A	1.0
Appliance Recycling	N/A	N/A	62%	0%	0.38

G.7 TRC

Table 173 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Penn Power's PY13 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY13 annual report and the model itself was well-organized and documented.

The program designs presented in FirstEnergy's Phase IV EE&C Plan are organized into the following sectors: (1) Residential; (2) Residential Low-Income; (3) Small Commercial and Industrial; and (4) Large Commercial and Industrial. The number of programs within these sectors decreased from nine in Phase III to five in Phase IV in part due to the exclusion of dispatchable demand response from Phase IV. The Appliance Turn-In Program is now a component of the Energy Efficient Products Program.

Both gross and net TRC ratios showed little change from PY12. The greatest increase was seen in the Low-Income Energy Efficiency Program. Pursuant to the 2021 TRC Test Order directive for Phase IV, the nominal discount rate is now 5% and no longer tied to WACC. All else being equal, a lower discount rate improves the TRC ratio.

Table 173: Summary of Penn Power's PY13 TRC Results

Program Name	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Energy Efficient Homes	\$2,146	\$1,609	1.33	\$1,746	\$1,327	1.32
Energy Efficient Products	\$1,240	\$1,290	0.96	\$561	\$826	0.68
Low Income Energy Efficiency	\$797	\$704	1.13	\$797	\$704	1.13
C&I Energy Solutions for Business - Small	\$654	\$783	0.84	\$537	\$723	0.74
C&I Energy Solutions for Business - Large	\$8,069	\$7,594	1.06	\$5,070	\$4,843	1.05
Portfolio Total	\$12,906	\$11,981	1.08	\$8,711	\$8,423	1.03

Three of Penn Power's five EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. All three of these programs were also found to be cost-effective

using net verified savings. The Energy Efficient Products program was not cost-effective on a gross verified or net verified basis, in part due to the high incremental costs relative to energy savings for ENERGY STAR appliances like clothes dryers and dishwashers. The C&I Energy Solutions for Business – Small program was also not cost-effective on a gross or net basis, in part due to the high administration and program overhead costs in the first year of the phase.

G.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- Penn Power’s annual electric energy savings are calculated and allocated by season (summer, winter, and shoulder) and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is consistent with the on-peak hours defined in the 2021 TRM (Monday – Friday 7AM to 11PM). The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions. The SWE also verified the correct avoided costs from Penn Power’s EE&C Plan were used in the TRC Model. The TRC Model accurately collapsed the 8,760 hourly load shapes into single annual weighted-average values used in the energy benefits calculations.
- Penn Power had the lowest PY13 TRC ratio of the four FirstEnergy EDCs. One of the key factors driving this result for Penn Power was the lower capacity value (\$/kW-year) compared to the other FirstEnergy companies.
- To calculate the avoided cost of natural gas, Penn Power used a three-segment approach outlined in the 2021 TRC Test Order. The SWE verified the TRC Model correctly applied the avoided costs to estimate TRC benefits.
- Pursuant to the 2021 TRC Test Order, the SWE verified Penn Power used a nominal discount rate of 5% to calculate the net present value of future program benefits. This discount rate is consistent with their EE&C plan. Line loss adjustment factors varied by sector. Residential (1.0949), Small C&I (1.0545) and Large C&I (1.0545).
- The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the Database for Energy Efficiency Resources (DEER), company assumptions, and actual project costs as gathered from the PY13 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent with Penn Power’s EE&C plan.
 - For non-residential lighting measures, Penn Power consistently applied the benefits and incremental costs of Early Replacement to all measures. This aligns with the definitions in Table 6 of the 2021 TRC Test Order and the measure vintage in the 2021 TRM.
- Realization rates for energy and demand impacts were applied to the reported gross program impacts in the TRC model to calculate verified gross savings.
- The calculation of NTG using free-ridership and spillover, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the 2021 TRC Test Order directive for Phase IV. The TRC model followed the protocol pertaining to the

treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.

- The SWE found that the cost categories were handled correctly in the TRC model. Participant incentives were not considered TRC costs, while administrative costs, incremental costs, and kits were incorporated as costs.
- The SWE verified the ex-ante demand and capacity savings were accurate in the TRC model by comparing to the Quarterly Tracking Data reported by Penn Power.
- According to the Phase IV Evaluation Framework, low-income measures are required to be provided at no cost to the participants. At first glance, it would appear that Penn Power's low-income programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the Low-Income Energy Efficiency Program (Table 64 in FirstEnergy's PY13 Annual Report). However, in their Phase IV EE&C Plan, Penn Power explains that these costs are only being allocated to landlords and owners of low-income properties, rather than the low-income customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Fossil Fuel Impacts and Total NPV Lifetime Water Impacts. The SWE verified that the savings were accounted for in accordance with 2021 TRC Test Order. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative Total NPV Lifetime Fossil Fuel Impact. The SWE verified the cost was counted as a negative non-electric benefit rather than a fossil fuel switching program cost. The TRC model claimed over 6 million gallons per year of water saving, which translates to approximately \$821,000 in NPV lifetime avoided costs.

G.8 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to the programs across the four FirstEnergy EDCs, including Penn Power, so the annual evaluation report of the four FirstEnergy EDCs reports identical information about the process evaluation. Therefore, [Appendix E.8](#) of the SWE's PY13 Final Annual Report, described previously for Met-Ed, applies to all four FirstEnergy utilities, including Penn Power. The customer survey for the Appliance Recycling component set a goal of completions by 68 Penn Power customers; the target was exceeded with 95 completions.

Appendix H FirstEnergy: West Penn Power Company PY13 Audit Detail

H.1 KEY AUDIT FINDINGS

- The SWE's review of PY13 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, and were generally accurate.
- West Penn Power provided their Residential and Low Income verified savings analyses prior to drafting their annual reports. This allowed the SWE to conduct an early review and had ample time and opportunity to discuss any questions, potential discrepancies, and review updated results that could be directly incorporated into the PY13 annual report for the FirstEnergy companies. In addition, the verified savings analyses were well organized, and included the documentation required to conduct verified savings checks from the measure-level all the way to program-level savings.
- West Penn Power initiated two new behavior HER cohorts in October 2021 and discontinued treatment for its legacy cohorts. One of the new cohorts was made up of market residential households and the other cohort consists of low-income households. Between the mid-year launch and lower overall number of households receiving behavioral messaging, HERs accounted for a smaller share of portfolio savings in PY13 (8% of MWh) compared to Phase III. HERs accounted for approximately 21% of West Penn Power's progress toward its low-income compliance target in PY13. Because the cohorts launched after the summer, West Penn Power claimed no peak demand savings from its PY13 HER efforts. The regression analysis was well-organized and replicable, and FirstEnergy's evaluation contractor, ADM Associates (ADM) was responsive to minor questions and suggestions from the SWE. Since the PY13 cohorts were new, the impact evaluation did not need to deal with new Phase IV accounting procedures for separating incremental savings from persisting savings from prior years.
 - The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY13 methods or results.
- The SWE discovered an error in the verified peak demand reductions for several FirstEnergy program components, resulting in an underestimate of verified savings in the FirstEnergy PY13 Annual Report. Line loss factors had been applied to reported savings but not verified for several program components, resulting in reduced realization rates that reduce verified savings. ADM was able to quickly confirm the error and calculate the revised estimates of verified peak demand reductions that increased peak demand reductions from 0.03 MW (Penn Power) to 0.12 MW (West Penn Power) and 0.33 MW cumulatively across the FirstEnergy companies.
- West Penn Power's non-residential portfolio was cost-effective in PY13 with a gross TRC ratio of 1.21 but showed a TRC ratio far lower than PPL and Duquesne Light despite similar a set of measure offerings. A key driver of the difference is incremental cost

assumptions for non-residential lighting. FirstEnergy assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures. The FirstEnergy cost perspective is consistent with the perspective used to estimate energy and demand savings. The SWE will work with the EDCs and their evaluation contractors to promote consistency for non-residential lighting cost assumptions in PY14 since it is by far the largest measure category statewide.

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in West Penn Power's PY13 Annual Report to the tracking data provided to the SWE on a quarterly basis. For all programs represented in the tracking data, the SWE was able to replicate the reported MWh savings and reported MW savings. We were unable to replicate participant counts and incentives exactly using the tracking data, but we did not expect to be able to do so.
- Project documentation for the non-residential programs submitted to the SWE for review was generally thorough and complete. The SWE only noted a few minor discrepancies.
- The SWE conducted a project file review for a sample of West Penn Power's residential and income-eligible solutions in PY13. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project files and supporting details, and the project files were found to match most of the tracking data.
- Overall, the ADM team estimated NTG following the recommended procedures outlined in the Phase IV Evaluation Framework and according to the approved EM&V plan.
- For the process evaluations, the ADM team completed all the PY13 activities detailed in the approved evaluation plan, and the reporting followed the SWE guidelines. The process evaluation discussion highlighted findings that should be of value to FirstEnergy and its CSPs.
- The SWE found several transcription errors in program component level NTG ratios for West Penn Power in the summary tables included in Chapter 2 of the FirstEnergy PY13 Annual Report. The NTG values reported in the program specific chapters and appendices were accurate, however. ADM was extremely responsive when the SWE pointed out the reporting errors and provided corrections to the SWE.

H.2 EM&V PLAN REVIEWS

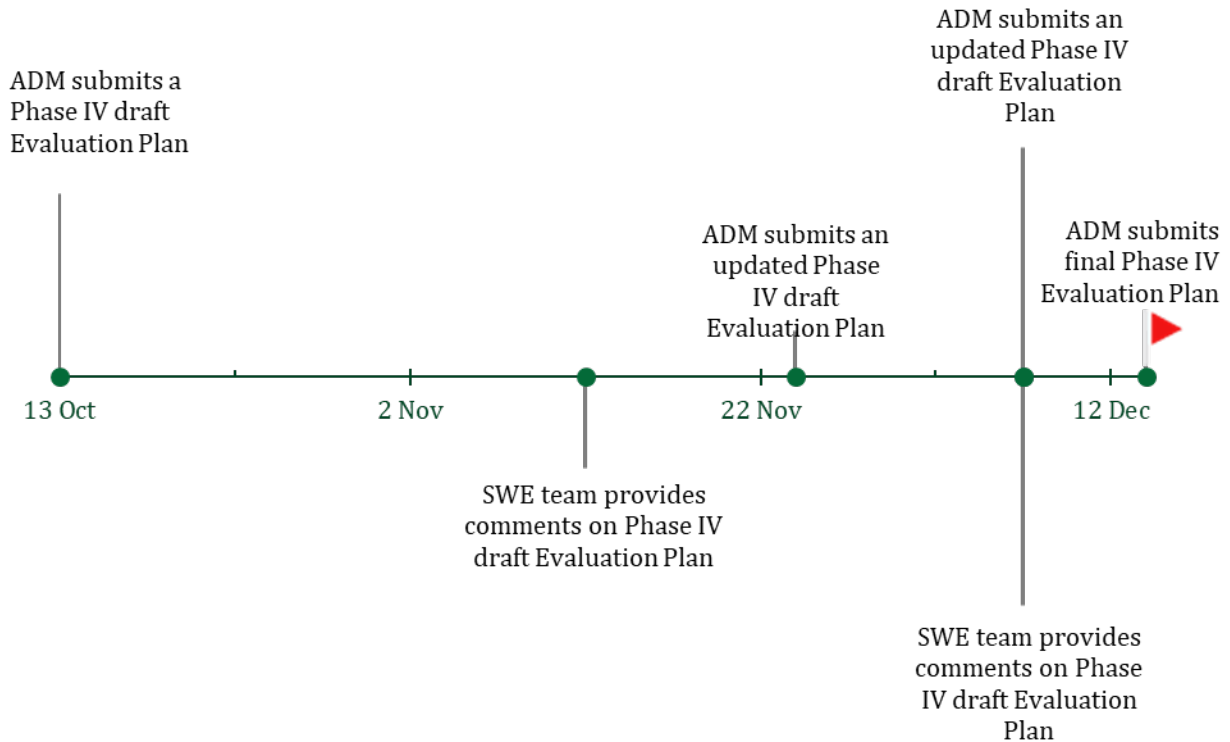
ADM first submitted a draft Phase IV EM&V plan on October 13, 2021. The plan was organized by sector detailed the gross impact, net impact, and process evaluation activities by program. After several rounds of comment from the SWE and revisions by ADM, the final evaluation plan was approved by the SWE in mid-December 2021. The SWE brought some of the following points to ADM during revision of the plans:

- Impact evaluation activities for PY17. The initial plan called for annual impact evaluations in PY13-PY16 with PY17 relying almost entirely on historic realization rates. The SWE and ADM ultimately agreed on staggering the historic realization rates across PY16 and PY17.
- The baseline wattage for LED lamps in energy efficiency kits.

