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# SWE Final Annual Report: Act 129 Program Year 14

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SUBMITTED TO:  
Pennsylvania Public Utility Commission

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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 14 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 (TRC) 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	Commercial and Industrial 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
DRIPE	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., PY14, from June 1, 2022, to May 31, 2023
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 (ICSP) and stored in the program tracking system.

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

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

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

**Annual Savings:** Energy and demand savings expressed on an annual basis, or the amount of energy and/or peak demand an EE&C measure or program can be expected to save over the course of a typical year. Annualized savings are noted as MWh/year or MW/year. The Pennsylvania Technical Reference Manual (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 PY14, the PSA savings will always equal the PYTD savings because PY14 is the first program year of the phase (no savings will be verified until the PY14 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 III of Act 129. This is the best estimate of an EDC's progress toward the Phase IV compliance targets.

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

## Executive Summary

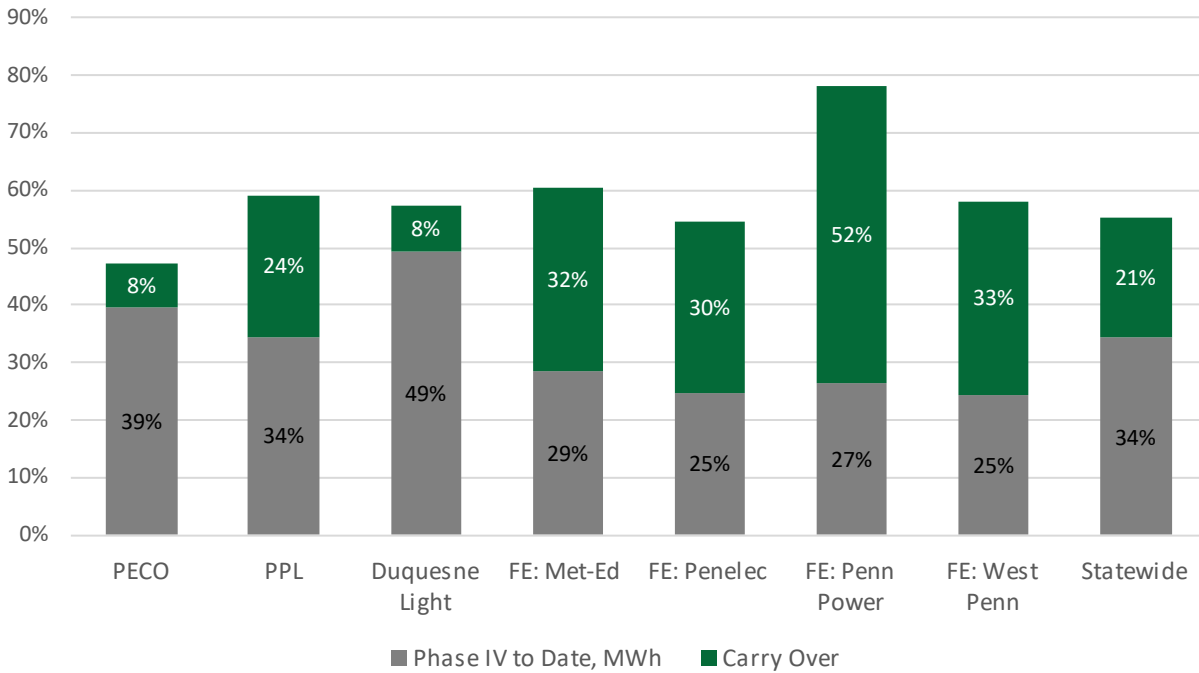
Program Year 14 (PY14), June 1, 2022, to May 31, 2023, is the second year of Phase IV of Pennsylvania's Act 129 Energy Efficiency and Conservation (EE&C) program. Phase IV goals were established on an incremental annual basis, meaning that progress toward goals is assessed by summing the annual energy 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 PY14 annual reports to the Public Utility Commission (PUC), the seven EDCs claimed a total of 938,209 MWh/year of verified gross energy savings for PY14 (approximately 21% of the statewide Phase IV target) and 164.62 MW of peak demand reductions (approximately 20% 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 PY14. The SWE audit validated most of the savings calculations. Errors were discovered in some of the EDC-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 PY14 gross verified statewide total of 938,016 MWh/year (approximately 21% of the statewide Phase IV target) and 164.62 MW/year of peak demand reductions (approximately 21% 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 25% (Penelec and West Penn Power) to 49% (Duquesne Light) (see [Figure 1](#) and [Table 1](#)). Including carryover savings from Phase III, total progress toward Phase IV targets ranged from 47% (PECO) to 78% (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 Targets<sup>1</sup>**

EDC	VTD (MWh/yr)	Phase III CO	VTD + CO (MWh/yr)	% of Goal	Phase IV Compliance Target (MWh/yr)
PECO	545,045	106,218	651,263	47%	1,380,837
PPL	430,558	306,275	736,833	59%	1,250,157
Duquesne Light	171,735	28,137	199,872	57%	348,126
FE: Met-Ed	132,211	147,303	279,514	60%	463,215
FE: Penelec	108,366	130,025	238,391	54%	437,676
FE: Penn Power	34,218	66,577	100,796	78%	128,909
FE: West Penn	123,808	168,480	292,288	58%	504,951
<b>Total</b>	<b>1,545,943</b>	<b>953,015</b>	<b>2,498,958</b>	<b>55%</b>	<b>4,513,871</b>

<sup>1</sup>Totals 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 30% (PPL) to 55% (PECO) in P4TD verified gross savings and 41% (Duquesne Light) to 87% (Penelec and 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

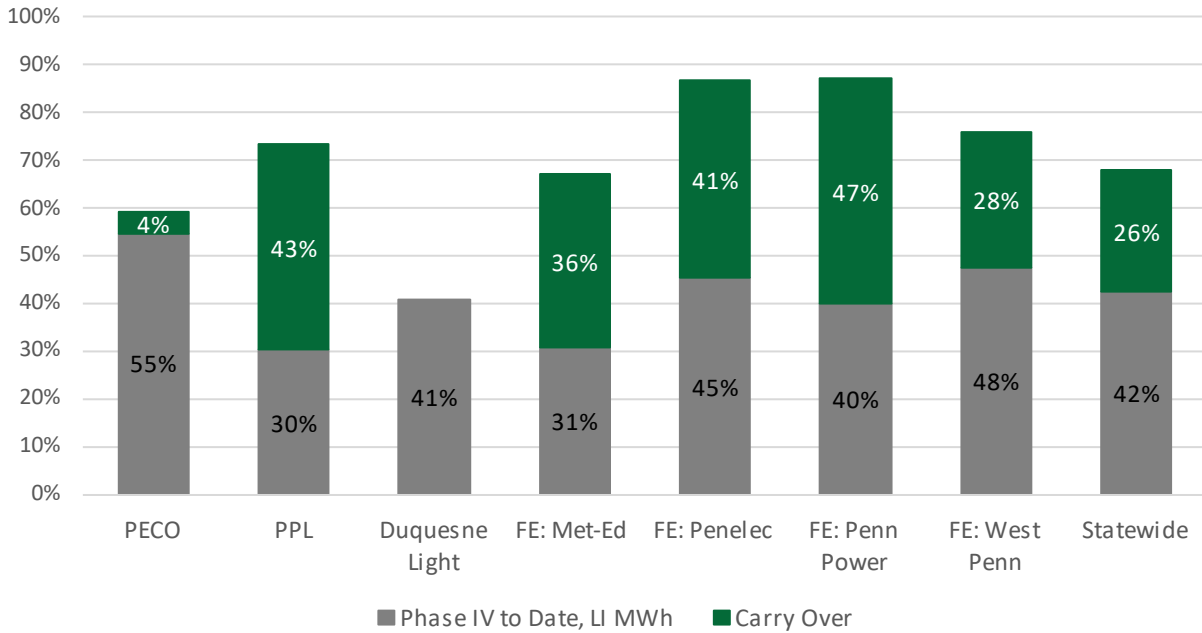


Table 2: Performance Toward Phase IV LI Targets<sup>1</sup>

EDC	LI VTD (MWh/yr)	Phase III CO	VTD + CO (MWh/yr)	% of Goal	Phase IV Compliance Target (MWh/yr)
PECO	43,865	3,452	47,317	59%	80,089
PPL	22,022	31,089	53,111	73%	72,509
Duquesne Light	7,553	-	7,553	41%	18,566
FE: Met-Ed	8,284	9,782	18,067	67%	26,866
FE: Penelec	11,529	10,466	21,995	87%	25,385
FE: Penn Power	2,996	3,504	6,500	87%	7,477
FE: West Penn Power	13,914	8,270	22,184	76%	29,287
<b>Total</b>	<b>110,163</b>	<b>66,563</b>	<b>176,726</b>	<b>68%</b>	<b>260,179</b>

<sup>1</sup> 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.<sup>1</sup> 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

<sup>1</sup> Pennsylvania Public Utility Commission, Energy Efficiency and Conservation Program Implementation Order, at Docket No. M-2020-3015228, (Phase IV Implementation Order), entered June 18, 2020. <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 PY14. [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, PY14**

EDC	Proportionate Number of Measures, Target	PY14 Proportionate Number of Measures, Reported	PY14 Proportionate Number of Measures, SWE Verified
PECO	8.80%	29.1%	32.5%
PPL	9.95%	22.2%	22.2%
Duquesne Light	8.40%	43.1%	44.6%
FE: Met-Ed	8.79%	17.5%	17.5%
FE: Penelec	10.23%	17.5%	17.5%
FE: Penn Power	10.64%	17.5%	17.5%
FE: West Penn Power	8.79%	17.5%	17.5%

### Phase IV Performance, Multifamily Housing

[Table 4](#) reports the PY14 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 0.5% (Penn Power) to 9% (PPL), while low-income multifamily housing accounts for a range of savings for the low-income segment from 4% (Penn Power) to 30% (PPL).

**Table 4: Summary of PY14 Verified Energy Savings for Multifamily Housing by EDC**

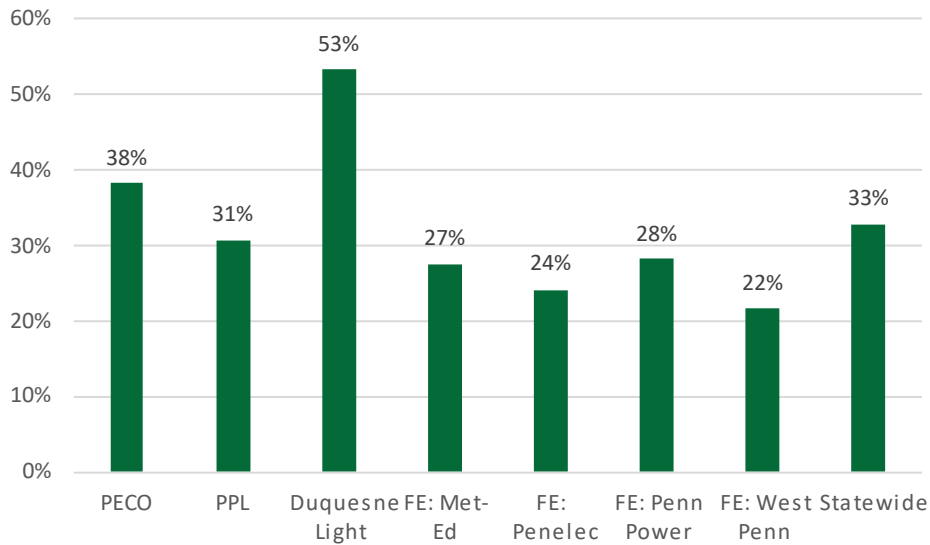
EDC	PY14 VTD (MWh/yr)	% of PY14 Residential and LI Segments	PY14 VTD, LI Households (MWh/yr)	% of PY14 LI Segment
PECO	8,545	8%	5,325	24%
PPL	4,437	9%	3,876	30%
Duquesne Light	612	4%	293	8%
FE: Met-Ed	368	1%	290	7%
FE: Penelec	633	2%	589	13%
FE: Penn Power	50	0.5%	50	4%
FE: West Penn Power	703	2%	634	10%
<b>Statewide</b>	<b>15,348</b>	<b>5%</b>	<b>11,057</b>	<b>20%</b>

### 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 22% (West Penn Power) to 53% (Duquesne Light) (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 Target<sup>1</sup>**

EDC	VTD (MW/yr)	% of Goal	Phase IV Compliance Target (MW/yr)
PECO	97.77	38%	256
PPL	70.22	31%	229
Duquesne Light	33.02	53%	62
FE: Met-Ed	20.89	27%	76
FE: Penelec	19.27	24%	80
FE: Penn Power	5.65	28%	20
FE: West Penn Power	18.57	22%	86
<b>Total</b>	<b>265.39</b>	<b>33%</b>	<b>809</b>

<sup>1</sup>Totals 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).<sup>2</sup> 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 PY14 verified gross demand savings and their plans for wholesale recognition of those capacity savings for the four delivery years they are eligible. Duquesne Light again did not nominate any capacity into the PJM FCM. They mention in their annual report that some non-residential lighting savings could be nominated in the future.

**Table 6: Planned FCM Nominations by EDC and PJM Delivery Year for PY14**

EDC	PY14 Verified Gross Demand Savings (MW/yr)	Estimated PY14 MW Acquisition for FCM in Delivery Years 2024-2027
PECO	55.66	25.2
PPL	43.01	1.5
Duquesne Light	23.57	0
FE: Met-Ed	13.79	[2.4 to 4.2]
FE: Penelec	12.33	[2.8 to 4.2]
FE: Penn Power	3.55	[0.8 to 1.2]
FE: West Penn Power	12.71	[2.3 to 4.1]
<b>Statewide</b>	<b>164.62</b>	<b>[35 to 40.4]</b>

If we assume the midpoint of each EDC's reported range for PY14 nominations, approximately 23% of the peak demand savings acquired by the EDCs in PY14 will be nominated to PJM's FCM with most of the MW coming from PECO.

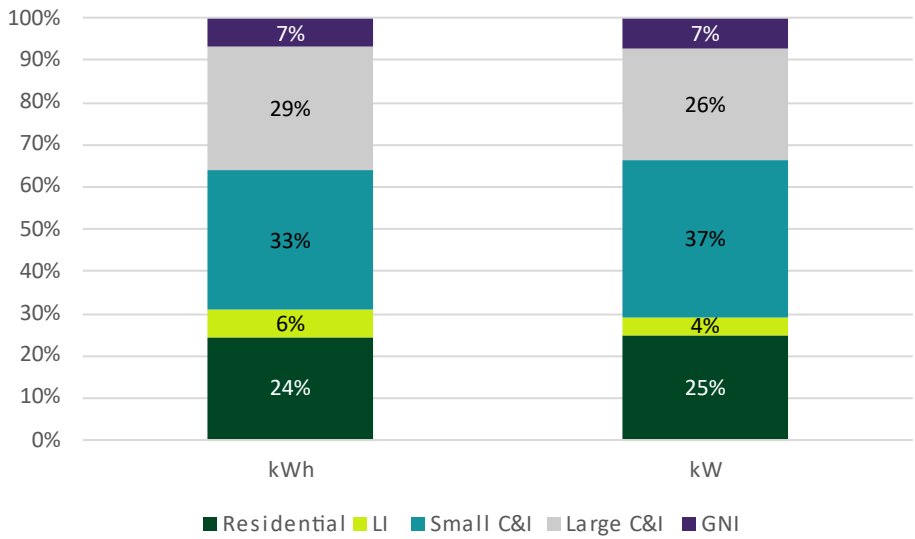
## PHASE IV PERFORMANCE BY CUSTOMER SEGMENT

Figure 4 presents the Phase-to-date 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).<sup>3</sup> Non-residential customers (small C&I, large C&I, and GNI) accounted for 68% of verified gross kWh savings and 70% of verified gross kW savings through PY14 (the non-residential totals may not equal the sum of the components of the bar due to rounding).

<sup>2</sup> <https://www.pjm.com/>

<sup>3</sup> 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.

**Figure 4: PY14 Verified Gross Savings by Customer Segment, Statewide**



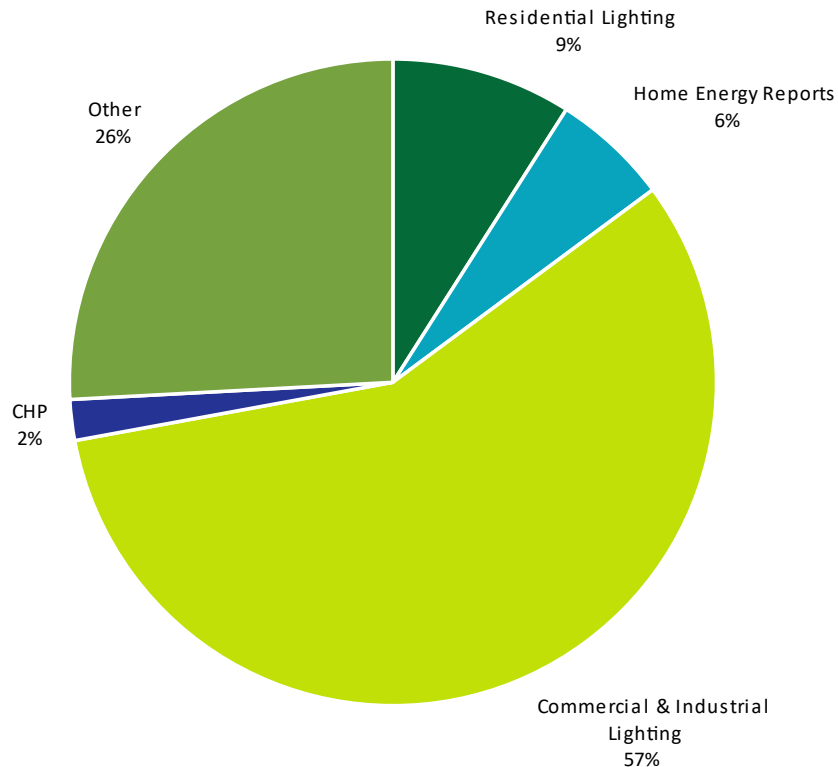
**TOP SAVINGS PROGRAM OFFERINGS**

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 PY14 verified gross portfolio MWh savings from lighting, HERs, combined heat and power (CHP), and all other offerings combined. In PY14, lighting, HERs, and CHP accounted for 74% of verified gross energy savings, an increase from 69% of savings in PY13, but whereas in Phase III of Act 129 these same measures accounted for nearly 80% of all verified gross energy savings.<sup>4</sup>

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

Figure 5: Top Savings Program Types in PY14



Fifty-seven percent of PY14 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. Horticultural lighting – particularly for cannabis – accounted for far more savings in PY14 than prior years of Act 129. 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 that disaggregates savings into persistent effects from prior years and incremental first year (compliance) savings. PPL also did not offer a HER program in PY14. CHP was also lower as only one CHP project was completed in PY14.

[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 PY14. 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 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 Order<sup>5</sup> 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 PY14, 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.<sup>6</sup> On a gross basis, PY14 programs saved the Commonwealth an estimated \$164.5 million (benefits minus costs). On a net basis, statewide savings from PY14 programs are estimated at \$99.5 million. The statewide PY14 TRC ratio is 1.38, increasing from 1.29 in PY13, and resulting in phase to date statewide TRC ratio is 1.34.

**Table 7: PY14 TRC Test Results by EDC<sup>1</sup>**

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO	\$186,032	\$184,858	1.01	\$137,253	\$138,625	0.99
PPL	\$183,600	\$112,762	1.63	\$124,633	\$82,064	1.52
Duquesne Light	\$71,507	\$36,614	1.95	\$46,734	\$28,075	1.66
FE: Met-Ed	\$46,369	\$30,831	1.50	\$32,873	\$23,138	1.42
FE: Penelec	\$47,473	\$24,986	1.90	\$34,671	\$19,904	1.74
FE: Penn Power	\$10,799	\$9,091	1.19	\$8,664	\$7,817	1.11
FE: West Penn Power	\$46,857	\$28,970	1.62	\$37,750	\$23,330	1.62
<b>Statewide</b>	<b>\$592,637</b>	<b>\$428,112</b>	<b>1.38</b>	<b>\$422,577</b>	<b>\$322,952</b>	<b>1.31</b>

<sup>1</sup> 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 P4TD spending and verified savings to their EE&C plan projections for the first two years of Phase IV. PPL has unverified savings from PY14, which lowers the MWh and MW ratio. Statewide, actual P4TD expenditures were 74% of EE&C Plan projections. The EDCs achieved 81% of the projected energy savings and 76% of the projected peak demand savings across the first two

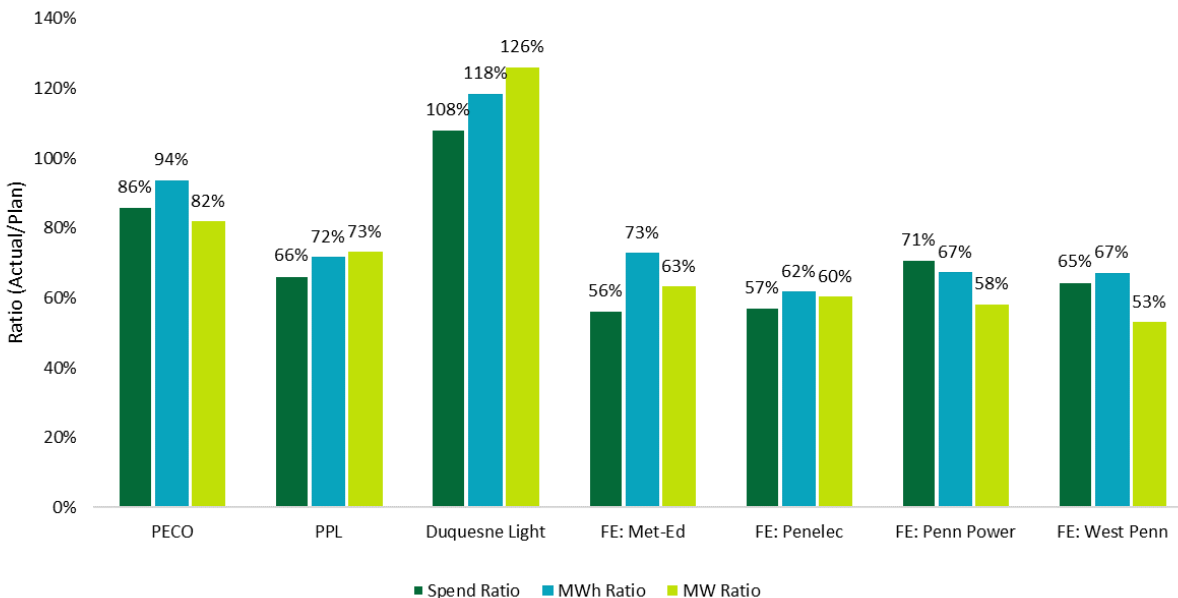
<sup>5</sup> Pennsylvania Public Utility Commission, 2021 TRC Test Final Order. From the Public Meeting of December 19, 2019, at Docket No. M-2019-3006868 (2021 TRC Test Order). Entered December 19, 2019.

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

<sup>6</sup> 2021 TRC Test Order. Pages 17-21.

years of Phase IV. 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.

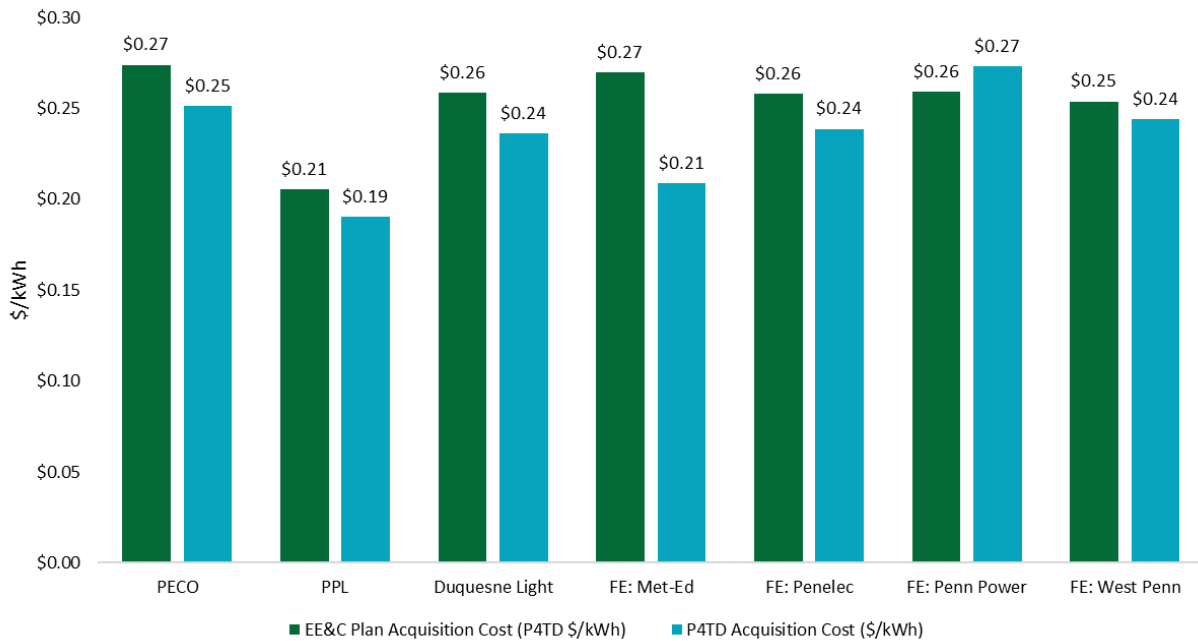
**Figure 6: P4TD Spending and Savings Compared to EE&C Plan**



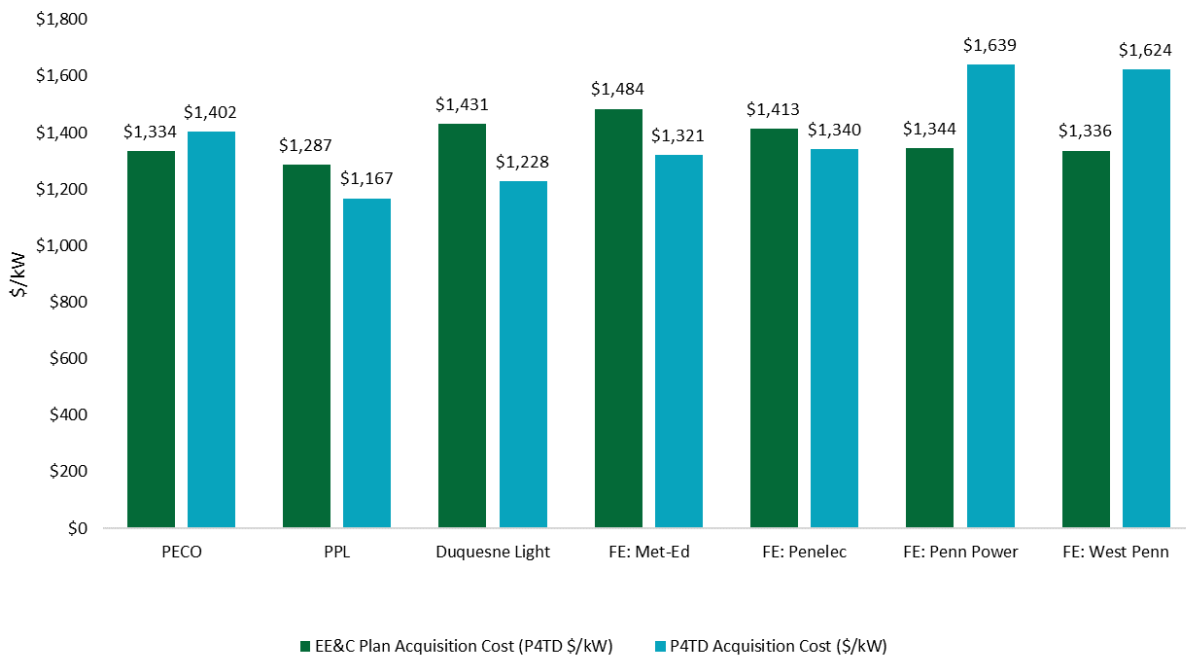
Because of the emphasis on Act 129 goal achievement and the fact that EDC budgets are fixed, acquisition cost is an important metric for EDCs subject to Act 129. Acquisition cost is a performance metric of dollars per first-year kWh (energy) or first-year kW (capacity). Figure 7 compares the projected 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 and capacity savings at a slightly lower unit cost than planned. Unverified savings from plan components at PPL 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 similar performance metrics for PY14 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 CO<sub>2</sub> emissions and climate change. Table 8 was compiled using the gross verified first year and lifetime MWh savings in PY14, EDC-specific line loss factors (LLFs), and an average of the 2022 marginal on-peak and off-peak CO<sub>2</sub> emissions rate in PJM’s spring 2023 Emissions Report.<sup>7</sup>

**Table 8: PY14 Carbon Dioxide Emission Impacts**

Performance Metric	Value
PY14 Verified Gross MWh/yr	938,016
PY14 Verified Gross Lifetime MWh	11,350,805
Weighted Average Measure Life (years)	12.10
Average CO <sub>2</sub> Emissions Rate (lbs/MWh)	1,009
First-Year Avoided Tons of CO <sub>2</sub>	508,115
Lifetime Avoided Tons of CO <sub>2</sub>	6,143,912

The lifetime emission impacts in Table 8 are calculated using the 2022 CO<sub>2</sub> 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 PY14, the emissions rate would decrease, and the lifetime CO<sub>2</sub> impacts would be lower. If the Act 129 TRC test valued CO<sub>2</sub> emissions at the Biden administration’s interim social cost of carbon – \$46 per short ton – the statewide PY14 gross TRC ratio would increase from the 1.31 value shown in Table 7 to approximately 1.99. The Environmental Protection Agency has proposed in 2023 to increase the social cost of carbon to \$172 per short ton. If this value were to go into effect, the value of avoided emissions would increase almost four times, raising the hypothetical TRC ratio to 3.83.

## SUMMARY OF SWE FINDINGS

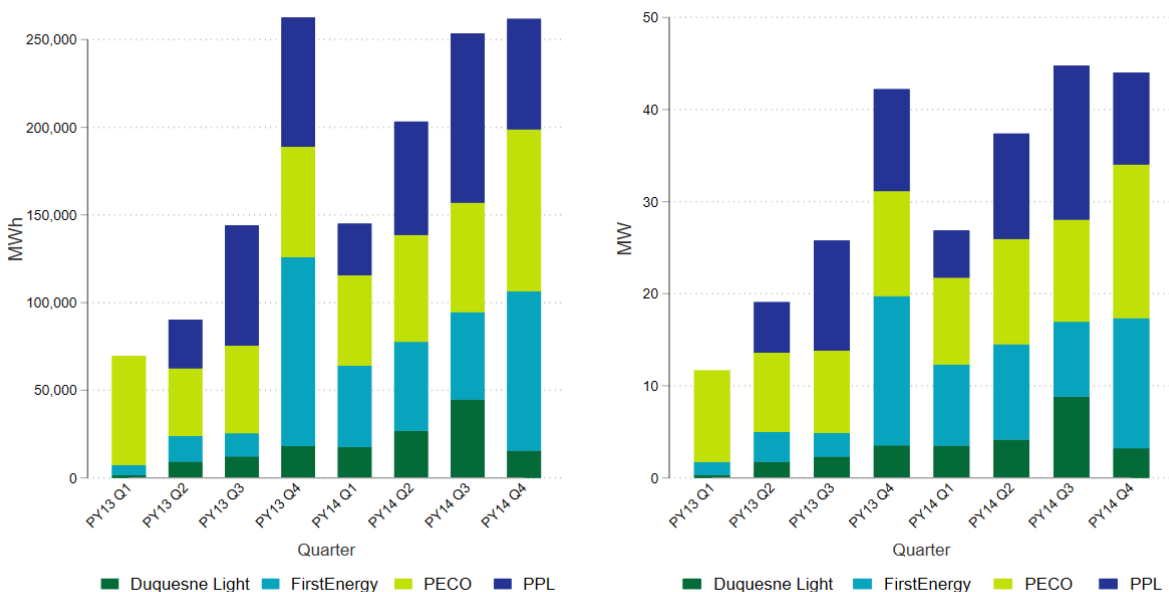
- Finding:** There is an interesting observation with respect to Phase III carryover and Phase IV peak demand savings goal attainment. PPL and the FirstEnergy EDCs started Phase IV with the most carryover savings but have made the least progress towards their Phase IV peak demand reduction target. While these EDCs are well-positioned on their Phase IV consumption reduction goals due to the carryover, they will need to acquire peak demand savings at an increased pace during PY15 – PY17 to meet the peak demand compliance goal. The SWE notes that PPL and the FirstEnergy EDCs have approved EE&C plans which forecast each EDC to exceed its peak demand targets. PECO and Duquesne Light started

<sup>7</sup> <https://www.pjm.com/-/media/library/reports-notice/special-reports/2023/2022-emissions-report.ashx>

Phase IV with the least amount of carryover and have made the most progress toward their Phase IV peak demand reduction goals.

- Finding:** The EDCs intend to nominate less than one-fourth of the peak demand savings acquired in PY14 to the PJM Forward Capacity Market (FCM). Not all Act 129 EE&C Plan measures are eligible for recognition in the FCM, so we expect EDC-nominated MW to be a subset of the total verified MW, but how little peak demand savings the EDCs are nominating thus far in Phase IV is a concern. For the second straight year Duquesne Light chose not to nominate any of the capacity savings from its EE programs into the FCM. PPL only intends to nominate approximately 3%. EDCs retaining the capacity rights, but not nominating the capacity is the worst possible outcome from a policy standpoint. Not only do FCM proceeds not flow back to the rate classes that contributed to the savings, but CSPs and customers cannot nominate the capacity either. This means that the financial benefits to participants and contractors are not realized and the price suppression effects – which accrue to all ratepayers – also do not occur. The Commission will need to make a difficult decision with respect to FCM participation in a potential Phase V. If capacity rights are retained by the EDCs, it is imperative that the peak demand savings are not stranded due to a lack of action by the EDCs.
- Finding:** Phase IV implementation was slow to ramp up in PY13 but finished with a strong PY13Q4. PY14 saw a similar trajectory with a light Q1 and a strong finish. [Figure 9](#) shows the breakdown of reported gross energy and peak demand savings by quarter. Savings attributable to HER programs are not included. Programs were slow to ramp-up and launch in comparison to their EE&C plans. Verified phase-to-date MWh savings ranged from 62% of planned savings (Penelec) to 118% of planned savings (Duquesne Light) while verified MW savings ranged from 53% of planned savings (West Penn Power) to 126% of planned savings (Duquesne Light).

**Figure 9: Reported Gross MWh and MW by Quarter**

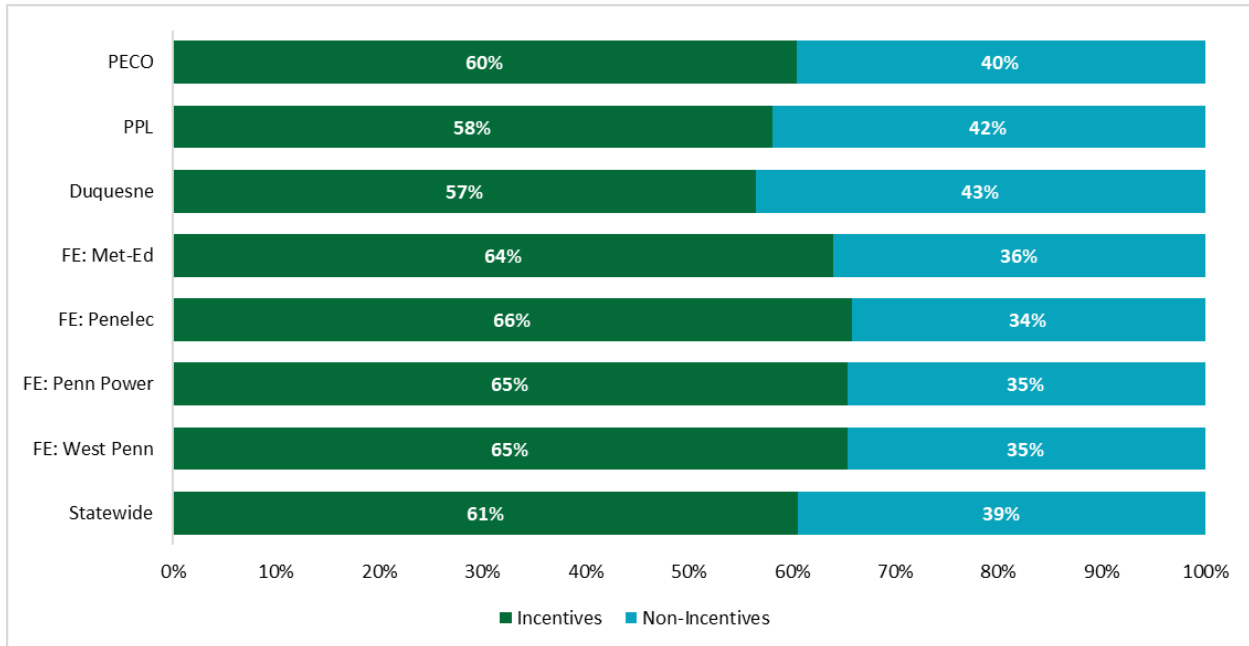


- **Finding:** Statewide energy savings continued to shift away from the residential sectors and into the non-residential sectors in PY14. Non-residential savings accounted for 70% of statewide MWh savings in PY14, compared to 66% in PY13 and 49% of savings in Phase III. Non-residential lighting accounted for the bulk of the PY14 savings (57% statewide). Penn Power was the only EDC that acquired more residential MWh savings in PY14 than non-residential savings.
- **Finding:** Residential Lighting, while still a top offering in Phase IV, continued to account for a smaller share of portfolio savings compared to Phase III. In PY14, Residential Lighting accounted for 9% of statewide MWh savings while it accounted for 30% of statewide MWh during Phase III. Residential Lighting will likely decline further in PY15 as point-of-sale and downstream lighting measures that meet the U.S. Department of Energy's (DOE) definitions of General Service Lamps (GSLs) will no longer be eligible (but direct install and kit-delivered lighting measures will still be eligible).
- **Finding:** Avoided Alternative Energy Portfolio Standards (AEPS) compliance costs are a component of the value of avoided energy in the TRC test. Since the Commission issued its 2021 TRC Test Order in 2019, the value of AEPS credits have increased 800%. While the increased value of AEPS credits is large on a relative basis, they are a small component of the overall avoided cost of electric energy, so the SWE does not recommend a mid-phase update of the avoided costs to account for changing AEPS credit value.
- **Finding:** In PY13, the SWE conducted its first annual comparison of market conditions to the Phase IV avoided cost forecast and found that the wholesale market values of avoided energy were much higher than forecasted but recommended against making updates to the forecast. In PY14, the SWE found that the actual wholesale energy costs began to fall back in line with EE&C Plan projections and still does not recommend any mid-phase updates.
- **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.*”<sup>8</sup> 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 61% in PY14. For comparison, the PY13 split was almost exactly 50/50. Administrative costs are generally highest in the first year of a phase due to program design and launch activities. [Figure 10](#) shows the division of spending between incentive and non-incentive cost centers by EDC and statewide. Our TRC audit activities found that EDC cost categorization was well-aligned with the directives of the 2021 TRC Test Order in PY14 with respect to energy efficiency kits and directly installed equipment.

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<sup>8</sup> Phase IV Implementation Order. Pages 119-127.

**Figure 10: PY14 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 SWE<sup>9</sup>, 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 thus far in Phase IV. PECO, FirstEnergy, and Duquesne Light moved to a rotating model where legacy waves are paused and then restarted once the assumed persistence has declined. HER programs contributed more MWh in PY14 than PY13, but the share of total verified gross energy savings was approximately 6% in each year. In Phase III of Act 129, HER programs accounted for between 12% and 20% of gross statewide MWh savings annually.
- 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 1.01 for PECO to 1.95 for 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 PY14.

<sup>9</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)

**Table 9: Incremental Measure Cost per Lifetime MWh**

EDC	Lifetime MWh	IMC (\$1,000)	IMC per Lifetime MWh
PECO	2,786,885	\$152,288	\$54.64
PPL	3,646,387	\$90,872	\$24.92
Duquesne Light	1,683,428	\$24,526	\$14.57
FE: Met-Ed	1,100,843	\$24,443	\$22.20
FE: Penelec	893,347	\$19,233	\$21.53
FE: Penn Power	216,757	\$7,077	\$32.65
FE: West Penn Power	1,023,157	\$22,263	\$21.76
<b>Statewide</b>	<b>11,350,805</b>	<b>\$340,702</b>	<b>\$30.02</b>

The single largest measure category for all seven EDCs is commercial lighting. PECO, PPL, and Duquesne Light all rely on the SWE Incremental Cost Database<sup>10</sup> 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 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's current market research indicates that the Incremental Cost Database has become outdated for commercial lighting with rapid improvements in the LED market. PECO's use of the Early Replacement vintage in the Incremental Cost Database is one rationale as to why their IMC per Lifetime MWh (\$54.61) is considerably higher than the statewide average (\$30.02).

- **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 PY13 evaluation processes. The SWE team found this issue was handled more consistently in PY14.
- **Finding:** Labor shortages and supply chain issues continued to affect project timelines and costs in PY14. Staffing challenges in the trades led to program-supported equipment from midstream delivery channels sitting in storage at participating facilities awaiting installation. In other cases, projects were delayed due to atypically long lead times for equipment components. The EDCs and their CSPs are in a unique position to help mitigate these issues for customers and offer services above and beyond simple financial incentives.

## Recommendations

- The diminished savings opportunity from residential lighting spurred a notable shift in EE&C program activity to the non-residential sector in PY14. 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

<sup>10</sup> [https://www.puc.pa.gov/media/1316/act129\\_incremental\\_cost\\_database\\_v4-0.xlsx](https://www.puc.pa.gov/media/1316/act129_incremental_cost_database_v4-0.xlsx)

sector to ensure a balanced portfolio across customer classes. For example, residential HVAC (midstream and downstream) and residential new construction showed promise in statewide residential savings in PY14.

- EDC evaluators are reminded that there are 20 Codes and Standards Guidance Memos that go into effect in PY15 and their reviews of reported savings should check for reported savings using the old measure characterizations.
- 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. This included energy and AEPS credits increasing and generation capacity decreasing relative to forecast. By spring 2023, natural gas prices and, in turn, wholesale electric prices had returned to the levels projected in Phase IV EE&C Plans. The SWE recommends the Commission continue to monitor market conditions and consider a TRC sensitivity analysis at the end of Phase IV.
- The market price of Tier II AEPS credits (which include EE) have increased dramatically in recent years. Given the sharp increase in the value of Tier II (energy efficiency) credits, the SWE suggests EDCs explore a process to facilitate AEPS registration as a “value add” element of Act 129 participation to help C&I participants to register their EE projects and take advantage of the elevated market prices.

## 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 companies<sup>11</sup> 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”<sup>12</sup>
- 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”<sup>13</sup>

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 13, 14, 15, 16, and 17). 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.<sup>14</sup>

#### 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 2% 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-recovery

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<sup>11</sup> This Act 129 requirement does not apply to EDCs with fewer than 100,000 customers.

<sup>12</sup> 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.

<sup>13</sup> 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.

<sup>14</sup> Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2020-3015228, (*Phase IV Implementation Order*), entered June 18, 2020.

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



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.<sup>15</sup> 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
<b>Statewide</b>	<b>\$1,222.9</b>	<b>4,513,871</b>	<b>809</b>

#### 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

<sup>15</sup> 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.

Regarding how to classify which measures 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
<b>Statewide</b>	-	<b>4,513,871</b>	<b>260,179</b>

#### 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 needed. 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 PY14 ENERGY SAVINGS

#### 2.1.1 Summary of PY14 Energy Savings Statewide and by EDC

Table 12 provides a summary of PY14 reported and verified energy savings by EDC. Realization rates in PY14 ranged from 94% (Penn Power) to 109% (Duquesne Light).

**Table 12: Summary of PY14 Reported and Verified Energy Savings by EDC<sup>1</sup>**

EDC	PY14 Reported (MWh/yr)	PY14 Verified Gross (MWh/yr)	Realization Rate
PECO	302,566	301,855	99.8%
PPL <sup>2</sup>	253,570	256,971	101.3%
Duquesne Light	112,313	122,634	109.2%
FE: Met-Ed	86,671	85,756	98.9%
FE: Penelec	69,661	72,345	103.9%
FE: Penn Power	19,512	18,284	93.7%
FE: West Penn Power	77,468	80,171	103.5%
<b>Statewide</b>	<b>921,761</b>	<b>938,016</b>	<b>101.8%</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

<sup>2</sup> Reported savings include unverified savings. The realization rate reported in this table includes the unverified savings as part of the reported savings. The PY14 realization rate will increase slightly in PY15 once the unverified savings are verified.

#### 2.1.2 Summary of PY14 Energy Savings by Sector

Table 13 presents the PY14 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).<sup>16</sup> Residential customers (including LI customers) accounted for 281,695 MWh of verified gross savings in PY14 (30% of PY14 energy savings) whereas non-residential customers accounted for 656,321 MWh of verified gross savings.

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<sup>16</sup> 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 PY14 Verified Savings by Customer Segment<sup>1,2</sup>**

EDC	Residential (MWh/yr)	LI (MWh/yr)	Small C&I (MWh/yr)	Large C&I (MWh/yr)	GNI (MWh/yr)	Total <sup>2</sup> (MWh/yr)
PECO	86,696	22,408	97,428	72,374	22,950	301,855
PPL	34,688	12,777	112,971	77,486	19,049	256,971
Duquesne Light	13,852	3,542	51,195	35,055	18,990	122,634
FE: Met-Ed	27,941	4,348	17,447	35,559	461	85,756
FE: Penelec	27,536	4,646	20,893	18,906	364	72,345
FE: Penn Power	9,488	1,160	4,909	1,673	1,054	18,284
FE: West Penn Power	26,300	6,314	26,605	20,152	799	80,171
<b>Statewide</b>	<b>226,501</b>	<b>55,195</b>	<b>331,449</b>	<b>261,206</b>	<b>63,667</b>	<b>938,016</b>

<sup>1</sup> Does not include carryover savings.

<sup>2</sup> Totals may not equal sum of column or row due to rounding.

### 2.1.3 Summary of PY14 Energy Savings for Multifamily Housing

Multifamily savings account for a range of 0.5% of savings for the residential and low-income customer segments (Penn Power) to 9% (PPL) while low-income multifamily housing accounts for a range of 4% of savings for the low-income segment (Penn Power) to 30% (PPL) see [Table 14](#)).

**Table 14: Summary of PY14 Verified Energy Savings for Multifamily Housing by EDC**

EDC	PY14 VTD (MWh/yr)	% of PY14 Residential and LI Segments	PY14 VTD, LI Households (MWh/yr)	% of PY14 LI Segment
PECO	8,545	8%	5,325	24%
PPL	4,437	9%	3,876	30%
Duquesne Light	612	4%	293	8%
FE: Met-Ed	368	1%	290	7%
FE: Penelec	633	2%	589	13%
FE: Penn Power	50	0.5%	50	4%
FE: West Penn Power	703	2%	634	10%
<b>Statewide</b>	<b>15,348</b>	<b>5%</b>	<b>11,057</b>	<b>20%</b>

## 2.2 SUMMARY OF PY14 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 PY14 Peak Demand Reductions Statewide and by EDC

[Table 15](#) provides a summary of PY14 reported and verified peak demand savings by EDC. Realization rates in PY14 ranged from 88% (Penn Power) to 111% (Duquesne Light).

**Table 15: Summary of PY14 Reported and Verified Peak Demand Reduction by EDC**

EDC	PY14 Reported (MW/yr)	PY14 Verified Gross (MW/yr)	Realization Rate
PECO	54.81	55.66	101.6%
PPL	40.46	43.01	106.3%
Duquesne Light	21.18	23.57	111.3%
FE: Met-Ed	13.85	13.79	99.6%
FE: Penelec	12.95	12.33	95.3%
FE: Penn Power	4.02	3.55	88.1%
FE: West Penn Power	14.00	12.71	90.8%
<b>Statewide</b>	<b>161.27</b>	<b>164.62</b>	<b>102.1%</b>

### 2.2.2 Summary of PY14 Peak Demand Savings by Sector

Compared to energy savings, non-residential customers account for a slightly higher percentage of peak demand reductions (71%). Residential customers (including LI customers) accounted for 29% of PY14 peak demand savings (Table 16).

**Table 16: Summary of PY14 Verified Peak Demand Reduction by Customer Segment<sup>1,2</sup>**

EDC	Residential (MW/yr)	LI (MW/yr)	Small C&I (MW/yr)	Large C&I (MW/yr)	GNI (MW/yr)	Total <sup>2</sup> (MW/yr)
PECO	16.40	2.52	19.36	13.08	4.29	55.65
PPL	5.27	1.52	19.47	13.55	3.2	43.01
Duquesne Light	2.63	0.39	11.78	5.06	3.71	23.57
FE: Met-Ed	5.18	0.79	3.09	4.65	0.08	13.79
FE: Penelec	4.79	0.64	3.93	2.92	0.06	12.33
FE: Penn Power	1.87	0.22	0.97	0.29	0.19	3.55
FE: West Penn Power	4.70	0.91	4.29	2.68	0.14	12.71
<b>Statewide</b>	<b>40.83</b>	<b>6.99</b>	<b>62.90</b>	<b>42.23</b>	<b>11.66</b>	<b>164.61</b>

<sup>1</sup> Does not include carryover savings.

<sup>2</sup> Totals may not equal sum of column or row due to rounding.

## 2.3 COMPARISON OF PY14 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 PY14. In PY14, all of the EDCs except Duquesne Light 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.

**Table 17: Comparison of PY14 Statewide Energy Efficiency Budgets and Expenditures<sup>1</sup>**

EDC	Actual PY14 Expenditures (\$1000)	Approved EE&C Plan Budget for PY14 (\$1000)	Difference Between Actual and EE&C Plan	Percent Difference from EE&C Plan
PECO	\$82,299	\$84,860	(\$2,561)	-3%
PPL	\$51,802	\$62,715	(\$10,913)	-17%
Duquesne Light	\$27,647	\$20,324	\$7,323	36%
FE: Met-Ed	\$16,791	\$25,106	(\$8,315)	-33%
FE: Penelec	\$15,913	\$23,209	(\$7,296)	-31%
FE: Penn Power	\$5,550	\$6,716	(\$1,166)	-17%
FE: West Penn Power	\$18,468	\$23,585	(\$5,117)	-22%
<b>Statewide</b>	<b>\$218,469</b>	<b>\$246,515</b>	<b>(\$28,046)</b>	<b>-11%</b>

<sup>1</sup>Totals 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 PY14 and Table 19 presents the same comparison for PY14 capacity savings.

**Table 18: Planned Versus Actual Energy Acquisition Costs in PY14**

EDC	PY14 Verified Savings (MWh/yr)	Forecasted PY14 Acquisition Cost per First-Year kWh Saved	Actual PY14 Acquisition Cost per First-Year kWh Saved	Percent Change from Forecasted Acquisition Cost
PECO	301,855	\$0.26	\$0.27	4%
PPL	256,971	\$0.20	\$0.20	-1%
Duquesne Light	122,634	\$0.26	\$0.23	-12%
FE: Met-Ed	85,756	\$0.26	\$0.20	-26%
FE: Penelec	72,345	\$0.25	\$0.22	-13%
FE: Penn Power	18,284	\$0.25	\$0.30	20%
FE: West Penn Power	80,171	\$0.25	\$0.23	-7%
<b>Statewide</b>	<b>938,016</b>	<b>\$0.24</b>	<b>\$0.23</b>	<b>-4%</b>

**Table 19: Planned Versus Capacity Acquisition Costs in PY14**

EDC	PY14 Verified Savings (MW/yr)	Forecasted PY14 Acquisition Cost per First-Year kW Saved	Actual PY14 Acquisition Cost per First-Year kW Saved	Percent Change from Forecasted Acquisition Cost
PECO	55.66	\$1,276	\$1,479	16%
PPL	43.01	\$1,278	\$1,204	-6%
Duquesne Light	23.57	\$1,409	\$1,173	-17%
FE: Met-Ed	13.79	\$1,459	\$1,218	-17%
FE: Penelec	12.33	\$1,399	\$1,290	-8%
FE: Penn Power	3.55	\$1,322	\$1,565	18%
FE: West Penn Power	12.71	\$1,306	\$1,453	11%
<b>Statewide</b>	<b>164.62</b>	<b>\$1,320</b>	<b>\$1,327</b>	<b>1%</b>

## 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 Order<sup>17</sup> to document the methodology and assumptions EDCs should use when calculating the costs and benefits of Phase IV EE&C portfolios.

Table 20 shows the NPV costs and benefits for each EDC portfolio in PY14, 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.<sup>18</sup> On a gross basis, PY14 programs saved the Commonwealth an estimated \$165.5 million (benefits minus costs). On a net basis, statewide savings from PY14 programs are estimated at \$99.6 million. The statewide PY14 TRC ratio is 1.38, increasing from 1.29 in PY13, and resulting in phase to date statewide TRC ratio is 1.35.

<sup>17</sup> 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>

<sup>18</sup> 2021 TRC Test Order. Pages 17-21.

**Table 20: PY14 TRC Test Results by EDC<sup>1</sup>**

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO	\$186,032	\$184,858	1.01	\$137,253	\$138,625	0.99
PPL	\$183,600	\$112,762	1.63	\$124,633	\$82,064	1.52
Duquesne Light	\$71,507	\$36,614	1.95	\$46,734	\$28,074	1.66
FE: Met-Ed	\$46,369	\$30,831	1.50	\$32,873	\$23,138	1.42
FE: Penelec	\$47,473	\$24,986	1.90	\$34,671	\$19,904	1.74
FE: Penn Power	\$10,799	\$9,091	1.19	\$8,664	\$7,817	1.11
FE: West Penn Power	\$46,857	\$28,970	1.62	\$37,750	\$23,330	1.62
<b>Statewide</b>	<b>\$592,637</b>	<b>\$428,112</b>	<b>1.38</b>	<b>\$422,577</b>	<b>\$322,952</b>	<b>1.31</b>

<sup>1</sup> 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 PY14, EDC incentives covered 39% of incremental measures costs and participants paid the other 61%. Water benefits accounted for over 61% of TRC benefits for low-income programs in PY14 thanks to a significant uptake of low-flow showerheads and faucet aerator measures. The PY14 statewide TRC Ratio was 1.38 with net benefits (benefits minus costs) of almost \$166 million.

The SWE has conducted a brief analysis to analyze the potential impact and sensitivity on the TRC by addressing inconsistencies in the characterization of commercial lighting incremental costs. From a statewide perspective, adjustments to EDC commercial lighting incremental cost characterization between the EDCs largely offset the differences. The statewide gross TRC ratio remains relatively unchanged, with a slight improvement in the gross TRC to 1.43 from 1.38. Because there is not a significant discrepancy at the statewide perspective and the EDCs are reporting costs consistent with their Phase IV EE&C plans, the SWE intends to amend incremental costs and clarify methodology for commercial lighting in the upcoming 2026 Technical Reference Manual (TRM) Order.

**Table 21: Summary of Statewide Portfolio Finances**

Row #	Cost Category*	PY14 (\$1000)	
<b>1</b>	<b>IMCs</b>	<b>\$340,702</b>	
2	Rebates to Participants and Trade Allies	\$68,863	
3	Upstream / Midstream Incentives	\$36,045	
4	Material Cost for Self-Install Programs (EE&C Kits)	\$12,275	
5	Direct Installation Program Materials and Labor	\$14,396	
<b>6</b>	<b>Participant Costs (Row 1 minus the sum of Rows 2 through 5)</b>	<b>\$209,124</b>	
		<b>EDC</b>	<b>CSP</b>
7	Program Design	\$0	\$45
8	Administration and Management	\$30,053	\$15,606
9	Marketing	\$5,406	\$3,473
10	Program Delivery	\$194	\$20,890
11	EDC Evaluation Costs	\$9,673	
12	SWE Audit Costs	\$1,256	
<b>13</b>	<b>Program Overhead Costs (Sum of rows 7 through 12)</b>	<b>\$86,593</b>	
<b>14</b>	<b>Total NPV TRC Costs (Sum of rows 1 and 13)</b>	<b>\$428,112</b>	
15	Total NPV Lifetime Electric Energy Benefits	\$333,380	
16	Total NPV Lifetime Electric Capacity Benefits	\$199,710	
17	Total NPV Lifetime O&M Benefits	\$38,176	
18	Total NPV Lifetime Fossil Fuel Impacts	-\$20,594	
19	Total NPV Lifetime Water Impacts	\$41,965	
<b>20</b>	<b>Total NPV TRC Benefits (Sum of rows 15 through 19)</b>	<b>\$592,637</b>	
<b>21</b>	<b>Statewide TRC Ratio (Row 20 divided by Row 14)</b>	<b>1.38</b>	

\* 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 Order<sup>19</sup> 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 small component of the larger avoided energy costs.

<sup>19</sup> 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 Act.<sup>20</sup> 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.

In the Act 129 Phase IV Avoided Energy and Capacity Cost Calculator,<sup>21</sup> 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 historic<sup>22</sup> 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 \$35.55 per credit, or \$6.58 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 almost a factor of eight. AEPS credit values originally made up about 3% of the avoided cost of energy and now it would be approximately 23%. While this is a large percentage increase, it is still a small portion of the overall avoided cost values.

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 show a continued trend toward increased AEPS costs over the last five years. This increase has roots in policy changes that originated in the amending of the AEPS Act by Act 40<sup>23</sup> of 2017 and Act 114<sup>24</sup> 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.

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<sup>20</sup> See 73 P.S. §§ 1648.1–1648.8 and 66 Pa. C.S. § 2814. See also 52 Pa. Code §§ 75.1–75.72.

<sup>21</sup> <https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/total-resource-cost-test/>

<sup>22</sup> See AEPS Act Historical Pricing reports at <https://www.pennaeps.com/reports/>.

<sup>23</sup> See PA Act 40 of 2017, Section 2804

<sup>24</sup> See PA Act 114 of 2020, Section 1799.10-E



## 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 Industrials<sup>25</sup> commented that EDCs should use actual experienced market prices rather than forecasted prices in annual and phase reporting. PA-EEFA<sup>26</sup> 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 forecasts of avoided costs were developed in summer 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 for PY13. Using LMP data from PJM’s DataMiner2, it was determined that the forecasted avoided costs had been underpredicted in comparison to experienced prices. The largest divergence from predictions was seen in the shoulder months. In PY14, much of the year experienced similarly high prices as seen in PY13, but the overall trend in LMPs was lower towards the end of the year, reaching similar levels to those of the forecast.

A review of the avoided cost of generation capacity forecasts was conducted in parallel to the review of forecasted avoided energy costs. In contrast, clearing prices for Phase IV 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. Long-term forecasts also predict the current trend of lower energy prices to continue in the coming years, becoming even 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.

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<sup>25</sup> 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

<sup>26</sup> 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 PY14 and phase-to-date savings.

**Table 22: Summary of Statewide PY14 Impacts and Phase IV Impacts: Gross and Net Annual and Lifetime Savings**

Savings Category	Statewide Total
Phase IV Reported Gross Savings (MWh/yr)	1,526,689
Phase IV Verified Gross Savings (MWh/yr)	1,545,943
Phase IV Net Savings (MWh/yr)	1,093,509
Phase IV Gross Lifetime Savings (MWh)	18,563,609
Phase IV Net Lifetime Savings (MWh)	12,800,464
PY14 Reported Gross Savings (MWh/yr)	921,761
PY14 Verified Gross Savings (MWh/yr)	938,016
PY14 Net Savings (MWh/yr)	673,046
PY14 Gross Lifetime Savings (MWh)	11,350,805
PY14 Net Lifetime Savings (MWh)	7,918,369

### 3.1 PECO

#### 3.1.1 Impact Evaluation

Table 23 summarizes PECO's energy impacts by program for PY14. Nearly two-thirds of the savings (62%) are attributable to the Non-Residential Program while the Residential Program accounted for 19% of verified savings in PY14.

**Table 23: PY14 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	58,515	97%	56,760	0.66	36,987
Income-Eligible	21,369	103%	22,092	1.00	22,092
Residential HER	34,048	99%	33,821	1.00	33,821
Income-Eligible HER	1,246	89%	1,108	1.00	1,108
Non-Residential	187,388	100%	188,075	0.70	131,352
<b>Portfolio Total<sup>1</sup></b>	<b>302,566</b>	<b>100%</b>	<b>301,855</b>	<b>0.75</b>	<b>225,360</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date energy impacts by program is presented in Table 24. Consistent with PY14, the bulk of savings (65%) in the phase is attributable to the Non-Residential Energy Efficiency Program.

**Table 24: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – PECO**

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Residential	100,524	97%	97,623	0.66	64,859
Income-Eligible	37,338	89%	33,403	1.00	33,403
Residential HER	57,837	100%	57,602	1.00	57,602
Income-Eligible HER	2,039	93%	1,903	1.00	1,903
Non-Residential	343,303	103%	354,515	0.67	237,858
<b>Portfolio Total<sup>1</sup></b>	<b>541,041</b>	<b>101%</b>	<b>545,045</b>	<b>0.73</b>	<b>395,625</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of the peak demand impacts by energy efficiency program for PY14 are presented in Table 25, while Table 26 shows the phase-to-date peak demand performance by program.

**Table 25: PY14 Peak Demand Savings by Program (MW/Year) – PECO**

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Residential	10.34	97%	9.99	0.65	6.47
Income-Eligible	2.35	106%	2.50	1.00	2.50
Residential HER	5.54	123%	6.83	1.00	6.83
Income-Eligible HER	0.20	82%	0.17	1.00	0.17
Non-Residential	36.38	99%	36.18	0.70	25.26
<b>Portfolio Total<sup>1</sup></b>	<b>54.81</b>	<b>102%</b>	<b>55.66</b>	<b>0.74</b>	<b>41.22</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

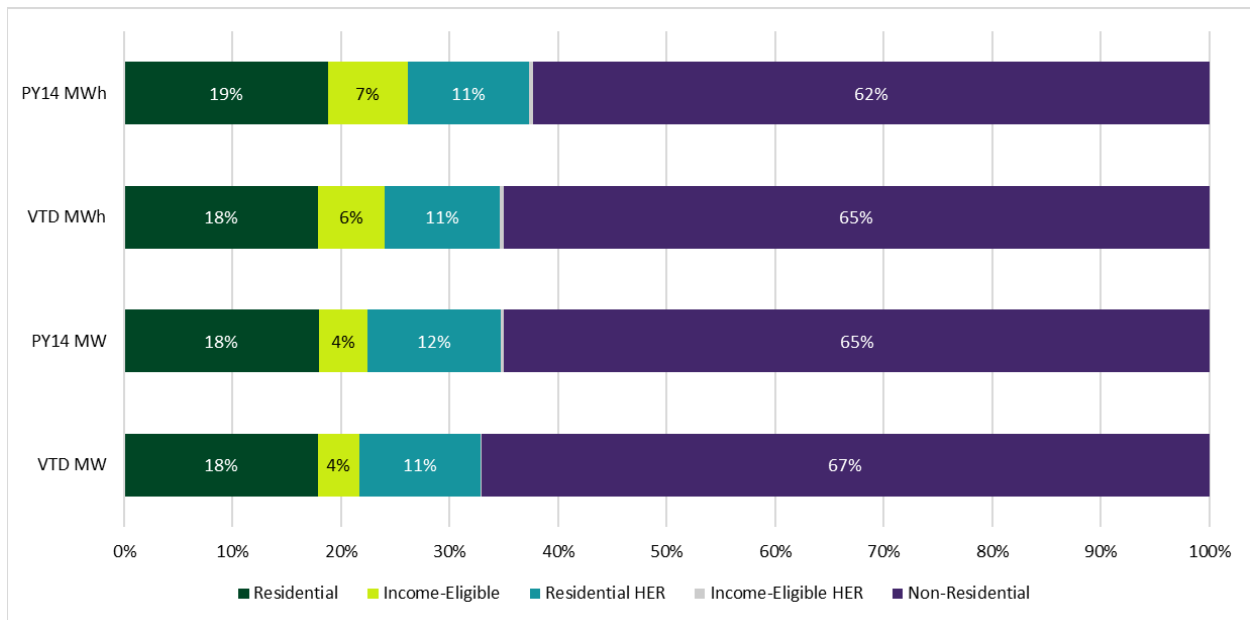
**Table 26: Phase-to-date Peak Demand Savings by Program (MW/Year) – PECO**

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Residential	17.98	97%	17.43	0.67	11.6
Income-Eligible	4.16	90%	3.75	1.00	3.75
Residential HER	9.41	116%	10.93	1.00	10.93
Income-Eligible HER	0.33	15%	0.05	1.00	0.05
Non-Residential	66.16	99%	65.6	0.68	44.35
<b>Portfolio Total<sup>1</sup></b>	<b>98.05</b>	<b>100%</b>	<b>97.77</b>	<b>0.72</b>	<b>70.68</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

Figure 11 shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. The Non-Residential program accounted for a smaller share of MWh and MW savings in PY14 compared to its P4TD contribution.

**Figure 11: Summary of PY14 and P4TD Program Contributions – 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.

Table 27 shows the TRC ratios by program and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.01 in PY14, improving from 0.98 in PY13. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

**Table 27: PY14 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	\$27,302	\$7,411	3.68	\$19,891
Income Eligible Home Energy Report	\$155	\$102	1.52	\$53
Residential Energy Efficiency	\$54,959	\$46,405	1.18	\$8,554
Residential Home Energy Reports	\$5,517	\$2,590	2.13	\$2,927
<b>Residential Total</b>	<b>\$87,933</b>	<b>\$56,508</b>	<b>1.56</b>	<b>\$31,425</b>
Non-Residential Energy Efficiency	\$98,098	\$117,211	0.84	(\$19,113)
<b>Non-Residential Total</b>	<b>\$98,098</b>	<b>\$117,211</b>	<b>0.84</b>	<b>(\$19,113)</b>
Cross-cutting	\$0	\$11,140	-	(\$11,140)
<b>Portfolio Total<sup>1</sup></b>	<b>\$186,031</b>	<b>\$184,859</b>	<b>1.01</b>	<b>\$1,172</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

### 3.1.3 Process Evaluation

Guidehouse reported on PY14 process evaluations for the following PECO programs and target market segments (Table 28).

**Table 28: PECO PY14 Process Evaluations Conducted for Program Components**

Programs and Program Components	
<b>Residential EE Program<sup>27</sup></b>	<b>Income-Eligible Program<sup>28</sup></b>
Rebates and Marketplace (Point of Purchase)	Multifamily
Appliance Recycling	Appliance Recycling
In-Home Assessment	
New Construction	<b>Non-Residential Program<sup>29</sup></b>
Multifamily	Downstream
	Small Business Direct Install
	New Construction

For PY14, Guidehouse conducted and reported on full process evaluations for a total of ten components within the PECO residential, income-eligible, and non-residential programs. A full process evaluation was conducted for all five components of the Residential EE Program: Rebates and Marketplace, In-Home Assessment, Multifamily, Appliance Recycling, and New Construction. The Rebates and Marketplace component of the Residential EE Program also contains four sub-components: Downstream, Trade Ally and Distributor Network, Point of Purchase, and Online Marketplace; a full process evaluation was only conducted for the Retail LED Point of Purchase pathway in PY14. The Income-Eligible EE Program has four components: Single-Family, Appliance Recycling, Multifamily, and Long-Term Savings; a full process evaluation was only conducted for the Appliance Recycling and Multifamily components of this program in PY14. Finally, the Non-Residential Program also contains four components: Downstream, Midstream, New Construction, and Small Business Direct Install; a process evaluation was conducted for all components except Midstream in PY14.

From these evaluations, the results produced process evaluation findings regarding program satisfaction from participants, retailers, and builders. Participant satisfaction information was collected for the In-Home Assessment (customer), Multifamily (tenant and property manager), and Appliance Recycling (customer) components of the Residential EE Program, the Appliance Recycling (customer) and Multifamily (tenant and property manager) components of the Income-Eligible Program, and the Downstream (customer), New Construction (customer), and Small

<sup>27</sup> 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, Trade Ally and Distributor Network, or Online Marketplace sub-components of the Rebates and Marketplace component in PY14 for the Residential EE Program.

<sup>28</sup> As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Single-Family and Long-Term Savings components of the Income-Eligible Program.

<sup>29</sup> As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Midstream component of the Non-Residential Program.

Business Direct Install (customer) components of the Non-Residential Program. On average, across these participant surveys, 95% of Residential EE Program participants (customers, tenants, and property managers), 91% of Income-Eligible Program participants (customers, tenants, and property managers), and 95% of Non-Residential Program participants (customers) were satisfied with the programs overall. Satisfaction information was also collected from retailers in one residential program component, with an average of 100% satisfaction for retailers active with the Rebates and Marketplace component. Satisfaction information was also collected from builders in one residential program component, with an average of 100% satisfaction for builders active with the New Construction component.

For the *PECO Residential EE Program*, the PY14 process evaluation provided several key findings but no recommendations. A key cross-program finding was on program satisfaction from participants, as well as retailers, builders, and property managers for certain program components. The evaluation conducted a participant survey for the In-Home Assessment, Multifamily, and Appliance Recycling components, a retailer survey for the Rebates and Marketplace (Retail LED Point of Purchase) component, a property manager survey for the Multifamily component, and a builder survey for the New Construction component. On average, 95% of the participants (customers only) were satisfied with the program. The evaluation also consisted of interviews for program and CSP staff, but no findings were reported on these interviews for PY14. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>30</sup>

- Likelihood of recommending the program
- Awareness of the program
- Ease of participating in the program
- Drivers of program component satisfaction

For the *PECO Income-Eligible EE Program*, the PY14 process evaluation provided key findings but no recommendations. A key cross-program finding was on program satisfaction based on a participant survey for the Appliance Recycling and Multifamily components of the income-eligible program, as well as an additional property manager survey for the Multifamily component. On average, 91% of the participants (customers only) were satisfied with the program. The evaluation also consisted of interviews for program and CSP staff, but neither satisfaction results nor findings were reported on these interviews for PY14. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>31</sup>

- Likelihood of recommending the program
- Awareness of the program
- Ease of participating in the program
- Drivers of program component satisfaction

For the *PECO Non-Residential EE Program*, the PY14 process evaluation provided key findings but no recommendations. A key cross-program finding was on program satisfaction based on a

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<sup>30</sup> The PECO annual report provides further detail regarding these topics.

<sup>31</sup> The PECO annual report provides further detail regarding these topics.

participant survey for the Downstream, New Construction, and Small Business Direct Install components of the non-residential program. On average, 95% of the participants (customers only) were satisfied with the program. The evaluation also consisted of interviews for program and CSP staff, but neither satisfaction results nor findings were reported on these interviews for PY14. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>32</sup>

- Likelihood of recommending the program
- Awareness of the program
- Ease of participating in the program
- Drivers of program component satisfaction

### 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 PY14 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 PY14 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.
- PECO's Phase IV EM&V Plan calls for an intermediate savings quantity between reported and verified gross savings referred to as "adjusted database savings." The ratio of verified savings to "adjusted database savings" is referred to as the "verification ratio." The adjusted database savings are computed for every program component annually, even in program years when no impact evaluation was conducted. The PY13 SWE report highlighted several issues with this multi-step process, particularly for some residential and income-eligible components, and requested improved documentation and file organization for PY14. While there were some improvements to the PY14 process, ultimately our inability to replicate verified savings will require an update to the annual evaluation plan for certain Residential and Income-Eligible program components because the SWE is not confident enough in the PY14 verification ratios to allow them to be applied prospectively.
- The PY14 impact evaluation of PECO's Long-Term Savings component failed to meet the  $\pm 15\%$  relative precision requirement in the Phase IV Evaluation Framework on its own. Despite being listed as a separate component in PECO's annual report, Long-Term Savings and Income Eligible Single-Family are evaluated together. They are only listed separately for administrative reasons. When evaluated as a single program, the  $\pm 15\%$  relative precision requirement is met.

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<sup>32</sup> The PECO annual report provides further detail regarding these topics.

- The SWE's audit of residential components found that the Guidehouse's incomplete annual data request response and complex, multi-stage savings verification process made it difficult for the SWE to replicate due to a number of factors, including the following: lack of syntax files used to calculate savings, poorly documented inputs used to calculate savings, poorly documented and at times ad hoc analytical decisions (for example, not using available survey results from the appliance recycling evaluation), lack of consistent unique identifiers across files and analyses, and problems with version control of files provided to the SWE for review.
- The SWE's review of verified savings for residential components, which include income-eligible programs, found that, overall, the adjusted database reviews followed proper TRM protocols. The SWE found errors with a few individual measures that largely offset – the cumulative impact was that verified MWh savings were overstated by less than 0.1%. However, the SWE had challenges with verifying the survey analysis and roll-up steps of the verified savings analysis.
- The SWE's review of PY14 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. Minor revisions included updating efficient lighting equipment power draw to align with DLC 5.1, applying site collected M&V data to revise HOU and CF values, and applying an evaluator developed regression model in place of raw trend data.
- PECO had five active behavioral HER cohorts in PY14 with approximately 435,000 treated households. One of the cohorts consists of low-income households. On average, HER recipients saved approximately 80 kWh, or 0.9% of their annual consumption, in PY14. PECO's 2015 cohort (Wave 3) was mature enough to require persistence calculations to separate incremental savings from persisting savings from prior exposure. The SWE was able to replicate the verified energy and demand savings values and found that HER impact evaluation was entirely consistent with their proposed and approved EM&V plans and the Phase IV HER account framework. The SWE team does not propose any revisions to the PY14 methods or results.
- The SWE's audit uncovered some confusion in the evaluation of PECO's Non-Residential Comprehensive Projects Pilot projects. These projects accounted for approximately 4% of the Downstream component's PY14 MWh savings but were inadvertently excluded from the sample frame. Pilot projects were also excluded from the tracking database analysis runs. Ultimately, realization rates from the appropriate strata were applied to Pilot component projects so the overall program savings should be unbiased assuming the pilot projects are not materially different from the broader Downstream component. Going forward, Pilot projects should be eligible for sampling if they are going to be claimed as part of the Downstream component.
- Project documentation reviews for 16 projects across five non-residential program components found a single inconsistency between the reported savings in the files and the project database. The more significant issue was the SBDI Program where none of the three reviewed projects contained enough information for the SWE to determine if the savings were calculated correctly.



- The SWE conducted a project file review for a quarterly sample of PECO’s residential and income-eligible components in PY14. 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.
- For the process evaluations, Guidehouse completed all the PY14 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.
- 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.
- PECO had the lowest portfolio TRC ratio of the seven EDCs subject to Act 129 in PY 13 and PY14. The marginal portfolio result was partially driven by assumptions in the non-residential program.
  - PECO assumes a retrofit perspective (full equipment cost plus labor) when assigning incremental measure cost to most commercial lighting measures.

## 3.2 PPL

### 3.2.1 Impact Evaluation

A summary of energy impacts by program for PY14 is presented in [Table 29](#). Over three quarters of the savings (82%) are attributable to the Non-Residential Energy Efficiency Program, which comprises two distinct program components – Efficient Equipment and Custom. The Custom component is designed to give customers the option to save electricity across lighting and non-lighting end-uses including those measures that are not covered by other programs.

**Table 29: PY14 Incremental Annual Energy Savings by Program (MWh/Year) – PPL**

Program	PYRTD (MWh/yr) <sup>2</sup>	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Low-Income	10,825	1.19	12,872	1.00	12,872
Residential	43,601	0.79	34,388	0.61	20,921
Non-Residential	199,144	1.05	209,711	0.68	142,556
<b>Portfolio Total<sup>1</sup></b>	<b>253,570</b>	<b>1.01</b>	<b>256,971</b>	<b>0.69</b>	<b>176,348</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

<sup>2</sup> Reported savings include unverified savings

Note that the PYRTD column includes a total of 10,528 unverified savings that will be verified in PY15, including 709 MWh for the Non-Residential program and 9,819 MWh for the Residential program. A summary of phase-to-date energy impacts by program is presented in [Table 30](#).



**Table 30: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – PPL**

Program	RTD (MWh/yr) <sup>2</sup>	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Low-Income	22,665	0.97	22,022	1.00	22,022
Residential	78,609	0.88	68,991	0.64	44,217
Non-Residential	322,300	1.05	339,544	0.64	216,498
<b>Portfolio Total<sup>1</sup></b>	<b>423,575</b>	<b>1.02</b>	<b>430,558</b>	<b>0.66</b>	<b>282,738</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

<sup>2</sup> Reported savings include unverified savings

Note that the RTD column includes a total of 10,528 unverified savings that will be verified in PY15, including 709 MWh for the Non-Residential program and 9,819 MWh for the Residential program.

A summary of the peak demand impacts by energy efficiency program for PY14 and P4TD are presented in [Table 31](#) and [Table 32](#), respectively.

