SWE Annual Report

Act 129 Phase III and Program Year 12

Version 1.1

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SUBMITTED TO:
Pennsylvania Public Utility Commission

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Pennsylvania Act 129 Phase III Results Summary

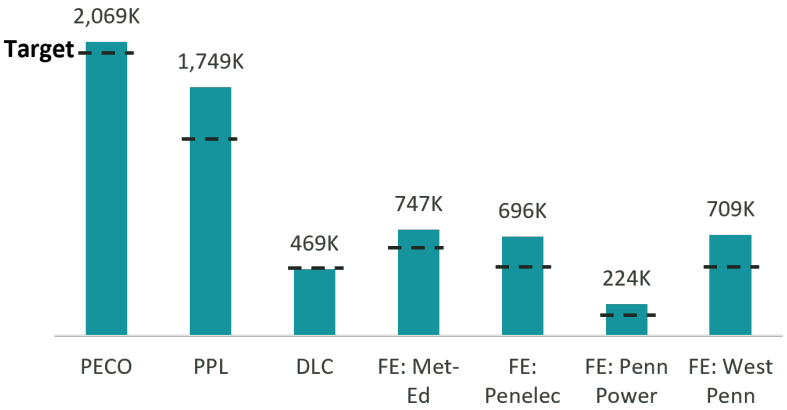
Pennsylvania enacted Act 129 in 2008. Act 129 requires Pennsylvania's seven major electric distribution companies (EDCs) to achieve targeted levels of energy consumption and demand savings annually and over phases. Phase III of Act 129 ran from June 1, 2016 to May 31, 2021 and comprised years eight through 12 of Act 129 implementation. **Overall, EDCs complied with Act 129 Phase III requirements.**

Phase III Electric Consumption Savings

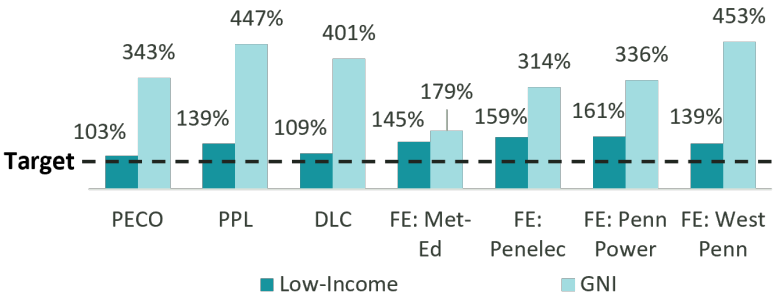
All EDCs complied with their portfolio Phase III energy savings targets, resulting in over **6.6 million MWh saved in Phase III.** That's enough electricity to power more than 630,000 homes for a year![1] Energy Efficiency programs also resulted in 904.5 MW savings (not pictured).

None of the EDCs needed Phase II carryover to meet their Phase III overall savings target (right). Every EDC complied with low-income and Government, Non-profit, Institutional (GNI) targets with most EDCs far exceeding their GNI target (bottom left). Over the whole phase, savings were split relatively evenly between residential and non-residential sectors (bottom right). Not shown is a trend of a reduced residential share of savings: at the start of the phase, residential savings comprised about two thirds of savings, while at the end of the phase, residential savings comprised one third of the savings. This reduction is due to transformation in the LED lighting market.

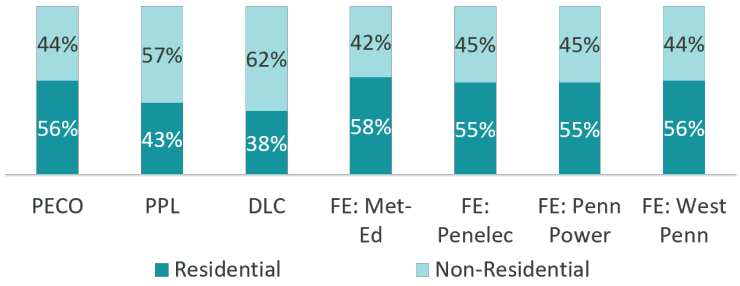
Total Verified Gross Savings Without Carryover (MWh)