- The expected types of measures and impact evaluation techniques for the CI Energy Management and New Construction sampling initiative.
- How to disentangle HER impacts from the Online Audit subprogram impact estimates.
- Peak demand savings methodology for behavioral Home Energy Reports.

Figure 90 shows the review timeline of correspondence between ADM and the SWE team to finalize the Phase IV EM&V plan.

Figure 90: West Penn Power Evaluation Plan Review Timeline 2021-2022



As discussed in Section 4.2, each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. West Penn Power, however, will evaluate verified gross impacts for all programs in PY13. West Penn Power will not use historic realization rates until PY15 and PY17. Table 174 shows all West Penn Power programs, which produced verified impacts in PY13.

Table 174: PY13 West Penn Power Program Impact Evaluation Summary

Sector	Components	PY13 Impacts
Residential	EE Kits	Verified
	Home Energy Reports	Verified
	Midstream	Verified
	New Homes	Verified
	Downstream HVAC	Verified
	LI Direct Install	Verified
	On-Line Audit	Verified
	Downstream Appliances	Verified
	LI - Home Energy Reports	Verified
	Smart Thermostats	Verified
	Audit and DI	Verified
Cross-Cutting	Appliance Recycling	Verified
	Multifamily	Verified
C&I	Custom	Verified
	Lighting Downstream	Verified
	Lighting Midstream	Verified
	Energy Management and New Construction	Verified
	Prescriptive Non-Lighting Downstream	Verified
	Prescriptive Non-Lighting Midstream	Verified

In addition to the evaluation plans, the SWE also reviewed and provided comments on draft survey instruments in April 2022 for multiple programs.

H.3 SAMPLE DESIGN REVIEW

The Phase IV Evaluation Framework establishes a maximum level of sampling uncertainty of $\pm 15\%$ at the 85% confidence level for each “initiative.” Beginning in Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. This change was implemented specifically for EDCs like West Penn Power, who define EE&C programs broadly, but have specific offerings that are a more logical grouping for evaluation purposes due to program delivery channel or supported technology.

West Penn Power’s EE&C portfolio consists of five programs: Energy Efficient Homes, Energy Efficient Products, Low Income Energy Efficiency, C&I Energy Solutions for Business – Large, and C&I Energy Solutions for Business – Small. The SWE performed its annual sample design review at the initiative level, which sometimes span multiple programs or sectors. In response to the annual data request, FirstEnergy’s EM&V contractor provided the SWE with a sample

disposition for each initiative detailing the project-level ex-ante and ex-post savings for each unit in the samples.

Table 175 shows the relative precision of PY13 energy and demand impacts by component at the 85% confidence level. Note that the Online Audit program, which had zero reported savings and demand impacts for PY13, is omitted.

Table 175: Relative Precision of PY13 Impacts by Program Component at the 85% Confidence Level

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	10.3%	10.3%
	LI - EE Kits	12.6%	12.7%
	Midstream	0.0%	0.0%
	New Homes & Smart Thermostats	14.0%	14.0%
	HVAC	11.9%	10.3%
	LI - Direct Install	7.5%	7.5%
	Downstream Appliances	8.6%	8.5%
	Audit and DI	7.8%	4.0%
Cross-Cutting	Appliance Recycling	6.0%	6.2%
	Multifamily	9.0%	9.0%
C&I	Custom	5.9%	12.6%
	Prescriptive	11.3%	11.4%
	Energy Management and New Construction	9.3%	9.9%

The Residential Midstream component has a relative precision of $\pm 0\%$. ADM evaluated all projects undertaken in that programs in PY13, so there is no sampling uncertainty.

ADM established in their Phase IV evaluation plan submitted to the SWE that they would use an assumed coefficient of variation derived from past program years for initial sample design. However, ADM also used these planning coefficients of variation to calculate and report initiative-level relative precision. For the C&I Prescriptive initiative, ADM designed its PY13 sample using a coefficient of variation of 0.4. The Phase IV EM&V plan notes that 0.4 was a deliberately conservative estimate of the expected coefficient of variation, which the SWE team found to be true for PY13. The SWE team replicated the C&I Prescriptive rollup instead using observed coefficients of variation and found the relative precision of savings estimates to be lower than the reported figures of 8.6% for energy and 9.5% for demand. The SWE team recommends that ADM use manual variance calculations in place of planning coefficients of variation in their PY14 report to yield more accurate estimates of relative precision. Although the SWE still recommends leaving

a hedge to guarantee that the $\pm 15\%$ relative precision threshold is met, ADM might be able to use fewer sample points than they did in PY13 for certain initiatives with low coefficients of variation.

The Behavioral Modification subprogram provides HERs to residential customers in the West Penn Power service territory. The subprogram is divided between market rate residential customers and LI customers, and each is administered as an RCT. Participants are enrolled in experimental cohorts and a monthly billing analysis regression is used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral programs are unique, with the Phase IV Evaluation Framework requiring the solution-level verifications achieve an absolute precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 176](#) shows the absolute precision of PY13 Behavioral Modification impacts at the 95% confidence level.

Table 176: Absolute Precision of PY13 Impacts for Behavioral Modification Programs at the 95% Confidence Level

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.25%
Behavioral Modification (LI)	0.39%

H.4 REPORTED GROSS SAVINGS AUDITS

H.4.1 Tracking Data Review

This report section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in West Penn Power's PY13 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh/yr)
- Reported gross peak demand savings (MW/yr)
- Participation counts
- Incentive dollars

The SWE leveraged West Penn Power's Q1-Q4 tracking data to audit these values. Note that the SWE does not receive the full tracking data set; rather, a subset of the full tracking data set tailored to our PY13 quarterly data request. Also note that HER programs are not audited using the tracking data, thus they are not included in the tables or totals in the following sections. The SWE's findings regarding the HER components of the Energy Efficient Homes and LIEEP can be found in [Appendix H.5.1.2](#).

Table 177 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in West Penn Power’s PY13 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by West Penn Power.

Table 177: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	12,935	12,935	Yes*
Energy Efficient Products	7,794	7,794	Yes
Low Income Energy Efficiency	4,361	4,361	Yes*
C&I Energy Solutions for Business - Small	7,268	7,268	Yes
C&I Energy Solutions for Business - Large	11,194	11,194	Yes
Portfolio Total	43,552	43,552	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 178 summarizes the SWE’s findings regarding reported gross peak demand savings, by program. The tracking data is provided at the meter-level. To facilitate the comparison, we applied the same line loss factors as the EDCs to adjust for transmission and distribution losses. Like with reported gross energy savings, the tracking data supports the West Penn Power PY13 Annual Report value exactly for all programs.

Table 178: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	1.75	1.75	Yes*
Energy Efficient Products	1.60	1.60	Yes
Low Income Energy Efficiency	0.53	0.53	Yes*
C&I Energy Solutions for Business - Small	1.22	1.22	Yes
C&I Energy Solutions for Business - Large	1.31	1.31	Yes
Portfolio Total	6.41	6.41	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 179 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for all programs. The portfolio totals, however, differ by 9,503 participants: 82,586 in the West Penn Power PY13 Annual Report and 73,083 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with the EDCs and their evaluation contractors to understand the Phase IV business rules around counting participants for different program components.

Table 179: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	58,724	53,141	No*
Energy Efficient Products	10,976	9,730	No
Low Income Energy Efficiency	12,700	10,042	No*
C&I Energy Solutions for Business - Small	174	160	No
C&I Energy Solutions for Business - Large	12	10	No
Portfolio Total	82,586	73,083	No*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 180 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in West Penn Power's PY13 Annual Report. The SWE was able to exactly replicate incentive dollars for the Low-Income Energy Efficiency and C&I Energy Solutions for Business – Large programs. For the other three programs, the SWE calculated directionally similar values using the tracking data. For these five programs, the totals are nearly identical: \$6,535,000 in the Annual Report and \$6,548,000 in the tracking data.

Table 180: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$2,149	\$2,140	No
Energy Efficient Products	\$971	\$988	No
Low Income Energy Efficiency	\$1,044	\$1,045	Yes
C&I Energy Solutions for Business - Small	\$1,713	\$1,717	No
C&I Energy Solutions for Business - Large	\$658	\$658	Yes
Portfolio Total	\$6,535	\$6,548	No

H.4.2 Project File Reviews

H.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of West Penn Power's residential project files for PY13 using the project file documentation provided by West Penn Power, the program implementors, and ADM. This is in response to the SWE's standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms.

Table 181 presents a summary of SWE's residential project file reviews.

Table 181: West Penn Power PY13 Residential Project File Review Summary

Program	Sub Program	Number of files reviewed ¹	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data? ²
EE Homes Program	Direct Install	7	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	4	✓	✓	✓	✓
EE Homes Program	Multifamily	4	✓	✓	✓	✓
EE Homes Program	New Homes	16	✓	✓	✓	✓
EE Products Programs	Appliances	13	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	8	✓	✓	✗	✓
EE Products Programs	HVAC	17	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	12	✓	✓	✓	✓
LIEEP	Appliances	4	✓	✓	✓	✓
LIEEP	Appliance Turn In	10	✓	✓	✓	✓
LIEEP	Direct Install	12	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all FirstEnergy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Energy Efficient Homes Program: Direct Install

Invoices along with customer applications were provided for West Penn Power's direct install component. A review of the sampled files did not reveal any discrepancies. No project files were submitted in Q1, Q2, or Q3. However, West Penn Power's participation was limited per the tracking data and PY13 annual report. The SWE notes that the information provided within each project matched the tracking database.

Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. Documentation for these programs were only supplied in Q4, however the SWE notes that the majority of activity for the component occurred in the final two months of PY13. The documentation included invoices and specification sheets for each kit by EDC, however the tracking database only provides information at the kit-level. The SWE verified the reported kit-level savings aligned with spec sheet values, and confirmed the date and quantity aligned with the tracking data.

For the school education kits, the documentation included invoices and specification sheets for each kit by the EDC at the individual level. The SWE was able to confirm the total orders for all FirstEnergy EDCs. The SWE was unable to confirm specific instances of kit delivery with the tracking data due to project documentation consisting of batch invoices. However, the SWE was able to verify that the reported savings for an individual kit aligned with the kit contents.

Energy Efficient Homes Program: Multifamily

Project files contained program applications, invoices, and landlord agreements. No project files were submitted for Q1, Q2, or Q4 however West Penn Power had limited participation per the tracking data and PY13 annual report. All information in project files matched the tracking database.

Energy Efficient Homes Program: New Homes

A review of the sampled files did not reveal any discrepancies between the project files and the tracking database. However, the SWE notes that reported savings for Q1 were unverifiable as the project files only contained REM/Rate reports rather than the REM/Rate building energy models, which are used to confirm that the reported savings values match the tracking data.

Energy Efficient Products Program: Appliances

The SWE observed a small discrepancy between the project files and the program tracking data. In one project file the attached receipt did not list quantity and therefore was unverifiable in the tracking database. However, in all other SWE reviewed project files all data matched the tracking data.

Energy Efficient Products Program: Appliance Recycling

The SWE was initially unable to match the photographs provided with the project documentation to the tracking data for Q1, Q3, and Q4 due to unclear identifying information between the project files and tracking data.⁸⁹ No projects files were provided in Q2 for West Penn Power. The SWE also notes that the quality of the photographs does not consistently and clearly capture the nameplate information of the recycled equipment but notes that quality of the photographs improved over the course of PY13. ADM included a useful analysis illustrating the improvement in photo quality and inclusion of verifiable nameplate or model number information. The other project documentation allowed the SWE to confirm the count of recycled appliances for each sampled project, however these counts were only provided in an Excel database with an electronic customer signature.

Energy Efficient Products Program: HVAC

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. Project files mostly matched the tracking data. In one instance tracking data was missing a thermostat included in the project file invoice.

The SWE observed the same discrepancy as previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular variable. In the tracking data, capacity was displayed as a singular *tons* variable.⁹⁰ That being said, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data.

Starting in PY9, ADM worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations. Most project requests did not include an AHRI certificate, which prevented verification of tracking data measures.

Energy Efficient Products Program: Midstream Appliances

The Midstream Appliance project files included invoices which listed out quantities, appliances, and the total cost. Many of the invoices were designated an EDC but spanned all four EDCs in the tracking data. In addition, these files spanned multiple quarters, so a full reconciliation of quantities did not always match when reviewing the quarterly data uploads of program tracking data. In these instances, the SWE was unable to verify total FirstEnergy and individual EDC quantities. However, ADM was able to confirm that invoice quantities matched when looking at full year tracking data.