**Table 31: PY14 Peak Demand Savings by Program (MW/Year) – PPL**

Program	PYRTD (MW/yr) <sup>2</sup>	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Low-Income	1.21	126%	1.53	1.00	1.53
Residential	6.15	83%	5.11	0.63	3.22
Non-Residential	33.1	110%	36.37	0.68	24.86
<b>Portfolio Total<sup>1</sup></b>	<b>40.46</b>	<b>106%</b>	<b>43.01</b>	<b>0.69</b>	<b>29.61</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

<sup>2</sup> Reported savings include unverified savings

**Table 32: Phase-to-date Peak Demand Savings by Program (MW/Year) – PPL**

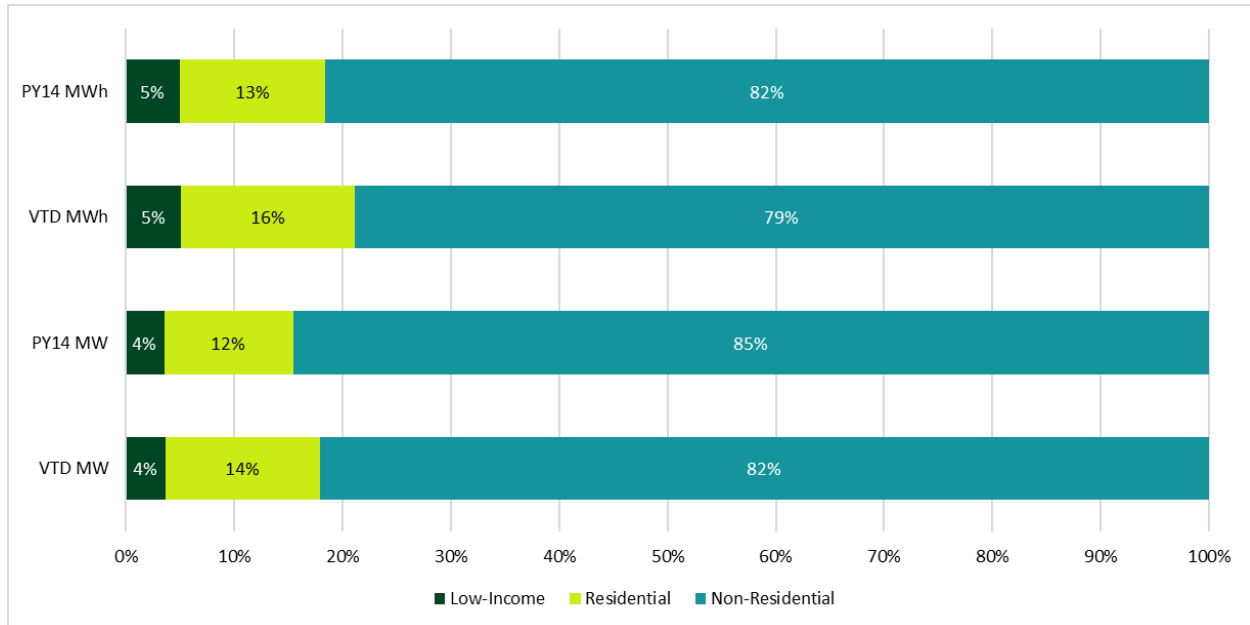
Program	RTD (MW/yr) <sup>2</sup>	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Low-Income	2.5	1.02	2.56	1.00	2.56
Residential	11.15	0.90	10.03	0.65	6.56
Non-Residential	53.47	1.08	57.63	0.64	36.67
<b>Portfolio Total<sup>1</sup></b>	<b>67.12</b>	<b>1.05</b>	<b>70.22</b>	<b>0.65</b>	<b>45.79</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

<sup>2</sup> Reported savings include unverified savings

[Figure 12](#) shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. The Non-Residential program accounted for a larger share of MWh and MW savings in PY14 compared to its P4TD contributions.

**Figure 12: Summary of PY14 and P4TD Program Contributions - 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.

Table 33 shows the TRC ratios by program component and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.63 in PY14. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

**Table 33: PY14 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	\$8,753	\$6,314	1.39	\$2,439
Appliance Recycling	\$2,577	\$2,024	1.27	\$553
Efficient Lighting	\$2,693	\$1,254	2.15	\$1,439
Energy Efficient Homes	\$22,297	\$19,033	1.17	\$3,264
Student Energy Efficient Education	\$0	\$0	-	\$0
<b>Residential Total</b>	<b>\$36,320</b>	<b>\$28,625</b>	<b>1.27</b>	<b>\$7,695</b>
Custom	\$64,886	\$26,127	2.48	\$38,759
Efficient Equipment	\$82,393	\$52,563	1.57	\$29,830
<b>Non-Residential Total</b>	<b>\$147,279</b>	<b>\$78,689</b>	<b>1.87</b>	<b>\$68,590</b>
Cross-cutting	\$0	\$5,449	-	(\$5,449)
<b>Portfolio Total</b>	<b>\$183,599</b>	<b>\$112,763</b>	<b>1.63</b>	<b>\$70,836</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

### 3.2.3 Process Evaluation

Cadmus reported on PY14 process evaluations for the following PPL programs and program components (Table 34).

**Table 34: PPL PY14 Process Evaluations Conducted for Program Components**

Programs and Program Components	
Residential Program <sup>33</sup>	Non-Residential Program <sup>34</sup>
Appliance Recycling	Efficient Equipment (downstream)
Energy Efficient Homes – Audit and Weatherization	Efficient Equipment (midstream)
Energy Efficient Homes - Online Marketplace	Custom
Energy Efficient Homes - Equipment (downstream)	
Student Energy Efficient Education	Low-Income (LI) Program
	Remote Energy Assessment (REA)
	In-Home (On-site)
	Welcome Kits

For PY14, Cadmus conducted and reported on full process evaluations for a total of eleven components and subcomponents within the PPL residential, non-residential, and LI programs. The Residential Program has four major 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.<sup>35</sup> 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) as well as two separate participant pathways within each sub-component (lighting and equipment). The LI Program has three components (REA, In-Home / On-Site, and Welcome Kits) with separate evaluations.

These evaluations generated a total of two process evaluation conclusions, which resulted in three recommendations, all of which have been implemented.<sup>36</sup> A key cross-program finding was

<sup>33</sup> For the Residential Program, the Efficient Lighting component and the New Homes sub-component of the Energy Efficient Homes component are not included because process evaluations were not completed for these sub-components in PY14.

<sup>34</sup> For the Non-Residential Program, the lighting participant pathway is not included as part of the Midstream subcomponent because a full process evaluation was not completed for this subcomponent in PY14. Please note that both the Downstream and Midstream sub-components include both non-lighting and lighting participation pathways.

<sup>35</sup> The Energy Efficient Homes component has a sixth sub-component, Instant Discount, which was not evaluated in PY14.

<sup>36</sup> Cadmus also shared with the SWE summary PowerPoint presentations that were provided to PPL. These PowerPoint presentations included additional process-related findings. The SWE is only reporting on the process-related findings included in the PY14 Annual Report. There are additional findings and recommendations in the PY14

on program satisfaction from participants and participating teachers and students. This collected participant satisfaction information 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 three residential LI program components (REA, On-Site, and Welcome Kits). On average, across all participant surveys, 85% of residential and LI participants, and 88% of non-residential participants were satisfied with the programs or program measures overall.<sup>37</sup>

For the *PPL Residential Program*, the PY14 process evaluation provided several key findings. A key cross-program finding was on program satisfaction from participant and participating student and teacher surveys. The evaluation conducted a participant survey for the Appliance Recycling component, a participant survey for the Audit and Weatherization sub-component of the 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, a distributor survey for the Midstream Equipment sub-component of the Efficient Home component, and participating teacher and student surveys for the Student Energy Efficient Education component. On average, 86% of the participants (including participating customers, teachers, and students) were satisfied with the program overall. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>38</sup>

- Ease of participation
- Drivers of program component satisfaction
- Opinions about PPL
- Likelihood to recommend the program component
- HVAC distributor satisfaction and market insights (for the Midstream Equipment subcomponent only)
- Program improvement suggestions

For the *PPL Non-Residential Program*, the PY14 process evaluation provided a total of one process conclusion and one process recommendation in the PPL PY14 Annual Report. The recommendation has been implemented. 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 component. On average, 88% of the participants were satisfied with the program overall. For Midstream Non-Lighting sub-component of the Efficient Equipment component, Cadmus conducted a process evaluation in PY14, including distributor interviews, though satisfaction estimates were not collected from the distributors. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>39</sup>

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report; however, this section reports only findings and recommendations that were specifically related to the process evaluation.

<sup>37</sup> Weighted by the number of PY14 participants in each program.

<sup>38</sup> The PPL annual report provides further detail regarding these topics.

<sup>39</sup> The PPL annual report provides further detail regarding these topics.

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

For the *PPL Residential LI Program*, the PY14 process evaluation provided a total of one process conclusion and two process recommendations. The two recommendations have been implemented. A key cross-program finding was program satisfaction from participant surveys. The evaluation conducted participant surveys for the REA component, for the On-Site component, and for the Welcome Kits component. On average, 86% of the participants were satisfied with the program overall. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>40</sup>

- Ease of participation
- Drivers of program component satisfaction
- Opinions about PPL
- Likelihood to recommend the program component
- Program improvement suggestions
- Program awareness
- Actions on recommendations
- Knowledge of energy efficiency
- Home comfort

### 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 PY14 Annual Report and the supporting detail provided by PPL's evaluation contractor. The detailed audit findings can be found in [Appendix C](#).

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PPL's PY14 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. 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 PY14 Annual Report values are pulled from a financial system as opposed to program tracking data.
- The SWE's review of PY14 verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework;

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<sup>40</sup> The PPL annual report provides further detail regarding these topics.

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.
- 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 PY14. 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. Like the key finding in PY13, 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).
- PPL's portfolio was cost-effective in PY14 with an improved gross TRC ratio of 1.63.
- 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 PY14 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 PY14 is presented in [Table 35](#). Eighty-six percent of the savings are attributable to non-residential programs. The Residential Behavioral accounted for the largest share of residential savings (5% of PY14 portfolio savings).

**Table 35: PY14 Incremental Annual Energy Savings by Program (MWh/Year)<sup>1</sup> – Duquesne Light**

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Residential Downstream Incentives	2,225	84%	1,860	80%	1,493
Residential Midstream Incentives	3	100%	3	100%	3
Residential Upstream Incentives	2,936	115%	3,378	62%	2,207
Residential Appliance Recycling	2,014	112%	2,262	47%	1,056
Low Income Energy Efficiency (LIEEP)	2,605	97%	2,519	100%	2,519
Residential Behavioral Savings	6,660	95%	6,350	100%	6,350
LI Residential Behavioral	971	75%	730	100%	730
Small Business Direct Install (SBDI)	3,740	81%	3,029	93%	2,802
Small Business Solutions	8,610	97%	8,360	66%	5,489
Small Business Midstream Solutions <sup>2</sup>	39,669	122%	48,220	67%	32,308
Small Business Virtual Commissioning	500	94%	472	100%	472
Commercial Large Business Solutions	6,633	98%	6,515	43%	2,801
Industrial Large Business Solutions	15,058	100%	15,065	43%	6,478
Large Business Midstream Solutions – Commercial	6,510	111%	7,253	67%	4,860
Large Business Midstream Solutions – Industrial	11,665	122%	14,176	67%	9,498
Large Business Virtual Commissioning	2,515	97%	2,442	100%	2,442
<b>Portfolio Total</b>	<b>112,313</b>	<b>109%</b>	<b>122,634</b>	<b>66%</b>	<b>81,508</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date energy impacts by program is presented in [Table 36](#). Consistent with PY14, the bulk of savings (83%) in the phase is attributable to Duquesne Light's Non-Residential Programs.

**Table 36: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year)<sup>1</sup> – Duquesne Light**

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Residential Downstream Incentives	3,759	79%	2,959	0.76	2,242
Residential Midstream Incentives	3	100%	3	1.00	3
Residential Upstream Incentives	4,163	117%	4,883	0.66	3,224
Residential Appliance Recycling	2,361	112%	2,653	0.47	1,239
Low Income Energy Efficiency (LIEEP)	5,139	91%	4,698	1.00	4,698
Residential Behavioral Savings	11,797	98%	11,577	1.00	11,577
LI Residential Behavioral	1,902	101%	1,926	1.00	1,926
Small Business Direct Install (SBDI)	5,038	87%	4,372	0.95	4,135
Small Business Solutions	14,898	113%	16,883	0.72	12,146
Small Business Midstream Solutions <sup>2</sup>	50,334	109%	54,658	0.68	36,943
Small Business Virtual Commissioning	500	94%	472	1.00	472
Commercial Large Business Solutions	15,822	107%	16,957	0.65	11,025
Industrial Large Business Solutions	17,200	99%	16,998	0.45	7,653
Large Business Midstream Solutions – Commercial	9,869	121%	11,980	0.69	8,263
Large Business Midstream Solutions – Industrial	14,506	126%	18,274	0.68	12,449
Large Business Virtual Commissioning	2,515	97%	2,442	1.00	2,442
<b>Portfolio Total</b>	<b>159,806</b>	<b>107%</b>	<b>171,735</b>	<b>0.70</b>	<b>120,437</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of the peak demand impacts by energy efficiency program for PY14 are presented in [Table 37](#).



**Table 37: PY14 Peak Demand Savings by Program (MW/Year) – Duquesne Light<sup>1</sup>**

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Residential Downstream Incentives	0.31	95%	0.29	0.76	0.22
Residential Midstream Incentives	0.00	100%	0.00	N/A	0
Residential Upstream Incentives	0.41	129%	0.53	0.68	0.36
Residential Appliance Recycling	0.49	109%	0.54	0.46	0.25
Low Income Energy Efficiency	0.25	98%	0.24	1.00	0.24
Residential Behavioral Savings	1.31	96%	1.27	1.00	1.27
LI Residential Behavioral	0.19	76%	0.15	1.00	0.15
Small Business Direct Install	0.7	102%	0.71	0.93	0.66
Small Business Solutions	1.97	105%	2.07	0.66	1.36
Small Business Midstream Solutions <sup>2</sup>	8.66	122%	10.55	0.67	7.07
Small Business Virtual Commissioning	0.02	494%	0.12	1.00	0.12
Commercial Large Business Solutions	1.47	96%	1.41	0.43	0.61
Industrial Large Business Solutions	1.17	100%	1.17	0.43	0.5
Large Business Midstream Solutions – Commercial	1.27	110%	1.4	0.67	0.94
Large Business Midstream Solutions – Industrial	2.7	99%	2.68	0.67	1.79
Large Business Virtual Commissioning	0.24	183%	0.44	1.00	0.44
<b>Portfolio Total</b>	<b>21.18</b>	<b>111%</b>	<b>23.57</b>	<b>0.68</b>	<b>15.97</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date peak demand impacts by energy efficiency program is presented in [Table 38](#).

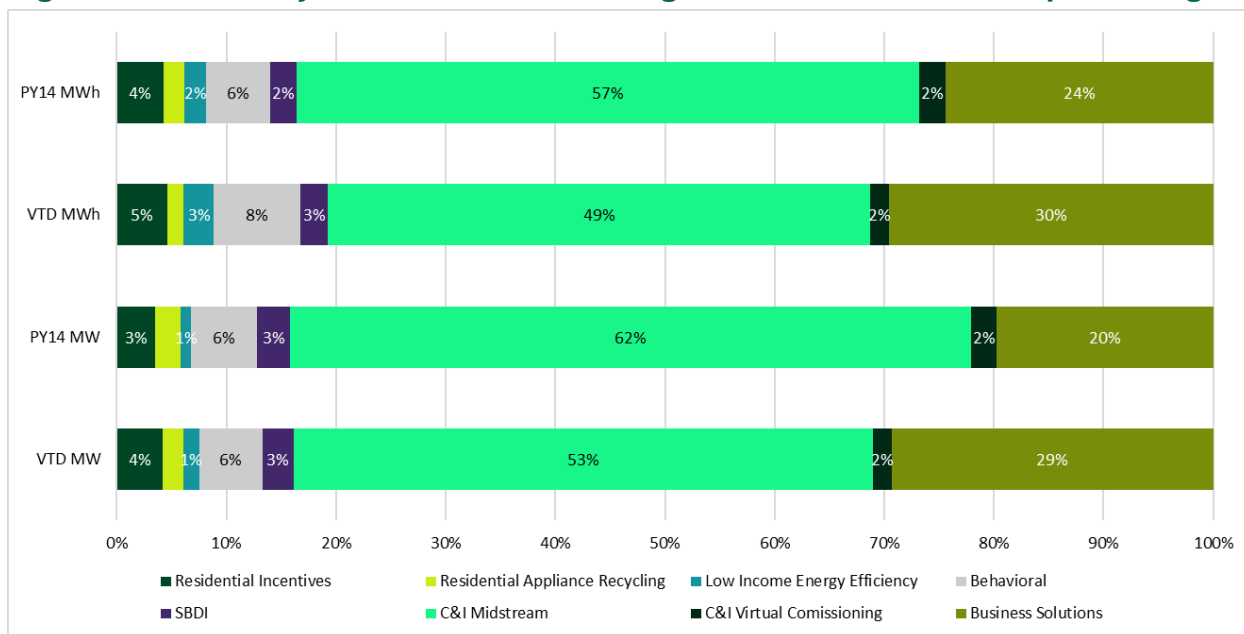
**Table 38: Phase-to-date Peak Demand Savings by Program (MW/Year) – Duquesne Light<sup>1</sup>**

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Residential Downstream Incentives	0.61	95%	0.58	0.71	0.41
Residential Midstream Incentives	0	100%	0	N/A	0
Residential Upstream Incentives	0.61	129%	0.81	0.72	0.58
Residential Appliance Recycling	0.56	109%	0.61	0.46	0.28
Low Income Energy Efficiency	0.52	98%	0.48	1.00	0.48
Residential Behavioral Savings	1.71	96%	1.65	1.00	1.65
LI Residential Behavioral	0.22	76%	0.25	1.00	0.25
Small Business Direct Install	0.9	102%	0.94	0.94	0.88
Small Business Solutions	3.26	105%	4.62	0.73	3.35
Small Business Midstream Solutions <sup>2</sup>	10.79	122%	12.09	0.68	8.18
Small Business Virtual Commissioning	0.02	494%	0.12	1.00	0.12
Commercial Large Business Solutions	3.3	96%	3.58	0.65	2.32
Industrial Large Business Solutions	1.52	100%	1.5	0.47	0.7
Large Business Midstream Solutions – Commercial	1.89	110%	2.04	0.69	1.4
Large Business Midstream Solutions – Industrial	3.36	99%	3.32	0.68	2.26
Large Business Virtual Commissioning	0.24	183%	0.44	1.00	0.44
<b>Portfolio Total</b>	<b>29.52</b>	<b>111%</b>	<b>33.02</b>	<b>0.71</b>	<b>23.29</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

Figure 13 shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. To increase the legibility of the figure, we collapsed several programs across sectors. For example, the Small Business Virtual Commissioning and Large Business Virtual Commissioning programs are combined into a single Virtual Commissioning entry.

Figure 13: Summary of PY14 and P4TD Program Contributions – 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.

Table 39 shows the TRC ratios by program and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.95 in PY14. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

**Table 39: PY14 Gross TRC Ratios by Program (\$1,000) – Duquesne Light<sup>1</sup>**

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Appliance Recycling	\$512	\$800	0.64	(\$288)
Residential Downstream Incentives	\$1,272	\$1,759	0.72	(\$487)
Residential Midstream Incentives	\$3	\$48	0.06	(\$45)
Residential Upstream Incentives	\$1,558	\$1,659	0.94	(\$101)
Residential Behavioral Energy Efficiency	\$631	\$634	1.00	(\$3)
Low Income Energy Efficiency	\$631	\$507	1.24	\$124
Low Income Behavioral Efficiency	\$73	\$312	0.23	(\$239)
<b>Residential Total</b>	<b>\$4,680</b>	<b>\$5,719</b>	<b>0.82</b>	<b>(\$1,039)</b>
Small Business Direct Install	\$2,173	\$2,098	1.04	\$75
Small Business Solutions	\$5,768	\$2,181	2.64	\$3,587
Small Business Midstream Solutions	\$32,215	\$15,122	2.13	\$17,093
Small Business Virtual Commissioning	\$336	\$84	4.00	\$252
Large Commercial Business Solutions	\$4,374	\$2,492	1.76	\$1,882
Large Commercial Business Midstream Solutions	\$4,724	\$2,075	2.28	\$2,649
Large Commercial Business Virtual Commissioning	\$1,560	\$133	11.73	\$1,427
Large Industrial Business Solutions	\$7,206	\$3,851	1.87	\$3,355
Large Industrial Business Midstream Solutions	\$8,471	\$2,826	3.00	\$5,645
Large Industrial Business Virtual Commissioning	\$0	\$33	-	(\$33)
<b>Non-Residential Total</b>	<b>\$66,827</b>	<b>\$30,895</b>	<b>2.16</b>	<b>\$35,932</b>
Cross-cutting	N/A	N/A	N/A	N/A
<b>Portfolio Total</b>	<b>\$71,507</b>	<b>\$36,614</b>	<b>1.95</b>	<b>\$34,893</b>

<sup>1</sup>Totals may not equal sum of column or row due to rounding.

### 3.3.3 Process Evaluation

Guidehouse reported on PY14 process evaluations for the following Duquesne Light programs.

**Table 40: Duquesne Light PY14 Process Evaluations Conducted for Program Components**

Programs and Program Components	
Residential Programs <sup>41</sup>	C&I Programs <sup>42</sup>
Residential Upstream Incentives Program	Small Business Solutions Program
Residential Behavioral Program	Small Business Direct Install Program
Residential Low Income Behavioral Program	Large Business Direct Install Program
Residential Low Income Energy Efficiency Program	

In total, Guidehouse reported on seven PY14 process evaluations for Duquesne Light covering four residential and three C&I programs.

The PY14 process evaluations of the residential programs generated a total of 11 findings and five recommendations. Eight of the findings and two of the recommendations pertain to the Residential Behavioral program; both recommendations were acknowledged. Three of the findings and three of the recommendations pertain to the Residential Upstream Incentives Program; one recommendation was accepted, and two are under consideration.

The PY14 process evaluations of the residential low-income programs generated a total of 14 findings and five recommendations. Seven of the findings and three recommendations pertain to the Residential Low Income Energy Efficiency program; all three recommendations were acknowledged. The other seven findings and two recommendations pertain to the Residential Low Income Behavioral Program; both recommendations were acknowledged.

The PY14 process evaluations of the C&I programs generated a total of 12 findings and six recommendations. Five of the findings and three of the recommendations pertain to the Small Business Direct Install program; all three recommendations were acknowledged. The other seven findings pertain to the Small Business Solutions and Large Business Solutions programs, which were combined in the evaluation activities. The three recommendations generated by the evaluation of the Small Business Solutions and Large Business Solutions programs are listed only for the Small Business Solutions program; all three recommendations were acknowledged.

A key finding of the PY14 process evaluations was overall program satisfaction. Residential program satisfaction was 77% for the Low-Income Behavioral program, 79% for the Residential Behavioral program, and 88% for the Residential Low Income Energy Efficiency program. Additionally, all the manufacturers interviewed for the Residential Upstream Incentives program

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<sup>41</sup> As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not conduct PY14 process evaluations for the Residential Downstream Incentive Program (RDIP), the Residential Midstream Incentive Program (RMIP), or the Residential Appliance Recycling Program.

<sup>42</sup> As described in the Phase IV Evaluation Plan approved by the SWE, Guidehouse did not conduct PY14 process evaluations for the Small Business Midstream Program, the Small Business Virtual Commissioning Program, the Large Business Virtual Commissioning Program, and the Large Business Midstream Program.

were satisfied. C&I program satisfaction was 95% for the Small and Large Business Solutions programs and 96% for the Small Business Direct Install program.

The process evaluation focused on the following areas:

- Program awareness
- Program influence and engagement
- Program satisfaction
- Program barriers and challenges
- Program marketing
- 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 PY14 Annual Report, and the supporting detail provided by Duquesne Light's evaluation contractor. The detailed audit findings can be found in [Appendix D](#).

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Duquesne Light's PY14 Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE was able to replicate the reported MWh savings and reported MW savings exactly. 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 PY14 impact evaluation of Duquesne Light's Small Business Direct Install program failed to meet the  $\pm 15\%$  relative precision requirement in the Phase IV Evaluation Framework. This will require an update to Duquesne Light's EM&V Plan. The approved EM&V Plan called for use of a historic realization rate in PY15. However, the Phase IV Evaluation Framework states that "*Impact evaluations that fail to meet the minimum precision requirements are not permitted to be used as historic realizations rates.*" This means Duquesne Light will need to conduct an impact evaluation of the component in PY15 or leave the savings unverified until the PY16 impact evaluation is complete (e.g., employ a two-year sample).
- Guidehouse provided their Residential and Low Income verified savings analyses prior to drafting their Duquesne Light PY14 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 PY14 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 five active behavioral HER cohorts in PY14 with approximately 144,000 treated households. Three of the cohorts consists of low-income households. On average, HER recipients saved approximately 49 kWh, or 0.7% of their annual consumption, in PY14. Two cohorts were mature enough to require persistence calculations to separate incremental savings from persisting savings from prior exposure. The SWE was able to replicate the verified energy and demand savings values and found that HER impact evaluation was entirely consistent with their proposed and approved

EM&V plans and the Phase IV HER account framework. The SWE team does not propose any revisions to the PY14 methods or results.

- The SWE's review of PY14 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 PY14 Annual Report.
- 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 including a missing invoice for a multi-family project that prevented the SWE from verifying that project scope aligned with reported savings values.
- The SWE conducted a project file review for a sample of Duquesne Light's residential and income-eligible solutions in PY14. 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 with some exceptions. The SWE observed discrepancies in some of the upstream lighting documentation that was reviewed, namely in quantities reported in the tracking data compared to the quantities listed in the lighting invoice.
- The portfolio TRC ratio of 1.95 was driven largely by the performance of the non-residential program, which had a gross TRC ratio of 2.10.
- 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 PY14 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.

## 3.4 FIRSTENERGY: METROPOLITAN EDISON COMPANY

### 3.4.1 Impact Evaluation

A summary of energy impacts by program for PY14 is presented in [Table 41](#). Sixty-two percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximately 33% of savings are attributable to the two market-rate residential programs.

**Table 41: PY14 Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed<sup>1</sup>**

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	19,048	80%	15,153	0.85	12,882
Energy Efficient Products	11,331	113%	12,788	0.46	5,925
Low Income Energy Efficiency	4,009	108%	4,348	1.00	4,348
C&I Energy Solutions for Business - Small	17,544	101%	17,805	0.75	13,348
C&I Energy Solutions for Business - Large	34,740	103%	35,662	0.61	21,883
<b>Portfolio Total</b>	<b>86,671</b>	<b>99%</b>	<b>85,756</b>	<b>0.68</b>	<b>58,386</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date energy impacts by program is presented in [Table 42](#). Consistent with PY14, the bulk of savings (58%) in the phase is attributable to the two non-residential programs.

**Table 42: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed<sup>1</sup>**

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Energy Efficient Homes	33,053	77%	25,419	0.84	21,367
Energy Efficient Products	20,629	109%	22,491	0.45	10,177
Low Income Energy Efficiency	8,069	101%	8,110	1.00	8,110
C&I Energy Solutions for Business - Small	22,787	103%	23,368	0.72	16,838
C&I Energy Solutions for Business - Large	51,319	103%	52,824	0.60	31,514
<b>Portfolio Total</b>	<b>135,858</b>	<b>97%</b>	<b>132,211</b>	<b>0.67</b>	<b>88,006</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.



A summary of the peak demand impacts by energy efficiency program for PY14 and P4TD are presented in [Table 43](#) and [Table 44](#), respectively.

**Table 43: PY14 Peak Demand Savings by Program (MW/Year) – Met-Ed<sup>1</sup>**

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	2.74	85%	2.33	0.85	1.98
Energy Efficient Products	2.72	105%	2.85	0.45	1.28
Low Income Energy Efficiency	0.56	142%	0.79	1.00	0.79
C&I Energy Solutions for Business - Small	3.18	99%	3.16	0.74	2.35
C&I Energy Solutions for Business - Large	4.66	100%	4.66	0.63	2.92
<b>Portfolio Total</b>	<b>13.85</b>	<b>100%</b>	<b>13.79</b>	<b>0.68</b>	<b>9.32</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

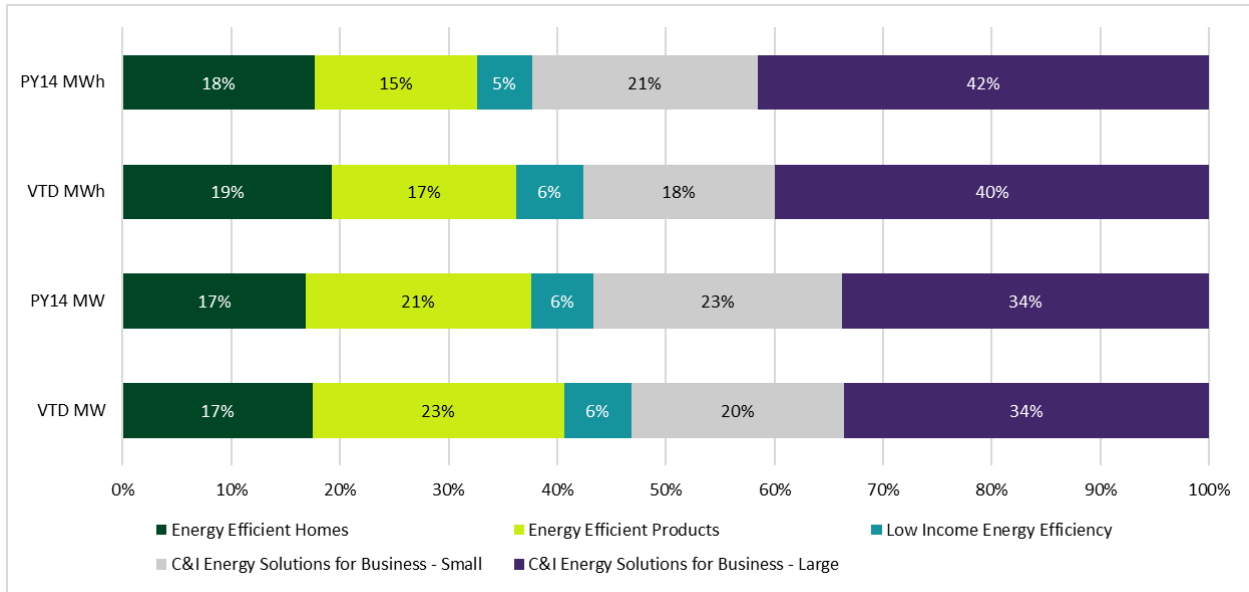
**Table 44: Phase-to-date Peak Demand Savings by Program (MW/Year) – Met-Ed<sup>1</sup>**

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Energy Efficient Homes	4.92	74%	3.65	0.82	3.01
Energy Efficient Products	4.66	104%	4.84	0.44	2.14
Low Income Energy Efficiency	1.09	118%	1.29	1.00	1.29
C&I Energy Solutions for Business - Small	4.13	99%	4.10	0.72	2.94
C&I Energy Solutions for Business - Large	6.98	101%	7.02	0.61	4.26
<b>Portfolio Total</b>	<b>21.79</b>	<b>96%</b>	<b>20.89</b>	<b>0.65</b>	<b>13.64</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

[Figure 14](#) shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. The non-residential programs account for a larger share of Met-Ed's energy savings than peak demand savings for both PY14 and P4TD.

Figure 14: Summary of PY14 and P4TD Program Contributions – 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.

Table 45 shows the TRC ratios by program and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.50 in PY14. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

Table 45: PY14 Gross TRC Ratios by Program (\$1,000) – Met-Ed<sup>1</sup>

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$11,377	\$4,938	2.30	\$6,439
Energy Efficient Products	\$7,058	\$8,244	0.86	(\$1,186)
Low Income Energy Efficiency	\$2,401	\$2,405	1.00	-5
<b>Residential Total</b>	<b>\$20,836</b>	<b>\$15,588</b>	<b>1.34</b>	<b>\$5,248</b>
C&I Energy Solutions for Business - Small	\$12,918	\$7,680	1.68	\$5,238
C&I Energy Solutions for Business - Large	\$12,616	\$7,563	1.67	\$5,053
<b>Non-Residential Total</b>	<b>\$25,533</b>	<b>\$15,243</b>	<b>1.68</b>	<b>\$10,290</b>
Cross-cutting	N/A	N/A	N/A	N/A
<b>Portfolio Total</b>	<b>\$46,369</b>	<b>\$30,831</b>	<b>1.50</b>	<b>\$15,538</b>

<sup>1</sup> 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 PY14 process evaluations for the following FirstEnergy Utilities programs and program components (Table 46).

**Table 46: FirstEnergy PY14 Process Evaluations Conducted for Program Components**

Programs and Program Components	
<b>Residential Program</b>	<b>Residential Income – Eligible Program</b>
Energy Efficient Products - Behavioral Home Energy Reports	Weatherization (Direct Install)
Energy Efficient Products - Online Audit	Appliance Rebates
Energy Efficient Products - New Homes	Behavioral Home Energy Reports
Energy Efficient Homes - Appliance Rebate	Multifamily (Residential) New Homes
<b>C&amp;I Energy Efficiency Solutions for Business Program - Small</b>	<b>C&amp;I Energy Efficiency Solutions for Business Program - Large</b>
Prescriptive	Prescriptive
Prescriptive – Other	Prescriptive – Other
Custom	Custom

For PY14, ADM/Tetra Tech conducted and reported on full process evaluations for a total of 11 components and subcomponents within the FirstEnergy Residential, Income-Eligible, and Non-Residential programs.

The Residential Program has two major components (Energy Efficient Products Program and Energy Efficient Homes Program). The Energy Efficient Products component within the Residential Program has four distinct sub-components (Appliance Recycling, Appliance Rebate, Consumer Electronics, and HVAC). In PY14, Appliance Rebate received a process evaluation. The Energy Efficient Homes component within the Residential Program has seven distinct sub-components (Comprehensive Audit, Behavioral Home Energy Reports, Online Audit, Multifamily Residential, School Education, EE Kits, and New Homes). In PY14, Behavioral Home Energy Report, Online Audit, and New Homes received process evaluations. The Residential Income-Eligible Program has seven distinct sub-components (Weatherization (Direct Install), Appliance Rebates, School Education, EE Kits, Behavioral Home Energy Report, Multifamily Residential, and New Homes). In PY14, Weatherization (Direct Install), Appliance Rebates, Behavioral Home Energy Report, Multifamily Residential, and New Homes received process evaluations.

The Non-Residential Program has two distinct components (Energy Efficiency Solutions for Business Program - Small and Energy Efficiency Solutions for Business Program – Large). Both components have five distinct sub-components (Multifamily, Prescriptive, Prescriptive – Other, Custom, and Energy Management).

For the *Residential Program*, this evaluation generated a total of 29 process evaluation findings, which resulted in eight recommendations, all of which were accepted.<sup>43</sup> A key cross-program finding was on program satisfaction from participants, as well as builders and HERS Raters for certain program components. The evaluation conducted a participant survey for the Appliance Rebate, Behavioral Home Energy Report, Online Audit, Weatherization (Direct Install), Multifamily Residential, and C&I components. On average, 76% of Residential participants (customers only), 85% of builders, and 83% of HERS raters were satisfied with the program. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>44</sup>

- Awareness of the program
- Influence of the program
- Drivers of program component satisfaction

For the *Residential Income-Eligible Program*, this evaluation generated a total of 40 process evaluation findings, which resulted in 12 recommendations, all of which were accepted.<sup>45</sup> A key cross-program finding was on program satisfaction from participants, as well as builders and HERS Raters for certain program components. The evaluation conducted a participant survey for the Weatherization (Direct Install), Appliance Rebate, Behavioral Home Energy Report, Multifamily Residential, and New Homes components. On average, 75% of Residential Income-Eligible participants (customers only), 85% of builders, and 83% of HERS raters were satisfied with the program. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>46</sup>

- Awareness of the program
- Influence of the program
- Drivers of program component satisfaction

For the *C&I Program*, this evaluation generated a total of five process evaluation findings, which resulted in four recommendations, all of which were accepted. A key cross-program finding was on program satisfaction from participants, as well as vendors and distributors. For the C&I

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<sup>43</sup> ADM/Tetra Tech also shared with the SWE process evaluation memos by program component. These memos included additional process-related findings. The SWE is only reporting on the process-related findings included in the PY14 Annual Report. There are additional findings and recommendations in the PY14 report; however, this section reports only findings and recommendations that were specifically related to the process evaluation.

<sup>44</sup> The FE annual report provides further detail regarding these topics.

<sup>45</sup> ADM/Tetra Tech also shared with the SWE process evaluation memos by program component. These memos included additional process-related findings. The SWE is only reporting on the process-related findings included in the PY14 Annual Report. There are additional findings and recommendations in the PY14 report; however, this section reports only findings and recommendations that were specifically related to the process evaluation.

<sup>46</sup> The FE annual report provides further detail regarding these topics.

Program, 85% of participants (customers only), 70% of vendors, and 47% of distributors were satisfied with the program. Findings for this program addressed other topics beyond satisfaction, including the following:<sup>47</sup>

- Awareness of the program
- Experience with the program
- Impacts of the program
- Participant business characteristics

#### 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 PY14 Annual Report and the supporting detail provided by Met-Ed's evaluation contractor. The detailed audit findings can be found in [Appendix E](#).

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Met-Ed's PY14 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's review of PY14 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. Revisions included updating lighting wattages to align with DLC 5.1, custom calculation of baseline compressor operation, and updating regional locations that shifted system equivalent full load hours. The SWE's feedback was provided to the evaluator with sufficient time for Met-Ed to include all suggested changes in the Met-Ed PY14 Annual Report.
- The SWE closely reviewed a large CHP project, which accounted for 37% of non-residential savings in PY14. ADM used trended measurements collected at the facility to determine the project's verified savings and worked with the SWE to validate parasitic loads. Overall, project reported savings were lowered from an initial annual estimate of 26.2 MWh to 19.1 MWh.
- Met-Ed provided their Residential and Low Income verified savings analyses prior to drafting the Met-Ed PY14 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 PY14 Annual Report. In addition, the verified savings analyses were well organized, and

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<sup>47</sup> The FE annual report provides further detail regarding these topics.

included the documentation required to conduct verified savings checks from the measure-level all the way to program-level savings.

- Met-Ed initiated two additional behavioral HER cohorts in June 2022 for a total of four active cohorts in PY14. One of the new cohorts consists of market residential households and the other cohort consists of low-income households. On average, HER recipients saved approximately 41 kWh, or 0.4% of their annual consumption, in PY14. Since the PY13 and PY14 cohorts were new, the impact evaluation did not need to deal with 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 PY14 methods or results.
- Met-Ed's portfolio was cost-effective in PY14 with a gross TRC ratio of 1.50 with an improved TRC ratio from PY13.
- The SWE conducted a project file review for a sample of Met-Ed's residential and income-eligible solutions in PY14. 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.
- 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.
- 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 PY14 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.

## 3.5 FIRSTENERGY: PENNSYLVANIA ELECTRIC COMPANY

### 3.5.1 Impact Evaluation

A summary of energy impacts by program for PY14 is presented in [Table 47](#). Fifty-six percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximately 38% of savings are attributable to the two market-rate residential programs.

**Table 47: PY14 Incremental Annual Energy Savings by Program (MWh/Year) – Penelec<sup>1</sup>**

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	18,700	104%	19,408	0.88	17,004
Energy Efficient Products	7,887	103%	8,128	0.58	4,681
Low Income Energy Efficiency	3,876	120%	4,646	1.00	4,646
C&I Energy Solutions for Business - Small	21,200	100%	21,243	0.70	14,911
C&I Energy Solutions for Business - Large	17,999	105%	18,920	0.66	12,510
<b>Portfolio Total</b>	<b>69,661</b>	<b>104%</b>	<b>72,345</b>	<b>0.74</b>	<b>53,752</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date energy impacts by program is presented in [Table 48](#). Consistent with PY14, just over half of savings (51%) in the phase is attributable to the two non-residential programs.

**Table 48: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – Penelec<sup>1</sup>**

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Energy Efficient Homes	27,107	100%	26,982	0.87	23,340
Energy Efficient Products	14,370	106%	15,192	0.58	8,851
Low Income Energy Efficiency	9,796	108%	10,588	1.00	10,588
C&I Energy Solutions for Business - Small	35,029	99%	34,649	0.77	26,521
C&I Energy Solutions for Business - Large	20,148	104%	20,956	0.67	14,102
<b>Portfolio Total</b>	<b>106,449</b>	<b>102%</b>	<b>108,366</b>	<b>0.77</b>	<b>83,402</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of the peak demand impacts by energy efficiency program for PY14 and P4TD are presented in [Table 49](#) and [Table 50](#), respectively.

**Table 49: PY14 Peak Demand Savings by Program (MW/Year) – Penelec<sup>1</sup>**

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	2.84	94%	2.67	0.90	2.42
Energy Efficient Products	2.11	100%	2.11	0.58	1.23
Low Income Energy Efficiency	0.59	108%	0.64	1.00	0.64
C&I Energy Solutions for Business - Small	4.35	92%	3.99	0.69	2.75
C&I Energy Solutions for Business - Large	3.05	96%	2.92	0.66	1.93
<b>Portfolio Total</b>	<b>12.95</b>	<b>95%</b>	<b>12.33</b>	<b>0.73</b>	<b>8.97</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

**Table 50: Phase-to-date Peak Demand Savings by Program (MW/Year) – Penelec<sup>1</sup>**

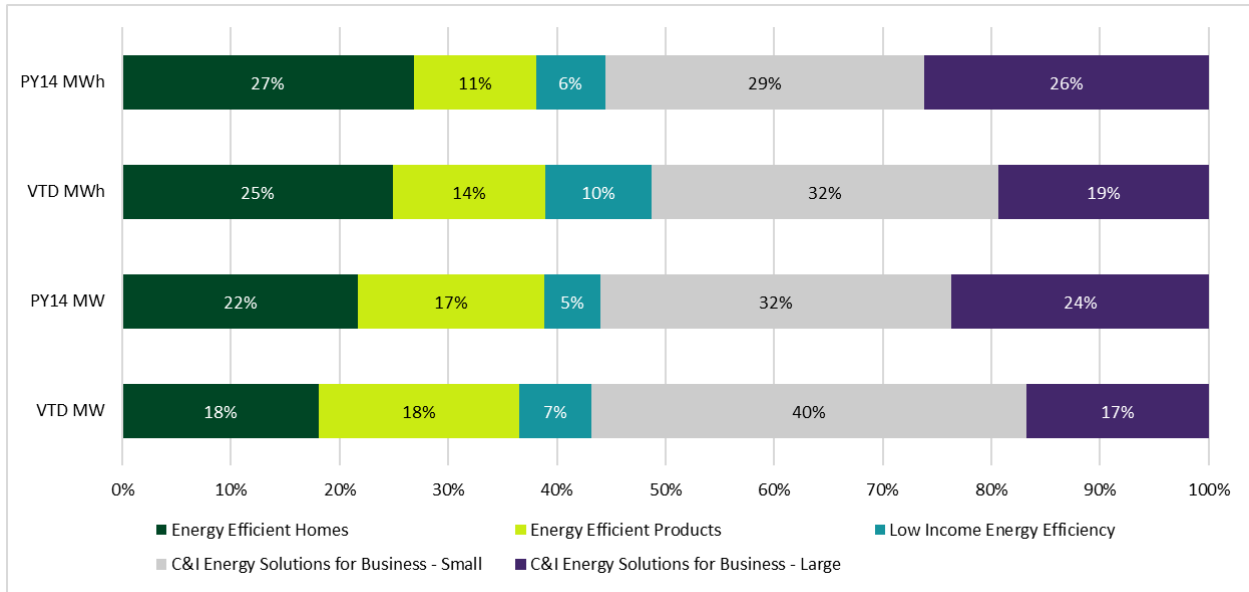
Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Energy Efficient Homes	3.71	94%	3.48	0.89	3.08
Energy Efficient Products	3.48	102%	3.56	0.59	2.09
Low Income Energy Efficiency	1.33	96%	1.28	1.00	1.28
C&I Energy Solutions for Business - Small	8.21	94%	7.72	0.78	6.02
C&I Energy Solutions for Business - Large	3.42	94%	3.23	0.67	2.18
<b>Portfolio Total</b>	<b>20.15</b>	<b>96%</b>	<b>19.27</b>	<b>0.76</b>	<b>14.65</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

Figure 15 shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. The Energy Efficient Homes program accounts for a larger share of Penelec's energy savings than peak demand savings for both PY14 and P4TD while Energy Efficient Products contributes a larger share of energy savings than peak demand savings.



Figure 15: Summary of PY14 and P4TD Program Contributions – 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.

Table 51 shows the TRC ratios by program and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.90 in PY14. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

Table 51: PY14 Gross TRC Ratios by Program (\$1,000) – Penelec<sup>1</sup>

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$13,298	\$3,330	3.99	\$9,968
Energy Efficient Products	\$4,491	\$6,020	0.75	(\$1,529)
Low Income Energy Efficiency	\$2,453	\$2,628	0.93	(\$176)
<b>Residential Total</b>	<b>\$20,242</b>	<b>\$11,978</b>	<b>1.69</b>	<b>\$8,264</b>
C&I Energy Solutions for Business - Small	\$16,251	\$7,976	2.04	\$8,275
C&I Energy Solutions for Business - Large	\$10,981	\$5,032	2.18	\$5,948
<b>Non-Residential Total</b>	<b>\$27,232</b>	<b>\$13,008</b>	<b>2.09</b>	<b>\$14,223</b>
Cross-cutting	N/A	N/A	N/A	N/A
<b>Portfolio Total</b>	<b>\$47,473</b>	<b>\$24,986</b>	<b>1.90</b>	<b>\$22,487</b>

<sup>1</sup> 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 PY14 process evaluation activities for the FirstEnergy Utilities programs ([Table 46](#)).

### 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 PY14 Annual Report and the supporting detail provided by Penelec's evaluation contractor. The detailed audit findings can be found in [Appendix F](#).

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penelec's PY14 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 Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.
- The SWE's review of PY14 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 only significant adjustment was a reduction in the baseline lighting wattage for a single project.
- 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 PY14 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 a new market rate HER cohort in June 2022 and reactivate a legacy market rate wave from 2012 for a total of three active cohorts and 66,000 treated homes in PY14. On average, HER recipients saved approximately 79 kWh, or 0.8% of their annual consumption, in PY14. Despite being paused for PY13, the 2012 cohort was mature enough to require persistence calculations to separate incremental savings from persisting savings from prior exposure. The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans and the Phase IV HER account framework. The SWE team does not propose any revisions to the PY14 methods or results.
- Penelec's portfolio was cost-effective in PY14 with a gross TRC ratio of 1.90 with an improved TRC ratio from PY13.
- 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 PY14. 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 PY14 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.

### 3.6 FIRSTENERGY: PENNSYLVANIA POWER COMPANY

#### 3.6.1 Impact Evaluation

A summary of energy impacts by program for PY14 is presented in [Table 52](#). Fifty-two percent of savings are attributable to the two market-rate residential programs and approximately 42% of savings are attributable to the two non-residential programs.

**Table 52: PY14 Incremental Annual Energy Savings by Program (MWh/Year) – Penn Power<sup>1</sup>**

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	6,279	98%	6,169	0.86	5,282
Energy Efficient Products	3,128	106%	3,319	0.43	1,441
Low Income Energy Efficiency	1,387	84%	1,160	1.00	1,160
C&I Energy Solutions for Business - Small	6,089	88%	5,366	0.90	4,834
C&I Energy Solutions for Business - Large	2,629	86%	2,271	0.86	1,953
<b>Portfolio Total</b>	<b>19,512</b>	<b>94%</b>	<b>18,284</b>	<b>0.80</b>	<b>14,670</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date energy impacts by program is presented in [Table 53](#). The non-residential programs account for 47% of the savings in the phase while the two market-rate residential programs account for 44% of the P4TD energy savings.

**Table 53: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – Penn Power<sup>1</sup>**

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Energy Efficient Homes	10,192	91%	9,304.04	0.85	7,939
Energy Efficient Products	5,677	104%	5,899.20	0.43	2,552
Low Income Energy Efficiency	3,125	92%	2,876.54	1.00	2,877
C&I Energy Solutions for Business - Small	7,239	90%	6,527.78	0.89	5,785
C&I Energy Solutions for Business - Large	9,922	97%	9,610.84	0.69	6,662
<b>Portfolio Total</b>	<b>36,155</b>	<b>95%</b>	<b>34,218.40</b>	<b>0.75</b>	<b>25,814</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of the peak demand impacts by energy efficiency program for PY14 and P4TD are presented in [Table 54](#) and [Table 55](#), respectively.

**Table 54: PY14 Peak Demand Savings by Program (MW/Year) – Penn Power<sup>1</sup>**

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	1.24	89%	1.10	0.88	0.97
Energy Efficient Products	0.75	102%	0.77	0.43	0.33
Low Income Energy Efficiency	0.18	120%	0.22	1.00	0.22
C&I Energy Solutions for Business - Small	1.31	80%	1.05	0.90	0.95
C&I Energy Solutions for Business - Large	0.53	76%	0.41	0.87	0.35
<b>Portfolio Total</b>	<b>4.02</b>	<b>88%</b>	<b>3.55</b>	<b>0.79</b>	<b>2.82</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

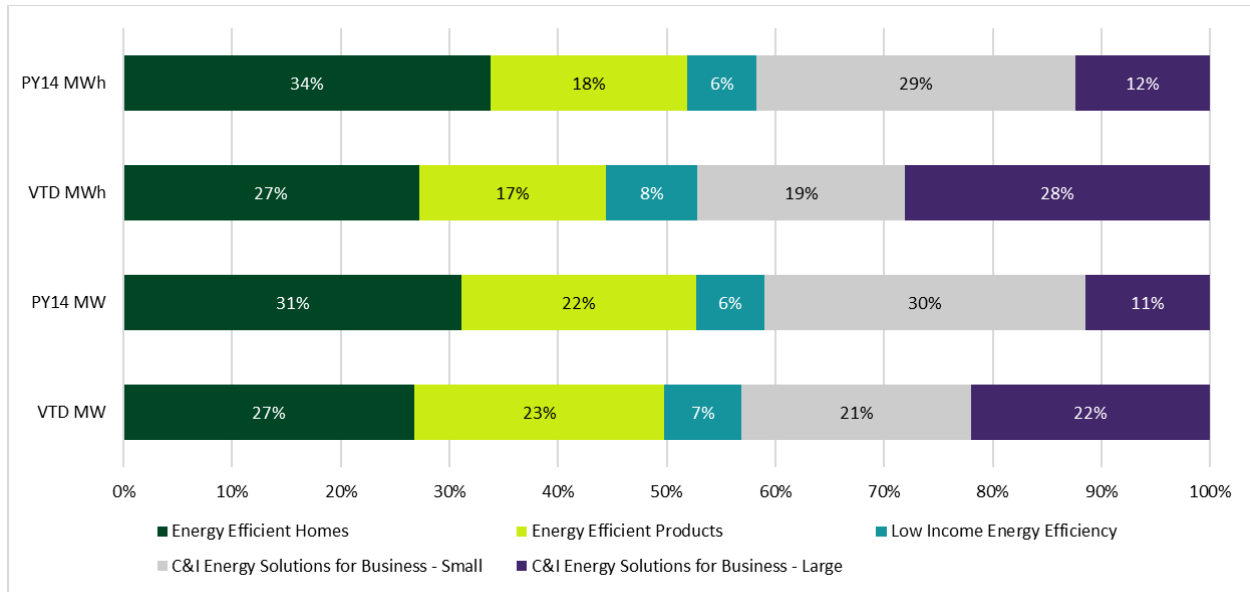
**Table 55: Phase-to-date Peak Demand Savings by Program (MW/Year) – Penn Power<sup>1</sup>**

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Energy Efficient Homes	2.00	76%	1.51	0.85	1.29
Energy Efficient Products	1.27	102%	1.30	0.43	0.56
Low Income Energy Efficiency	0.42	96%	0.40	1.00	0.40
C&I Energy Solutions for Business - Small	1.48	81%	1.20	0.89	1.07
C&I Energy Solutions for Business - Large	1.37	90%	1.24	0.72	0.90
<b>Portfolio Total</b>	<b>6.55</b>	<b>86%</b>	<b>5.65</b>	<b>0.74</b>	<b>4.21</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

Figure 16 shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. The C&I Energy Solutions for Business – Large program accounted for a much smaller share of PY14 energy and peak demand savings than P4TD energy and peak demand savings.

**Figure 16: Summary of PY14 and P4TD Program Contributions – 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.

Table 56 shows the TRC ratios by program and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.19 in PY14.

**Table 56: PY14 Gross TRC Ratios by Program (\$1,000) – Penn Power<sup>1</sup>**

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$3,804	\$2,191	1.74	\$1,613
Energy Efficient Products	\$1,721	\$1,694	1.02	\$26
Low Income Energy Efficiency	\$385	\$837	0.46	(\$452)
<b>Residential Total</b>	<b>\$5,909</b>	<b>\$4,722</b>	<b>1.25</b>	<b>\$1,187</b>
C&I Energy Solutions for Business - Small	\$3,534	\$2,806	1.26	\$728
C&I Energy Solutions for Business - Large	\$1,356	\$1,563	0.87	(\$207)
<b>Non-Residential Total</b>	<b>\$4,890</b>	<b>\$4,369</b>	<b>1.12</b>	<b>\$521</b>
Cross-cutting	N/A	N/A	N/A	N/A
<b>Portfolio Total</b>	<b>\$10,799</b>	<b>\$9,091</b>	<b>1.19</b>	<b>\$1,708</b>

<sup>1</sup> 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 PY14 process evaluation activities for the FirstEnergy Utilities programs ([Table 46](#)).

### 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 PY14 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 performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penn Power's PY14 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 Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.
- The SWE's review of PY14 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 only significant adjustment was a reduction in the baseline lighting wattage at a Midstream project to align with equipment found during an on-site visit.
- 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 PY14 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 continued to treat the two HER cohorts launched October 2021 in PY14. One of the active cohorts consists of market residential households and the other cohort consists of low-income households. On average, HER recipients saved approximately 70 kWh, or 0.7% of their annual consumption, in PY14. Since the cohorts were in their second year of HER exposure, the impact evaluation did not need to deal with 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 PY14 methods or results.
- The SWE conducted a project file review for a sample of Penn Power's residential and income-eligible solutions in PY14. 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.
- 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.
- 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 PY14 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 portfolio was cost-effective in PY14 with a gross TRC ratio of 1.19 with an improved TRC ratio from PY13.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penn Power's PY14 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, which we anticipated. The Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.

## 3.7 FIRSTENERGY: WEST PENN POWER

### 3.7.1 Impact Evaluation

A summary of energy impacts by program for PY14 is presented in [Table 57](#). Fifty-nine percent of savings are attributable to the two non-residential programs (C&I Energy Solutions for Business, Small and Large) and approximately 33% of savings are attributable to the two market-rate residential programs.

**Table 57: PY14 Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power<sup>1</sup>**

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Energy Efficient Homes	17,244	90%	15,509	1.03	16,019
Energy Efficient Products	9,994	108%	10,791	0.60	6,463
Low Income Energy Efficiency	5,802	109%	6,314	1.00	6,314
C&I Energy Solutions for Business - Small	26,034	105%	27,313	0.76	20,828
C&I Energy Solutions for Business - Large	18,394	110%	20,243	0.66	13,397
<b>Portfolio Total</b>	<b>77,468</b>	<b>103%</b>	<b>80,171</b>	<b>0.79</b>	<b>63,022</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of phase-to-date energy impacts by program is presented in [Table 58](#). Consistent with PY14, the bulk of savings (53%) in the phase is attributable to the two non-residential programs.

**Table 58: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power<sup>1</sup>**

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Energy Efficient Homes	31,929	84%	26,884.57	1.03	27,811
Energy Efficient Products	17,788	107%	19,061.21	0.61	11,538
Low Income Energy Efficiency	11,199	108%	12,130.75	1.00	12,131
C&I Energy Solutions for Business - Small	33,302	103%	34,245.56	0.75	25,786
C&I Energy Solutions for Business - Large	29,588	106%	31,486.31	0.64	20,223
<b>Portfolio Total</b>	<b>123,806</b>	<b>100%</b>	<b>123,808.39</b>	<b>0.79</b>	<b>97,488</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

A summary of the peak demand impacts by energy-efficiency program for PY14 and P4TD are presented in [Table 59](#) and [Table 60](#), respectively.



**Table 59: PY14 Peak Demand Savings by Program (MW/Year) – West Penn Power<sup>1</sup>**

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Energy Efficient Homes	2.65	79%	2.10	1.00	2.09
Energy Efficient Products	2.53	103%	2.60	0.61	1.59
Low Income Energy Efficiency	0.80	113%	0.91	1.00	0.91
C&I Energy Solutions for Business - Small	4.99	89%	4.42	0.75	3.30
C&I Energy Solutions for Business - Large	3.02	89%	2.69	0.67	1.80
<b>Portfolio Total</b>	<b>14.00</b>	<b>91%</b>	<b>12.71</b>	<b>0.76</b>	<b>9.70</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

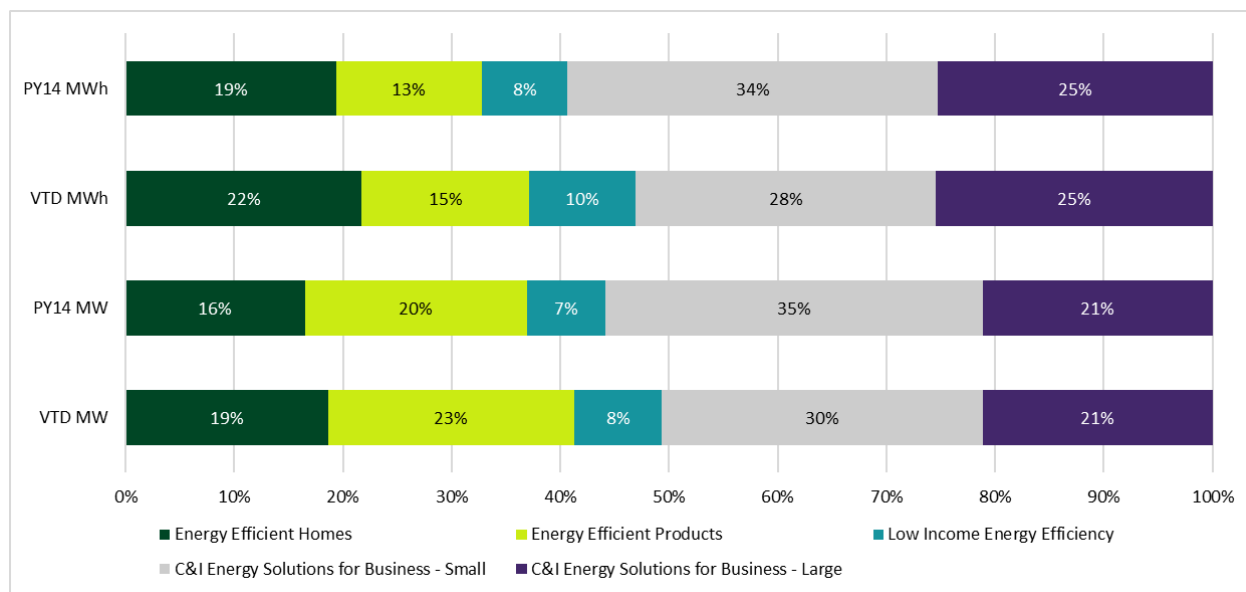
**Table 60: Phase-to-date Peak Demand Savings by Program (MW/Year) – West Penn Power<sup>1</sup>**

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Energy Efficient Homes	4.92	70%	3.46	1.00	3.45
Energy Efficient Products	4.13	102%	4.21	0.61	2.58
Low Income Energy Efficiency	1.61	93%	1.50	1.00	1.50
C&I Energy Solutions for Business - Small	6.22	88%	5.49	0.74	4.06
C&I Energy Solutions for Business - Large	4.33	91%	3.92	0.65	2.55
<b>Portfolio Total</b>	<b>21.20</b>	<b>88%</b>	<b>18.57</b>	<b>0.76</b>	<b>14.15</b>

<sup>1</sup> Totals may not equal sum of column or row due to rounding.

Figure 17 shows the PY14 and VTD energy and peak demand savings by program on a normalized basis. The C&I programs accounted for a larger share of PY14 energy and peak demand savings than P4TD energy and peak demand savings.

**Figure 17: Summary of PY14 and P4TD Program Contributions – 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.

Table 61 shows the TRC ratios by program and for the portfolio. The ratio of TRC benefits to TRC costs is the TRC ratio, which was 1.62 in PY14. The benefits were calculated using gross verified impacts. Costs and benefits are expressed in 2022 dollars.

**Table 61: PY14 Gross TRC Ratios by Program (\$1,000) – West Penn Power<sup>1</sup>**

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Energy Efficient Homes	\$11,609	\$5,473	2.12	\$6,137
Energy Efficient Products	\$4,809	\$6,562	0.73	(\$1,752)
Low Income Energy Efficiency	\$3,310	\$3,092	1.07	\$218
<b>Residential Total</b>	<b>\$19,728</b>	<b>\$15,126</b>	<b>1.30</b>	<b>\$4,602</b>
C&I Energy Solutions for Business - Small	\$16,843	\$9,652	1.74	\$7,190
C&I Energy Solutions for Business - Large	\$10,286	\$4,192	2.45	\$6,095
<b>Non-Residential Total</b>	<b>\$27,129</b>	<b>\$13,844</b>	<b>1.96</b>	<b>\$13,285</b>
Cross-cutting	N/A	N/A	N/A	N/A
<b>Portfolio Total</b>	<b>\$46,857</b>	<b>\$28,970</b>	<b>1.62</b>	<b>\$17,887</b>

<sup>1</sup> 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 PY14 process evaluation activities for the FirstEnergy Utilities programs ([Table 46](#)).

### 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 PY14 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 performed a detailed comparison of the energy, demand, participation, and incentive amounts in West Penn Power's PY14 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 Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.
- The SWE's review of PY14 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 PY14 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 an additional behavioral HER cohort in June 2022 for a total of three active cohorts in PY14. The new cohort consists of approximately 34,000 market residential households. On average, HER recipients saved approximately 24 kWh, or 0.3% of their annual consumption, in PY14. Since the three active cohorts were in their first or second year of HER exposure, the impact evaluation did not need to deal with 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 PY14 methods or results.
- 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 PY14. In general, adequate numbers of project files were submitted, the sampled project file packages included the requested number of project

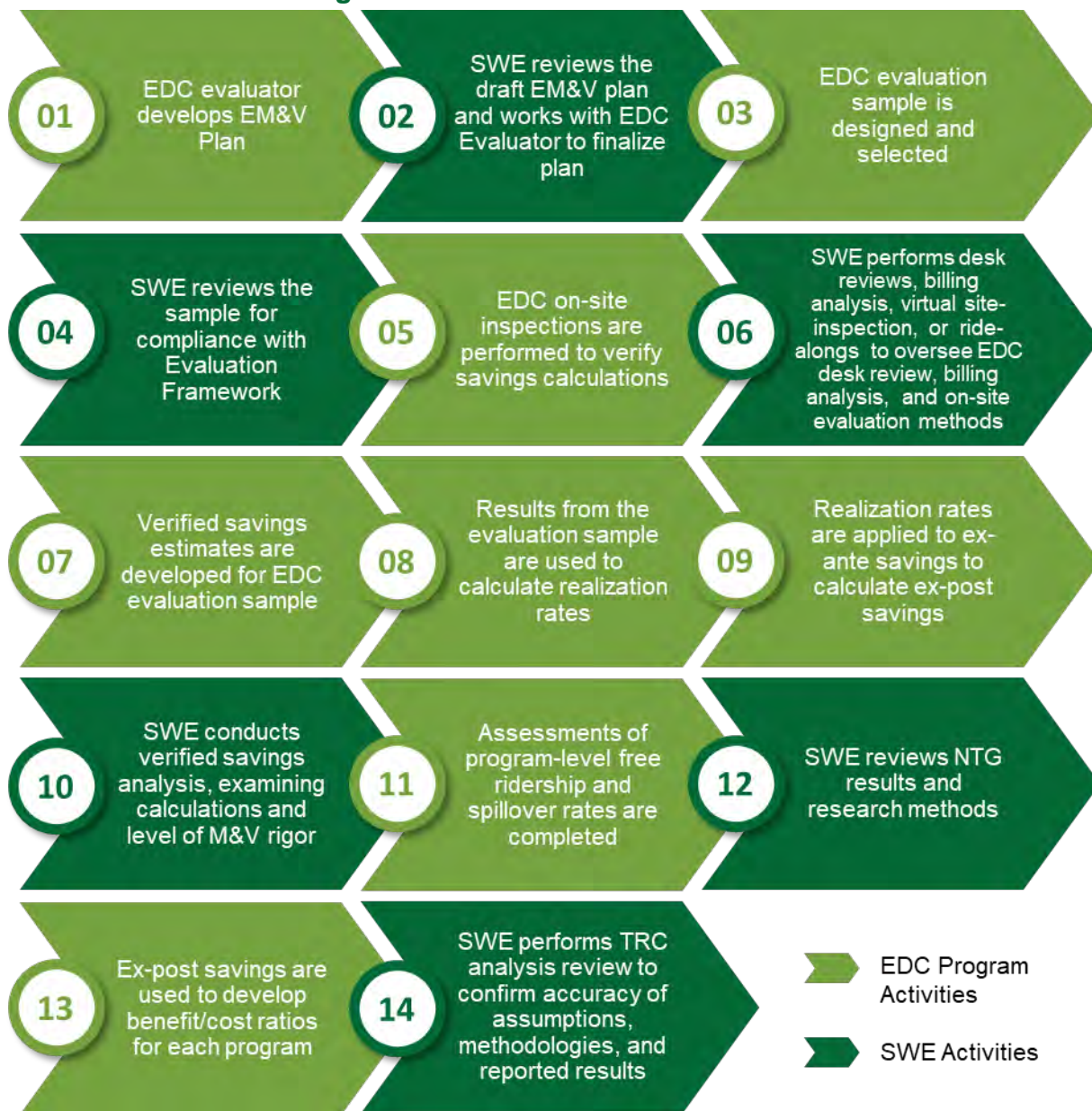
files and supporting details, and the project files were found to match most of the tracking data.

- 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 PY14 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 portfolio was cost-effective in PY14 with an improved gross TRC ratio of 1.62.

## Section 4 Cross-Cutting SWE Activities

This section presents a summary of the audit and cross-cutting activities conducted by the SWE during PY14, 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 18](#) shows the C&I sector specific SWE audit activities and their correspondence to the evaluation steps.

Figure 18: The SWE Audit Activities<sup>48</sup>



<sup>48</sup> 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 PY14.

### 4.1.1 2026 TRM Update

The SWE conducted a detailed review of the 2021 TRM in preparation for the 2026 TRM Update. The 2026 TRM will be released in 2024 and takes effect in June 2026 at the beginning of Phase V of Act 129. The 2026 TRM will also serve as a technical foundation for the SWE's Phase V Market Potential Study. Key areas of focus for the TRM update include the following:

- Updates to federal standards, ENERGY STAR specifications, and building codes
- Updated climate assumptions for weather-dependent measures
- Updated measure assumptions to reflect the most recent industry equipment studies on operating characteristics and the results of the 2023 Act 129 baseline studies
- Adapting measures to allow for a midstream program delivery model
- Updated Equivalent Full Load Hours (EFLH) and Coincidence Factor (CF) assumptions for residential HVAC measures
- Adding winter energy-to-demand factors (ETDFs) or CFs to allow for calculating winter peak demand savings
- Addition of new measures. Many new measures were submitted in PY13 and PY14 as Interim Measure Protocols
- General TRM consistency and clarity

### 4.1.2 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 11 IMPs were developed, reviewed, and approved to be effective during PY14 ([Table 62](#)). Common themes in PY14 IMPs included reissuing PY13-approved IMPs with codes and standards updates and the continued measure expansion to address midstream delivery as several EDCs' Phase IV EE&C Plans called for midstream delivery of non-lighting technologies.



**Table 62: IMPs Approved During PY14**

TRM Section Number	IMP Name
3.2.1	HVAC Variable Frequency Drive (VFD) Improvements – Midstream Delivery
NA	Building Operator Certification
NA (3.2.xx)	Commercial Building Duct Sealing and Insulation
3.7.9	ENERGY STAR Commercial Dishwasher for Midstream Delivery – C&S Update
3.7.5	ENERGY STAR Combination Oven for Midstream Delivery – C&S Update
3.7.6	ENERGY STAR Commercial Convection Oven for Midstream Delivery – C&S Update
2.2.7	Window Heat Pumps
NA (2.3.xx)	Smart Water Heater Controller
3.2.4	Non-Res HVAC System Midstream Delivery Option
2.2.1	Res High Efficiency Equipment for Midstream Delivery: ASHP, CAC, PTAC, PTHP – C&S Update
NA (3.2.xx)	Adjustment of Programmable Thermostats for C&I Buildings

**4.1.3 TRM Codes and Standards Review**

The Phase IV Energy Efficiency and Conservation (EE&C) Implementation Order and 2021 TRM Final Order direct 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 19](#) summarizes the process.

**Figure 19: 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 2023, the SWE team delivered a memo to TUS summarizing the SWE’s research into changes to codes, standards, and ENERGY STAR specifications since the previous codes and standards review completed in 2022. The memo also estimated the direction and magnitude (in MWh) of the changes to Phase IV savings for PY16 and PY17 should the Commission choose to pursue an update to the 2021 TRM, effective June 1, 2024, based on any impacted parameters



in effect by July 1, 2023.<sup>49</sup> The research uncovered six affected measures and the overall impact on Phase IV EE&C plans was very limited (less than 0.05%). 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.

Because the codes and standards changes do not go into effect until PY16 (June 1, 2024), the SWE only completed preliminary work on the guidance memos during PY14 and will issue the guidance memos in PY15. The most impactful update was for ENERGY STAR room air conditioners (the final version 5.0 of the ENERGY STAR specification for room air conditioners was released and went into effect on October 30, 2023). This new specification includes updates to the combined energy efficiency ratio (CEER) requirements and will increase savings over the federal minimum standards in the range of 8% to 20%. Table 63 summarizes the six measures affected by codes and standards updates.<sup>50</sup>

**Table 63: Forthcoming Codes and Standards Guidance Memos**

TRM Measure #	TRM Measure Name	Type of Change	Effective Date of Changes
2.2.7 & 3.2.7	ENERGY STAR Room Air Conditioners	Change to ES standard	10/30/23
2.4.8	ENERGY STAR Dishwashers	Change to ES standard	7/19/2023
2.6.5	ENERGY STAR Windows	Change to ES standard	10/23/2023
2.2.11	ENERGY STAR® Certified Connected Thermostats	Possible change to ES standard	TBD, In progress
2.5.1	ENERGY STAR Office Equipment	Possible change to ES standard	TBD, In progress
NA	Commercial Electric Cooktops (New)	Possible new ES standard	In development (New Product)

**4.1.4 TRM Question Tracker and Guidance Memos**

The SWE maintains a central repository of clarifying TRM-related questions posted by the EDCs and EDC evaluators and responses from the SWE. In PY14, the SWE developed and shared a database of the clarifying questions submitted by EDCs that have been asked in Phase IV. This database covers questions surrounding the 2021 TRM and IMP measures and the corresponding SWE guidance. This was developed and shared with all EDC and EDC evaluators to ensure

<sup>49</sup> The SWE’s estimates of projected MWh savings by measure come from the EDCs’ Phase IV EE&C Plans

<sup>50</sup> In addition, the SWE has learned a new, final federal rule for air purifiers has been issued by the U.S. DOE (TRM measure 2.4.12) and goes into effect Jan 1, 2024. The SWE will issue an updated guidance memo for PY16 for air purifiers. <https://www.energy.gov/sites/default/files/2023-03/air-cleaners-ecs-dfr.pdf>

awareness of all questions asked about a given measure, and the SWE response to those questions. The SWE addressed five questions about TRM algorithms and protocols during PY14. In some cases, the SWE issued guidance memos to provide more detailed guidance on a TRM-related topic. The SWE issued three guidance memos during PY14 on the following topics:

- Guidance on the eligibility for central air conditioning 2021 TRM Section 2.2.1: High Efficiency Equipment: ASHP, CAC, GSHP, PTAC, PTHP. CACs will be eligible for the duration of Phase IV, despite the proposed sunseting of CACs from the ENERGY STAR specification V6.1.
- Guidance on incremental cost assumptions and methodologies used for annual report TRC calculations for non-residential lighting.
- Guidance on claiming verified MWh and MW savings for C&I EE&C programs that rely on regression analysis of utility meter data to claim savings.

## 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 that may indicate program issues warrant more frequent evaluations.

The SWE reviewed the revised PY14 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 PY14.

### 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 that 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 that 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<sup>51</sup> 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 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

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<sup>51</sup> 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.

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 BASELINE STUDIES

In 2023, the SWE conducted a residential baseline study and a non-residential baseline study. These end-use saturation studies examine the penetration, saturation, and fuel shares of various end-use equipment as well as building envelope characteristics that affect energy consumption. The results of the baseline studies are used to update the Pennsylvania TRM and provide key inputs for the Phase V Market Potential Study. The 2023 studies are the fourth set of Act 129 baseline assessments with prior studies conducted in 2011, 2013, and 2018. This allows for useful time-series comparisons of equipment characteristics over time.

- Residential Baseline Study Report
- Non-Residential Baseline Study Report

## 4.8 AD HOC TASKS

The SWE team's contract provides for ad hoc support for 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 PY14 as well as technical work in support of the 2026 Total Resource Cost (TRC) Test Order that was begun during PY14.

### 4.8.1 Annual Avoided Costs Review

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 Industrials<sup>52</sup> commented that EDCs should use actual experienced market prices rather than forecasted prices in annual and phase

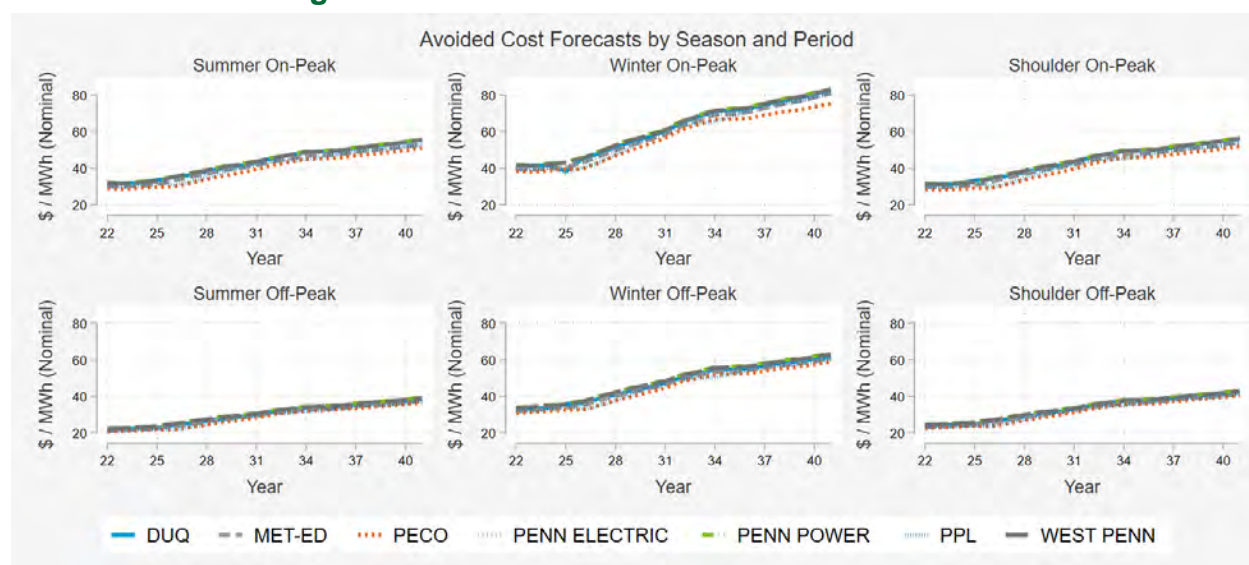
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<sup>52</sup> The Met-Ed Industrial Users Group, the Penelec Industrial Customer Alliance, the Philadelphia Area Industrial Energy Users Group, the PP&L Industrial Customer Alliance, the West Penn Power Industrial Intervenors, and the Pennsylvania Energy Consumer Alliance

reporting. PA-EEFA<sup>53</sup> comments recommended an annual review of market conditions by the SWE to assess whether an update to the avoided cost 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)<sup>54</sup> to standardize the process by which EDCs to develop avoided costs for Phase IV. A 20-year period dissected into three segments is used for the 2021 TRC Test Order, with six distinct periods per year (winter, summer, and shoulder seasons with on and off-peaks). The ACC draws upon different projections in each of the three segments to estimate avoided costs. Figure 20 shows the 20-year avoided costs forecast for Phase IV, by EDC and costing period.

**Figure 20: 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 in the 2021 TRC Test Order. In many states, the value of CO<sub>2</sub> 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 (DRIPE), 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.

<sup>53</sup> 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))

<sup>54</sup> 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>



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 PY14 (6/1/2022 – 5/31/2023) from PJM's Data Miner 2 tool.<sup>55</sup> 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.

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

The forecasted PY14 avoided cost of energy was underestimated for each EDC in each period across PY14 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 and PY14 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. Starting in PY14, average LMP remained high in summer 2022, but declined over time except in December 2022. The trend was normal for 29 out of 31 days in December, while December 23 – 24 were bitterly cold and caused loads to increase dramatically. The average LMPs on these two days were many times their normal value, which meant that the average LMP value for the month was much higher than the other winter months. Outside of December 2022, the general trend of LMP values was down and beginning to reach levels in line with the forecasted avoided costs. [Figure 21](#) displays average monthly LMP across seasons.

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<sup>55</sup> PJM Data Miner 2. Accessed June 1, 2022. <https://dataminer2.pjm.com/>

Figure 21: Average LMP by Month

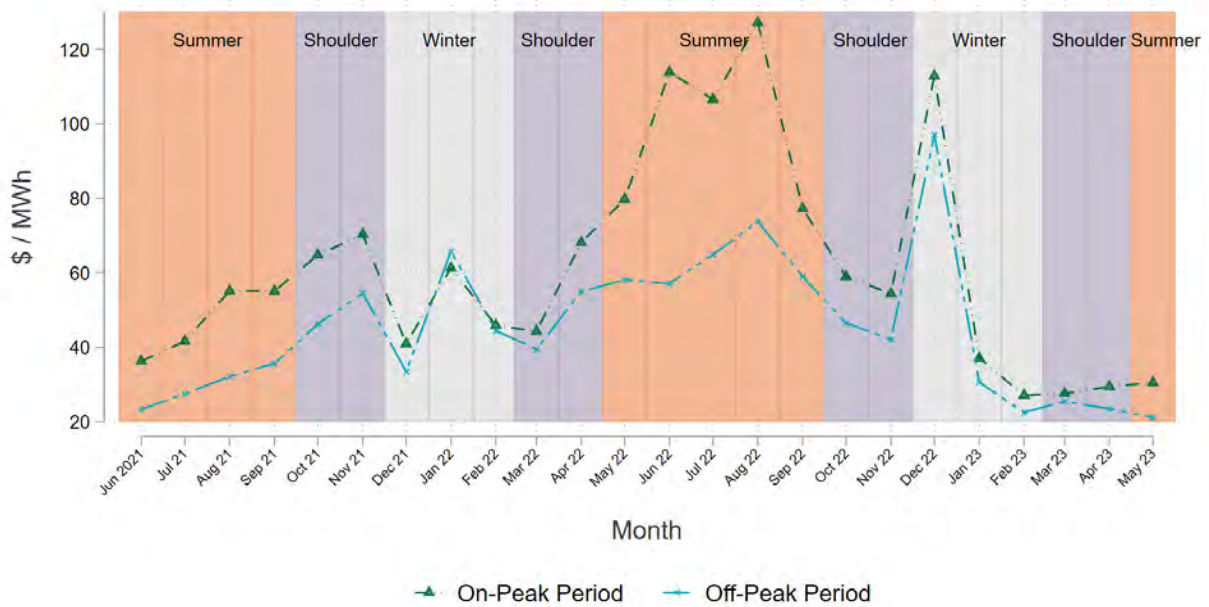


Table 64 presents the PY14 results by EDC, season, and period, including the percent difference from the forecasted avoided costs of PY14 to the real-time LMP weighted average.