Carve-Out Verified Gross MWh Savings With Carryover (Percent of Target)



Sector Verified Gross Savings Without Carryover (MWh)

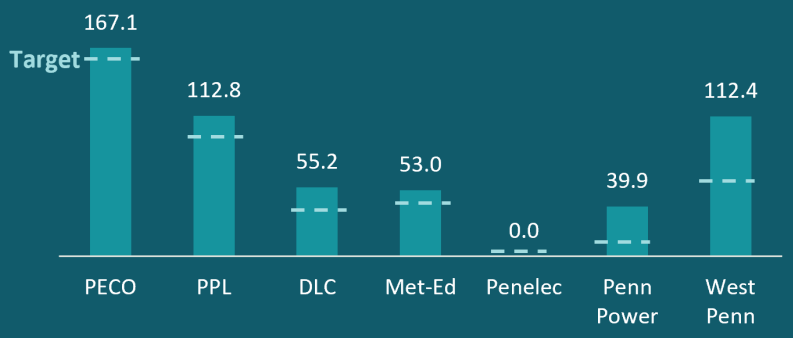


[1] Assumes average annual Pennsylvanian residential customer electric consumption in 2020 of 10,151 kWh from eia.gov.

Phase III Electric Demand Savings

Every EDC complied with the primary demand response target which required minimum average performance across all events in program years nine, ten, and eleven.

All EDCs exceeded their target. Penelec did not have a target. This target refers only to dispatchable demand response programs and not MW savings from energy efficiency programs.



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Phase III Costs and Benefits

The table on the right shows **every EDC had cost effective portfolios** of energy efficiency offerings. Overall net-benefits were worth $750.5 million to Pennsylvanians.[2] This translates to $1.40 in benefits for every $1.00 spent.

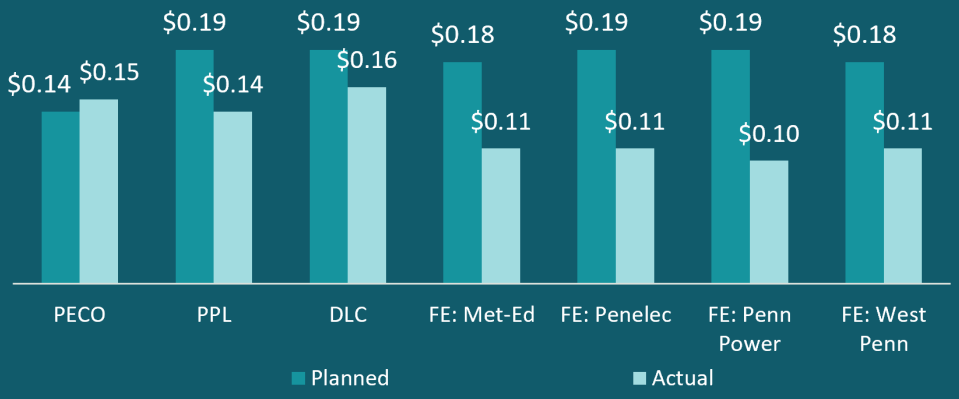
Phase III Overall TRC Results

EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio
PECO	$701,664	$643,362	1.09
PPL	$873,601	$538,436	1.62
Duquesne	$228,490	$102,150	2.24
FE: Met-Ed	$259,133	$171,815	1.51
FE: Penelec	$229,776	$170,012	1.35
FE: Penn Power	$81,581	$55,241	1.48
FE: West Penn	$247,837	$190,546	1.30
Statewide*	$2,622,084	$1,871,562	1.40

*Rows may not sum to statewide totals due to rounding

Overall, total actual EDC **expenditures were 14% less than planned.** The figure to the right shows planned acquisition costs compared to actual for each EDC. The FirstEnergy companies delivered energy savings at approximately 42% of the cost estimated in their EE&C plans.