⁸⁹ ADM provided the SWE with detailed information on how to corroborate the appliance recycling pictures with the program tracking data, and the SWE confirmed the photographs could be tied back to the program tracking data.

⁹⁰ For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

Low-Income Energy Efficiency Program: Appliances

The SWE observed no discrepancies between project files and tracking data. Project files included application rebate forms and quantity, size, and recreated savings all matched tracking data. No project files were submitted in Q1 or Q2 however participation was limited per the program tracking data.

Low-Income Energy Efficiency Program: Appliance Turn-In

The SWE review of LI Appliance Turn-In files is summarized in the appliance recycling subsection above.

Low-Income Energy Efficiency Program: Kits

The SWE review of LI kit files is summarized in the energy efficient kits subsection above.

Low-Income Energy Efficiency Program: New Homes

The SWE review of LI New Homes files is summarized in the New Homes subsection above.

Low-Income Energy Efficiency Program: Direct Install

The project documentation for the LI Direct Install mostly matched the quarterly tracking data. The SWE observed one discrepancy in which the tracking data was missing all lighting information included in the project file and the model number for the refrigerator.

H.4.2.2 Non-Residential

As part of its audit process, the SWE conducts a review of ex-ante savings. This review involves assessing specific project files for a sample of West Penn Power's non-residential programs in PY13. Project file documentation is provided each quarter of the program year by West Penn Power, the program implementors, and the evaluation contractor to the SWE. Project documentation provided typically includes program rebate applications and approvals, letters of attestation, invoices for installed equipment, equipment specification or "cut" sheets, post-inspection forms, and calculation workbooks. The SWE reviews these documents for completeness and consistency. The SWE also compares the data points in the documentation against the program tracking database to ensure values such as savings, rebate amounts, installation, approval, and invoice dates align.

Project files were generally well-organized, complete, and accurate. [Table 182](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 182: West Penn Power PY13 C&I Project File Review Summary

Program	Sub-Program	Number of Files Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program – Large	Custom - LCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Custom - SCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Large	Lighting - LCI	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	Lighting - SCI	3	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	Multifamily - SCI	4	0/4	0/4	2/4	0/4	✓	-
C&I Energy Solutions for Business Program – Small	Energy Management - SCI	2	✓	✓	✓	✓	✓	-

The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were estimated. However, the SWE did note a few issues to the Multifamily projects reviewed. The SWE noted specific project files with deficiencies as addressed below by sub-program.

- **Multifamily - SCI**
 - Missing documentation to check calculated savings with tracking data
 - For two of the projects, the 16 cu. Ft. refrigerator measure was listed in the tracker, but the actual refrigerators installed were 17 cu Ft.

Despite minor issues with some project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

H.5 VERIFIED GROSS SAVINGS AUDITS

H.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the West Penn Power portfolio of residential programs. West Penn Power's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy Efficient Homes Initiative, the Energy Efficient Products Initiative, and the LI Energy Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings into the three following sections: upstream lighting, residential non-lighting, and behavior.

The SWE identified the evaluation activities used to verify savings for the residential programs. [Table 183](#) provides a summary of the evaluation and M&V approaches used by West Penn Power in their PY13 verified savings calculations.

Table 183: Residential Program Evaluation Activities – West Penn Power

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Energy Efficient Homes				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
Energy Efficient Products				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
Low-Income Energy Efficiency Program				
LI Direct Install	-	✓	✓	✓
LI Appliance Turn-in	✓	-	✓	-
LI Appliances	✓	-	✓	-
LI New Homes	-	✓	✓	-
LI Kits	✓	-	✓	-

H.5.1.1 Residential Non-HER

The SWE's review of verified savings for residential non-lighting programs found that, generally, the verified savings followed proper TRM protocols and that the verified savings are accurate. However, the SWE did observe a discrepancy in the kits and appliance program components that led to an underreporting of verified demand savings.

Energy Efficient Homes Program and LIEEP: Energy Efficient and School Education Kits

The SWE reviewed both the energy efficient kits and the school kits subprograms. The SWE worked with ADM to correct any observed discrepancies prior to the filing of the FirstEnergy annual report. The SWE reviewed that the savings calculations were in accordance with the TRM and that the survey results were correctly applied to calculate the program-level realization rates. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the West Penn Power PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE

confirmed that participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes the review and results also cover the low-income energy efficient and education kit program components.

Energy Efficient Homes Program and LIEEP: New Homes

The SWE worked with ADM to resolve any discrepancies in the evaluated savings prior to annual reporting. ADM conducted a QA/QC of REM/Rate energy models, confirming model entries were accurate with on-site data. The SWE confirmed the verified savings were in accordance with TRM protocols, including the application of demand savings. In addition, the SWE confirmed the realization rates were correctly applied to calculate program-level savings.

The SWE notes that the review also covered the LIEEP New Homes program component.

Energy Efficient Homes Program and LIEEP: Direct Install

The Direct Install subcomponent of the EE Homes program includes both weatherization and non-weatherization measures. There were no weatherization projects conducted for West Penn Power in PY13. The SWE reviewed the non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included lighting, nightlights, advanced power strips, connected thermostats, and water heater setbacks.

The SWE also reviewed the LIEEP Direct Install subcomponent, which provides LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE confirmed these measures also applied the correct TRM algorithms to calculate verified savings.

The SWE also confirmed the application of realization rates, participation counts, and the verified savings were accurate in the PY13 report.

Energy Efficient Products Program and LIEEP: Appliances

ADM used a combination of verification surveys, invoice and application reviews, and applied EDC collected data, such as efficiency and capacity data, to program tracking data inputs when deemed appropriate by the TRM. The appliance component includes measures such as: refrigerators, freezers, clothes washers and dryers, dehumidifiers, dishwashers, window ACs, HPWHs, and connected thermostats. The SWE was able to conduct an early review and confirmed that the savings values were correctly calculated using the TRM protocols. While the savings were correctly calculated, the SWE observed a discrepancy with the calculation of the realization rate for verified demand savings that were subsequently claimed in the West Penn Power PY13 Annual Report. The demand realization rate was calculated from the sample using meter-level demand savings divided by system-level demand savings. Essentially this discounted the realization rate and led to an underreporting of demand savings. The SWE confirmed that participation, energy savings, and energy realization rates were in alignment with those in the annual report.

The SWE notes that the appendix for this component includes a list of the variables for each appliance, and where the data source came from. This was a helpful addition for the review process.

The SWE notes that the review also covered the LIEEP Appliances program component.

Energy Efficient Products Program and LIEEP: Appliance Recycling

The SWE performed audits on all measures included in the LI and non-LI Appliance Turn-In (ATI) programs, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

Energy Efficient Homes Program: Multifamily

The SWE reviewed the Multifamily subcomponent of the EE Homes program for FirstEnergy. The Multifamily subcomponent directly installed ENERGY STAR lighting, LED night lights, and advanced power strips in residential multifamily units. The SWE observed that the savings were calculated in accordance with the TRM. The SWE also confirmed that the participation counts, realization rates, and total savings were correct.

Energy Efficient Products Program: HVAC

The SWE conducted an early review of the HVAC component. The SWE determined ADM applied survey results and model-specific values appropriately. The SWE confirmed the participation counts, realization rates, and verified savings aligned with the annual report.

Energy Efficient Products Program: Midstream Appliances

The SWE conducted an early review of the Midstream Appliances component. ADM's evaluation included a full review of the program tracking data and aligning savings estimates with the TRM and product specific data. The SWE did not observe any discrepancies with the application of the TRM algorithms, or the application of EDC gathered data. The SWE confirmed participation counts, realization rates, and verified savings were reported accurately.

Energy Efficient Products Program: Upstream Electronics

The FirstEnergy companies did not offer the Upstream Electronics component of the EE products program in PY13.

H.5.1.2 Behavior

Home Energy Reports were issued to around 53,000 residential and residential-LI households in PY13. 21% of West Penn Power's progress toward its low-income target in PY13 came from HERs. West Penn Power's behavioral portfolio consists of two different waves, or cohorts, of homes. Both cohorts were launched during PY13 and one of them targets low-income households. [Table 184](#) summarizes the average number of active households during PY13 by cohort.

Table 184: West Penn Power HER Cohort Summary

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	42,795	11,583
2021 Low-Income	9/30/2021	9,234	9,381

The program ICSP Oracle implemented both cohorts as a randomized control trial (RCT) where the eligible households were identified and then randomly assigned to either a treatment or control group. Following randomization, ADM conducted statistical tests on the pre-treatment energy usage patterns to confirm equivalence between the treatment and control groups.

RCT Validation

The SWE team conducted an audit of randomization soundness and pre-treatment equivalence for the two cohorts introduced in PY13. The SWE team ran a simple fixed effects regression model using the pre-treatment data with indicator variables for each month and for the treatment. During the pre-treatment period, we’d expect the “treatment” indicator variable to be statistically insignificant, as the treatment effect is only expected after HER delivery begins. Indeed, we found the treatment indicator variable to be statistically insignificant for both cohorts. The SWE team also ran a t-test of pre-period usage by treatment status for each cohort and found all differences in usage to be statistically insignificant. [Figure 91](#) and [Figure 92](#) display the monthly distribution of daily kWh usage for the treatment and control groups of each of the cohorts. These visuals reinforce the finding that pre-treatment usage patterns are extremely similar between the treatment and control groups of each cohort.

Figure 91: Pre-Treatment Equivalence, Residential Cohort

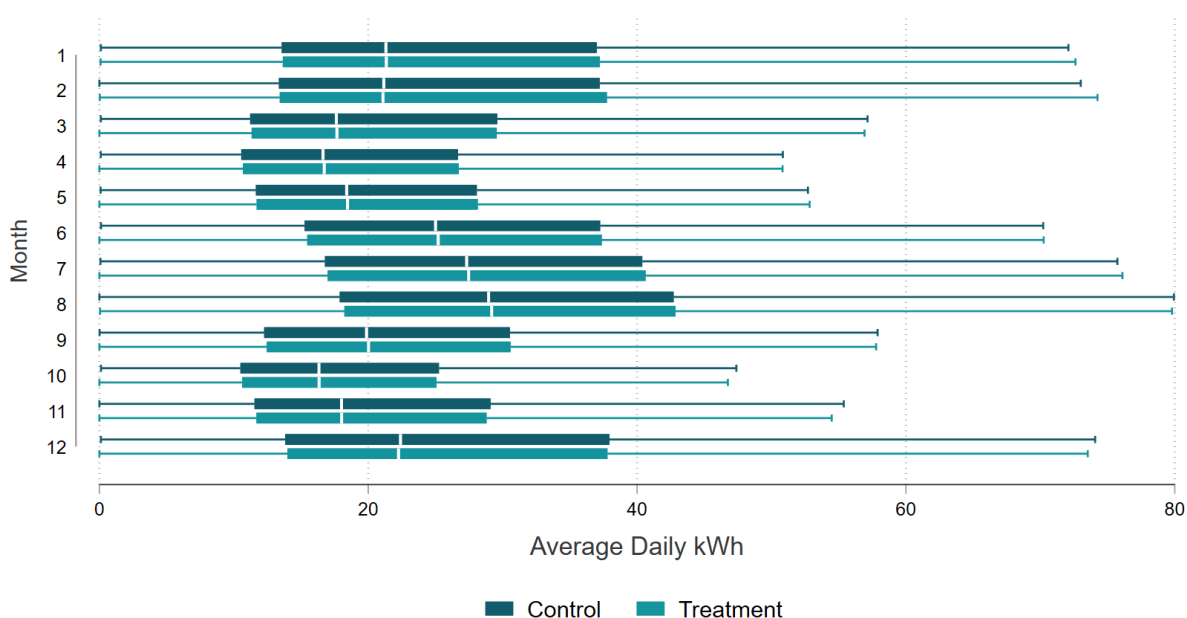
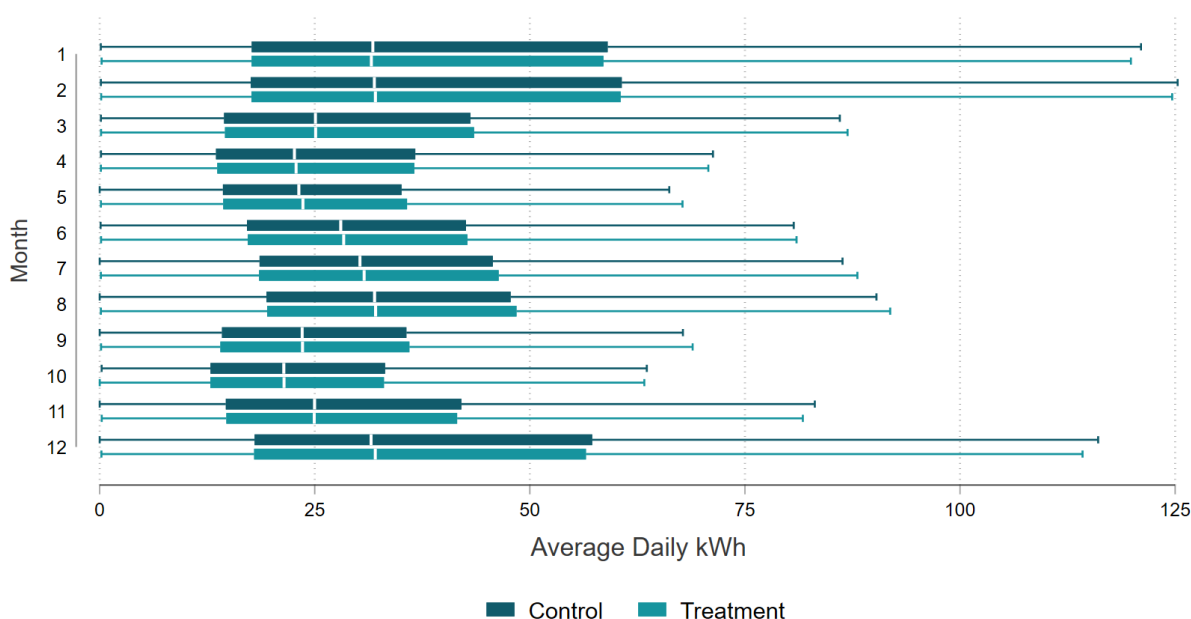