Table 64: Load-Weighted Average LMPs by Season and Period for PY14

Season	Period	Forecasted Avoided Cost	Load-Weighted Average LMP	Percent Difference
Shoulder	Off-Peak	\$23.52	\$34.93	48%
	On-Peak	\$29.52	\$41.27	40%
Summer	Off-Peak	\$21.56	\$60.96	183%
	On-Peak	\$30.07	\$95.41	217%
Winter	Off-Peak	\$32.41	\$70.50	118%
	On-Peak	\$39.54	\$62.84	59%

PJM conducted the Base Residual Auction (BRA) for the 2022/2023 (PY14), 2023/2024 (PY15) and 2024/2025 (PY16) delivery years since the EDCs developed their avoided cost forecast 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 much 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 65 compares the forecasted and actual zoning clearing price for generation capacity, by EDC.



**Table 65: Forecast versus Actual Generation Capacity (\$/kW-year)**

EDC	PY14 ACC	PY14 BRA	PY15 ACC	PY15 BRA	PY16 ACC	PY16 BRA
PECO	\$60.73	\$35.79	\$61.94	\$18.10	\$63.18	\$20.13
PPL	\$41.70	\$35.19	\$42.54	\$18.14	\$43.39	\$18.13
Duquesne Light	\$40.16	\$18.28	\$40.96	\$12.48	\$41.78	\$10.58
FE: Met-Ed	\$53.16	\$35.19	\$54.23	\$18.14	\$55.31	\$18.13
FE: Penelec	\$53.16	\$35.19	\$53.23	\$18.14	\$55.31	\$18.13
FE: Penn Power	\$65.06	\$18.28	\$66.36	\$12.48	\$67.69	\$10.58
FE: West Penn	\$53.16	\$18.28	\$54.23	\$12.48	\$55.31	\$10.58

Phase IV avoided costs were developed at the height of a global pandemic when wholesale prices were at historic lows. In the three years since, wholesale prices swung widely in the opposite direction, creating a gap between forecast and actual marginal energy costs during PY13 and much of PY14. Towards the end of PY14 though, actual avoided costs experienced by the PA EDCs returned around projected levels. There is an amount of uncertainty expected for any long-term forecast as seen with the high LMP values for much of PY13 and PY14. The Phase IV avoided cost of energy forecast for PY14 proved to underestimate the value of saved energy relative to actual market conditions for most of the year. The practical implication of this outcome is that PY14 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 cost of demand forecast for PY14, PY15, and PY16 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 that nearly balanced each other out in our sensitivity analysis.

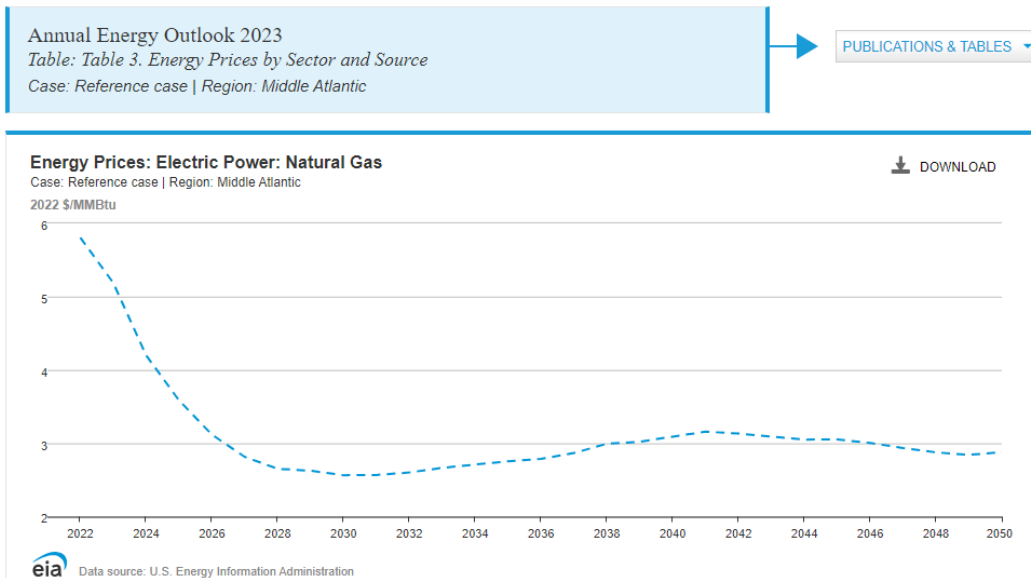
Despite the magnitude of differences in short-term forecasted and actual avoided energy costs, it is important to remember that avoided cost forecast is grounded in historic data. In [Figure 22 Henry Hub Natural Gas Spot Prices](#) shows the Phase IV avoided cost projections were made at nearly the lowest price level during global pandemic. After reaching their peak during summer 2022, prices began to gradually recede and eventually stabilized at approximately 2.5 dollars per MMBTU by the end of PY14.

**Figure 22: Henry Hub Natural Gas Spot Price**



Energy efficiency is a long-term investment, and the forecast is a long-term projection. Figure 23 shows the US Energy Information Administration’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 2026 – 2027. If the declining trend of Henry Hub Natural Gas Spot Price continues and the projected trend is accurate, the Phase IV avoided cost forecasts should continue to become increasingly in line with actual market conditions.

**Figure 23: Energy Information Administration Gas Price Projections (\$2022)**



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 20, the Phase IV avoided cost 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.

#### 4.8.2 Summary of Alternative Energy Portfolio Standards Costs

Per the 2021 TRC Test Order,<sup>56</sup> 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, despite a large percentage increase in the AEPS values, the SWE does not recommend any mid-cycle update to the AEPS costs as they remain a 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 Act.<sup>57</sup> The AECs are categorized into three tiers: Non-Solar Tier I, Tier II and Solar, with their eligible credit sources listed in Table 66.

**Table 66: 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.

<sup>56</sup> 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>

<sup>57</sup> See 73 P.S. §§ 1648.1–1648.8 and 66 Pa. C.S. § 2814. See also 52 Pa. Code §§ 75.1–75.72.

In the PA Act 129 Phase IV Avoided Energy and Capacity Cost Calculator,<sup>58</sup> 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 is constructed. The procedure for producing the weighted average price is shown in [Table 67](#), which shows the AEPS costs currently in the Act 129 Phase IV TRC Test ACC.

**Table 67: 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 Spectron<sup>59</sup> 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 historic<sup>60</sup> 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 67](#). The results are shown in [Table 68](#).

<sup>58</sup> <https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/total-resource-cost-test/>

<sup>59</sup> 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>.

<sup>60</sup> See AEPS Act Historical Pricing reports at <https://www.pennaeps.com/reports/>.

**Table 68: 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
2023	\$44.00	\$24.30	\$12.00	\$3.36	\$18.18
<b>2023 (Current)</b>	<b>\$37.00</b>	<b>\$33.50</b>	<b>\$37.13</b>	<b>\$6.58</b>	<b>\$35.55</b>
<b>2021 TRC Test Order</b>	<b>\$55.00</b>	<b>\$6.30</b>	<b>\$0.55</b>	<b>\$0.83</b>	<b>\$4.51</b>

Using current Marex Spectron prices, the weighted average cost of the AECs is \$35.55 per credit, or \$6.58 per MWh. Compared to the values originally included in the ACC, the current value of credits is up by almost a factor of eight. AEPS credit values originally made up about 3% of the avoided cost of energy and now it would be approximately 23%. While this is a large percentage increase, it is still a small portion of the overall avoided cost values.

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 show a continued trend toward increased AEPS costs over the last five years. This increase has roots in policy changes that originated in the amending of the AEPS Act by Act 40<sup>61</sup> of 2017 and Act 114<sup>62</sup> of 2020. Act 40 requires that

<sup>61</sup> See PA Act 40 of 2017, Section 2804

<sup>62</sup> See PA Act 114 of 2020, Section 1799.10-E

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.

### 4.8.3 Technical Work in Support of the 2026 TRC Test Order

During PY14 the SWE began technical work in support of the 2026 Total Resource Cost (TRC) Test Order. The technical work covered three key topics.

#### 4.8.3.1 Avoided Cost of Transmission and Distribution Capacity Study

In the TRC Test, three distinct benefit streams are applied to peak demand reductions to calculate the avoided capacity benefits of EE&C programs.

1. Avoided cost of generation capacity
2. Avoided cost of transmission capacity
3. Avoided cost of distribution capacity

The avoided cost of generation capacity comes directly from PJM's forward capacity auction process for the region and is straightforward to collect. The reduced capital investment required for transmission and distribution (T&D) capacity associated with a reduction in peak demand is more complex and does not come from PJM planning parameters. The 2021 TRC Test Order directed the Phase IV SWE to develop a new methodology for the avoided cost of T&D capacity in Pennsylvania.

*"We will direct the Phase IV SWE, in collaboration with EDC system planners, to develop a more granular alternative methodology for the avoided cost of T&D capacity in Pennsylvania. The status quo calculation methodology is predicated on some amount of overall growth in the peak demand forecast. We understand that a methodological change will be inevitable as some EDCs begin to experience flat or declining peak demand forecasts but still experience growth-related capital expenditures in certain areas of their systems."<sup>63</sup>*

The goal of the study is to provide valuable information regarding the timing of local peaking conditions and constraints and inform decisions about capacity valuation in a potential Phase V.

#### 4.8.3.2 Demand Reduction Induced Pricing Effects (DRIPE)

DRIPE, or wholesale price suppression impacts, are not included as a TRC benefit in the 2021 TRC Test Order. However, in the 2021 TRC Test Order, the PUC stated that it would direct the SWE to monitor the issue. The Phase IV SWE team recently completed an analysis of capacity DRIPE and is working on a similar analysis of energy DRIPE. Once the two DRIPE analyses are

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<sup>63</sup> 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. Pages 49-50. <https://www.puc.pa.gov/pcdocs/1648126.docx>

complete, the SWE team will review with the TUS Staff and finalize the Commission's proposed handling of DRIPE in the 2026 TRC Test Tentative Order.

#### **4.8.3.3 Impact of Act 129 Income-Eligible Programs on Arrearages and Collections**

In the Phase IV Implementation Order, stakeholders pointed out that the arrearages and uncollected debt were a cost of supplying electricity and suggested the PUC quantify potential reductions of these costs as benefits in the TRC Test for income-eligible programs.

Utilities can realize financial savings from their income-eligible energy-efficiency programs. Energy-efficient technologies installed by energy-efficiency programs often result in reduced energy bills for participants, which can decrease the likelihood that customers experience difficulties paying their utility bills. In turn, utilities may realize reduced costs associated with arrearages and late payments, uncollectible bills and bad debt write-offs, service terminations and reconnections, bill-related customer calls, and the bill collections process.

The study will seek to quantify and monetize EDC financial savings through an analysis of EDC data on customer arrearages, shutoffs, and collections actions for income-eligible program participants and eligible non-participants. To the extent that data is available from the EDC, the study will include the following types of financial savings:

- Reduced arrearage carrying cost
- Reduced bad debt write-offs
- Fewer shutoffs and reconnects
- Fewer notices
- Fewer collections calls

## Section 5 PY14 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

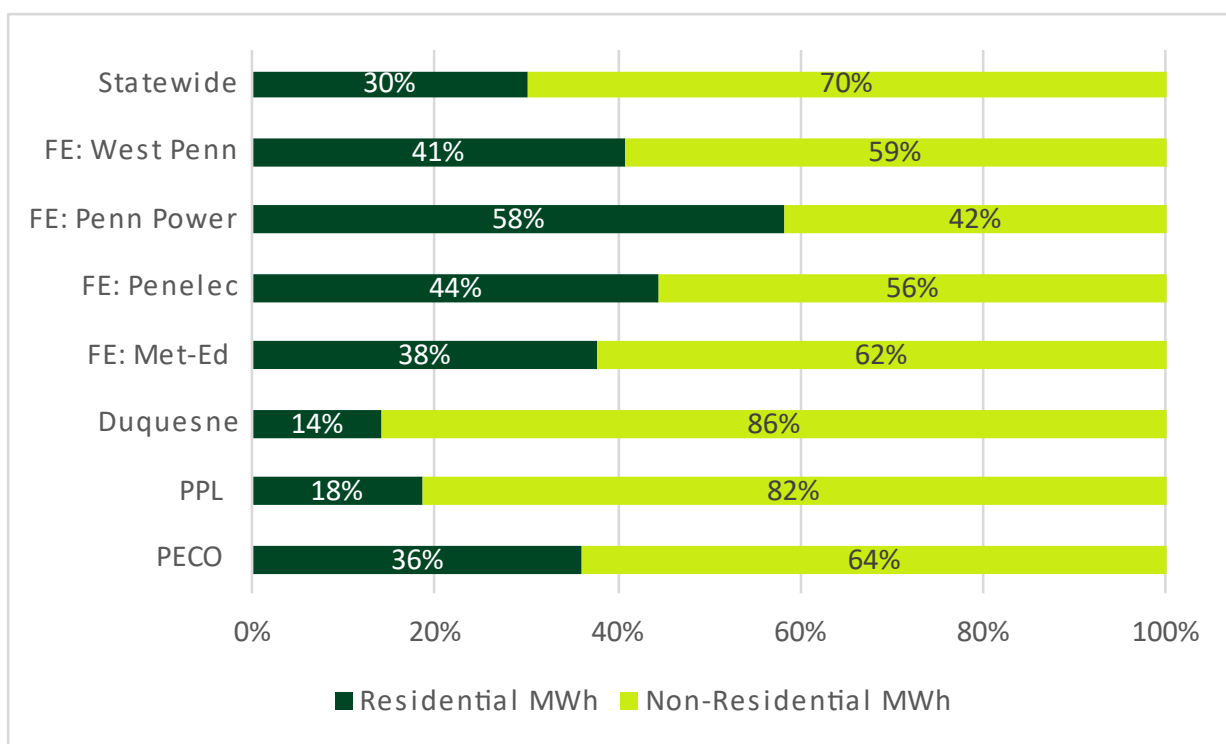
- Progress toward the individual EDC Phase IV compliance targets to date in verified gross energy savings ranged from 25% (Penelec and West Penn Power) to 49% (Duquesne Light). Including carryover savings from Phase III, total progress toward Phase IV targets ranged from 47% (PECO) to 78% (Penn Power).
- Progress toward the LI target ranged from 30% (PPL) to 55% (PECO) in P4TD verified gross savings and 41% (Duquesne Light) to 87% (Penelec and 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 22% (West Penn Power) to 53% (Duquesne Light).
- There is an interesting trend emerging with respect to Phase III carryover and Phase IV peak demand savings goal attainment. PPL and the FirstEnergy EDCs started Phase IV with the most carryover savings but have made the least progress towards their Phase IV peak demand reduction target. While these EDCs are well-positioned on their Phase IV consumption reduction goals due to the carryover, they will need to acquire peak demand savings at an increased pace during PY15 – PY17 to meet the peak demand compliance goal. PECO and Duquesne Light started Phase IV with the least amount of carryover and have made the most progress toward their Phase IV peak demand reduction goals.
- The EDCs intend to nominate less than one-fourth of the peak demand savings acquired in PY14 to the PJM Forward Capacity Market. For the second straight year Duquesne Light chose not to nominate any of the capacity savings from its EE programs into the FCM. PPL only intends to nominate approximately 3%. EDCs retaining the capacity rights, but not nominating the capacity is the worst possible outcome from a policy standpoint. Not only do FCM proceeds not flow back to the rate classes that contributed the savings, but CSPs and customers cannot nominate the capacity either. This means that the financial benefits to participants and contractors are not realized and the price suppression effects – which accrue to all ratepayers – also do not occur. The Commission will need to make a difficult decision with respect to FCM participation in a potential Phase V. If capacity rights are retained by the EDCs, it is imperative that the peak demand savings are not stranded due to a lack of action by the EDCs.
- Labor shortages and supply chain issues continued to affect project timelines and costs in PY14. Staffing challenges in the trades led to program-supported equipment from



midstream delivery channels sitting in storage at participating facilities awaiting installation. In other cases, projects were delayed due to atypically long lead times for equipment components. The EDCs and their CSPs are in a unique position to help mitigate these issues for customers and offer services above and beyond simple financial incentives.

- Statewide energy savings continued to shift away from the residential sectors and into the non-residential sectors in PY14 (Figure 24). Non-residential savings accounted for 70% of statewide MWh savings in PY14, compared to 66% in PY13 and 49% of savings in Phase III. Non-residential lighting accounted for the bulk of the PY14 savings (57% statewide). Penn Power was the only EDC that acquired more residential MWh savings in PY14 than non-residential savings.

**Figure 24: Share of Residential and Non-Residential PY14 Verified Gross MWh Savings by EDC and Statewide**



- Residential Lighting, while still a top offering in Phase IV, continued to account for a smaller share of portfolio savings compared to Phase III. In PY14, Residential Lighting accounted for only 9% of statewide MWh savings while it accounted for 30% of statewide MWh during Phase III. Residential Lighting will likely decline further in PY15 as point-of-sale and downstream lighting measures that meet the U.S. Department of Energy’s (DOE) definitions of General Service Lamps (GSLs) will no longer be eligible (but direct install and kit-delivered lighting measures will still be eligible).

- 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 SWE that 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 thus far in Phase IV. PECO, FirstEnergy, and Duquesne Light moved to a rotating model where legacy waves are paused and then restarted once the assumed persistence has declined. HER programs contributed more MWh in PY14 than PY13, but the share of total verified gross energy savings was approximately 6% in each year. In Phase III of Act 129, HER programs accounted for between 12% and 20% of gross statewide MWh savings annually.

### 5.1.2 Evaluation

The Pennsylvania EDCs and their evaluation contractors conducted a significant volume of verification and program design research in PY14. 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 PY14. The accounting method for HER programs changed in Phase IV with the introduction of a HER protocol in the 2021 TRM and the transition to a multi-year measure life perspective. Under the Phase IV accounting method, verified gross savings from prior program years are inputs to the PY14 incremental annual impact calculation for legacy cohorts. PECO, Duquesne Light, and Penelec all delivered HERs to legacy cohorts in PY14 and successfully followed the 2021 TRM guidelines for estimating the persistent impacts of previous years of HER exposure. The EDC evaluation contractors also used data-driven approaches to estimate the peak demand savings from HER programs during summer 2022.
- In PY13, the SWE conducted its first annual comparison of market conditions to the Phase IV avoided cost forecast and found that the wholesale market values of avoided energy were much higher than forecasted but recommended against making updates to the forecast. In PY14, the SWE found that the actual wholesale energy costs began to fall back in line with EE&C Plan projections and still does not recommend any mid-phase updates.
- Avoided Alternative Energy Portfolio Standards (AEPS) compliance costs are a component of the value of avoided energy in the TRC Test. Since the Commission issued its 2021 TRC Test Order in 2019, the value of AEPS credits have increased 800%. While the increased value of AEPS credits is large on a relative basis, they are a small component of the overall avoided cost of electric energy, so the SWE does not recommend a mid-phase update of the avoided costs to account for changing AEPS credit value.
- 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 69](#) provides an overview of the PY14 process evaluations conducted by each EDC.

**Table 69: PY14 Process Evaluations by EDC: Percent of Participating Customers Satisfied**

EDC	# of PY14 Programs & Components Evaluated	% of Satisfied Residential & LI Customers*	% of Satisfied C&I Customers*
PECO	10	94%	95%
PPL	11	85%	88%
Duquesne Light	7	79%	96%
FirstEnergy EDCs**	11	76%	85%

\* Average across all programs for which participant surveys were conducted. The average is weighted by the number of PY14 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 PY14, and comparison of EDC and SWE verified savings.

### A.1 EDC PERFORMANCE AGAINST PORTFOLIO TARGETS

**Table 70: Summary of PY14 Verified Energy Savings and Phase IV Portfolio Targets<sup>1</sup>**

EDC	Phase IV Compliance Target (MWh/yr)		PY14 Verified Gross Savings (MWh.yr)	
	Overall	LI	Overall	LI
PECO	1,380,837	80,089	301,855	28,718
PPL	1,250,157	72,509	256,971	12,872
Duquesne Light	348,126	18,566	122,634	3,542
FE: Met-Ed	463,215	26,866	85,756	4,462
FE: Penelec	437,676	25,385	72,345	5,141
FE: Penn Power	128,909	7,477	18,284	1,160
FE: West Penn Power	504,951	29,287	80,171	6,940
<b>Statewide</b>	<b>4,513,871</b>	<b>260,179</b>	<b>938,016</b>	<b>62,836</b>

<sup>1</sup>Totals may not equal sum of column or row due to rounding.

**Table 71: Comparison of EDC and SWE PY14 Verified Energy Savings<sup>1</sup>**

EDC	PY14 EDC Verified Gross Savings (MWh/yr)		PY14 SWE Verified Gross Savings (MWh.yr)	
	Overall	LI	Overall	LI
PECO	302,048	28,847	301,855	28,718
PPL	256,971	12,872	256,971	12,872
Duquesne Light	122,634	3,542	122,634	3,542
FE: Met-Ed	85,756	4,462	85,756	4,462
FE: Penelec	72,345	5,141	72,345	5,141
FE: Penn Power	18,284	1,160	18,284	1,160
FE: West Penn Power	80,171	6,940	80,171	6,940
<b>Statewide</b>	<b>938,209</b>	<b>62,966</b>	<b>938,016</b>	<b>62,836</b>

<sup>1</sup>Totals may not equal sum of column or row due to rounding.

**Table 72: Summary of Phase to Date Verified Energy Savings and Phase IV Portfolio Targets<sup>1</sup>**

EDC	Phase IV Compliance Target (MWh/yr)		Phase IV Verified Gross Savings (MWh/yr)	
	Overall	LI	Overall	LI
PECO	1,380,837	80,089	545,045	43,865
PPL	1,250,157	72,509	430,558	22,022
Duquesne Light	348,126	18,566	171,735	7,553
FE: Met-Ed	463,215	26,866	132,211	8,284
FE: Penelec	437,676	25,385	108,366	11,529
FE: Penn Power	128,909	7,477	34,218	2,996
FE: West Penn Power	504,951	29,287	123,808	13,914
<b>Statewide</b>	<b>4,513,871</b>	<b>260,179</b>	<b>1,545,943</b>	<b>110,163</b>

<sup>1</sup>Totals may not equal sum of column or row due to rounding.

**Table 73: Summary of PY14 Verified Peak Demand Savings and Phase IV Portfolio Targets<sup>1</sup>**

EDC	Phase IV Compliance Target (MW/yr)	PY14 SWE Verified (MW/yr)
PECO	256	55.66
PPL	229	43.01
Duquesne Light	62	23.57
FE: Met-Ed	76	13.79
FE: Penelec	80	12.33
FE: Penn Power	20	3.55
FE: West Penn Power	86	12.71
<b>Statewide</b>	<b>809</b>	<b>164.62</b>

<sup>1</sup>Totals may not equal sum of column or row due to rounding.

**Table 74: Comparison of EDC and SWE PY14 Verified Peak Demand Savings<sup>1</sup>**

EDC	PY14 EDC Verified (MW/yr)	PY14 SWE Verified (MW/yr)
PECO	55.66	55.66
PPL	43.01	43.01
Duquesne Light	23.57	23.57
FE: Met-Ed	13.79	13.79
FE: Penelec	12.33	12.33
FE: Penn Power	3.55	3.55
FE: West Penn Power	12.71	12.71
<b>Statewide</b>	<b>164.62</b>	<b>164.62</b>

<sup>1</sup>Totals may not equal sum of column or row due to rounding.

**Table 75: Summary of Phase to Date Verified Peak Demand Savings and Phase IV Portfolio Targets<sup>1</sup>**

EDC	Phase IV Compliance Target (MW/yr)	Phase IV SWE Verified (MW/yr)
PECO	256	97.77
PPL	229	70.22
Duquesne Light	62	33.02
FE: Met-Ed	76	20.89
FE: Penelec	80	19.27
FE: Penn Power	20	5.65
FE: West Penn Power	86	18.57
<b>Statewide</b>	<b>809</b>	<b>265.39</b>

<sup>1</sup>Totals 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.<sup>64</sup> 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 76](#) reports the required minimum proportions and results of the SWE’s verification analysis.

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<sup>64</sup> Pennsylvania Public Utility Commission, Energy Efficiency and Conservation Program Implementation Order, at Docket No. M-2020-3015228, (Phase IV Implementation Order), entered June 18, 2020.  
<https://www.puc.pa.gov/pcdocs/1666981.docx>

**Table 76: LI Measure Proportionality Targets and SWE Verification Results**

EDC	Proportionate Number of Measures, Target	PY14 Proportionate Number of Measures, Reported	PY14 Proportionate Number of Measures, SWE Verified
PECO	8.80%	29.1%	32.5%
PPL	9.95%	22.2%	22.2%
Duquesne Light	8.40%	43.1%	44.6%
FE: Met-Ed	8.79%	17.5%	17.5%
FE: Penelec	10.23%	17.5%	17.5%
FE: Penn Power	10.64%	17.5%	17.5%
FE: West Penn Power	8.79%	17.5%	17.5%

### A.2.1 Matching Measures to TRM Algorithms Subheading

EDCs reported compliance with the proportionate number of measures targeted in their individual PY14 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.”<sup>65</sup>

The SWE matched measures as reported by the EDCs to TRM algorithm sections. Doing so identified a few cases in which multiple EDC-reported measures should be considered a single measure because they corresponded with a single algorithm section, or measures should be excluded because they do not result in energy savings.<sup>66</sup> 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

<sup>65</sup> 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](https://www.puc.pa.gov/media/1584/swe-phaseiv_evaluation_framework071621.pdf)

<sup>66</sup> 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/pccdocs/1692531.docx>

is a straightforward algorithm that calculates the difference between baseline and new wattage regardless of bulb type and location and should not be split out by bulb type and location.

- **“Most Efficient” Appliances:** 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, and should not be split out into multiple measures.
- **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). While the TRM does not have different algorithm sections with separate headings for freezers and refrigerators, the inputs for each measure are substantially different and the analysis treats them as four separate measures.
- **Double Counting Measures:** 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) are counted twice in the denominator of the compliance equation.

### A.2.3 Results

Every EDC complied with the LI proportionality requirement. The SWE found no errors with PPL’s and FirstEnergy’s analysis and very minor and isolated errors for PECO and Duquesne Light, with the SWE finding slightly higher levels of compliance for both PECO and Duquesne Light.

#### A.2.3.1 PECO

PECO reported that 29.4% of its 85 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, 32.5% qualify as LI measures. The increase in compliance is largely attributable to PECO counting the same TRM measure multiple times (for example, counting variations of residential lighting (2.1.1) and commercial lighting (3.1.1) multiple times. Matching measures to the TRM and double counting the proper measures resulted in 77 rather than 85 total measures and the same number of low-income measures, 25.

#### A.2.3.2 PPL

PPL reported that 22.2% of its 72 conservation measures qualified as LI measures, which surpasses its 8.8% requirement. The SWE concurs with PPL’s assessment.



### **A.2.3.3 Duquesne Light**

Duquesne Light reported that 43.1% of its 72 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, there were 65 total conservation measures, 29 of which qualified as LI measures, or 44.6%.

### **A.2.3.4 FirstEnergy Companies**

The FirstEnergy EDCs were all assessed as a group since their measure counts are identical, and the SWE concurs with FirstEnergy's assessment that 17.5% of its conservation measures qualified as LI measures. There were no changes in the measure offerings from PY13 to PY14 and the FirstEnergy companies' analysis matched the SWE's analysis from PY13.

## **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 PY14 Audit Detail

### B.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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. Minor revisions included updating efficient lighting equipment power draw to align with DLC 5.1, applying site collected M&V data to revise HOU and CF values, and applying an evaluator developed regression model in place of raw trend data.
- PECO's Phase IV EM&V Plan calls for an intermediate savings quantity between reported and verified gross savings referred to as "adjusted database savings." The ratio of verified savings to "adjusted database savings" is referred to as the "verification ratio". The adjusted database savings are computed for every program component annually, even in program years when no impact evaluation was conducted. The PY13 SWE report highlighted several issues with this multi-step process, particularly for some residential and income-eligible components, and requested improved documentation and file organization for PY14. While there were some improvements to the PY14 process, ultimately our inability to replicate verified savings will require an update to the annual evaluation plan for certain Residential and Income-Eligible program components because the SWE is not confident enough in the PY14 verification ratios to allow them to be applied prospectively.
- PECO had the lowest portfolio TRC ratio of the seven EDCs subject to Act 129 in PY 13 and PY14. The marginal portfolio result was partially driven by assumptions in the non-residential program.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PECO's PY14 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.
- PECO had five active behavioral HER cohorts in PY14 with approximately 435,000 treated households. One of the cohorts consists of low-income households. On average, HER recipients saved approximately 80 kWh, or 0.9% of their annual consumption, in PY14. PECO's 2015 cohort (Wave 3) was mature enough to require persistence calculations to separate incremental savings from persisting savings from prior exposure. The SWE was able to replicate the verified energy and demand savings values and found that HER impact evaluation was entirely consistent with their proposed and approved EM&V plans and the Phase IV HER account framework. The SWE team does not propose any revisions to the PY14 methods or results.
- The SWE's audit uncovered some confusion in the evaluation of PECO's Non-Residential Comprehensive Projects Pilot projects. These projects accounted for approximately 4%

of the Downstream component's PY14 MWh savings but were inadvertently excluded from the sample frame. Pilot projects were also excluded from the tracking database analysis runs. Ultimately, realization rates from the appropriate strata were applied to Pilot component projects so the overall program savings should be unbiased assuming the pilot projects are not materially different from the broader Downstream component. Going forward, Pilot projects should be eligible for sampling if they are going to be claimed as part of the Downstream component.

- The PY14 impact evaluation of PECO's Long-Term Savings component failed to meet the  $\pm 15\%$  relative precision requirement in the Phase IV Evaluation Framework on its own. Despite being listed as a separate component in PECO's annual report, Long-Term Savings and Income Eligible Single-Family are evaluated together. They are only listed separately for administrative reasons. When evaluated as a single program, the  $\pm 15\%$  relative precision requirement is met.
- The SWE's audit of residential components found that Guidehouse's incomplete annual data request response and complex, multi-stage savings verification process made it difficult for the SWE to replicate due to a number of factors, including the following: lack of syntax files used to calculate savings, poorly documented inputs used to calculate savings, poorly documented and at times ad hoc analytical decisions (for example, not using available survey results from the appliance recycling evaluation), lack of consistent unique identifiers across files and analyses, and problems with version control of files provided to the SWE for review.
- The SWE's review of verified savings for residential components, which include income-eligible programs, found that, overall, the adjusted database reviews followed proper TRM protocols. The SWE found errors with a few individual measures that largely offset – the cumulative impact was that verified MWh savings were overstated by less than 0.1%. However, the SWE had challenges with verifying the survey analysis and roll-up steps of the verified savings analysis.
- Project documentation reviews for 16 projects across five non-residential program components found a single inconsistency between the reported savings in the files and the project database. The more significant issue was the SBDI Program where none of the three reviewed projects contained enough information for the SWE to determine if the savings were calculated correctly.
- The SWE conducted a project file review for a sample of PECO's residential and income-eligible components in PY14. 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 PY14 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, submitted a redline version of their PY14 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, Guidehouse submitted several memos detailing their sampling approach for program components selected for impact, process and NTG evaluations in PY14.

As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. [Table 77](#) shows which PECO programs produced verified impacts in PY14, and which used historic realizations rates from PY13.

**Table 77: PY14 PECO Program Impact Evaluation Summary**

Program	Component	Delivery Channel	PY14 Impacts
Residential	Rebates and Marketplace	Downstream	Verified for thermostats, otherwise PY13 verification ratios
		Trade ally and Distributor Network	PY13 verification ratios
		Point of Purchase	PY13 verification ratios
		Marketplace	PY13 verification ratios
	Appliance Recycling	N/A	Verified
	In-Home Assessments	N/A	Verified
	New Construction	N/A	PY13 verification ratios
Residential HER	Multifamily	N/A	Verified
	HER	N/A	Verified
Income-Eligible	Single-Family	All	Verified
	Appliance Recycling	N/A	Verified
	Long-Term Savings	All	Verified
Income-Eligible HER	HER	N/A	Verified
Non-Residential	Downstream Rebates	N/A	Verified
	Midstream Rebates	N/A	Verified
	New Construction	N/A	PY13 verification ratios
	Small Business Direct Install	N/a	Verified

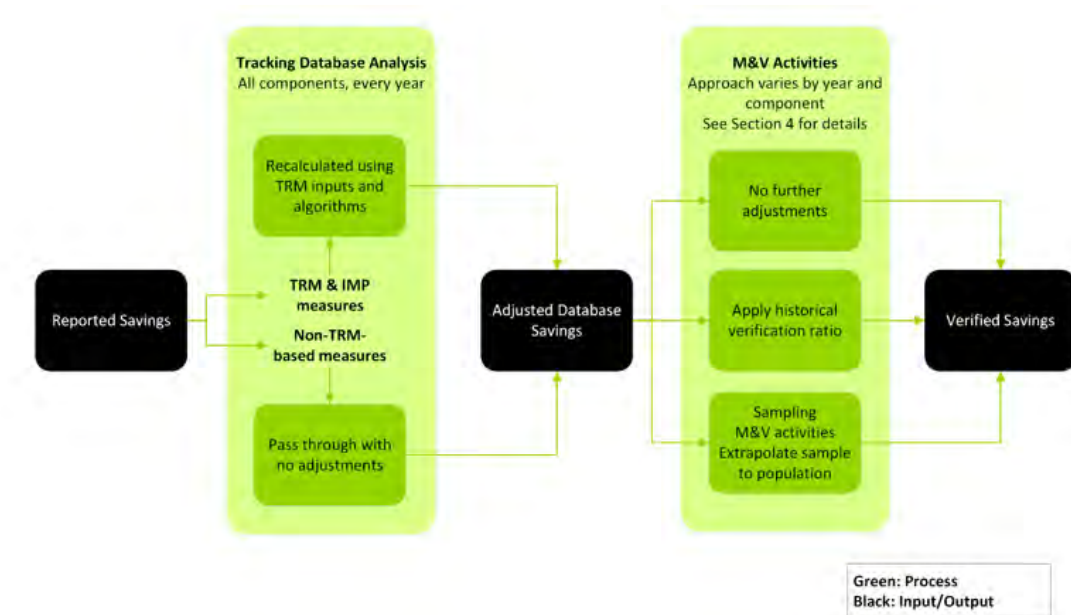
In addition to the evaluation plans, the SWE also reviewed and provided comments on draft surveys and interview guides for the applicable components.

### B.3 SAMPLE DESIGN REVIEW

Of the seven EDCs subject to Act 129, PECO had the most complex sample design and expansion process in PY14. 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 25 documents the two-step process by which Guidehouse verified PY14 impacts, taken from the PECO Phase IV EM&V plan.

**Figure 25: Phase IV Savings Verification Process**



In PY14, 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 Multifamily component saw an approximately 35% 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 PY14, the data provided to the SWE had these fields spread across different files without solid unique identifiers for merging.

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 PY14 Annual Report by component. Samples were devised to meet the 85/15 sampling requirement for each program component.

The Pilot initiative in the Non-Residential Downstream component was erroneously left out of the sampling pool and the subsequent sampling rollup file used to recreate calculations. This initiative was assigned the same realization rate as the Downstream component overall. While the initiative should have been in the sampling pool, there is no reason to believe that it is inherently different from the other initiatives that make up the component. In the future all eligible initiatives should be included in the pool for sampling to ensure that the sample is representative of the population overall.

Table 78 shows the relative precision of the energy savings for each component evaluated in PY14. The SWE reproduced the precision values for energy with the project-level sample dispositions furnished in response to the SWE annual data request. Note that program components that relied on historic realization rates have been omitted. Behavioral programs, which have no uncertainty associated with sampling, have also been omitted.

**Table 78: Relative Precision of PY14 Impacts by Component at the 85% Confidence Level**

Program	Component	Relative Precision (Energy)	Relative Precision (Demand)
Residential	Rebates and Marketplace	0%	0%
	Appliance Recycling	2%	2%
	In-Home Assessment	6%	7%
	Multifamily	11%	16%
Income Eligible	Single-Family	6%	7%
	Long-Term Savings	88%	79%
Non-Residential	Appliance Recycling	2%	2%
	Downstream	9%	12%
	Midstream	12%	9%
	Small Business Direct Install	6%	8%

The SWE team was able to largely replicate the reported relative precision values for energy and demand in the table above. The Long-Term Savings component, however, failed to meet the ±15% relative precision requirement in the Phase IV Evaluation Framework on its own. Despite being listed as a separate component in PECO’s annual report, Long-Term Savings and Income Eligible Single-Family are actually evaluated together. They are only listed separately for

administrative reasons. When evaluated as a single program, the  $\pm 15\%$  relative precision requirement is met.

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 PY14 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 standing 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 79 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in PECO’s PY14 Annual Report and “No” otherwise. The tracking data supports the Annual Report for all programs.

**Table 79: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Energy Efficiency Program	58,515	58,515	Yes*
Residential Income-Eligible Program	21,369	21,369	Yes*
Non-Residential Energy Efficiency Program	187,388	187,388	Yes
<b>Portfolio Total</b>	<b>267,272</b>	<b>267,272</b>	<b>Yes*</b>

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

Table 80 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 PY14 Annual Report value exactly for all programs.



**Table 80: MW Savings by Program**

Program	Annual Report MW	Tracking Data MW	Match
Residential Energy Efficiency Program	10.34	10.34	Yes*
Residential Income-Eligible Program	2.35	2.35	Yes*
Non-Residential Energy Efficiency Program	36.38	36.38	Yes
<b>Portfolio Total</b>	<b>49.07</b>	<b>49.07</b>	<b>Yes*</b>

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

Table 81 shows participation counts for each of PECO's programs. For all three programs, the SWE calculated directionally similar counts via the tracking data. The portfolio totals, though not exactly equal, line up well: 44,495 in the PECO PY14 Annual Report and 45,572 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with PECO and their evaluation contractor to understand the Phase IV business rules around counting participants for different program components.

**Table 81: Participation by Program**

Program	Annual Report Participants	Tracking Data Participants	Match
Residential Energy Efficiency Program	32,277	31,387	No*
Residential Income-Eligible Program	6,588	8,699	No*
Non-Residential Energy Efficiency Program	5,630	5,486	No
<b>Portfolio Total</b>	<b>44,495</b>	<b>45,572</b>	<b>No*</b>

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

Finally, Table 82 summarizes the SWE's ex ante findings regarding incentive dollars. The SWE was able to replicate incentives shown in PECO's PY14 Annual Report for all programs after including Giveaway Costs as incentives.

**Table 82: Incentives by Program (\$1,000)**

Program	Annual Report Incentives	Tracking Data Incentives	Match
Residential Energy Efficiency Program	\$7,971	\$7,971	Yes
Residential Income-Eligible Program	\$7,771	\$7,771	Yes
Non-Residential Energy Efficiency Program	\$33,987	\$33,987	Yes
<b>Portfolio Total</b>	<b>\$49,729</b>	<b>\$49,729</b>	<b>Yes</b>

## 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 PY14 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 83 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 83: 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? <sup>1</sup>
Residential EE Program	In-Home Assessment	12	✓	✓	✓	✓
Residential EE Program	Rebates and Marketplace	8	✓	✓	✓	✓
Residential EE Program	Appliance Recycling	8	✓	✓	✓	✓
Residential EE Program	Residential New Construction	16	✓	✓	✓	✓
Residential EE Program	Multifamily	8	✓	✓	✓	✓
Income-Eligible EE Program	Single-Family Income Eligible	12	✓	✓	✓	✓
Income-Eligible EE Program	Appliance Recycling	8	✓	✓	✓	✓
Income-Eligible EE Program	Long-Term Savings	0	-	-	-	-

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? <sup>1</sup>
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<sup>1</sup> 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 project file documentation that was provided for the In-Home Assessment solution included reports containing energy assessments for customers who specified home address, wattage, information about new equipment installed. The SWE determined that project file documentation matched the tracking data for the sampled residential rebates and marketplace projects.

**Residential EE Program: Rebates and Marketplace**

The project file documentation that was provided for the rebates and marketplace solution 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. In Q3, there were ten invoices for upstream lighting, each invoice of varying amounts that ranged from 500 to 8,000 light bulbs, but the SWE was unable to clearly confirm the invoices, including dates, incentive amounts, and quantities of light bulbs to the tracking data.

**Residential and Income-Eligible EE Program: Appliance Recycling Component**

The project file documentation that was provided for the appliance recycling solution included one word document for each quarter containing screen grabs of electronic data collection, signature forms, and in some cases pictures of nameplate and appliance. The SWE notes that photos were sometimes blurry, did not include nameplates, or were generally unavailable for some of the sampled projects that were reviewed. Signature forms specified number of units, unit type, location, brand, model, color, age, size, amps, defrost setting, and driver notes. Generally, the data available in the project files matched the program tracking data, however in cases without photos some variables were not able to be confirmed.

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 a

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 no discrepancies between the tracking data and the provided REM/Rate files.

#### **Residential EE Program: Multifamily**

The project file documentation that was provided for the Income Eligible MF giveaway program included invoices that detailed incentives and quantities for equipment that matched the corresponding entries in the program tracking data. While the invoices for quantities matched the tracking data, in some cases there was missing documentation that accounted for the administrative costs.

#### **Income-Eligible EE Program: Single-Family Income Eligible**

The project file documentation that was provided for the Income Eligible EE – SFIE giveaway program included invoices that detailed incentives and quantities for equipment that matched the corresponding entries in the program tracking data. While the invoices for quantities matched the tracking data, in some cases there was missing documentation that accounted for the administrative costs.

#### **Income-Eligible EE Program: Long Term Savings**

The SWE did not review any long-term savings projects in the review of sampled projects. The SWE notes that this may have been due to these projects being included within the sampled projects for other programs.

#### **B.4.2.2 Non-Residential**

The SWE reviewed a sample of PECO's Downstream, Midstream, and Small Business Direct Install (SBDI) projects for PY14 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. The majority of the reviewed project file packages included all documentation requested and were well organized.

Table 84 presents an overview of the results of the SWE's C&I project file reviews. The SWE noted 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 84: PECO PY14 C&amp;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	LCI	4	✓	3/4	✓	✓	✓
Downstream	Muni	2	1/2	✓	1/2	✓	✓
Midstream	Midstream	4	✓	✓	-	✓	-
Downstream	SCI	3	✓	2/3	2/3	✓	1/3
Direct Install	SBS	3	✓	✓	✓	X	X

- **Large Commercial Solutions**
  - For one project, the reported kW savings from the tracker did not match the calculated kW savings in the project documentation.
- **Muni Solutions**
  - One of the two projects reviewed did not include a project summary to compare the many invoices included. It therefore was difficult for the SWE to understand the scope of the project from the invoice.
- **Small Commercial Solutions**
  - For one project, an incorrect wattage was used for the replacement fixture in the calculation workbook.
  - For a second project, occupancy sensors were purchased according to the invoice, but controls savings were not calculated in the savings calculator.
- **Small Business Direct Install Solutions**
  - None of these projects contained enough information for the SWE to determine if the savings were calculated correctly. All three project files inspected were missing documentation of the savings calculations.

## 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), Residential New Construction, and separate Home Energy Reports (HER) Income-Eligible HER programs. In addition, the SWE's audit covered the Income-Eligible Program that 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.

As was noted in Appendix B.3, Guidehouse has the most complex sample design and expansion process of any EDC that incorporates a multi-step process to reach verified savings. While the approach is fine in theory, the incomplete annual data request response made it difficult to replicate due to a number of factors, including the following: lack of syntax files used to calculate savings, poorly documented inputs used to calculate savings, poorly documented and at times ad hoc analytical decisions (for example, not using available survey results from the appliance recycling evaluation), lack of consistent unique identifiers across files and analyses, and problems with version control of files provided to the SWE for review. Because of these challenges, the SWE is not confident enough in the PY14 verification ratios for some components to allow them to be applied prospectively without either further verification by the SWE or changes to the EM&V Plan (such as leaving savings unverified until the PY16 impact evaluation is complete).

Table 85 provides a summary of the evaluation and M&V approaches used by PECO in their PY14 verified savings calculations.

**Table 85: Residential and LI Impact Evaluation Activities - PECO**

Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis	Historic Realization Rate
<b>Residential Program</b>					
Appliance Recycling	✓	-	✓	-	-
Rebates and Marketplace	✓	-	✓	-	✓
Residential In-Home Assessments	✓	-	✓	-	-
Multifamily (includes income eligible) <sup>1</sup>	✓	✓	✓	-	-
New Construction	-	-	✓	-	✓
Home Energy Report	-	-	-	✓	-
<b>Income-Eligible Program</b>					
Single-family	✓	-	✓	-	-
Appliance Recycling	✓	-	✓	-	-
Long-Term Savings	-	-	✓	-	✓

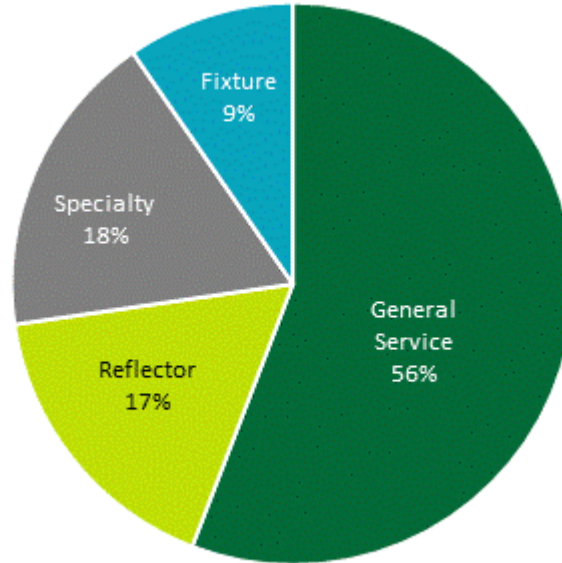
<sup>a</sup> The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.

<sup>1</sup> The Multifamily site visits include surveys

### B.5.1.1 Upstream Stream Lighting & Cross-Sector Sales

Customers purchased over 2.5 million efficient light bulbs and fixtures through PECO's PY14 upstream lighting program component within the Rebates and Marketplace component of the Residential Program. [Figure 26](#) displays the distribution of sales by product type. Over half (56%) were general service lamps, followed by reflectors (17%), specialty bulbs (18%), and fixtures (9%).

Figure 26: PECO PY14 Upstream Lighting Sales by Product Type



### **Audit Findings**

Guidehouse provided the PY14 impact analysis for PECO's upstream lighting before the PY14 PECO 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 PY14 but applied the TRM default cross-sector sales rate of 7.4%.

#### **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 adjusted database reviews followed proper TRM protocols. The SWE found errors with a few individual measures that largely offset – the cumulative impact was that verified savings were overstated by less than 0.1%. However, as noted in the previous section and detailed below, the SWE had challenges with verifying the survey analysis and roll-up steps of the verified savings analysis.

#### **Appliance Recycling (Market-Rate and Income-Eligible)**

The SWE reviewed the Appliance Recycling component of the Residential program, which recycles refrigerators, freezers, and room air conditioning units. Guidehouse conducted a tracking database analysis of the PY14 tracking data and conducted survey-based verification of a sample of projects.

The SWE reviewed the tracking database analysis and confirmed that most of the correct TRM inputs were being used, but that an incorrect refrigerator part use factor value was used for



calculating refrigerator recycling savings in the tracking database analysis for both the market-rate and income-eligible program components.

The SWE reviewed the survey analysis and found that the analysis had not incorporated the survey data for the part-use factor. The SWE notified the Guidehouse evaluation team, who concurred and revised the data files and calculations to apply the correct part use factor based on the survey response analysis. The SWE reviewed the updated survey analysis file and the overall updated savings values for market rate appliance recycling were in alignment with the rollup files, but for IE AR the SWE found the total survey-based verified savings for the survey sample did not match the corresponding savings of the sampled records in the rollup file. In addition, it was cumbersome for the SWE to verify survey findings had been incorporated into survey-based verified savings and to verify the same savings values had been incorporated into the rollup files because of the lack of common unique identifiers across all files and worksheets. The SWE understands that PECO's appliance recycling offering is currently unavailable. Should the offering re-open during Phase IV, the SWE will work with Guidehouse to conduct further review before approving the PY14 verification ratios for use prospectively.

### **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 ENERGY STAR Certified Connected Thermostats.

The SWE reviewed the tracking database analysis and confirmed that savings aligned with TRM guidelines for nearly all measures. The SWE identified a few records for air-source heat pumps (ASHP) that had incorrect base values for SEER and HSPF. Guidehouse acknowledged the errors and will address them going forward. The SWE reviewed the survey analysis of thermostats, which found a decrease in verified savings due to ISRs less than one for some survey respondents. The SWE also found that total reported savings, database review savings, and survey-verified savings for the survey sample matched the corresponding savings of the sampled records in the rollup file.

### **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 PY14 data to confirm the measure savings adhered to the TRM protocols and conducted a customer survey-based verification of a sample of projects.

The SWE confirmed that the tracking data review applied the correct default values and EDC collected data to the TRM algorithms. The SWE's review of the customer survey analysis was

challenging because of a lack of consistent unique identifiers across files and analyses and because verified survey-based savings are exported from a Guidehouse analytical tool (that are difficult to link to the survey data without common unique identifiers). It was cumbersome for the SWE to verify survey findings had been incorporated into survey-based verified savings and to verify the same savings values had been incorporated into the rollup files. For example, the total survey-verified savings for the survey sample did not match the corresponding savings of the sampled records in the rollup file. Guidehouse informed the SWE that the discrepancies were due to the rollup file including savings from installed measures not verified in the survey (kit measures). The SWE will work with Guidehouse to conduct further review before approving the PY14 verification ratios for use prospectively.

### **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 tracking data review to confirm reported savings values matched energy model outputs and then applied verification ratios from the PY13 evaluation. The SWE's review concluded that the verification ratio that was applied was from the single-family stratum from the PY13 report but was not able to determine whether Guidehouse further stratified the PY14 population based on the other PY13 stratum verification ratios to calculate verified savings due to limited documentation.

### **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, data included in the tracking data, and data provided by the CSP. The SWE reviewed the tracking database analysis and confirmed that savings aligned with TRM guidelines for most measures. Exceptions included faucet aerators and low flow showerheads. For faucet aerators, 'unknown' number of household members was commonly used as an input rather than the default for multifamily households while for kit-delivered aerators, 'kitchen' inputs for several location-specific variables were used rather than unknown location, resulting in overstated savings. For showerheads, there was a similar error in the number of household members and number of showerheads per home, resulting in overstated savings.

In addition to the tracking database analysis, Guidehouse conducted a customer survey and engineering desk review verification for a sample of projects. Reviewing the customer survey analysis was challenging because of a lack of consistent unique identifiers across files and analyses and because verified survey-based savings are exported from a Guidehouse analytical tool (that are difficult to link to the survey data without common unique identifiers). It was cumbersome for the SWE to verify survey findings had been incorporated into survey-based verified savings and to verify the same savings values had been incorporated into the rollup files. In addition, the survey analysis results were reported for market rate and income-eligible multifamily components combined while these components are reported separately and have different sets of verification ratios for reporting purposes. While the survey analysis adjusted

savings based on verified ISRs, it did not adjust for other inputs, such as faucet location, which would result in errors in verification ratios for respondents that had installed measures with incorrect database adjusted savings.

None of the total savings values (reported, database adjusted, survey-verified) from the survey sample in the survey analysis file matched the corresponding savings of the sampled records in the rollup file. Guidehouse informed the SWE that the discrepancies were due to the rollup file including savings from installed measures not verified in the survey. The SWE will work with Guidehouse to conduct further review before approving the PY14 verification ratios for use prospectively.

### **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 PY14 tracking data to verify that reported savings aligned with the TRM. The SWE reviewed the tracking database analysis and confirmed that savings aligned with TRM guidelines for most measures. Exceptions included ENERGY STAR lighting, LED nightlights, faucet aerators, and low flow showerheads. 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 five models. In addition, the baseline wattages for around 75% of LED nightlights were unreasonably high for nightlights (15 to 100 watts; the SWE noted the same issue in PY13). For kit-delivered faucet aerators, kitchen location was assumed rather than unknown location, overstating verified savings. However, for most direct install faucet aerators, the kit ISR of 28% was applied, significantly understating verified savings. Lastly, for the low flow showerheads savings calculations, the SWE found instances where the multifamily default value was used for number of showerheads in place of the single-family default, as well as one instance where the multifamily default value was used for number of persons, instead of the single-family default.

In addition to the tracking database analysis, Guidehouse conducted a customer survey and engineering desk review verification for a sample of projects. Reviewing the customer survey analysis was challenging because of a lack of consistent unique identifiers across files and analyses and because verified survey-based savings are exported from a Guidehouse analytical tool (that are difficult to link to the survey data without common unique identifiers). It was cumbersome for the SWE to verify survey findings had been incorporated into survey-based verified savings and to verify the same savings values had been incorporated into the rollup files. For example, the total database review savings for the survey sample did not match the corresponding savings of the sampled records in the rollup file. The rollup files are used to develop and apply verification ratios from the sample to the program population. The SWE will work with Guidehouse to conduct further review before approving the PY14 verification ratios for use prospectively.

### **Long-Term Savings (Income-Eligible)**

The Long-Term Savings (LTS) 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 PY14 tracking data. The SWE reviewed the tracking database analysis and confirmed that savings aligned with TRM guidelines for all measures.

In addition to the tracking database analysis, the PECO PY14 Annual Report indicates the LTS component was included with Income-Eligible survey and analysis, but the survey analysis and rollup files did not indicate any LTS participants were included in the survey sample.

### B.5.1.3 Behavior

Approximately 11.6% of the PY14 verified gross energy savings listed in PECO's PY14 Annual Report came from Home Energy Reports issued to over 435,000 households. For PY14, the HER programs provided 34,929 MWh in energy savings with 1,108 MWh accruing to low-income households in the Residential Income-Eligible HER program. The HER programs also generated 6.48 MW of meter-level peak demand savings and 7.00 MW of system-level peak demand savings toward PECO's Phase IV PDR target.

PECO's Residential HER and Income-Eligible HER programs consist of seven waves in total, with later waves further subdivided into smaller groups. Waves 3 and 7 were the only active waves in PY14, therefore they were the only waves evaluated in PY14. [Table 86](#) shows the average number of active households by wave and group during PY14, rounded to the nearest hundred:

**Table 86: PECO HER Waves Summary**

Wave	Wave Start Date	Treatment Group Homes	Control Group Homes
3	Jun 1, 2015	47,200	14,300
7 - Dual Fuel	Jun 27, 2021	94,700	22,500
7 - Has Email	Jun 27, 2021	195,600	14,600
7 - Income Eligible	Jun 27, 2021	19,200	10,500
7 - No Email	Jun 27, 2021	80,000	17,700

Wave 3 participants began receiving home energy reports on June 1, 2015. Wave 7 participants began receiving home energy reports on June 27, 2021. Additionally, Wave 7 is divided into four groups by customer type, which combined account for 89% of the PECO customers that received HER's during PY14. Oracle is the ICSP 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 program 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 Wave 7 were designated by customer characteristics after the initial random assignment.

To validate Oracle’s random assignment of customers to receive HER’s, pre-treatment energy use patterns are compared across the treatment and control groups. Pre-treatment usage for treatment and control group customers for all waves have been reported previously. For all groups, the SWE confirmed that pre-treatment energy use patterns were similar across treatment and control groups. 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.

These equivalence checks were run in prior evaluation years, and all evaluated waves passed the equivalency checks.

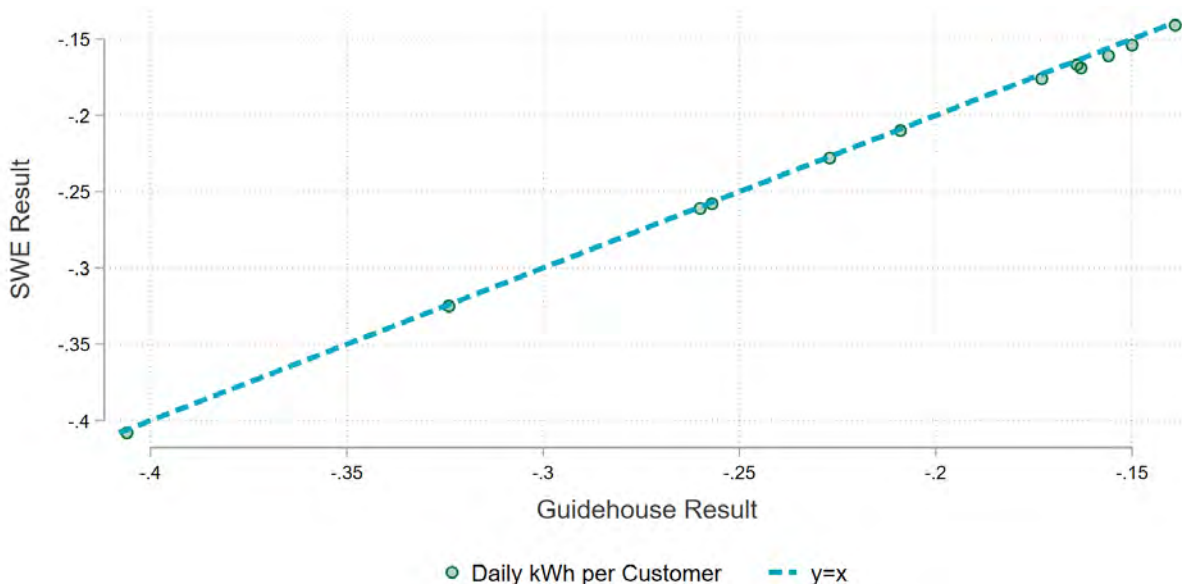
**Energy Impact Estimates**

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. Figure 27, Figure 28, Figure 29, Figure 30, and Figure 31 compare the results between the average daily kWh impacts reported by Guidehouse and the results from the data prepared by the SWE by wave. For each wave, the figures show that the SWE estimates were very similar to the energy impacts reported by Guidehouse.

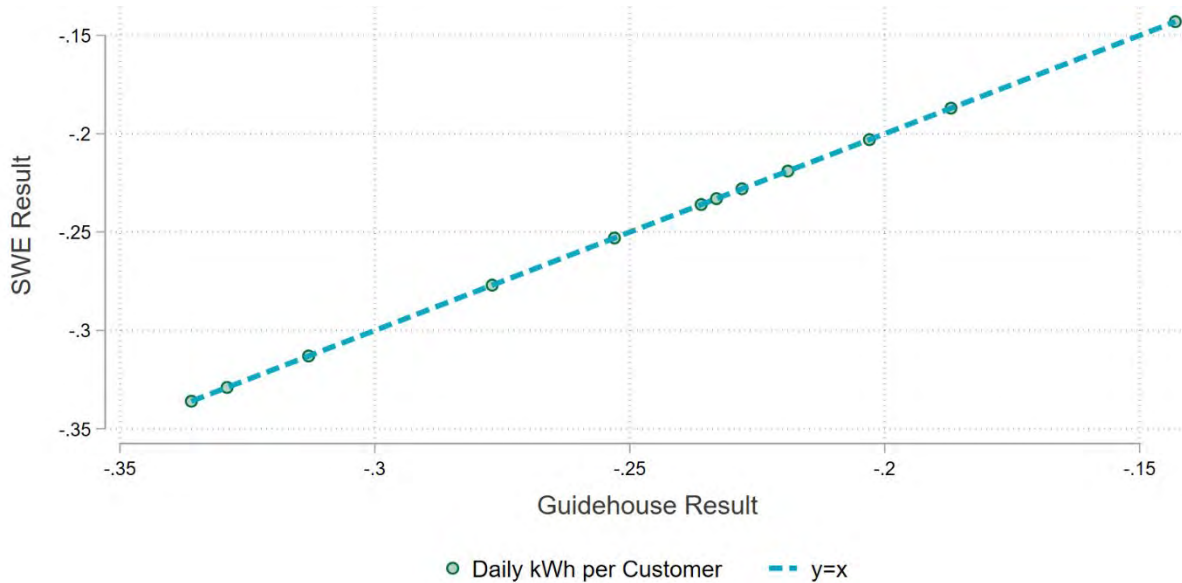
**Figure 27: PECO and SWE Regression Coefficient Comparison, Average Daily kWh Impacts by Month (Wave 3)**



**Figure 28: PECO and SWE Regression Coefficient Comparison, Average Daily kWh Impacts by Month (Wave 7 – Dual Fuel)**

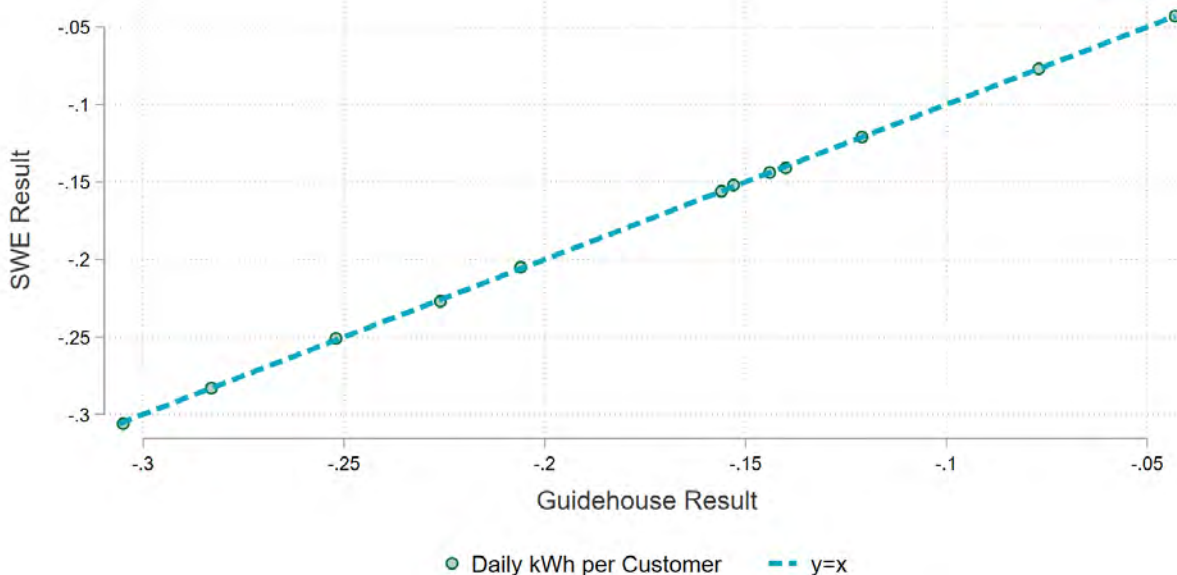


**Figure 29: PECO and SWE Regression Coefficient Comparison, Average Daily kWh Impacts by Month (Wave 7 – Has Email)**

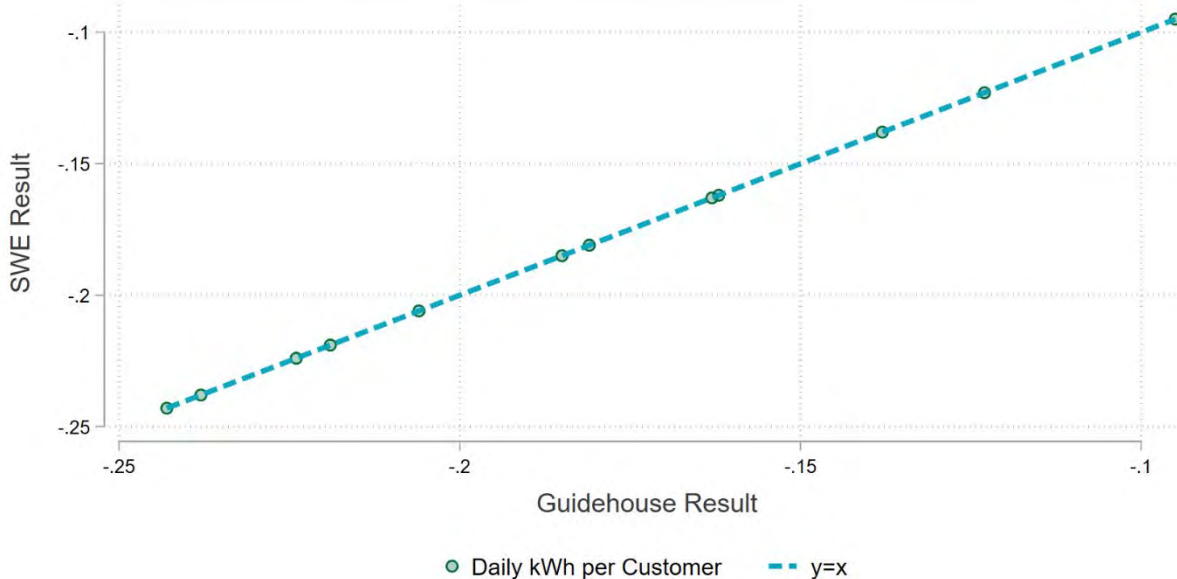




**Figure 30: PECO and SWE Regression Coefficient Comparison, Average Daily kWh Impacts by Month (Wave 7 – Income Eligible)**



**Figure 31: PECO and SWE Regression Coefficient Comparison, Average Daily kWh Impacts by Month (Wave 7 – No Email)**



Guidehouse estimated the average daily impact of HER’s on energy use with a lagged-dependent-variable (LDV) regression model. The model estimates usage in PY14 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 are aggregated to annual estimates for PY14 in [Table 87](#) below.

### Dual Participation

Home Energy Reports promote participation in additional PECO EE&C programs such as ENERGY STAR appliances, efficient lighting, HVAC, and others. To the extent that treatment-group households participate in these programs more frequently, gross savings estimates capture impacts of both the HER's 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 87](#), HER savings estimates are reduced to account for the difference in program participation observed between the treatment and control groups.

For PY14, estimated gross savings before adjusting for dual participation was 46,754 MWh. Of this, 2,417 MWh can be attributed to upstream or downstream dual participation.

**Table 87: PY14 Energy Savings from Home Energy Reports (MWh)**

Wave	Gross Savings	Downstream Dual Participation	Upstream Dual Participation	Persistence	PY14 Incremental Savings
3	16,785	885	477	9,408	6,016
7 - Dual Fuel	7,301	268	105	-	6,927
7 - Has Email	16,483	187	244	-	16,052
7 - Income Eligible	1,136	11	17	-	1,108
7 - No Email	5,049	149	74	-	4,827
<b>Total</b>	<b>46,754</b>	<b>1,500</b>	<b>917</b>	<b>9,408</b>	<b>34,929</b>

### Persistence

Some PECO customers have been receiving Home Energy Reports for multiple years, with impacts persisting, to some degree, from HER's 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's in the current program year only. Act 129 compliance goals are based on first-year incremental savings only. Guidehouse provided the SWE team with estimated impacts for each wave from all previous years. These were used to calculate first-year savings for the earliest program years, with the estimates carried forward to calculate the FYSATE for program years 11-13. FYSATE estimates were then used in Equation 1 below to calculate persistence for each wave.

As shown in [Table 87](#), more than half of the measured PY14 savings in Wave 3 are attributable to persistent impacts from previous years' HERs. Guidehouse thus calculated PECO's first-year savings as PY14 savings (net of uplift) minus estimated impacts from the previous three program



years. Impacts from previous years are assumed to decay at a rate of 31.3% for up to three years.<sup>67</sup>

Following the 2021 Pennsylvania TRM, persistence is assumed to be zero for the first two years of HER exposure, 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 and are in their second year, have no persistent impacts removed.

For waves receiving HER’s for two years or more, the FYSATE is calculated as the ATE minus the decayed impacts from each of the previous three program years, as shown in Equation 1 below:

**Equation 1: First Year Savings Average Treatment Effect**

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

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 five (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 HER’s on each wave of PECO participants are shown in Table 88. Any impacts before PY11 are assumed to have decayed to zero. Daily impacts in Table 88 are multiplied by participants and days to yield the total persistent savings shown in Table 87. This value is subtracted from the measured impacts along with the dual participation adjustment.

**Table 88: Persistent Impacts from PY11 – PY13, Average Daily Savings (kWh)**

Wave	Persistent Impact from PY13	Persistent Impact from PY12	Persistent Impact from PY11	Total
3	0.191	0.286	0.080	0.558

The SWE team found that Guidehouse accurately estimated persistent savings for each wave following TRM specifications.

**Low-Income Participants**

PECO identified Income-Eligible customers within the Wave 7 treatment and control groups. These participants’ (“Wave 7: Income Eligible” in Table 89 and Table 90) form the Residential Income-Eligible HER program and their savings count directly towards PECO’s Phase IV low-income target. 19,200 Wave 7 participants were income-eligible (2.7% of Wave 7 participants),

<sup>67</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)

with total PY14 savings of 1,108 MWh. The Residential Income-Eligible HER program accounted for approximately 5% of PECO PY14 progress towards its Phase IV low-income compliance target.

**Table 89: PY14 First-Year Savings by Income Groups**

Cohort	Program	Incremental Savings (MWh)
Wave 3	Residential HER	6,016
Wave 7: Market Rate (combined)	Residential HER	27,806
Wave 7: Income-Eligible	Residential Income-Eligible HER	1,108
<b>Total</b>		<b>34,929</b>

### **Peak Demand Impacts**

For PY14, peak-demand savings from HERs were estimated with hourly usage data. Peak periods were defined as hours from 2 to 6 p.m. 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 PY14 only. 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 in June, July, and August of 2022 while controlling for average hourly usage in each month. [Table 90](#) shows the estimated meter-level demand impacts by month and wave.

**Table 90: PY14 Peak Demand Savings from Home Energy Reports (MW)**

Wave	June 2022	July 2022	August 2022	Average Monthly
3	0.69	0.63	0.67	0.66
7 - Dual Fuel	1.23	1.76	1.96	1.65
7 - Has Email	2.99	3.54	3.77	3.43
7 - Income Eligible	0.11	0.17	0.18	0.16
7 - No Email	0.52	0.66	0.57	0.58
<b>Total</b>	<b>5.54</b>	<b>6.76</b>	<b>7.15</b>	<b>6.48</b>

The SWE largely replicated Guidehouse's estimated peak demand savings for all waves. 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 are clear and repeatable for the HER programs. 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 PY14 savings reported by Guidehouse for PECO's Residential and Income-Eligible HER programs.

### **B.5.2 Non-Residential Audit Activities**

The SWE conducted various review and audit activities for PECO's non-residential programs. These activities included a review of the evaluation efforts and an audit of the savings verification completed by PECO'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 M&V methods 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 M&V method applied.

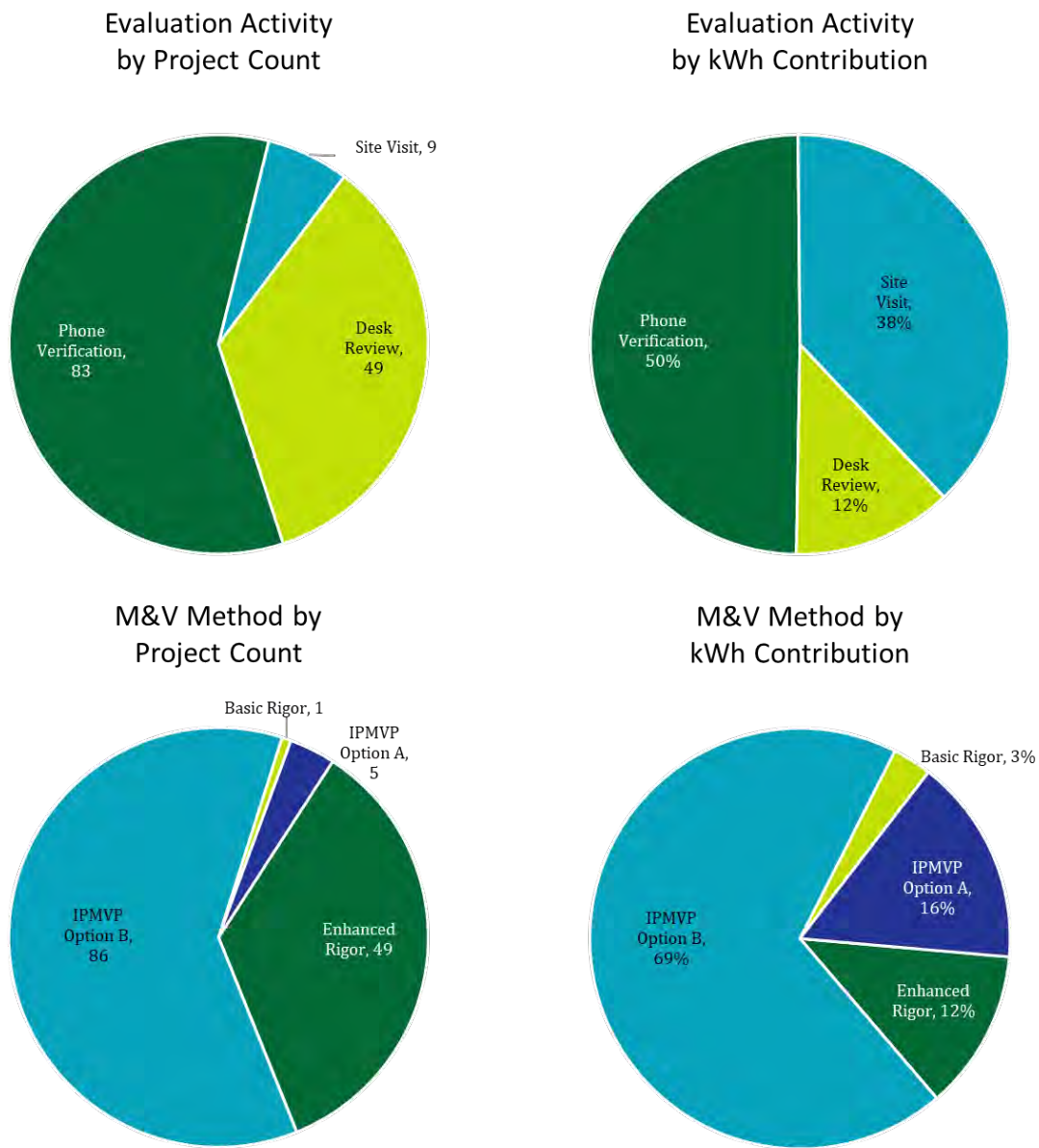
[Table 91](#) outlines the evaluation activities by project count for each of PECO's non-residential programs, along with the evaluation realization rates.

**Table 91: Summary of PECO's PY14 Nonresidential Evaluation Activities by Program**

Program / Strata	Sample Quantity	RR-Energy	RR-Demand	Desk Review	Phone Interview	On-Site Verification
<b>Downstream</b>	<b>37</b>	<b>92%</b>	<b>106%</b>	<b>6</b>	<b>23</b>	<b>8</b>
Extra Large	5	85%	118%	-	1	4
Large	11	102%	94%	1	6	4
Medium	10	106%	106%	1	9	-
Small	10	81%	75%	4	6	-
Extra Small	1	100%	100%	-	1	-
<b>Midstream</b>	<b>74</b>	<b>97%</b>	<b>96%</b>	<b>35</b>	<b>38</b>	<b>1</b>
Large	15	93%	89%	4	10	1
Medium	27	98%	106%	15	12	-
Small	32	124%	116%	16	16	-
<b>Small Business Direct Install</b>	<b>27</b>	<b>98%</b>	<b>90%</b>	<b>8</b>	<b>19</b>	<b>-</b>
Large	10	99%	87%	2	8	-
Small	17	97%	97%	6	11	-
<b>New Construction</b>	<b>-</b>	<b>101%</b>	<b>102%</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>TOTAL</b>	<b>138</b>			<b>49</b>	<b>80</b>	<b>9</b>

Figure 32 provides a summary of the evaluation activities and M&V methods utilized by PECO's evaluation contractor in their PY14 verified savings calculations. Guidehouse conducted site verification for nine of the PY14 evaluation samples, which includes 38% of evaluated energy savings.

**Figure 32: Summary of PECO’s Nonresidential Evaluation Activities**



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. Individual programs were evaluated within 10% of their reported values. Strata within programs fell within 20% of reported savings with the exception of the small stratum in the Downstream program that realized 25% of reported peak demand savings.

### B.5.2.1 Downstream

The Downstream component operates under the Municipal Lighting, Small C&I, Large C&I, Small Government/Non-Profit/Institutional (GNI), and Large GNI programs comprising 39% of PECO's Non-Residential reported energy savings and 37% of reported peak demand savings. The 891 participants contributed to over 1,000 rebated projects. The EDC evaluator, Guidehouse, derived a sample of 37 projects from each segment and allocated them to multiple strata based on project type and size.

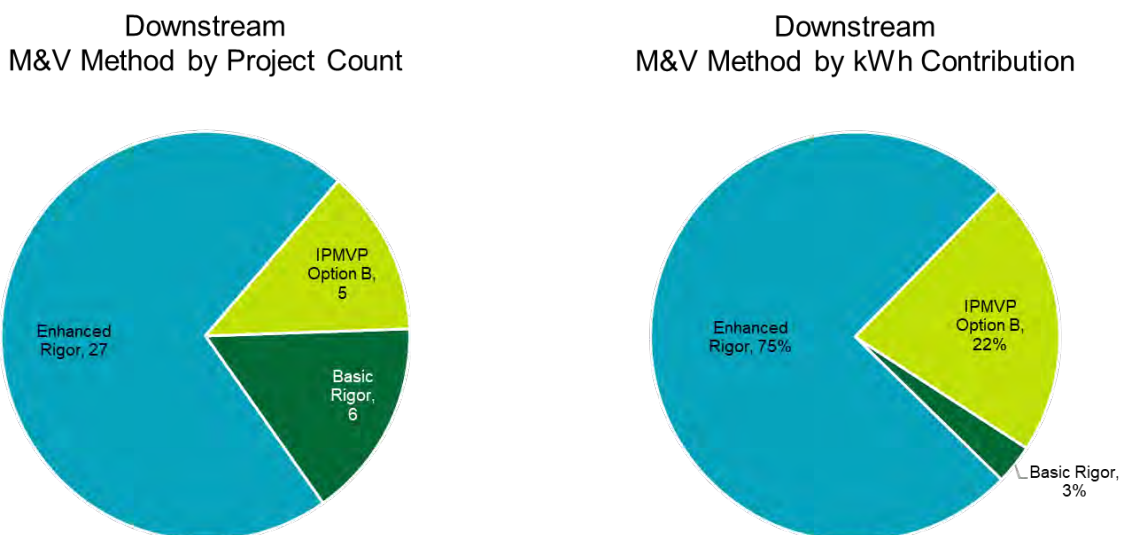
- Large C&I (16): Lighting and Lighting Controls (11), Custom (5)
- Small C&I (16): Lighting and Lighting Controls (14), Custom (1). Refrigeration (1)
- Municipal Lighting (1)
- Large GNI (3): HVAC (1), Custom (2)
- Small GNI Lighting (1)

The SWE attended Guidehouse's site visits for five of the sampled 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 the implementation contractor. 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. Nine (9) of the projects had verified energy savings values above 120% of the reported values, while four (4) 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 interviews.
- Peak demand savings was re-calculated for one large project to account for equipment operation and savings during peak demand windows; reported calculations divide annual energy savings by HOU.
- Database tracking data analysis revealed minor discrepancies including Ductless Mini-Split Heat Pumps, Energy Star Certified Thermostats, Electric Chiller, LED Refrigerated Case Lighting, and Evaporator Fan EC Motors.