Planned vs. Actual Phase III Energy-Efficiency Acquisition Cost

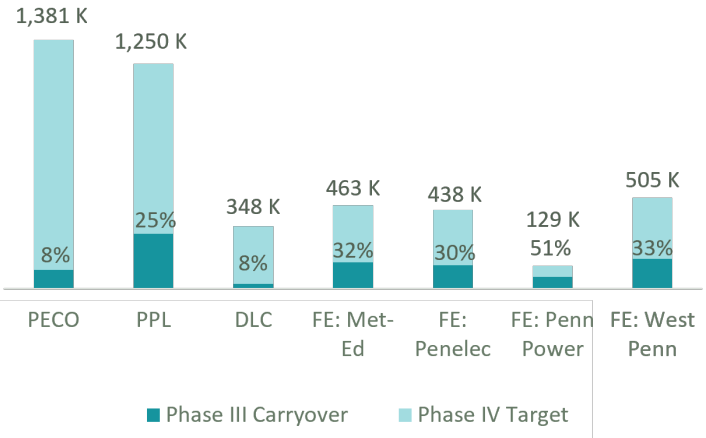


[2] Using 2016 dollars.

Carryover Savings for Phase IV

The implementation order for Phase IV allows EDCs to carryover savings generated in Phase III in excess of their Phase III target without considering any carryover from Phase II. The figures below show the carryover each EDC earned in Phase III as a share of their Phase IV overall target (left) and low-income target (right). There are no GNI targets in Phase IV.

Total Phase III Carryover as a Share of Phase IV Target (MWh)



Low-Income Phase III Carryover as a Share of Phase IV Target (MWh)

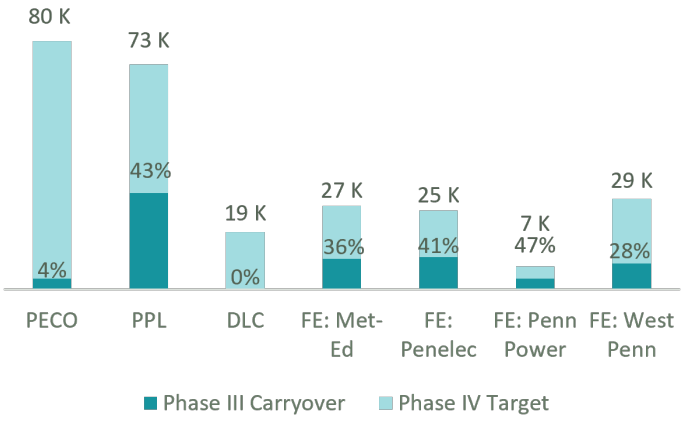


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Table of Contents

Figures

Tables

Acknowledgments

The Act 129 Phase III Statewide Evaluation (SWE) Team thanks the Energy Association of Pennsylvania, Pennsylvania's investor-owned electric distribution companies (EDCs), and the EDCs' Act 129 program staff and evaluation contractors for their timely provision of data and information for this report, and for timely response to questions during the SWE's Act 129 auditing and reporting. The SWE recognizes the many hours that the EDCs' staff and contractors have devoted to the design and implementation of the EDCs' Phase III Act 129 energy-efficiency and demand reduction programs, and to monitoring the progress of these programs.

The Phase III 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 III, including updating the SWE Evaluation Framework for Phase III 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 III Program Year 12 and Phase III Final Report presents the findings, conclusions, and recommendations of the Phase III SWE only and, as such, is not necessarily agreed to by the EDCs or the Commission. The Commission, while not adopting the findings, conclusions, and recommendations contained in this annual report, may consider and adopt some or all of them in appropriate proceedings, such as future updates to the Pennsylvania TRM, Total Resource Cost Test Order, and individual EDC energy-efficiency and conservation plan revision proceedings.