Figure 92: Pre-Treatment Equivalence, Low-Income Cohort



Data Preparation

The SWE team received interval data from ADM at three different levels: hourly, daily, and monthly. The monthly data is the primary input in the estimation of HER impacts. The SWE team independently checked the aggregation of the daily data to the monthly level, and we found the calculations to be sound (and we also found the distribution of monthly kWh to be reasonable). ADM used a lagged seasonal (LS) regression model for the PY13 impact analysis as called for in the West Penn Power PY13 EM&V plan. The LS model contains three lag variables: one for average usage during the pre-treatment period (all months), one for average summer usage during the pre-treatment period, and one for average winter usage during the pre-treatment period. The SWE team was able to replicate the three lagged variables calculated by ADM.

Participant Counts

ADM obtains active customer counts for each month by tallying up the number of accounts that have hourly interval data for the month. Only active accounts where HER delivery has begun are included in these calculations. An inconsequential number of accounts were not counted for other reasons (placed in both the control group and treatment group or multiple treatment starting dates). A larger number of accounts (1.6% of the total treatment accounts) were not included in the counts because Oracle never began HER delivery to these homes or due to pre-start date attrition.

The SWE team validated ADM enrollment counts by performing a similar counting method on the hourly interval data. Customers are considered active through the end of the month that they last have interval data. For example, if a customer's final AMI record is from February 15, the customer would be included in the count for February but not in March or any month following. The SWE team's final customer counts matched ADM's counts within 0.1 percent for each month and each cohort.

Customers that did not have 12 months of pre-treatment data were not included in the impact estimation (because the lagged variables for these customers could not be calculated), but they were included in the customer counts.

Impacts

By month, the daily impact estimates are plotted in [Figure 93](#) (residential) and [Figure 94](#) (low-income). Notably, June through September are not included in the figure. This is because HER delivery did not begin until October. For each cohort, [Table 185](#) shows the average of the PY13 monthly impact estimates (across the eight active months). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.19 kWh per day, on average, during PY13. The SWE was able to replicate ADM's impact estimate for each cohort/month combination.

Table 185: West Penn Power HER Impact Estimates

Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.19
2021 Low-Income	0.68

Figure 93: Average Daily Savings (kWh) by Month, Residential Cohort

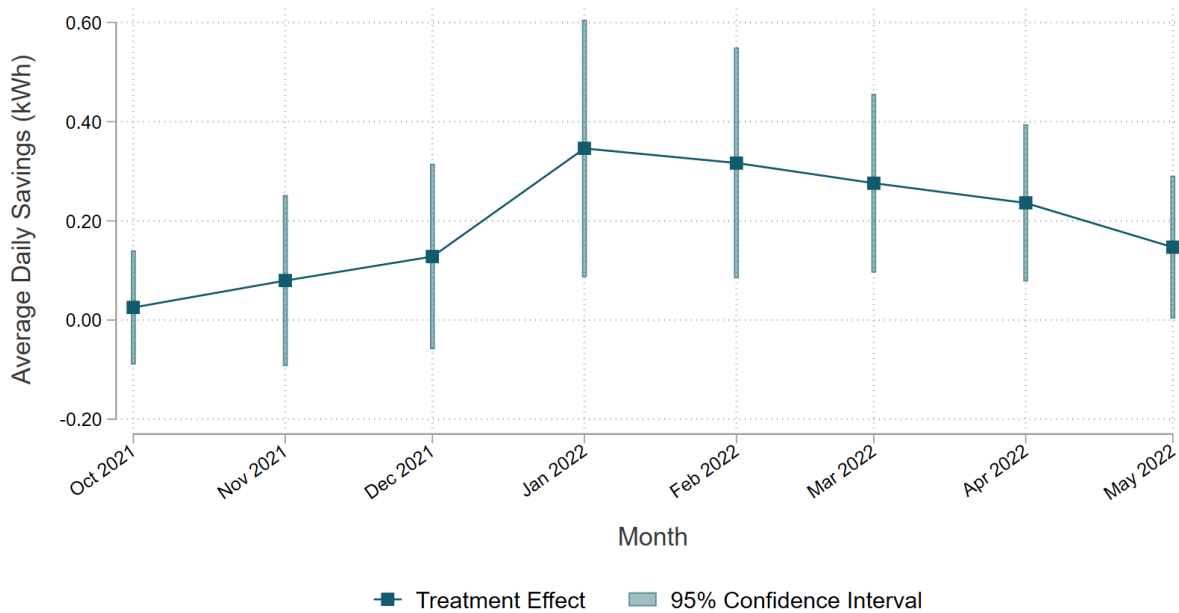
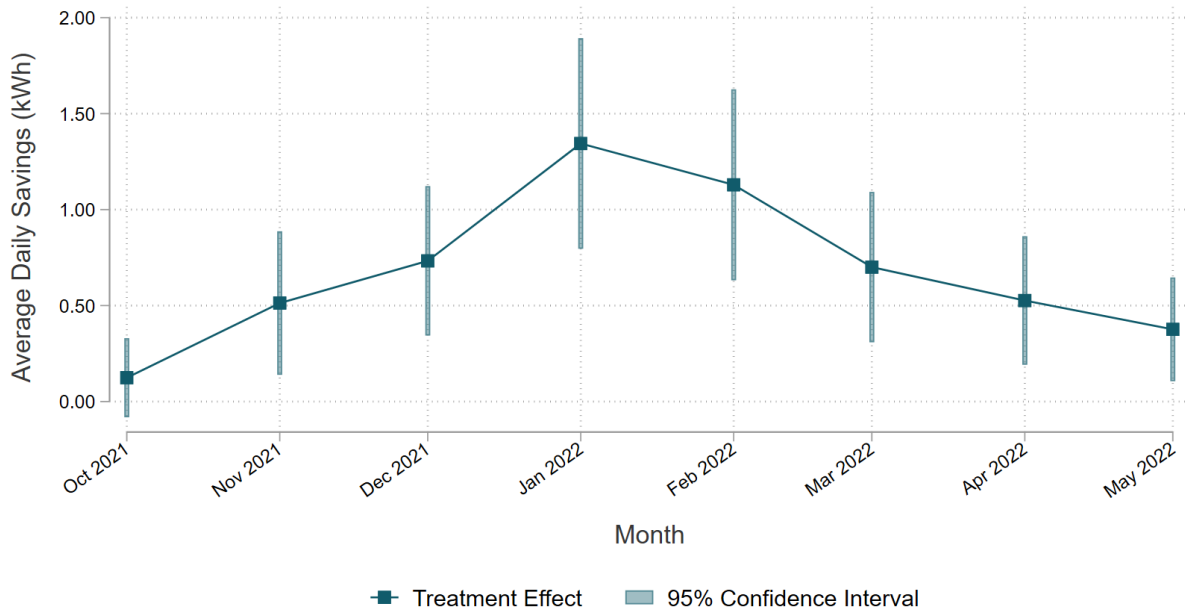


Figure 94: Average Daily Savings (kWh) by Month, Low-Income Cohort



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 186](#) shows the aggregate PY13 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, which are discussed in greater detail later, and the PY13 incremental gross savings estimate.

Table 186: PY13 HER Energy Savings

Cohort	Gross Savings (MWh/yr)	Downstream Dual Participation (MWh/yr)	Upstream Dual Participation (MWh/yr)	Persistence (MWh/yr)	Incremental Savings (MWh/yr)
2021 Residential	2,005	29	0	0	1,975
2021 Low-Income	1,506	8	0	0	1,498
Total	3,511	37	0	0	3,474

Dual Participation

In [Table 186](#), gross savings before adjusting for dual participation were 3,474 MWh. It is important to note that Home Energy Reports advertise other West Penn Power residential EE&C programs and measures such as ENERGY STAR appliances, water heaters, HVAC etc. To the extent that treatment group households participate in these programs more frequently than control group homes, the incremental savings is captured in the regression estimates for the HER analysis. To avoid double-counting, the HER savings are reduced to account for the incremental program participation observed in the treatment group compared to the control group.

Regarding upstream dual participation, note that West Penn Power did not offer an upstream lighting program in PY13. The Upstream Electronics component of the Energy Efficient Products Program was not offered in PY13 either. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

Persistence

PY13 saw the introduction of a new framework for separating persisting savings from previous program years from incremental savings attributable to the treatment in the current program year. The 2021 TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research⁹¹ on the persistent effects of behavioral energy efficiency treatment in the years after discontinuing treatment. Since Act 129 compliance goals are based on first-year incremental savings, these persistent impacts are subtracted from the measured savings to estimate incremental first-year savings (those directly due to the current program year of treatment).

Because both PY13 West Penn Power waves were launched during PY13, all savings are first-year savings. Separating persisting savings from incremental savings was not necessary.

Peak Demand Impacts

The 2021 TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 PM to 6:00 PM Eastern Daylight Time on non-holiday weekdays during June, July, and August. Because HER delivery did not begin until the fall, there were no peak demand impacts in PY13.

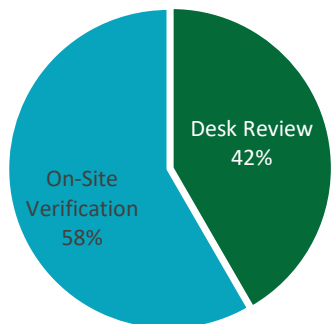
H.5.2 Non-Residential Audit Activities

Figure 95 provides a summary of the evaluation activities and M&V approaches utilized by West Penn Power's evaluation contractor, ADM, in their PY13 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY13, West Penn Power's evaluation contractor completed site visits to 58% of evaluated projects, and these projects represented 55% of total evaluated energy savings. In total, 35 site visits were completed. IPMVP Options A, B, and D were employed for 81% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 19% of the total evaluated savings, including the majority of prescriptive projects and most energy management projects.

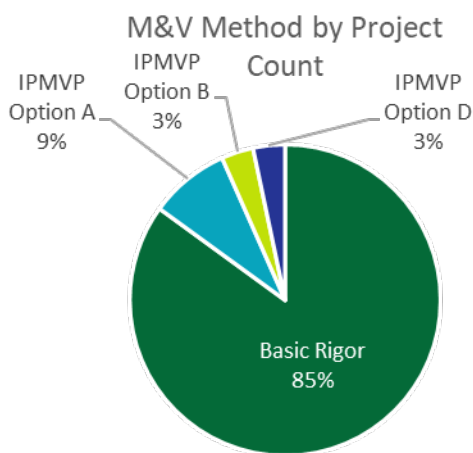
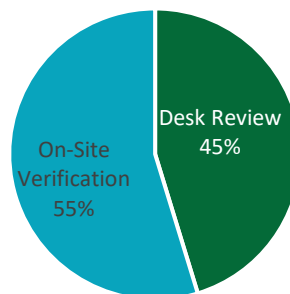
⁹¹ Addendum to Act 129 Home Energy Report Persistence Study. November 2018. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf

Figure 95: Summary of West Penn Power’s C&I Evaluation Activities

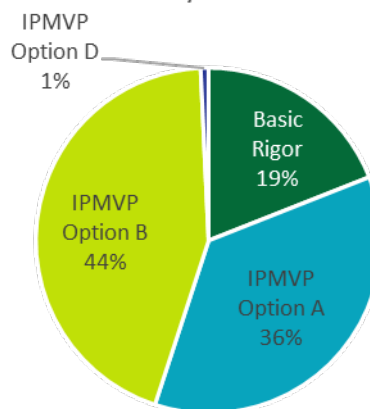
Evaluation Activity by Project Count



Evaluation Activity by kWh contribution



M&V Method by kWh contribution



West Penn Power’s evaluation contractor conducted sampling within defined evaluation initiatives. Measures across West Penn Power’s C&I programs are assigned to one of four evaluation initiatives, as West Penn Power’s programs target specific sectors of C&I customers, but offerings are often identical across the programs. [Table 187](#) provides a summary of the evaluation activities West Penn Power’s evaluation contractor used across strata for all projects by initiative.