Figure 33 displays the share of M&V methods performed under the Downstream component. IPMVP methods accounted for 22% of the evaluated savings, and only represented one of the projects.

**Figure 33: Summary of PECO's PY14 Downstream M&V Methods**

### B.5.2.2 Midstream

The Midstream component operates under the Municipal Lighting, Small C&I, and Large C&I programs and contributed approximately 52% of evaluated energy savings and 55% evaluated peak demand savings to PECO's non-residential portfolio. The Municipal Lighting segment represents less than 1% of the energy savings for this program. Guidehouse sampled 76 participants from this program that includes 40 phone interviews, 35 desk reviews, and one on-site verification.

- (27) Large C&I
- (45) Small C&I
- (1) Municipal Lighting
- (1) Large GNI
- (1) Small GNI

The SWE attended Guidehouse's phone interview visits for two of the sampled projects and conducted desk reviews for an additional three 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 documents provided by PECO. Guidehouse supplemented desk reviews with on-site verification and metering. Most sampled projects from the Midstream component achieved realization rates for both demand and energy within 20% of the expected values. (15) of the projects had verified savings values above 120% of the reported values, while four of the projects fell below 80% of reported values. Guidehouse observed the following conditions that resulted in adjustments to reported savings:

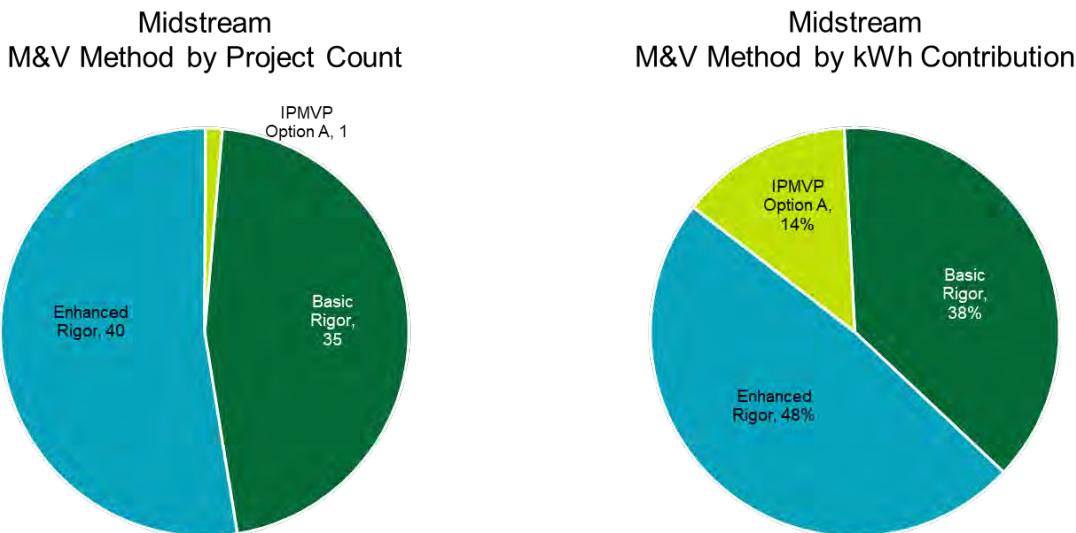
- Updated HOU (24), lighting control type (13), and HVAC type (4) contributed most significantly to evaluated energy savings realization rates.



- Updated coincident factor (20), lighting control type (10), and HVAC type (12) contributed most significantly to evaluated peak demand savings realization rates.

Figure 34 displays the share of M&V methods performed under the Midstream component. IPMVP methods accounted for 14% of the evaluated savings, and only represented one of the evaluated projects.

**Figure 34: Summary of PECO's PY14 Midstream M&V Methods**

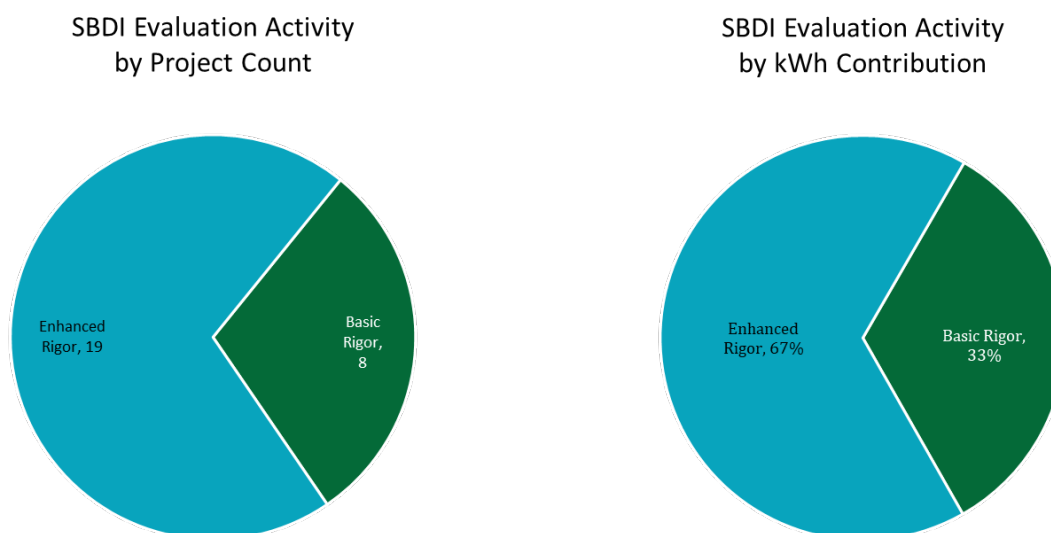


**B.5.2.3 Small Business Direct Install**

The Small Business Direct Install component contributed approximately 5% of evaluated energy savings and 5% evaluated peak demand savings to PECO’s non-residential portfolio. This program operates under Municipal Lighting, Small C&I, and Small GNI programs. Guidehouse sampled 27 participants from this program that includes 19 phone interviews, and eight (8) desk reviews.

The SWE attended one of the phone interviews and conducted three desk reviews on sampled SBDI projects.



**Figure 35: Summary of PECO's PY14 Small Business Direct Install M&V Methods**

#### B.5.2.4 New Construction

The Non-Residential New Construction segment represented approximately 4% of PECO's reported energy savings and 3% of PECO's peak demand savings portfolios. Guidehouse did not evaluate any projects from this component in PY14 and applied the PY13 verification ratios to the PY14 tracking adjusted database savings to arrive at the PY14 final realization rates and gross impact results.

#### 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 PY14 included review of 14 projects, encompassing the following activities:

- 12 Field and Analysis Engineers observed
- 11 Lighting and 3 Custom measures reviewed
- 5 Ride-Alongs conducted, 4 in person and 1 virtual
- 25% of Verified Non-Res Energy Savings reviewed
- 24% of Verified Non-Res Demand Savings reviewed

Table 92 provides the overall results of the SWE Verified Savings Audit for C&I projects:

**Table 92: PECO C&I Verified Savings Audit Results**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
14	5,736,006	104.2%	856	106.6%

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 five (5) projects. Project revision recommendations include (2) lighting power input updates to DLC 5.1 values, (1) lighting HOU and CF value to logging results, (1) removing demand savings due to HOU modification, and (1) application of a site-specific regression model rather than direct trend data.

## B.6 NTG

Table 93 lists PECO's PY14 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 93: Summary of PECO's PY14 NTG Results**

Program Name	Component	NTG
Residential	Rebates and Marketplace	0.61
Residential	Appliance Recycling	0.53
Residential	In-Home Assessment	0.95
Residential	New Construction	0.55
Residential	Multifamily	0.82
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	0.72
Non-Residential	Midstream	0.69
Non-Residential	Small Business Direct Install	0.88
Non-Residential	New Construction	0.38
<b>Portfolio Total</b>		<b>0.75</b>

### B.6.1 Residential Programs

Guidehouse planned and enacted NTG research for the In-Home Assessment, New Construction, and Multifamily, and Rebates and Marketplace Point of Purchase components of the Residential

Energy Efficiency Program (Table 94). The Rebates and Marketplace Point of Purchase NTG results were not statistically representative of the population, and therefore Guidehouse did not report the results in the PY14 annual report. Guidehouse utilized participant surveys to estimate free-ridership, spillover and NTG for In-Home Assessments and Multifamily, and builder surveys for New Construction. Guidehouse utilized question batteries that were consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation. However, the SWE found an error in Guidehouse's calculation of NTG for the In-Home Assessment component and will verify a revised NTG estimate when it is available from Guidehouse.

**Table 94: Summary of PECO's PY14 Residential NTG Results**

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
In-Home Assessment <sup>68</sup>	Participant survey	184	0.25	0.2	0.95
New Construction	Builder survey	3	0.45	0.0	0.55
Multifamily	Property Manager survey	7	0.18	0.0	0.82
<b>Residential Total</b>					<b>0.66</b>

### B.6.2 C&I Energy Efficiency Programs

Guidehouse planned and enacted NTG research for the Downstream component of the Non-Residential Energy Efficiency Program

**Table 95: Summary of PECO's PY14 C&I NTG Results**

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Downstream	Participant survey	34	.29	.01	0.72
<b>C&amp;I Total</b>		<b>34</b>	<b>.29</b>	<b>.01</b>	<b>0.72</b>

## B.7 TRC

Table 96 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for PECO's PY14 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 PY14 Annual Report.

<sup>68</sup> This table shows the In-Home Assessment values reported by Guidehouse in the PY14 PECO annual report. SWE is awaiting a revised NTG calculator addressing an error in FR calculations.

The Non-Residential Energy Efficiency program had a TRC ratio below 1, meaning it was not cost-effective in PY14.

**Table 96: Summary of PECO's PY14 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	\$27,302	\$7,411	3.68	\$27,302	\$7,411	3.68
Income Eligible Home Energy Reports	\$155	\$102	1.52	\$155	\$102	1.52
Non-Residential Energy Efficiency	\$98,098	\$117,211	0.84	\$68,485	\$84,839	0.81
Residential Energy Efficiency	\$54,959	\$46,405	1.18	\$35,794	\$32,543	1.00
Residential Home Energy Reports	\$5,517	\$2,590	2.13	\$5,517	\$2,590	2.13
Common Portfolio Costs	\$0	\$11,140	-	0	\$11,140	N/A
<b>Portfolio Total</b>	<b>\$186,031</b>	<b>\$184,859</b>	<b>1.01</b>	<b>\$137,253</b>	<b>\$138,625</b>	<b>0.99</b>

Four of PECO's five programs were found to be cost-effective, using net and gross savings, in PY14 led by the Income Eligible Energy Efficiency program. In PY14, 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. Non-Residential Energy Efficiency had a gross TRC ratio of 0.84 in PY14. One contributor to PECO's non-residential program TRC ratio less is the approach to utilize incremental measure costs based upon an early retirement vintage for lighting measures. Non-Residential lighting measures contributed 85% of the verified energy savings for the non-residential program and 54% of the entire energy efficiency portfolio in PY14; therefore, any assumptions with these measures will have a significant impact on the TRC outcomes. While the approach to utilize an early retirement perspective is consistent the definitions of 2021 TRC Test Order, the incremental costs have been found to be outdated, too high, and thus are resulting in an understated outcome if current lighting technology costs were utilized.

### B.7.1 Notes from the TRC Model Review

The PY14 TRC model was developed by Guidehouse using the Analytica software. Below is a summary of the assumptions and inputs verified by the SWE.

- The PY14 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 approach results in an understated TRC ratio as commercial lighting incremental costs in the Incremental Cost Database are outdated with recent market improvements.
- 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 PY14 TRC model and found them to be consistent with the 2021 TRM.
- The PY14 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 PY14 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 PY14 Annual Report.
- In PY14, 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 PY14, the Low-Income Energy Efficiency program had the highest TRC ratio at 3.68. 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 been reduced to 1.79. Benefits from water savings in this program were almost twice as high as savings from energy. However, it was noted that In Service Rates were not applied to water savings correctly. Adjusting water conservation benefits for In Service Rates would reduce the Low-Income Energy Efficiency program had the highest TRC ratio to 2.76.
- The PY14 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.

## B.8 PROCESS

### B.8.1 Residential EE Program

For PY14, Guidehouse reported on a process evaluation for the Residential EE Program. The Residential Program is made up of five components, shown below:

- Rebates and Marketplace<sup>69</sup> (Point of Purchase process evaluation only in PY14)
- In-Home Assessments
- Multifamily
- Appliance Recycling
- New Construction

Table 97 summarizes program component or sub-component satisfaction for the Residential EE Program.

**Table 97: PECO PY14 Program Satisfaction Summary - Residential EE Program**

Program Component / Sub-component	Population	% Satisfied
Rebates and Marketplace - Point of Purchase	Retailers	100%
In-Home Assessment	Participants	90%
Multifamily	Participants (Tenants)	100%
Multifamily	Participants (Property Managers)	100%
Appliance Recycling	Participants	96%
New Construction	Builders	100%
Residential EE Program - Overall	Participants	95%

### B.8.1.1 Rebates and Marketplace Component

#### **Summary of the Process Evaluation Findings**

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed Point of Purchase retailers. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 100% (retailers only).

#### **Summary of the Process Evaluation Audit**

Guidehouse completed all the PY14 activities listed in the Phase IV Evaluation Plan. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those

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<sup>69</sup> 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

tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy.

The evaluator contacted 35 retailers who participated in the PECO Retail LED Instant Discounts pathway and achieved a total of two completed surveys for a 5% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

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

#### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed program 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, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 90% (participants only).

#### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 2,936 customers who participated in the In-Home Assessment component and achieved a total of 184 completed surveys for a 6% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.



### B.8.1.3 Multifamily Component

#### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed tenants and property managers who participated in the Multifamily component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 100% (participating tenants only).

#### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 50 tenants and 42 property managers who participated in the Multifamily component and achieved a total of two completed tenant surveys for a 4% response rate, as well as 7 completed property manager surveys for a 17% response rate. Please note that the property manager surveys represent both market-rate and income-eligible properties.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

### B.8.1.4 Appliance Recycling Component

#### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed customers who participated in the Appliance Recycling component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 96% (participants only).

#### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 1,828 customers who participated in the Appliance Recycling component and achieved a total of 127 completed responses for a 7% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

#### **B.8.1.5 New Construction Component**

##### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed builders who participated in the Residential New Construction component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 100% (builders only).

##### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 24 builders who participated in the Residential New Construction component and achieved a total of three completed responses for a 13% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

#### **B.8.2 Residential Home Energy Reports Program**

No process evaluation was conducted in PY14 beyond interviews with program and CSP staff.

### B.8.3 Income-Eligible Program

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

- Single-Family (no process evaluation in PY14)
- Multifamily
- Appliance Recycling
- Long-Term Savings (no process evaluation in PY14)

Table 98 summarizes program component or sub-component satisfaction for the Income-Eligible Program.

**Table 98: PECO PY14 Program Satisfaction Summary – Income-Eligible Program**

Program Component / Sub-component	Population	% Satisfied
Appliance Recycling	Participants	100%
Multifamily	Participants	81%
Income-Eligible Program - Overall	Participants	91%

#### B.8.3.1 Single-Family Component

No process evaluation was conducted in PY14 beyond interviews with program and implementation staff.

#### B.8.3.2 Multifamily Component

##### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed tenants and property managers who participated in the Income-Eligible Multifamily component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, program awareness, and areas of strength and improvement. Based on these data, the mean satisfaction for the component overall was 81% (participating tenants only).

##### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 548 tenants and 42 property managers who participated in the Income-Eligible Multifamily component and achieved a total of 28 completed tenant surveys for a 5% response rate, as well as 7 completed property manager surveys for a 17% response rate. Please note that the property manager surveys represent both market-rate and income-eligible properties.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

### **B.8.3.3 Appliance Recycling Component**

#### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed customers who participated in the Income-Eligible Appliance Recycling component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, program awareness, and areas of strength and improvement. Based on these data, the mean satisfaction for the component overall was 100% (participants only).

#### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 272 customers who participated in the Income-Eligible Appliance Recycling component and achieved a total of 12 completed responses for a 4% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

### B.8.3.4 Long-Term Component

No process evaluation was conducted in PY14 beyond interviews with program and implementation staff.

### B.8.4 Income-Eligible Home Energy Reports Program

No process evaluation was conducted in PY14 beyond interviews with program and implementation staff.

### B.8.5 Non-Residential Program

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

- Downstream Rebates
- Midstream Rebates (no process evaluation in PY14)
- New Construction
- Small Business Direct Install

Table 99 summarizes program component or sub-component satisfaction for the Non-Residential Program.

**Table 99: PECO PY14 Program Satisfaction Summary – Non-Residential Program**

Program Component / Sub-component	Population	% Satisfied
Downstream Rebates	Participant	95%
New Construction	Participant	75%
Small Business Direct Install	Participant	97%
Non-Residential Program - Overall	Participant	95%

#### B.8.5.1 Downstream Rebate Component

##### **Summary of the Process Evaluation Findings**

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed customers who participated in the Non-Residential Downstream component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 95% (participants only).

##### **Summary of the Process Evaluation Audit**

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 508 customers who participated in the Downstream component and achieved a total of 34 completed responses for a 7% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

#### **B.8.5.2 Midstream Rebate Component**

No process evaluation was conducted in PY14 beyond interviews with program and implementation staff.

#### **B.8.5.3 New Construction Component**

##### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed customers who participated in the Non-Residential New Construction component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 75% (participants only).

##### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 47 customers who participated in the New Construction component and achieved a total of four completed responses for a 9% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

#### **B.8.5.4 Small Business Direct Install Component**

##### ***Summary of the Process Evaluation Findings***

For the process evaluation of this program, Guidehouse reviewed program documents and data, interviewed PECO program managers and CSP staff, and surveyed customers who participated in the Non-Residential New Construction component. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included program goals, significant implementation changes, customer satisfaction, likeliness to recommend the program to others, and program awareness. Based on these data, the mean satisfaction for the component overall was 97% (participants only).

##### ***Summary of the Process Evaluation Audit***

Guidehouse completed all the PY14 activities listed in 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 evaluator contacted 324 customers who participated in the Small Business Direct Install component and achieved a total of 28 completed responses for a 9% response rate.

The SWE also determined that the reporting followed the SWE guidelines. The PECO PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations, though there were no process recommendations made for program improvement in PY14 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 generally succinct and highlighted findings that should be of value to the administrator and implementer.

## Appendix C PPL PY14 Audit Detail

### C.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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.
- PPL provided their Residential and Low Income verified savings analyses prior to drafting their PPL PY14 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 PPL PY14 Annual Report. In addition, the SWE confirmed that minor errors that were uncovered during the early review of impact analysis were corrected for the EDC report. The SWE also reviewed and confirmed that analysis results matched the savings and realization rates that were included in the PPL PY14 annual report.
- PPL's portfolio was cost-effective in PY14 with an improved gross TRC ratio of 1.63.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PPL's PY14 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. 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 PY14 Annual Report values are pulled from a financial system as opposed to program tracking data.
- 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 PY14. 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. Similar to the key finding in PY13, 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 PY14 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, submitted a summary memo of the PY14 and Phase IV EM&V plans for each program and program component as well as redline versions of the individual EM&V plan for each program in PPL's Phase IV EE&C plan. The PY14 plans had relatively minor adjustments to the evaluation approach detailed in PY13. The SWE reviewed and approved the plans, generally with minor revisions.

As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. [Table 100](#) shows which PPL programs produced verified impacts in PY14, and which will wait until PY15 to verify results. A two-year sample size will be used to verify results in PY15. Three components are the source of 10,528 MWh and 1.26 MW of unverified savings reported by PPL in its PY14 Annual Report.



Table 100: PY14 PPL Program Impact Evaluation Summary

Program	Component	Delivery Channel	PY14 Impacts
Non-Residential Program	Custom	Large	Verified
		Small	Verified (2-year sample)
		CHP	Verified
	Equipment	Downstream	Verified
		Midstream	Unverified until PY15 (2-year sample)
	Lighting	Downstream	Verified
		Midstream	Verified
	Low-Income Program	All strata	All strata
Residential Program	Appliance Recycling	Refrigerators	Verified
		Freezers	Verified
		Room AC's and dehumidifiers	Verified
	Energy Efficient Home	Audit and Weatherization	Verified
		Midstream Equipment	Unverified until PY15
		Downstream Equipment	Historic realization rate
		Online Marketplace	Unverified until PY15
		New Homes	Verified
	Efficient Lighting	Lighting	Historic realization rate
	Student Energy Efficiency Education	All strata	Unverified until PY15

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  $\pm 15\%$  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. 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 101](#) shows the relative precision of energy and demand savings estimates by PPL program component. The Student Energy Efficient Education component is omitted below as the initiative was not evaluated during PY14.

**Table 101: Relative Precision of PY14 Impacts by Component at the 85% Confidence Level**

Program	Component	Relative Precision (Energy)	Relative Precision (Demand)
Non-Residential Program	Custom	1.1%	1.3%
	Efficient Equipment (Lighting)	8.7%	5.5%
	Efficient Equipment (Equipment)	9.2%	11.1%
Low-Income Program	All evaluated strata	7.2%	7.5%
Residential Program	Appliance Recycling	6.0%	6.0%
	Energy Efficient Home	21.7%	9.1%
	Efficient Lighting	0.0%	0.0%

Within the Energy Efficient Home component, only the Audit and Weatherization and New Home subcomponents were verified for PY14. Instant Discount and Online Marketplace were left unverified, and the realization rates and relative precision values were carried over from PY13 impacts for the Downstream Equipment subcomponents. While the relative precision of PY14 impacts for the Audit and Weatherization and New Home subcomponents met the  $\pm 15\%$  threshold for relative precision, the historic realization rate from the Downstream Equipment component did not. Thus, the total relative precision for PY14 impacts for the Energy Efficient Home component does not meet relative precision threshold requirements ([Table 101](#)). In the PPL PY13 Annual Report, Cadmus previously addressed the missed  $\pm 15\%$  threshold for relative precision for the Energy Efficient Home component, citing one outlier project having a realization rate of over 1,000%, causing increased variance and reduced precision of savings estimates. The SWE expects that these issues will be remedied next year, as the Downstream Equipment component impacts will be evaluated during PY15.

## 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 PY14 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 PY14 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 102 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in the PPL PY14 Annual Report and “No” otherwise. The tracking data supports PPL’s PY14 Annual Report for all programs.

**Table 102: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Non-Residential	199,144	199,144	Yes
Low-Income	10,825	10,825	Yes
Residential	43,601	43,601	Yes
<b>Portfolio Total</b>	<b>253,570</b>	<b>253,570</b>	<b>Yes</b>

Table 103 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 PY14 Annual Report value exactly for all programs.

**Table 103: MW Savings by Program**

Program	Annual Report MW	Tracking Data MW	Match
Non-Residential	33.10	33.10	Yes
Low-Income	1.21	1.21	Yes
Residential	6.15	6.15	Yes
<b>Portfolio Total</b>	<b>40.46</b>	<b>40.46</b>	<b>Yes</b>

Table 104 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: 829,509 in the PPL PY14 Annual Report and 829,509 in the tracking data.

**Table 104: Participation by Program**

Program	Annual Report Participants	Tracking Data Participants	Match
Non-Residential	6,659	6,659	Yes
Low-Income	24,889	24,889	Yes
Residential	797,961	797,961	Yes
<b>Portfolio Total</b>	<b>829,509</b>	<b>829,509</b>	<b>Yes</b>

Finally, [Table 105](#) summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in PPL's PY14 Annual Report. The Annual Report incentives are directionally similar for the Non-Residential and Low-Income programs. 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 PY14 Annual Report values are pulled from a financial system as opposed to program tracking data. The SWE team will work with PPL and its evaluation contractor to understand these differences and get updated PY14 tracking data if necessary, so that the statewide tracking data better reflects actual program activity.

**Table 105: Incentives by Program (\$1,000)**

Program	Annual Report Incentives	Tracking Data Incentives	Match
Non-Residential	\$20,477	\$18,775	No
Low-Income	\$3,104	\$3,119	No
Residential	\$6,514	\$10,905	No
<b>Portfolio Total</b>	<b>\$30,095</b>	<b>\$61,996</b>	<b>No</b>

## 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 PY14 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 106](#) presents a summary of the SWE's residential project file reviews.

**Table 106: 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? <sup>1</sup>
Appliance Recycling	n/a	12	✓	✓	✓	✓ <sup>1</sup>
Energy Efficient Homes	New Homes	20	✓	✓	✓	✓
Energy Efficient Homes	Downstream Equipment	14	✓	✓	✓	✓
Energy Efficient Homes	Online Market Place	12	✓	✓	✓	✓
Energy Efficient Homes	Efficient Lighting	12	✓	✓	✓	✓
Energy Efficient Homes	Audit and Weatherization	14	✓	✓	✓	✓
Low-Income Program	REA, In-Home, and Multifamily	12	✓	✓	✓	✓

<sup>1</sup> 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 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 recycled refrigerators, while the tracking data listed one dehumidifier. While there were no additional discrepancies between the tracking database and the project files reviewed, the photographs for ten of the projects provided by the CSP do not clearly capture the nameplates of the recycled equipment. Additionally, six project files did not include a photo of the appliance being recycled

and four of these projects did not include documentation of a signature on the equipment pickup form. 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, the most recent version of the software at the start of PY14, 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 with quarterly samples of project documentation for downstream equipment. The SWE found that the project file documentation matched the tracking data.

#### **Energy Efficient Homes: Audit**

Invoices were provided for each of the sampled in-home audits, and the documentation generally matched the tracking database. However, the quality of the documentation varied greatly. The SWE observed four projects included a complete PPL “In-Home Audit” form, and/or itemized invoice, while most were simple receipts or non-itemized invoices, and the audit forms were missing making it difficult to match the items with the tracking data. All but one of the projects reviewed contained an equipment model number or specification sheet for verification.

#### **Energy Efficient Homes: Weatherization**

In-Home Audit project files were comprised either a rebate application or a payment authorization form and an invoice. One project was missing an invoice or rebate amount, but the application was present. The remaining projects contained all the necessary files for savings verification and were easy to find in the tracking data.

Weatherization project files were comprised of invoices from weatherization service providers with itemized receipts. All the reviewed files were easy to find in the tracking data and accurate.

#### **Energy Efficient Homes: Online Marketplace**

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. The only provided project documentation was in the form of invoices that were organized by date. Three invoices were provided for each quarter, the SWE was able to match invoices to the tracking data.

#### **Energy Efficient Homes: Efficient Lighting**

Projects were documented through batches of invoices organized by date rather than file or job number, making it difficult to locate them in the tracking data. Invoice quantities and bulb types typically matched the tracking data. However, in one instance the SWE was unable to locate the project in the tracking data, and observed two instances where the quantities of rebated items in the tracking data did not match the quantities listed in the invoices. One of the invoices listed 39 units, while the tracking data listed 96 units. The other invoice listed 48 units and the tracking data listed 30 units. Given the invoice or project file documentation was located in the tracking data by

date, the SWE notes that the discrepancies may be accounted for under different line items in the tracking data.

### **Low-Income Program: Remote Energy Assessment, In-Home Audits, Multifamily**

Documentation of in-home and phone-guided audits, as well as equipment specification sheets, provided details that can be used for savings verification. Itemized equipment lists organized by account number matched the tracking data in Q1, Q2, and Q4. The Q3 documentation did not include any itemized documentation, making it difficult to locate within the tracking data or verify counts, rebate and savings amounts. However, two of the three projects reviewed in Q3 contained work orders or audit forms noting the old equipment was being replaced and which new equipment would replace it. No discrepancies in rebate and savings amounts were found between the projects and tracking data.

#### **C.4.2.2 Non-Residential**

The SWE reviewed a sample of PPL's Efficient Equipment projects for PY14 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 thirty-two projects sampled.

Table 107 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 one project per sub-program, except in the case of Downstream Lighting.

**Table 107: PPL PY14 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?
Custom	Custom	8	✓	✓	✓	✓	-
Efficient Equipment	Lighting - Downstream	8	7/8	6/8	✓	✓	✓
Efficient Equipment	Lighting - Midstream	8	✓	✓	✓	✓	✓
Efficient Equipment	Non-Lighting	8	✓	7/8	7/8	7/8	✓

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 in the Efficient Equipment projects reviewed. The SWE noted specific project files with deficiencies as addressed below by sub-program.

- **Efficient Equipment – Lighting**
  - Two projects reviewed had values in savings calculators that did not match the reported values in the tracker (inconsistencies with rebates, kWh savings, and kW savings).
  - For one project, custom HOUs were used in lighting savings calculations. A document verifying the custom hours of use should be included for completeness.
- **Efficient Equipment – Non-Lighting**
  - For an HVAC retrofit project, the savings and rebate values did not match between the calculator and tracker. There was one additional HVAC unit in calculations that was not included in the project scope.

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.

## 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, In-Home / 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 108 provides a summary of the EM&V approaches used by Cadmus in their PY14 verified savings calculations.



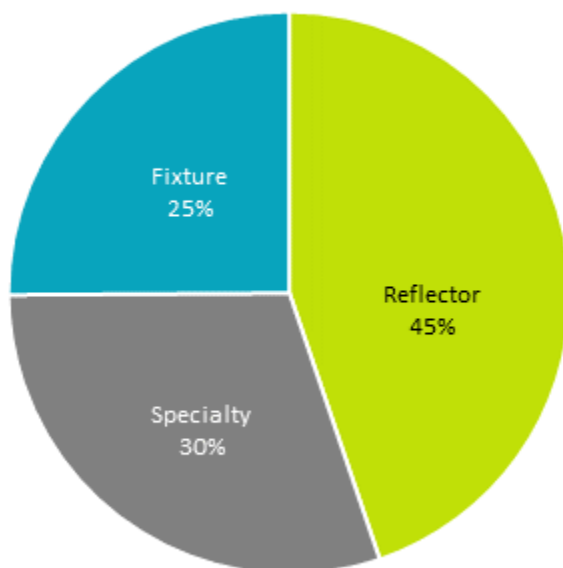
Table 108: Residential and LI Impact Evaluation Activities - PPL

Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis	Historic Realization Rate
Residential Program					
EE Homes, Downstream Equipment <sup>b</sup>	-	-	-	-	✓
EE Homes, Online Marketplace <sup>c</sup>	-	-	-	-	-
EE Homes, Instant Discount <sup>c</sup>	-	-	-	-	-
EE Homes, New Homes	-	✓	✓	-	-
EE Homes, Audit and Weatherization	✓	-	✓	-	-
EE Homes, Midstream HVAC <sup>e</sup>	-	-	-	-	-
Appliance Recycling	-	-	✓	-	-
Student Energy Efficient Education (SEEE) <sup>d</sup>	-	-	-	-	-
Efficient Lighting	-	-	-	-	✓
Low-Income Program					
Remote Energy Assessment	✓	-	✓	-	-
In-Home Assessments	•	-	✓	-	-
Welcome Kits	-	-	✓	-	-
<sup>a</sup> The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews. <sup>b</sup> Downstream equipment applied the realization rate from PY13. <sup>c</sup> Online Marketplace and Instant discount were not evaluated in PY14. The savings are unverified and will be verified in PY15, using a two-year sampling approach in PY15. <sup>d</sup> Savings were not verified for the SEEE subprogram in PY14. <sup>e</sup> Midstream HVAC was not evaluated in PY14 due to lack of participation.					

### C.5.1.1 Upstream Lighting and Cross-Sector Sales

Customers purchased approximately 745,000 efficient light bulbs and fixtures through PPL's PY14 upstream lighting program. Figure 36 displays the distribution of sales by product type. Nearly one-half (45%) were reflectors, followed by specialty bulbs (30%) and fixtures (25%).

Figure 36: PPL PY14 Upstream Lighting Sales by Product Type



### ***Audit Findings***

The EMV plan stated that Cadmus would apply PY13 realization ratios to PY14 ex ante savings for Efficient Lighting. The SWE verified that gross savings had been calculated correctly in accordance with the EMV plan.

### ***Cross-Sector Sales***

Cadmus did not conduct cross-sector sales research in PY14 but applied the TRM default cross-sector sales rate of 7.4%.

#### **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.

#### **Residential Program: Energy Efficient (EE) Homes, Equipment**

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. For PY14, Cadmus stratified the sample according to end use and used historic realization rates from PY13. 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 and applied the correct historic realization rates.

The Energy Efficient Homes component also provides instant discounts on Energy Efficient Products via an Online Marketplace and an Instant Discount subcomponent. These include connected thermostats, dehumidifiers, smart strips, lighting, weatherstripping, and kits. These two subcomponents were not evaluated in PY14, and savings remain unverified. These two subcomponents will be evaluated in PY15 using a two-year sampling approach.

#### **Residential Program: Student Energy Efficient Education (SEEE)**

The Student Energy Efficient Education component of PPL's Residential Program was not evaluated in PY14.

#### **Residential Program: Appliance Recycling**

The Appliance Recycling component applied the PY13 realization rates for refrigerators and freezers to PY14 correctly. In addition, the SWE confirmed the planned adjustment to map HDD and CDD variables to the TRM. The SWE also confirmed that savings from room air conditioners and dehumidifiers were calculated in accordance with the TRM.

#### **Residential Program: EE Homes, New Homes**

The New Homes component of PPL's Residential Program evaluated both PY13 and PY14 projects in PY14, as PY13 savings were unverified. A sample of homes had a site visit and corresponding engineering desk review conducted, and the results were applied to the population correctly for both PY13 and PY14. The SWE found that the evaluation followed TRM protocols and did not uncover any errors. However, the SWE notes that a minor amount of verified savings for this program were left unclaimed in the EDC report due to conservative rounding approaches.

#### **Residential Program: EE Homes, Audits and Weatherization**

The SWE conducted an early review of the Audits and Weatherization component. The Cadmus evaluation included a full review of the program tracking data and aligned savings estimates with the TRM, product specific data, and evaluation surveys. 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.

#### **Residential Program: EE Homes, Midstream HVAC**

The Midstream HVAC component of PPL's Residential Program was not evaluated in PY14 due to lack of participants in the midstream program in PY14.

#### **Low-Income Program**

The Low-Income Program provides four job types (baseload, low-cost, full-cost, and welcome kits) to income-qualified customers that offer services such as: HVAC, lighting, water-saving and heating, power strips, and energy education. These services are offered through welcome kits, remote energy assessments, and in-home assessments. 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, in-home assessment, and welcome kit components of the Low-Income Program. The evaluator, Cadmus, calculated verified savings at

the stratum-level to estimate population total verified savings. The SWE found no discrepancies for welcome kits, in-home assessments, or remote energy assessments and found the survey results were correctly incorporated and the 2021 TRM inputs were correctly applied to the population savings.

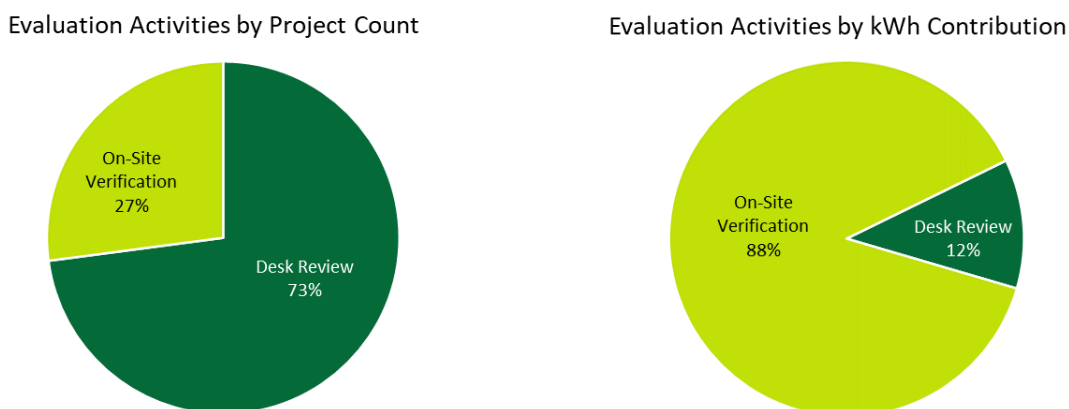
In PY14, PPL’s evaluation contractor, Cadmus, calculated verified savings for energy education using values in the 2021 TRM along with per-unit energy savings and demand reductions. The SWE did not find any discrepancies in the calculation of the household energy education savings of 75.70 kWh/year in PY14.

### C.5.2 Non-Residential Audit Activities

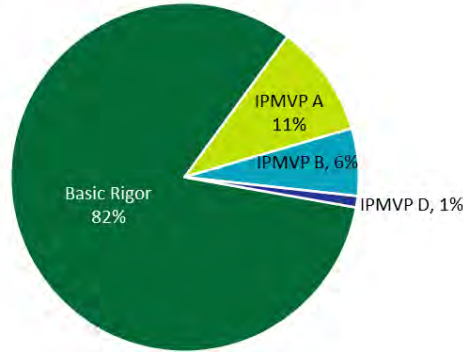
The SWE conducted various review and audit activities for PPL’s energy efficiency programs. These activities included a review of the evaluation efforts and an audit of the savings verification completed by PPL’s evaluation contractor, Cadmus. The remainder of this section presents the SWE’s findings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

Figure 37 provides a summary of the evaluation activities and M&V approaches utilized by PPL’s evaluation contractor in their PY14 verified savings calculations summarized by total project counts and evaluated savings. For PY14, PPL’s evaluation contractor completed site visits to 26% of projects. 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 (88%) 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 37 provides a summary of the share of projects, which underwent Cadmus’ evaluation activities by quantity of projects and evaluated savings. Figure 37 also displays the share of projects that were reviewed using basic rigor methods and IPMVP methods.

**Figure 37: Summary of PPL’s C&I Evaluation Activities**



M&V Method by Project Count



M&V Method by kWh Contribution

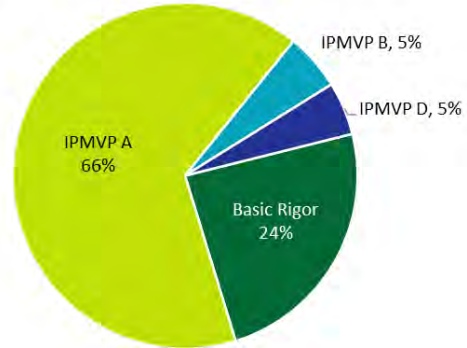


Table 109 provides a summary of the evaluation activities and M&V approaches PPL’s evaluation contractor used across strata for all projects stratified by program.

**Table 109: Summary of PPL’s PY14 C&I Evaluation Activities by Program**

Program / Strata	Sample Quantity	Realization Rate	Desk Review	On-Site Verification
<b>Non-Residential Equipment Program</b>	<b>20</b>	<b>104%</b>	<b>17</b>	<b>3</b>
Downstream - HVAC	9	109%	6	3
Downstream - motors	1	112%	1	0
Downstream - other equipment	5	100%	5	0
Downstream - refrigeration	5	100%	5	0
<b>Non-Residential Lighting Program</b>	<b>57</b>	<b>97%</b>	<b>53</b>	<b>4</b>
Midstream	24	163%	24	0
Downstream (<120K kWh/year)	12	97%	12	0
Downstream (120-750K kWh/yr)	13	98%	12	1
Downstream threshold (>750K kWh/yr)	8	97%	5	3
<b>Custom Program</b>	<b>17</b>	<b>100%</b>	<b>0</b>	<b>17</b>
Large	12	100%	0	12
Small	7	106%	0	7
CHP	0	N/A	-	-
<b>Total</b>	<b>96</b>	<b>99%</b>	<b>70</b>	<b>26</b>

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 PY14 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 (17 by desk review and three site visits).

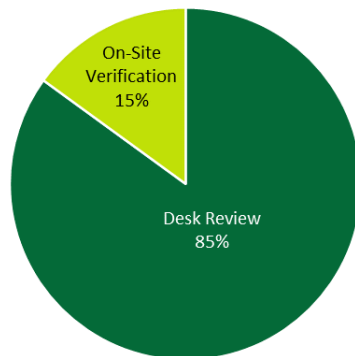
In summary, the strata and substrata for the Non-Residential Efficient Equipment program were as follows:

- Non-Lighting Equipment
  - Downstream – HVAC
  - Downstream – Motors
  - Downstream – Other Equipment
  - Downstream – Refrigeration

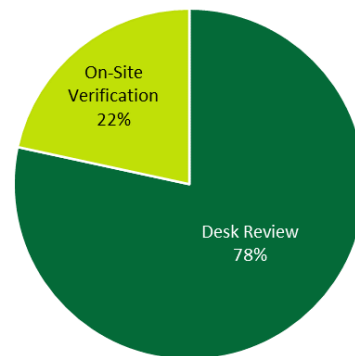
As shown in [Figure 38](#), PPL's evaluation contractor verified approximately 85% of projects via desk reviews and the rest of projects via on-site verification.

**Figure 38: Summary of PPL's PY14 Efficient Equipment Program Evaluation Activities (Non-Lighting)**

Evaluation Activities by Project Count



Evaluation Activities by kWh Contribution



### C.5.2.2 Non-Residential Efficient Lighting Program

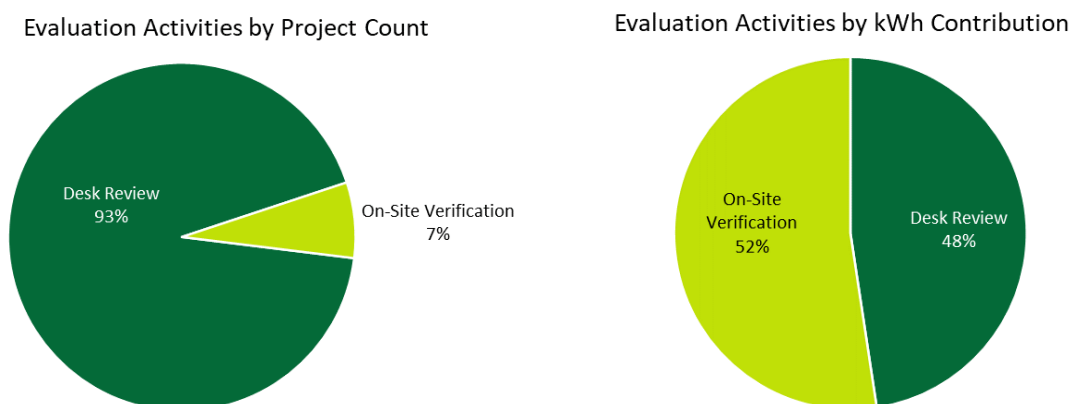
In PY14, Cadmus grouped the efficient lighting projects into downstream and midstream stratum. The PY14 evaluation sampling plan was designed to meet 90% confidence and  $\pm 10\%$  precision (90/10) for the lighting stratum. The program met both relative precision targets for energy and demand for lighting 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 PY14 projects. Cadmus conducted four site visits and 29 desk audits to evaluate 33 total downstream projects (only one of these desk reviews involved phone interview). Cadmus conducted desk reviews for all 24 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 39](#), PPL's evaluation contractor verified approximately 93% of projects via desk reviews and the rest of projects via on-site verification.

**Figure 39: Summary of PPL's PY14 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:

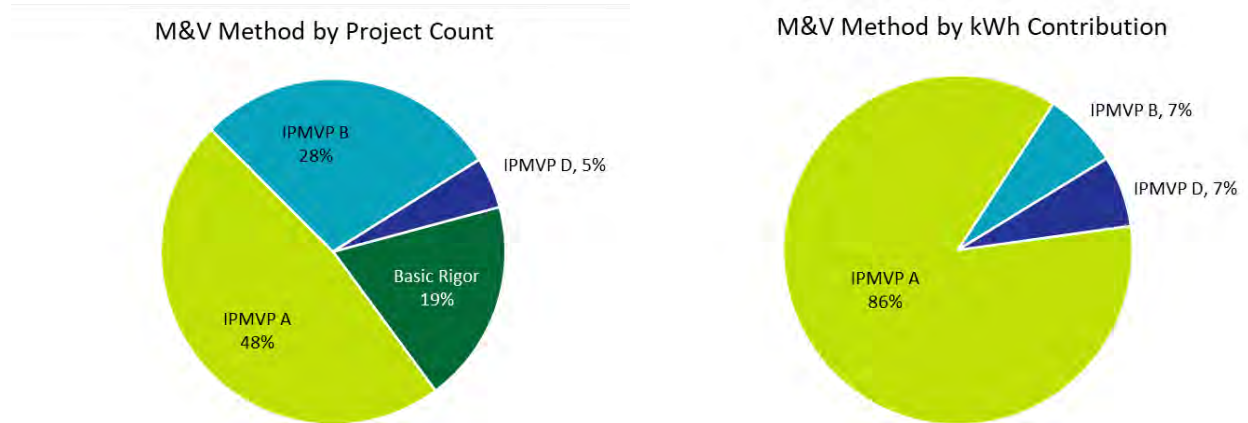
- Large (Expected energy savings greater than 2,000,000 kWh/yr. or high level of uncertainty. Solar PV projects were also included in the large stratum if their expected energy savings exceeded 1 million kWh/yr.)
- Small (expected energy savings below 2,000,000 kWh/yr.)
- CHP

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

The large project verification strata was 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. The program did not contain any CHP projects and hence no projects were available for verification. Cadmus prepared SSMVPs for each project and then conducted post-installation inspections and verified savings. IPMVP Option A and B were used to calculate the first-year energy savings for both the large and small strata project. One large project was evaluated using IPMVP Option D. Four Small stratum projects were also evaluated using basic rigor. [Figure 40](#) 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, B and D encompass 100% of the evaluated energy savings in PY14.



**Figure 40: Summary of PPL’s PY14 Custom Program M&V Methods**



**C.5.2.4 Verified Savings Audits**

The SWE audited the above activities through a detailed audit of Cadmus’ evaluation work for a sample of their evaluated projects. The SWE audit for Cadmus’ activities in PY14 included review of fourteen (14) projects, encompassing the following activities:

- 4 Measure Types reviewed
- 8 Ride-Alongs conducted
- 19% of Verified Non-Res Energy Savings reviewed
- 15% of Verified Non-Res Demand Savings reviewed

Table 110 provides the overall results of the SWE Verified Savings Audit for C&I projects.

**Table 110: PPL C&I Verified Savings Audit Results**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
14	20,912,641	98.3%	2,640	97.2%

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 a total of five reviewed projects. For these projects, the SWE either revised the reported hours of use, coincident factor, lamp wattages, or the lamp quantity. The SWE’s proposed modifications to these projects resulted in marginally (1.7%) lower energy savings.

**C.6 NTG**

Table 111 lists PPL’s PY14 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 111: Summary of PPL's PY14 NTG Results

Program Name	Component	NTG
Non-Residential	Custom	0.74
Non-Residential	Efficient Equipment	0.63
Low-Income	Low-Income	1.0
Residential	Appliance Recycling	0.56
Residential	Efficient Lighting	1.07
Residential	Energy Efficient Homes	0.53
Residential	Student Energy Efficient Education	1.0
<b>Portfolio Total</b>		<b>0.69</b>

### C.6.1 Residential Programs

Cadmus planned and conducted PY14 residential program NTG estimation for Energy Efficient Homes. The Appliance Recycling NTG and the Efficient Lighting NTG were estimated previously for PY13. The Energy Efficient Homes NTG was estimated by weighting three program strata NTG by PY14 gross savings. New data were collected for the Audit and Weatherization stratum NTG (0.61 total) and for the New Homes stratum NTG (0.64), both of which were then combined with the Downstream Equipment stratum NTG (0.51), which had been estimated previously in PY13. Over 88% of the PY14 Energy Efficient Homes program savings came from the Downstream Equipment strata so the overall program NTG of 0.53 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 112).

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 112: Summary of PPL's PY14 Residential NTG Results

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Appliance Recycling	N/A	N/A	45%	1%	0.56
Efficient Lighting	N/A	N/A	N/A	N/A	1.07
Energy Efficient Homes	Self-report surveys	72	48%	1%	0.53
Student Energy Efficient Education	N/A	N/A	N/A	N/A	1.0
<b>Program Total</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>0.60</b>

### C.6.2 Non-Residential Energy Efficiency Programs

PY14 Non-Residential program NTG estimation was planned and conducted for the Non-Residential Custom and Efficient Equipment (Non-Lighting and Lighting strata only) programs (Table 113). The PY14 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 0.16 and a Lighting NTG of 0.65. The Midstream Lighting NTG was estimated previously for PY11. The Custom NTG (0.74) was calculated using survey data from 12 PY14 participants (13% 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 Custom and Efficient Equipment programs to estimate NTG in future efforts.

**Table 113: Summary of PPL's PY14 Non-Residential NTG Results**

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Custom	Self-report surveys	12	26%	0%	0.74
Efficient Equipment Non-Lighting	Self-report surveys	4	84%	0%	0.16
Efficient Equipment Lighting	Self-report surveys	22	35%	0%	0.65
Midstream Lighting	N/A	0	38%	0%	0.62
<b>Program Total</b>	<b>N/A</b>		<b>N/A</b>	<b>N/A</b>	<b>0.68</b>

### C.7 TRC

Table 114 shows the high-level TRC Test results for PPL in PY14 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 114: Summary of PPL's PY14 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	\$64,886	\$26,127	2.48	\$48,016	\$20,125	2.39
Efficient Equipment	\$82,393	\$52,563	1.57	\$51,899	\$35,292	1.47
Low-Income	\$8,753	\$6,314	1.39	\$8,753	\$6,314	1.39
Appliance Recycling	\$2,577	\$2,024	1.27	\$1,443	\$2,024	0.71
Efficient Lighting	\$2,693	\$1,254	2.15	\$2,155	\$1,254	1.72
Energy Efficient Home	\$22,297	\$19,033	1.17	\$12,367	\$11,606	1.07
Student Energy Efficient Education	\$0	\$0	-	\$0	\$0	-
Common Portfolio costs	\$0	\$5,449	-	n/a	5449	-
<b>Portfolio Total</b>	<b>\$183,599</b>	<b>\$112,763</b>	<b>1.63</b>	<b>\$124,633</b>	<b>\$82,064</b>	<b>1.52</b>

PY14 TRC test results showed that every program was cost-effective in gross terms, while all but Appliance Recycling were cost-effective on a net basis. The non-residential sectors accounted for 80% of the total TRC Gross Benefits in PY14. The Residential program with the highest individual Gross TRC benefits was Efficient Lighting at 2.15. The Non-Residential program with the highest Gross TRC ratio was the Custom program component at 2.48.

### C.7.1 Notes from the TRC Model Review

The PY14 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 PY14 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 PY14 fossil fuel benefits through a similar process as described for the electric benefits. The derivation of these non-electric impacts was well-documented in PY14 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.
- The SWE team found that PPL utilized a replacement on burnout measure vintage for incremental measure costs for prescriptive non-residential lighting measures. The savings

and associated benefits were calculated using the early replacement vintage per the 2021 TRM.

- The SWE found, through spot checking, that EULs were correctly applied from the 2021 TRM.

## 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 (no process evaluation in PY14)
- Energy Efficient Homes component
  - New Homes sub-component (no process evaluation in PY14)
  - Audit and Weatherization sub-component
  - Online Marketplace sub-component
  - Downstream Equipment sub-component
  - Midstream Equipment sub-component
- Student Energy Efficient Education component

Table 115 summarizes program component or sub-component satisfaction for the Residential Program.

**Table 115: PPL PY14 Program Satisfaction Summary- Residential Program**

Program Component / Sub-component	Population	% Satisfied
Appliance Recycling	Participants	93%
Energy Efficient Home – Audit and Weatherization	Participants	84%
Energy Efficient Home – Online Marketplace	Participants	75%
Energy Efficient Homes – Equipment (downstream)	Participants	77%
Energy Efficient Homes – Overall	Participants	78%
Student Energy Efficient Education	Students	86%
Student Energy Efficient Education	Teachers	99%
Student Energy Efficient Education – Overall	Students and Teachers	86%
Residential Program – Overall	Participants, Teachers, Students	85%

#### 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. 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; and customer sub-component program satisfaction. Based on these data, the following key process findings emerged:

- Appliance Recycling remains the Residential Program component with the highest levels of participant satisfaction, with 93% of respondents reporting they were either very satisfied or somewhat satisfied (n=139).
- The program component did not undergo any significant changes in PY14.

### **Summary of Process Evaluation Audit**

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan, except for an additional survey to assess overall participant satisfaction with the Appliance Recycling component.

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 participants for the participant survey responses and achieved a total of 139 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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.8.1.2 Efficient Lighting**

No process evaluation was conducted in PY14.

#### **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 customers. Cadmus also made updates to the Phase III logic model for the Midstream Equipment subcomponent, 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; opinions about PPL; likelihood to recommend the program sub-component; HVAC distributor satisfaction and market insights (for the Midstream Equipment subcomponent only); and recommendations. Based on these data, the following key process findings emerged:

- Audit and Weatherization participants were satisfied with their experience; 84% of respondents were very satisfied or somewhat satisfied (n=68). Respondents in both groups noted a very positive experience with their contractor or auditor. Weatherization respondents' satisfaction was also particularly driven by the rebate they received for installing insulation as well as the reduction in their energy bill. Respondents who received an in-home audit reported the findings from the audit were more useful than those who received a virtual assessment.
- Cadmus interviewed one of two distributors associated with Midstream Equipment subcomponent who indicated interest in the delivery channel in early PY14. The other distributor declined the interview due to recent staff changes. The distributor who was interviewed was very satisfied with their experience with the Midstream Equipment subcomponent, noting that the ICSP had been very responsive and helpful with the onboarding process. However, this distributor had not made any eligible sales through the delivery channel and therefore had limited feedback on how it was running.

### **Summary of Process Evaluation Audit**

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan, with a few exceptions. For the interview with the midstream equipment distributors, Cadmus contacted all participating distributors for an interview, but one was unable to participate due to recent staff changes, resulting in just one completed interview. Cadmus also completed two additional online surveys to measure customer satisfaction among Downstream Equipment and Online Marketplace subcomponent participants. The reason for these changes 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 all eligible Audit and Weatherization participant survey responses, all eligible Online Marketplace participant survey responses, and all eligible Downstream Equipment participant survey responses. It achieved a total of 68 Audit and Weatherization participant survey responses, 105 Online Marketplace participant survey responses, and 155 Downstream Equipment participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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.8.1.4 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. 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, 86% of PY14 responding participants gave positive ratings of the Student Energy Efficient Education component (86% very satisfied or somewhat satisfied for students, and 99% excellent or good for teachers).
- In PY14, the question wording and response scale for overall satisfaction with the component in the teacher evaluation forms changed to align with the response scale in the student HEWs.
- Changes for PY14 included moving to all in-person presentations, the inclusion of dusk to dawn bulbs to all kits and an additional LED nightlight for the Take Action Cohort.
- Teachers had particularly positive comments about the PY14 presenters.

#### 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 14,500 student survey responses and 124 teacher survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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 Non-Residential Program

The Non-Residential Program is made up of the following components and sub-components, shown below:

- Efficient Equipment component



- Downstream including lighting (process evaluation in PY14) and equipment (process evaluation in PY14) participant pathways
- Midstream sub-component, including lighting (no process evaluation in PY14) and equipment (process evaluation in PY14) participant pathways
- Custom component (process evaluation in PY14)

Table 116 summarizes program component or sub-component satisfaction for the Non-Residential Program.

**Table 116: PPL PY14 Program Satisfaction Summary- Non-Residential Program**

Program Component / Sub-component	Population	% Satisfied
Efficient Equipment (downstream)	Participants	89%
Lighting (downstream)	Participants	89%
Custom	Participants	83%
Non-Residential Program – Overall	Participants	86%

### 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. 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:

- The overall satisfaction rate was 89%.
- A majority of the survey respondents (73%; n=26) reported that participating was either very easy or easy, a decline from 88% in PY13 (n=28).
- Similar to PY13, the program components that most affected customers' satisfaction rating was the rebate amount (62%; n=26), reducing energy bills (62%), and increasing energy savings (58%).
- Most survey respondents (72%; n=25) said their opinion of PPL Electric Utilities had either improved significantly or improved somewhat after participating in the Efficient Equipment component.
- The percentage of customers who reported being likely to recommend the program component decreased from 85% in PY13 (n=26) to 77% in PY14 (n=26).
- The main source of awareness of the program component is the contractor (39%), followed by a PPL Electric Utilities representative (14%; n=28).



### 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 (up to 23) was not reached for each Downstream Lighting group (Downstream, Direct Install, and Direct Discount).<sup>70</sup>

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 non-lighting participant survey responses and all eligible lighting participant survey responses. It achieved a total of six non-lighting participant survey responses and 24 lighting participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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)

For midstream non-lighting equipment, Cadmus conducted a process evaluation in PY14, including distributor interviews, to inform the logic model review. Cadmus received useful responses from 8 of 12 distributors contacted, and six completed interviews. Cadmus also interviewed staff from PPL Electric Utilities and the ICSP about the status of midstream lighting and non-lighting offerings. The evaluation activities were consistent with the planned activities.

### 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, surveyed participating distributors. Cadmus also made updates to the Phase III logic model, with updates based on interviews with PPL 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; midstream equipment marketing, and recommendations. Based on these data, the following key process findings emerged:

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<sup>70</sup> The Process section of the PPL EM&V Plan indicated that the targeted sample size for the Downstream Lighting subcomponent was all eligible respondents for the process evaluation, but the Net Savings section of the PPL EM&V Plan indicated the targeted sample size for the Lighting subcomponent was up to 23 survey completes per Lighting group (Downstream, Direct Install, and Direct Discount) for the questions used in net savings estimation.

- Cadmus interviewed non-lighting equipment distributors who offered agriculture and food service equipment and heard about challenges that differed by industry and equipment type.
- All six distributors reported that the onboarding process was easy, and that ICSP staff provided all the support that was needed.
- Cadmus interviewed five agriculture distributors and received open-ended feedback from two more who declined to be interviewed because they had not applied for any incentives through the program yet: six of these seven agriculture distributors reported that many of their sales did not qualify for midstream incentives because their customers had residential electric rates. Currently, only non-residential customers of PPL Electric Utilities can qualify for program incentives.
- The food service distributor faced a different set of challenges including issues with the incentive portal and that the program subcomponent only covers electric equipment.

### **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 achieved a total of six non-lighting participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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.8.2.3 Lighting (Midstream)**

No process evaluation was conducted in PY14 beyond interviews with program and implementation staff for the Midstream Lighting sub-component.

#### **C.8.2.4 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. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; customer program satisfaction, drivers of program component satisfaction; ease of participating in the program;

opinions about PPL; likelihood to recommend the program component; and recommendations. Based on this data, the following key process findings emerged:

- Ten of the 12 survey respondents were either very or somewhat satisfied with the program component.
- Most survey respondents reported being satisfied with the installation experience, the quality of the installed product, the contractor they worked with, and the availability of the contractor in their area.
- The main drivers of high satisfaction in PY14 were communication, increased energy savings, and the rebate amount.
- Eight of the 12 survey respondents reported that it was easy to participate in this program component.
- Seven of the 12 survey respondents reported having a better opinion of PPL Electric Utilities after participating in the Custom component.
- Overall, 11 of the 12 survey participants were likely to recommend the component to a friend, family member, or colleague.

### 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 12 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 this program component; 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.8.3 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
  - In-Home / On-site sub-component
  - Welcome Kits sub-component

Table 117 summarizes program component or sub-component satisfaction for the LI Program.

**Table 117: PPL PY14 Program Satisfaction Summary- LI Program**

Program Component / Sub-component	Population	% Satisfied
Low-Income Assessment – Remote Energy Assessment (REA)	Participants	90%
Low-Income Assessment – In-Home / On-Site	Participants	79%
Low-Income Assessment – Welcome Kits	Participants	86%
LI Program – Overall	Participants	86%

### C.8.3.1 Remote Energy Assessment (REA)

#### Summary of Process Evaluation Results

For the process evaluation of this program sub-component, Cadmus reviewed program documents and data, conducted monthly check in meetings with PPL and ICSP program managers, and surveyed participants. The research issues addressed by the primary data-collection activities (monthly check in meetings 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; recommendations; program awareness; actions on recommendations; knowledge of energy efficiency, and home comfort. Based on these data, the following key process findings emerged:

- Cadmus found that 90% of PY14 REA responding participants (81% very satisfied and 9% somewhat satisfied; n=75) were satisfied with the program overall.
- Eighty-four percent (n=73) of PY14 REA responding participants found it very easy or easy to participate in the program.
- The most common reason PY14 REA responding participants were very or somewhat satisfied with the program sub-component was reduced energy bills.
- Of 102 REA and on-site survey respondents, over half (59%) said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 31% said their opinion had not changed, and 9% (four respondents) said their opinion decreased.
- Overall, 74% (n=73) of PY14 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 two exceptions. Cadmus deferred interviews with master-metered multifamily (MMMMF) owners to PY15 due to low participation in PY14 and conducted monthly check in meetings with PPL and the ICSP staff instead of in-depth interviews. 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 30 participant survey responses and achieved a total of 58 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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 In-Home / On-Site

#### Summary of Process Evaluation Results

For the process evaluation of this program sub-component, Cadmus reviewed program documents and data, conducted monthly check in meetings with PPL and ICSP program managers, and surveyed participants. The research issues addressed by the primary data-collection activities (monthly check in meetings 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; recommendations; program awareness; actions on recommendations; knowledge of energy efficiency, and home comfort. Based on these data, the following key process findings emerged:

- Cadmus found that 79% of PY14 On-Site responding participants (67% very satisfied, 12% somewhat satisfied, n=42) were satisfied with the program overall.
- Ninety-eight percent (n=42) of PY14 On-Site responding participants found it very easy or easy to participate in the program.
- The most common reason PY14 On-Site responding participants were very or somewhat satisfied with the program sub-component was the performance of their auditor.
- Of 102 REA and On-Site survey respondents, over half (59%) said their opinion of PPL Electric Utilities had improved after participating in the Low-Income Program, 31% said their opinion had not changed, and 9% (four respondents) said their opinion decreased.
- Overall, 68% (n=43) of PY14 On-Site 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 two exceptions. Cadmus deferred interviews with master-metered multifamily (MMMMF) owners to PY15 due to low participation in PY14 and conducted monthly check in meetings with PPL and the ICSP staff instead of in-depth interviews. 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 36 participant survey responses and achieved a total of 31 participant survey responses. For on-site assessments, Cadmus sent additional waves of invitations to participants in an attempt to reach 36 responses but did not reach the desired target.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 and that applied to this program component; both recommendations have 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.8.3.3 Welcome Kits

#### Summary of Process Evaluation Results

For the process evaluation of this program sub-component, Cadmus reviewed program documents and data, conducted monthly check in meetings with PPL and ICSP program managers, and surveyed participants. The research issues addressed by the primary data-collection activities (monthly check in meetings and surveys) included the effectiveness of program administration, implementation, and delivery; customer program satisfaction, drivers of program sub-component satisfaction; opinions about PPL; and recommendations. Based on these data, the following key process findings emerged:

- Cadmus found that 86% of welcome kit respondents (75% very satisfied and 11% somewhat satisfied; n=73) were satisfied with the program overall.
- The most common reason responding PY14 welcome kit recipients were very or somewhat satisfied with the program sub-component was reduced energy bills.
- Of 67 welcome kit survey respondents, 52% said their opinion of PPL had improved after participating in the Low-Income Program, 37% said their opinion had not changed, and 10% (seven respondents) said their opinion decreased.

#### Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase IV Evaluation Plan, with two exceptions. Cadmus deferred interviews with master-metered multifamily (MMMMF) owners to PY15 due to low participation in PY14 and conducted monthly check in meetings with PPL and the ICSP staff instead of in-depth interviews. 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 30 participant survey responses and achieved a total of 86 participant survey responses.

The SWE also determined that the reporting followed the SWE guidelines. The PPL PY14 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 PY14 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.



## Appendix D Duquesne Light PY14 Audit Detail

### D.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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 PY14 Annual Report.
- Guidehouse provided their Residential and Low Income verified savings analyses prior to drafting their Duquesne Light PY14 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 PY14 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.
- The portfolio result was driven largely by the performance of the non-residential program, which had a gross TRC ratio of 2.10.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Duquesne Light's PY14 Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE was able to replicate the reported MWh savings and reported MW savings exactly. 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.
- Duquesne Light had five active behavioral HER cohorts in PY14 with approximately 144,000 treated households. Three of the cohorts consists of low-income households. On average, HER recipients saved approximately 49 kWh, or 0.7% of their annual consumption, in PY14. Two cohorts were mature enough to require persistence calculations to separate incremental savings from persisting savings from prior exposure. The SWE was able to replicate the verified energy and demand savings values and found that HER impact evaluation was entirely consistent with their proposed and approved EM&V plans and the Phase IV HER account framework. The SWE team does not propose any revisions to the PY14 methods or results.
- The PY14 impact evaluation of Duquesne Light's Small Business Direct Install program failed to meet the  $\pm 15\%$  relative precision requirement in the Phase IV Evaluation Framework. This will require an update to Duquesne Light's EM&V Plan. The approved EM&V Plan called for use of a historic realization rate in PY15. However, the Phase IV Evaluation Framework states that "*Impact evaluations that fail to meet the minimum precision requirements are not permitted to be used as historic realizations rates.*" This means Duquesne Light will need to conduct an impact evaluation of the component in PY15 or leave the savings unverified until the PY16 impact evaluation is complete (e.g., employ a two-year sample).



- 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 PY14. 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 with some exceptions. The SWE observed discrepancies in some of the upstream lighting documentation that was reviewed, namely in quantities reported in the tracking data compared to the quantities listed in the lighting invoice.
- 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 PY14 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 redline version of their PY14 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, Guidehouse submitted several memos detailing their sampling approach for program components selected for impact, process and NTG evaluations in PY14.

As discussed in [Section 4.2](#), each EDC was given freedom to determine the appropriate cadence of impact verification for its programs. [Table 118](#) shows which Duquesne Light programs produced verified impacts in PY14 and which used historic realization rates in PY14.

**Table 118: PY14 Duquesne Light Program Impact Evaluation Summary**

Sector	Program	PY14 Impacts
Residential	Upstream Incentives	Verified
	Midstream Incentives	Historic realization rate
	Downstream Incentives	Historic realization rate
	Appliance Recycling	Historic realization rate
	Residential Behavioral	Verified
Low-Income	Low-Income Behavioral	Verified
	Low-Income Energy Efficiency	Verified
Small C&I	Small Business Direct-Install	Verified
	Small Business Solutions	Verified
	Small Business Midstream	Verified
	Small Virtual Commissioning	Verified
Large C&I	Large Business Solutions	Verified
	Large Business Midstream	Verified
	Large Virtual Commissioning	Verified

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 that serve multiple sectors. [Table 119](#) shows the reported relative precision of savings estimates by sector and program. The residential downstream incentives, midstream incentives, and appliance recycling initiatives were verified

using historic realization rates and are therefore omitted from the table. Behavioral programs that do not have uncertainty associated with sampling are also omitted from the table.

**Table 119: Relative Precision of PY14 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%
	LI Energy Efficiency	1.4%	1.3%
Small Medium C&I	Small Business Direct Install	29.0%	5.0%
	Small Business Solutions	5.1%	14.3%
Large C&I	Large Business Solutions	0.0%	2.0%
Cross Cutting	Midstream Solutions	13.0%	11.0%

In addition to reporting relative precision by program, Guidehouse also reported relative precision at an aggregated initiative level. For PY14, Guidehouse evaluated the six different initiatives shown in [Table 119](#), grouping small business and large business midstream solutions together when estimating the relative precision of energy and demand. All initiatives evaluated during PY14 met the 85/15 precision requirement for energy and demand impacts except for Small Business Direct Install (SBDI). In the Duquesne Light PY14 Annual Report, Guidehouse addresses the missed  $\pm 15\%$  threshold for the SBDI initiative, citing difficulty contacting sites combined with unexpected high variance and low realization rates compared to prior evaluations of similar programs. The SWE was able to replicate the realization rates and 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 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 solution-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 SWE reviewed the design of Duquesne Light's behavioral offerings and found the treatment and control group sizes were adequate to achieve  $\pm 0.5$  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 PY14 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. 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 120 summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in Duquesne Light’s PY14 Annual Report and “No” otherwise. The SWE was able to replicate all values reported by Duquesne Light.

**Table 120: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Downstream Incentives	2,225	2,225	Yes
Residential Midstream Incentives	3	3	Yes
Residential Upstream Incentives	2,936	2,936	Yes
Residential Appliance Recycling	2,014	2,014	Yes
Low Income Energy Efficiency	2,605	2,605	Yes
Small Business Direct Install	3,740	3,740	Yes
Small Business Solutions	8,610	8,610	Yes
Small Business Midstream Solutions	39,669	39,669	Yes
Small Business Virtual Commissioning	500	500	Yes
Commercial Large Business Solutions	6,633	6,633	Yes
Industrial Large Business Solutions	15,058	15,058	Yes
Large Business Midstream Solutions – Commercial	6,510	6,510	Yes
Large Business Midstream Solutions – Industrial	11,665	11,665	Yes
Large Business Virtual Commissioning	2,515	2,515	Yes
<b>Portfolio Total</b>	<b>104,682</b>	<b>104,682</b>	<b>Yes*</b>

\*The Residential Energy Efficiency Programs have HER components 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. The SWE was able to replicate all values reported by Duquesne Light.

Table 121: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Residential Downstream Incentives	0.31	0.31	Yes
Residential Midstream Incentives	0.00	0.00	Yes
Residential Upstream Incentives	0.41	0.41	Yes
Residential Appliance Recycling	0.49	0.49	Yes
Low Income Energy Efficiency	0.25	0.25	Yes
Small Business Direct Install	0.70	0.70	Yes
Small Business Solutions	1.97	1.97	Yes
Small Business Midstream Solutions	8.66	8.66	Yes
Small Business Virtual Commissioning	0.02	0.02	Yes
Commercial Large Business Solutions	1.47	1.47	Yes
Industrial Large Business Solutions	1.17	1.17	Yes
Large Business Midstream Solutions – Commercial	1.27	1.27	Yes
Large Business Midstream Solutions – Industrial	2.70	2.70	Yes
Large Business Virtual Commissioning	0.24	0.24	Yes
<b>Portfolio Total</b>	<b>19.66</b>	<b>19.66</b>	<b>Yes*</b>

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

Table 122 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar or exactly replicate participation counts for all programs except Low Income Energy Efficiency. The portfolio totals, though not exactly equal, line up well: 49,164 in the Duquesne Light PY14 Annual Report and 40,036 in the tracking data.

Table 122: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Residential Downstream Incentives	29,179	27,916	No
Residential Midstream Incentives	1	0	No
Residential Upstream Incentives	0	0	Yes
Residential Appliance Recycling	3,339	3,109	No
Low Income Energy Efficiency	13,227	5,601	No
Small Business Direct Install	252	244	No
Small Business Solutions	167	167	Yes
Small Business Midstream Solutions	2,191	2,191	Yes
Small Business Virtual Commissioning	7	7	Yes
Commercial Large Business Solutions	48	48	Yes
Industrial Large Business Solutions	8	8	Yes
Large Business Midstream Solutions – Commercial	573	570	No
Large Business Midstream Solutions – Industrial	166	164	No
Large Business Virtual Commissioning	6	6	Yes
<b>Portfolio Total</b>	<b>49,164</b>	<b>40,036</b>	<b>No*</b>

\*The Residential Energy Efficiency Programs have HER components 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 Duquesne Light's PY14 Annual Report. The SWE was able to exactly replicate incentive dollars for several programs. For most of the remaining programs, the SWE calculated directionally similar values using the tracking data. The portfolio totals are also directionally similar: \$15,627,000 in the Duquesne Light PY14 Annual Report and \$13,998,000 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 123: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Residential Downstream Incentives	\$60	\$87	No
Residential Midstream Incentives	\$1	\$1	Yes
Residential Upstream Incentives	\$470	\$470	Yes
Residential Appliance Recycling	\$163	\$163	Yes
Low Income Energy Efficiency	\$1,458	\$60	No
Small Business Direct Install	\$2,141	\$1,575	No
Small Business Solutions	\$395	\$589	No
Small Business Midstream Solutions	\$6,394	\$6,455	No
Small Business Virtual Commissioning	\$95	\$88	No
Commercial Large Business Solutions	\$561	\$458	No
Industrial Large Business Solutions	\$1,072	\$1,072	Yes
Large Business Midstream Solutions – Commercial	\$894	\$867	No
Large Business Midstream Solutions – Industrial	\$1,458	\$1,452	No
Large Business Virtual Commissioning	\$465	\$443	No
<b>Portfolio Total</b>	<b>\$15,627</b>	<b>\$13,998</b>	<b>No</b>

## D.4.2 Project File Reviews

### D.4.2.1 Residential

The SWE conducted a project file review for a sample of projects within Duquesne Light's residential programs in PY14 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 124 presents a summary of SWE's residential project file reviews. Project files were found to match most of the tracking data, though there were some exceptions.

**Table 124: Duquesne Light PY14 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? <sup>1</sup>
Residential Incentives	Downstream Rebates, Audits, EE Education	11	✓	✓	✓	✓
Residential Recycling	Appliance	11	✓	✓	✓	✓
Residential Incentive <sup>2</sup>	Midstream	-	-	-	-	-
Residential Incentive	Upstream Lighting, Appliances	9	✓	✓	X	X
Low Income Efficiency	Energy	10	✓	✓	✓	✓

<sup>1</sup> It should be noted that while the data typically matches, minor discrepancies were 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 project file packages and quarterly tracking data.

In general, the SWE found that tracking data matched the measures and quantities in project documentation. However, there were some exceptions, most notably within the Residential Upstream Incentive program. Overall, the SWE felt that the documentation provided for Duquesne Light residential and low-income programs fulfilled the requirements, though there is area for improvement regarding the clarity of upstream documentation.

**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. These project files were accompanied by a list containing the Energy Star ID number for the majority of the purchased equipment. The SWE verified that the reviewed project files matched the measures and quantities in the tracking data.

**Residential Appliance Recycling**

The Residential Appliance Recycling program had project files containing photos of the recycled appliances. These project files were accompanied by a list of recycled appliances, and the associated dates, addresses, rebates paid, ages, and sizes. The SWE notes that some of the

photos of the appliances did not include nameplates, and as result certain characteristics were unable to be verified. However, the SWE notes the general thoroughness of the documentation.

#### **Residential Midstream Incentive**

There was limited participation in PY14 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 appliances. While these files contained project numbers or similar designations that would aid in matching the purchases with their respective entries within the tracking data, in the third quarter the designations had no corresponding counterparts in the tracking data. In addition, the quantities reported in the files that could be matched to the tracking data were inconsistent with the provided documentation. This discrepancy in quantities was noted in four of the five files with corresponding tracking data. In one file, for example, the listed quantity was 2.78 lamps while the invoice noted 133 packs of lightbulbs, totaling 338 lamps.

#### **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 matched the measures and quantities in the tracking data. However, the SWE does note that there were three cases where the premise type in the tracking data did not align with the premise type listed in the documentation.

#### **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 PY14 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 125 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 125: Duquesne Light PY14 C&amp;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?
Large C&I	Industrial Large Business Solutions	1	✓	✓	✓	✓	✓
Large C&I	Commercial Large Business Solutions	2	✓	✓	✓	1/2	✓
Small C&I	Small Business Solutions	4	✓	✓	3/4	✓	✓
Small C&I	Small Multifamily Housing Retrofit	1	✓	✓	✓	✓	✓
Small C&I	Small Business Direct Install	7	✓	6/7	✓	✓	✓

A few project discrepancies are described below by each program.

- **Large Commercial Business Solutions**
  - For one lighting retrofit project, a detailed line-by-line invoice was not included in project documentation.
- **Small Business Direct Install (SBDI) Solutions**
  - For one new construction lighting project, some fixtures quantities in the COMCheck document did not align with quantities in the App C calculator.

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 126 provides a summary of the evaluation and M&V approaches used by Duquesne Light in their PY14 verified savings calculations.

**Table 126: Residential Program Evaluation Activities – Duquesne Light Company**

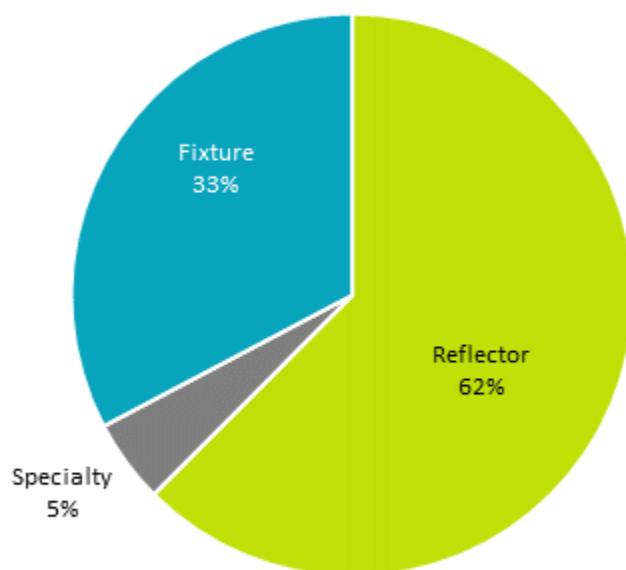
Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis	Applied Historic RR
RDIP (Rebates)	-	-	-	-	✓
RDIP (Audits)	-	-	-	-	✓
RDIP (EE Education)	-	-	-	-	✓
RARP	-	-	-	-	✓
RMIP <sup>b</sup>	-	-	-	-	-
RIUP (lighting)	-	-	✓	-	-
RIUP (appliances)	-	-	✓	-	-
LIEEP – Audits	✓	-	✓	-	-
LIEEP – Kits	-	-	✓	-	-
Residential Behavior	-	-	-	✓	-

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

<sup>b</sup> The Residential Midstream Incentive program was not evaluated due to limited activity, evaluation activities are planned for PY15.