Background Information

ACRONYMS

AEO	Annual Energy Outlook
ASHP	Air Source Heat Pump
ATI	Appliance Turn-In
BDR	Behavioral Demand Response
C&I	Commercial and Industrial
CAC	Central Air Conditioner
CACS	Central Air Conditioner Switch
CBL	Customer Baseline Load
CEP	Commercial Efficiency Program
CEEP	Community Education Energy-Efficiency Program
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CSP	Conservation Service Provider or Curtailment Service Provider
CV	Coefficient of Variation
DLC	Direct Load Control
DDR	Dispatchable Demand Response
DEER	Database for Energy-Efficiency Resources
DR	Demand Response
EAP	Energy Association of Pennsylvania
EDC	Electric Distribution Company
EE&C	Energy Efficiency and Conservation
EEPDR	Energy Efficiency and Peak Demand Reduction
EF	Energy Factor
EFLH	Equivalent Full Load Hours
ELRP	Emergency Load Response Program
EM&V	Evaluation, Measurement, and Verification
ER	Early Replacement
EUL	Effective Useful Life
EXP	Express Efficiency Program
5CP	Five Coincident Peak
FE	FirstEnergy
GNI	Government, Non-Profit, Institutional
HER	Home Energy Report
HOU	Hours of Use
HPWH	Heat Pump Water Heater
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IDI	In-Depth Interview
IEF	Integrated Energy Factor
IEP	Industrial Efficiency Program

IMP	Interim Measure Protocol
IPMVP	International Performance Measurement and Verification Protocol
ISR	In-Service Rate
IVR	Interactive Voice Response
kW	Kilowatt
kWh	Kilowatt-Hour
LCL	Large Curtailable Load
LED	Light-Emitting Diode
LI	Low-Income
LIEEP	Low-Income Energy-Efficiency Program
LIURP	Low-Income Usage Reduction Program
LLF	Line Loss Factor
M&V	Measurement and Verification
MFHR	Multifamily Housing Retrofit
ML	Midstream Lighting
MPS	Market Potential Study
MSRP	Manufacturer Suggested Retail Price
MW	Megawatt
MWh	Megawatt-Hour
NPV	Net Present Value
NTG	Net-to-Gross
NTGR	Net-to-Gross Ratio
O&M	Operation and Maintenance
P3TD	Phase III to Date
PAPP	Public Agency Partnership Program
PA PUC	Pennsylvania Public Utility Commission
PCT	Programmable Communicating Thermostat
PUC	Public Utility Commission
PY	Program Year: e.g., PY8, from June 1, 2016 to May 31, 2017
PYRTD	Program Year Reported to Date
PYVTD	Program Year Verified to Date
RARP	Residential Appliance Recycling Program
RCT	Randomized Control Trial
REEP	Residential Energy-Efficiency Program
ROB	Replace on Burnout
RRMSE	Relative Root Mean Square Error
RTD	Phase III to Date Reported Gross Savings
SCDI	Small Commercial Direct Install Program
SO	Spillover
RTO	Regional Transmission Organization
SWE	Statewide Evaluator
TRC	Total Resource Cost
TRM	Technical Reference Manual
VTD	Phase III to Date Verified Gross Savings
WACC	Weighted Average Cost of Capital

WHRP	Whole House Retrofit Program
WRAP	Weatherization Relief Assistance
WSA	Weather Sensitive Adjustment

TYPES OF SAVINGS

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

Net Savings: The total change in energy consumption and/or peak demand 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 non-participant spillover (SO), and other causes of changes in energy consumption or demand not directly attributable to the EE&C program.

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

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

Lifetime Savings: Energy and demand savings expressed in terms of the total expected savings over the useful life of the measure. Typically calculated by multiplying the annual savings of a measure by its effective useful life (EUL). 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. PYTD values for energy efficiency will always be reported as gross savings in a semi-annual or preliminary annual report.

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

Phase III to Date (P3TD): The energy and peak demand savings achieved by an EE&C program or portfolio within Phase III of Act 129. Reported in several permutations, described below.