Table 187: Summary of West Penn Power's PY13 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
Appliance Recycling		100%	95%	-	-
Custom	4	100%	100%	2	2
Custom – C	3	100%	100%	1	2
Custom – 1	1	100%	100%	1	-
Prescriptive	24	101%	87%	1	23
Downstream Lighting - C	3	100%	101%	-	3
Downstream Lighting - 2	3	118%	98%	-	3
Downstream Lighting - 1	16	71%	50%	-	16
Downstream Non-Lighting	1	100%	100%	1	-
Midstream Lighting	1	106%	79%	-	1
Midstream Non-Lighting	-	-	-	-	-
EMNC	15	95%	95%	10	5
EMNC	3	100%	100%	3	-
Building Tune-Ups	12	94%	94%	7	5
Multifamily	17	78%	79%	12	5
TOTAL	60			25	35

The SWE's review of verified savings for non-residential programs found that, overall, the verified savings estimation was aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and that the verified savings are generally accurate. The following sections describe the SWE's audit of the verified savings methodology for non-residential programs in further detail.

H.5.2.1 Appliance Recycling Initiative

In PY13, projects in West Penn Power's Appliance Recycling Sub-Initiative were evaluated through a review of tracking and reporting data. The gross energy and demand realization rates for each evaluation stratum were taken to be the realization rates from the broader initiative-level evaluation which included the residential and low-income residential components.

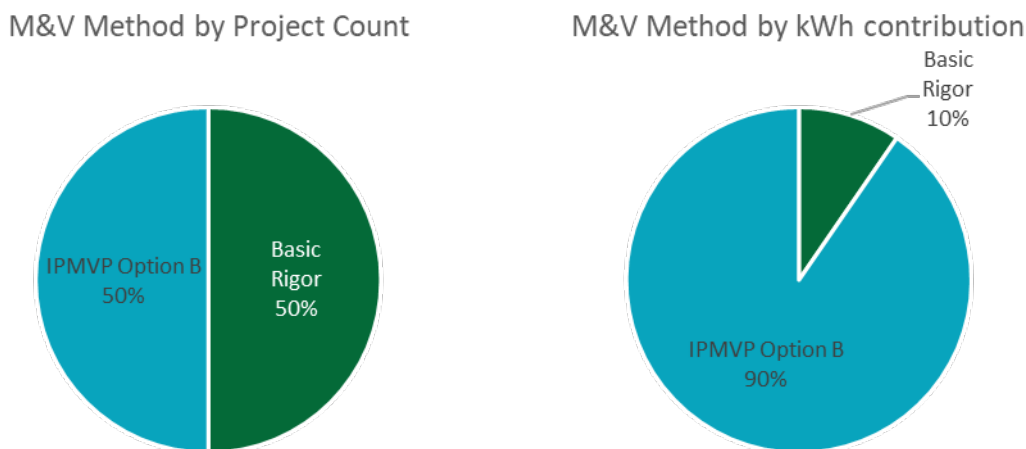
H.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews and/or IPMVP evaluation methods for all sampled projects. No site visits were conducted for PY13 custom sampled projects. The evaluation was satisfactorily conducted through desk reviews for all projects using data provided by the customer (EMS data, billing data, etc.).

West Penn Power’s evaluation contractor employed two strata for projects in the Custom initiative. The largest projects, with ex-ante savings estimates of 500 MWh or more, are separated into a “certainty” stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

The distribution of rigor across the sample strata is in keeping with Table 14 of the Phase IV Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. Enhanced rigor methods were employed to evaluate half of the projects, with IPMVP Option B selected for 50% of all evaluated custom projects, as shown in [Figure 96](#).

Figure 96: Summary of West Penn Power’s C&I Custom Program M&V Methods



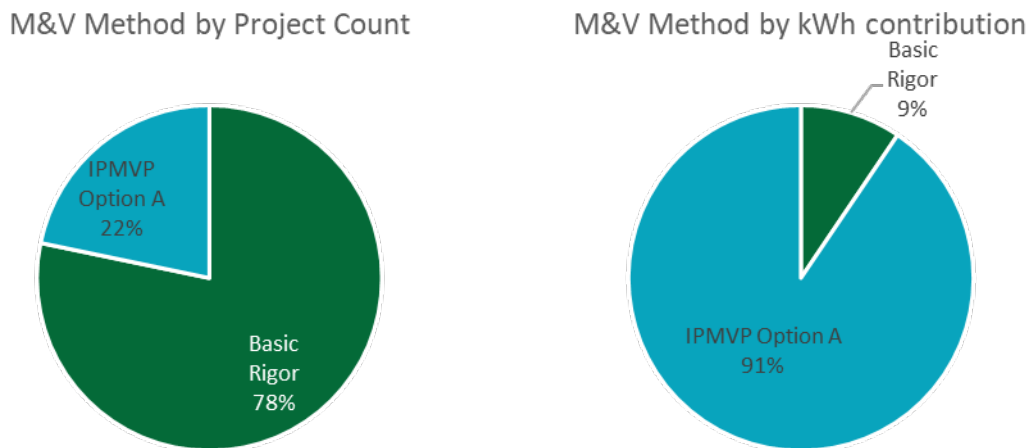
H.5.2.3 Prescriptive Initiative

Evaluation activities for this initiative include desk reviews for most projects and primary data collection of lighting hours of use for medium and high savings projects. TRM deemed hours of operation were applied in basic rigor desk reviews for low savings projects. All sampled projects undergo a full documentation review prior to site visits, and site-specific M&V plans are developed for most.

West Penn Power’s evaluation contractor employed three strata for projects in the Prescriptive initiative. The largest projects, with ex-ante savings estimates of 750 MWh or more, are separated into a “Downstream - Certainty” stratum. These projects are automatically sampled for evaluation, and evaluation activities are generally completed prior to rebate approval.

Basic Rigor was employed for 78% of evaluated projects in this initiative with the remaining projects using IPMVP Option A, as seen in [Figure 97](#) below.

Figure 97: Summary of West Penn Power’s C&I Prescriptive Program M&V Methods



H.5.2.4 Commercial and Industrial Energy Management and New Construction Initiative (CI EMNC)

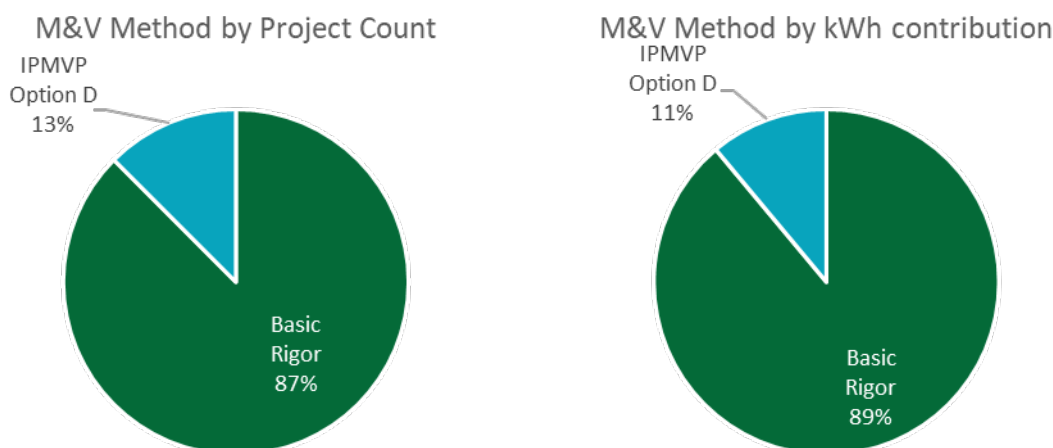
The CI EMNC Initiative has five subcomponents, but only two were active in PY13: Building Tune-Up and New Construction.

Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Basic rigor M&V methods were applied to these projects, incorporating TRM algorithms and reconciliations of invoices with equipment specification sheets.

Projects in the New Construction strata were evaluated using IPMVP Option D, which included review of baseline and as-built simulation models developed in the implementer’s custom simulation tool.

Basic Rigor was employed for 87% of evaluated projects in this initiative with the remaining projects using IPMVP Option D, as seen in [Figure 98](#) below.

Figure 98: Summary of West Penn Power’s CI EMNC Program M&V Methods



H.5.2.5 Master-Metered Multifamily Direct Install Initiative (CI MF)

All sampled projects in the CI MF initiative were evaluated using basic rigor desk reviews, with on-site inspections conducted for about one-third of the sample. The desk review process included reconciliation of invoices and re-calculation of reported savings using TRM algorithms.

H.5.2.6 Verified Savings Audits

The SWE audited the activities above through a detailed audit of ADM’s evaluation work for a sample of their evaluated projects. The SWE audit for ADM’s West Penn Power evaluation in PY13 included review of seven (7) projects, encompassing the following activities:

- 5 Field and Analysis Engineers were observed
- 4 Measure Types were observed
- 52% of Verified Energy Savings reviewed
- 36% of Verified Demand Savings reviewed

Overall, the SWE found that West Penn Power’s evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods for custom measures. The overall energy and demand savings attainment percentages of West Penn Power’s reviewed projects were 100% for both energy and demand savings.

Table 188 provides an overview of the SWE milestones for the verified savings audit review of evaluated West Penn Power’s projects.

Table 188: West Penn Power Verified Savings Audit Review Milestones

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
7	9,370,683	100%	819.13	100%

H.6 NTG

Table 189 lists West Penn Power's PY13 NTG results across all programs. Details concerning the methods and data used to estimate NTG values are in sections H.6.1 and H.6.2. The values in the NTG tables are taken from the FirstEnergy PY13 Annual Report program specific sections and appendices.⁹²

Table 189: Summary of West Penn Power's PY13 NTG Results

Program Component	Component	NTG
Energy Efficient Homes	EE Kits	1.10
Energy Efficient Homes	Home Energy Reports	1.0
Energy Efficient Homes	Direct Install	1.04
Energy Efficient Homes	New Homes	0.73
Energy Efficient Homes	Multifamily	0.80
Energy Efficient Homes	Online Audits	1.0
Energy Efficient Products	Appliance Recycling	0.70
Energy Efficient Products	Upstream Electronics	0.58
Energy Efficient Products	HVAC	0.52
Energy Efficient Products	Appliances	0.65
Energy Efficient Products	Midstream Appliances	0.51
Low-Income	Appliances	1.0
Low-Income	Appliances Turn-In	1.0
Low-Income	Direct Install	1.0
Low-Income	Home Energy Reports	1.0
Low-Income	Kits	1.0
Low-Income	New Homes	1.0
Low-Income	Online Audits	1.0
C&I Solutions for Business Programs - Small and Large	Prescriptive	0.66
C&I Solutions for Business Programs - Small and Large	Custom	0.58
C&I Solutions for Business Programs - Small and Large	EMNC	0.66
C&I Solutions for Business Programs - Small and Large	Multifamily	1.0
C&I Solutions for Business Programs - Small and Large	Appliance Recycling	0.70

H.6.1 Residential Programs

ADM planned and enacted NTG research for the residential Appliance Recycling program for PY13. ADM utilized participant surveys to estimate free-ridership and NTG reasoning that

⁹² The FirstEnergy PY13 Annual Report reviewed by the SWE for the SWE Final Annual Report included several NTG values reported in the impact evaluation summary table in Chapter 2 of the report (Table 12) that were not consistent with the value reported in program specific sections and appendices of the report. ADM was able to confirm the correct NTG values to the SWE

spillover was not necessary since the Appliance Recycling program does not lead to installation of Energy Efficient Products. ADM utilized a free-ridership battery of questions that was consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation (excluding spillover).

All other residential programs utilized NTG values estimated, and SWE verified during Phase III with the exception of the Home Energy Report Program. The Home Energy Report program NTG was assigned a value of 1.0, in accordance with the Phase IV Evaluation Framework. The random control trial (RCT) design of the program eliminates the need for NTG analysis because the control group does everything the treatment group would have done and the estimated savings are technically net savings.