#### D.5.1.1 Upstream Lighting and Cross-Sector Sales

Customers purchased over 183,000 efficient light bulbs and fixtures through Duquesne Light's PY14 upstream lighting program. Figure 41 displays the distribution of sales by product type. Most sales were either reflectors (62%) or fixtures (33%).

**Figure 41: Duquesne Light PY14 Upstream Lighting Sales by Product Type**

### ***Audit Findings***

Guidehouse provided the PY14 impact analysis for Duquesne Light's upstream lighting before the PY14 Duquesne Light 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 reviewed Duquesne Light's tracking data and Guidehouse's analysis to verify that Guidehouse used the appropriate values and TRM algorithms 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. The SWE will work with Guidehouse to correct the minor discrepancies going forward for the remainder of Phase IV.

The SWE verified that all of 329 models in the PY14 tracking system were ENERGY STAR qualified and that the lumens and wattages matched those listed in the ENERGY STAR qualified products list. The SWE notes that, for three models, there were multiple entries with different lumens and or wattages, only some of which were correct.

Sixteen models in the tracking system were designated for outdoor use. Guidehouse applied the appropriate hours of use, interactive effects, and coincidence factors for the residential bulbs installed outdoors, but not for the portion of bulbs assumed to have been installed in commercial settings (i.e., cross-sector sales). The commercial bulbs still utilized indoor hours of use, interactive effects, and coincidence factors.

### **Cross-Sector Sales**

Guidehouse did not conduct cross-sector sales research in PY14 but applied the TRM default cross-sector sales rate of 7.4%.

### **Recommendations**

The SWE recommends:

- For each model, ensuring that lumens and wattages are the same for all entries.
- For outdoor models, ensuring that outdoor hours of use, interactive effects, and coincidence factors are used for both residential and commercial bulbs.

#### **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 Residential Downstream Incentive Program applied historic realization rates from the PY13 evaluation. The SWE confirmed the reported savings values, and the historic realization rates were correctly applied for each stratum.

#### **Residential Appliance Recycling Program**

The Residential Appliance Recycling Program applied historic realization rates from the PY13 evaluation. The SWE confirmed the reported savings values, and the historic realization rates were correctly applied for each stratum.

#### **Residential Midstream Incentive Program**

There was no evaluation conducted for the Residential Midstream Incentives Program in PY14 due to limited activity. Evaluation activities are anticipated for PY15.

#### **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 (upstream lighting is detailed above). The SWE confirmed that the verified savings values for appliances 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. Guidehouse conducted a tracking database review for kit and giveaway events and surveyed customers that participated in the Audit component. The SWE confirmed that the measures savings were calculated in accordance with the TRM and the survey results were



applied correctly. The SWE confirmed that the savings and population counts aligned between the analysis files and the EDC report.

### D.5.1.3 Behavior

Approximately 5.8% of Duquesne Light's verified gross energy savings for PY14 came from Home Energy Reports issued to around 144,000 residential and residential-LI households. Twenty-one percent of Duquesne Light's progress toward its low-income target in PY14 came from HERs. Duquesne Light's behavioral portfolio consists of seven different waves in total. In PY14, five waves were active and received Home Energy Reports. [Table 127](#) summarizes the average number of active households during for these five cohorts. Duquesne Light has two active market rate cohorts that both began receiving HERs in 2021 and three cohorts targeting low-income households that began receiving HERs in 2015, 2018, and 2021. The 2021 cohorts include a trial of digital HER delivery and traditional non-digital delivery.

**Table 127: Duquesne Light HER Cohort Summary**

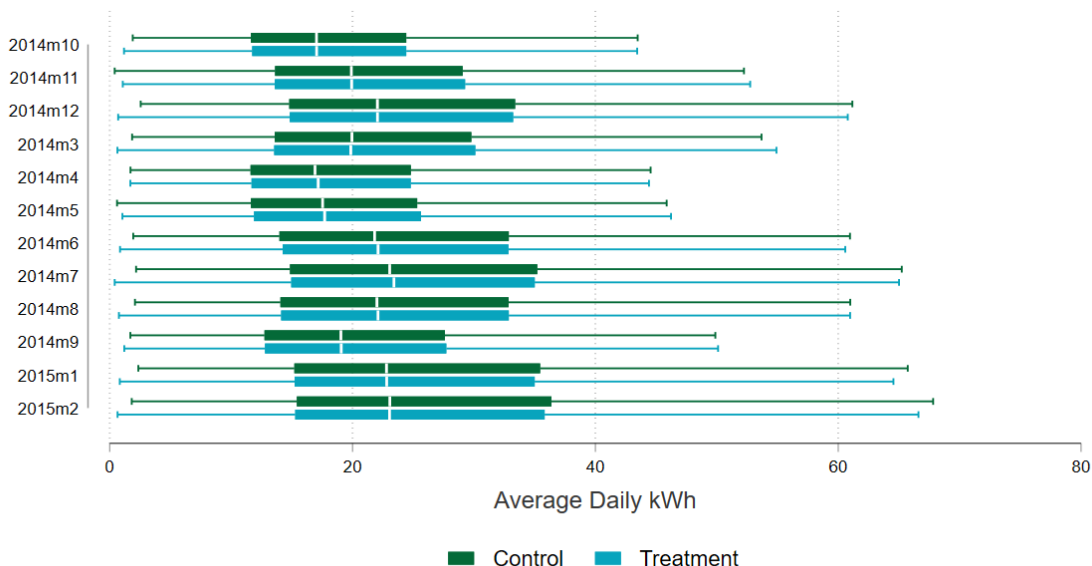
Wave	First HER Mailing	Treatment Group Homes	Control Group Homes
2015 Low Income	Mar 2015	7,410	3,691
2018 Low Income	Jul 2018	1,756	1,726
2021 Digital	Oct 2021	62,934	16,780
2021 Low Income	Oct 2021	10,402	7,731
2021 Non-Digital	Oct 2021	61,855	17,697

### ***RCT Validation***

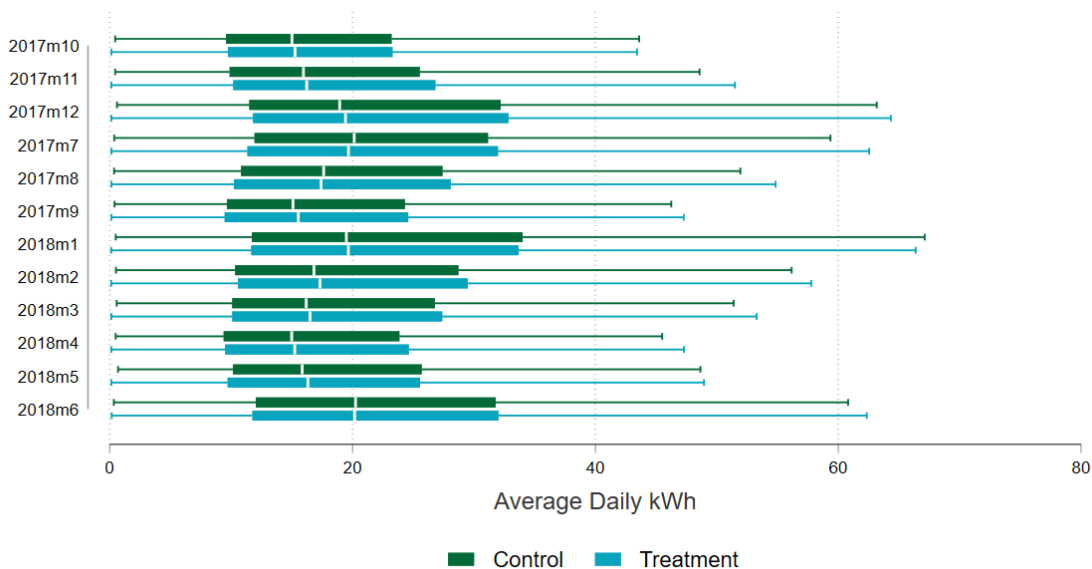
The number of treatment group homes at the initial launch of the 2015 and 2018 low-income waves was around 15,000 and 3,800, respectively, and the number of control homes was 8,000 and 3,800. By PY14, the number of treatment homes was around 7,400 and 1,760, and the number of control homes was around 3,700 and 1,730. While there is no reason to think HER recipients move or close their account with Duquesne Light differently from control group homes, the SWE felt that the shrinking size of these cohorts warranted a reconsideration of pre-treatment equivalence for the remaining households. The SWE team verified that pre-treatment daily usage was similar between treatment and control groups by (1) performing a simple fixed effects regression and (2) performing a t-test of daily usage between treatment and control. After running the fixed effects regression on month and treatment using pre-treatment data, the SWE team found the coefficient on treatment to be statistically insignificant, as the p-values for the treatment coefficients were greater than 0.10 for both the 2015 and 2018 low-income waves. In addition, the SWE team found differences in pre-treatment daily usage to be statistically insignificant with the t-test. [Figure 42](#) and [Figure 43](#) compare the monthly daily usage between treatment and control for the 2015 and 2018 low-income waves, reinforcing the SWE team's finding that

differences between treatment and control for pre-treatment usage are still negligible amongst the remaining active households.

**Figure 42: Pre-Treatment Equivalence (2015 Low Income)**



**Figure 43: Pre-Treatment Equivalence (2018 Low Income)**



**Data Preparation and Regression Coefficients**

The SWE team received both raw and calendarized billing data in response to the annual billing 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 PY14 impact analysis as called for in the Duquesne Light PY14 EM&V plan, and the model matches the specification in the EM&V plan exactly.

The SWE team first used Guidehouse-prepared data and regression specification and replicated exactly the regression coefficients reported by Guidehouse in their PY14 results. The SWE team then used SWE-prepared data to produce regression coefficients and found any differences between SWE coefficients and Duquesne Light coefficients to be insignificant. The following figures compare the regression coefficients of the SWE and Duquesne Light for each active wave and illustrate that any differences between the two sets of coefficients are insignificant. These coefficients have the units of daily kWh per customer.

The SWE offers the following observations regarding the performance of the active cohorts in PY14.

- The 2015 low-income wave shows more savings overall than the 2018 low-income wave.
- The 2018 low-income wave shows slight negative savings and wide confidence intervals due to the small number of homes remaining in the cohort.
- The 2021 low-income cohort shows higher average savings than the 2018 low-income cohort with estimated savings in all 12 months of PY14.
- All months during PY14 show statistically significant savings for the 2021 Digital wave.
- The 2021 non-digital cohort shows fewer savings than the 2021 Digital wave, but the SWE cannot make any causal inference that the difference in savings is a function of the treatment medium due to the non-random assignment of homes to the two 2021 Market Rate waves.

**Figure 44: Monthly Coefficient Comparison (2015 Low Income)**

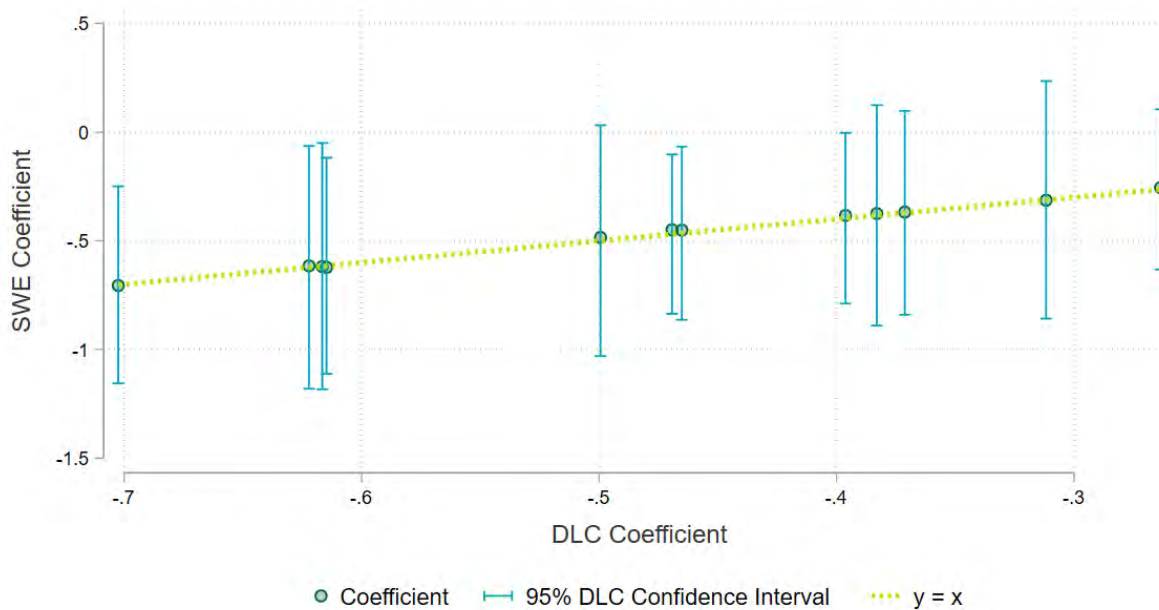


Figure 45: Monthly Coefficient Comparison (2018 Low Income)

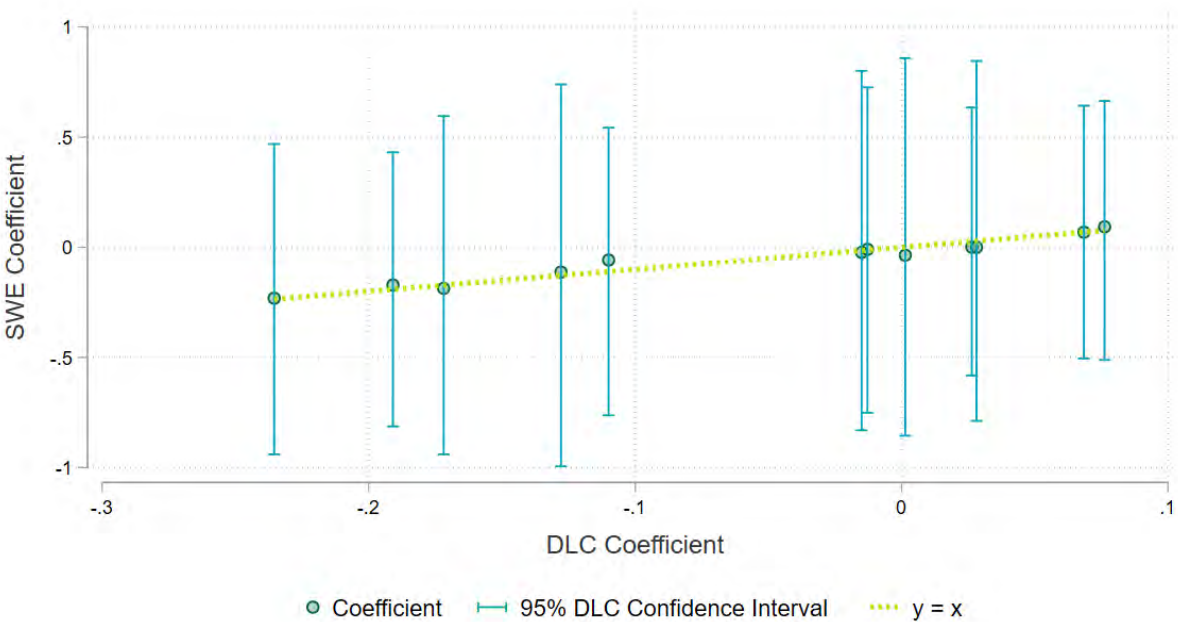


Figure 46: Monthly Coefficient Comparison (2021 Low Income)

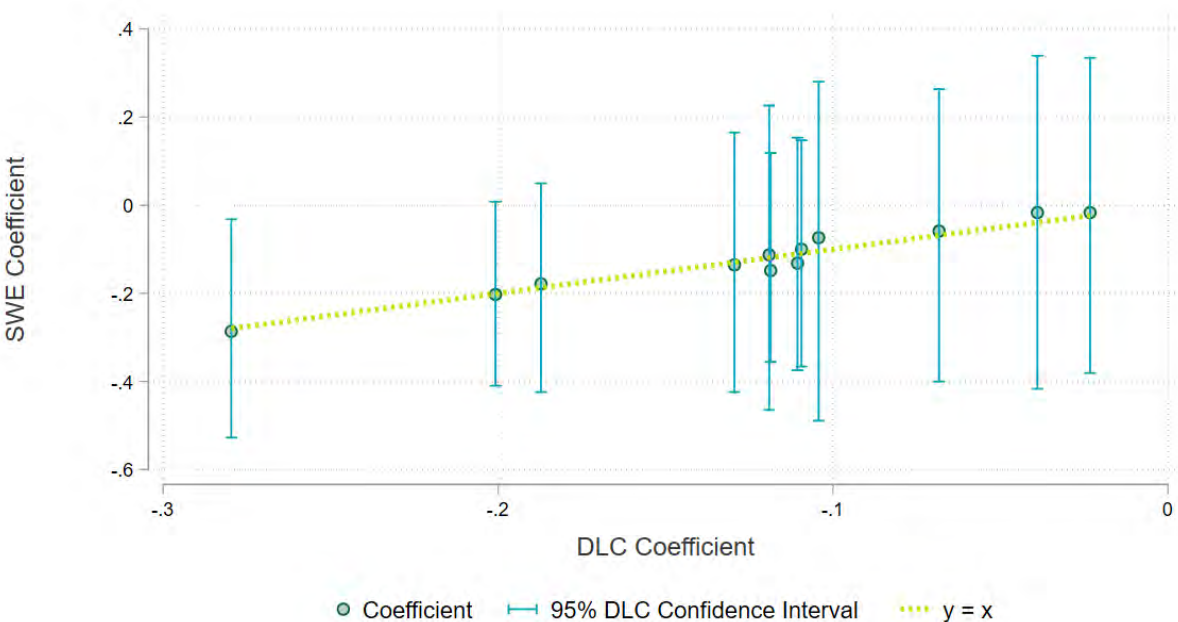


Figure 47: Monthly Coefficient Comparison (2021 Digital)

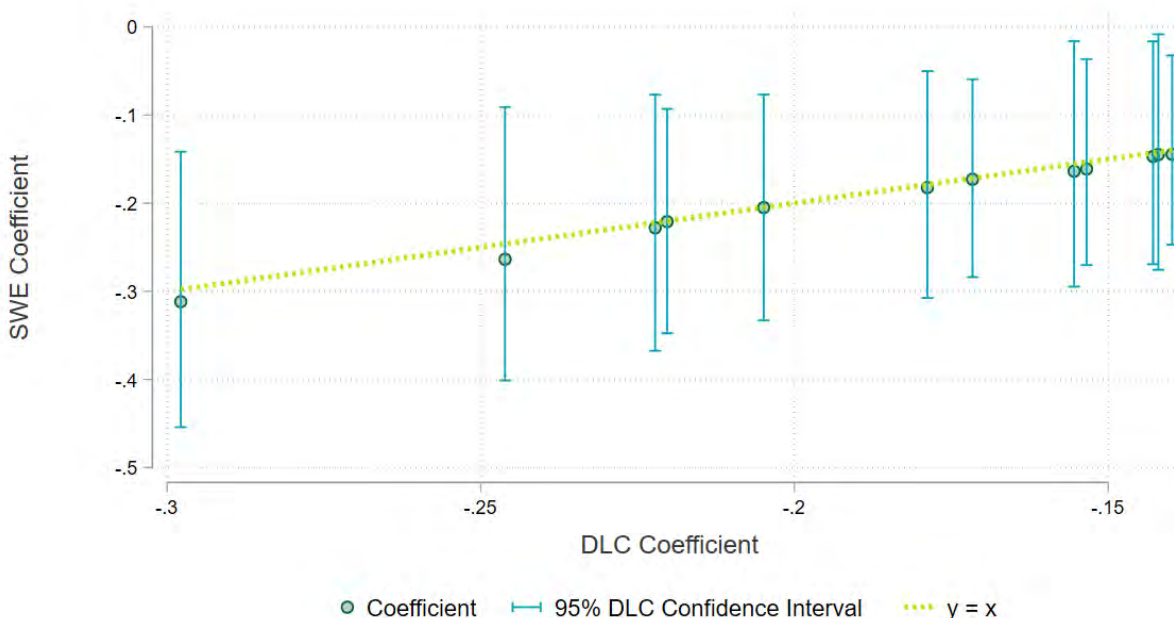
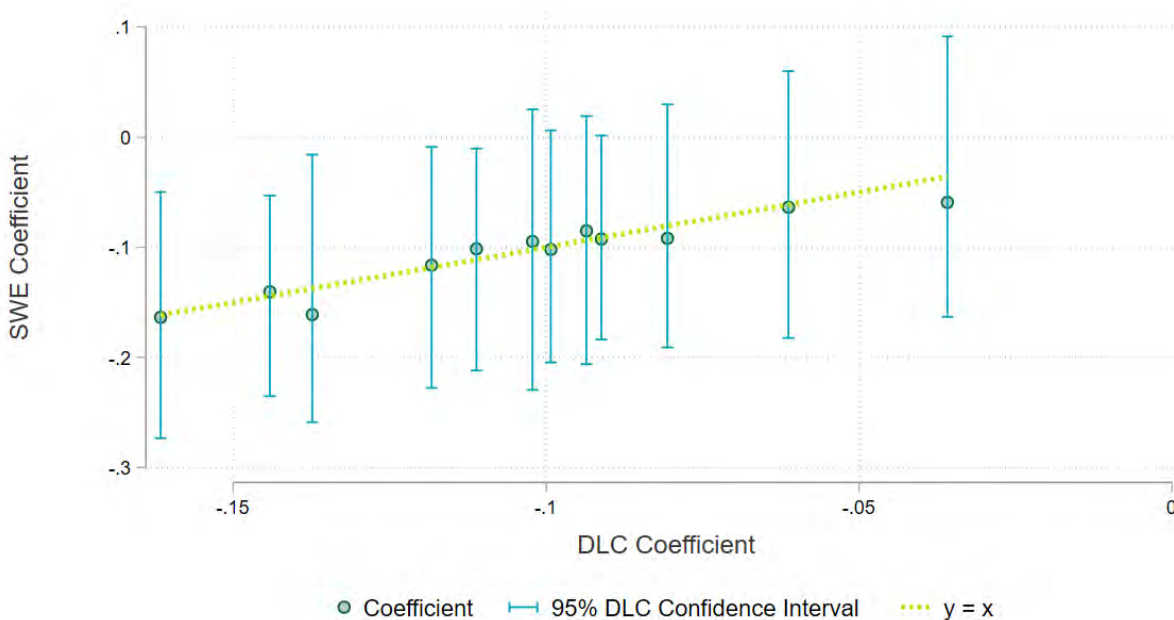


Figure 48: Monthly Coefficient Comparison (2021 Non-Digital)



Additionally, the SWE replicated the PY14 gross monthly savings for each cohort using data prepared by the SWE and found negligible differences.

**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 2022, then they would be counted in June, July, and August 2022, but not in September or any month following. The SWE team's final customer counts matched Guidehouse's counts within 0.1% for each month and each cohort.

### **Impacts**

The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and SWE's estimates closely match Guidehouse's estimates. [Table 128](#) shows the aggregate PY14 pre-adjustment gross savings (MWh) for each wave. Gross savings as well as first year incremental savings are the largest for the 2021 Digital wave. Dual Participation and persistence are discussed in the sections following [Table 128](#).

**Table 128: PY14 HER Energy Savings**

Wave	DLC Gross Savings (MWh)	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Gross Savings Net of Dual Participation (MWh)	Persistence (MWh)	First Year Incremental Savings (MWh)
2015 Low Income	1,285	198	33	1,054	771	284
2018 Low Income	37	28	0.27	8.73	29	-20
2021 Digital	4,344	124	63	4,157	0	4,156
2021 Low Income	480	6	7	467	0	466
2021 Non-Digital	2,340	113	33	2,194	0	2,194
<b>Total</b>	<b>8,485</b>	<b>469</b>	<b>137</b>	<b>7,879</b>	<b>800</b>	<b>7,079</b>

### **Dual Participation**

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. [Table 128](#) shows

that the total gross savings before adjusting for dual participation was 8,485 MWh, and after adjusting for dual participation was 7,879 MWh.

**Persistence**

The 2021 Pennsylvania TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research<sup>71</sup> 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<sub>y</sub> is the average daily savings attributable to HERs delivered in the current year (Y) and FYSATE<sub>y-x</sub> 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 five cohorts, which the SWE team verified matched TRM accounting rules. Table 129 displays persistence and first-year savings and their respective percentage of PY14 total dual-participation-adjusted savings. First-year savings make up a significant portion of PY14 total savings, as persistence is assumed to be zero for the three cohorts that launched in 2021 for the first two years. In addition, persistence from the 2018 low-income wave is minimal because the wave was inactive in PY13 and delivered only modest savings in Phase III.

**Table 129: PY14 HER Persistence and First-Year Savings**

Component	Savings (MWh)	Percentage of PY14 Total
Persistence from Prior Years	800	10%
PY14 First-Year Savings	7,079	90%
<b>Total</b>	<b>7,879</b>	<b>100%</b>

<sup>71</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)



### Low-Income

The 2021 digital and non-digital cohorts are classified as market rate. [Table 130](#) shows the breakdown of total HER first-year savings by sector.

**Table 130: PY14 HER First-Year Savings by Sector**

Sector	PY14 MWh
Market Rate	6,349
Low-Income	730
<b>Total</b>	<b>7,079</b>

### 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, the same method Guidehouse employed for estimating peak demand impacts for PY13. 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 is calculated as follows for HER in PY14:

$$\text{Incremental Peak Demand Savings} = \frac{7,079 \text{ MWh}}{8,760 \text{ hours}} * 1.63 * 1.0741 = 1.41 \text{ MW}$$

The total incremental first savings (7,079 MWh) was converted to MW by dividing by 8760, scaled by the peak demand multiplier (1.63), and finally, scaled by the line loss factor of 1.0741. Thus, the incremental peak demand savings is 1.41 MW, a result the SWE team agrees with.

### Conclusion

The SWE team found that Guidehouse's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 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 results from the SWE's review of Guidehouse's evaluation methodology that were applied to estimate project and program impacts from their sample of evaluated projects. The SWE completed this review using evaluation sample and population extracts provided by Guidehouse. These files provided details on each sampled project including the type of evaluation activity completed and the level of rigor applied to achieve evaluated results.

[Table 131](#) outlines the evaluation activities by project count for each of Duquesne Light's non-residential programs, along with the evaluation realization rates.

Table 131: Duquesne Light Evaluation Activities by Project Count

Program / Strata	Sample Quantity (PY13/PY14)	RR-Energy	RR-Demand	Desk Review	Phone Interview	On-Site Verification
<b>Downstream Business Solutions</b>	<b>29</b>	<b>99%</b>	<b>99%</b>	<b>1</b>	<b>12</b>	<b>16</b>
Industrial – Certainty	2	100%	100%	-	2	-
Commercial – Large	3	98%	98%	-	-	3
Commercial – Medium	4	98%	94%	-	1	3
Commercial – Small	2	99%	99%	-	1	1
Industrial – Large	3	100%	100%	1	-	2
Industrial – Medium	2	101%	101%	-	-	2
Small Business – Medium	5	92%	99%	-	1	4
Small Business – Small	8	105%	116%	-	7	1
<b>Midstream Business Solutions</b>	<b>42</b>	<b>124%</b>	<b>97%</b>	<b>-</b>	<b>9</b>	<b>33</b>
Large Business – Large	8	76%	61%	-	1	7
Large Business – Medium	3	94%	123%	-	-	3
Large Business – Small	6	361%	402%	-	1	5
Small Business – Large	6	329%	239%	-	-	6
Small Business – Medium	13	123%	99%	-	3	10
Small Business – Small	6	86%	90%	-	4	2
<b>Small Commercial Direct Install</b>	<b>10</b>	<b>89%</b>	<b>101%</b>	<b>-</b>	<b>1</b>	<b>9</b>
Large	3	74%	106%	-	-	3
Medium	5	82%	95%	-	1	4
Multifamily	2	99%	101%	-	-	2
<b>Virtual Commissioning</b>	<b>13</b>	<b>97%</b>	<b>211%</b>	<b>13</b>	<b>-</b>	<b>-</b>
Large	6	97%	183%	6	-	-
Small	7	94%	494%	7	-	-
<b>Total</b>	<b>94</b>			<b>14</b>	<b>22</b>	<b>58</b>

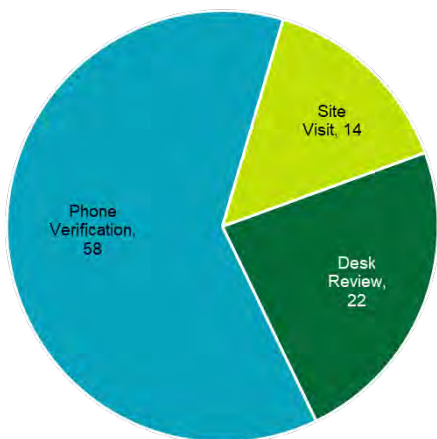
Figure 49 provides a summary of the evaluation activities and M&V approaches utilized by Duquesne Light's evaluation contractor in their PY14 verified savings calculations. Guidehouse conducted site verification for approximately 62% of the PY14 evaluation sample, with IPMVP Options A and C applied to estimate 70% of the evaluation sample energy savings.

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 individual Midstream Business Solutions program realized 124% energy

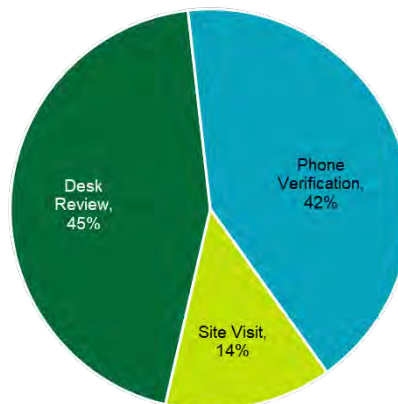
savings and the Small Commercial Direct Install program realized 89% energy savings, which balanced the overall average. The following subsections outline the evaluation activities for each of Duquesne Light’s non-residential programs in PY14.

**Figure 49: Summary of Duquesne Light’s C&I Evaluation Activities Small and Large Business Solutions**

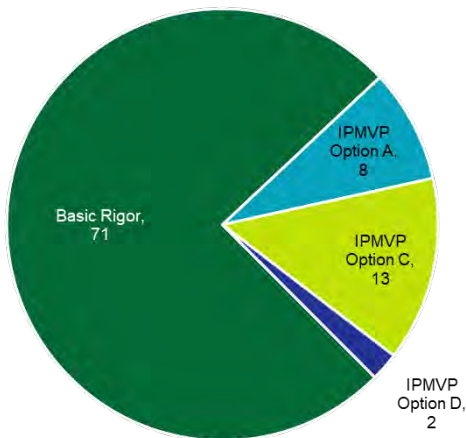
Evaluation Activity by Project Count



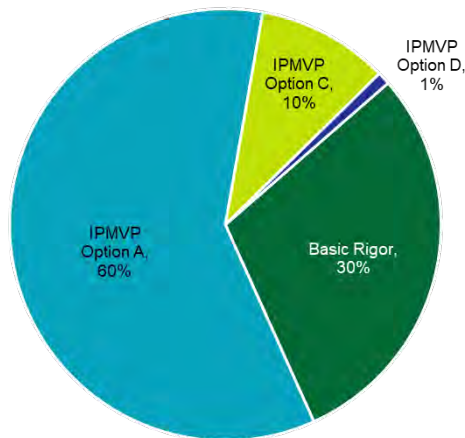
Evaluation Activity by kWh Contribution



Level of Rigor by Project Count



Level of Rigor by kWh Contribution

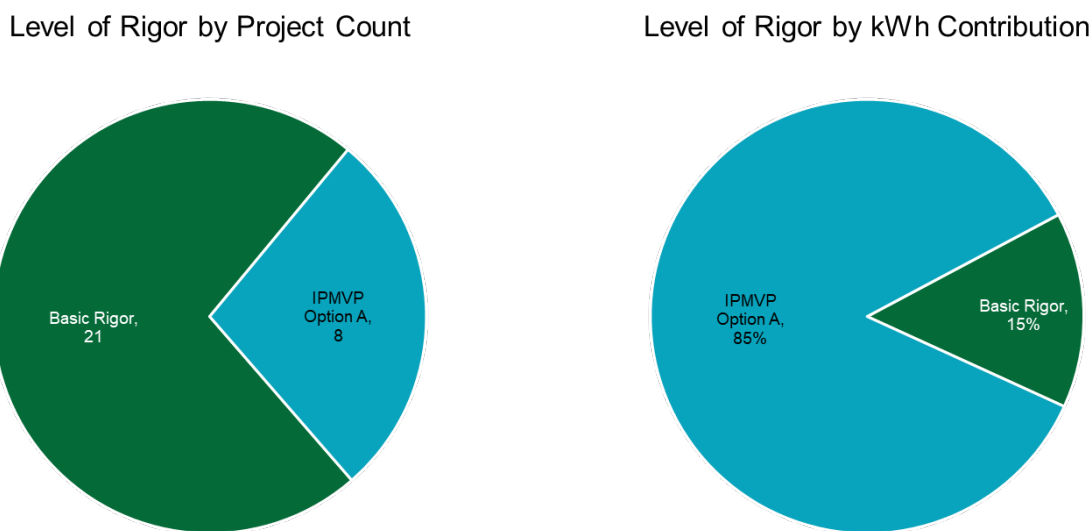


These programs offer rebates to offset the higher cost of high efficiency equipment compared to standard efficiency equipment. Program incentives help bridge the cost difference between standard and high efficiency equipment; increasing customer adoption of energy and demand saving equipment. The primary objective of the programs 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 — the small C&I program and the large C&I program. From the participant perspective the two programs are marketed together as Business Solutions.

Although they share a common structure, the Large Business Solutions program targets C&I customers with 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.

The Downstream Business Solution programs account for approximately 70% of the sampled PY14 nonresidential program savings. Figure 50 provides a summary of the M&V approaches utilized by Duquesne Light’s evaluation contractor in their PY14 verified savings calculations. Guidehouse employed Enhanced Rigor – IPMVP Option A for approximately 85% of the PY14 verified savings in this solution.

**Figure 50: Summary of Duquesne Light’s PY14 Small and Large Downstream Business Solutions Evaluation Activities**



### D.5.2.1 Small and Large Business Midstream Solutions

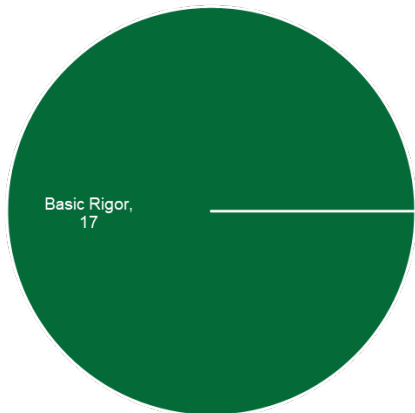
The Non-Residential Midstream Lighting program delivers utility incentives to end-use customers via C&I product distributors or manufacturers. End-use customers, property/facility managers, and installation contractors acting on behalf of C&I end-use customers may purchase qualified products from a participating 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. There has only been one non-lighting project included in the LBMS program to date that accounts for <1% of program savings.

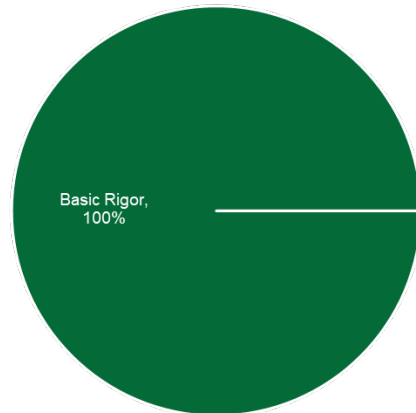
Figure 51 provides a summary of evaluation activities performed by Guidehouse in PY14 for evaluating midstream projects. Site visits were performed for 88% of large and 72% of small midstream projects in the sample. These verification site visits applied basic rigor and reviewed 93% of the sample verified Midstream savings.

**Figure 51: Summary of Duquesne Light’s PY14 Midstream Lighting Program Evaluation Activities**

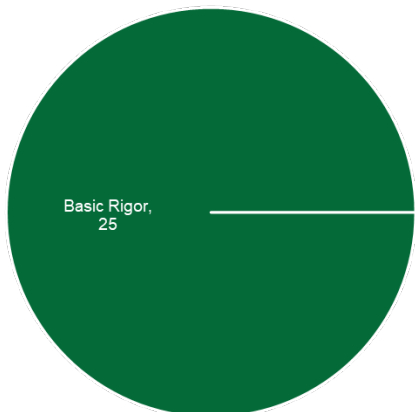
Evaluation Activity by Project Count for Large Business Midstream Solutions



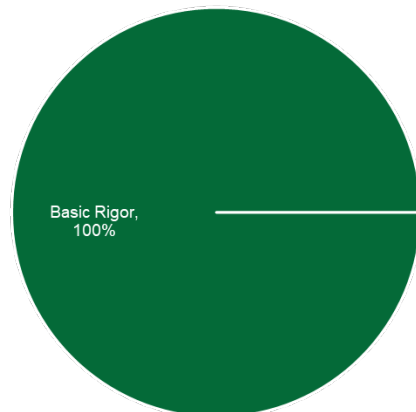
Evaluation Activity by kWh Contribution for Large Business Midstream Solutions



Evaluation Activity by Project Count for Small Business Midstream Solutions



Evaluation Activity by kWh Contribution for Large Business Midstream Solutions



**D.5.2.2 Small Business Direct Install**

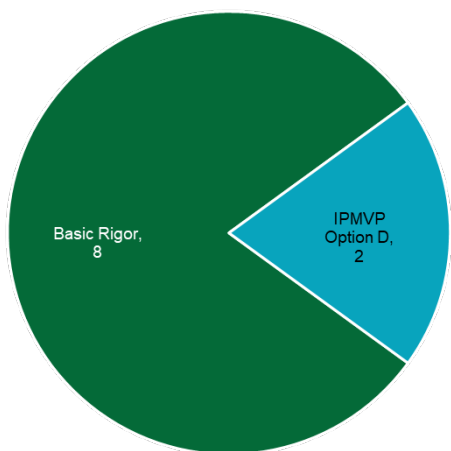
The Small Business Direct Install (SBDI) program targets Duquesne Light C&I customers and municipalities with monthly demand less than 300 kW. The SBDI program is designed to address sector-specific barriers to small and medium C&I customers and municipalities. During Phase IV, this program emphasizes very small businesses (micro-businesses), such as small local bakeries or hardware stores. In addition to the SBDI program, Guidehouse is reporting the common area portion of the Small Multifamily Housing Retrofit Program (SMHR) under SBDI. For Phase IV,

participating customers will receive a no-cost energy assessment and incentives that cover up to 80% of the resulting equipment and installation costs. A limited quantity of energy savings products may be provided at the time of assessment at no cost.

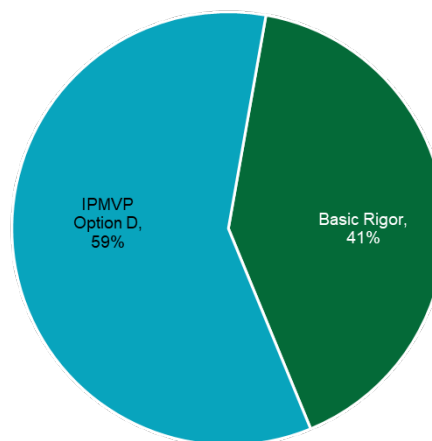
Realization rates for PY14 were developed based on field work conducted in PY14 as well as field work from three (3) projects Guidehouse sampled in PY13. Despite numerous contact attempts and attempting to verify every single alternate site for SBDI, this program did not meet its statistical precision requirements.

**Figure 52: Summary of Duquesne Light’s PY14 Small Business Direct Install Program Evaluation Activities**

Level of Rigor by Project Count



Level of Rigor by kWh Contribution

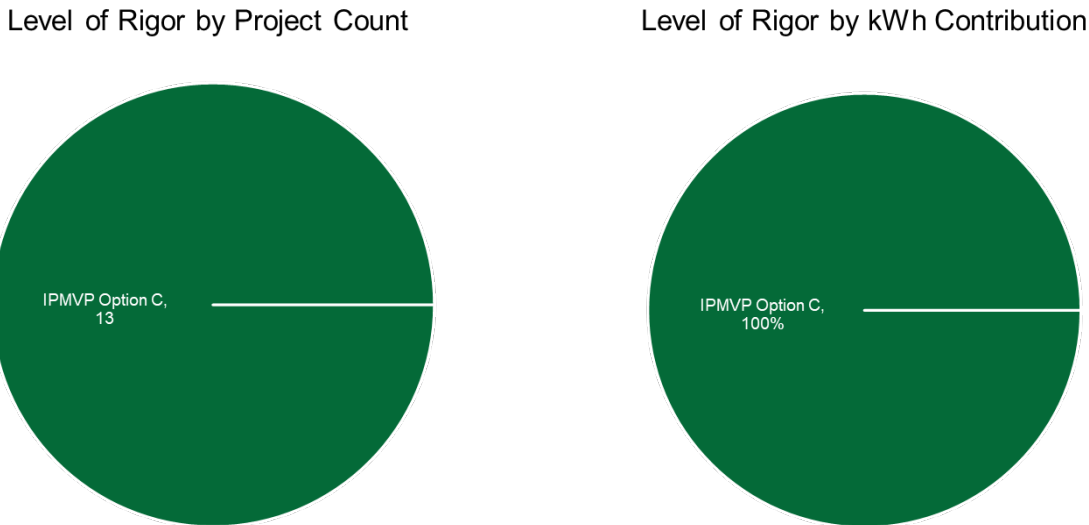


**D.5.2.3 Virtual Commissioning**

The Virtual Commissioning (VCx) programs use a turnkey approach that targets system-based no- to low-cost operational savings for commercial customers and public facilities. This program is filed as two programs in Duquesne Light’s Phase IV plan—one as a small C&I program and one as a large C&I program. However, to the customer and implementer there is only one program.

The Large Business Virtual Commissioning (LBVCx) program targets C&I customers having annual demand savings greater than or equal to 300 kW, whereas the Small Business Virtual Commissioning (SBVCx) program targets customers having annual maximum demand less than 300kW. The program used advanced metering infrastructure (AMI) data analytics to identify and qualify customers with significant potential for energy savings. Customers are then contacted by the CSP to help them understand their energy usage and provide them with personalized recommendations for low- to no-cost energy savings opportunities.

**Figure 53: Summary of Duquesne Light’s PY14 Virtual Commissioning Program Evaluation Activities**



**D.5.2.4 Virtual Commissioning**

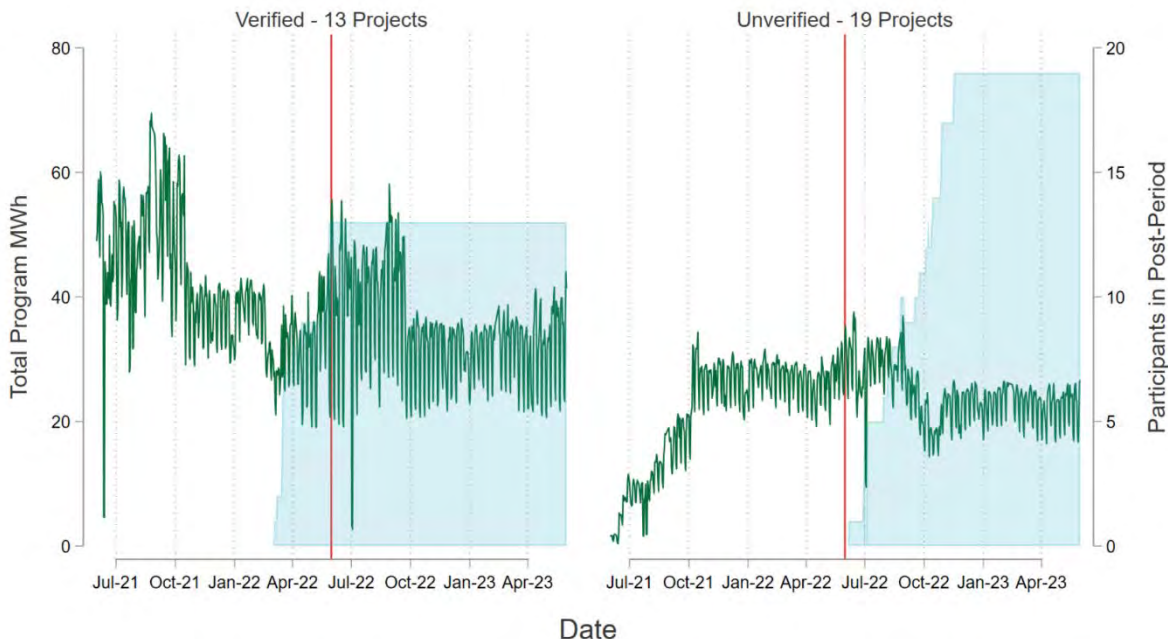
The Virtual Commissioning (VCx) program provides a data-driven approach to energy efficiency engagement for sites that do not fit the traditional model of using trade allies, mass marketing, or standardized prescriptive retrofits. To evaluate the VCx program, a pre-post, weather-normalized regression analysis is performed using hourly AMI and temperature data. This fitted model estimates the annualized savings for each participant.

This methodology is based on a meter-based savings concept that is gaining traction in the industry as an alternative to traditional M&V practices, sometimes referred to as Normalized Metered Energy Consumption (NMEC). Projects that rely on an NMEC methods should only claim gross verified savings once a full 365 days of post-installation (or performance) data is available for analysis by the EM&V contractor. This rule ensures that project performance is observed over a full range of seasonal and weather conditions. Without a full year of performance and weather data, there is potential to introduce bias via the weather-normalization procedure due to out-of-sample estimation.

Figure 54 looks at 32 VCx projects that reported savings in PY14. The verified projects meet the 365-day requirement in the post-period, since installation occurred before May 31, 2022, denoted by the red line. The unverified projects were installed after May 31,2022.

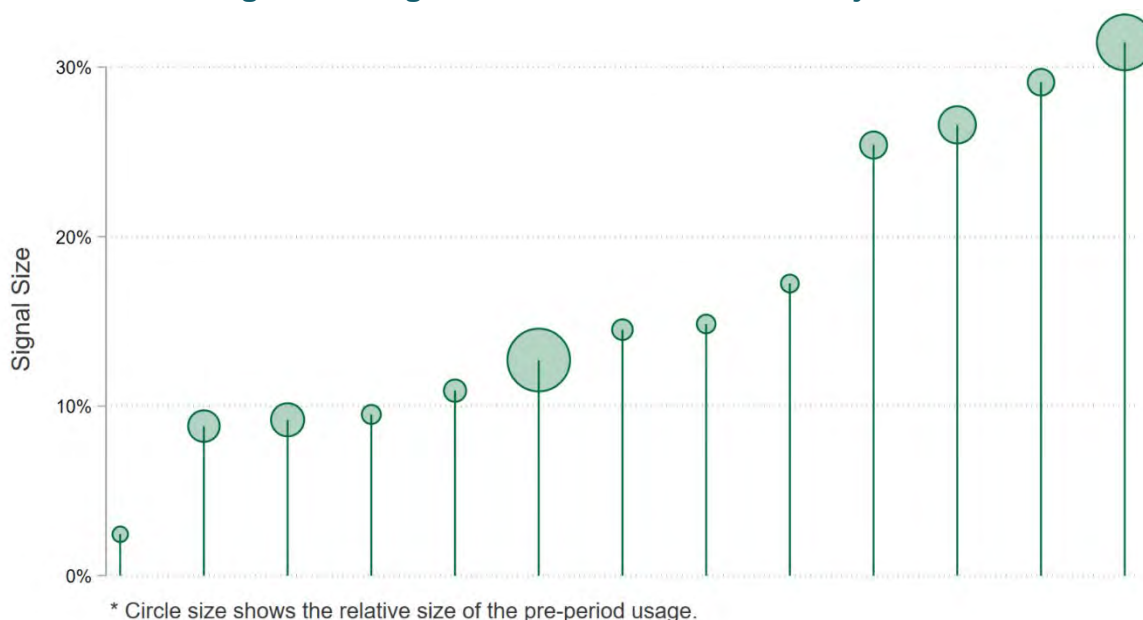


Figure 54: VCx Usage Patterns



For programs that measure savings through NMEC methods, we typically recommend focusing on volume and signal size to ensure stability in aggregate results. The volume for VCx is limited and becomes even more so when reporting only the verified projects, which only includes 13 projects. Figure 55 shows the signal size, or the percentage of pre-period usage that is saved after the efficiency installation, for the 13 verified projects. Almost all the projects achieve a signal size at or above 10%, which is the common recommendation for customers participating in NMEC programs.

Figure 55: Signal Size for VCx Verified Projects



The realization rate for energy in the VCx program is 97% of the 3,015 MWh reported. This is, at least partially, attributable to the significant signal size of the program savings. The demand realization rate is 211% of the 0.26 MW reported because 8 of the 13 verified projects did not report any demand savings. All projects that reduce peak demand should report demand savings moving forward, to reflect program savings more accurately.

#### 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 Light in PY14 included review of 15 projects, encompassing the following activities:

- 3 Field and Analysis Engineers were observed
- 8 Midstream Lighting, 6 Prescriptive Lighting, 1 HVAC, and 1 Custom measure observed
- 5 In-Person ride-alongs were conducted
- 58% of sample Verified Energy Savings reviewed
- 46% of sample Verified Demand Savings reviewed

Table 132 provides an overview of the SWE milestones for the verified savings audit review of evaluated Duquesne Light projects.

**Table 132: Duquesne Light Verified Savings Audit Review Milestones**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
15	17,091,562	100%	1,635	100%

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 100% for both energy and demand savings. The SWE proposed minor modifications to six lighting analyses that were accepted by the evaluator.

## D.6 NTG

Table 133 lists Duquesne Light's PY14 NTG as listed in the Duquesne Light PY14 Annual Report. Details concerning the methods and data used to estimate NTG values are in sections D.6.1 and D.6.2.

**Table 133: Summary of Duquesne Light's PY14 NTG Results**

Program Name	Component	NTG
Residential	Downstream Incentives	0.80
Residential	Midstream Incentives	N/A
Residential	Upstream Incentives	0.62
Residential	Appliance Recycling	0.47
Residential	HER Total	1.0
Low-Income	Low-Income	1.0
Non-Residential	Small Business Direct-Install	0.93
Non-Residential	Small Business Solutions	0.66
Non-Residential	Small Business Midstream Solutions	0.67
Non-Residential	Small Business Virtual Commissioning	N/A
Non-Residential	Commercial – Large Business Solutions	0.43
Non-Residential	Industrial – Large Business Solutions	0.43
Non-Residential	Commercial-- Large Business Midstream Solutions	0.67
Non-Residential	Industrial – Large Business Midstream Solutions	0.67
Non-Residential	Large Business Virtual Commissioning	N/A
<b>Portfolio Total</b>		<b>0.66</b>

### D.6.1 Residential Programs

Guidehouse planned for and enacted NTG research for the Upstream Incentives program (Table 134). 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 Downstream Incentives and Appliance Recycling NTG values are from previous evaluations.

**Table 134: Summary of Duquesne Light's PY14 Residential NTG Results**

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Downstream Incentives— Rebates	N/A	N/A	N/A	N/A	N/A
Midstream Incentives	N/A	N/A	N/A	N/A	N/A
Upstream Incentives	Manufacturer interviews	7	38%	0%	0.62
Appliance Recycling	N/A	N/A	N/A	N/A	0.47
HER Total	RCT	N/A	0%	0%	1.0
<b>Portfolio Total</b>					<b>0.63</b>

### D.6.2 C&I Energy Efficiency Programs

Guidehouse planned and enacted NTG research and estimation for the Small Business Direct Install, Small Business Solutions, and Large Business Solutions programs (Table 135). The SWE reviewed the survey, data, and analysis files that informed the NTG estimation and found that all methods were consistent with the recommended NTG methodology outlined in the Phase IV Evaluation Framework.

Guidehouse collected data from four participants for a NTG evaluation of the Small Business Direct Install program in PY13. Due to the small sample size, they were unable to estimate a NTG that satisfied statistical rigor for PY13. For PY14, NTG data was collected for 19 Small Business Direct Install participants and combined with the four PY13 participants for a total sample of 23.

Guidehouse conducted the impact analysis of Small and Large Business Solutions together and collected data from a total of 21 participants (19 for Small and two for Large Business Solutions). The NTG results for Large Business Solutions should be interpreted with caution due to the small sample size of two respondents that participated in the Commercial Large Business Solutions program (Guidehouse's sample target was a census attempt up to ten survey completes from a population of 29 from both Commercial and Industrial Large Business Solutions).

Midstream Solutions, Commercial Large Business Midstream Solutions, and Industrial Large Business Midstream Solutions program NTG values are from previous years evaluations.

**Table 135: Summary of Duquesne Light's PY14 C&I NTG Results**

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Small Business Direct-Install	2-year rolling sample; participant web survey	23	7%	0%	0.93 <sup>1</sup>
Small Business Solutions	Participant web survey	19	35%	1%	0.66 <sup>1</sup>
Small Business Midstream Solutions	N/A	N/A	N/A	N/A	0.67
Small Business Virtual Commissioning	N/A	N/A	N/A	N/A	N/A
Commercial – Large Business Solutions	Participant web survey	2	57%	0%	0.43
Industrial – Large Business Solutions	Participant web survey	2	57%	0%	0.43
Commercial-- Large Business Midstream Solutions	N/A	N/A	N/A	N/A	0.67
Industrial – Large Business Midstream Solutions	N/A	N/A	N/A	N/A	0.67
Large Business Virtual Commissioning	N/A	N/A	N/A	N/A	N/A
<b>Portfolio Total</b>					<b>0.64</b>

## D.7 TRC

Table 136 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Duquesne Light's PY14 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 PY14 Annual Report and the model itself was well-organized and documented.

Table 136: Summary of Duquesne Light's PY14 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	\$512	\$800	0.64	\$239	\$712	0.34
Res Downstream Incentives	\$1,272	\$1,759	0.72	\$1,021	\$1,589	0.64
Res Midstream Incentives	\$3	\$48	0.06	\$3	\$48	0.06
Res Upstream Lighting	\$1,558	\$1,659	0.94	\$1,018	\$1,394	0.73
Res Behavioral EE	\$631	\$634	1.00	\$631	\$634	1.00
Low Income Energy Efficiency	\$631	\$507	1.24	\$631	\$507	1.24
Low Income Behavioral EE	\$73	\$312	0.23	\$73	\$312	0.23
Small Business Direct Install	\$2,173	\$2,098	1.04	\$2,010	\$1,962	1.02
Small Business Downstream	\$5,768	\$2,181	2.64	\$3,807	\$1,728	2.20
Small Business Midstream	\$32,215	\$15,122	2.13	\$21,584	\$11,123	1.94
Small Business VCx	\$336	\$84	4.00	\$336	\$84	4.00
Large Commercial Downstream	\$4,374	\$2,492	1.76	\$1,881	\$1,659	1.13
Large Commercial Midstream	\$4,724	\$2,075	2.28	\$3,165	\$1,607	1.97
Large Commercial VCx	\$1,560	\$133	11.73	\$1,560	\$133	11.73
Large Industrial Downstream	\$7,206	\$3,851	1.87	\$3,099	\$2,353	1.32
Large Industrial Midstream	\$8,471	\$2,826	3.00	\$5,676	\$2,196	2.58
Large Industrial VCx	\$0	\$33	-	\$0	\$33	-
<b>Portfolio Total<sup>1</sup></b>	<b>\$71,507</b>	<b>\$36,614</b>	<b>1.95</b>	<b>\$46,734</b>	<b>\$28,074</b>	<b>1.66</b>

<sup>1</sup>Rows may not sum to totals due to rounding

Eleven of Duquesne Light's 17 EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. The same eleven programs were found to be cost-effective using net verified savings. The non-residential sectors accounted for 93% of the total TRC gross benefits in PY14. The Residential program with the highest gross TRC ratio was the Low- Income Energy Efficiency program component at 1.24, which also had the largest gross TRC benefits of any Residential Duquesne Light program in PY14. The Non-Residential program with the highest gross TRC ratio was the Large Commercial Virtual Commissioning (VCx) program component at 11.73. The Small Business Midstream program had the largest amount of gross TRC benefits of any Duquesne Light program in PY14.

### D.7.1 Notes from the TRC Model Review

The PY14 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 PY14 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 PY14 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 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).
- 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 PY14, Guidehouse conducted process evaluation activities for four Duquesne Light residential programs: the RUIP, the Residential Behavioral Program, the Residential Low-Income Energy Efficiency Program, and the Residential Low Income Behavioral Program.

For the PY14 process evaluations of the residential programs, Guidehouse interviewed the Duquesne Light program manager and the CSP, and reviewed program materials that were provided by Duquesne Light. Guidehouse also conducted surveys of program participants and manufacturers.



For these programs, the SWE provides a summary of the process evaluation findings and the SWE's audit of those findings.

Table 137 summarizes program component or sub-component satisfaction for the Residential Programs.

**Table 137: Duquesne PY14 Program Satisfaction Summary- Residential Programs**

Program Component / Sub-component	Population	% Satisfied
Residential Upstream Incentive Program (RUIP)	Manufacturers	100%
Residential Behavioral Program	Participants	79%
Low Income Energy Efficiency Program (LIEEP)	Participants	88%
Low Income Residential Behavioral Program	Participants	77%
Residential Programs - Overall	Participants	79%

#### **D.8.1.1 Residential Downstream Incentives Program (RDIP)**

Guidehouse did not conduct process evaluation research for the Residential Downstream Incentives Program in PY14 and plans to complete it in PY15.

#### **D.8.1.2 Residential Midstream Incentives Program**

Guidehouse did not conduct process evaluation research for the Residential Midstream Incentives Program in PY14 and plans to complete it in PY15.

#### **D.8.1.3 Residential Upstream Incentives Program**

##### **Summary of Process Evaluation Findings**

The Residential Upstream Incentives Program (RUIP) offers point of sale incentives for qualified energy efficient lighting and appliances to Duquesne Light's residential customers, which are paid directly to manufacturers so that customers purchase the discounted products without having to complete rebate applications.

The process evaluation for the RUIP in PY14 included in-depth interviews with seven of the 18 participating manufacturers, who had available contact information. The interviews focused on their experience and satisfaction with the program processes and opportunities for program improvement. Guidehouse also interviewed program managers and the CSPs, which aided the development of the manufacturer interview questions.

Key findings from the manufacturer interviews centered on awareness, satisfaction, and marketing.

- About half of the interviewees learned about RUIP through previous work with Duquesne Light or had participated in the program for a long time and did not recall the initial source of awareness. The other half reported learning about the program through the CSP or Duquesne Light. The CSP utilized their channel delivery team's existing relationships to recruit manufacturers to the program.
- Program satisfaction is very high with five of the seven interviewees rating it a 10 on a scale of 0 to 10 where 0 means not at all satisfied and 10 means very satisfied. One



interviewee rated the program an 8 due to slow responses and delays in communication with program contacts. Another interviewee rated it a seven due to the size of the incentives.

- Duquesne Light program managers were concerned that marketing point-of-purchase (POP) materials were not displayed when field auditors visited participating retailer locations. Most of the manufacturers interviewed believed it was the CSP's responsibility to set up and monitor the POP materials at participating retail locations and were thus aware of the need to communicate to retailers the importance of displaying POP marketing materials.

### **Summary of Process Evaluation Audit**

The process evaluation of RUIP appears to have been generally consistent with the Phase IV evaluation plan relying on interviews with program staff, the CSP, and participating manufacturers.

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 Duquesne Light PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether Duquesne Light was implementing or considering those recommendations. The process evaluation generated three recommendations; one was accepted and two are 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.

#### **D.8.1.4 Residential Appliance Recycling Program**

Guidehouse did not conduct process evaluation research for the Residential Appliance Recycling Program in PY14 and plans to complete it in PY15.

#### **D.8.1.5 Residential Behavioral Program**

##### **Summary of Process Evaluation Findings**

The Residential Behavioral Program influences behavior changes in customers by providing personalized Home Energy Reports (HERs) to participants. These reports provide participants with information about their recent and historic energy use and compare it with electricity use of similar homes. The reports also provide participants with energy-saving tips and information on other Duquesne Light energy efficiency programs.

The process evaluation of the Residential Behavioral Program was combined with the process evaluation of the Residential Low-Income Behavioral Program, which has a similar design and administration. The process evaluation included interviews with the Duquesne Light program manager and program implementer as well as online participant surveys. Key findings from the process evaluation centered on program engagement, influence, and satisfaction.

- Just over one-half (53%) of survey respondents believe the HERS accurately compare their household energy usage with that of similar homes.
- Seventy-seven percent of survey respondents reported taking some actions to conserve energy within the past year.
- Most of the participants surveyed (79% for the Residential Behavioral and 77% for the Low-Income Behavioral programs) were satisfied with their HERS, rating them as 7 or above on a 0-10 scale. This is slightly higher than in the previous survey conducted in PY11.

### **Summary of Process Evaluation Audit**

The process evaluation of the Residential Behavioral program appears to have been generally consistent with the Phase IV evaluation plan relying on interviews with program staff, the implementer, and participating customers.

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 plan had targeted 40 completed surveys for the Residential Behavioral Program and 40 completed surveys for the Low-Income Behavioral Program, noting that this was the minimum sample size needed to achieve at least 15% relative precision at 85% confidence level. The fielding of the survey was intended to achieve a greater number of responses. There were 163 completed responses for the Residential Behavioral Program and 181 completed responses for the Low-Income Behavioral Program.

The SWE also determined that the reporting followed the SWE guidelines. The Duquesne Light PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether Duquesne Light was implementing or considering those recommendations. The process evaluation generated two recommendations for both programs; both were acknowledged. 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.

#### **D.8.1.6 Residential Low-Income Energy Efficiency Program**

##### **Summary of Process Evaluation Findings**

The Residential Low-Income Energy Efficiency Program (LIEEP) is a direct-install program that includes virtual and on-site audits, provides energy efficiency education, and installs energy efficient products and equipment at no cost to households who are at or below 150% of the federal poverty income level. The program also mailed out energy efficient kits to prospective participants and distributed a number of giveaway measures at local events.

The process evaluation included interviews with the Duquesne Light program manager and program implementer as well as online participant surveys. The participant surveys covered two groups that were analyzed separately: customers who received an audit and direct-install measures and those who received a no-cost energy efficiency kit. Key findings from the process

evaluation centered on program awareness and marketing, satisfaction, and barriers to participation.

- Customers who received audits and direct-install measures were most likely to learn about the program from the Duquesne Light website (24%), direct phone outreach by a program representative (22%), and referral from another Duquesne Light program (16%). Those receiving kits were also most likely to learn about the program from the Duquesne Light website (44%), but they also noted email advertisements from Duquesne Light (24%), and information from friends and family (13%).
- Satisfaction with both components is high. Most of the customers (92%) receiving audits and direct-install measures rated the products and services as 7 or above on a 0-10 scale. Similarly, most of the customers (86%) receiving kits rated them as 7 or above on a 0-10 scale.
- The majority of respondents (65% of those receiving audits and direct install measures and 64% of those receiving kits) see no barriers to participation. A few respondents (8% of those receiving audits and direct installation measures and 7% of those receiving kits) thought the program did not offer the equipment they needed.

### **Summary of Process Evaluation Audit**

The process evaluation of the Residential Low Income Energy Efficiency program appears to have been generally consistent with the Phase IV evaluation plan relying on interviews with program staff, the implementer, and participating customers.

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 plan had targeted 46 completed surveys for the audit and direct install measure recipients and 46 completed surveys for the kit recipients, noting that this was the minimum sample size needed to achieve at least 15% relative precision at 85% confidence level. The fielding of the survey was intended to achieve a greater number of responses and, indeed, there were 79 responses for the audit and direct install measure recipients and 148 responses for the kit recipients.

The SWE also determined that the reporting followed the SWE guidelines. The Duquesne Light PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether Duquesne Light was implementing or considering those recommendations. The process evaluation generated three recommendations; all three were acknowledged. 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.

### D.8.1.7 Residential Low-Income Behavioral Program

#### Summary of Process Evaluation Findings

The Residential Low Income Behavioral Program targets qualified customers whose household is at or below 150% of federal poverty income level. Its implementation and administration is similar to the Residential Behavioral Program described above. Please refer to [Appendix D.8.1.5](#) for the process evaluation findings.

#### Summary of Process Evaluation Audit

Please refer to Section [Appendix D.8.1.5](#) for the process evaluation audit.

### 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 PY14, Guidehouse conducted process evaluation activities for three Duquesne Light C&I programs; the Small Business Direct Install Program, the Small Business Solutions Program, and the Large Business Solutions Program.

For the PY14 process evaluations of the C&I programs, Guidehouse interviewed the Duquesne Light program manager and the CSP, and reviewed program materials that were provided by Duquesne Light. Guidehouse also conducted surveys of program participants.

For these programs, the SWE provides a summary of the process evaluation findings and the SWE's audit of those findings.

[Table 138](#) summarizes program component or sub-component satisfaction for the Residential Programs.

**Table 138: Duquesne PY14 Program Satisfaction Summary- C&I Programs**

Program Component / Sub-component	Population	% Satisfied
Small Business Direct-Install Program	Participants	96%
Small Business Solutions Program	Participants	95%
Large Business Solutions Program	Participants	95%
C&I Programs - Overall	Participants	96%

#### D.8.2.1 Small Business Direct Install Program

##### Summary of Process Evaluation Findings

The Small Business Direct Install (SBDI) program targets C&I customers and municipalities with monthly demand less than 300 kW. These customers are often subject to split-incentives, where electric bill-paying customers are tenants but not the owners of the properties. The program

addresses split-incentives by providing no-cost efficiency upgrades. Participating customers also receive a no-cost energy assessment and incentives that cover up to 80% of the resulting equipment and installation costs. During Phase IV, this program emphasizes very small businesses (micro-businesses), such as small local bakeries or hardware stores.

Guidehouse began a process evaluation of the SBDI Program in PY13 and extended it to PY14 in order to obtain more participant survey completions. The process evaluation included interviews with the Duquesne Light program manager and program implementer as well as online participant surveys. Key findings from the process evaluation centered on program awareness and engagement, satisfaction, and barriers to participation.

- The most common sources of program awareness are through the energy advisor or contractor who conducts the energy assessment and installs equipment (29%) and through word of mouth (25%). The program rebates and information provided by installation contractors have the strongest influence on participants installing recommended measures, while current program marketing has the least influence.
- Customer satisfaction is very high with 96% of respondents rating it 7 or higher on a scale of 0-10. A great majority of respondents also rated each step of the program participation process 7 or higher.
- While 29% of respondents reported that there were no main barriers to participating in the program, others indicated several common barriers. These include businesses not having discretionary funds to dedicate to energy efficiency upgrades (33%), the cost of equipment being too high (29%), participation being too time-consuming (21%), paperwork being too burdensome (12%), the program not offering the necessary equipment (8%), and difficulty qualifying for the program (8%).

### **Summary of Process Evaluation Audit**

The process evaluation of the Small Business Direct Install program appears to have been generally consistent with the Phase IV evaluation plan relying on interviews with program staff, the implementer, and participating customers. However, due to significantly lower program participation than expected in PY13 and low response rates for PY13 and PY14, the number of surveys completed fell below the target 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 plan had targeted 12 completes from PY13 participants and 21 completes from PY14 participants; the actual completes were four for PY13 participants and 20 for PY14 participants. Combining the two years helped provide more meaningful results from the participant survey.

The SWE also determined that the reporting followed the SWE guidelines. The Duquesne Light PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether Duquesne Light was implementing or considering those recommendations. The process evaluation generated three recommendations; all three were acknowledged. 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.

### **D.8.2.2 Small Business Solutions Program**

#### **Summary of Process Evaluation Findings**

The Small Business Solutions (SBS) program offers rebates to offset the higher cost of high efficiency equipment and increase its adoption. It targets C&I customers having annual demand less than 300 kW and offers two core participation tracks: prescriptive and custom. The prescriptive track offers a simplified method on predefined measures. The custom track makes it possible to include more complex, site-specific measures and projects that show specific and verifiable energy savings and costs.

The process evaluation included interviews with the Duquesne Light program manager and CSP as well as online participant surveys. The participant surveys also included customers who had participated in the Large Business Solutions Program, which is similar and targets customers with an annual demand equal to or greater than 300 kW. Key findings from the process evaluation centered on program awareness and engagement, satisfaction, and barriers to participation.

- Participants were more likely to know of the program through previous knowledge or research (33%), the Duquesne Light website (24%), a consultant that advises on rebates (19%), and lighting vendors (19%). The program rebate and recommendations from a program contractor or trade ally were the most influential in the respondents' decision to purchase energy efficient equipment.
- Customer satisfaction is very high with 95% of respondents rating it 7 or higher on a scale of 0-10. A great majority of respondents also rated each step of the program participation process 7 or higher.
- While 38% of respondents reported that there were no main barriers to participating in the program, others indicated several common barriers. These include the paperwork being too burdensome (24%), participation being too time-consuming (19%), and the program not offering the equipment needed(14%).

#### **Summary of Process Evaluation Audit**

The process evaluation of the Small Business Solutions program appears to have been generally consistent with the Phase IV evaluation plan relying on interviews with program staff, the implementer, and participating customers.

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 plan had a target of ten completed participant surveys; it had 19 completes.

The SWE also determined that the reporting followed the SWE guidelines. The Duquesne Light PY14 Annual Report included descriptions of the methods, summary of conclusions, and a table of recommendations with a description of whether Duquesne Light was implementing or considering those recommendations. The process evaluation generated three recommendations;



all three were acknowledged. 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.

### **D.8.2.3 Small Business Midstream Solutions Program**

Guidehouse did not conduct process evaluation for the Small Business Midstream Solutions Program in PY14 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 PY14 and plans to complete it in PY15.

### **D.8.2.5 Large Business Solutions Program**

#### **Summary of Process Evaluation Findings**

The Large Business Solutions (LBS) Program is similar to the Small Business Solutions Program; it targets C&I customers having annual demand equal to or greater than 300 kW. Please refer to [Appendix D.8.2.2](#) for process evaluation findings.

#### **Summary of Process Evaluation Audit**

Please refer to Section [Appendix D.8.2.2](#) for the process evaluation audit. It should be noted that the evaluation plan had targeted ten participant survey responses for the Large Business Solutions program but only achieved two completes. While the Small and Large Business Solutions Programs are similar, the participant survey findings may be more relevant for the Small Business Solutions program.

The process evaluation generated three recommendations; all three were acknowledged.

### **D.8.2.6 Large Business Midstream Solutions Program**

Guidehouse did not conduct process evaluation for the Large Business Midstream Solutions Program in PY14 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 PY14 and plans to complete it in PY15.

## Appendix E FirstEnergy: Metropolitan Edison Company PY14 Audit Detail

### E.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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. Revisions included updating lighting wattages to align with DLC 5.1, custom calculation of baseline compressor operation, and updating regional locations that shifted system equivalent full load hours. The SWE's feedback was provided to the evaluator with sufficient time for Met-Ed to include all suggested changes in the Met-Ed PY14 Annual Report.
- The SWE closely reviewed a large CHP project, which accounted for 37% of non-residential savings in PY14. ADM used trended measurements collected at the facility to determine the project's verified savings and worked with the SWE to validate parasitic loads. Overall, project reported savings were lowered from an initial annual estimate of 26.2 MWh to 19.1 MWh.
- Met-Ed provided their Residential and Low Income verified savings analyses prior to drafting the Met-Ed PY14 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 PY14 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 additional behavioral HER cohorts in June 2022 for a total of four active cohorts in PY14. One of the new cohorts consists of market residential households and the other cohort consists of low-income households. On average, HER recipients saved approximately 41 kWh, or 0.4% of their annual consumption, in PY14. Since the PY13 and PY14 cohorts were new, the impact evaluation did not need to deal with 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 PY14 methods or results.
- Met-Ed's portfolio was cost-effective in PY14 with a gross TRC ratio of 1.50 with an improved TRC ratio from PY13.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Met-Ed's PY14 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 conducted a project file review for a sample of Met-Ed's residential and income-eligible solutions in PY14. 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.
- 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.
- 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 PY14 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, FirstEnergy's evaluation contractor, submitted a redline version of their PY14 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, the ADM team submitted several memos detailing their sampling approach for program components selected for impact, process and NTG evaluations in PY14.

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 PY14. Met-Ed will not use historic realization rates until PY15.

[Table 139](#) shows all Met-Ed program components and indicates that verified impacts were developed for each in PY14.

**Table 139: PY14 Met-Ed Impact Evaluation Summary**

Sector	Components	PY14 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 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 140 shows the relative precision of PY14 energy and demand impacts by component at the 85% confidence level.

**Table 140: Relative Precision of PY14 Impacts by Program Component at the 85% Confidence Level**

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	6.6%	6.7%
	LI - EE Kits	15.4%	15.6%
	New Homes & Smart Thermostats	14.5%	14.5%
	Multifamily Direct Install	5.2%	5.2%
	Appliance Recycling	5.7%	5.0%
	HVAC	8.8%	7.0%
	Residential Appliances	7.9%	10.4%
	LI – Appliance Recycling	11.9%	9.8%
	LI - Direct Install	11.5%	11.4%
	Midstream Appliances	0.0%	0.0%
	Audit and DI	9.7%	9.9%
C&I	Appliance Recycling	0.0%	0.0%
	Multifamily	0.0%	0.0%
	Custom	2.4%	0.8%
	Prescriptive	10.9%	11.7%
	Energy Management and New Construction	11.0%	11.0%

The Residential Midstream Appliances, Non-Residential Appliance recycling, and Non-Residential Multifamily components have a relative precision of ± 0%. ADM evaluated all projects undertaken in those programs in PY14, so there is no sampling uncertainty. The Residential Upstream program was not offered in PY14. The Low-Income EE Kits components did not meet the 15% threshold for relative precision on their own, but the overall precision for the EE Kits initiative did meet the threshold.

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 PY14 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 PY14. The SWE team replicated the C&I Prescriptive rollup for energy savings instead using observed coefficients of variation and found the relative precision of savings estimates to be lower than the reported figure of 10.9%. 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 PY14 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 programs 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 141](#) shows the absolute precision of PY14 Behavioral Modification impacts at the 95% confidence level.

**Table 141: Absolute Precision of PY14 Impacts for Behavioral Modification Programs at the 95% Confidence Level**

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.17%
Behavioral Modification (LI)	0.15%

The Online Audit component also relies on regression analysis of all participants and a matched control group of non-participants. While there is no sampling error, there is uncertainty associated with the regression model. The relative precision of the market rate Online Audit energy savings was  $\pm 42.5\%$  at the 85% confidence level and the relative precision of the Low-Income Online Audit energy savings was  $\pm 27.0\%$  at the 85% confidence level. The relative precision of the low-income group was better than the market rate group despite a much smaller number of homes because the savings estimate for low-income recipients was significantly higher.

## E.4 REPORTED GROSS SAVINGS AUDITS

### E.4.1 Tracking Data Review

This report section summarizes the SWE team's assessment of the reported gross savings, participation counts, and incentives reported in Met-Ed's PY14 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 PY14 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 142** summarizes our findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the values in Met-Ed's PY14 Annual Report and "No" otherwise. For each program, the SWE was able to replicate the values reported by Met-Ed.

**Table 142: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	19,048	19,048	Yes*
Energy Efficient Products	11,331	11,331	Yes
Low Income Energy Efficiency	4,009	4,009	Yes*
C&I Energy Solutions for Business - Small	17,544	17,544	Yes
C&I Energy Solutions for Business - Large	34,740	34,740	Yes
<b>Portfolio Total</b>	<b>86,671</b>	<b>86,671</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

**Table 143** 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 143: MW Savings by Program**

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	2.74	2.74	Yes*
Energy Efficient Products	2.72	2.72	Yes
Low Income Energy Efficiency	0.56	0.56	Yes*
C&I Energy Solutions for Business - Small	3.18	3.18	Yes
C&I Energy Solutions for Business - Large	4.66	4.66	Yes
<b>Portfolio Total</b>	<b>13.85</b>	<b>13.85</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 144 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for all programs. The portfolio totals differ with 115,614 total participants listed in the Met-Ed PY14 Annual Report and 99,131 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 better understand the Phase IV business rules around counting participants for different program components.

**Table 144: Participation by Program**

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	72,192	55,368	No*
Energy Efficient Products	31,233	33,342	No
Low Income Energy Efficiency	11,334	9,951	No*
C&I Energy Solutions for Business - Small	656	435	No
C&I Energy Solutions for Business - Large	199	35	No
<b>Portfolio Total</b>	<b>115,614</b>	<b>99,131</b>	<b>No*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 145 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in Met-Ed's PY14 Annual Report. The SWE was able to exactly replicate incentive dollars for the C&I Energy Solutions for Business – Large program. For the other four programs, the SWE calculated directionally similar values using the tracking data. For these five programs, the totals are also directionally similar: \$10,910,000 in the Annual Report and \$10,393,000 in the tracking data.

**Table 145: Incentives by Program (\$1,000)**

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$2,968	\$2,825	No
Energy Efficient Products	\$2,083	\$2,029	No
Low Income Energy Efficiency	\$1,571	\$1,496	No
C&I Energy Solutions for Business - Small	\$2,997	\$2,752	No
C&I Energy Solutions for Business - Large	\$1,291	\$1,291	Yes
<b>Portfolio Total</b>	<b>\$10,910</b>	<b>\$10,393</b>	<b>No</b>

## 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 PY14 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 146 Table presents a summary of the SWE's residential project file reviews.

**Table 146: Met-Ed PY14 Project File Review Summary**

Program	Sub Program	Number of files reviewed <sup>1</sup>	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? <sup>2</sup>
EE Homes Program	Direct Install	41	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	50	✓	✓	✓	✓
EE Homes Program	Multifamily	20	✓	✓	✓	✓
EE Homes Program	New Homes	32	✓	✓	✓	✓
EE Products Programs	Appliances	49	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	35	✓	✓	✓	✓
EE Products Programs	HVAC	10	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	36	✓	✓	✓	✓
LIEEP	Appliances	49	✓	✓	✓	✓
LIEEP	Appliance Turn In	35	✓	✓	✓	✓
LIEEP	Direct Install	10	✓	✓	✓	✓

<sup>1</sup> The number of files reviewed reflects the total number for all FirstEnergy EDCs.

<sup>2</sup> It should be noted that appliances and appliance recycling counts include both the EE products program and LIEEP program totals.

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. Overall, the SWE did not find any notable discrepancies between the project file documentation and the tracking data in PY14.

#### **Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits**

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. The documentation for the Energy Efficiency Kits program consisted of shipment data, specification sheets, and kit contents. The shipment data was similar to the quarterly tracking data but was broken out by month and income status. The SWE did not find any discrepancies between the project documentation and the tracking data for the reviewed sample projects.