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

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

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

Executive Summary

Program Year 12 (PY12), June 1, 2020 to May 31, 2021, is the fifth and final year of Phase III of Pennsylvania's Act 129 Energy-Efficiency and Conservation (EE&C) program. Over the five-year phase, the seven Electric Distribution Companies (EDCs) subject to Act 129 have a cumulative incremental annual energy savings goal of 5.7 million MWh/year. Phase III goals were established on an incremental annual basis, meaning that progress towards goals is assessed by summing the *annual* energy savings of new measure installations in a program year. The seven EDCs subject to Act 129 were forecast to sell approximately 145 million MWh per year from 2016 to 2021.[1] Act 129 programs are expected to achieve nearly a 4% cumulative reduction in annual electricity use statewide over the five-year phase (or approximately 0.8% per year).

In their PY12 annual reports to the Public Utility Commission (PUC), the seven EDCs claimed a total of 1,255,563 MWh of verified gross energy savings for PY12 (approximately 22% of the statewide Phase III target) and a total of 6,662,298 MWh of verified gross energy savings for Phase III (approximately 117% of the statewide Phase III target). The SWE audit validated most of the savings calculations. Errors were discovered in the verified savings calculations of two of the seven EDCs that led to both increases and decreases in the MWh and MW totals for those EDCs, and a net increase statewide in savings resulting in a revised PY12 gross verified statewide total of 1,222,779 MWh/year (approximately 21% of the statewide Phase III target) and Phase III verified gross savings of 6,663,502 MWh/year (117% of the statewide Phase III target). Minor audit findings were noted for other programs but did not result in changes to the verified savings. The errors were within acceptable limits specified in the Evaluation Framework (less than 1%), but the EDCs are expected to update their processes to correct the issues in Phase IV.[2]

Compliance Summary

To assist with the PUC's review of Phase III compliance, we have prepared the following tables. They compare the final SWE-audited performance totals to the Phase III compliance requirements. While the PUC will make the final determination of compliance, Table 1 and Table 2 report the SWE's assessment of EDC compliance with Phase III energy-efficiency and demand response targets. For completeness, Table 3 reports the SWE's assessment of Phase III EE&C plan requirements.

[1] Energy Efficiency Potential Study for Pennsylvania. February 2015. Figure ES-2. Docket No. M-2014-2424864. http://www.puc.pa.gov/pcdocs/1345079.pdf

[2] The Phase III Evaluation Framework notes that the EDC should correct errors in the EDCs' Final Annual Reports greater than 1% of annual portfolio savings and refile the Final Annual Report, but not refile their reports for errors less than 1% of annual portfolio savings.

Table 1: Energy-Efficiency Targets, Phase III Compliance Checklist

EDC	Portfolio Consumption	GNI Consumption	Low-Income Consumption
PECO	✓	✓	✓
PPL	✓	✓	✓
Duquesne Light	✓	✓	✓
FE: Met-Ed	✓	✓	✓
FE: Penelec	✓	✓	✓
FE: Penn Power	✓	✓	✓
FE: West Penn Power	✓	✓	✓

Table 2: Demand Response Targets, Phase III Compliance Checklist

EDC	Phase III Average Performance	85% of Target During Each Event (PY9-PY11)
PECO	✓	✗
PPL	✓	✓
Duquesne Light	✓	✓
FE: Met-Ed	✓	✓
FE: Penelec	N/A	N/A
FE: Penn Power	✓	✓
FE: West Penn Power	✓	✗

PECO and West Penn Power each missed the 85% event-specific performance requirement one time during Phase III. PECO fell short of its per-event minimum performance level of 136.9 MW for the DR event on July 18, 2019, with gross verified load reduction of 133.7 MW. Outdoor temperatures in the Philadelphia area dropped abruptly that day when a thunderstorm moved through the area and reduced performance of the Residential DR program. West Penn Power showed verified DR performance of 47.7 MW on July 21, 2017, falling short of its 54.4 MW per-event target. For both PECO and West Penn Power, the upper bound of the margin of error around the savings estimate exceeded the 85% target on the event day that triggered the red "X" in Table 2.