Table 190: Summary of West Penn Power's PY13 Residential NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
EE Kits	N/A	N/A	23%	33%	1.10
Home Energy Reports	RCT	N/A	0%	0%	1.0
Direct Install	N/A	N/A	20%	24%	1.04
New Homes	N/A	N/A	27%	0%	0.73
Multifamily	N/A	N/A	20%	0%	0.80
Online Audits	N/A	N/A	0%	0%	1.0
Appliance Recycling	Self-Report Survey	155	30%	0%	0.70
Upstream Electronics	N/A	N/A	N/A	N/A	0.58
HVAC	N/A	N/A	48%	0%	0.52
Appliances	N/A	N/A	49%	14%	0.65
Midstream Appliances	N/A	N/A	49%	0%	0.51

H.6.2 C&I Energy Efficiency Programs

ADM did not conduct any new NTG research for C&I programs in PY13. They applied NTG values from Phase III NTG evaluations that have been verified by SWE during Phase III. ADM did apply the residential Appliance Recycling PY13 NTG to the C&I Appliance Recycling program and assigned a NTG value of 1 to the C&I Multifamily program as it is a low-income program.

Table 191: Summary of West Penn Power's PY13 C&I NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	N/A	N/A	34%	1%	0.66
Custom	N/A	N/A	42%	0%	0.58
EMNC	N/A	N/A	34%	0%	0.66
Multifamily	N/A	N/A	N/A	N/A	1.0
Appliance Recycling	N/A	N/A	20%	0%	0.80

H.7 TRC

Table 192 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for West Penn Power's PY13 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the West Penn Power PY13 Annual Report and the model itself was well-organized and documented.

The program designs presented in FirstEnergy's Phase IV EE&C Plan are organized into the following sectors: (1) Residential; (2) Residential Low-Income; (3) Small Commercial and Industrial; and (4) Large Commercial and Industrial. The number of programs within these sectors decreased from nine in Phase III to five in Phase IV in part due to the exclusion of dispatchable demand response from Phase IV. The Appliance Turn-In Program is now a component of the Energy Efficient Products Program.

Both gross and net TRC ratios increased slightly from PY12, with the largest increase occurring in the Low-Income Energy Efficiency program and slight decreases occurring in the Energy Efficient Homes, Energy Efficient Products, and C&I Energy Solutions for Business - Small programs. Pursuant to the 2021 TRC Test Order directive for Phase IV, the nominal discount rate is now 5% and no longer tied to WACC. All else being equal, a lower discount rate improves the TRC ratio.

Table 192: Summary of West Penn Power's PY13 TRC Results

Program Name	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Energy Efficient Homes	\$7,546	\$4,440	1.70	\$7,907	\$4,188	1.89
Energy Efficient Products	\$3,328	\$4,550	0.73	\$1,929	\$3,126	0.62
Low Income Energy Efficiency	\$2,673	\$1,730	1.54	\$2,673	\$1,730	1.54
C&I Energy Solutions for Business - Small	\$4,075	\$4,245	0.96	\$2,913	\$3,500	0.83
C&I Energy Solutions for Business - Large	\$5,605	\$3,774	1.49	\$3,401	\$2,620	1.30
Portfolio Total	\$23,227	\$18,739	1.24	\$18,823	\$15,164	1.24

Three of West Penn Power's five EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. All three of these programs were also found to be cost-effective using net verified savings. The Energy Efficient Products program was not cost-effective on a gross or net basis, in part due to the high incremental costs relative to energy savings for certain ENERGY STAR products like clothes dryers and dishwashers. The C&I Energy Solutions for Business – Small program was also not cost-effective on a gross or net basis, in part due to the high administration and program overhead costs in the first year of the phase.

H.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- West Penn Power's annual electric energy savings are calculated and allocated by season (summer, winter, and shoulder) and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is consistent with the on-peak hours defined in the 2021 TRM (Monday – Friday 7AM to 11PM). The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions. The SWE also verified the correct avoided costs from West Penn Power's EE&C Plan were used in the TRC Model. The TRC Model accurately collapsed the 8,760 hourly load shapes into single annual weighted-average values used in the energy benefits calculations.
- To calculate the avoided cost of natural gas, West Penn Power used a three-segment approach outlined in the 2021 TRC Test Order. The SWE verified the TRC Model correctly applied the avoided costs to estimate TRC benefits.
- Pursuant to the 2021 TRC Test Order, the SWE verified West Penn Power used a nominal discount rate of 5% to calculate the net present value of future program benefits. This discount rate is consistent with their EE&C plan and the 2021 TRC Test Order. Line loss adjustment factors varied by sector. Residential (1.0943), Small C&I (1.079) and Large C&I (1.079).
- The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the Database for Energy Efficiency Resources (DEER), company assumptions, and actual project costs as gathered from the PY13 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent with West Penn Power's EE&C plan.
 - For non-residential lighting measures, West Penn Power consistently applied the benefits and incremental costs of Early Replacement to all measures. This aligns with the definitions in Table 6 of the 2021 TRC Test Order and the measure vintage in the 2021 TRM.
- Realization rates for energy and demand impacts were applied to the reported gross program impacts in the TRC model to calculate verified gross savings.
- The calculation of NTG using free-ridership and spillover, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the 2021 TRC Test

Order directive for Phase IV. The TRC model followed the protocol pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.

- The SWE found that the cost categories were handled correctly in the TRC model. Participant incentives were not considered TRC costs, while administrative costs, incremental costs, and kits were incorporated as costs.
- The SWE verified the ex-ante demand and capacity savings were accurate in the TRC model by comparing it to the Quarterly Tracking Data reported by West Penn Power.
- According to the Phase IV Evaluation Framework, low-income measures are required to be provided at no cost to the participants. At first glance, it appears that West Penn Power's low-income programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the Low-Income Energy Efficiency Program (Table 65 in FirstEnergy's PY13 Annual Report). However, in their Phase IV EE&C Plan, West Penn Power explains that these costs are only being allocated to landlords and owners of low-income properties, rather than the low-income customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Fossil Fuel Impacts and Total NPV Lifetime Water Impacts. The SWE verified that the savings were accounted for in accordance with the 2021 TRC Test Order. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative benefit rather than a program cost. The TRC model claimed nearly 27 million gallons per year of water savings, which translates to approximately \$3,515,000 in NPV lifetime avoided costs.

H.8 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to the programs across the four FirstEnergy EDCs, including West Penn Power, so the annual evaluation report of the four FirstEnergy EDCs reports identical information about the process evaluation. Therefore, [Appendix E.8](#) of the SWE's PY13 Final Annual Report, described previously for Met-Ed, applies to all four FirstEnergy utilities, including West Penn Power. The customer survey for the Appliance Recycling component set a goal of completions by 130 West Penn Power customers; the target was exceeded with 163 completions.

Appendix I ACEEE Scorecard

The tables in this appendix provide the data needed for the ACEEE State Energy Efficiency Scorecard, including Pennsylvania's statewide energy efficiency budgets and expenditures, verified gross annual and lifetime savings, and verified net annual and lifetime savings.

Table 193: PA Statewide Energy Efficiency Budgets and Expenditures

EDC	Actual PY13 Expenditures	Approved Budget for PY13
PECO	\$54,820	\$74,460
PPL	\$30,161	\$60,824
Duquesne Light	\$13,359	\$17,053
FE: Met-Ed	\$10,808	\$23,850
FE: Penelec	\$9,959	\$22,018
FE: Penn Power	\$3,795	\$6,459
FE: West Penn Power	\$11,742	\$23,166
Statewide	\$134,644	\$227,830

Table 194: PA Statewide Gross Verified Annual and Lifetime MWh Savings

EDC	Gross Verified Annual Savings (PY13)	Gross Verified Lifetime Savings (PY13)
PECO	243,190	2,517,930
PPL	167,361	2,343,803
Duquesne Light	49,101	618,645
FE: Met-Ed	46,455	569,089
FE: Penelec	36,021	432,826
FE: Penn Power	15,934	201,450
FE: West Penn Power	43,638	508,298
Statewide	601,700	7,192,040

Table 195: PA Statewide Net Verified Annual and Lifetime MWh Savings

EDC	Net Verified Annual Savings (PY13)	Net Verified Lifetime Savings (PY13)
PECO	170,265	1,717,214
PPL	103,733	1,432,982
Duquesne Light	38,929	507,071
FE: Met-Ed	29,620	361,665
FE: Penelec	29,649	359,093
FE: Penn Power	11,144	139,798
FE: West Penn Power	34,466	390,190
Statewide	417,807	4,871,611

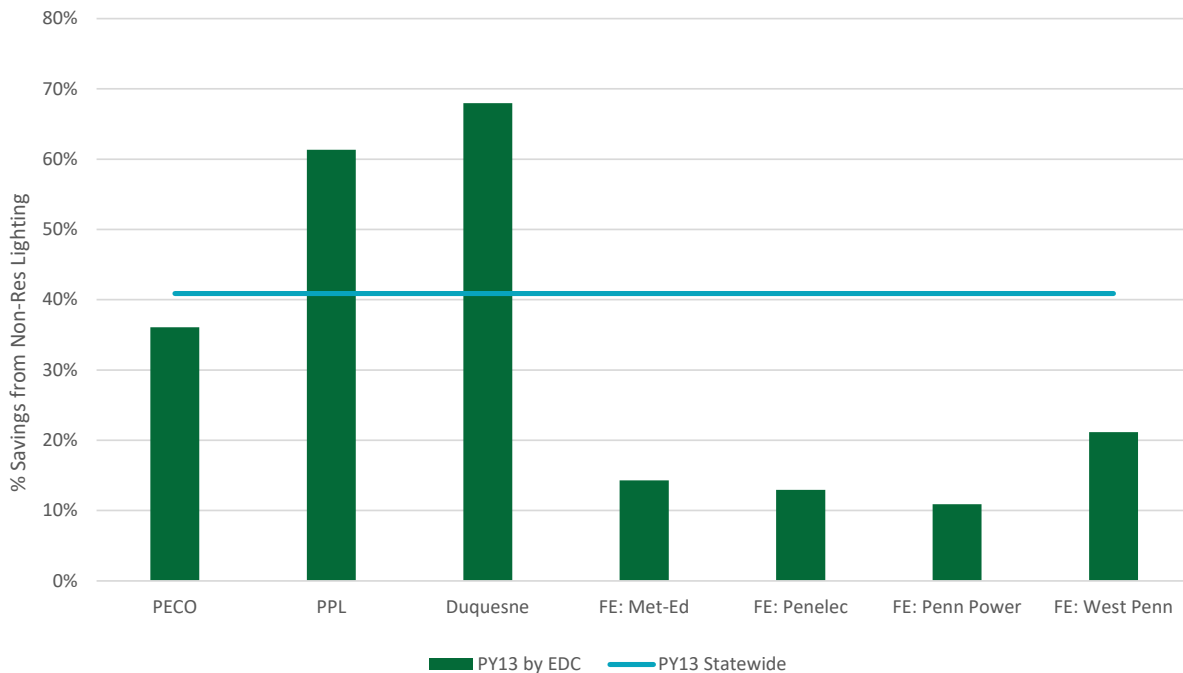
Appendix J Top Savings Programs for PY13

J.1 NON-RESIDENTIAL LIGHTING

Non-residential lighting improvements accounted for 41% of statewide PY13 energy savings. These projects largely utilized TRM provided measure methodologies, with smaller shares of savings being achieved through midstream lighting programs and custom measure protocols. Light emitting diode (LED) technologies have rapidly increased market share in the last several years, now accounting for a significant majority of all PY13 non-residential lighting improvements in both downstream and midstream programs.

Variation in the Non-Residential lighting share across the seven EDCs was observed. As shown in Figure 99, Non-Residential lighting contributed more than 60% of PY13 energy savings for PPL and Duquesne Light. For the FirstEnergy companies, the overall share of savings was considerably lower, ranging from 11% to 21%.