#### **Energy Efficient Homes Program: Comprehensive Audits**

The project documentation for the Comprehensive Audit program included invoices and audit reports that included information on the installed measures and what potential additional measures could improve efficiency outcomes. Overall, the SWE found no discrepancies between the tracking data and the project file documentation in the reviewed sample projects.

#### **Energy Efficient Homes Program: Multifamily**

The Multifamily program contains invoices, audit forms and energy assessments report. The SWE notes that no projects were submitted for Q1 due to a file transfer issue, noted by the evaluator. A review of the sampled files did not reveal any discrepancies with measure names and quantities, and the information provided within each project corresponded with the reported savings in the tracking data.

#### **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. 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 Products Program: Appliances**

The Appliance Rebate program had project files containing either receipts for rebated appliances, appliance rebate application forms, or both. These project files were accompanied by tracking data that recorded the date the appliance was purchased, the type of appliance, and its quantity. While the data was very well organized, a notable omission from the data was the rebate amount. The SWE reviewed a total of 49 files amongst the First Energy Companies for this program and notes the project files well organized and included thorough documentation.

#### **Energy Efficient Products Program: Appliance Recycling**

The Appliance Recycling program had project files containing photos of the participant's signatures, photos of the nameplates of the recycled appliances, and photos of the recycled appliances themselves. These project files were accompanied by tracking data that recorded the type of recycled appliances, the date it was recycled, the town it was from, and the quantity of



recycled appliances. Although some of the photos of the appliances did not include nameplates, the SWE notes the thoroughness of the documentation.

#### **Energy Efficient Products Program: HVAC**

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. There were no discrepancies found in the project files as compared to the tracking database. However, there were some instances where the SWE was unable to confirm the tracking data matched the project file due to missing documentation such as the AHRI certificate.

#### **Energy Efficient Products Program: Midstream Appliances**

The project files for Midstream Appliances were comprised of invoice-styled excel sheets with tracking data that could be easily matched to the sample data given for each quarter. The invoice data recorded the type of appliance rebated, quantity, the appliance price, and the rebate amount. The SWE review of the sampled files did not reveal any discrepancies between the project files and the tracking database.

#### **Low-Income Energy Efficiency Program: Appliances**

The SWE review of the LI Appliance rebate files is summarized in the Appliance subsection above.

#### **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.

#### **Energy Efficient Homes Program: LI WARM**

Invoices, audit forms, preassessment, and post assessment forms were provided for sampled projects. The SWE notes that some projects had varying levels of documentation described above, but generally the necessary documentation existed for each sampled project reviewed by the SWE. A review of the sampled files did not reveal any discrepancies and the information provided within each project matched the tracking database.

#### **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 PY14.

#### **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 project files for a sample of Met-Ed's non-residential programs in PY14. 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 147](#) presents an overview of the results of the SWE’s C&I project file reviews.

Table 147: Met-Ed PY14 C&amp;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?
C&I Energy Solutions for Business Program – Large	DS Prescriptive - LCI	2	✓	✓	✓	1/2	✓
C&I Energy Solutions for Business Program – Small	DS Prescriptive - SCI	1	✓	✓	✓	X	✓
C&I Energy Solutions for Business Program – Large	Energy Management - LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Energy Management - SCI	1	✓	✓	✓	✓	✓
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	MS Prescriptive - LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	MS Prescriptive - SCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Multifamily - SCI	1	✓	✓	✓	✓	✓

The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were estimated. The SWE noted specific project files with deficiencies as addressed below by sub-program.

- **DS Prescriptive – LCI**
  - For one project, many files contained outdated or inaccurate information. This made the review process difficult for the SWE to conduct.
- **DS Prescriptive – SCI**
  - Custom HOUs were used for one lighting project. A document with proof of custom hours should be included for completeness.

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 Energy Efficient Homes Program, the Energy Efficient Products Program, and the LI Energy Efficiency Program. 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 148](#) provides a summary of the evaluation and M&V approaches used by Met-Ed in their PY14 verified savings calculations.

**Table 148: Residential Program Evaluation Activities – Met-Ed**

Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis
<b>Energy Efficient Homes</b>				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
<b>Energy Efficient Products</b>				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
<b>Low-Income Energy Efficiency Program</b>				
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.

#### Energy Efficiency Kits Initiative: EE Kits and Low-Income Kits

The Energy Efficiency Kits (EE Kits) initiative has two sub-initiatives – EE Kits and Low-Income EE Kits. Each sub-initiative has two sub-components: EE Kits and School Education. The SWE reviewed the energy efficiency kits and school education kits for both the EE Kits and Low-Income EE Kits sub-initiatives. The energy conservation kits in the EE Kit subprogram contained LED lamps, LED night lights, energy saving aerators, a furnace whistle, an energy saving showerhead, and electrical outlet gaskets. The kits provided through the School Education sub-component contained LED lamps, LED night lights, a furnace whistle, and electrical outlet gaskets. The Low-Income kits included advanced power strips in place of electrical outlet gaskets. The SWE confirmed the verified savings for each sub-initiative were in accordance with the TRM protocols for the relevant measures and worked with ADM to resolve any discrepancies prior to the filing of the FirstEnergy annual report. The SWE also confirmed that participation, energy and demand savings, and energy realization rates were in alignment with those in the annual report.

**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.

**The Residential and Residential Low-Income Direct Install Initiatives**

The Direct Install Initiative includes both weatherization and non-weatherization measures. The SWE reviewed the weatherization and non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included LED lighting, LED nightlights, advanced power strips, and water heater setbacks.

The SWE also reviewed the WARM subcomponent of the Low-Income Direct Install Initiative, which provides water heater temperature setbacks, smart power strips, showerheads, refrigerators, pipe insulation, ENERGY STAR lighting, LED night lights, heat pump water heaters, furnace whistles, refrigerator/freezer removal, filter whistles, dehumidifiers, connected thermostats, and aerators. 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 PY14 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. 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.

For the final report, Low-Income and Non Low-Income Energy Efficient Products Programs were combined. There was one small change in population sizes for pool pumps in the final report, which was verified as accurate by the SWE.

**Energy Efficient Products Program and LIEEP: Online Audit**

In PY13, FirstEnergy launched an Online Audit component to the Behavioral subprogram included in both the Energy Efficient Homes (EEH) and Low-Income Energy Efficiency (LI) programs. The Online Audit component operates on an opt-in basis and offers residential customers a web-

based platform featuring energy usage visualizations, energy-saving tips, and promotion of other FirstEnergy residential energy efficiency programs. A total of 6,415 residential and 562 residential-LI households participated in Online Audit in PY14. The PY13 evaluation did not find statistically significant savings amongst Online Audit homes, so Met-Ed claimed not verified savings for the component in PY13. The PY14 analysis identified statistically significant savings the Online Audit component generated approximately 0.9% of Met-Ed’s verified gross MWh savings in PY14.

The Phase IV Online Audit subprogram is an opt-in program, and the SWE team reviewed the propensity score matching ADM performed to create a comparison group using five pre-treatment variables, latitude, and longitude. Due to the non-RCT design of Online Audit component, ADM included weather terms to improve model fit and control for potential variability between the treatment and control group. The SWE team independently calculated per-household kWh savings from regression coefficients, active participant counts, and aggregate MWh and MW impacts. Our estimates match ADM’s estimates.

The SWE also reviewed the dual participation analysis. Online Audit participants tend to participate in other Met-Ed EE&C programs at a higher rate than the matched control groups so this adjustment is necessary to avoid double-counting. To calculate gross verified demand savings, ADM generated an ETDF using residential load profiles corresponding to the treatment group and then applied ETDF to energy savings to estimate. The SWE was able to replicate the verified demand savings for both the residential and residential low-income group.

Table 149 shows the aggregate PY14 verified gross MWh and MW savings by cohort. The table also shows the number of participants and average percentage savings per household by program group. Using the first impact estimate as an example, the practical interpretation is as follows: all treatment group homes in the EEH Program saved 519 MWh and each household lowered their annual electric consumption by 0.59% during PY14. It is unclear why the low-income households saved more energy per-household than their market rate counterparts in PY14. The population size for the LI program is much smaller so it is possible that the difference is simply noise in the results.

**Table 149: PY14 Met-Ed Online Audit Energy and Demand Savings**

Program	Participants	Verified Gross Energy Savings (MWh)	Gross Demand Savings (MW)	Average Percentage Savings per Home
EEH Program	6,415	519	0.10	0.59%
LI Program	562	272	0.05	3.10%
-	<b>6,977</b>	<b>791</b>	<b>0.15</b>	-

The SWE team found that ADM’s evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **Appliance Recycling and Low-Income Appliance Turn-In Initiative**

The SWE performed audits on the Appliance Recycling, Low Income Appliance Recycling, and Midstream Appliance Recycling sub-initiatives of the Appliance Recycling (ATI) Initiative. The five measures included were refrigerator recycling, freezer recycling, room air conditioner (RAC) recycling, dehumidifier recycling, and mini refrigerator recycling. 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 Direct Install Initiative, which includes ENERGY STAR lighting, LED night lights, aerators, 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 PY14.

#### **E.5.1.2 Behavior**

Home Energy Reports were issued to around 77,000 Met-Ed residential and residential-LI households in PY14. HERs accounted for 3.7% of all Met-Ed PY14 verified energy savings and 6.0% of Met-Ed's progress toward its low-income target in PY14. Met-Ed's behavioral portfolio consists of both active waves as well as other inactive legacy waves, which may be re-activated later in Phase IV. Four waves, or cohorts, were active during PY14 and two of them targets low-income households. [Table 150](#) summarizes the average number of active households during PY14 by cohort.



**Table 150: Met-Ed HER Cohort Summary**

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	31,019	10,694
2021 Low-Income	9/30/2021	10,597	9,620
2022 Residential	6/3/2022	25,587	11,075
2022 Low-Income	6/3/2022	9,282	9,271

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 PY14 since the 2021 cohorts were checked last year. 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 56](#) and [Figure 57](#) 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 56: Pre-Treatment Equivalence, 2022 Residential Cohort

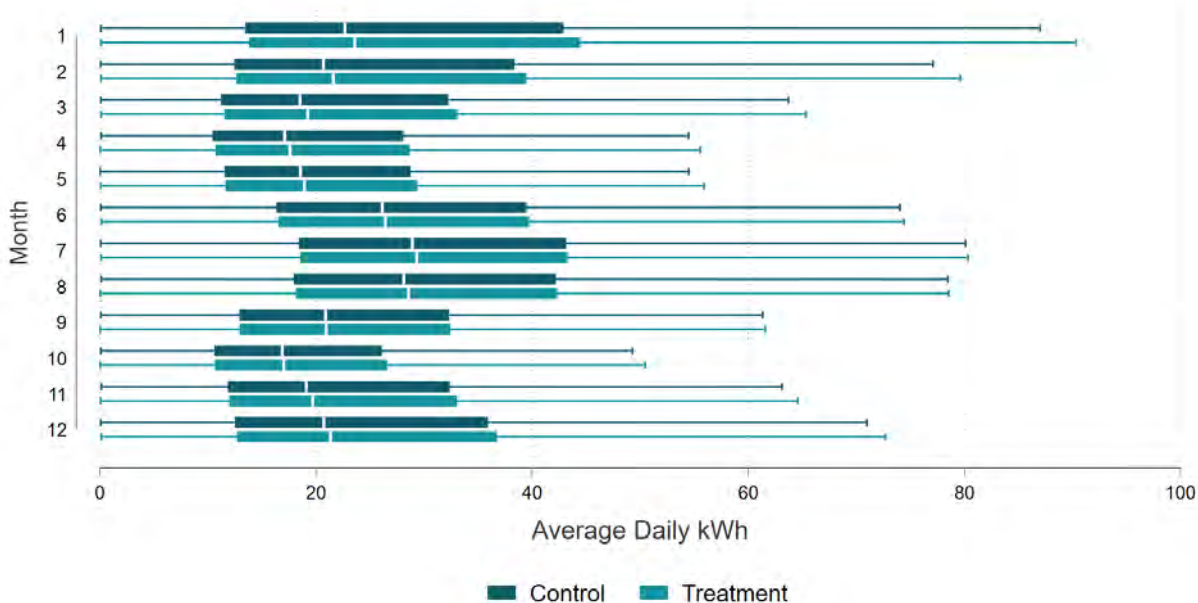
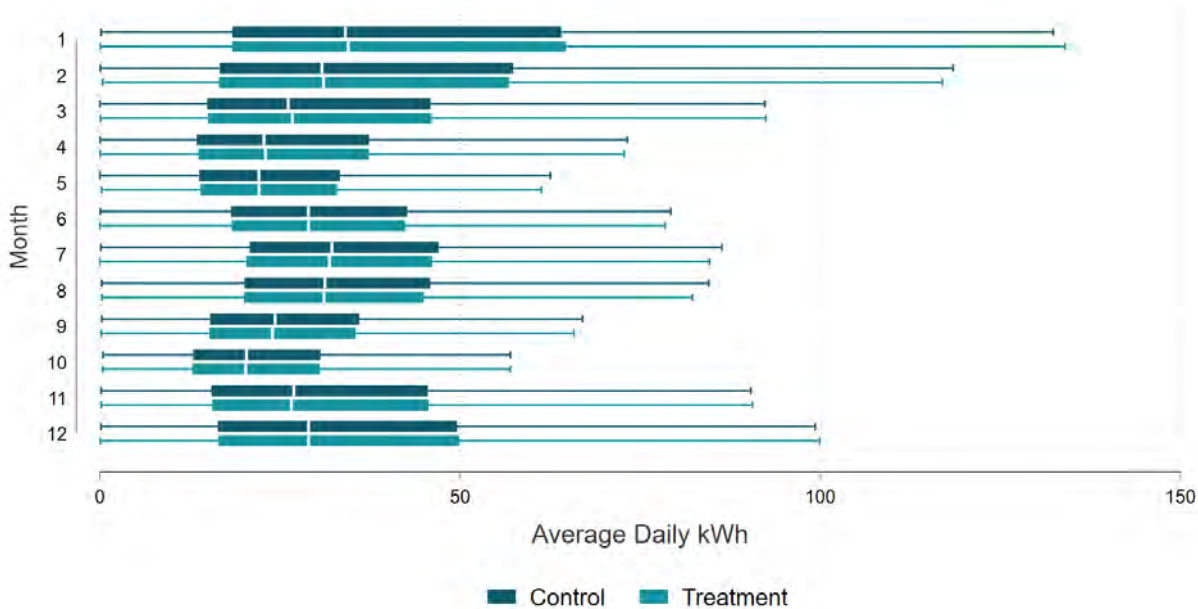


Figure 57: Pre-Treatment Equivalence, 2022 Low-Income Cohort



**Data Preparation**

The SWE team received interval data from ADM at two different levels: 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 PY14 impact analysis as called for in the Met-Ed PY14 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 daily 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 (3.7% 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 to within 0.1% 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 58](#) (2021 residential), [Figure 59](#) (2021 low-income), [Figure 60](#) (2022 residential), and [Figure 61](#) (2022 low-income). For each cohort, [Table 151](#) shows the average of the PY14 monthly impact estimates. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.22 kWh per day, on average, during PY14. The SWE was able to replicate ADM's impact estimate for each cohort/month combination.

**Table 151: Met-Ed HER Impact Estimates**

Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.22
2021 Low-Income	0.05
2022 Residential	0.06
2022 Low-Income	0.05

Figure 58: Average Daily Savings (kWh) by Month, 2021 Residential Cohort

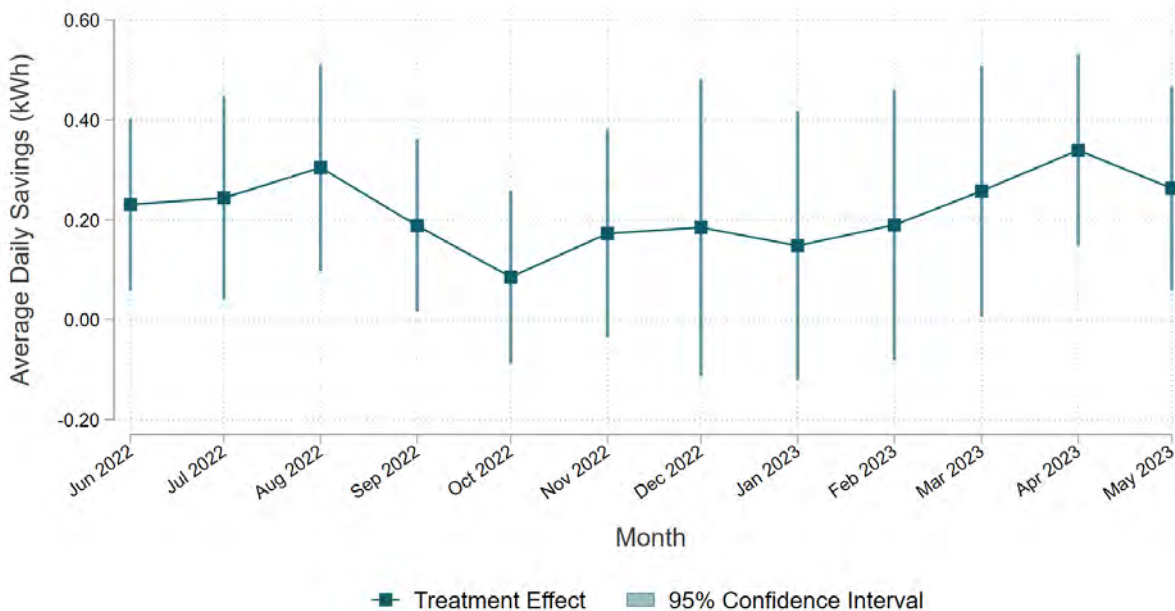


Figure 59: Average Daily Savings (kWh) by Month, 2021 Low-Income Cohort

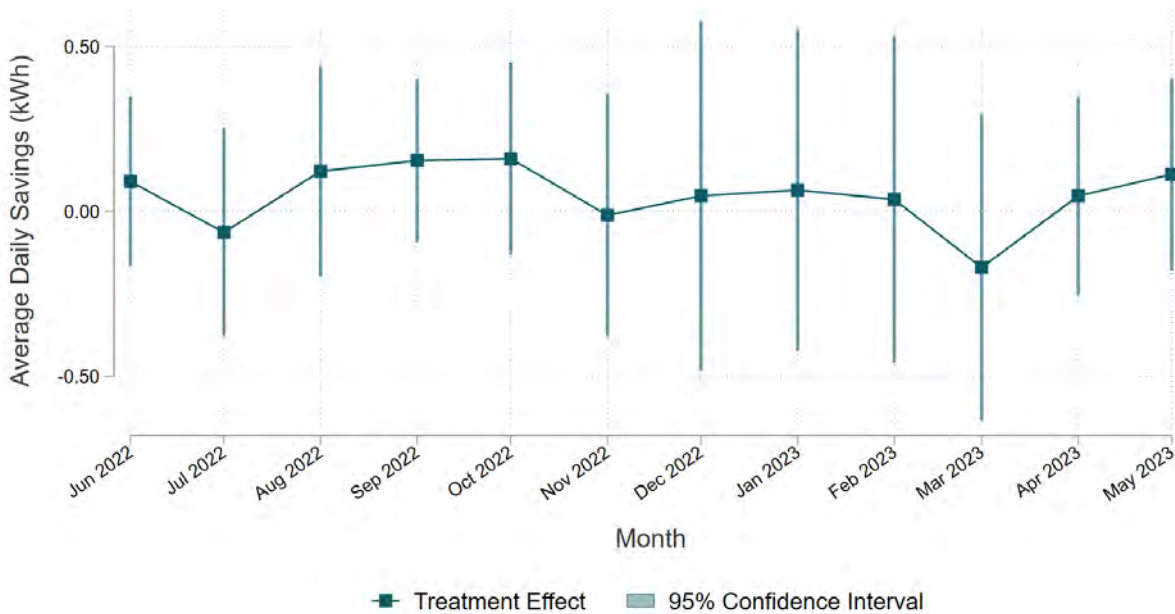


Figure 60: Average Daily Savings (kWh) by Month, 2022 Residential Cohort

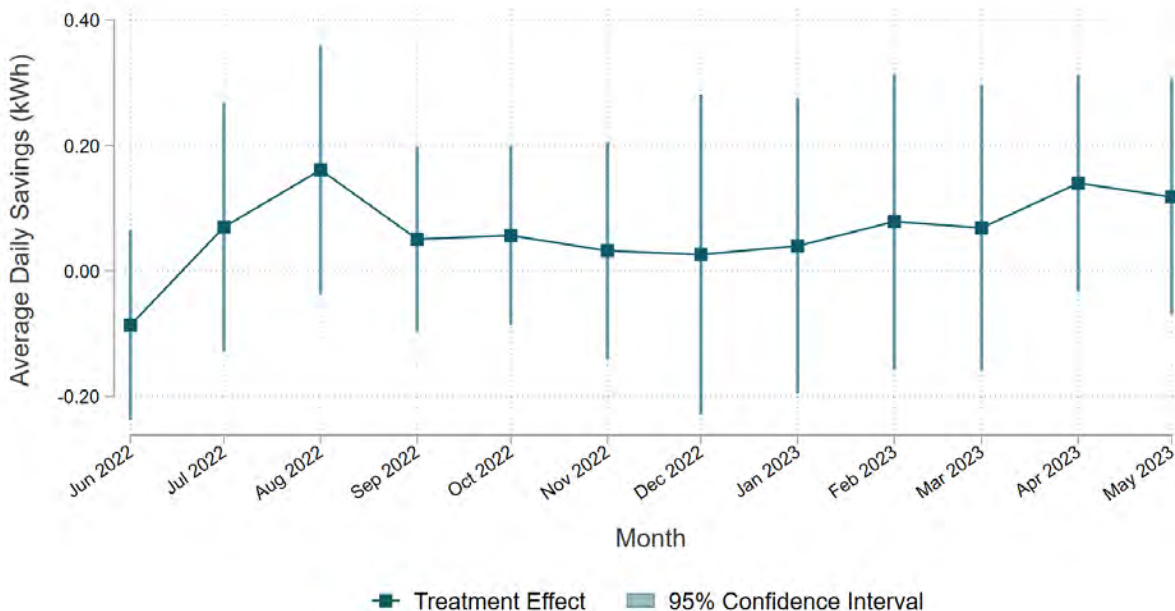
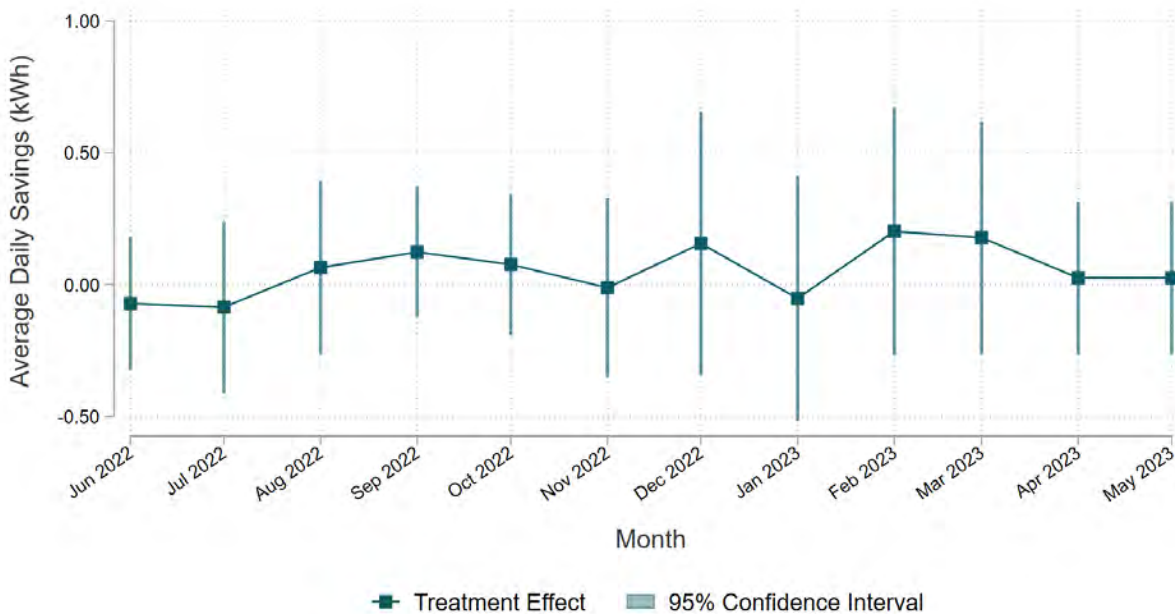


Figure 61: Average Daily Savings (kWh) by Month, 2022 Low-Income Cohort



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 152](#) shows the aggregate PY14 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, which are discussed in greater detail later, and the PY14 incremental gross savings estimate.

**Table 152: PY14 HER Energy Savings**

Cohort	Gross Savings (MWh)	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Persistence (MWh)	Incremental Savings (MWh)
2021 Residential	2,386	29	0	0	2,358
2021 Low-Income	169	51	0	0	118
2022 Residential	535	-8	0	0	543
2022 Low-Income	159	8	0	0	151
<b>Total</b>	<b>3,250</b>	<b>80</b>	<b>0</b>	<b>0</b>	<b>3,170</b>

**Dual Participation**

In [Table 152](#), gross savings before adjusting for dual participation were 3,250 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 and PY14. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

**Persistence**

The 2021 Pennsylvania TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research<sup>72</sup> 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). Because Met-Ed's active waves were launched during PY13 and PY14, all savings are first-year incremental savings. Separating persisting savings from incremental savings was not necessary.

**Peak Demand Impacts**

The Pennsylvania TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 p.m. to 6:00 p.m. Eastern Daylight Time on non-holiday weekdays during

<sup>72</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)



June, July, and August. For each cohort, [Table 153](#) shows the daily peak demand impact estimates and peak demand reduction in PY14. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.01 kWh per hour during peak demand window and saved 0.34 MW without line loss and 0.37 MW with line loss during peak hours, on average, during PY14. The SWE was able to replicate ADM's peak demand impact estimate and peak demand reduction for each cohort.

**Table 153: Met-Ed HER Peak Demand Impacts**

Cohort	Peak Demand Impact Estimate (kWh saved per home per hour)	Peak Demand Reduction without line losses (MW)	Peak Demand Reduction with line losses (MW)
2021 Residential	0.01	0.34	0.37
2021 Low-Income	0.01	0.10	0.11
2022 Residential	0.01	0.17	0.19
2022 Low-Income	0.01	0.06	0.06
<b>Total</b>	<b>0.01</b>	<b>0.66</b>	<b>0.72</b>

### **Conclusion**

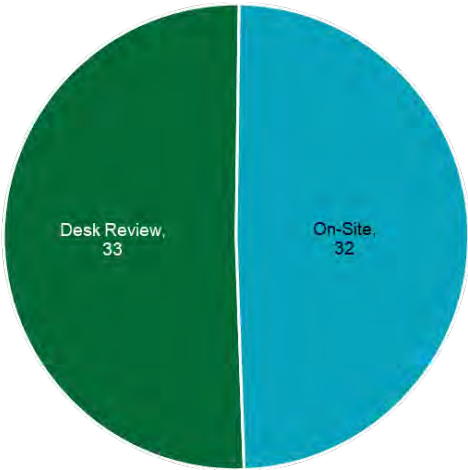
The SWE team found that ADM's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **E.5.2 Non-Residential Audit Activities**

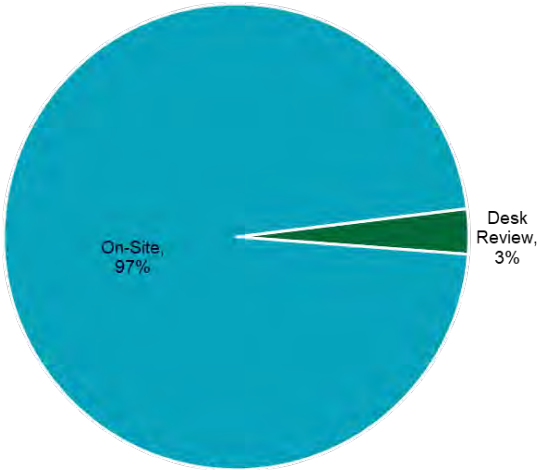
[Figure 62](#) provides a summary of the evaluation activities and M&V approaches utilized by ADM in their PY14 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY14, Met-Ed's evaluation contractor completed site visits to approximately half (32 of 65) of evaluated projects, and these projects represented 97% of total evaluated energy savings. IPMVP Options A, B, and C were employed for 90% of the total evaluated energy savings. Basic Rigor (verification only) was employed for the remaining 10% of the total evaluated savings, including the majority of prescriptive projects and most energy management projects.

Figure 62: Summary of Met-Ed’s C&I Evaluation Activities

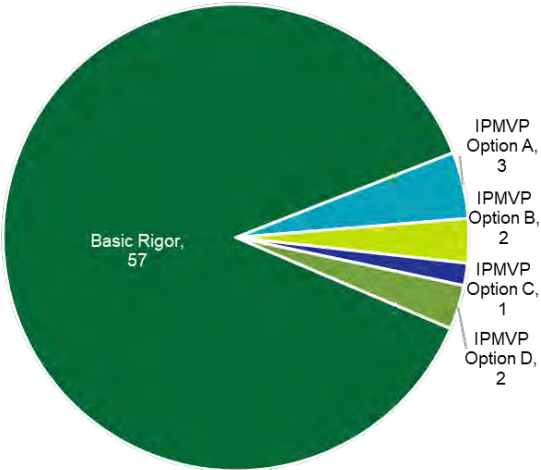
M&V Activity by Project Count



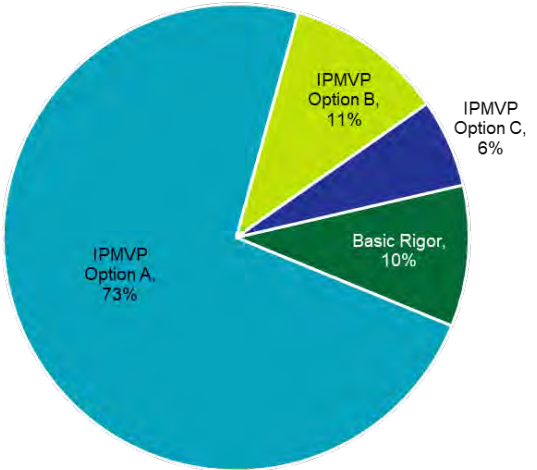
M&V Activity by kWh Contribution



M&V Method by Project Count



M&V Method by kWh Contribution





Met-Ed's evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Met-Ed's C&I programs are assigned to one of five evaluation initiatives, as Met-Ed's programs target specific sectors of C&I customers, but offerings are often identical across the programs. Table 154 provides a summary of the evaluation activities Met-Ed's evaluation contractor used across strata for all projects by initiative.

**Table 154: Summary of Met-Ed's PY14 C&I Evaluation Activities by Initiative**

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
<b>Appliance Recycling</b>	-	<b>116%</b>	<b>113%</b>	-	-
<b>Custom</b>	<b>4</b>	<b>103%</b>	<b>100%</b>	<b>1</b>	<b>3</b>
Custom – C	2	100%	100%	-	2
Custom – 1	2	173%	112%	1	1
<b>Prescriptive</b>	<b>33</b>	<b>103%</b>	<b>100%</b>	<b>18</b>	<b>15</b>
Downstream Lighting - C	3	100%	99%	-	3
Downstream Lighting - 2	5	102%	102%	1	4
Downstream Lighting - 1	10	103%	102%	5	5
Downstream Non-Lighting	5	99%	101%	4	1
Midstream Lighting	10	107%	98%	8	2
Midstream Non-Lighting	-	-	-	-	-
<b>EMNC</b>	<b>25</b>	<b>98%</b>	<b>97%</b>	<b>13</b>	<b>12</b>
EMNC	-	-	-	-	-
Building Tune-Ups	25	98%	97%	13	12
<b>Multifamily</b>	<b>3</b>	<b>92%</b>	<b>92%</b>	<b>1</b>	<b>2</b>
<b>TOTAL</b>	<b>65</b>			<b>33</b>	<b>32</b>

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 PY14, 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.

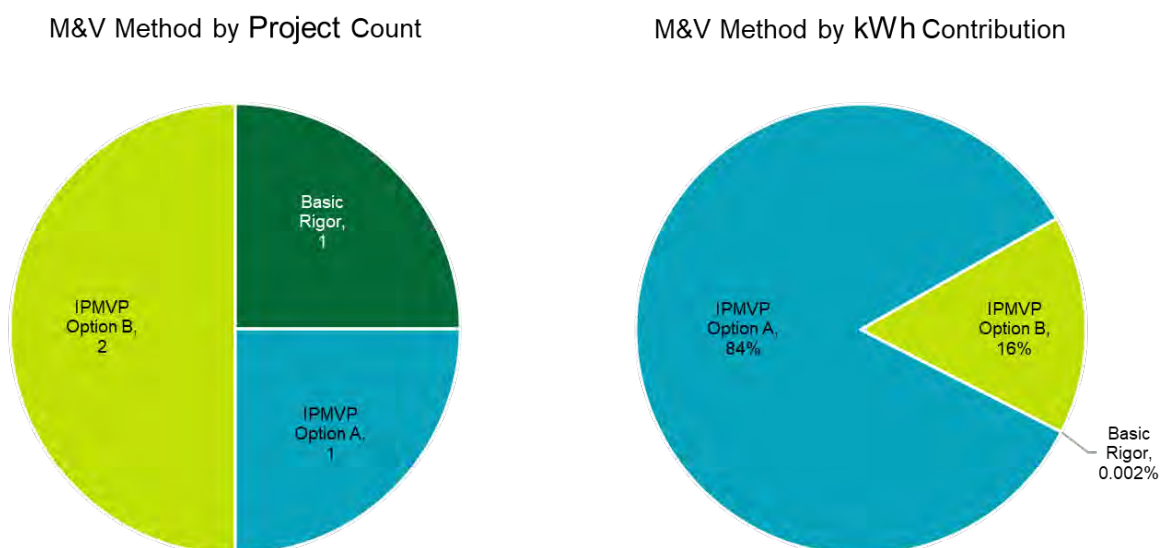
### E.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews and/or IPMVP evaluation methods for all sampled projects. No site visits were conducted for PY14 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 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 Options A and B selected as the primary enhanced M&V methods, as shown in [Figure 63](#).

**Figure 63: Summary of Met-Ed's C&I Custom Program M&V Methods**



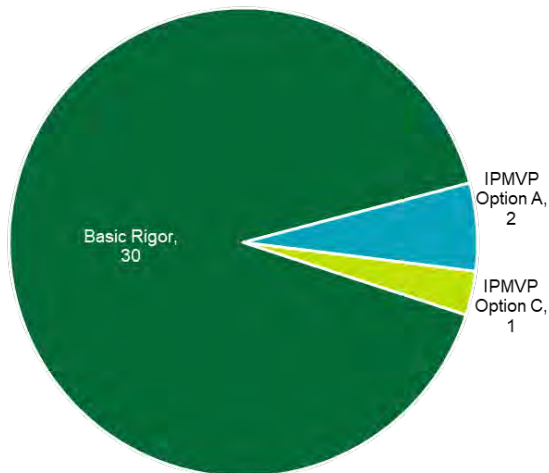
### E.5.2.3 Prescriptive Initiative

Met-Ed's evaluation contractor employed six 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.

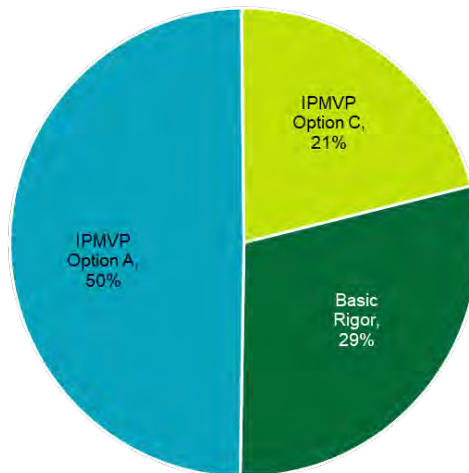
Basic Rigor was employed for 29% of evaluated project savings in this initiative with the remaining projects using IPMVP Options A and C, as seen in [Figure 64](#) below.

**Figure 64: Summary of Met-Ed’s C&I Prescriptive Program M&V Methods**

M&V Method by Project Count



M&V Method by kWh Contribution



**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 PY14: Building Tune-Up and New Construction.

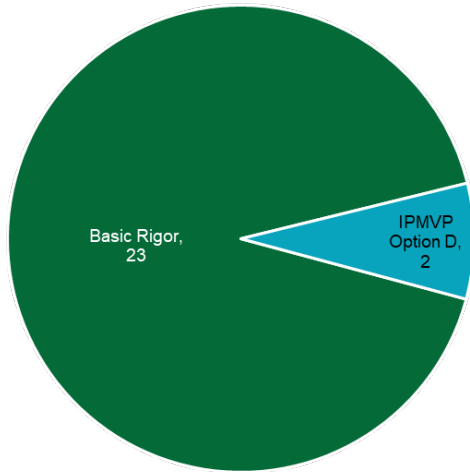
Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Primarily basic rigor M&V methods were applied to these 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.

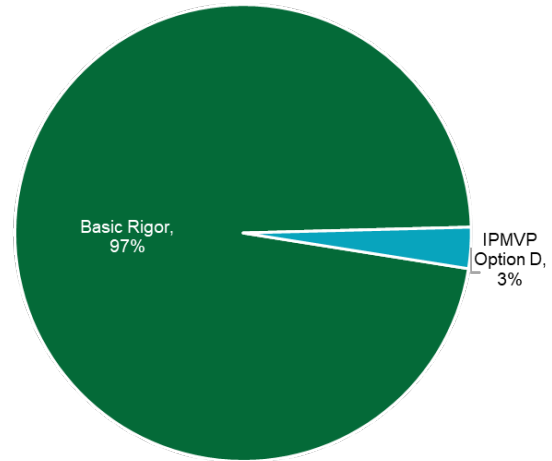
Basic Rigor was employed for 97% of evaluated project savings in this initiative with the remaining projects using IPMVP Option D, as seen in [Figure 65](#) below.

**Figure 65: Summary of Met-Ed's CI EMNC Program M&V Methods**

M&amp;V Method by Project Count



M&amp;V Method by kWh Contribution



#### 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 PY14 included review of (12) projects, encompassing the following activities:

SWE Audit activities for PY14 encompassed the following metrics.

- 4 Field and Analysis Engineers were observed
- 7 Lighting, 2 HVAC, 1 Appliance, 1 CHP, and 1 Custom Measure Observed
- 2 In-person Ride-alongs conducted
- 84% of Verified Energy Savings reviewed
- 82% of Verified Demand Savings reviewed

Table 155 provides an overview of the SWE milestones for the verified savings audit review of evaluated Met-Ed projects.

**Table 155: Met-Ed Verified Savings Audit Review Milestones**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
12	27,858,492	98%	3,257	97%

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 the following:

- Lighting wattages updates to DLC 5.1-rated values
- Custom calculation baseline compressor operation
- Location change affecting EFLHs

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 98% for the SWE's audited sample, and a demand savings attainment percentage of 97%.

## E.6 NTG

Table 156 lists Met-Ed's PY14 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 156: Summary of Met-Ed's PY14 NTG Results**

Program Name	Component	NTG
Energy Efficient Products	Appliances	0.67
Energy Efficient Homes	New Homes	0.72
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	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 Homes	Multifamily	0.81
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
Energy Efficient Products	Midstream Appliances	0.47
C&I Solutions for Business Programs – Small and Large	Prescriptive	0.73
C&I Solutions for Business Programs – Small and Large	Custom	0.57
C&I Solutions for Business Programs – Small and Large	EMNC	0.98
C&I Solutions for Business Programs – Small and Large	Multifamily	1.0
C&I Solutions for Business Programs – Small and Large	Multifamily	1.0

### E.6.1 Residential Programs

ADM planned and enacted NTG research for the Residential Downstream Appliances component of the EE Products Program and the New Homes component of the EE Homes Program (Table 157). ADM utilized participant surveys to estimate free-ridership, spillover and NTG for downstream appliances and building interviews for New Homes. ADM utilized question batteries that were consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation.

**Table 157: Summary of Met-Ed's PY14 Residential NTG Results**

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
New Homes	Builder Interviews	20	28%	0%	0.72
Appliances	Self-Report Survey	98	42%	9%	0.67

## E.6.2 C&I Energy Efficiency Programs

ADM conducted NTG research for the prescriptive, custom, and EMNC programs in PY14. (Table 158). ADM applied the residential Appliance Recycling PY10 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. The NTG for the Prescriptive program is a savings-weighted average of the downstream and midstream lighting and non-lighting stratum.

**Table 158: Summary of Met-Ed's PY14 C&I NTG Results**

Program Components	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	Participant & Vendor Surveys	57	32%	2%	0.69
Custom	Participant & Vendor Surveys	7	43%	0%	0.57
EMNC	Participant & Vendor Surveys	34	2%	0%	0.98
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 159 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Met-Ed's PY14 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 PY14 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.

Both gross and net TRC ratios increased slightly from PY13, with the largest increase occurring in the C&I Energy Solutions for Business – Small program.

Table 159: Summary of Met-Ed's PY14 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
Residential – Energy Efficient Homes	\$11,377	\$4,938	2.30	\$9,239	\$4,542	2.03
Residential – Energy Efficient Products	\$7,058	\$8,244	0.95	\$3,436	\$5,002	0.69
Low Income Energy Efficiency	\$2,401	\$2,405	1.40	\$2,401	\$2,405	1.00
C&I Energy Solutions for Business – Small	\$12,918	\$7,680	1.36	\$9,655	\$6,117	1.58
C&I Energy Solutions for Business – Large	\$12,616	\$7,563	1.21	\$8,142	\$5,072	1.61
<b>Portfolio Total</b>	<b>\$46,369</b>	<b>\$30,831</b>	<b>1.50</b>	<b>\$32,873</b>	<b>\$23,138</b>	<b>1.42</b>

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.

- The SWE also verified the correct avoided costs from Met-Ed's EE&C Plan were used in the TRC model.
- 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 PY14 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent.
- 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.
- 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.

## 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 two residential programs: Energy Efficient Products and Energy Efficient Homes. Each program has multiple components. In PY14, ADM/Tetra Tech completed process evaluations for the following components within the two residential programs:

- Energy Efficient Products Program
  - Appliance Rebate
- Energy Efficient Homes Program
  - Behavioral Home Energy Reports
  - New Homes

#### E.8.1.1 Energy Efficient Products Program – Appliance Rebate

##### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff and implementation staff, surveyed customers, surveyed the general population, conducted retailer interviews, and completed benchmarking and database reviews. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *While major marketing efforts for retailers are managed at the corporate level, each store we spoke to adopts its practices for promoting either the point-of-sale (POS) or mail-in rebate component.*
- *Participant survey results show marketing efforts, primarily through store displays and signage and bill inserts, are effective in producing program awareness.*
- *Participant satisfaction across multiple program aspects is high.*
- *The general population survey shows over one-quarter of the refrigerator and standalone freezer owners have units that are at least ten years old.*
- *Only 22% of the general population survey respondents believed their home is very energy efficient.*
- *The cost of upgrading is the most frequently mentioned reason for not making energy-efficient changes in the home (61%), according to the general population survey respondents.*

### **Summary of Process Evaluation Audit**

The process evaluation of the Appliance Rebate component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 70 participant surveys with Met-Ed customers; the target was nearly met with 69 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

### **E.8.1.2 Energy Efficient Products Homes – Behavioral Home Energy Report**

#### **Summary of Process Evaluation Results**

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff and implementation staff, surveyed customers, and analyzed customer engagement metrics. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *Customers express high satisfaction with FirstEnergy, and the program raises satisfaction for many. Two-thirds of treatment and control customers are very satisfied or extremely satisfied with the overall quality of service provided by their EDC. About one in five*

*treatment customers say their opinion of their EDC has improved since they have been receiving Home Energy Reports (HER).*

- *Readership of the HERs is high and steady throughout the year. Among treatment customers who were surveyed, one-half say that “someone (in the household) reads the entire paper report.” Less than 1% say “no one reads the paper report.” Of those who receive electronic HERs (eHER), which are sent monthly, almost two-thirds read “all or almost all” of the 12 reports in the past year.*
- *Most treatment customers understand general energy-saving guidance from the reports, but a smaller proportion remember specific tips. Survey participants report a long list of energy-saving ideas that are broadly consistent with tips promoted through the HERs. However, fewer customers accurately recall more specific recommendations. Over one-half of the survey participants responded “do not recall” or were not able to provide a specific response when asked to name a HER recommendation.*
- *Recall of recommended thermostat settings from the summer- and winter-themed HERs is low, especially for the summer cooling season. Slightly over one-half accurately recall a recommended winter setting of 68 degrees; only 14% correctly cited the recommended summer setting of 78 degrees.*
- *Most participants find information in the HERs useful. Almost 80% find the charts and other information somewhat useful, and about one in three say they are either very or extremely useful. The report’s comparison of one’s own energy use now with the same time a year prior received the highest share of useful ratings, followed by hours of the day with the most energy use.*
- *Cost continues to be a barrier to saving energy for most customers. Almost two-thirds of the treatment customers and one-half of the control customers selected the “cost of doing things to save energy” as a reason for not taking action to save energy.*
- *Awareness of energy efficiency offerings is relatively low for both treatment and control customers. Across five survey questions referencing different FirstEnergy offerings, no more than 60% were aware of the program. Less than one-half knew of rebates for purchasing eligible appliances, and only 20% were aware of discounted prices on qualifying appliances at selected stores.*

### **Summary of Process Evaluation Audit**

The process evaluation of the Behavioral Home Energy Report component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 35 participant surveys with Met-Ed customers; the target was exceeded with 97 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering

those recommendations. 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.

### E.8.1.3 Energy Efficient Products Homes – Online Audits

#### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff and implementation staff, and surveyed customers. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

The evaluators reported on the following key findings:

- *Awareness and understanding of the program are low.* Many program participants did not remember completing the online energy audit when contacted for the survey. Survey responses and *qualitative* information suggest that most come upon the audit accidentally while visiting the website. Recall of energy-saving tips is low—among customers who remembered completing the online audit, about 60% clicked on the categories to see relevant energy-saving tips. About one-half of those customers did not recall any energy-saving tips or provided generic statements instead of specific tips.
- *Customers report that it was easy to both log in to the online audit webpage and answer the questions in the online audit.* Almost all customers reported that it was very easy or somewhat easy to log in to the webpage and answer the questions.
- *Customers were likely to implement energy-saving actions if they saw tips through the online audit.* Customers were most likely to report that they changed the temperature on their thermostat, turned off lights when not in the room, or installed energy-efficient lighting as a result of completing the online audit. At least one-third of the customers indicated doing or planning to do things months after completing the online audit.
- *Cost continues to be a barrier to saving energy for most customers.* Almost one-third of the customers selected the cost of doing things to save energy as a reason for not taking action to save energy.
- *Customers express high satisfaction with aspects of the program.* Between 61 and 78% are at least very satisfied with each of three aspects of the program—the program overall, the length of time it took to answer the questions in the online audit<sup>73</sup>, and the information and tips received on how to save energy.
- *Customers express high satisfaction with FirstEnergy.* About 70% are at least very satisfied with the overall quality of service provided by their EDC. Roughly one in five

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<sup>73</sup> Throughout this memo, we refer to the program as the “Online Audit program” and the tool itself as the “online audit”.

reported that their opinion of the company improved as a result of their participation in the program.

### Summary of Process Evaluation Audit

The process evaluation of the Online Audits component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 120 participant surveys with Met-Ed customers; the target was nearly met with 119 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

#### E.8.1.4 Energy Efficient Products Homes – New Homes

### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff, implementation staff, and trade allies (HERS raters and builders). The research issues addressed by the primary data-collection activities (in-depth interviews) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *Participating program builders' overall satisfaction was the program is high. Similar to Phase III, the mean satisfaction score was 4.3 on a scale of 1 (not at all satisfied) to 5 (very satisfied).*
- *Performance Systems Development's (PSD) (the conservation service provider (CSP)) communication with builders remains a program strength. Builders continue to value the support and information that PSD provides to them.*
- *Builders are aware of updated Section 45L Tax Credits for ENERGY STAR® new homes, but they are not enticed to begin building ENERGY STAR-certified homes. The main reasons included a lack of interest among their clients and high compliance costs. Several raters are working with builders to show them how to balance the ENERGY STAR cost equation.*
- *The program influenced builders to increase the efficiency of new homes under the IECC 2015 code. NTG was estimated at 72% for PY14. Builders credited the program for increasing their efficiency above code.*

- *Builders repeatedly mentioned that the program provided valuable information and that the program staff was helpful and responsive.* Builders also said that PSD and raters enhance builders' building practices through on-site training on building methods and new technologies.
- *Raters report very high satisfaction with the program overall, with a mean score of 4.75 on a scale of 1 (not at all satisfied) and 5 (very satisfied).*
- *Raters' satisfaction with PSD remains very high (4.5), as it has been in previous years' evaluations.*
- *Raters spend a significant amount of time uploading multifamily information to Compass.* Raters are required to upload information separately for each unit, which is very time-consuming and results in higher costs to multifamily developers and builders.
- *Raters are eagerly awaiting the roll-out of Ekotrope as an approved software for providing home ratings to Compass.* Ekotrope is used by builders and raters participating in other new homes programs across the country.
- *Raters expressed mixed views on the ease with which builders would be able to exceed the 2018 International Energy Conservation Code (IECC) in PY15.* Most of the raters we interviewed (5 of 6) were optimistic that adjusting to the 2018 code would entail less significant changes in building practices for many builders. However, exceeding 2018 IECC code would be challenging for some, and especially smaller builders who may leave the program as a result.

### Summary of Process Evaluation Audit

The process evaluation of the New Homes component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

### E.8.2 Residential Low-Income Program

There is one Low-Income Residential Program, Low-Income Energy Efficiency, which has seven components. In PY14, ADM/Tetra Tech completed process evaluations for the following components within the low-income residential program:

- Low-Income Energy Efficient Program
  - Weatherization (WARM) Direct Install
  - Appliance Rebate



- Behavioral Home Energy Reports
- Multifamily
- New Homes

### E.8.2.1 Weatherization (Direct Install)

#### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff and implementation staff, surveyed customers, and interviewed trade allies (Energy Auditor Contractors). The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *Participants learn about the program from a variety of sources.* The most common source of program awareness was bill inserts and direct mail (21%), followed by word-of-mouth (15%). Assistance programs were also cited frequently, especially the Low-Income Home Energy Assistance Program (LIHEAP) (14%), followed by the Pennsylvania Customer Assistance Program (PCAP) (13%). Telephone calls, mentioned by 12%, are a new source of awareness in this evaluation phase. This increase in telephone calls is likely a result of the outreach by contractors once eligible customers are identified.
- *There is a good recall of energy-saving tips provided by the energy auditors.* More than 70% of respondents remember the energy auditor discussed the benefits or recommended turning off lights when leaving rooms and unplugging electronics when not in use. Another 65% remembered discussing washing clothes in cold water to save energy.
- *Most equipment received through the program is still installed.* For most measures, reported installation persistence is above 90%. Low-flow showerheads, furnace whistles, and window air conditioners are the most likely to be removed after installation. Window air conditioners are mostly removed seasonally. Air sealing, smart thermostats, and reflective tint all remain installed.
- *Energy specialists provide respondents with clear explanations of their actions in the participant's home.* Almost 90% of participants said their energy specialist explained what they were doing in their homes. Of those, only 1% (three participants) said they could not understand their explanation.
- *Participants are very satisfied with the program.* Thirty-nine percent of participants said they were extremely satisfied, and another 41% said they were very satisfied. The highest-rated aspects of the program were interactions with the energy auditor, the types of energy-efficient items received through the program, and the quality of the energy-efficient items received.
- *Energy auditors have positive experiences with program processes.* Two of the eight contractors interviewed rated the overall program process as very easy (a 5, on a scale of 1 to 5), and one other rated all aspects of the process a 5 except for payment. Two more rated the overall process a 4.5.

- *Energy audit contractors continue to experience difficulties completing projects with customers who express interest in the program.* Scheduling audit visits has become more challenging in Phase IV, and COVID-19 has added to the existing barriers for energy auditors to complete the necessary work in customers' homes.
- *The workload for completing audits and direct installs is split between CLEAResult and subcontractors.* CLEAResult, the conservation service provider (CSP), delivers most audit and direct install projects for WARM Plus. They deliver all projects in Penn Power's service territory and cover other territories where its subcontractors do not have the capacity. CLEAResult continues to recruit subcontractors and added two in PY14.

### Summary of Process Evaluation Audit

The process evaluation of the Weatherization (Direct Install) component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 70 participant surveys with Met-Ed customers; the target was exceeded with 71 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

#### E.8.2.2 Appliance Rebate

### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff and implementation staff, surveyed customers, surveyed the general population, conducted retailer interviews, and completed benchmarking and database reviews. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *While major marketing efforts for retailers are managed at the corporate level, each store we spoke to adopts its practices for promoting either the point-of-sale (POS) or mail-in rebate component.*
- *Participant survey results show marketing efforts, primarily through store displays and signage and bill inserts, are effective in producing program awareness.*
- *Participant satisfaction across multiple program aspects is high.*



- *The general population survey shows over one-quarter of the refrigerator and standalone freezer owners have units that are at least ten years old.*
- *Only 22% of the general population survey respondents believed their home is very energy efficient.*
- *The cost of upgrading is the most frequently mentioned reason for not making energy-efficient changes in the home (61%), according to the general population survey respondents.*

### **Summary of Process Evaluation Audit**

The process evaluation of the Appliance Rebate component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 35 participant surveys with Met-Ed customers; the target was nearly met with 29 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

### **E.8.2.3 Behavioral Home Energy Report**

#### **Summary of Process Evaluation Results**

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff and implementation staff, surveyed customers, and analyzed customer engagement metrics. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *Customers express high satisfaction with FirstEnergy, and the program raises satisfaction for many.* Two-thirds of treatment and control customers are very satisfied or extremely satisfied with the overall quality of service provided by their EDC. About one in five treatment customers say their opinion of their EDC has improved since they have been receiving Home Energy Reports (HER).
- *Readership of the HERs is high and steady throughout the year.* Among treatment customers who were surveyed, one-half say that “someone (in the household) reads the entire paper report.” Less than 1% say “no one reads the paper report.” Of those who

receive electronic HERs (eHER), which are sent monthly, almost two-thirds read “all or almost all” of the 12 reports in the past year.

- *Most treatment customers understand general energy-saving guidance from the reports, but a smaller proportion remember specific tips.* Survey participants report a long list of energy-saving ideas that are broadly consistent with tips promoted through the HERs. However, fewer customers accurately recall more specific recommendations. Over one-half of the survey participants responded “do not recall” or were not able to provide a specific response when asked to name a HER recommendation.
- *Recall of recommended thermostat settings from the summer- and winter-themed HERs is low, especially for the summer cooling season.* Slightly over one-half accurately recall a recommended winter setting of 68 degrees; only 14% correctly cited the recommended summer setting of 78 degrees.
- *Most participants find information in the HERs useful.* Almost 80% find the charts and other information somewhat useful, and about one in three say they are either very or extremely useful. The report’s comparison of one’s own energy use now with the same time a year prior received the highest share of useful ratings, followed by hours of the day with the most energy use.
- *Cost continues to be a barrier to saving energy for most customers.* Almost two-thirds of the treatment customers and one-half of the control customers selected the “cost of doing things to save energy” as a reason for not taking action to save energy.
- *Awareness of energy efficiency offerings is relatively low for both treatment and control customers.* Across five survey questions referencing different FirstEnergy offerings, no more than 60% were aware of the program. Less than one-half knew of rebates for purchasing eligible appliances, and only 20% were aware of discounted prices on qualifying appliances at selected stores.

### Summary of Process Evaluation Audit

The process evaluation of the Behavioral Home Energy Report component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 35 participant surveys with Met-Ed customers; the target was exceeded with 70 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

### E.8.2.4 Multifamily (Residential)

#### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff, implementation staff, and trade allies (program energy auditors), and surveyed customers. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *Participants learn about the program through a variety of sources. The most common source of program awareness was their landlord (41%) or word-of-mouth (13%), followed by bill inserts and direct mail (12%).* Engagement with property managers and leasing agents (11%) while recruiting tenants to participate in the program was also cited as a source of program awareness.
- *There is a high level of recall of energy-saving tips provided by the energy auditors. More than 85% of respondents remember the energy auditor discussed the benefits or recommended turning off lights when leaving rooms, and 69% remembered discussing unplugging electronics when not in use.*
- *Most of the equipment received through the program is still installed. Most equipment installed through the program remained installed at the time of the survey (at least 85%). Smart power strips had lower retention: Almost 24% (7 of 29) of participants had removed the power strip, primarily because it interfered with their use of televisions and gaming consoles (four participants) or was never installed (two participants).*
- *Most participants felt that their energy auditors were clear in explaining the actions they were taking in the participant's home. Almost 88% (42 participants) said that their energy auditor explained what they were doing in their home, and of those, almost 100% (41 participants) said that they were able to understand the explanation they were given. Although survey participants were highly engaged, contractors reported low levels of engagement among multifamily tenants.*
- *Participants are very satisfied with the program. Forty-two percent of participants said they were extremely satisfied, and another 45% said they were very satisfied. The highest-rated aspects of the program were interactions with the energy auditor, the types of energy-efficient items received through the program, and the quality of the energy-efficient items received.*
- *All energy auditors (five) experienced difficulties scheduling audits with customers who expressed interest in the program. Scheduling audit visits has become more challenging in Phase IV, and the COVID-19 pandemic continues to be a barrier for energy auditors to complete the necessary work in customer homes.*
- *Energy auditors find the program process easy. One contractor rated the program process as very easy (1 on a scale of 1 to 5), and two others rated the process as a 2, noting that the rating was not a 1 due to scheduling difficulties and payment delays. Two energy auditors rated the program process a 4 due to recruitment and scheduling difficulties, delayed payments, and limited time to build relationships with building owners and customers.*

- *Energy auditors feel that the LEEN tracking system is easy to use. However, they also reported uploading individual multifamily unit data is extremely time-consuming.* Three of the five contractors interviewed mentioned the LEEN system is built for single-family homes rather than multifamily buildings. The example most often given was that LEEN does not allow them to bulk-upload multifamily unit/building information and documentation.
- *The workload for completing audits and direct installs is split between CLEAResult and subcontractors.* CLEAResult, the conservation service provider (CSP), is conducting a large portion of the audits and direct-install projects (approximately 46%). This is primarily due to having a limited number or no subcontractors providing services in the Met-Ed and Penelec service territories. Three of the five subcontractor firms interviewed are working on adding and training new staff to take on more work in the FirstEnergy service territories they are currently working within.

### Summary of Process Evaluation Audit

The process evaluation of the Multifamily component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 20 participant surveys with Met-Ed customers; the target was nearly met with 15 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

#### E.8.2.5 New Homes

### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff, implementation staff, and trade allies (HERS raters and builders). The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. The evaluators reported on the following key findings:

- *Participating program builders' overall satisfaction was the program is high.* Similar to Phase III, the mean satisfaction score was 4.3 on a scale of 1 (*not at all satisfied*) to 5 (*very satisfied*).

- *Performance Systems Development's (PSD) (the conservation service provider (CSP)) communication with builders remains a program strength.* Builders continue to value the support and information that PSD provides to them.
- *Builders are aware of updated Section 45L Tax Credits for ENERGY STAR® new homes, but they are not enticed to begin building ENERGY STAR-certified homes.* The main reasons included *a lack of interest among their clients and high compliance costs.* Several raters are working with builders to show them how to balance the ENERGY STAR cost equation.
- *The program influenced builders to increase the efficiency of new homes under the IECC 2015 code.* NTG was estimated at 72% for PY14. Builders credited the program for increasing their efficiency above code.
- *Builders repeatedly mentioned that the program provided valuable information and that the program staff was helpful and responsive.* Builders also said that PSD and raters enhance builders' building practices through on-site training on building methods and new technologies.
- *Raters report very high satisfaction with the program overall, with a mean score of 4.75 on a scale of 1 (not at all satisfied) and 5 (very satisfied).*
- *Raters' satisfaction with PSD remains very high (4.5), as it has been in previous years' evaluations.*
- *Raters spend a significant amount of time uploading multifamily information to Compass.* Raters are required to upload information separately for each unit, which is very time-consuming and results in higher costs to multifamily developers and builders.
- *Raters are eagerly awaiting the roll-out of Ekotrope as an approved software for providing home ratings to Compass.* Ekotrope is used by builders and raters participating in other new homes programs across the country.
- *Raters expressed mixed views on the ease with which builders would be able to exceed the 2018 International Energy Conservation Code (IECC) in PY15.* Most of the raters we interviewed (5 of 6) were optimistic that adjusting to the 2018 code would entail less significant changes in building practices for many builders. However, exceeding 2018 IECC code would be challenging for some, and especially smaller builders who may leave the program as a result.

### **Summary of Process Evaluation Audit**

The process evaluation of the New Homes component appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering



those recommendations. 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.

### E.8.3 Commercial & Industrial Programs

There are two C&I programs: Energy Solutions for Business-Small and Energy Solutions for Business-Large. Each program has five components: Multifamily, Prescriptive, Custom, and Energy Management. The components use downstream, midstream, and direct install delivery channels. In PY14, ADM/Tetra Tech completed process evaluations for both C&I programs.

#### E.8.3.1 C&I Energy Solutions for Business (Small)

##### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff, implementation staff, and trade allies (distributors), and surveyed customers and vendors. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. Most practical aspects of the programs are managed as one general effort rather than distinct programs, so the interviews covered both programs. The evaluators reported on the following key findings:

- *Satisfaction among participating customers and vendors remains high.* The average participant rating across all program aspects was 3.8 or higher for customers and 3.0 or higher for vendors on a 1 to 5 scale, where 1 was *not at all satisfied*, and 5 was *very satisfied*. More than one-half of participating customers have recommended the program to others, and 85% said they were very likely to participate again.
- *Trade allies (contractors and vendors) continue to be the most common source of respondent awareness.* Two-thirds of customer respondents learned about the program from their contractor or vendor. Alternatively, customers said they *prefer* to receive information about the energy efficiency programs from FirstEnergy, specifically electronically through an email or a direct mail piece. Vendors echoed this feedback saying they felt the most effective communication was from FirstEnergy (i.e., account manager, call center, bill inserts).
- *The application process received mixed feedback.* While most program participants (75%) had no problems completing the program application, the application was mentioned as one of the features of the program that customer and vendor respondents would change. Simplifying the process and adding an electronic signature option were mentioned by both respondent groups. The application was also one of the program aspects customer respondents rated the lowest for their satisfaction.
- *Most customer respondents had no recommended improvements or changes to the program, while most vendor respondents felt improvements were needed (65% each).* Customers with recommendations mentioned increasing program awareness (17%), expanding service offerings (16%), and simplifying the application (16%). Vendor

respondent recommendations included more/clearer communication (five respondents), simplifying the process (five respondents), no more wet signatures (four respondents), increased incentives (three respondents), and more qualifying measures (two respondents).

- *The Midstream Instant Discount program has successfully launched with mixed feedback on awareness.* Distributors were fairly satisfied with the overall program and were very satisfied with Franklin Energy (Franklin). Most of the distributors felt the rebates helped to increase their sales, and they all stocked or could get quick delivery on all the eligible equipment for the program. Awareness is high among customers who received equipment through the Midstream Instant Discount program, but only one-third of customers participating in downstream components knew about the program discount.

### Summary of Process Evaluation Audit

The process evaluation of the Energy Solutions for Business-Small Program appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 95 participant surveys with Met-Ed customers; the target was nearly met with 86 completed surveys. The PY14 evaluation team targeted 41 vendor surveys; the target was exceeded with 51 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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.

### E.8.3.2 C&I Energy Solutions for Business (Large)

#### Summary of Process Evaluation Results

For the process evaluation of this program component, ADM/Tetra Tech reviewed program documents and data, interviewed program staff, implementation staff, and trade allies (distributors), and surveyed customers and vendors. The research issues addressed by the primary data-collection activities (in-depth interviews and surveys) included the effectiveness of program administration, implementation, and delivery; and customer sub-component program awareness and satisfaction. Most practical aspects of the programs are managed as one general effort rather than distinct programs, so the interviews covered both programs. The evaluators reported on the following key findings:

- *Satisfaction among participating customers and vendors remains high.* The average participant rating across all program aspects was 3.8 or higher for customers and 3.0 or



higher for vendors on a 1 to 5 scale, where 1 was *not at all satisfied*, and 5 was *very satisfied*. More than one-half of participating customers have recommended the program to others, and 85% said they were very likely to participate again.

- *Trade allies (contractors and vendors) continue to be the most common source of respondent awareness.* Two-thirds of customer respondents learned about the program from their contractor or vendor. Alternatively, customers said they *prefer* to receive information about the energy efficiency programs from FirstEnergy, specifically electronically through an email or a direct mail piece. Vendors echoed this feedback saying they felt the most effective communication was from FirstEnergy (i.e., account manager, call center, bill inserts).
- *The application process received mixed feedback.* While most program participants (75%) had no problems completing the program application, the application was mentioned as one of the features of the program that customer and vendor respondents would change. Simplifying the process and adding an electronic signature option were mentioned by both respondent groups. The application was also one of the program aspects customer respondents rated the lowest for their satisfaction.
- *Most customer respondents had no recommended improvements or changes to the program, while most vendor respondents felt improvements were needed (65% each).* Customers with recommendations mentioned increasing program awareness (17%), expanding service offerings (16%), and simplifying the application (16%). Vendor respondent recommendations included more/clearer communication (five respondents), simplifying the process (five respondents), no more wet signatures (four respondents), increased incentives (three respondents), and more qualifying measures (two respondents).
- *The Midstream Instant Discount program has successfully launched with mixed feedback on awareness.* Distributors were fairly satisfied with the overall program and were very satisfied with Franklin Energy (Franklin). Most of the distributors felt the rebates helped to increase their sales, and they all stocked or could get quick delivery on all the eligible equipment for the program. Awareness is high among customers who received equipment through the Midstream Instant Discount program, but only one-third of customers participating in downstream components knew about the program discount.

### Summary of Process Evaluation Audit

The process evaluation of the Energy Solutions for Business-Large Program appears to have been generally 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 SWE notes that the PY14 annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

The PY14 evaluation team targeted 27 participant surveys with Met-Ed customers; the target was not met with 12 completed surveys. The PY14 evaluation team targeted 41 vendor surveys; the target was exceeded with 51 completed surveys.

The SWE also determined that the reporting followed the SWE guidelines. The FirstEnergy PY14 Annual Report included descriptions of the methods, summaries of conclusions, and a list of recommendations with a description of whether FirstEnergy was implementing or considering those recommendations. 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 F FirstEnergy: Pennsylvania Electric Company PY14 Audit Detail

### F.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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 only significant adjustment was a reduction in the baseline lighting wattage for a single project.
- 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 PY14 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 a new market rate HER cohort in June 2022 and reactivated a legacy market rate wave from 2012 for a total of three active cohorts and 66,000 treated homes in PY14. On average, HER recipients saved approximately 79 kWh, or 0.8% of their annual consumption, in PY14. Despite being paused for PY13, the 2012 cohort was mature enough to require persistence calculations to separate incremental savings from persisting savings from prior exposure. The SWE team found that ADM's HER impact evaluation was entirely consistent with their proposed and approved EM&V plans and the Phase IV HER account framework. The SWE team does not propose any revisions to the PY14 methods or results.
- Penelec's portfolio was cost-effective in PY14 with a gross TRC ratio of 1.90 with an improved TRC ratio from PY13.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penelec's PY14 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 Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.
- 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 PY14. 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 PY14 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, FirstEnergy's evaluation contractor, submitted a redline version of their PY14 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, the ADM team submitted several memos detailing their sampling approach for program components selected for impact, process and NTG evaluations in PY14.

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 PY14. Penelec will not use historic realization rates until PY15 and PY17. [Table 160](#) shows all Penelec programs, which produced verified impacts in PY14.

**Table 160: PY14 Penelec Program Impact Evaluation Summary**

Sector	Components	PY14 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
	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 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 161 shows the relative precision of PY14 energy and demand impacts by component at the 85% confidence level. Note that the Online Audit program used an energy-to-demand factor (ETDF) to convert the measured kWh savings to peak demand savings, so the relative precision of the peak demand savings is the same as the energy savings.

**Table 161: Relative Precision of PY14 Impacts by Program Component at the 85% Confidence Level**

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	7.8%	7.9%
	LI - EE Kits	13.7%	13.7%
	Midstream	0.0%	0.0%
	New Homes & Smart Thermostats	14.3%	14.3%
	Multifamily	7.5%	7.5%
	Appliance Recycling	5.7%	5.3%
	LI – Appliance Recycling	12.2%	8.7%
	HVAC	10.5%	10.5%
	LI - Direct Install	9.3%	9.3%
	Residential Appliances	6.6%	7.4%
	Audit and DI	8.9%	8.9%
C&I	Appliance Recycling	0.0%	0.0%
	Multifamily	13.4%	13.4%
	Custom	11.9%	11.9%
	Prescriptive	11.6%	12.9%
	Energy Management and New Construction	10.8%	10.8%

The Residential Midstream Appliances and Non-Residential Appliance recycling components have a relative precision of  $\pm 0\%$ . ADM evaluated all projects undertaken in those programs in PY14, so there is no sampling uncertainty. The Residential Upstream program was not offered in PY14. Two components did not meet the 15% threshold for relative precision including both online audit components.

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 PY14 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. The SWE team replicated the C&I Prescriptive rollup for energy savings instead using observed coefficients of variation and found the relative precision of savings estimates to be comparable to the reported figure of 11.6%. 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 PY14 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 to achieve an absolute precision of  $\pm 0.5\%$  at the 95% confidence level (two-tailed). [Table 162](#) shows the absolute precision of PY14 Behavioral Modification impacts at the 95% confidence level.

**Table 162: Absolute Precision of PY14 Impacts for Behavioral Modification Programs at the 95% Confidence Level**

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.29%
Behavioral Modification (LI)	0.40%

The Online Audit component also relies on regression analysis of all participants and a matched control group of non-participants. While there is no sampling error, there is uncertainty associated with the regression model. The relative precision of the market rate Online Audit energy savings was  $\pm 111.2\%$  at the 85% confidence level and the relative precision of the Low-Income Online Audit energy savings was  $\pm 30.9\%$  at the 85% confidence level. The relative precision of the low-income group was better than the market rate group despite a much smaller number of homes because the savings estimate for low-income recipients was significantly higher.

## 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 PY14 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 PY14 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 163](#) summarizes our findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the values in Penelec's PY14 Annual Report and "No" otherwise. For each program, the SWE was able to replicate the values reported by Penelec.

**Table 163: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	18,700	18,700	Yes*
Energy Efficient Products	7,887	7,887	Yes
Low Income Energy Efficiency	3,876	3,876	Yes*
C&I Energy Solutions for Business - Small	21,200	21,200	Yes
C&I Energy Solutions for Business - Large	17,999	17,999	Yes
<b>Portfolio Total</b>	<b>69,661</b>	<b>69,661</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

[Table 164](#) 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 PY14 Annual Report value exactly for all programs.

**Table 164: MW Savings by Program**

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	2.84	2.84	Yes*
Energy Efficient Products	2.11	2.11	Yes
Low Income Energy Efficiency	0.59	0.59	Yes*
C&I Energy Solutions for Business - Small	4.35	4.35	Yes
C&I Energy Solutions for Business - Large	3.05	3.05	Yes
<b>Portfolio Total</b>	<b>12.95</b>	<b>12.95</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 165 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for most programs. The portfolio totals are higher in Penelec's annual report than our counts from the quarterly tracking data: 110,380 in the Penelec PY14 Annual Report and 92,690 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 better understand the Phase IV business rules around counting participants for different program components.

**Table 165: Participation by Program**

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	70,656	53,761	No*
Energy Efficient Products	28,158	29,712	No
Low Income Energy Efficiency	10,374	8,760	No*
C&I Energy Solutions for Business - Small	1,053	409	No
C&I Energy Solutions for Business - Large	139	48	No
<b>Portfolio Total</b>	<b>110,380</b>	<b>92,690</b>	<b>No*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 166 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in Penelec's PY14 Annual Report. The SWE was not able to replicate incentive dollars for any program. The SWE calculated directionally similar values for the Energy Efficient Products, C&I Energy Solutions for Business - Small, and C&I Energy Solutions for Business - Large programs. The Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes rebate amounts.

**Table 166: Incentives by Program (\$1,000)**

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$2,444	\$203	No
Energy Efficient Products	\$1,281	\$788	No
Low Income Energy Efficiency	\$1,769	\$91	No
C&I Energy Solutions for Business - Small	\$4,399	\$3,527	No
C&I Energy Solutions for Business - Large	\$726	\$1,095	No
<b>Portfolio Total</b>	<b>\$10,619</b>	<b>\$5,704</b>	<b>No</b>

## 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 PY14 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 167 presents a summary of the SWE's residential project file reviews.

**Table 167: Penelec PY14 Residential Project File Review Summary**

Program	Sub Program	Number of files reviewed <sup>1</sup>	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? <sup>2</sup>
EE Homes Program	Direct Install	41	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	50	✓	✓	✓	✓
EE Homes Program	Multifamily	20	✓	✓	✓	✓
EE Homes Program	New Homes	32	✓	✓	✓	✓
EE Products Programs	Appliances	49	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	35	✓	✓	✓	✓
EE Products Programs	HVAC	10	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	36	✓	✓	✓	✓
LIEEP	Appliances	4	✓	✓	✓	✓
LIEEP	Appliance Turn In	10	✓	✓	✓	✓
LIEEP	Direct Install	10	✓	✓	✓	✓

<sup>1</sup> The number of files reviewed reflects the total number for all FirstEnergy EDCs.

<sup>2</sup> 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, revealing that, overall,

the SWE did not find any notable discrepancies between the project file documentation and the tracking data in PY14.

### **Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits**

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. The documentation for the Energy Efficiency Kits program consisted of shipment data, specification sheets, and kit contents. The shipment data was similar to the quarterly tracking data but was broken out by month and income status. The SWE did not find any discrepancies between the project documentation and the tracking data for the reviewed sample projects.

### **Energy Efficient Homes Program: Comprehensive Audits**

The project documentation for the Comprehensive Audit program included invoices and audit reports that included information on the installed measures and what potential additional measures could improve efficiency outcomes. Overall, the SWE found no discrepancies between the tracking data and the project file documentation in the reviewed sample projects.

### **Energy Efficient Homes Program: Multifamily**

The Multifamily program contains invoices, audit forms and energy assessments report. The SWE notes that no projects were submitted for Q1 due to a file transfer issue, which was noted by the evaluator. A review of the sampled files did not reveal any discrepancies with measure names and quantities, and the information provided within each project corresponded with the reported savings in the tracking data.

### **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. 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 Products Program: Appliances**

The Appliance Rebate program had project files containing either receipts for rebated appliances, appliance rebate application forms, or both. These project files were accompanied by tracking data that recorded the date the appliance was purchased, the type of appliance, and its quantity. While the data was very well organized, a notable omission from the data was the rebate amount. The SWE reviewed a total of 49 files amongst the First Energy Companies for this program and notes the project files well organized and included thorough documentation.

### **Energy Efficient Products Program: Appliance Recycling**

The Appliance Recycling program had project files containing photos of the participant's signatures, photos of the nameplates of the recycled appliances, and photos of the recycled appliances themselves. These project files were accompanied by tracking data that recorded the type of recycled appliances, the date it was recycled, the town it was from, and the quantity of recycled appliances. Although some of the photos of the appliances did not include nameplates, the SWE notes the thoroughness of the documentation.

**Energy Efficient Products Program: HVAC**

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. There were no discrepancies found in the project files as compared to the tracking database. However, there were some instances where the SWE was unable to confirm the tracking data matched the project file due to missing documentation such as the AHRI certificate.

**Energy Efficient Products Program: Midstream Appliances**

The project files for Midstream Appliances were comprised of invoice-styled excel sheets with tracking data that could be easily matched to the sample data given for each quarter. The invoice data recorded the type of appliance rebated, quantity, the appliance price, and the rebate amount. The SWE review of the sampled files did not reveal any discrepancies between the project files and the tracking database.

**Low-Income Energy Efficiency Program: Appliances**

The SWE review of the LI Appliance rebate files is summarized in the Appliance subsection above.

**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.

**Energy Efficient Homes Program: LI WARM**

Invoices, audit forms, preassessment, and post assessment forms were provided for sampled projects. The SWE notes that some projects had varying levels of documentation described above, but generally the necessary documentation existed for each sampled project reviewed by the SWE. A review of the sampled files did not reveal any discrepancies and the information provided within each project matched the tracking database.

**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 PY14.

**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 PY14. 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 168](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 168: Penelec PY14 C&amp;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?
C&I Energy Solutions for Business Program – Large	DS Prescriptive - LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Large	Energy Management - LCI	2	✓	✓	✓	1/2	1/2
C&I Energy Solutions for Business Program – Small	Energy Management - SCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Custom - SCI	2	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Large	DS Prescriptive - LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	MS Prescriptive - SCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Multifamily	2	✓	✓	✓	✓	✓



The SWE found nearly all 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 one of the Energy Management projects reviewed.

- **Energy Management - LCI**
  - One of the two projects the SWE reviewed was missing a document detailing HVAC unit capacity and efficiency. The SWE was also unable to unlock the calculator to verify savings.

Despite minor issues with a locked calculation workbook and a missing document, 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 Energy Efficient Homes Program, the Energy Efficient Products Program, and the LI Energy Efficiency Program. 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 169](#) provides a summary of the evaluation and M&V approaches used by Penelec in their PY14 verified savings calculations.

**Table 169: Residential Program Evaluation Activities - Penelec**

Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis
<b>Energy Efficient Homes</b>				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
<b>Energy Efficient Products</b>				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
<b>Low-Income Energy Efficiency Program</b>				
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 the verified savings followed proper TRM protocols and that the verified savings are accurate.

#### Energy Efficiency Kits Initiative: EE Kits and Low-Income Kits

The Energy Efficiency Kits (EE Kits) initiative has two sub-initiatives – EE Kits and Low-Income EE Kits. Each sub-initiative has two sub-components: EE Kits and School Education. The SWE reviewed the energy efficiency kits and school education kits for both the EE Kits and Low-Income EE Kits sub-initiatives. The energy conservation kits in the EE Kit subprogram contained LED lamps, LED night lights, energy saving aerators, a furnace whistle, an energy saving showerhead, and electrical outlet gaskets. The kits provided through the School Education sub-component contained LED lamps, LED night lights, a furnace whistle, and electrical outlet gaskets. The Low-Income kits included advanced power strips in place of electrical outlet gaskets. The SWE confirmed the verified savings for each sub-initiative were in accordance with the TRM protocols for the relevant measures and worked with ADM to resolve any discrepancies prior to the filing of the FirstEnergy annual report. The SWE also confirmed that participation, energy and demand savings, and energy realization rates were in alignment with those in the annual report.