Table 3: EE&C Plan Requirements, Phase III Compliance Checklist

EDC	Proportionate Number of Measures	15% of Goal Each Year	TRC > 1.0	Comprehensive Residential and Non-Residential Program	At Least One Energy-Efficiency Program Per Customer Class	Cost of Acquiring DR for PJM participants
PECO	✓	✓	✓	✓	✓	✓
PPL	✓	✓	✓	✓	✓	✓
Duquesne Light	✓	✓	✓	✓	✓	✓
FE: Met-Ed	✓	✓	✓	✓	✓	✓
FE: Penelec	✓	✓	✓	✓	✓	✓
FE: Penn Power	✓	✓	✓	✓	✓	✓
FE: West Penn Power	✓	✓	✓	✓	✓	✓

ACT 129 AND SUMMARY OF PUC ORDERS

Act 129 requires the PUC to establish an energy-efficiency and conservation program with the following characteristics:

- Adopt an "energy-efficiency and conservation program to require electric distribution companies [EDCs] [3] to adopt and implement cost-effective energy-efficiency and conservation plans to reduce energy demand and consumption within the service territory of each EDC in this commonwealth."[4]
- Adopt additional incremental reductions in consumption if the benefits of the EE&C Program exceed its costs.
- Evaluate the costs and benefits of the Act 129 EE&C programs in Pennsylvania by November 30, 2013, and every five years thereafter.
- Ensure that the EE&C Program incorporates "an evaluation process, including a process to monitor and verify data collection, quality assurance, and results of each plan and the program."[5]

Further, the Phase I Implementation Order detailed that the PUC is responsible for "establishing the standards each plan must meet and providing guidance on the procedures to be followed for

[3] This Act 129 requirement does not apply to an EDC with fewer than 100,000 customers.
[4] 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.
[5] 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.

submittal, review, and approval of all aspects of EDC EE&C plans."[6] Based on findings from the Phase II Market Potential Study, dated February 2015, the PUC determined that the benefits of a Phase III Act 129 program would exceed its costs; therefore, the PUC adopted additional required incremental reductions in consumption and peak demand for another EE&C Program term of June 1, 2016 through May 31, 2021 (program years eight, nine, ten, eleven, and twelve). In its Phase III Implementation Order, the PUC established targets for those incremental reductions in electricity consumption for each of the seven EDCs in Pennsylvania; established Demand Response (DR) targets for six of the seven EDCs; 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 EDC EE&C plans for Phase III.[7]

EE&C Program – Phase III Implementation Order

The Commission's Phase III Implementation Order established additional incremental reductions in electricity consumption to be achieved by the end of Phase III by each of the seven EDCs subject to Act 129 and established standards that EDCs' EE&C plans for Phase III had to meet:

1. EDCs must include in their filing an EE&C Plan that obtained at least 3.5% of all consumption reduction requirements from the federal, state, and local governments, including municipalities, school districts, institutions of higher education, and nonprofit entities.
2. Each EDC Phase III EE&C Plan must obtain at least 5.5% of its consumption reduction requirements from programs solely directed at low-income (LI) customers or LI-verified participants in multifamily housing programs. Savings from non-LI programs, such as general residential programs, were not to be counted for compliance. 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 proportionate to each EDC's total LI consumption relative to the total energy usage in the service territory. The SWE has advised that EDCs should consider the definition of a LI measure to include a measure targeted to LI customers and available at no cost to LI customers.
3. EDCs are awarded credit for all new, first-year, incremental savings delivered in each year of the Phase.
4. EDCs were to develop EE&C Plans designed to achieve at least 15% of the target amount in each program year.
5. EDCs were to include at least one comprehensive program for residential customers and at least one comprehensive program for non-residential customers.
6. EDCs determined 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-

[6] See Energy Efficiency and Conservation Program Implementation Order, at Docket No. M-2008-2069887 (entered Jan. 16, 2009) (hereinafter Phase I Implementation Order).
https://www.puc.pa.gov/electric/pdf/Act129/EEC_Implementation_Order.pdf
[7] Pennsylvania Public Utility Commission, Phase III Final Implementation Order. From the Public Meeting of June 11, 2015, at page 4. Docket No. M-2014-2424864, (Phase III Implementation Order).
http://www.puc.pa.gov/pcdocs/1367313.doc

efficiency programs for all customers. However, EDCs' Phase III EE&C Plans had to ensure that the utility offered each customer class at least one energy-efficiency program.