Figure 99: EDC Non-Residential Lighting Savings Shares



J.2.3.1 Downstream Lighting Programs

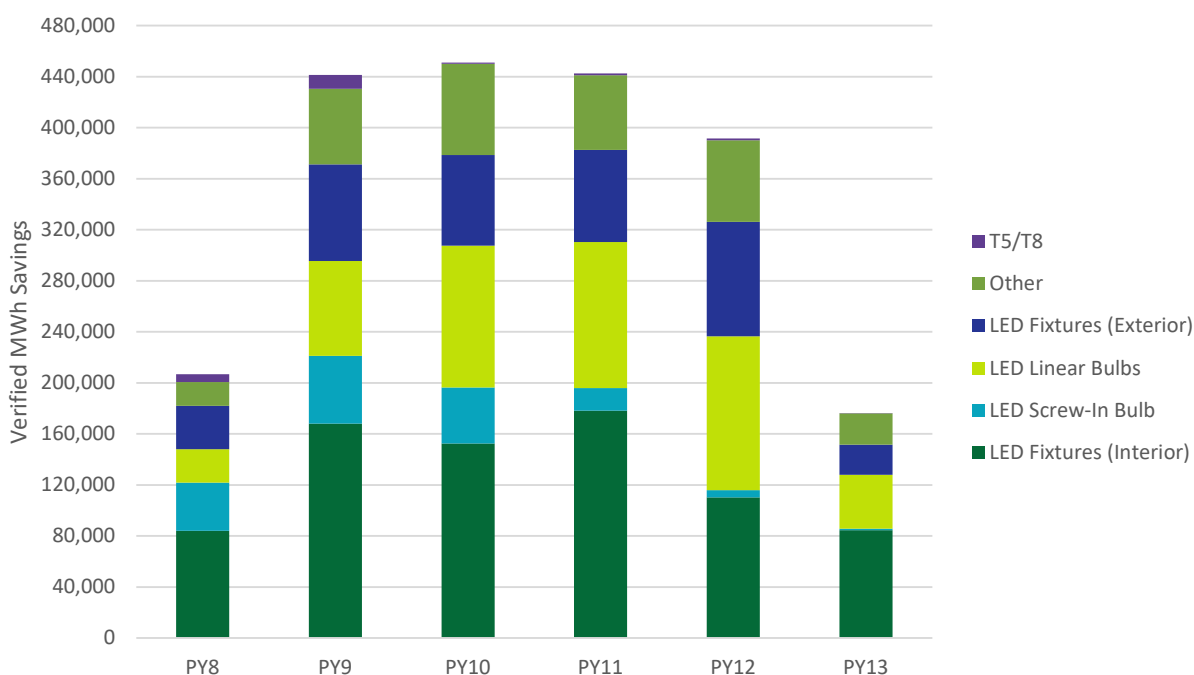
Downstream offerings continue to dominate the lighting programs across the EDCs and represent the single largest program offering, accounting for 29% of statewide PY13 verified gross energy savings. Downstream programs provide direct incentives for business customers who upgrade their facilities with energy efficient equipment. Typically, pre-determined incentives are made available to customers for common energy efficiency measures to facilitate the implementation of cost-effective energy efficiency improvements. To participate in a downstream program, a

customer typically applies with requested project documentation, such as invoices, project specification sheets, and other applicable information.

LED technology improvements have rapidly matured in the last several years, which have been readily accepted by non-residential customers and lighting contractors. LED technologies include direct lamp replacement options for linear, screw-in, and high-intensity applications, along with integral LED fixture replacements for interior low-bay and high-bay applications, exterior lighting, and street lighting. In addition to LED lighting lamp and fixture technologies, the availability of enhanced control options integrated with LED fixtures is increasing.

Figure 100 shows verified energy savings for Program Years 8 through 13 for downstream lighting offerings. The level of achieved energy savings in PY13 decreased significantly relative to the savings achieved in prior years. LED screw-in bulbs shares have reduced each year since PY9 and were only a negligible share of savings in PY13. Savings from exterior LED fixtures were the largest share of PY13 downstream lighting savings. Overall, LED technologies accounted for 72% of PY13 verified non-residential downstream lighting energy savings.

Figure 100: PY8 – PY13 Downstream Lighting Technologies



J.2.3.2 Midstream Lighting Programs

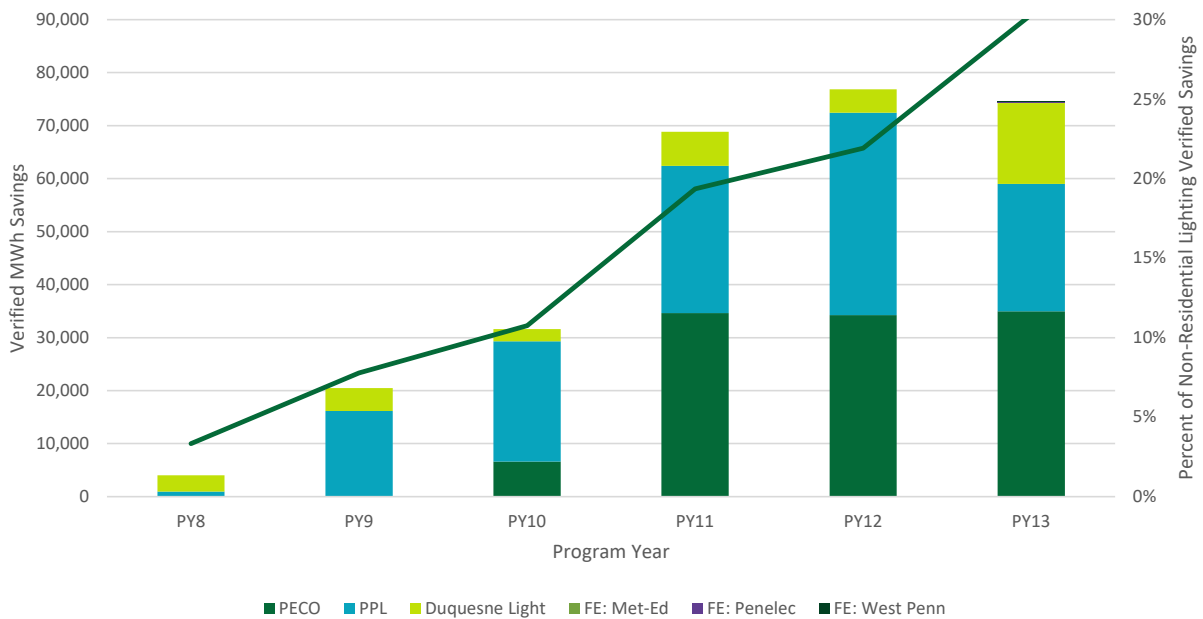
All seven EDCs offered a midstream lighting program in PY13, though Penn Power did not report any PY13 savings. Energy savings contribution results are presented in Table 196. The combined savings from these programs are about 28% of all verified non-residential lighting savings in PY13.

Table 196: Midstream Lighting Verified Energy Savings by EDC

EDC	Total Non-Residential Lighting (MWh.yr)	Midstream Lighting (MWh.yr)
PECO	87,784	34,977
PPL	102,646	24,025
Duquesne Light	33,384	15,265
FE: Met-Ed	6,646	96
FE: Penelec	4,659	87
FE: West Penn Power	9,226	157
TOTAL	245,544	74,607

Figure 101 illustrates how the midstream components of non-residential lighting have expanded since PY8. PECO’s program was a new offering in PY10 but has reported consistent levels of savings since PY11. PPL’s midstream program noticeably decreased in total verified energy savings in PY13, while Duquesne Light’s midstream program expanded. The FirstEnergy companies’ midstream offering is new for PY13.

Figure 101: PY8 – PY13 Midstream Non-Residential Lighting Programs



J.2 RESIDENTIAL LIGHTING

Residential lighting, and upstream lighting in particular, has historically been one of the primary sources of energy savings for EDCs. It continued to be one of the top program offerings in PY13, accounting for 10% of statewide savings, despite a baseline of 45 lumens/Watt in the 2021 TRM.⁹³ While still a top program offering, the quantity of savings is substantially lower than in previous years – PY13 savings are equal to 40% of PY12 residential lighting savings and only 14% of PY11 residential lighting savings. In Phase III of Act 129, residential lighting measures accounted for between 12% and 42% of gross statewide MWh savings annually.

Figure 102: PY8-PY13 Verified MWh from Residential Lighting

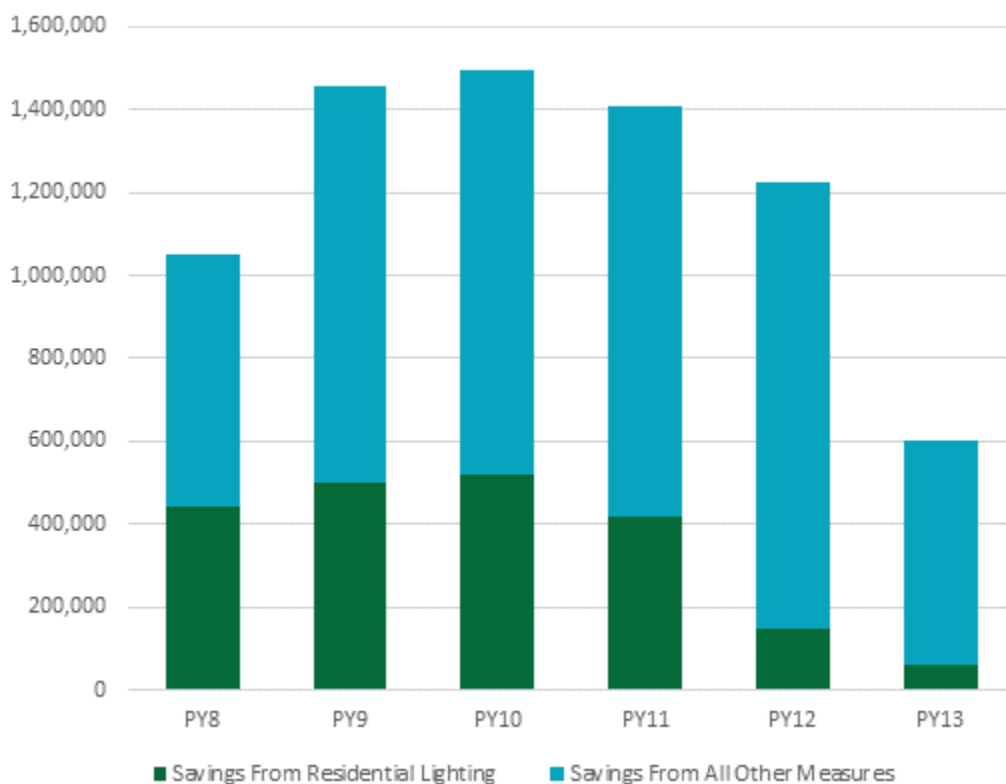


Table 197 displays PY13 energy savings from residential lighting by EDC. Despite not offering upstream lighting programs in PY13, the FirstEnergy companies had the highest percent of energy savings from residential lighting: from 15% for Met-Ed and Penn Power to 21% for Penelec. Most of the FirstEnergy companies' lighting measures were distributed in kits. PECO, PPL, and Duquesne each derived less than 10% of energy savings from residential lighting.

⁹³ For direct installation programs where the removed bulb is known, and the bulb is in working condition, EDCs may use the wattage of the replaced bulb as the baseline rather than a 45 lumens / Watt baseline.

Table 197: PY13 Energy Savings, Upstream Residential Lighting, Non-Upstream Residential Lighting, and All Residential Lighting

EDC	PY13 Verified Gross (MWh/yr)	Upstream Res Lighting (MWh/yr)	Non-Upstream Res Lighting (MWh/yr)	All Res Lighting (MWh/yr)	Percent of PY13 MWh from Res Lighting
PECO	243,190	16,267	5,572	21,839	9%
PPL	167,361	4,349	5,239	9,588	6%
Duquesne Light	49,101	1,010	1,064	2,075	4%
FE: Met-Ed	46,455	0	6,937	6,937	15%
FE: Penelec	36,021	0	7,433	7,433	21%
FE: Penn Power	15,934	0	2,327	2,327	15%
FE: West Penn Power	43,638	0	8,046	8,046	18%
Total	601,700	21,626	36,618	58,245	10%

Figure 103 displays the distribution of upstream lighting products by type from PY8 to PY13. The proportion of general service lamps declined from 63% to 19% in PY12 when the baseline for general service lamps was reduced to 45 lumens per watt. The proportion of general service lamps rebounded to 36% in PY13 when the baseline for all other types was reduced to 45 lumens per watt.