### **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.

### **The Residential and Residential Low-Income Direct Install Initiatives**

The Direct Install Initiative includes both weatherization and non-weatherization measures. There were no weatherization projects conducted for Penelec in PY14. The SWE reviewed the non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included LED lighting, LED nightlights, advanced power strips, and water heater setbacks.

The SWE also reviewed the WARM subcomponent of the Low-Income Direct Install Initiative, which provides water heater temperature setbacks, smart power strips, showerheads, refrigerators, pipe insulation, ENERGY STAR lighting, LED night lights, heat pump water heaters, furnace whistles, refrigerator/freezer removal, filter whistles, dehumidifiers, connected thermostats, and aerators. 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 PY14 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. 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.

For the final report, Low-Income and Non Low-Income Energy Efficient Products Programs were combined. There was one small change in population sizes for pool pumps in the final report, which was verified as accurate by the SWE.

### **Energy Efficient Homes and LIEEP: Online Audit**

In PY13, FirstEnergy launched an Online Audit component to the Behavioral subprogram included in both the Energy Efficient Homes (EEH) and Low-Income Energy Efficiency (LI) programs. The Online Audit component operates on an opt-in basis and offers residential customers a web-

based platform featuring energy usage visualizations, energy-saving tips, and promotion of other FirstEnergy residential energy efficiency programs. A total of 3,938 residential and 700 residential-LI households participated in Online Audit in PY14. The PY13 evaluation did not find statistically significant savings amongst Online Audit homes, so Penelec claimed not verified savings for the component in PY13. The PY14 analysis identified statistically significant savings the Online Audit component generated approximately 0.6% of Penelec's verified gross MWh savings in PY14.

The Phase IV Online Audit subprogram is an opt-in program, and the SWE team reviewed the propensity score matching ADM performed to create a comparison group using five pre-treatment variables, latitude, and longitude. Due to the non-RCT design of Online Audit component, ADM included weather terms to improve model fit and control for potential variability between the treatment and control group. The SWE team independently calculated per-household kWh savings from regression coefficients, active participant counts, and aggregate MWh and MW impacts. Our estimates match ADM's estimates.

The SWE also reviewed the dual participation analysis. Online Audit participants tend to participate in other Penelec EE&C programs at a higher rate than the matched control groups, so this adjustment is necessary to avoid double-counting. To calculate gross verified demand savings, ADM generated an ETDF using residential load profiles corresponding to the treatment group and then applied ETDF to energy savings to estimate. The SWE was able to replicate the verified demand savings for both the residential and residential low-income group.

Table 170 shows the aggregate PY14 verified gross MWh and MW savings by cohort. The table also shows the number of participants and average percentage savings per household by program group. Using the first impact estimate as an example, the practical interpretation is as follows: all treatment group homes in the EEH Program saved 120 MWh and each household lowered their annual electric consumption by 0.26% during PY14. It is unclear why the low-income households saved more energy per-household than their market rate counterparts in PY14. The population size for the LI program is much smaller so it is possible that the difference is simply noise in the results.

**Table 170: PY14 Penelec Online Audit Energy and Demand Savings**

Program	Participants	Verified Gross Energy Savings (MWh)	Gross Demand Savings (MW)	Average Percentage Savings per Home
EEH Program	3,938	120	0.02	0.26%
LI Program	700	290	0.04	3.11%
-	<b>4,638</b>	<b>410</b>	<b>0.06</b>	-

The SWE team found that ADM's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **Appliance Recycling and Low-Income Appliance Turn-In Initiative**

The SWE performed audits on the Appliance Recycling, Low Income Appliance Recycling, and Midstream Appliance Recycling sub-initiatives of the Appliance Recycling (ATI) Initiative. The five measures included were refrigerator recycling, freezer recycling, room air conditioner (RAC) recycling, dehumidifier recycling, and mini refrigerator recycling. 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 Direct Install Initiative, which includes ENERGY STAR lighting, LED night lights, aerators, 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 PY14.

#### **F.5.1.2 Behavior**

Home Energy Reports were issued to around 66,000 Penelec residential and residential-LI households in PY14. HERs accounted for 7.2% of all Penelec's PY14 verified energy savings and 10.8% of Penelec's progress toward its low-income target in PY14. Penelec's behavioral portfolio consists of both active waves as well as other inactive legacy waves, which may be re-activated later in Phase IV. Three waves, or cohorts, were active during PY14 and one of them targets low-income households. [Table 171](#) summarizes the average number of active households during PY14 by cohort.

**Table 171: Penelec HER Cohort Summary**

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2012 Residential	7/1/2012	42,003	16,756
2021 Low-Income	9/30/2021	9,916	9,369
2022 Residential	6/3/2022	13,897	10,644

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 2012 and 2022 cohorts since the 2021 cohorts were checked last year. 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 66](#) and [Figure 67](#) 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 66: Pre-Treatment Equivalence, 2012 Residential Cohort

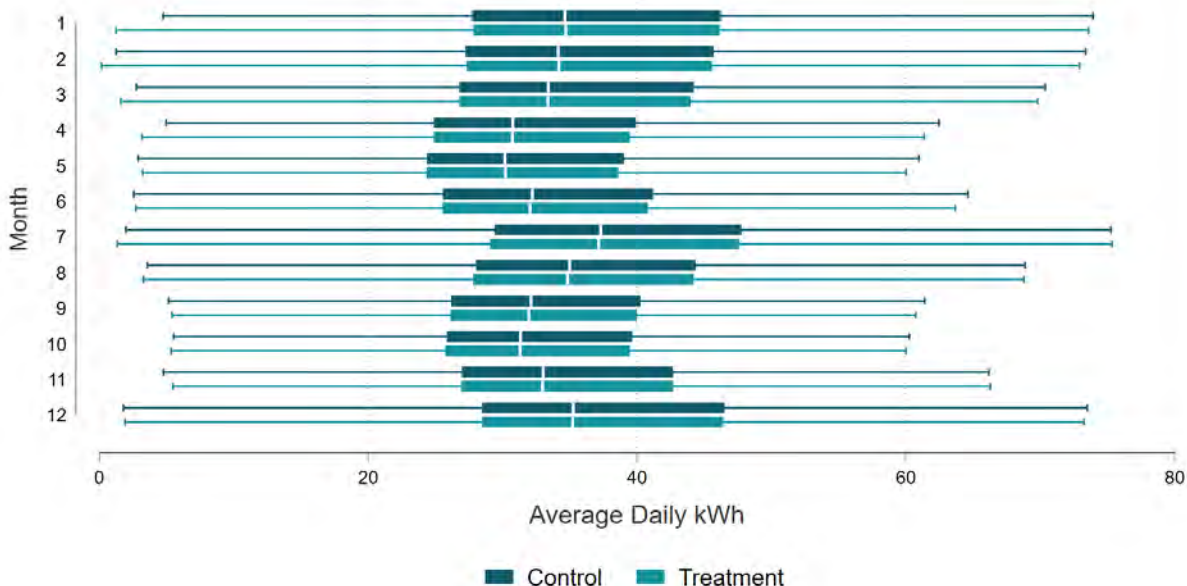
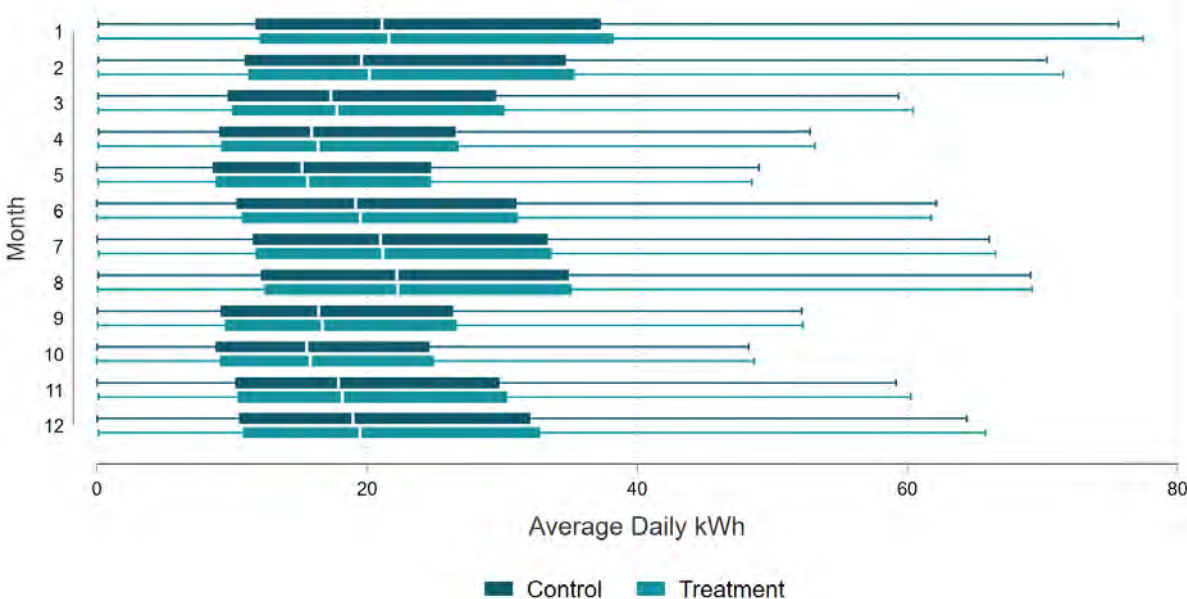


Figure 67: Pre-Treatment Equivalence, 2022 Residential Cohort



**Data Preparation**

The SWE team received interval data from ADM at two different levels: 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 PY14 impact analysis as called for in the Penelec



PY14 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 daily 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 (2.6% 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% 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.

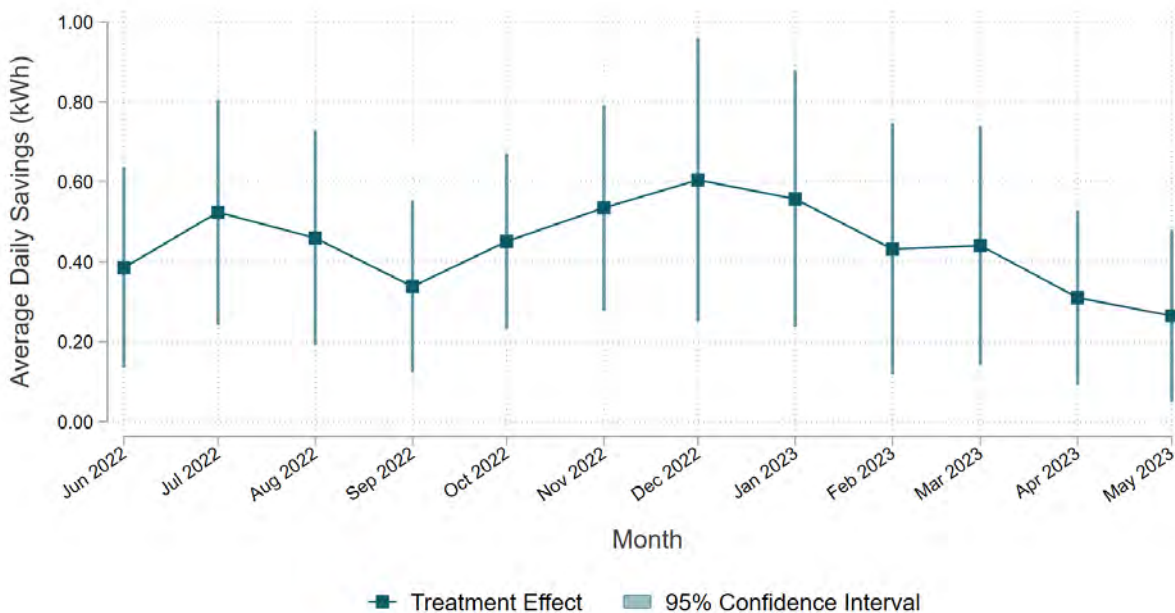
### ***Impacts***

By month, the daily impact estimates are plotted in [Figure 68](#) (2012 residential), [Figure 69](#) (2021 low-income), and [Figure 70](#) (2022 residential). For each cohort, [Table 172](#) shows the average of the PY14 monthly impact estimates. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2012 Residential cohort saved 0.44 kWh per day, on average, during PY14. The SWE was able to replicate ADM's impact estimate for each cohort/month combination.

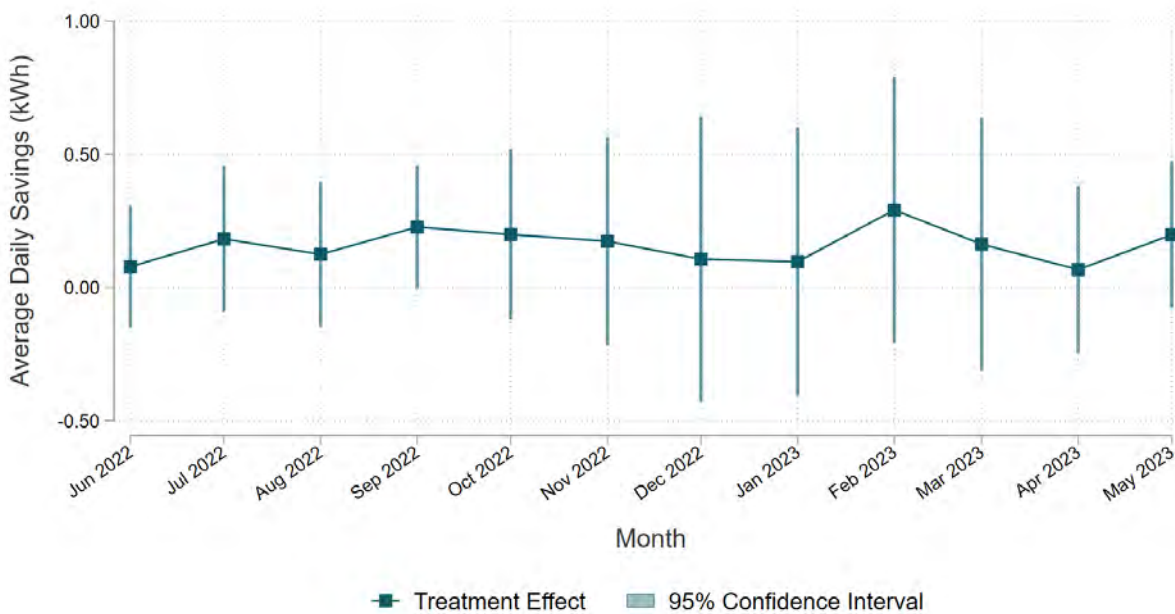
**Table 172: Penelec HER Impact Estimates**

Cohort	Impact Estimate (kWh saved per home per day)
2012 Residential	0.44
2021 Low-Income	0.16
2022 Residential	0.21

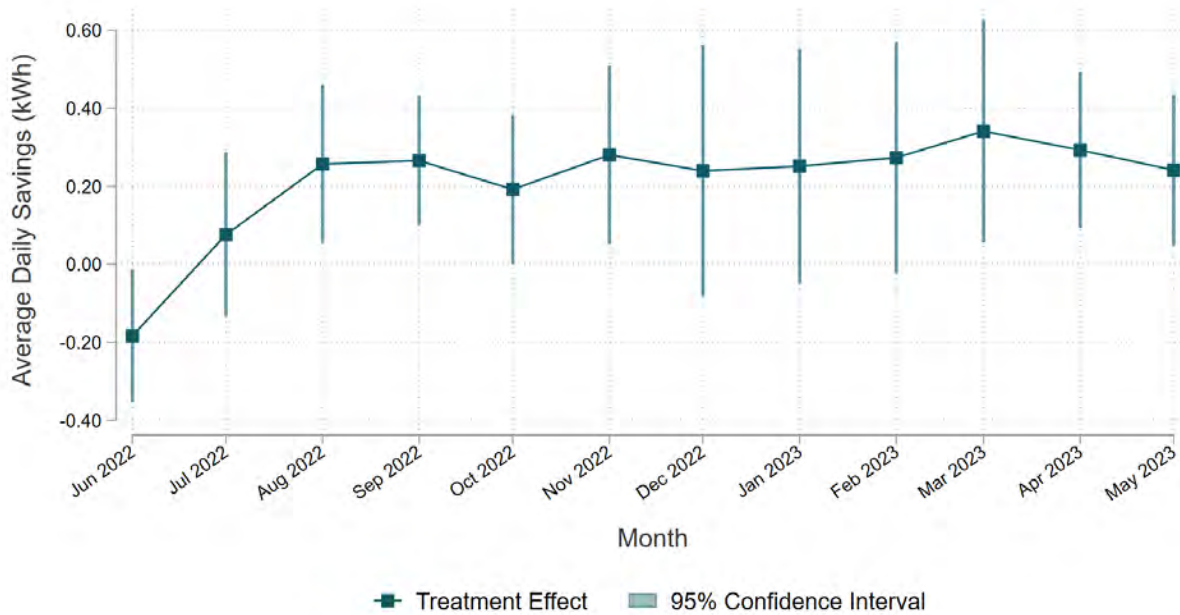
**Figure 68: Average Daily Savings (kWh) by Month, 2012 Residential Cohort**



**Figure 69: Average Daily Savings (kWh) by Month, 2021 Low-Income Cohort**



**Figure 70: Average Daily Savings (kWh) by Month, 2022 Residential Cohort**



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 173](#) shows the aggregate PY14 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, discussed in greater detail later, and the PY14 incremental gross savings estimate.

**Table 173: PY14 HER Energy Savings**

Cohort	Gross Savings (MWh)	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Persistence (MWh)	Incremental Savings (MWh)
2012 Residential	6,514	874	169	1,848	3,624
2021 Low-Income	522	-34	0	0	556
2022 Residential	1,055	2	0	0	1,053
<b>Total</b>	<b>8,092</b>	<b>841</b>	<b>169</b>	<b>1,848</b>	<b>5,233</b>

**Dual Participation**

In [Table 173](#), gross savings before adjusting for dual participation were 8,092 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 and PY14. Thus, an upstream dual participation adjustment is only applied to the gross savings estimate of 2012 Residential cohort.

### **Persistence**

The 2021 Pennsylvania TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research<sup>74</sup> 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.

Because the 2021 low-income and 2022 residential waves were launched during PY13 and PY14, all savings are considered incremental. Separating persistent savings from incremental savings was not necessary for these two waves while 2012 residential wave featured such an adjustment. The SWE team found that ADM correctly modeled persistence in accordance with TRM specifications for the 2012 Residential wave.

### **Peak Demand Impacts**

The Pennsylvania TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 p.m. to 6:00 p.m. Eastern Daylight Time on non-holiday weekdays during June, July, and August. For each cohort, [Table 174](#) shows the daily peak demand impact estimates and peak demand reduction in PY14. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2012 Residential cohort saved 0.03 kWh per hour during peak demand window and saved 1.26 MW without line loss and 1.38 MW with line loss during peak hours, on average, during PY14. The SWE was able to replicate ADM's peak demand impact estimate and peak demand reduction for each cohort.

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<sup>74</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)

**Table 174: Penelec HER Peak Demand Impacts**

Cohort	Peak Demand Impact Estimate (kWh saved per home per hour)	Peak Demand Reduction without line losses (MW)	Peak Demand Reduction with line losses (MW)
2012 Residential	0.03	1.26	1.38
2021 Low-Income	0.00	0.04	0.05
2022 Residential	0.00	0.00	0.00
<b>Total</b>	<b>0.02</b>	<b>1.30</b>	<b>1.43</b>

**Conclusion**

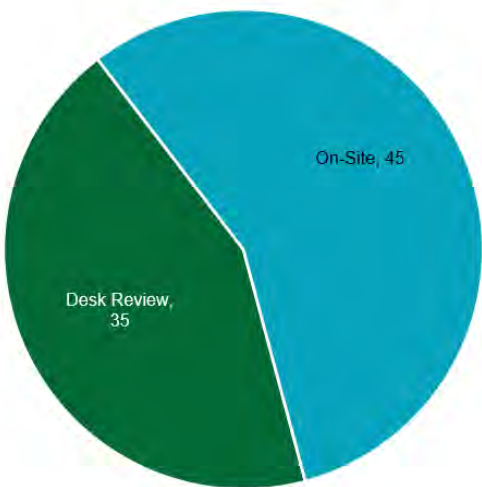
The SWE team found that ADM's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

**F.5.2 Non-Residential Audit Activities**

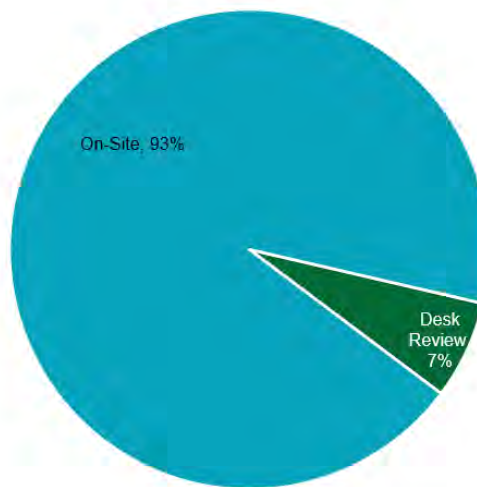
Figure 71 provides a summary of the evaluation activities and M&V approaches utilized by Penelec's evaluation contractor, ADM, in their PY14 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY14, Penelec's evaluation contractor completed site visits to 45 of 70 evaluated projects, and these projects represented 93% of total evaluated energy savings. IPMVP Options A, B, C, and D were employed for 75% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 25% of the total evaluated savings, including the majority of prescriptive projects and most energy management projects.

**Figure 71: Summary of Penelec’s C&I Evaluation Activities**

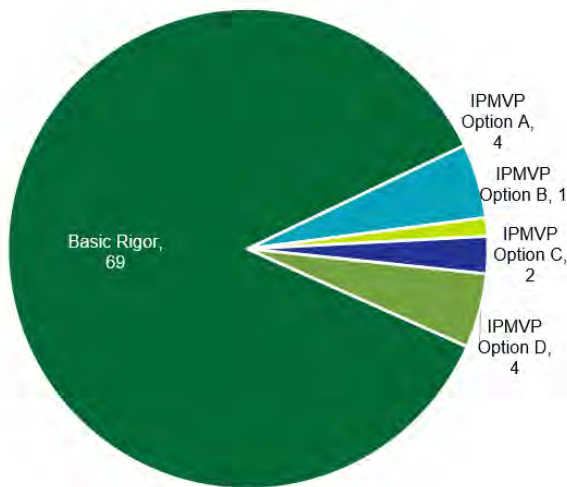
M&V Activity by Project Count



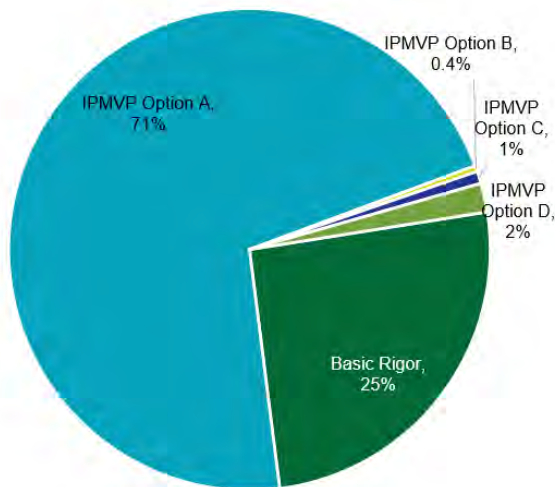
M&V Activity by kWh Contribution



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 175](#) provides a summary of the evaluation activities Penelec’s evaluation contractor used across strata for all projects by initiative.



**Table 175: Summary of Penelec’s PY14 C&I Evaluation Activities by Initiative**

Initiative / Strata	Sample Quantity	RR – Energy	RR – Demand	Desk Review	On-Site Verification
<b>Appliance Recycling</b>	-	<b>106%</b>	<b>102%</b>	-	-
<b>Custom</b>	<b>10</b>	<b>101%</b>	<b>102%</b>	<b>10</b>	-
Custom – C	-	-	-	-	-
Custom – 1	10	101%	102%	10	-
<b>Prescriptive</b>	<b>31</b>	<b>106%</b>	<b>96%</b>	<b>10</b>	<b>21</b>
Downstream Lighting – C	1	97%	95%	-	1
Downstream Lighting – 2	5	101%	99%	-	5
Downstream Lighting – 1	8	91%	92%	2	6
Downstream Non-Lighting	6	43%	43%	1	5
Midstream Lighting	10	134%	99%	7	3
Midstream Non-Lighting	1	100%	81%	-	1
<b>EMNC</b>	<b>25</b>	<b>85%</b>	<b>72%</b>	<b>11</b>	<b>14</b>
EMNC	1	153%	194%	-	1
Building Tune-Ups	24	84%	71%	11	13
<b>Multifamily</b>	<b>14</b>	<b>90%</b>	<b>90%</b>	<b>4</b>	<b>10</b>
<b>TOTAL</b>	<b>80</b>			<b>35</b>	<b>45</b>

The SWE’s review of verified savings for non-residential programs found that, overall, the verified energy 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 (24) Building Tune-Up projects are over one-quarter of the sample with a 71% peak demand realization rate. 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 PY14, 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**

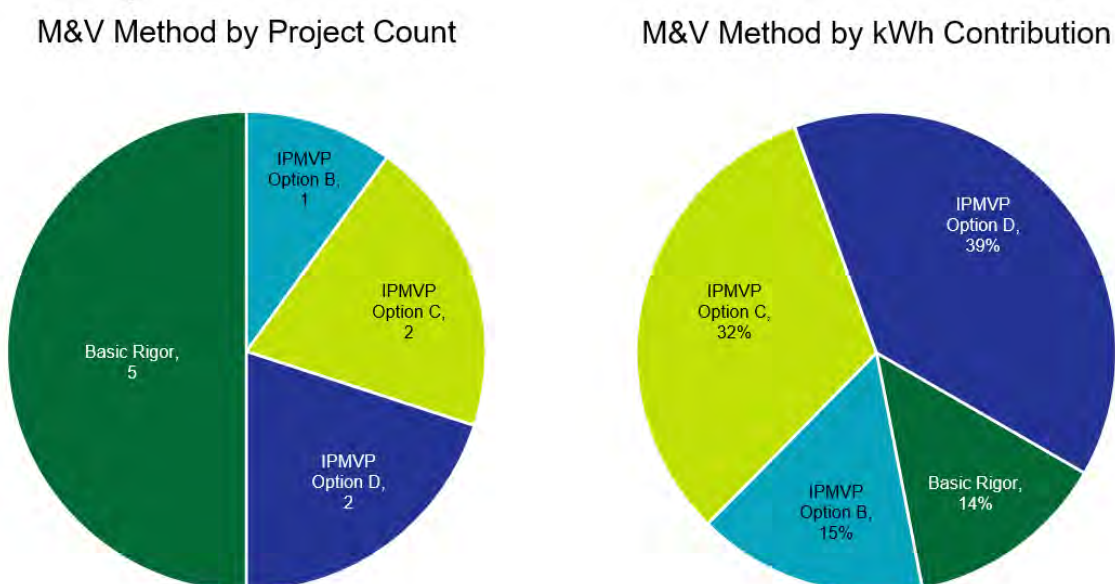
Evaluation activities for this initiative include desk reviews and/or IPMVP evaluation methods for all sampled projects. Site visits were conducted for one of ten PY14 custom sampled projects. The evaluation was satisfactorily conducted through desk reviews for all projects using data provided by the 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 Options B, C, and D selected as the primary enhanced M&V method for half of evaluated custom projects, accounting for 86% of evaluated savings, as shown in [Figure 72](#).

**Figure 72: Summary of Penelec’s C&I Custom Program M&V Methods**



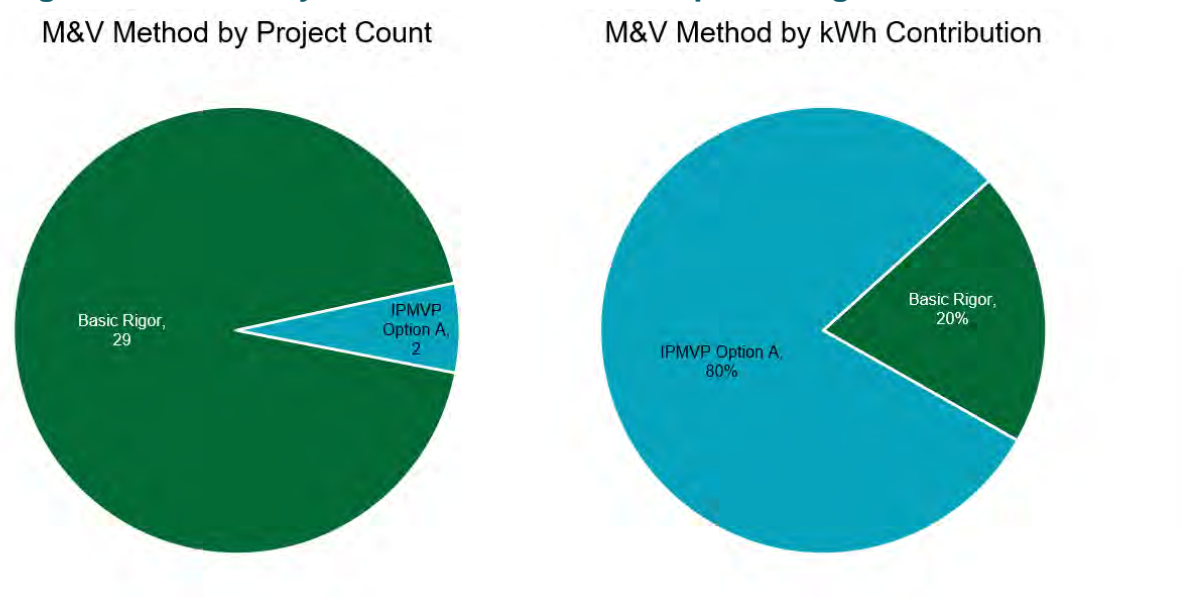
### F.5.2.3 Prescriptive Initiative

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. The 67% majority of these 66 projects included a site visit by the evaluator. 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 20% of evaluated project savings in this initiative with the remaining projects using IPMVP Option A, as seen in [Figure 73](#) below.

**Figure 73: Summary of Penelec’s C&I Prescriptive Program M&V Methods**



**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 PY14: Building Tune-Up and New Construction.

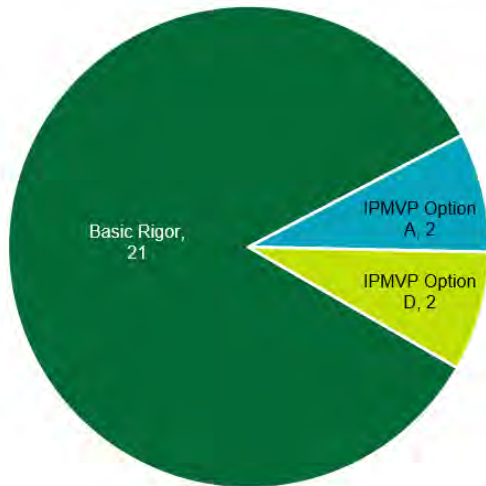
Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Basic rigor M&V methods were applied to these projects, incorporating TRM algorithms and reconciliations of invoices with equipment specification sheets.

All projects in the New Construction and two in the Building-Tune Up 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.

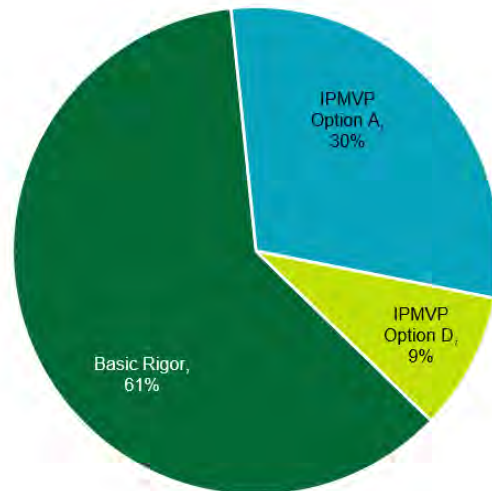
Basic Rigor was employed for 61% of evaluated project savings in this initiative for Penelec as seen in [Figure 74](#) below.

**Figure 74: Summary of Penelec's C&I Energy Management and New Construction Initiative Program M&V Methods**

M&V Method by Project Count



M&V Method by kWh Contribution



#### 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. No site visits were conducted for PY14 custom sampled projects. 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 PY14 included review of 12 projects, encompassing the following activities:

- 6 Field and Analysis Engineers were observed
- 4 Lighting, 4 HVAC, 4 Refrigeration, and 1 Custom Measure Observed
- 3 In-Person Ride-Alongs conducted
- 77% of Verified Energy Savings reviewed
- 65% of Verified Demand Savings reviewed

Table 176 provides an overview of the SWE milestones for the verified savings audit review of evaluated Penelec's projects.

**Table 176: Penelec Verified Savings Audit Review Milestones**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
12	10,374,402	97%	1,176	96%

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. A baseline lighting fixture power adjustment on a large lighting project accounted for most of the differences found by the SWE. The overall energy and demand savings attainment percentages of Penelec’s reviewed projects were 97% and 96% respectively.

## F.6 NTG

Table 177 lists Penelec’s PY14 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 177: Summary of Penelec PY14 NTG Results**

Program Name	Component	NTG
Energy Efficient Products	Downstream Appliances	0.48
Energy Efficient Homes	New Homes	0.72
C&I Solutions for Business Programs – Small and Large	Prescriptive	0.66
C&I Solutions for Business Programs – Small and Large	Custom	0.52
C&I Solutions for Business Programs – Small and Large	EMNC	0.84
C&I Solutions for Business Programs – Small and Large	Multifamily	1.0

### F.6.1 Residential Programs

ADM planned and enacted NTG research for the Residential Downstream Appliances component of the EE Products Program and the New Homes component of the EE Homes Program (Table 178). ADM utilized participant surveys to estimate free-ridership, spillover and NTG for downstream appliances and building interviews for New Homes. ADM utilized question batteries that were consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation.

**Table 178: Summary of Penelec's PY14 Residential NTG Results**

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
New Homes	Builder Interviews	20	28%	0%	0.72
Appliances	Self-Report Survey	120	52%	0.1%	0.48

### F.6.2 C&I Energy Efficiency Programs

ADM conducted NTG research for the prescriptive, custom, and EMNC programs in PY14 (Table 179). ADM applied the residential Appliance Recycling PY10 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. The NTG for the Prescriptive program is a savings-weighted average of the downstream and midstream lighting and non-lighting stratum.

**Table 179: Summary of Penelec's PY14 C&I NTG Results**

Program Component	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	Participant & Vendor Surveys	109	36%	2%	0.66
Custom	Participant & Vendor Surveys	13	48%	0%	0.52
EMNC	Participant & Vendor Surveys	32	16%	0%	0.84
Multifamily	N/A	N/A	N/A	N/A	1.0
Appliance Recycling	N/A	N/A	35%	0%	0.65

## F.7 TRC

Table 180 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Penelec's PY14 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 PY14 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.

Both gross and net TRC ratios increased from PY13, with the largest increase occurring in both C&I Energy Solutions for Business – Small and Large programs.

**Table 180: Summary of Penelec’s PY14 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
Residential – Energy Efficient Homes	\$13,298	\$3,330	3.99	\$11,201	\$3,319	3.38
Residential – Energy Efficient Products	\$4,491	\$6,020	0.75	\$2,473	\$3,733	0.66
Low Income Energy Efficiency	\$2,453	\$2,628	0.93	\$2,453	\$2,628	0.93
C&I Energy Solutions for Business – Small	\$16,251	\$7,976	2.04	\$11,273	\$6,434	1.75
C&I Energy Solutions for Business – Large	\$10,981	\$5,032	2.18	\$7,270	\$3,791	1.92
<b>Portfolio Total</b>	<b>\$47,473</b>	<b>\$24,986</b>	<b>1.90</b>	<b>\$34,671</b>	<b>\$19,904</b>	<b>1.74</b>

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 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.

- 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.
- Penelec had the highest PY14 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 PY14 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent.

- 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 Penelec.
- 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.

## 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. Details on survey targets and completes for Penelec are provided in the subsections below. [Appendix E.8](#) of the SWE's PY14 Final Annual Report, described previously for Met-Ed, applies to all four FirstEnergy utilities, including Penelec.

### F.8.1 Residential Programs

#### F.8.1.1 Energy Efficient Products Program – Appliance Rebate

The PY14 evaluation team targeted 70 participant surveys with Penelec customers; the target was exceeded with 71 completed surveys.

#### F.8.1.2 Energy Efficient Products Homes – Behavioral Home Energy Report

The PY14 evaluation team targeted 35 participant surveys with Penelec customers; the target was exceeded with 83 completed surveys.

#### F.8.1.3 Energy Efficient Products Homes – Online Audits

The PY14 evaluation team targeted 120 participant surveys with Penelec customers; the target was not met with 81 completed surveys.



#### **F.8.1.4 Energy Efficient Products Homes – New Homes**

There were not any surveys as part of the PY14 evaluation.

### **F.8.2 Residential Low-Income Program**

#### **F.8.2.1 Weatherization (Direct Install)**

The PY14 evaluation team targeted 70 participant surveys with Penelec customers; the target was met with 70 completed surveys.

#### **F.8.2.2 Appliance Rebate**

The PY14 evaluation team targeted 35 participant surveys with Penelec customers; the target was exceeded with 49 completed surveys.

#### **F.8.2.3 Behavioral Home Energy Report**

The PY14 evaluation team targeted 35 participant surveys with Penelec customers; the target was exceeded with 69 completed surveys.

#### **F.8.2.4 Multifamily (Residential)**

The PY14 evaluation team targeted 35 participant surveys with Penelec customers; the target was nearly met with 28 completed surveys.

#### **F.8.2.5 New Homes**

There were not any surveys as part of the PY14 evaluation.

### **F.8.3 Commercial & Industrial Programs**

#### **F.8.3.1 C&I Energy Solutions for Business (Small)**

The PY14 evaluation team targeted 154 participant surveys with Penelec customers; the target was nearly met with 143 completed surveys.

#### **F.8.3.2 C&I Energy Solutions for Business (Large)**

The PY14 evaluation team targeted 29 participant surveys with Penelec customers; the target was nearly met with 18 completed surveys.

## Appendix G FirstEnergy: Pennsylvania Power Company PY14 Audit Detail

### G.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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 only significant adjustment was a reduction in the baseline lighting wattage at a Midstream project to align with equipment found during an on-site visit.
- 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 PY14 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 continued to treat the two HER cohorts launched October 2021 in PY14. One of the active cohorts consists of market residential households and the other cohort consists of low-income households. On average, HER recipients saved approximately 70 kWh, or 0.7% of their annual consumption, in PY14. Since the cohorts were in their second year of HER exposure, the impact evaluation did not need to deal with 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 PY14 methods or results.
- Penn Power's portfolio was cost-effective in PY14 with a gross TRC ratio of 1.19 with an improved TRC ratio from PY13.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Penn Power's PY14 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 Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.
- The SWE conducted a project file review for a sample of Penn Power's residential and income-eligible solutions in PY14. 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.

- 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.
- 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 PY14 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.

## G.2 EM&V PLAN REVIEWS

ADM, FirstEnergy's evaluation contractor, submitted a redline version of their PY14 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, the ADM team submitted several memos detailing their sampling approach for program components selected for impact, process and NTG evaluations in PY14.

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 PY14. Penn Power will not use historic realization rates until PY15 and PY17. [Table 181](#) shows all Penn Power programs, which produced verified impacts in PY14.

**Table 181: PY14 Penn Power Program Impact Evaluation Summary**

Sector	Components	PY14 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
	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 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 182 shows the relative precision of PY14 energy and demand impacts by component at the 85% confidence level.

**Table 182: Relative Precision of PY14 Impacts by Program Component at the 85% Confidence Level**

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	11.8%	11.8%
	LI – EE Kits	41.8%	42.5%
	New Homes & Smart Thermostats	14.1%	14.0%
	Multifamily Direct Install	0.0%	0.0%
	Appliance Recycling	7.7%	7.0%
	HVAC	12.2%	8.7%
	Residential Appliances	6.8%	8.5%
	LI – Appliance Recycling	11.4%	11.9%
	LI – Direct Install	9.9%	9.9%
	Midstream Appliances	0.0%	0.0%
	Audit and DI	8.4%	8.5%
C&I	Appliance Recycling	0.0%	0.0%
	Multifamily	0.0%	0.0%
	Custom	0.0%	0.0%
	Prescriptive	12.7%	13.1%
	Energy Management and New Construction	10.4%	11.5%

Several components in the above table have a relative precision of  $\pm 0\%$ . ADM evaluated all projects undertaken in those programs in PY14, so there is no sampling uncertainty. Residential Multifamily, however, was incorrectly attributed a relative precision of 100% in the annual EDC report. The Residential Upstream program was not offered in PY14. The low-income EE kits component did not meet the 15% threshold for relative precision on its own, but the overall precision of the EE Kits initiative did meet the threshold.

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 PY14 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 PY14. The SWE team replicated the C&I Prescriptive rollup for energy instead using observed coefficients of variation and found the relative precision of savings estimates to be lower than the reported figure of 12.7%. 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 PY14 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 programs are unique, as the Phase IV Evaluation Framework requires the solution-level verification achieve an absolute precision of  $\pm 0.5\%$  at the 95% confidence level (two-tailed). [Table 183](#) shows the absolute precision of PY14 Behavioral Modification impacts at the 95% confidence level.

**Table 183: Absolute Precision of PY14 Impacts for Behavioral Modification Programs at the 95% Confidence Level**

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.25%
Behavioral Modification (LI)	0.46%

The Online Audit component also relies on regression analysis of all participants and a matched control group of non-participants. While there is no sampling error, there is uncertainty associated with the regression model. The relative precision of the market rate Online Audit energy savings was  $\pm 69.9\%$  at the 85% confidence level and the relative precision of the Low-Income Online Audit energy savings was  $\pm 27.7\%$  at the 85% confidence level. The relative precision of the low-income group was better than the market rate group despite a much smaller number of homes because the savings estimate for low-income recipients was significantly higher.

## 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 PY14 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 PY14 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 184** summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in Penn Power’s PY14 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by Penn Power.

**Table 184: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	6,279	6,279	Yes*
Energy Efficient Products	3,128	3,128	Yes
Low Income Energy Efficiency	1,387	1,387	Yes*
C&I Energy Solutions for Business – Small	6,089	6,089	Yes
C&I Energy Solutions for Business – Large	2,629	2,629	Yes
<b>Portfolio Total</b>	<b>19,512</b>	<b>19,512</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

**Table 185** 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 PY14 Annual Report value exactly for all programs.

**Table 185: MW Savings by Program**

Program	Annual Report MW	Tracking Data MW	Match
Energy Efficient Homes	1.24	1.24	Yes*
Energy Efficient Products	0.75	0.75	Yes
Low Income Energy Efficiency	0.18	0.18	Yes*
C&I Energy Solutions for Business – Small	1.31	1.31	Yes
C&I Energy Solutions for Business – Large	0.53	0.53	Yes
<b>Portfolio Total</b>	<b>4.02</b>	<b>4.02</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.



Table 186 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: 33,315 in the Penn Power PY14 Annual Report and 32,173 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 186: Participation by Program**

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	20,867	15,780	No*
Energy Efficient Products	10,829	11,280	No
Low Income Energy Efficiency	1,366	1,457	No*
C&I Energy Solutions for Business – Small	214	150	No
C&I Energy Solutions for Business – Large	39	13	No
<b>Portfolio Total</b>	<b>33,315</b>	<b>32,173</b>	<b>No*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 187 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in Penn Power's PY14 Annual Report. The SWE calculated a directionally similar value for the Energy Efficient Products program and replicated incentive calculations exactly for the C&I Energy Solutions for Business – Small and C&I Energy Solutions for Business – Large programs. The Annual Report values uses a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes rebate amounts.

**Table 187: Incentives by Program (\$1,000)**

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$1,048	\$414	No
Energy Efficient Products	\$481	\$473	No
Low Income Energy Efficiency	\$550	\$21	No
C&I Energy Solutions for Business – Small	\$1,406	\$1,406	Yes
C&I Energy Solutions for Business – Large	\$192	\$192	Yes
<b>Portfolio Total</b>	<b>\$3,678</b>	<b>\$2,505</b>	<b>No</b>

## 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 PY14 using the project file documentation provided by Penn Power, 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 188 presents a summary of the SWE's residential project file reviews.

**Table 188: Penn Power PY14 Residential Project File Review**

Program	Sub Program	Number of files reviewed <sup>11</sup>	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? <sup>2</sup>
EE Homes Program	Direct Install	41	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	50	✓	✓	✓	✓
EE Homes Program	Multifamily	20	✓	✓	✓	✓
EE Homes Program	New Homes	32	✓	✓	✓	✓
EE Products Programs	Appliances	49	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	35	✓	✓	✓	✓
EE Products Programs	HVAC	10	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	36	✓	✓	✓	✓
LIEEP	Appliances	49	✓	✓	✓	✓
LIEEP	Appliance Turn In	35	✓	✓	✓	✓
LIEEP	Direct Install	10	✓	✓	✓	✓

<sup>1</sup> The number of files reviewed reflects the total number for all FirstEnergy EDCs.

<sup>2</sup> It should be noted that appliances and appliance recycling counts include both the EE products program and LIEEP program totals.

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, revealing that, overall, the SWE did not find any notable discrepancies between the project file documentation and the tracking data in PY14.

### **Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits**

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. The documentation for the Energy Efficiency Kits program consisted of shipment data, specification sheets, and kit contents. The shipment data was similar to the quarterly tracking data but was broken out by month and income status. The SWE did not find any discrepancies between the project documentation and the tracking data for the reviewed sample projects.

### **Energy Efficient Homes Program: Comprehensive Audits**

The project documentation for the Comprehensive Audit program included invoices and audit reports that included information on the installed measures and what potential additional measures could improve efficiency outcomes. Overall, the SWE found no discrepancies between the tracking data and the project file documentation in the reviewed sample projects.

### **Energy Efficient Homes Program: Multifamily**

The Multifamily program contains invoices, audit forms and energy assessments report. The SWE notes that no projects were submitted for Q1 due to a file transfer issue, which was noted by the evaluator. A review of the sampled files did not reveal any discrepancies with measure names and quantities, and the information provided within each project corresponded with the reported savings in the tracking data.

### **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. 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 Products Program: Appliances**

The Appliance Rebate program had project files containing either receipts for rebated appliances, appliance rebate application forms, or both. These project files were accompanied by tracking data that recorded the date the appliance was purchased, the type of appliance, and its quantity. While the data was very well organized, a notable omission from the data was the rebate amount. The SWE reviewed a total of 49 files amongst the First Energy Companies for this program and notes the project files well organized and included thorough documentation.

### **Energy Efficient Products Program: Appliance Recycling**

The Appliance Recycling program had project files containing photos of the participant's signatures, photos of the nameplates of the recycled appliances, and photos of the recycled appliances themselves. These project files were accompanied by tracking data that recorded the type of recycled appliances, the date it was recycled, the town it was from, and the quantity of

recycled appliances. Although some of the photos of the appliances did not include nameplates, the SWE notes the thoroughness of the documentation.

#### **Energy Efficient Products Program: HVAC**

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. There were no discrepancies found in the project files as compared to the tracking database. However, there were some instances where the SWE was unable to confirm the tracking data matched the project file due to missing documentation such as the AHRI certificate.

#### **Energy Efficient Products Program: Midstream Appliances**

The project files for Midstream Appliances were comprised of invoice-styled excel sheets with tracking data that could be easily matched to the sample data given for each quarter. The invoice data recorded the type of appliance rebated, quantity, the appliance price, and the rebate amount. The SWE review of the sampled files did not reveal any discrepancies between the project files and the tracking database.

#### **Low-Income Energy Efficiency Program: Appliances**

The SWE review of the LI Appliance rebate files is summarized in the Appliance subsection above.

#### **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.

#### **Energy Efficient Homes Program: LI WARM**

Invoices, audit forms, preassessment, and post assessment forms were provided for sampled projects. The SWE notes that some projects had varying levels of documentation described above, but generally the necessary documentation existed for each sampled project reviewed by the SWE. A review of the sampled files did not reveal any discrepancies and the information provided within each project matched the tracking database.

#### **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 PY14.

#### 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 PY14. 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.

Project files were generally well-organized, complete, and accurate. [Table 189](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 189: Penn Power PY14 C&amp;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?
C&I Energy Solutions for Business Program – Large	DS Prescriptive – LCI	2	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	DS Prescriptive – SCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Large	Energy Management – LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Energy Management – SCI	1	✓	✓	X	✓	✓
C&I Energy Solutions for Business Program – Small	Custom – SCI	2	✓	✓	1/2	✓	-
C&I Energy Solutions for Business Program – Large	MS Prescriptive – LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	MS Prescriptive – 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 some general observations in a handful of project files. In addition to these general observations, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **DS Energy Management – SCI**
  - In a project with both lighting and refrigeration measures, the savings in the summary report of the calculator did not match the values from the individual measure calculations. The tracking data savings do match the misreported summary values.
- **Custom – SCI**
  - A refrigeration controller project had an invoice with both cooler and freezer controls purchased and installed, but savings were only calculated for the freezer.

Despite the minor issues discussed with the above project files, the SWE did find all 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 Energy Efficient Homes Program, the Energy Efficient Products Program, and the LI Energy Efficiency Program. 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 190](#) provides a summary of the evaluation and M&V approaches used by Penn Power in their PY14 verified savings calculations.



**Table 190: Residential Program Evaluation Activities – Penn Power**

Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis
<b>Energy Efficient Homes</b>				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
<b>Energy Efficient Products</b>				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
<b>Low-Income Energy Efficiency Program</b>				
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 the verified savings followed proper TRM protocols and that the verified savings are accurate.

#### Energy Efficiency Kits Initiative: EE Kits and Low-Income Kits

The Energy Efficiency Kits (EE Kits) initiative has two sub-initiatives – EE Kits and Low-Income EE Kits. Each sub-initiative has two sub-components: EE Kits and School Education. The SWE reviewed the energy efficiency kits and school education kits for both the EE Kits and Low-Income EE Kits sub-initiatives. The energy conservation kits in the EE Kit subprogram contained LED lamps, LED night lights, energy saving aerators, a furnace whistle, an energy saving showerhead, and electrical outlet gaskets. The kits provided through the School Education sub-component contained LED lamps, LED night lights, a furnace whistle, and electrical outlet gaskets. The Low-Income kits included advanced power strips in place of electrical outlet gaskets. The SWE confirmed the verified savings for each sub-initiative were in accordance with the TRM protocols for the relevant measures and worked with ADM to resolve any discrepancies prior to the filing of the FirstEnergy annual report. The SWE also confirmed that participation, energy and demand savings, and energy realization rates were in alignment with those in the annual report.

### **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.

### **The Residential and Residential Low-Income Direct Install Initiatives**

The Direct Install Initiative includes both weatherization and non-weatherization measures. The SWE reviewed the weatherization and non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included LED lighting, LED nightlights, advanced power strips, and water heater setbacks.

The SWE also reviewed the WARM subcomponent of the Low-Income Direct Install Initiative, which provides water heater temperature setbacks, smart power strips, showerheads, refrigerators, pipe insulation, ENERGY STAR lighting, LED night lights, heat pump water heaters, furnace whistles, refrigerator/freezer removal, filter whistles, dehumidifiers, connected thermostats, and aerators. 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 PY14 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. 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.

For the final report, Low-Income and Non Low-Income Energy Efficient Products Programs were combined. There was one small change in population sizes for pool pumps in the final report, which was verified as accurate by the SWE.

### **Energy Efficient Homes and LIEEP: Online Audit**

In PY13, FirstEnergy launched an Online Audit component to the Behavioral subprogram included in both the Energy Efficient Homes (EEH) and Low-Income Energy Efficiency (LI) programs. The Online Audit component operates on an opt-in basis and offers residential customers a web-

based platform featuring energy usage visualizations, energy-saving tips, and promotion of other FirstEnergy residential energy efficiency programs. A total of 1,308 residential and 138 residential-LI households participated in Online Audit in PY14. The PY13 evaluation did not find statistically significant savings amongst Online Audit homes, so Penn Power claimed not verified savings for the component in PY13. The PY14 analysis identified statistically significant savings the Online Audit component generated approximately 0.7% of Penn Power’s verified gross MWh savings in PY14.

The Phase IV Online Audit subprogram is an opt-in program, and the SWE team reviewed the propensity score matching ADM performed to create a comparison group using five pre-treatment variables, latitude, and longitude. Due to the non-RCT design of Online Audit component, ADM included weather terms to improve model fit and control for potential variability between the treatment and control group. The SWE team independently calculated per-household kWh savings from regression coefficients, active participant counts, and aggregate MWh and MW impacts. Our estimates match ADM’s estimates.

The SWE also reviewed the dual participation analysis. Online Audit participants tend to participate in other Penn Power EE&C programs at a higher rate than the matched control groups, so this adjustment is necessary to avoid double-counting. To calculate gross verified demand savings, ADM generated an ETDF using residential load profiles corresponding to the treatment group and then applied ETDF to energy savings to estimate. The SWE was able to replicate the verified demand savings for both the residential and residential low-income group.

Table 191 shows the aggregate PY14 verified gross MWh and MW savings by cohort. The table also shows the number of participants and average percentage savings per household by program group. Using the first impact estimate as an example, the practical interpretation is as follows: all treatment group homes in the EEH Program saved 63 MWh and each household lowered their annual electric consumption by 0.34% during PY14. It is unclear why the low-income households saved more energy per-household than their market rate counterparts in PY14. The population size for the LI program is much smaller so it is possible that the difference is simply noise in the results.

**Table 191: PY14 Penn Power Online Audit Energy and Demand Savings**

Program	Participants	Verified Gross Energy Savings (MWh)	Gross Demand Savings (MW)	Average Percentage Savings per Home
EEH Program	1,308	63	0.01	0.34%
LI Program	138	62	0.01	3.15%
-	<b>1,446</b>	<b>125</b>	<b>0.02</b>	-

The SWE team found that ADM’s evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **Appliance Recycling and Low-Income Appliance Turn-In Initiative**

The SWE performed audits on the Appliance Recycling, Low Income Appliance Recycling, and Midstream Appliance Recycling sub-initiatives of the Appliance Recycling (ATI) Initiative. The five measures included were refrigerator recycling, freezer recycling, room air conditioner (RAC) recycling, dehumidifier recycling, and mini refrigerator recycling. 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 PY14 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 PY14.

#### **G.5.1.2 Behavior**

Home Energy Reports were issued to around 23,000 Penn Power residential and residential-LI households in PY14. HERs accounted for 8.8% of all Penn Power's PY14 verified energy savings and 28.9% of Penn Power's progress toward its low-income target in PY14. Penn Power's behavioral portfolio consists of both active waves as well as other inactive legacy waves, which may be re-activated later in Phase IV. Two waves, or cohorts, were active during PY14 and one of them targets low-income households. [Table 192](#) summarizes the average number of active households during PY14 by cohort.

**Table 192: Penn Power HER Cohort Summary**

Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	16,905	10,745
2021 Low-Income	9/30/2021	5,608	5,637

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 did not conduct an audit of randomization soundness and pre-treatment equivalence for the two cohorts introduced in PY13 since the 2021 cohorts were checked last year. 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. The finding showed that pre-treatment usage patterns are extremely similar between the treatment and control groups of each cohort.

### ***Data Preparation***

The SWE team received interval data from ADM at two different levels: 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 PY14 impact analysis as called for in the Penn Power PY14 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 daily 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 (4.6% 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% 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.

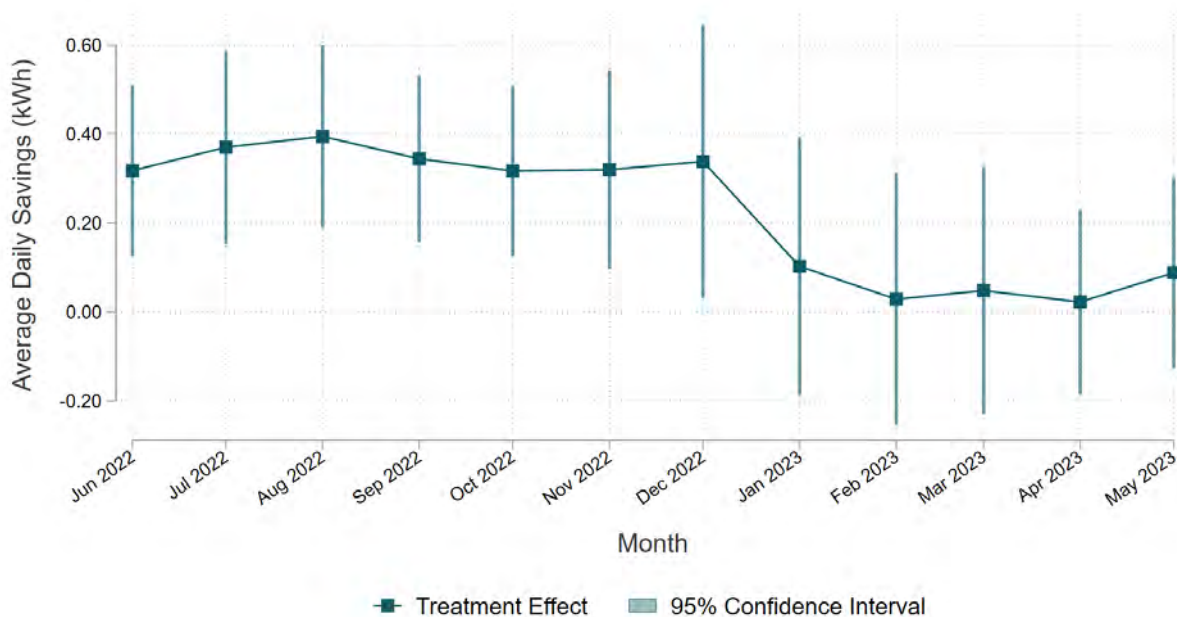
**Impacts**

By month, the daily impact estimates are plotted in [Figure 75](#) (2021 residential) and [Figure 76](#) (2021 low-income). For each cohort, [Table 193](#) shows the average of the PY14 monthly impact estimates. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.22 kWh per day, on average, during PY14. The SWE was able to replicate ADM’s impact estimate for each cohort/month combination.

**Table 193: Penn Power HER Impact Estimates**

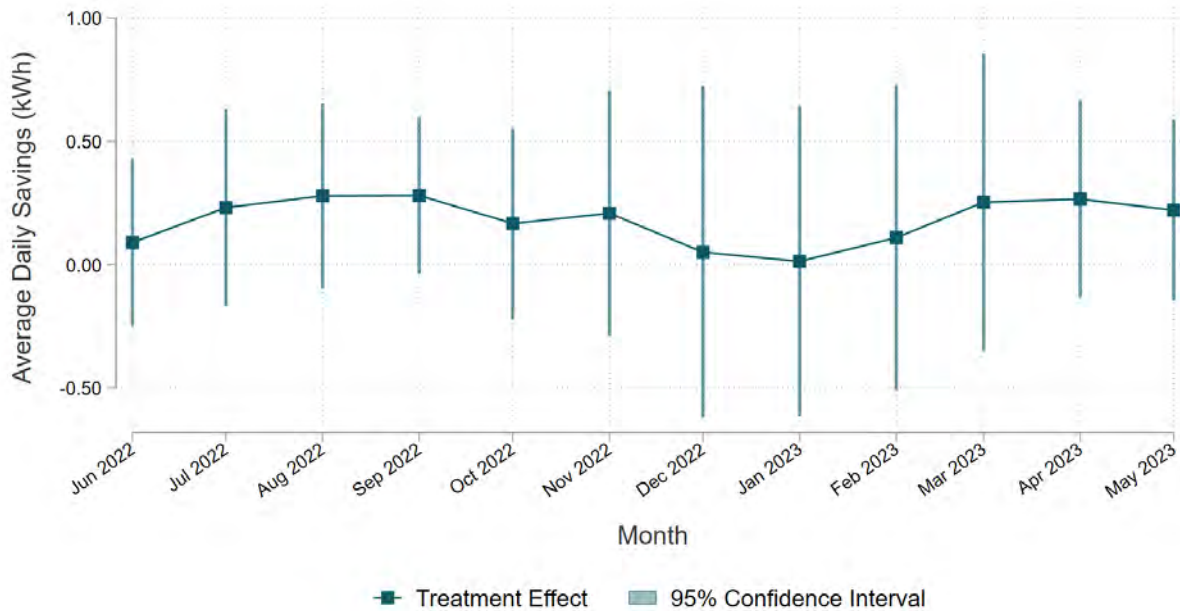
Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.22
2021 Low-Income	0.18

**Figure 75: Average Daily Savings (kWh) by Month, 2021 Residential Cohort**





**Figure 76: Average Daily Savings (kWh) by Month, 2021 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 194](#) shows the aggregate PY14 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, discussed in greater detail later, and the PY14 incremental gross savings estimate.

**Table 194: PY14 HER Energy Savings**

Cohort	Gross Savings (MWh)	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Persistence (MWh)	Incremental Savings (MWh)
2021 Residential	1,333	58	0	0	1,275
2021 Low-Income	341	6	0	0	335
<b>Total</b>	<b>1,674</b>	<b>64</b>	<b>0</b>	<b>0</b>	<b>1,610</b>

**Dual Participation**

In [Table 194](#), gross savings before adjusting for dual participation were 1,674 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 and PY14. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

### **Persistence**

The 2021 Pennsylvania TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research<sup>75</sup> 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). Because Penn Power's active waves were launched during PY13, all savings are considered incremental annual savings. Separating persisting savings from incremental savings was not necessary.

### **Peak Demand Impacts**

The Pennsylvania TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 p.m. to 6:00 p.m. Eastern Daylight Time on non-holiday weekdays during June, July, and August. For each cohort, [Table 195](#) shows the daily peak demand impact estimates and peak demand reduction in PY14. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.02 kWh per hour during peak demand window and saved 0.39 MW without line loss and 0.43 MW with line loss during peak hours, on average, during PY14. The SWE was able to replicate ADM's peak demand impact estimate and peak demand reduction for each cohort.

**Table 195: Penn Power HER Peak Demand Impacts**

Cohort	Peak Demand Impact Estimate (kWh saved per home per hour)	Peak Demand Reduction without line losses (MW)	Peak Demand Reduction with line losses (MW)
2021 Residential	0.02	0.39	0.43
2021 Low-Income	0.01	0.08	0.09
<b>Total</b>	<b>0.02</b>	<b>0.47</b>	<b>0.52</b>

### **Conclusion**

<sup>75</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)

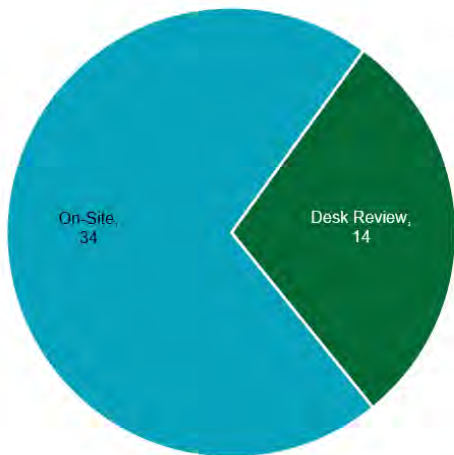
The SWE team found that ADM's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **G.5.2 Non-Residential Audit Activities**

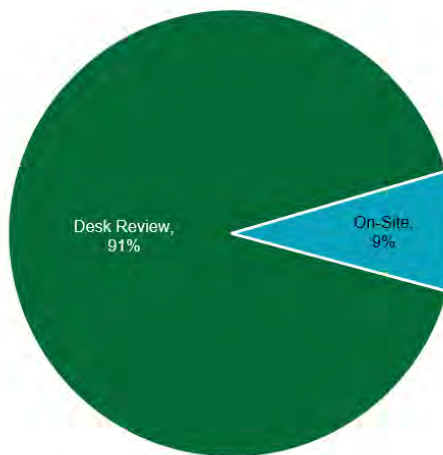
Figure 77 provides a summary of the evaluation activities and M&V approaches utilized by ADM in their PY14 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY14, Penn Power's evaluation contractor completed site visits to 34 of 48 of evaluated projects, and these projects represented 91% of total evaluated energy savings. IPMVP Options A, B, and D were employed for 40% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 60% of the total evaluated savings, including the majority of prescriptive projects and most energy management projects.

Figure 77: Summary of Penn Power’s C&I Evaluation Activities

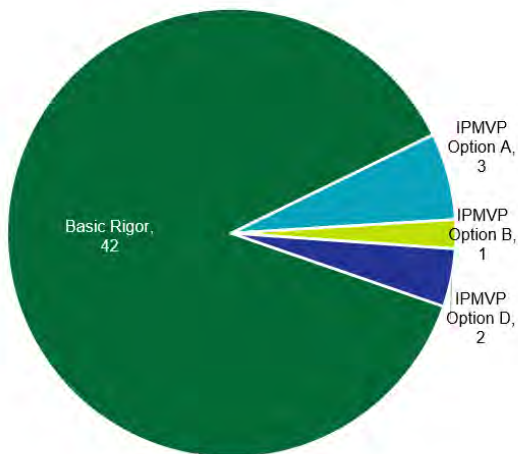
M&V Activity by Project Count



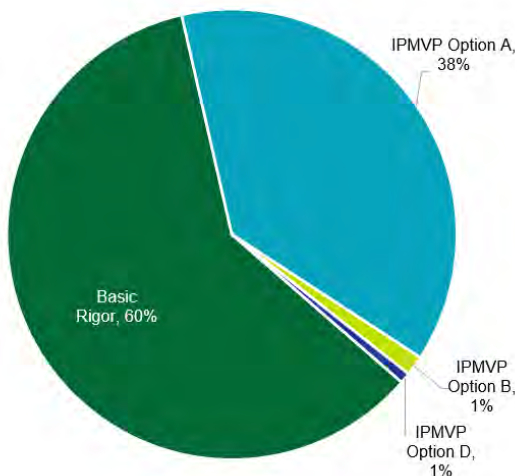
M&V Activity by kWh Contribution



M&V Method by Project Count



M&V Method by kWh Contribution



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 196 provides a summary of the evaluation activities Penn Power’s evaluation contractor used across strata for all projects by initiative.

**Table 196: Summary of Penn Power’s PY14 C&I Evaluation Activities by Initiative**

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
<b>Appliance Recycling</b>	-	<b>104%</b>	<b>102%</b>	-	-
<b>Custom</b>	<b>3</b>	<b>101%</b>	<b>98%</b>	<b>3</b>	-
Custom – C	-	-	-	-	-
Custom – 1	3	101%	98%	3	-
<b>Prescriptive</b>	<b>26</b>	<b>85%</b>	<b>72%</b>	<b>5</b>	<b>21</b>
Downstream Lighting - C	-	-	-	-	-
Downstream Lighting - 2	4	93%	69%	-	4
Downstream Lighting - 1	11	83%	74%	1	10
Downstream Non-Lighting	4	97%	100%	2	2
Midstream Lighting	7	75%	74%	2	5
Midstream Non-Lighting	-	-	-	-	-
<b>EMNC</b>	<b>19</b>	<b>91%</b>	<b>88%</b>	<b>6</b>	<b>13</b>
EMNC	2	127%	59%	-	2
Building Tune-Ups	17	86%	92%	6	11
<b>Multifamily</b>	-	-	-	-	-
<b>TOTAL</b>	<b>48</b>			<b>14</b>	<b>34</b>

The SWE’s review of verified savings for non-residential programs found that, overall, the verified energy 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. However, demand savings estimates were 27% lower than initially estimated largely stemming from the EMNC, Downstream Lighting-2, Downstream Lighting-1, and Midstream Lighting strata. 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 PY14, 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 that included the residential and low-income residential components.

### G.5.2.2 Custom Initiative

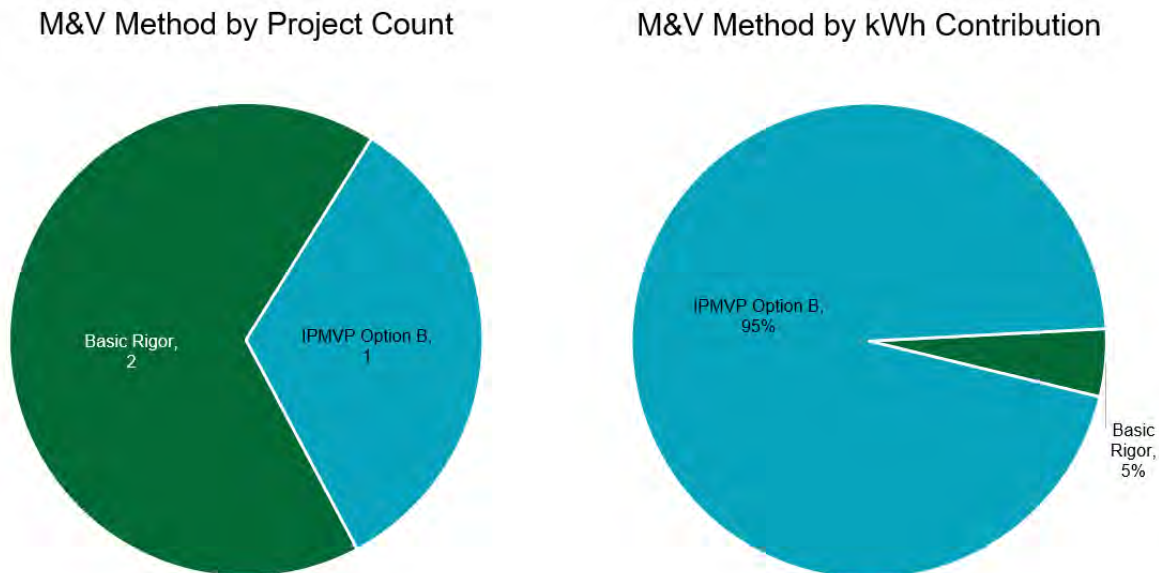
Evaluation activities for this initiative include desk review or site visit and IPMVP evaluation methods for all sampled projects.

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. IPMVP Option B selected as the primary enhanced M&V method for the largest custom project, accounting for 95% of evaluated savings in this stratum, as shown in [Figure 78](#).

**Figure 78: Summary of Penn Power’s C&I Custom Program M&V Methods**



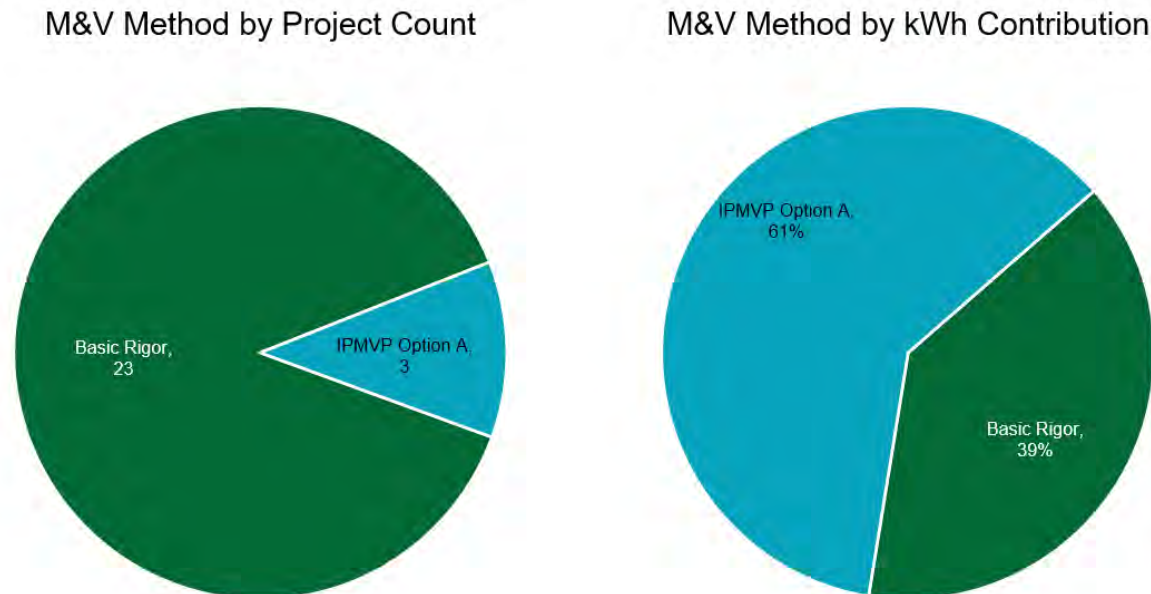
### G.5.2.3 Prescriptive Initiative

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.

IPMVP Option A was employed for 61% of evaluated project savings in this initiative with the remaining projects evaluated using Basic Rigor, as seen in [Figure 79](#) below.

**Figure 79: Summary of Penn Power’s C&I Prescriptive Program M&V Methods**



**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 PY14: 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.

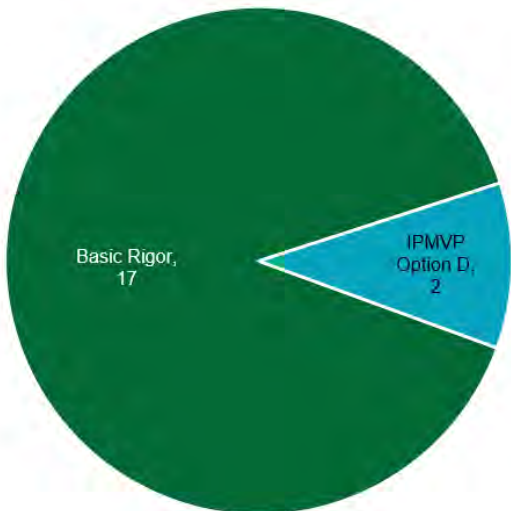
Projects in the New Construction strata were evaluated using IPMVP Option D, which included review of baseline and as-built simulation models developed in the implementer’s custom simulation tool.

Basic Rigor was employed for 98% of evaluated project savings in this initiative with the remaining projects using IPMVP Option D, as seen in [Figure 80](#) below.

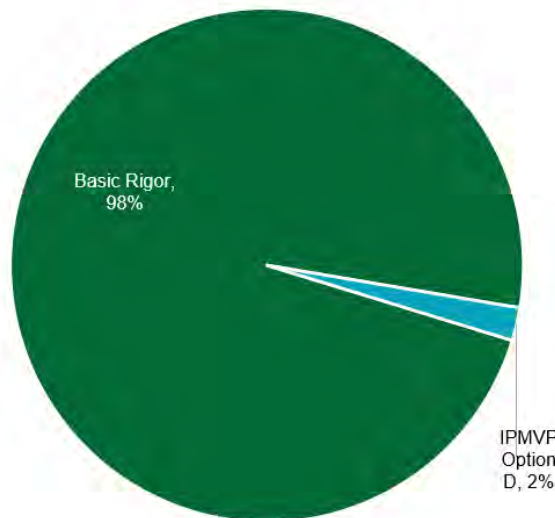


**Figure 80: Summary of Penn Power’s CI EMNC Program M&V Methods**

M&V Method by Project Count



M&V Method by kWh Contribution



**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 85% of the sample. None of the sampled projects for this initiative are served by Penn Power.

**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 PY14 included review of 12 projects, encompassing the following activities:

- 7 Field and Analysis Engineers were observed
- 7 Lighting, 4 HVAC, and 2 Custom Measure Observed
- 82% of Verified Energy Savings reviewed
- 74% of Verified Demand Savings reviewed

Table 197 provides an overview of the SWE milestones for the verified savings audit review of evaluated Penn Power’s projects.

**Table 197: Penn Power Verified Savings Audit Review Milestones**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
13	2,185,426	99%	319	97%

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 one significant finding was the reduction of a midstream baseline lighting fixture power draw to align with data collected on-site in lieu of the TRM assumption. The overall energy and demand savings attainment percentages of Penn Power's reviewed projects were 99% and 97% respectively.

## G.6 NTG

Table 198 lists Penn Power's PY14 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 PY14 Annual Report program specific sections and appendices.<sup>76</sup>

**Table 198: Penn Power PY14 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	0.72
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	0.51
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	0.83
C&I Solutions for Business Programs - Small and Large	Custom	1.0
C&I Solutions for Business Programs - Small and Large	EMNC	0.97
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

### G.6.1 Residential Programs

ADM planned and enacted NTG research for the Residential Downstream Appliances component of the EE Products Program and the New Homes component of the EE Homes Program (Table 199). ADM utilized participant surveys to estimate free-ridership, spillover and NTG for

<sup>76</sup> The FirstEnergy PY14 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.

downstream appliances and building interviews for New Homes. ADM utilized question batteries that were consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation.

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 199: Summary of Penn Power’s PY14 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	Builder & Rater Interviews	20	28%	0%	0.72
Multifamily	N/A	N/A	19%	0%	0.81
Online Audits	N/A	N/A	0%	0%	1.0
Appliance Recycling	N/A	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	Self-Report Survey	89	50%	1%	0.51
Midstream Appliances	N/A	N/A	56%	0%	0.44

### G.6.2 C&I Energy Efficiency Programs

ADM conducted NTG research for the prescriptive, custom, and EMNC programs in PY14. 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 PY14 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 200). The NTG for the Prescriptive program is a savings-weighted average of the downstream and midstream lighting and non-lighting stratum.

**Table 200: Summary of Penn Power's PY14 C&I NTG Results**

Program Name	Approach	Sample Size	Free Ridership	Spillover	NTG
Prescriptive	Participant & Vendor Surveys	36	1%	2%	0.83
Custom	Participant & Vendor Surveys	4	0%	0%	1.0
EMNC	Participant & Vendor Surveys	11	3%	0%	0.97
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 201 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Penn Power's PY14 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 PY14 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.

Both gross and net TRC ratios showed a slight improvement from PY12. The greatest increase was seen in the C&I Energy Solutions for Business - Small Program.

**Table 201: Summary of Penn Power's PY14 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
Residential - Energy Efficient Homes	\$3,804	\$2,191	1.74	\$3,142	\$1,896	1.66
Residential - Energy Efficient Products	\$1,721	\$1,694	1.02	\$777	\$1,044	0.74
Low Income Energy Efficiency	\$385	\$837	0.46	\$385	\$837	0.46
C&I Energy Solutions for Business - Small	\$3,534	\$2,806	1.26	\$3,187	\$2,568	1.24
C&I Energy Solutions for Business - Large	\$1,356	\$1,563	0.87	\$1,174	\$1,472	0.80
<b>Portfolio Total</b>	<b>\$10,799</b>	<b>\$9,091</b>	<b>1.19</b>	<b>\$8,664</b>	<b>\$7,817</b>	<b>1.11</b>

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 – Large 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.