7. Demand response programs were designed to meet the following criteria in PY9 through PY11 (DR programs were voluntary in PY8 and PY12):
    a. The EDCs were to obtain no less than 85% of the target in any one event.
    b. Curtailment events were limited to the months of June through September.
    c. Curtailment events were called for the first six days that a peak hour of PJM's day-ahead forecast for the PJM regional transmission organization (RTO) was greater than 96% of the PJM RTO summer peak demand forecast for the months of June through September for each year of the program.
    d. Each curtailment event lasted four consecutive hours.
    e. Each curtailment occurred during the day's forecasted highest peak hour above 96% of PJM's RTO summer peak demand forecast.
    f. Once six curtailment events were called in a program year, the peak demand reduction program was suspended for that program year.
    g. The reductions attributable to a four-consecutive-hour curtailment event are based on the average MW reduction achieved during each hour of an event.
    h. Compliance is based on the average MW reductions achieved from events called in the last four years of the program.
    i. The EDCs, in their plans, demonstrated that the cost to acquire MWs from customers who participate in PJM's Emergency Load Response Program (ELRP) was no more than half the cost to acquire MWs from customers in the same rate class that were not participating in PJM's ELRP. In addition, EDCs' DR programs were to allow for dual participation in Act 129 and PJM's ELRP; dual-enrolled participants had a 50% discount on Act 129 DR incentives imposed.

Each EDC had a DR target of 0 MW during PY8 to allow for adequate time to enroll participants and ramp up the programs. In response to the COVID-19 pandemic, the PUC modified its Phase III Implementation Order to make PY12 DR programs voluntary.[8]

EDC Cost Recovery for Act 129 EE&C Programs

Pennsylvania Act 129 allows each EDC to recover all prudent and reasonable costs relating to the provision or management of its EE&C Plan but limits such costs to an amount not to exceed two percent of the EDC's total annual revenue as of December 31, 2006, excluding LI Usage Reduction Programs established under 52 Pa. Code § 58. 66 Pa. C.S. § 2806.1(g). The cost-recovery mechanism also ensures that approved measures are financed by the customer class that receives the direct energy and conservation benefit of the measure.

[8] Pennsylvania Public Utility Commission, Phase III Modification Order. From the Public Meeting of May 21, 2020. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1665150.docx

The Act also requires that each EDC's plan include 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.

Phase III Conservation Targets for Each EDC

The PUC's June 2015 Implementation Order explained that it was required to establish electric energy consumption reduction compliance targets for Phase III of Act 129. Table 4 contains these targets as percentages of sales and five-year cumulative totals in MWh/year for each of the seven EDCs.

Table 4: Act 129 Phase III Five-Year Energy-Efficiency Reduction Compliance Targets[1]

EDC	Portfolio Energy-Efficiency Budget Allocation (Million $)	Program Acquisition Costs ($/1st-YR MWh Saved)	Five-Year Value of Reductions (MWh)	% of 2010 Forecast
PECO	$384.3	$195.8	1,962,659	5.0%
PPL	$292.1	$202.4	1,443,035	3.8%
Duquesne Light	$88.0	$199.5	440,916	3.1%
FE: Met-Ed	$114.4	$190.9	599,352	4.0%
FE: Penelec	$114.9	$202.9	566,168	3.9%
FE: Penn Power	$30.0	$190.4	157,371	3.3%
FE: West Penn Power	$106.0	$196.0	540,986	2.6%
Statewide	**$1,129.6**	**$197.8**	**5,710,488**	**3.9%**

[1] Note that the statewide values reported in this table are from the 2nd Addendum to the 2015 SWE Market Potential Studies. https://www.puc.pa.gov/pcdocs/1367057.docx

The final Phase III Implementation Order also established DR targets for each EDC covered by Act 129 (with no DR target for Penelec). The percentage reduction targets, as well as the value of reductions in MW, are reported in Table 5. It is important to note that the EDCs were not required to obtain peak demand reductions in the first program year of Phase III (PY8). Following the outbreak of the COVID-19 pandemic, the Commission's Phase III Modification Order[9] permitted EDCs to operate DR programs on a voluntary basis in PY12. As a result, performance during PY12 DR events does not affect compliance with Phase III DR targets. The targets reported in Table 5 are for the other four program years in Phase III.