Figure 103: PY8-PY13 Upstream Lighting Sales by Product Type

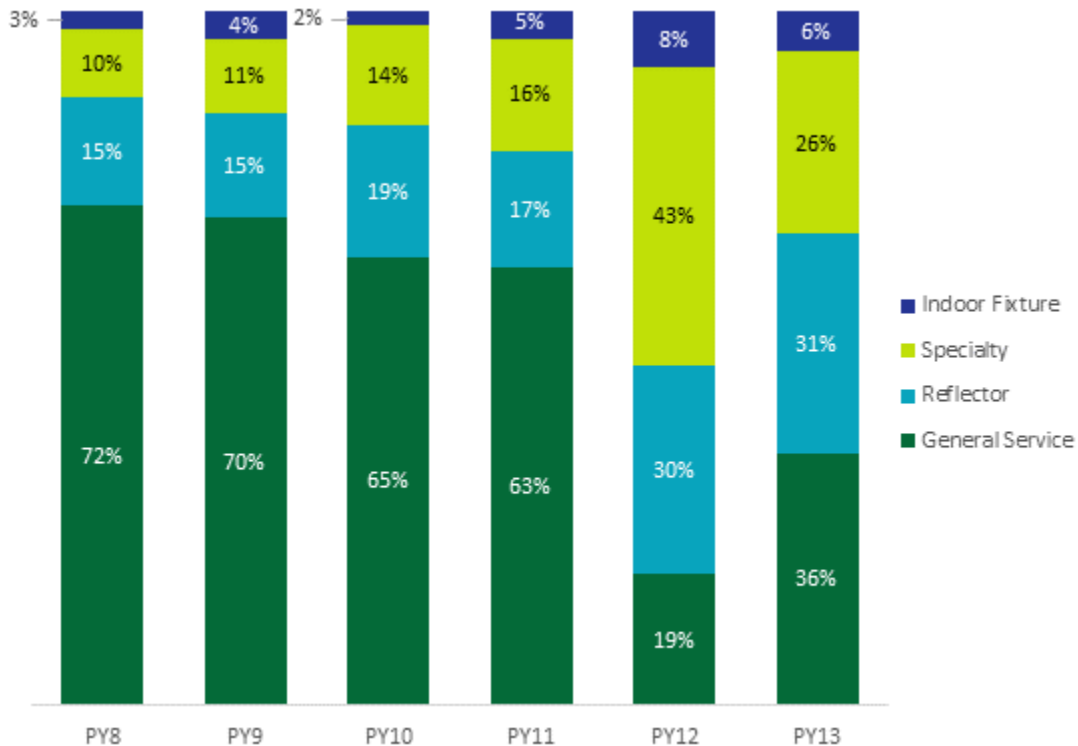
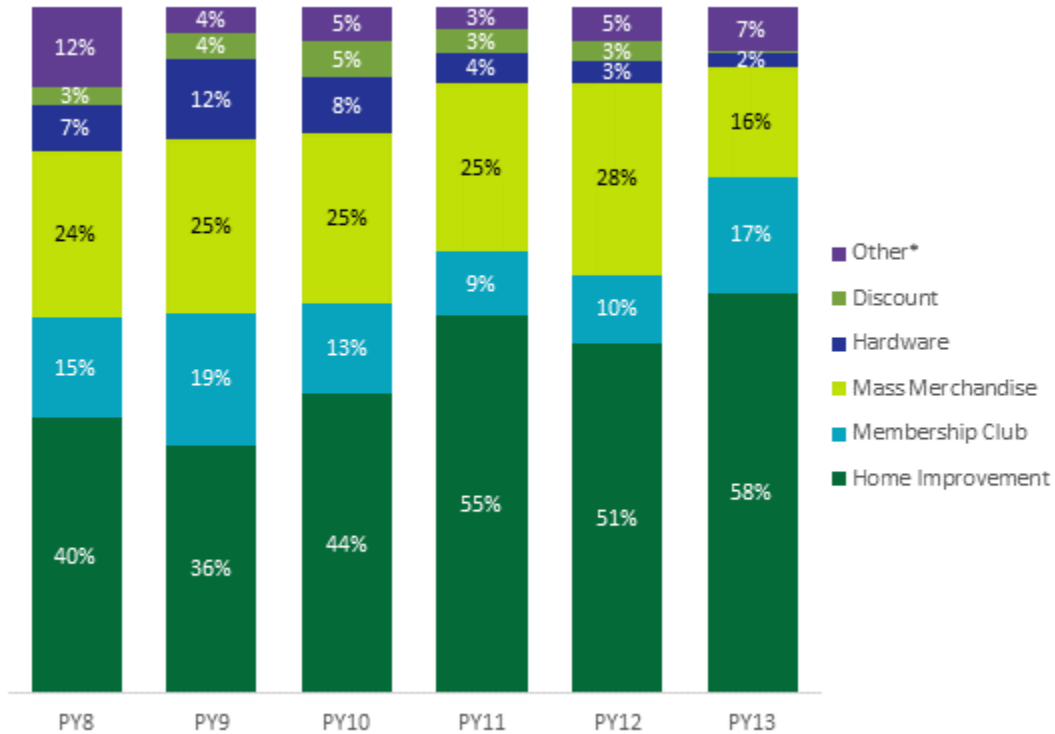


Figure 104 displays the distribution of upstream lighting sales by retail channel from PY8 to PY13. The proportion of statewide upstream lighting products sold through home improvement channels

rose to a high of 58% in PY13. Meanwhile, the proportion of products sold through mass merchandisers fell to a low of 16% in PY13.

Figure 104: PY8-PY13 Upstream Lighting Sales by Retail Channel



J.3 HERs

Almost 930,000 Pennsylvania households received home energy reports in PY13. As [Table 198](#) shows, this represents 18% of residential customers for the EDCs evaluated under Act 129, including 38% for PECO and Duquesne Light.⁹⁴ Participation in HER programs for PY13 increased from roughly 880,000 in PY12. PPL discontinued their HER offering during PY12 while Met-Ed, Penelec, and West Penn Power greatly diminished theirs for PY13. However, these reductions were more than offset by large expansions at PECO (380,000 participants in PY12 to over 570,000 in PY13) and Duquesne Light (58,000 to 206,000).

⁹⁴ Data on residential customers includes bundled and delivery service in 2021 FERC Form 861 filings by the listed PA EDCs.

Table 198: PY13 Statewide HER Program Participation

EDC	Residential Premises	PY13 HER Recipients	Percent of Homes Receiving HERs
PECO	1,514,000	572,000	38%
PPL	1,279,000	-	-
Duquesne Light	544,000	206,000	38%
FE: Met-Ed	512,000	44,000	9%
FE: Penelec	498,000	29,000	6%
FE: Penn Power	147,000	24,000	16%
FE: West Penn Power	631,000	52,000	8%
Total	5,125,000	928,000	18%

While HERs generate smaller savings per participant than other energy efficiency programs, they are relatively low-cost interventions and affect many customers. HERs are able reach the full range of customers, including low-income households, whose impacts are detailed in the next section. The reports also give tailored information for each customer individually.

For each of the evaluated EDCs, HER programs are set up as randomized control trials, with customers randomly assigned to treatment or control groups. Using the randomly selected control group in comparisons nets out any trends in energy use directly, so no adjustments are made for free-ridership or spillover. “Recipients” listed in [Table 198](#) are customers in treatment groups only.

[Table 199](#) shows evaluated PY13 savings per HER recipient as well as participants’ baseline annual electric usage (with HER savings added back in) and percent reductions. Average percent savings ranged from 0.2% to 0.6% per household.

Table 199: Average HER Impacts per Participant

EDC	PY13 kWh Usage (HER Recipients)	Average PY13 kWh Savings per Recipient	Average Percent Reduction
PECO	12,299	43	0.3%
PPL	-	-	-
Duquesne Light	12,691	29	0.2%
FE: Met-Ed	10,297	34	0.3%
FE: Penelec	8,636	19	0.2%
FE: Penn Power	10,289	38	0.4%
FE: West Penn Power	10,243	62	0.6%
Combined	12,008	40	0.3%

Per-household HER impacts in PY13 are smaller than previous years, when impacts were generally over 1% of annual usage. The reduced estimates are largely due to the updated accounting framework in PY13 which removes persistent impacts from prior HER exposure. Removing persistent impacts isolates the incremental effect of HER exposure during the program year only. This accounting was required for Phase IV of Act 129 compliance and a departure from prior phases where all measured savings was considered first-year incremental savings.

Pennsylvania HER participants are thus saving much more energy than the amounts shown in [Table 199](#), but a significant percentage of the savings are not attributed to PY13.

New program waves accounted for much of the PY13 HER savings. Since these waves had no prior exposure to HERs, all their savings count directly as first-year incremental savings. The timing of the new program waves likely led to smaller impacts, however. Both PECO and Duquesne Light greatly expanded their HER offerings in PY13, but the programs did not begin until June 27 (PECO) and October 1 (Duquesne Light). The FirstEnergy EDCs similarly launched their new waves in October. Overall, most new participants were not treated for all or part of the summer, when greater savings are generally achieved.

J.3.1 HER Contribution to LI Targets

In PY13, each of the six EDCs with HER offerings counted savings from HERs issued to low-income households toward their LI compliance target. In each case, HER participants were randomly chosen from the full pool of customers, with low-income treatment and control households separated out afterwards to measure savings toward the targets. Low-income households may also receive reports including energy-saving suggestions with little to no direct costs to implement. [Table 200](#) shows the PY13 verified gross LI savings for each EDC and the percentage of total LI savings coming from HER programs.

Duquesne Light achieved the largest share of its LI savings from HERs (28%). Since Duquesne Light increased HER participants more than threefold in PY13, low-income participation greatly expanded as well. Duquesne Light and West Penn Power accrued the largest share of low-income savings from HERs at 28% and 21% respectively. In PY13, PECO also counted HER savings toward its LI target for the first time. Low-income savings were only measured for participants in PECO's newest treatment wave, but all that wave's savings are counted as first-year incremental savings.

Table 200: HER Contribution Toward Low Income Targets

EDC	PYVTD LI MWh	PYVTD LI MWh from HERs	Percent of PY13 LI Savings from HERs
PECO	12,249	793	6%
PPL	10,449	-	-
Duquesne Light	3,375	931	28%
FE: Met-Ed	3,822	197	5%
FE: Penelec	6,387	645	10%
FE: Penn Power	1,836	275	15%
FE: West Penn Power	6,974	1,498	21%
Total	49,408	4,339	9%

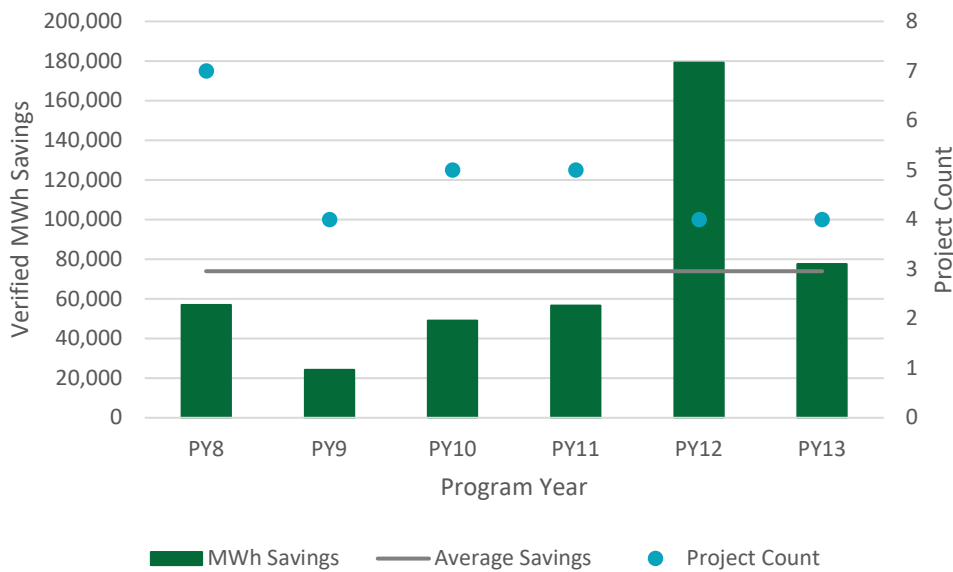
J.4 COMBINED HEAT AND POWER (CHP)

The PUC has made a commitment to advance the prevalence of CHP and released a Final Policy Statement on CHP in April of 2018, which is designed to advance the deployment of CHP

technology throughout Pennsylvania. The four CHP projects completed in PY13 accounted for nearly 15% of the statewide gross verified savings.

Figure 105 shows the energy savings contributions from Act 129 CHP projects over the past six years. The average CHP contribution is 73,883 MWh per program year, with notable variation observed from year to year. The variance of annual impacts from CHP projects is largely due to the long development timelines for these projects, often exceeding 24 months for planning, construction, and financing. The number of CHP projects, (four) reported in PY13 was consistent with the range observed over the previous four years. PY13 verified savings for CHP projects were 77,536 MWh, which is a significant reduction from PY12 but more consistent with prior program years.

Figure 105: PY8 – PY13 CHP Savings



In PY13, four CHP projects were completed by three EDCs – PECO, PPL, and Penelec – as shown in Table 201.

Table 201: PY13 CHP Verified Energy Savings and Realization Rate by EDC

EDC	Qty	Verified Savings (MWh.yr)	Realization Rate
PECO	1	53,980	100%
PPL	2	14,555	100%
FE: Penelec	1	9,001	100%
TOTAL	4	77,536	