- 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.
- Penn Power had the lowest PY14 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 PY14 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent.
- 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 Penn Power.

- 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.

## 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. Details on survey targets and completes for Penn Power are provided in the subsections below. [Appendix E.8](#) of the SWE's PY14 Final Annual Report, described previously for Met-Ed, applies to all four FirstEnergy utilities, including Penn Power.

### G.8.1 Residential Programs

#### G.8.1.1 Energy Efficient Products Program – Appliance Rebate

The PY14 evaluation team targeted 70 participant surveys with Penn Power customers; the target was exceeded with 74 completed surveys.

#### G.8.1.2 Energy Efficient Products Homes – Behavioral Home Energy Report

The PY14 evaluation team targeted 35 participant surveys with Penn Power customers; the target was exceeded with 82 completed surveys.

#### G.8.1.3 Energy Efficient Products Homes – Online Audits

The PY14 evaluation team targeted 60 participant surveys with Penn Power customers; the target was not met with 20 completed surveys.

#### G.8.1.4 Energy Efficient Products Homes – New Homes

There were not any surveys as part of the PY14 evaluation.

### G.8.2 Residential Low-Income Program

#### G.8.2.1 Weatherization (Direct Install)

The PY14 evaluation team targeted 59 participant surveys with Penn Power customers; the target was met with 76 completed surveys.

#### G.8.2.2 Appliance Rebate

The PY14 evaluation team targeted 35 participant surveys with Penn Power customers; the target was not met with 15 completed surveys.

#### G.8.2.3 Behavioral Home Energy Report

The PY14 evaluation team targeted 35 participant surveys with Penn Power customers; the target was exceeded with 89 completed surveys.

#### **G.8.2.4 Multifamily (Residential)**

The PY14 evaluation team targeted five participant surveys with Penn Power customers; the target was not met with two completed surveys.

#### **G.8.2.5 New Homes**

There were not any surveys as part of the PY14 evaluation.

### **G.8.3 Commercial & Industrial Programs**

#### **G.8.3.1 C&I Energy Solutions for Business (Small)**

The PY14 evaluation team targeted 49 participant surveys with Penn Power customers; the target was nearly met with 46 completed surveys.

#### **G.8.3.2 C&I Energy Solutions for Business (Large)**

The PY14 evaluation team targeted ten participant surveys with Penn Power customers; the target was nearly met with five completed surveys.



## Appendix H FirstEnergy: West Penn Power Company PY14 Audit Detail

### H.1 KEY AUDIT FINDINGS

- The SWE's review of PY14 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 PY14 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 an additional behavioral HER cohort in June 2022 for a total of three active cohorts in PY14. The new cohort consists of approximately 34,000 market residential households. On average, HER recipients saved approximately 24 kWh, or 0.3% of their annual consumption, in PY14. Since the three active cohorts were in their first or second year of HER exposure, the impact evaluation did not need to deal with 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 PY14 methods or results.
- West Penn Power's portfolio was cost-effective in PY14 with an improved gross TRC ratio of 1.62.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in West Penn Power's PY14 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 Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes Rebate Amount in incentive calculations.
- 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 PY14. 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 PY14 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.

## H.2 EM&V PLAN REVIEWS

ADM, FirstEnergy's evaluation contractor, submitted a redline version of their PY14 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, the ADM team submitted several memos detailing their sampling approach for program components selected for impact, process and NTG evaluations in PY14.

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 PY14. West Penn Power will not use historic realization rates until PY15 and PY17. [Table 202](#) shows all West Penn Power programs, which produced verified impacts in PY14.

**Table 202: PY14 West Penn Power Program Impact Evaluation Summary**

Sector	Components	PY14 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
	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 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 203 shows the relative precision of PY14 energy and demand impacts by component at the 85% confidence level.

**Table 203: Relative Precision of PY14 Impacts by Program Component at the 85% Confidence Level**

Sector	Components	Relative Precision (Energy)	Relative Precision (Demand)
Residential	EE Kits	6.9%	6.8%
	LI - EE Kits	10.7%	10.5%
	New Homes & Smart Thermostats	14.3%	14.1%
	Multifamily Direct Install	9.6%	9.6%
	Appliance Recycling	5.2%	4.6%
	HVAC	8.5%	6.6%
	Residential Appliances	8.2%	9.0%
	LI – Appliance Recycling	10.5%	8.0%
	LI - Direct Install	9.3%	9.3%
	Midstream Appliances	0.0%	0.0%
	Audit and DI	9.1%	9.1%
C&I	Appliance Recycling	0.0%	0.0%
	Multifamily	11.7%	8.6%
	Custom	6.4%	7.6%
	Prescriptive	14.1%	13.3%
	Energy Management and New Construction	10.5%	10.5%

Residential Midstream Appliances and C&I Appliance Recycling have a relative precision of  $\pm 0\%$ . ADM evaluated all projects undertaken in those programs in PY14, so there is no sampling uncertainty. The Residential Upstream program was not offered in PY14.

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 PY14 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 did not find to be true for PY14. The SWE team replicated the C&I Prescriptive rollup for energy instead using observed coefficients of variation and found the relative precision of savings estimates to be higher than the reported figure of 14.1%. 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 PY14 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 to achieve an absolute precision of  $\pm 0.5\%$  at the 95% confidence level (two-tailed). [Table 204](#) shows the absolute precision of PY14 Behavioral Modification impacts at the 95% confidence level.

**Table 204: Absolute Precision of PY14 Impacts for Behavioral Modification Programs at the 95% Confidence Level**

Program	Absolute Precision (Energy)
Behavioral Modification (Market Rate)	0.15%
Behavioral Modification (LI)	0.36%

The Online Audit component also relies on regression analysis of all participants and a matched control group of non-participants. While there is no sampling error, there is uncertainty associated with the regression model. The relative precision of the market rate Online Audit energy savings was  $\pm 58.7\%$  at the 85% confidence level and the relative precision of the Low-Income Online Audit energy savings was  $\pm 28.5\%$  at the 85% confidence level. The relative precision of the low-income group was better than the market rate group despite a much smaller number of homes because the savings estimate for low-income recipients was significantly higher.

## 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 PY14 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 PY14 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 205 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 PY14 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by West Penn Power.

**Table 205: MWh Savings by Program**

Program	Annual Report MWh	Tracking Data MWh	Match
Energy Efficient Homes	17,244	17,244	Yes*
Energy Efficient Products	9,994	9,994	Yes
Low Income Energy Efficiency	5,802	5,802	Yes*
C&I Energy Solutions for Business - Small	26,034	26,034	Yes
C&I Energy Solutions for Business - Large	18,394	18,394	Yes
<b>Portfolio Total</b>	<b>77,468</b>	<b>77,468</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 206 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 PY14 Annual Report value exactly for all programs.

**Table 206: MW Savings by Program**

Program	Annual Report MW	Annual Report MW	Match
Energy Efficient Homes	2.65	2.65	Yes*
Energy Efficient Products	2.53	2.53	Yes
Low Income Energy Efficiency	0.80	0.80	Yes*
C&I Energy Solutions for Business - Small	4.99	4.99	Yes
C&I Energy Solutions for Business - Large	3.02	3.02	Yes
<b>Portfolio Total</b>	<b>14.00</b>	<b>14.00</b>	<b>Yes*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 207 summarizes the SWE's findings regarding program participation. The SWE was able to calculate directionally similar participation counts for most programs. The portfolio totals, however, differ by 13,449 participants: 110,703 in the West Penn Power PY14 Annual Report and 97,254 in the tracking data. The SWE does not find the discrepancies a cause for concern. We will work with West Penn Power and their evaluation contractor to better understand the Phase IV business rules around counting participants for different program components.

**Table 207: Participation by Program**

Program	Annual Report Participants	Tracking Data Participants	Match
Energy Efficient Homes	65,303	53,890	No*
Energy Efficient Products	29,951	31,950	No
Low Income Energy Efficiency	14,214	10,849	No*
C&I Energy Solutions for Business - Small	1,059	523	No
C&I Energy Solutions for Business - Large	176	42	No
<b>Portfolio Total</b>	<b>110,703</b>	<b>97,254</b>	<b>No*</b>

\*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, Table 208 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in West Penn Power's PY14 Annual Report. The SWE was able to replicate incentive dollars exactly for the C&I Energy Solutions for Business - Large program. The SWE calculated directionally similar values for the Energy Efficient Products and C&I Energy Solutions for Business - Small programs. The Annual Report values use a more inclusive definition of incentives for programs with kits or direct install, while the tracking data only includes rebate amounts.

**Table 208: Incentives by Program (\$1,000)**

Program	Annual Report Incentives	Tracking Data Incentives	Match
Energy Efficient Homes	\$2,875	\$817	No
Energy Efficient Products	\$1,515	\$1,496	No
Low Income Energy Efficiency	\$2,308	\$87	No
C&I Energy Solutions for Business - Small	\$4,409	\$4,170	No
C&I Energy Solutions for Business - Large	\$1,128	\$1,128	Yes
<b>Portfolio Total</b>	<b>\$12,235</b>	<b>\$7,699</b>	<b>No</b>



## 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 Met-Ed's residential project files for PY14 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 209 presents a summary of the SWE's residential project file reviews.

**Table 209: West Penn Power PY14 Residential Project File Review Summary**

Program	Sub Program	Number of files reviewed <sup>1</sup>	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? <sup>2</sup>
EE Homes Program	Direct Install	41	✓	✓	✓	✓
EE Homes Program and LIEEP	EE Kits	50	✓	✓	✓	✓
EE Homes Program	Multifamily	20	✓	✓	✓	✓
EE Homes Program	New Homes	32	✓	✓	✓	✓
EE Products Programs	Appliances	49	✓	✓	✓	✓
EE Products Programs	Appliance Recycling	35	✓	✓	✓	✓
EE Products Programs	HVAC	10	✓	✓	✓	✓
EE Products Programs	Midstream Appliances	36	✓	✓	✓	✓
LIEEP	Appliances	49	✓	✓	✓	✓
LIEEP	Appliance Turn In	35	✓	✓	✓	✓
LIEEP	Direct Install	10	✓	✓	✓	✓

<sup>1</sup> The number of files reviewed reflects the total number for all FirstEnergy EDCs.

<sup>2</sup> It should be noted that appliances and appliance recycling counts include both the EE products program and LIEEP program totals.

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. Overall, the SWE did not find any notable discrepancies between the project file documentation and the tracking data in PY14.

#### **Energy Efficient Homes Program and LIEEP: Energy Efficiency Kits**

The Energy Efficiency Kits program contains two subcomponents: energy efficient kits and school education. The documentation for the Energy Efficiency Kits program consisted of shipment data, specification sheets, and kit contents. The shipment data was similar to the quarterly tracking data but was broken out by month and income status. The SWE did not find any discrepancies between the project documentation and the tracking data for the reviewed sample projects.

#### **Energy Efficient Homes Program: Comprehensive Audits**

The project documentation for the Comprehensive Audit program included invoices and audit reports that included information on the installed measures and what potential additional measures could improve efficiency outcomes. Overall, the SWE found no discrepancies between the tracking data and the project file documentation in the reviewed sample projects.

#### **Energy Efficient Homes Program: Multifamily**

The Multifamily program contains invoices, audit forms and energy assessments report. The SWE notes that no projects were submitted for Q1 due to a file transfer issue, noted by the evaluator. A review of the sampled files did not reveal any discrepancies with measure names and quantities, and the information provided within each project corresponded with the reported savings in the tracking data.

#### **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. 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 Products Program: Appliances**

The Appliance Rebate program had project files containing either receipts for rebated appliances, appliance rebate application forms, or both. These project files were accompanied by tracking data that recorded the date the appliance was purchased, the type of appliance, and its quantity. While the data was very well organized, a notable omission from the data was the rebate amount. The SWE reviewed a total of 49 files amongst the First Energy Companies for this program and notes the project files well organized and included thorough documentation.

#### **Energy Efficient Products Program: Appliance Recycling**

The Appliance Recycling program had project files containing photos of the participant's signatures, photos of the nameplates of the recycled appliances, and photos of the recycled appliances themselves. These project files were accompanied by tracking data that recorded the type of recycled appliances, the date it was recycled, the town it was from, and the quantity of

recycled appliances. Although some of the photos of the appliances did not include nameplates, the SWE notes the thoroughness of the documentation.

#### **Energy Efficient Products Program: HVAC**

The HVAC project files included AHRI certifications, invoices equipment registration and rebate application forms. There were no discrepancies found in the project files as compared to the tracking database. However, there were some instances where the SWE was unable to confirm the tracking data matched the project file due to missing documentation such as the AHRI certificate.

#### **Energy Efficient Products Program: Midstream Appliances**

The project files for Midstream Appliances were comprised of invoice-styled excel sheets with tracking data that could be easily matched to the sample data given for each quarter. The invoice data recorded the type of appliance rebated, quantity, the appliance price, and the rebate amount. The SWE review of the sampled files did not reveal any discrepancies between the project files and the tracking database.

#### **Low-Income Energy Efficiency Program: Appliances**

The SWE review of the LI Appliance rebate files is summarized in the Appliance subsection above.

#### **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.

#### **Energy Efficient Homes Program: LI WARM**

Invoices, audit forms, preassessment, and post assessment forms were provided for sampled projects. The SWE notes that some projects had varying levels of documentation described above, but generally the necessary documentation existed for each sampled project reviewed by the SWE. A review of the sampled files did not reveal any discrepancies and the information provided within each project matched the tracking database.

#### **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 PY14.

#### **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 PY14. 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 210](#) presents an overview of the results of the SWE’s C&I project file reviews.

Table 210: West Penn Power PY14 C&amp;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?
C&I Energy Solutions for Business Program – Large	DS Prescriptive - LCI	2	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	DS Prescriptive - SCI	1	✗	✓	✓	✗	✓
C&I Energy Solutions for Business Program – Large	Energy Management - LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Energy Management - SCI	2	✓	✓	✓	1/2	✓
C&I Energy Solutions for Business Program – Small	Custom - SCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Large	MS Prescriptive - LCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	MS Prescriptive - SCI	1	✓	✓	✓	✓	✓
C&I Energy Solutions for Business Program – Small	Multifamily - SCI	1	✓	✗	✓	✓	✓

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 in some projects. The SWE noted specific project files with deficiencies as addressed below by sub-program.

- **Prescriptive – SCI**
  - A smart thermostat retrofit project did not include documentation for existing HVAC specifications (i.e., unit capacity and efficiency)
- **Multifamily - SCI**
  - The rebate amount in the savings calculator for one project did not match the reported rebate amount in the tracking database.

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 Energy Efficient Homes Program, the Energy Efficient Products Program, and the LI Energy Efficiency Program. 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 211](#) provides a summary of the evaluation and M&V approaches used by West Penn Power in their PY14 verified savings calculations.

**Table 211: Residential Program Evaluation Activities – West Penn Power**

Program/ Subprogram	Surveys	Site Visits	Desk Review <sup>a</sup>	Billing Analysis
<b>Energy Efficient Homes</b>				
Energy Efficiency Kits	✓	-	✓	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	✓	-
Residential Direct Install – Multifamily	-	-	✓	-
Residential New Construction	-	✓	✓	-
<b>Energy Efficient Products</b>				
Upstream Electronics	-	-	-	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliance Turn-in	✓	-	✓	-
Midstream Appliances	-	-	✓	-
<b>Low-Income Energy Efficiency Program</b>				
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 the verified savings followed proper TRM protocols and that the verified savings are accurate.

#### Energy Efficiency Kits Initiative: EE Kits and Low-Income Kits

The Energy Efficiency Kits (EE Kits) initiative has two sub-initiatives – EE Kits and Low-Income EE Kits. Each sub-initiative has two sub-components: EE Kits and School Education. The SWE reviewed the energy efficiency kits and school education kits for both the EE Kits and Low-Income EE Kits sub-initiatives. The energy conservation kits in the EE Kit subprogram contained LED lamps, LED night lights, energy saving aerators, a furnace whistle, an energy saving showerhead, and electrical outlet gaskets. The kits provided through the School Education sub-component contained LED lamps, LED night lights, a furnace whistle, and electrical outlet gaskets. The Low-Income kits included advanced power strips in place of electrical outlet gaskets. The SWE confirmed the verified savings for each sub-initiative were in accordance with the TRM protocols for the relevant measures and worked with ADM to resolve any discrepancies prior to the filing of the FirstEnergy annual report. The SWE also confirmed that participation, energy and demand savings, and energy realization rates were in alignment with those in the annual report.



### **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.

### **The Residential and Residential Low-Income Direct Install Initiatives**

The Direct Install Initiative includes both weatherization and non-weatherization measures. The SWE reviewed the weatherization and non-weatherization measures and confirmed they adhered to the 2021 TRM. These measures included LED lighting, LED nightlights, advanced power strips, and water heater setbacks.

The SWE also reviewed the WARM subcomponent of the Low-Income Direct Install Initiative, which provides water heater temperature setbacks, smart power strips, showerheads, refrigerators, pipe insulation, ENERGY STAR lighting, LED night lights, heat pump water heaters, furnace whistles, refrigerator/freezer removal, filter whistles, dehumidifiers, connected thermostats, and aerators. 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 PY14 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. 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.

For the final report, Low-Income and Non Low-Income Energy Efficient Products Programs were combined. There was one small change in population sizes for pool pumps in the final report, which was verified as accurate by the SWE.

### **Energy Efficient Homes and LIEEP: Online Audit**

In PY13, FirstEnergy launched an Online Audit component to the Behavioral subprogram included in both the Energy Efficient Homes (EEH) and Low-Income Energy Efficiency (LI) programs. The Online Audit component operates on an opt-in basis and offers residential customers a web-

based platform featuring energy usage visualizations, energy-saving tips, and promotion of other FirstEnergy residential energy efficiency programs. A total of 5,306 residential and 454 residential-LI households participated in Online Audit in PY14. The PY13 evaluation did not find statistically significant savings amongst Online Audit homes, so West Penn Power claimed not verified savings for the component in PY13. The PY14 analysis did identify statistically significant savings the Online Audit component generated approximately 0.6% of West Penn Power's verified gross MWh savings in PY14.

The Phase IV Online Audit subprogram is an opt-in program, and the SWE team reviewed the propensity score matching ADM performed to create a comparison group using five pre-treatment variables, latitude, and longitude. Due to non-RCT design of Online Audit component, ADM included weather terms to improve model fit and control for potential variability between the treatment and control group. The SWE team independently calculated per-household kWh savings from regression coefficients, active participant counts, and aggregate MWh and MW impacts. Our estimates match ADM's estimates.

The SWE also reviewed the dual participation analysis. Online Audit participants tend to participate in other West Penn Power EE&C programs at a higher rate than the matched control groups, so this adjustment is necessary to avoid double-counting. To calculate gross verified demand savings, ADM generated an ETDF using residential load profiles corresponding to the treatment group and then applied ETDF to energy savings to estimate. The SWE was able to replicate the verified demand savings for both the residential and residential low-income group.

Table 212 shows the aggregate PY14 verified gross MWh and MW savings by cohort. The table also shows the number of participants and average percentage savings per household by program group. Using the first impact estimate as an example, the practical interpretation is as follows: all treatment group homes in the EEH Program saved 303 MWh and each household lowered their annual electric consumption by 0.40% during PY14. It is unclear why the low-income households saved more energy per-household than their market rate counterparts in PY14. The population size for the LI program is much smaller so it is possible that the difference is simply noise in the results.

**Table 212: PY14 West Penn Power Online Audit Energy and Demand Savings**

Program	Participants	Verified Gross Energy Savings (MWh)	Gross Demand Savings (MW)	Average Percentage Savings per Home
EEH Program	5,306	303	0.05	0.40%
LI Program	454	203	0.03	2.88%
-	<b>5,760</b>	<b>506</b>	<b>0.08</b>	-

The SWE team found that ADM's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **Appliance Recycling and Low-Income Appliance Turn-In Initiative**

The SWE performed audits on the Appliance Recycling, Low Income Appliance Recycling, and Midstream Appliance Recycling sub-initiatives of the Appliance Recycling (ATI) Initiative. The five measures included were refrigerator recycling, freezer recycling, room air conditioner (RAC) recycling, dehumidifier recycling, and mini refrigerator recycling. 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 Direct Install Initiative, which includes ENERGY STAR lighting, LED night lights, aerators, 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 PY14.

#### **H.5.1.2 Behavior**

Home Energy Reports were issued to around 114,000 West Penn Power residential and residential-LI households in PY14. 3.4% of all West Penn Power PY14 savings came from HERs and 11.1% of West Penn Power's progress toward its low-income target in PY14 came from HERs. West Penn Power's behavioral portfolio consists of three different waves, or cohorts, of homes and there are other legacy waves that may be re-activated. Three cohorts were active during PY14 and one of them targets low-income households.

Home Energy Reports were issued to around 83,000 residential and residential-LI households in PY14. HERs accounted for 3.4% of all West Penn Power's PY14 verified energy savings and 11.1% of West Penn Power's progress toward its low-income target in PY14. West Penn Power's behavioral portfolio consists of both active waves as well as other inactive legacy waves that may be re-activated later in Phase IV. Three waves, or cohorts, were active during PY14 and one of them targets low-income households. [Table 213](#) summarizes the average number of active households during PY14 by cohort.

**Table 213: West Penn Power HER Cohort Summary**

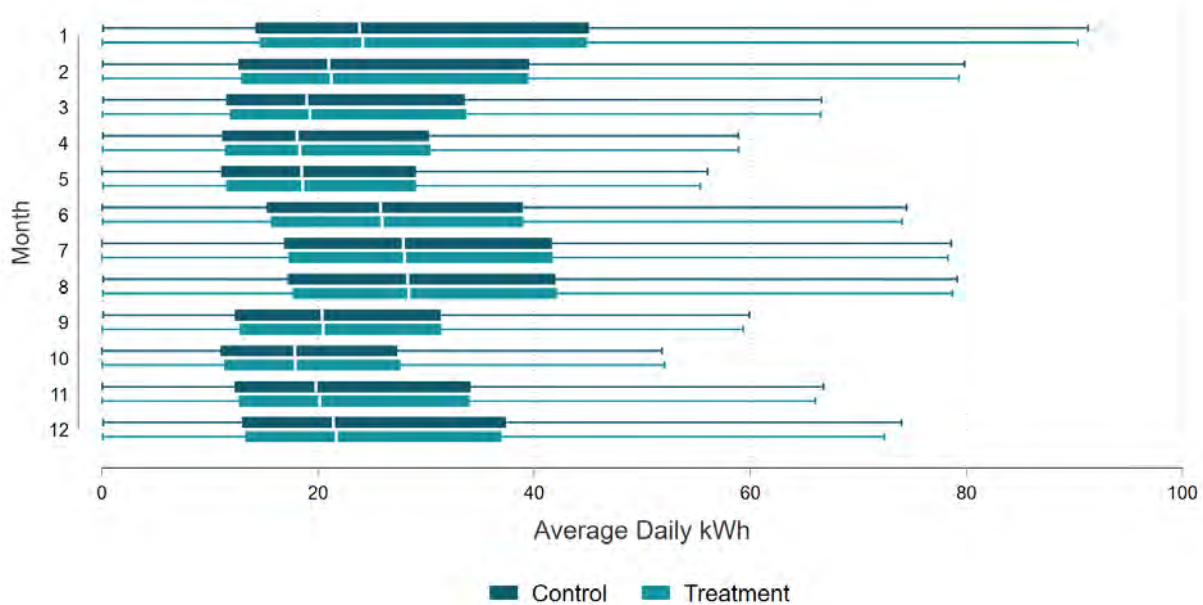
Cohort	First HER Mailing	Treatment Group Homes	Control Group Homes
2021 Residential	9/30/2021	40,928	11,019
2021 Low-Income	9/30/2021	8,361	8,512
2022 Residential	6/3/2022	33,801	11,142

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 cohort introduced in PY14 since the 2021 cohorts were checked last year. 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 81](#) displays 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 81: Pre-Treatment Equivalence, 2022 Residential Cohort



### Data Preparation

The SWE team received interval data from ADM at two different levels: 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 PY14 impact analysis as called for in the West Penn Power PY14 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 daily 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 (1.8% 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 to within 0.1% 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.

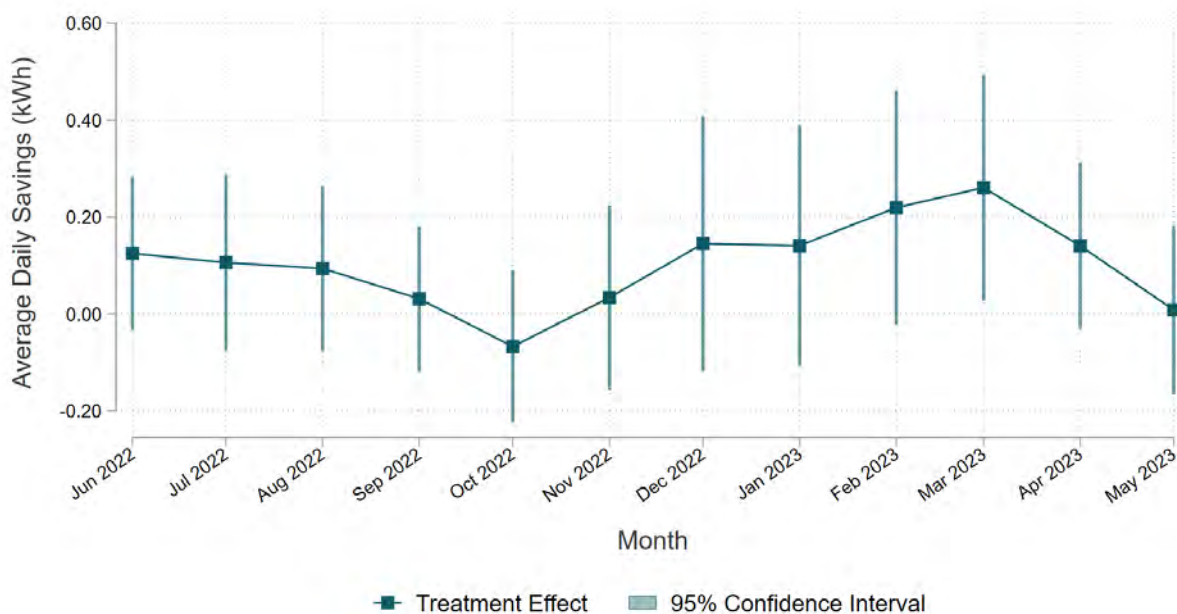
**Impacts**

By month, the daily impact estimates are plotted in [Figure 82](#) (2021 residential), [Figure 83](#) (2021 low-income) and [Figure 84](#) (2022 Residential). For each cohort, [Table 214](#) shows the average of the PY14 monthly impact estimates. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.10 kWh per day, on average, during PY14. The SWE was able to replicate ADM’s impact estimate for each cohort/month combination.

**Table 214: West Penn Power HER Impact Estimates**

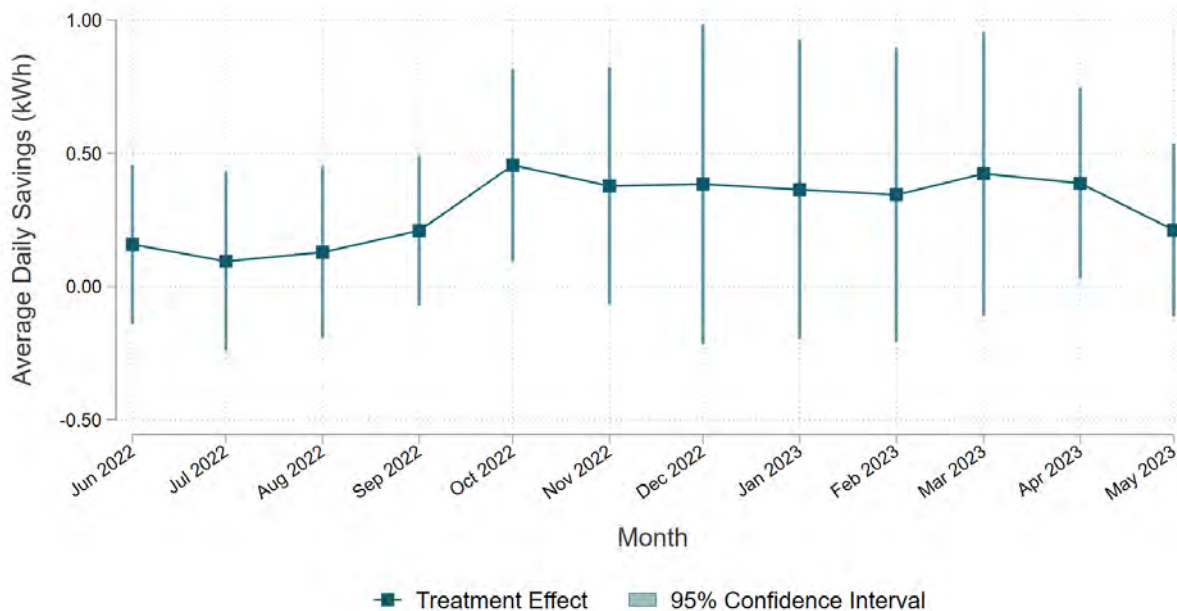
Cohort	Impact Estimate (kWh saved per home per day)
2021 Residential	0.10
2021 Low-Income	0.29
2022 Residential	0.05

**Figure 82: Average Daily Savings (kWh) by Month, 2021 Residential Cohort**

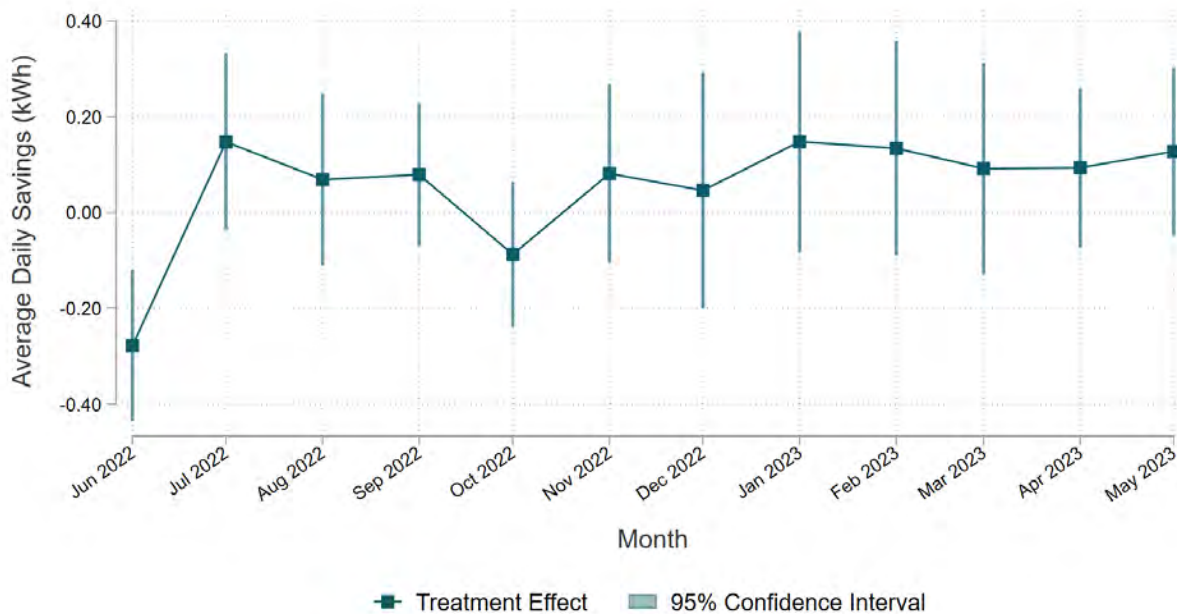




**Figure 83: Average Daily Savings (kWh) by Month, 2022 Low-Income Cohort**



**Figure 84: Average Daily Savings (kWh) by Month, 2022 Residential Cohort**



The SWE team independently calculated gross MWh savings from regression coefficients and active participant counts, and our estimates match ADM’s estimates. [Table 215](#) shows the aggregate PY14 pre-adjustment gross MWh savings by cohort. The table also shows three adjustments, discussed in greater detail later, and the PY14 incremental gross savings estimate.



**Table 215: PY14 HER Energy Savings**

<b>Cohort</b>	<b>Gross Savings (MWh)</b>	<b>Downstream Dual Participation (MWh)</b>	<b>Upstream Dual Participation (MWh)</b>	<b>Persistence (MWh)</b>	<b>Incremental Savings (MWh)</b>
2021 Residential	1,457	78	0	0	1,378
2021 Low-Income	808	39	0	0	769
2022 Residential	648	60	0	0	588
<b>Total</b>	<b>2,912</b>	<b>177</b>	<b>0</b>	<b>0</b>	<b>2,735</b>

**Dual Participation**

In [Table 215](#), gross savings before adjusting for dual participation were 2,912 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 and PY14. Thus, an upstream dual participation adjustment is not applied to the gross savings estimate.

**Persistence**

The 2021 Pennsylvania TRM assumes an annual decay rate of 31.3% derived from Pennsylvania-specific research<sup>77</sup> 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). Because West Penn Power's active waves were launched during PY13 and PY14, all savings are considered incremental first-year impacts. Separating persisting savings from incremental savings was not necessary.

**Peak Demand Impacts**

The Pennsylvania TRM defines peak demand impacts as the average reduction in electric consumption from 2:00 p.m. to 6:00 p.m. Eastern Daylight Time on non-holiday weekdays during

<sup>77</sup> 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](https://www.puc.pa.gov/Electric/pdf/Act129/SWE_Res_Behavioral_Program-Persistence_Study_Addendum2018.pdf)

June, July, and August. For each cohort, [Table 216](#) shows the daily peak demand impact estimates and peak demand reduction in PY14. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the 2021 Residential cohort saved 0.01 kWh per hour during peak demand window and saved 0.26MW without line loss and 0.29 MW with line loss during peak hours, on average, during PY14. The SWE was able to replicate ADM's peak demand impact estimate and peak demand reduction for each cohort.

**Table 216: West Penn Power HER Peak Demand Impacts**

Cohort	Peak Demand Impact Estimate (kWh saved per home per hour)	Peak Demand Reduction without line losses (MW)	Peak Demand Reduction with line losses (MW)
2021 Residential	0.01	0.26	0.29
2021 Low-Income	0.01	0.08	0.08
2022 Residential	0.00	-0.03	-0.03
<b>Total</b>	<b>0.01</b>	<b>0.31</b>	<b>0.34</b>

### **Conclusion**

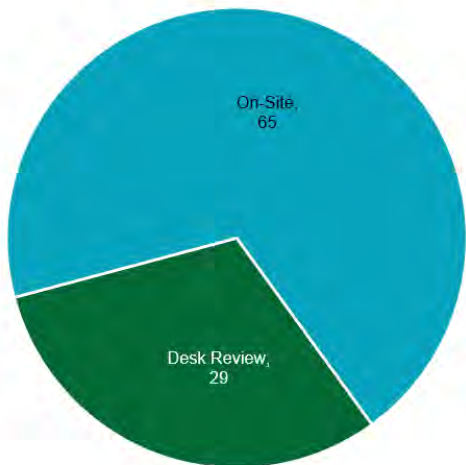
The SWE team found that ADM's evaluation was entirely consistent with their proposed and approved EM&V plans. The SWE team does not propose any revisions to the PY14 methods or results.

### **H.5.2 Non-Residential Audit Activities**

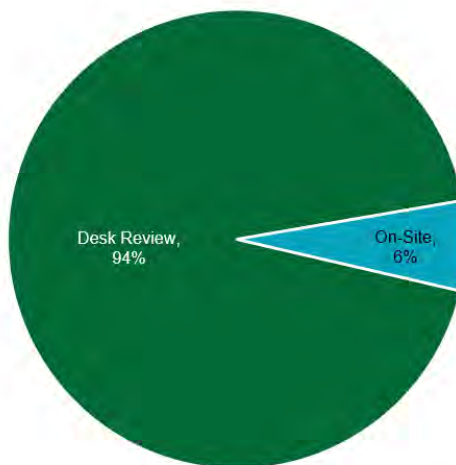
[Figure 85](#) provides a summary of the evaluation activities and M&V approaches utilized by West Penn Power's evaluation contractor, ADM, in their PY14 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY14, West Penn Power's evaluation contractor completed site visits to 65 of 94 of evaluated projects, and these projects represented 94% of total evaluated energy savings. IPMVP Options A, B, C, and D were employed for 80% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 20% of the total evaluated savings, including the majority of prescriptive projects and most energy management projects.

Figure 85: Summary of West Penn Power’s C&I Evaluation Activities

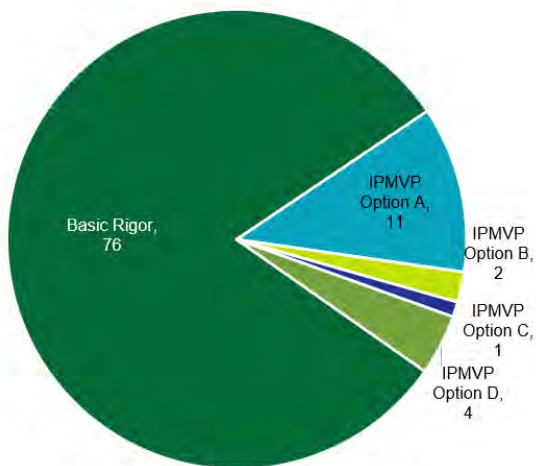
M&V Activity by Project Count



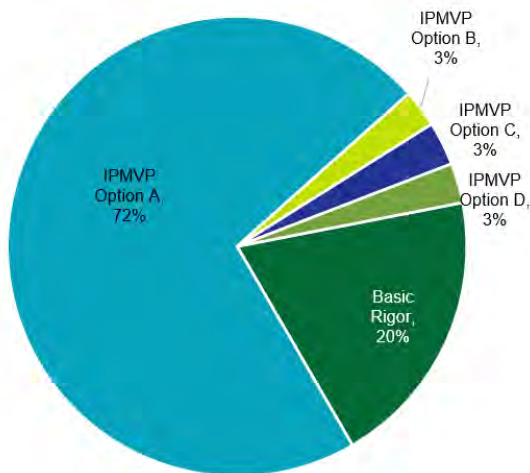
M&V Activity by kWh Contribution



M&V Method by Project Count



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 217](#) provides a summary of the evaluation activities West Penn Power’s evaluation contractor used across strata for all projects by initiative.

**Table 217: Summary of West Penn Power’s PY14 C&I Evaluation Activities by Initiative**

Initiative / Strata	Sample Quantity	RR - Energy	RR - Demand	Desk Review	On-Site Verification
<b>Appliance Recycling</b>		<b>106%</b>	<b>106%</b>	-	-
<b>Custom</b>	<b>15</b>	<b>92%</b>	<b>87%</b>	<b>9</b>	<b>6</b>
Custom – C	1	100%	100%	-	1
Custom – 1	14	88%	84%	9	5
<b>Prescriptive</b>	<b>35</b>	<b>112%</b>	<b>95%</b>	<b>10</b>	<b>25</b>
Downstream Lighting - C	5	101%	101%	-	5
Downstream Lighting - 2	7	90%	81%	-	7
Downstream Lighting - 1	9	80%	87%	3	6
Downstream Non-Lighting	6	20%	29%	2	4
Midstream Lighting	7	184%	94%	4	3
Midstream Non-Lighting	1	42%	42%	1	-
<b>EMNC</b>	<b>27</b>	<b>89%</b>	<b>89%</b>	<b>10</b>	<b>17</b>
EMNC	3	96%	86%	1	2
Building Tune-Ups	24	89%	89%	9	15
<b>Multifamily</b>	<b>17</b>	<b>82%</b>	<b>60%</b>	-	<b>17</b>
<b>TOTAL</b>	<b>94</b>			<b>29</b>	<b>65</b>

The SWE’s review of verified savings for non-residential programs found that, overall, the verified energy 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. However, all initiatives underestimate demand savings, most prevalent in the Multifamily initiative. 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 PY14, 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.

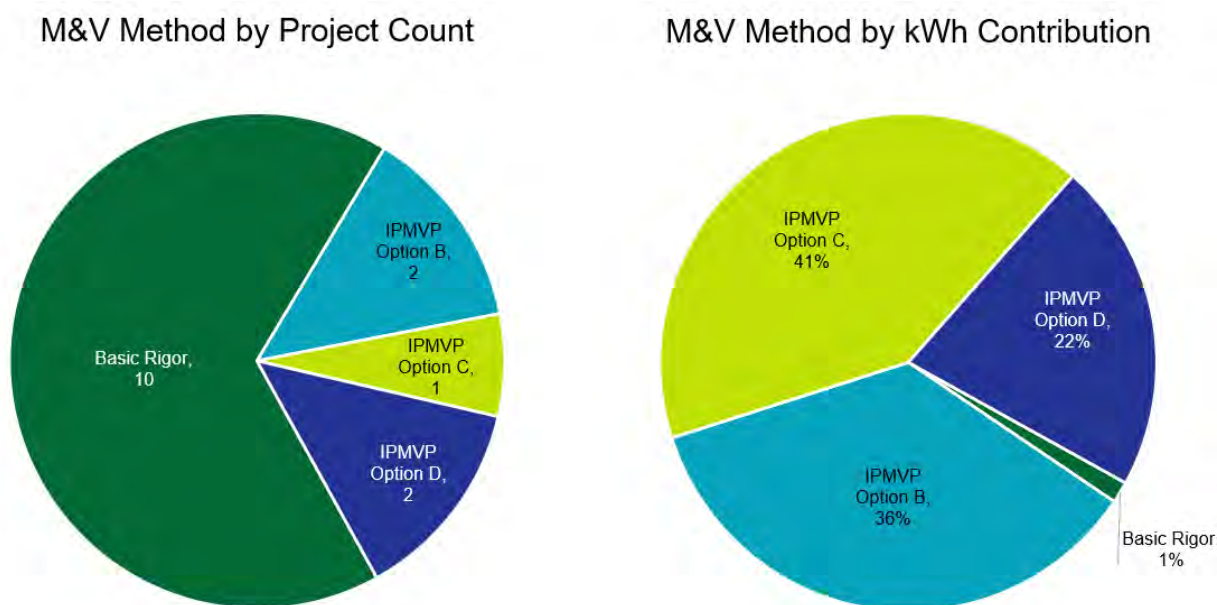
#### H.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews and/or IPMVP evaluation methods for all sampled projects. No site visits were conducted for PY14 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 one-third of the projects, accounting for 99% of all evaluated custom project savings, as shown in [Figure 86](#).

**Figure 86: Summary of West Penn Power’s C&I Custom Program M&V Methods**



### H.5.2.3 Prescriptive Initiative

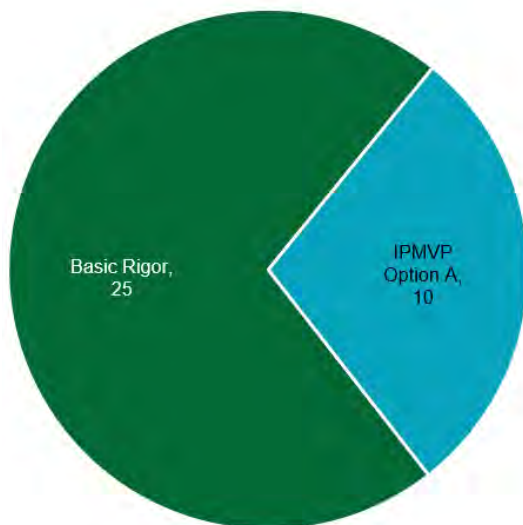
Evaluation activities for this initiative include site visits for most projects and primary data collection of lighting hours of use for medium and high savings projects. TRM deemed hours of operation were applied in basic rigor desk reviews for low savings projects. All sampled projects undergo a full 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.

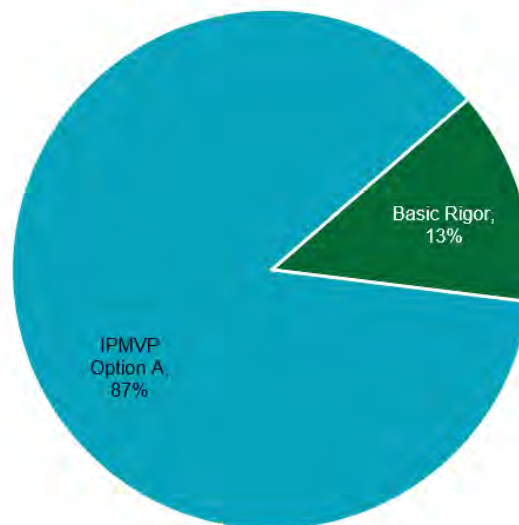
IPMVP Option A was used for 87% of evaluated project savings in this initiative with the remaining projects using Basic Rigor, as seen in [Figure 87](#) below.

**Figure 87: Summary of West Penn Power's C&I Prescriptive Program M&V Methods**

M&V Method by Project Count



M&V Method by kWh Contribution



#### 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 PY14: Building Tune-Up and New Construction.

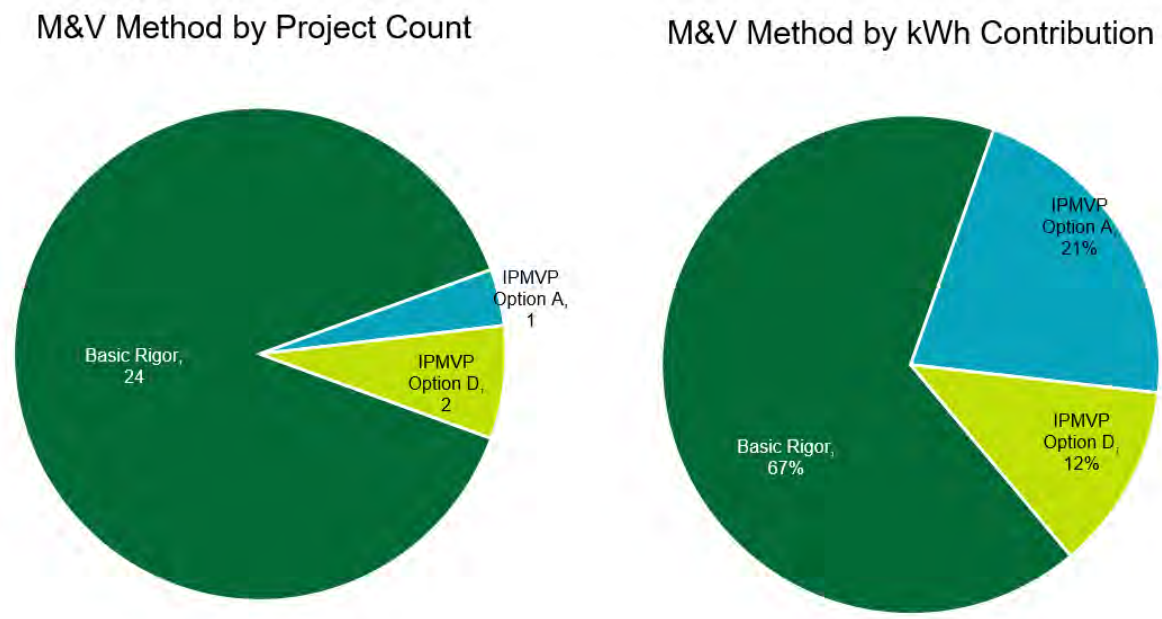
Evaluation activities for this initiative include desk reviews and on-site inspections. The evaluator opted to conduct on-site inspections for most sampled projects in the Building Tune-Up strata, considering the lack of implementation history. Basic rigor M&V methods were applied to these projects, 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 67% of evaluated project savings in this initiative with the remaining projects using IPMVP Options A and D, as seen in [Figure 88](#) below.



**Figure 88: 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 one of the samples. 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 PY14 included review of 14 projects, encompassing the following activities:

- 5 Field and Analysis Engineers were observed
- 6 Lighting, 6 HVAC, 1 Refrigeration, and 1 Custom Measure Observed
- 3 In-Person Ride-alongs conducted
- 39% of Verified Energy Savings reviewed
- 35% of Verified Demand Savings reviewed

Table 218 provides an overview of the SWE milestones for the verified savings audit review of evaluated West Penn Power’s projects.

**Table 218: West Penn Power Verified Savings Audit Review Milestones**

Projects Audited	Energy Savings Audited (kWh)	Energy Attainment Percentage	Demand Savings Audited (kW)	Demand Attainment Percentage
14	5,375,905	100%	622.1	100%



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 attainment percentages of West Penn Power's reviewed projects were 100% for both energy and demand.

## H.6 NTG

Table 219 lists West Penn Power's PY14 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 PY14 Annual Report program specific sections and appendices.<sup>78</sup>

**Table 219: Summary of West Penn Power's PY14 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	0.72
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	0.51
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	0.49
C&I Solutions for Business Programs - Small and Large	EMNC	1.1
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 completed NTG research for the Residential Downstream Appliances component of the EE Products Program and the New Homes component of the EE Homes

<sup>78</sup> The FirstEnergy PY14 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.

Program (). ADM utilized participant surveys to estimate free-ridership, spillover and NTG for downstream appliances and building interviews for New Homes. ADM utilized question batteries that were consistent with the recommendations in the Phase IV Evaluation Framework NTG methodologies and applied the common NTG calculation.

All other residential programs utilized NTG values estimated, and SWE verified during PY13 or Phase III except for 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 220: Summary of West Penn Power’s PY14 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	Builder & Rater Interviews	20	28%	0%	0.72
Multifamily	N/A	N/A	20%	0%	0.80
Online Audits	N/A	N/A	0%	0%	1.0
Appliance Recycling	N/A	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	Self-Report Survey	114	50%	1%	0.51
Midstream Appliances	N/A	N/A	49%	0%	0.51

**H.6.2 C&I Energy Efficiency Programs**

ADM conducted NTG research for the prescriptive, custom, and EMNC programs in PY14. They applied NTG values from Phase III NTG evaluations that have been verified by SWE during Phase III. ADM applied the residential Appliance Recycling PY10 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. The NTG for the Prescriptive program is a savings-weighted average of the downstream and midstream lighting and non-lighting stratum.

**Table 221: Summary of West Penn Power's PY14 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 222 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for West Penn Power's PY14 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 PY14 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.

Both the Portfolio gross and net TRC ratios increased from PY13, with the largest increase occurring in both C&I Energy Solutions for Business - Small and Large programs.

**Table 222: Summary of West Penn Power's PY14 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
Residential - Energy Efficient Homes	\$11,609	\$5,473	2.12	\$12,232	\$4,982	2.46
Residential - Energy Efficient Products	\$4,809	\$6,562	0.73	\$2,679	\$4,187	0.64
Low Income Energy Efficiency	\$3,310	\$3,092	1.07	\$3,310	\$3,092	1.07
C&I Energy Solutions for Business - Small	\$16,843	\$9,652	1.74	\$12,712	\$7,963	1.60
C&I Energy Solutions for Business - Large	\$10,286	\$4,192	2.45	\$6,817	\$3,106	2.19
<b>Portfolio Total</b>	<b>\$46,857</b>	<b>\$28,970</b>	<b>1.62</b>	<b>\$37,750</b>	<b>\$23,330</b>	<b>1.62</b>

Four of West Penn Power's five EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. All four 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.

### 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.

- 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.
- 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 PY14 evaluation. The SWE spot checked the incremental measure costs used in the TRC model and found them to be generally reasonable and consistent.
- 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.
- 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.

## 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. Details on survey targets and completes for West Penn Power are provided in the subsections below. [Appendix E.8](#) of the SWE's PY14 Final Annual Report, described previously for Met-Ed, applies to all four FirstEnergy utilities, including West Penn Power.

## **H.8.1 Residential Programs**

### **H.8.1.1 Energy Efficient Products Program – Appliance Rebate**

The PY14 evaluation team targeted 70 participant surveys with West Penn Power customers; the target was exceeded with 72 completed surveys.

### **H.8.1.2 Energy Efficient Products Homes – Behavioral Home Energy Report**

The PY14 evaluation team targeted 35 participant surveys with West Penn Power customers; the target was exceeded with 101 completed surveys.

### **H.8.1.3 Energy Efficient Products Homes – Online Audits**

The PY14 evaluation team targeted 120 participant surveys with West Penn Power customers; the target was not met with 83 completed surveys.

### **H.8.1.4 Energy Efficient Products Homes – New Homes**

There were not any surveys as part of the PY14 evaluation.

## **H.8.2 Residential Low-Income Program**

### **H.8.2.1 Weatherization (Direct Install)**

The PY14 evaluation team targeted 59 participant surveys with West Penn Power customers; the target was met with 76 completed surveys.

### **H.8.2.2 Appliance Rebate**

The PY14 evaluation team targeted 70 participant surveys with West Penn Power customers; the target was exceeded with 75 completed surveys.

### **H.8.2.3 Behavioral Home Energy Report**

The PY14 evaluation team targeted 35 participant surveys with West Penn Power customers; the target was exceeded with 75 completed surveys.

### **H.8.2.4 Multifamily (Residential)**

The PY14 evaluation team targeted 35 participant surveys with West Penn Power customers; the target was nearly met with 31 completed surveys.

### **H.8.2.5 New Homes**

There were not any surveys as part of the PY14 evaluation.

### **H.8.3 Commercial & Industrial Programs**

#### **H.8.3.1 C&I Energy Solutions for Business (Small)**

The PY14 evaluation team targeted 168 participant surveys with West Penn Power customers; the target was nearly met with 156 completed surveys.

#### **H.8.3.2 C&I Energy Solutions for Business (Large)**

The PY14 evaluation team targeted 22 participant surveys with West Penn Power customers; the target was not met with 11 completed surveys.



## 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 223: PA Statewide Energy Efficiency Budgets and Expenditures**

EDC	Actual PY14 Expenditures	Approved Budget for PY14
PECO	\$82,299	\$84,860
PPL	\$51,802	\$62,715
Duquesne Light	\$27,647	\$20,324
FE: Met-Ed	\$16,791	\$25,106
FE: Penelec	\$15,913	\$23,209
FE: Penn Power	\$5,550	\$6,716
FE: West Penn Power	\$18,468	\$23,585
<b>Statewide</b>	<b>\$218,469</b>	<b>\$246,515</b>

**Table 224: PA Statewide Gross Verified Annual and Lifetime MWh Savings**

EDC	Gross Verified Annual Savings (PY14)	Gross Verified Lifetime Savings (PY14)
PECO	301,855	2,786,886
PPL	256,971	3,646,387
Duquesne Light	122,634	1,683,428
FE: Met-Ed	85,756	1,100,843
FE: Penelec	72,345	893,347
FE: Penn Power	18,284	216,757
FE: West Penn Power	80,171	1,023,157
<b>Statewide</b>	<b>938,016</b>	<b>11,350,805</b>

**Table 225: PA Statewide Net Verified Annual and Lifetime MWh Savings**

<b>EDC</b>	<b>Net Verified Annual Savings (PY14)</b>	<b>Net Verified Lifetime Savings (PY14)</b>
PECO	225,360	2,018,116
PPL	176,348	2,465,203
Duquesne Light	81,508	1,084,696
FE: Met-Ed	58,386	740,904
FE: Penelec	53,752	643,595
FE: Penn Power	14,670	175,553
FE: West Penn Power	63,022	790,302
<b>Statewide</b>	<b>673,046</b>	<b>7,918,369</b>

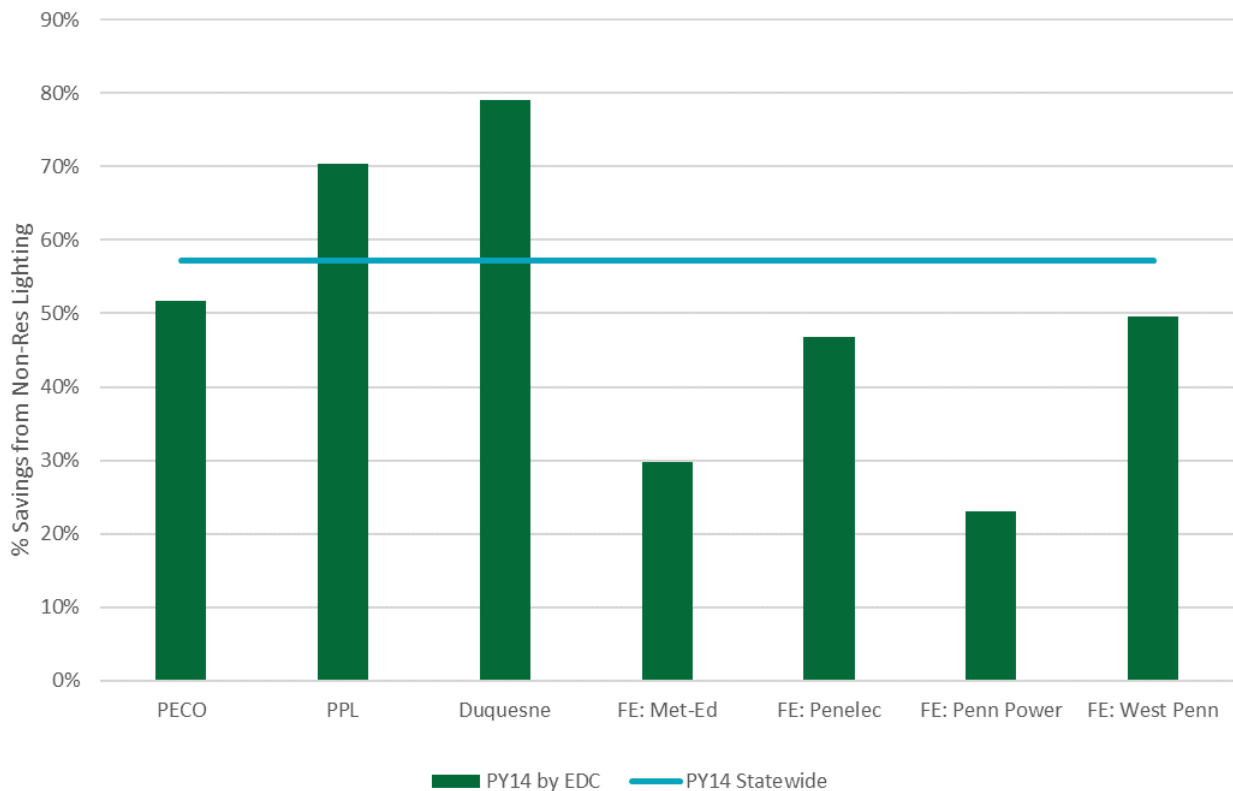
## Appendix J Top Savings Programs for PY14

### J.1 NON-RESIDENTIAL LIGHTING

Non-residential lighting improvements accounted for 57% of statewide PY14 energy savings. These projects largely utilized TRM provided measure methodologies, with additional shares of savings being achieved through midstream lighting programs and custom measure protocols. Light emitting diode (LED) technologies have continued to increase in market share in the last several years, now accounting for a significant majority of all PY14 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 89](#), Non-Residential lighting contributed more than 70% of PY14 energy savings for PPL and Duquesne Light. For PECO and the FirstEnergy companies, the overall share of savings was considerably lower, yet still ranging from 23-52%.

**Figure 89: EDC Non-Residential Lighting Savings Shares**



#### J.2.3.1 Downstream Lighting Programs

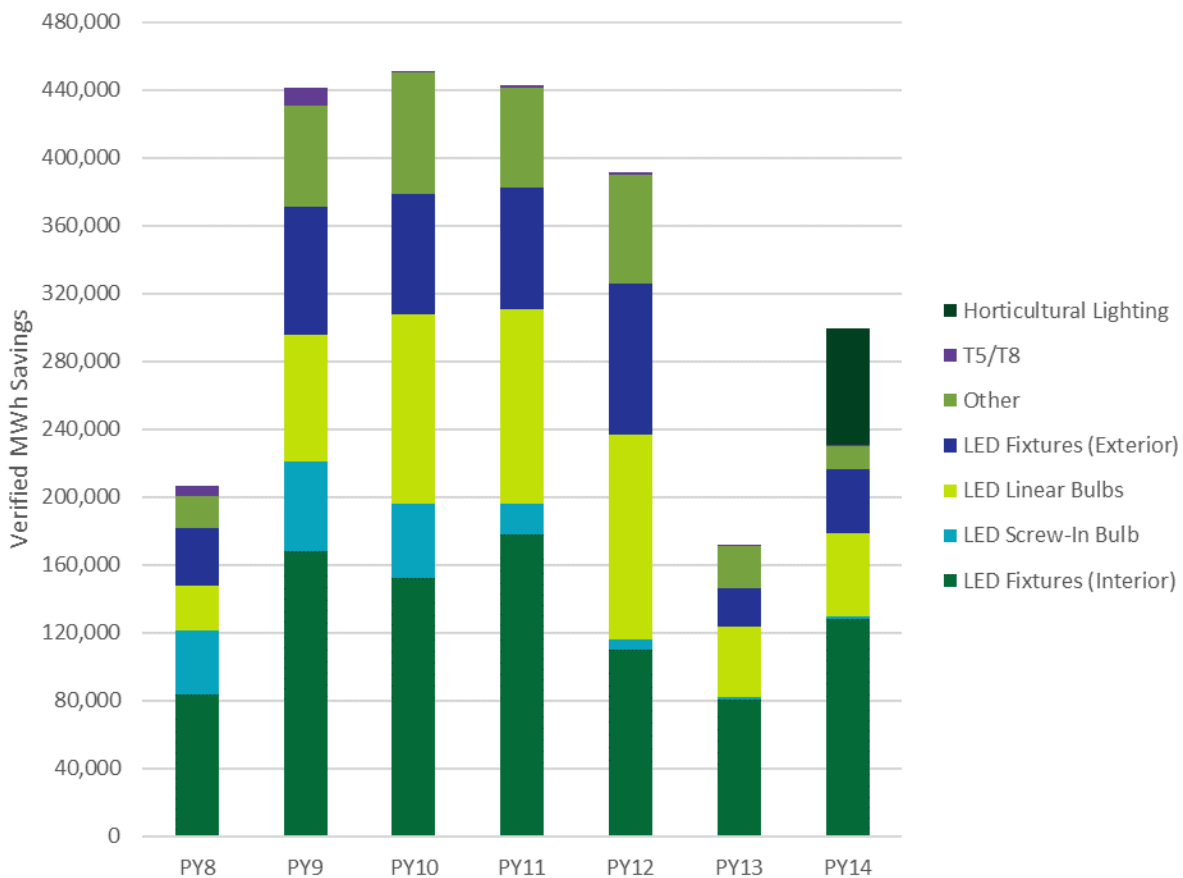
Downstream offerings continue to dominate the lighting programs across the EDCs and represent the single largest program offering, accounting for 32% of statewide PY14 verified gross energy savings. Downstream programs provide direct incentives for business customers who upgrade

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. As a recent addition, horticultural lighting opportunities are now a part of PY14.

Figure 90 shows verified energy savings for Program Years 8 through 14 for downstream lighting offerings. The level of achieved energy savings in PY14 increased relative to the savings achieved in PY13 but is still lower compared to prior years. LED screw-in bulbs shares have reduced each year since PY9 and were only a negligible share of savings in PY14. Savings from interior LED fixtures were the largest share of PY14 downstream lighting savings. Overall, LED technologies accounted for nearly 100% of PY14 verified non-residential downstream lighting energy savings.

**Figure 90: PY8 – PY14 Downstream Lighting Technologies**



### J.2.3.2 Midstream Lighting Programs

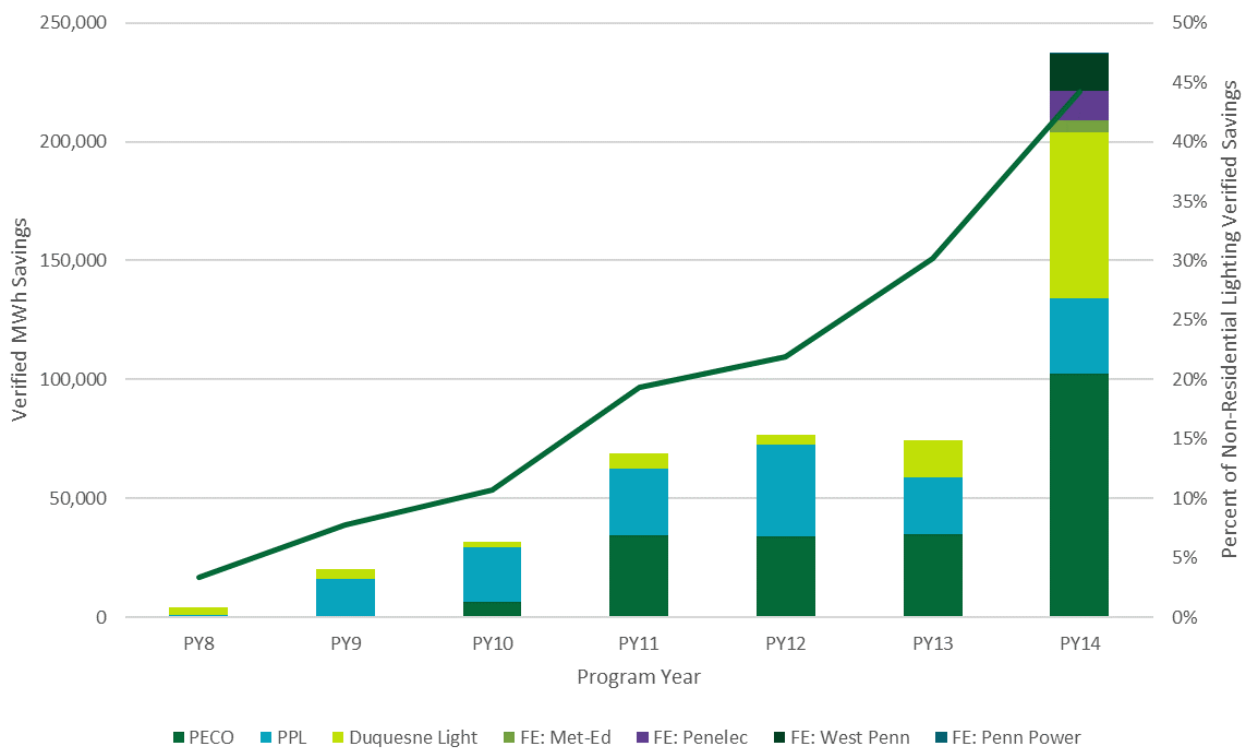
All seven EDCs offered a midstream lighting program in PY14. Energy savings contribution results are presented in [Table 226](#). The combined savings from these programs are about 44% of all verified non-residential lighting savings in PY14.

**Table 226: Midstream Lighting Verified Energy Savings by EDC**

EDC	Total Non-Residential Lighting (MWh.yr)	Midstream Lighting (MWh.yr)	% of Total Non-Residential Lighting
Duquesne Light	96,876	69,448	72%
PECO	156,225	102,231	65%
FE: West Penn Power	39,756	15,446	39%
FE: Penelec	33,907	12,232	36%
FE: Met-Ed	25,493	5,327	21%
FE: Penn Power	4,215	868	21%
PPL	180,699	32,071	18%
<b>TOTAL</b>	<b>537,171</b>	<b>237,622</b>	<b>44%</b>

[Figure 91](#) illustrates how the midstream components of non-residential lighting have expanded since PY8. PECO's program nearly tripled in verified savings from PY13 to PY14, while Duquesne Light's midstream program expanded fourfold from PY13 to PY14. Both PECO and Duquesne Light's midstream offerings now contribute to approximately two-thirds of non-residential lighting savings. PPL's midstream program likewise increased in total verified energy savings in PY14, making up 18% of verified non-residential lighting savings. The FirstEnergy companies' midstream offering was new in PY13 with savings now being reported in PY14. One-third of the FirstEnergy companies' non-residential lighting savings are from midstream programs. In general, a significant increase in midstream non-residential lighting occurred across all seven EDCs in PY14.

Figure 91: PY8 – PY14 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. However, the quantity of savings from residential lighting began a downward trend in PY12 with the advent of the 45 lumens/Watt in the 2021 TRM.<sup>79</sup> In PY14 residential lighting accounted for 9% of statewide savings.

**Figure 92: PY8-PY14 Verified MWh from Residential Lighting**



Table 227 displays PY14 energy savings from residential lighting by EDC. PPL and Duquesne Light derived 4% of energy savings or less from residential lighting, while the other EDCs derived from 9% to 16% of energy savings from residential lighting.

<sup>79</sup> 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.

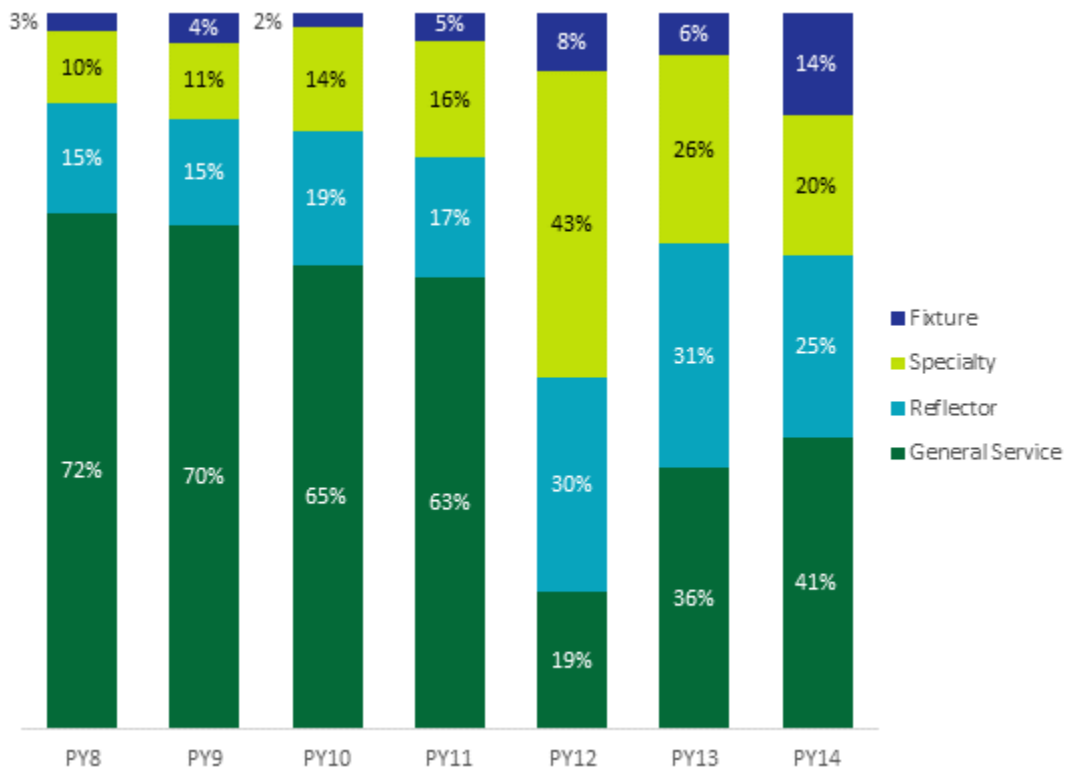


**Table 227: PY14 Energy Savings, Upstream Residential Lighting, Non-Upstream Residential Lighting, and All Residential Lighting**

EDC	PY14 Verified Gross (MWh/yr)	Upstream Res Lighting (MWh/yr)	Non-Upstream Res Lighting (MWh/yr)	All Res Lighting (MWh/yr)	Percent of PY14 MWh from Res Lighting
PECO	301,855	23,386	16,252	39,637	13%
PPL	256,971	4,226	6,533	10,759	4%
Duquesne Light	122,634	2,125	1,993	4,118	3%
FE: Met-Ed	85,756	0	8,103	8,103	9%
FE: Penelec	72,345	0	9,443	9,443	13%
FE: Penn Power	18,284	0	2,870	2,870	16%
FE: West Penn Power	80,171	0	9,568	9,568	12%
<b>Total</b>	<b>938,016</b>	<b>29,737</b>	<b>54,761</b>	<b>84,498</b>	<b>9%</b>

Figure 93 displays the distribution of upstream lighting products by type from PY8 to PY14. The proportion of general service lamps dropped in PY12 when the baseline was reduced to 45 lumens per watt, then rebounded somewhat once the baseline for all other types was reduced to 45 lumens per watt.

**Figure 93: PY8-PY14 Upstream Lighting Sales by Product Type**



### J.3 HERs

Almost 859,000 Pennsylvania households received home energy reports in PY14. As [Table 228](#) shows, this represents 17% of residential customers for the EDCs evaluated under Act 129.<sup>80</sup> Participation in HER programs for PY14 decreased slightly relative PY13, but the verified MWh savings from HER programs increased. PPL has not implemented an HER program to date in Phase IV.

**Table 228: PY14 Statewide HER Program Participation**

EDC	Residential Premises	PY14 HER Recipients	Percent of Homes Receiving HERs
PECO	1,522,000	435,000	29%
PPL	1,284,000	-	-
Duquesne Light	553,000	144,000	26%
FE: Met-Ed	515,000	77,000	15%
FE: Penelec	498,000	66,000	13%
FE: Penn Power	149,000	23,000	15%
FE: West Penn Power	632,000	114,000	18%
<b>Total</b>	<b>5,153,000</b>	<b>859,000</b>	<b>17%</b>

While HERs generate smaller savings per participant than other energy efficiency programs, they are relatively low-cost interventions and affect many customers. HERs can 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 228](#) are customers in treatment groups only.

[Table 229](#) shows evaluated PY14 savings per HER recipient as well as participants’ baseline annual electric usage (with HER savings added back in) and percentage reductions. The average energy statewide savings in PY14 were 64 kWh per home (0.7%), up from 40 kWh per recipient in PY13.

<sup>80</sup> Data on residential customers includes bundled and delivery service in 2022 FERC Form 861 filings by the listed PA EDCs.

Table 229: Average HER Impacts per Participant

EDC	PY14 kWh Usage (HER Recipients)	Average PY14 kWh Savings per Recipient	Average Percentage Reduction
PECO	8,956	80	0.9%
PPL	N/A	N/A	N/A
Duquesne Light	7,404	49	0.7%
FE: Met-Ed	9,527	41	0.4%
FE: Penelec	10,047	79	0.8%
FE: Penn Power	9,524	70	0.7%
FE: West Penn Power	9,299	24	0.3%
<b>Combined</b>	<b>8,891</b>	<b>64</b>	<b>0.7%</b>

The average savings per HER recipient in PY14 shown here are incremental savings rather than the observed savings at the meter. For cohorts older than two years, the Phase IV HER accounting framework separates persistent impacts from new savings generated by additional continued 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 were considered first-year incremental savings. Pennsylvania HER participants are thus saving more energy than the amounts shown in [Table 229](#), but a portion of the savings are not attributed to PY14.

### J.3.1 HER Contribution to LI Targets

In PY14, 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 230](#) shows the PY14 verified gross LI savings for each EDC and the percentage of total LI savings coming from HER programs. Penn Power achieved the largest share of its LI savings from HERs (28.9%) and PECO had the smallest share (3.8%) other than PPL, who did not implement an HER program.

Table 230: HER Contribution Toward Low Income Targets

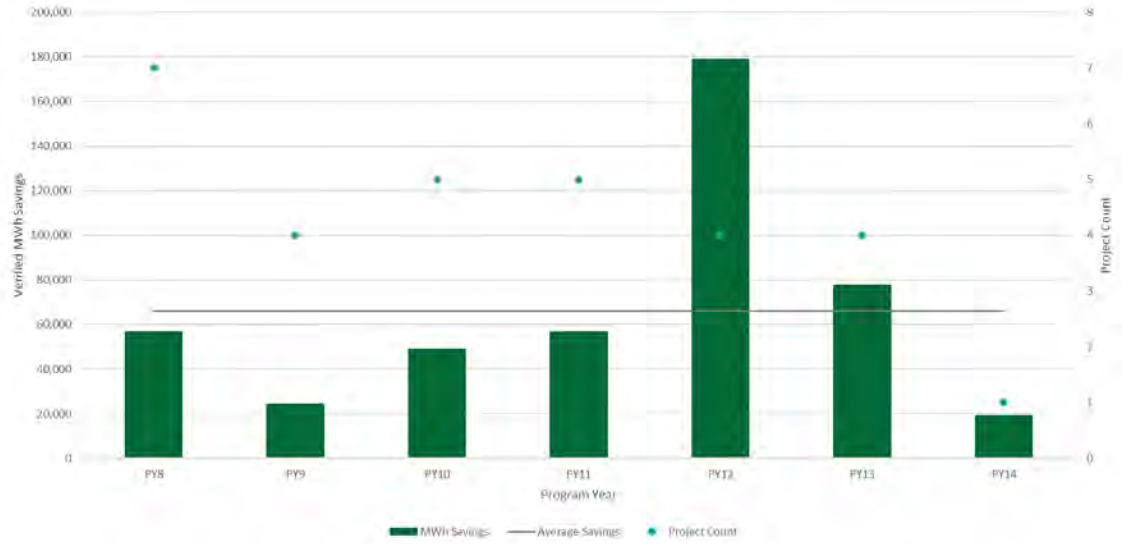
EDC	PYVTD LI MWh	PYVTD LI MWh from HERs	Percentage of PY14 LI Savings from HERs
PECO	28,847	1,108	3.8%
PPL	12,872	0	0.0%
Duquesne Light	3,542	730	20.6%
FE: Met-Ed	4,462	269	6.0%
FE: Penelec	5,141	556	10.8%
FE: Penn Power	1,160	335	28.9%
FE: West Penn Power	6,940	769	11.1%
<b>Total</b>	<b>62,966</b>	<b>3,767</b>	<b>6.0%</b>

#### 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 2018, designed to advance the deployment of CHP technology throughout Pennsylvania. This statement sought out to encourage EDCs to make CHP a part of their energy efficiency and resiliency plans and design interconnection processes and rates for owners and operators of CHP facilities. The one CHP project completed by Met-Ed in PY14 accounted for just 2% of the statewide gross verified savings.

Figure 94 shows the energy savings contributions from Act 129 CHP projects over the past seven years. The average CHP contribution is 66,063 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 one CHP project reported in PY14 shows a notable decrease in projects from the previous four years. PY14 verified savings for CHP projects were just 19,144 MWh, a significant reduction from all prior program years. Despite the low participation in PY14, PPL expects two additional CHP projects to come online in Phase IV, further contributing to Phase IV savings.

Figure 94: PY8 – PY14 CHP Savings



In PY14, just one CHP project was completed by Met-Ed as shown in [Table 231](#).

Table 231: PY14 CHP Verified Energy Savings and Realization Rate by EDC

EDC	Qty	Verified Savings (MWh.yr)	Realization Rate
Met-Ed	1	19,144	100%