[9] Pennsylvania Public Utility Commission, Phase III Modification Order. From the Public Meeting of May 21, 2020. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1665150.docx

Table 5: Act 129 Phase III Five-Year Energy DR Reduction Compliance Targets[1]

EDC	Five-Year DR Spending Allocation (Million $)	Program Acquisition Costs ($/MW/year)	Average Annual Potential Savings (MW)	% Reduction (Relative to 2007-2008 Peak Demand)
PECO	$42.70	$66,370	161	2.0%
PPL	$15.38	$41,622	92	1.4%
Duquesne Light	$9.77	$57,976	42	1.7%
FE: Met-Ed	$9.95	$51,210	49	1.8%
FE: Penelec	$0.00	$50,782	0	0.0%
FE: Penn Power	$3.33	$49,349	17	1.7%
FE: West Penn Power	$11.78	$46,203	64	1.8%
Statewide	**$92.90**	**$54,714**	**425**	**1.6%**

[1] Note that the statewide values reported in this table are from the 2nd Addendum to the 2015 SWE Market Potential Studies. https://www.puc.pa.gov/pcdocs/1367057.docx

LI and GNI Customer Savings

Each EDC Phase III EE&C Plan must obtain at least 5.5% of its consumption reduction requirements from programs solely directed at LI customers or LI-verified participants in multifamily housing programs and at least 3.5% of all consumption reduction requirements from GNI entities. Savings from non-LI programs, such as general residential programs, will not be counted for compliance. LI customers are defined as households whose incomes are at or below 150% of the Federal Poverty Income Guidelines. As detailed in Carryover Savings from Phase II, LI & GNI carryover savings for Phase III were based on attained savings in Phase II that were in excess of the overall Phase II targets and the individual Phase II carveout targets. If an EDC exceeded the LI or GNI target in Phase II but did not exceed the portfolio target, the EDC was not permitted to carry over savings for the carveout(s) in Phase III.[10]

In addition, the Phase III Implementation Order directed EDCs to offer conservation measures to the LI customer segment based on the proportion of electric sales attributable to LI households. 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 proportionate to each EDC's total LI consumption relative to the total energy usage in the service territory. A LI measure is defined as a measure targeted to LI customers and available at no cost to LI customers.

A summary of the LI and GNI carve-out information and LI measure proportionality is provided in Table 6.

[10] Pennsylvania Public Utility Commission, Phase II Final Compliance Order. From the Public Meeting of August 3, 2017. Docket No. M-2012-2289411. https://www.puc.pa.gov/pcdocs/1530728.docx

Table 6: Act 129 Phase III LI and GNI Carve-Out Information

EDC	Proportionate Number of Measures (LI)	2016-2021 Potential Savings (MWh)	5.5% LI Savings Target (MWh)	3.5% GNI Savings Target (MWh)
PECO	8.80%	1,962,659	107,946	68,693
PPL	9.95%	1,443,035	79,367	50,507
Duquesne Light	8.40%	440,916	24,250	15,432
FE: Met-Ed	8.79%	599,352	32,964	20,977
FE: Penelec	10.23%	566,168	31,139	19,816
FE: Penn Power	10.64%	157,371	8,655	5,508
FE: West Penn Power	8.79%	540,986	29,754	18,935
Statewide		**5,710,488**	**314,075**	**199,868**

Carryover Savings from Phase II

The PUC's Phase III Implementation Order specifies that the EDCs are allowed to use savings attained in Phase II in excess of their targets for application toward Phase III targets. These carryover savings may only be savings attained in Phase II. The Phase II Final Compliance Order further clarified that in order to carry over savings for the LI and Government, Non-Profit, Institutional (GNI) carveouts, an EDC must attain savings in Phase II in excess of their Phase II targets for application towards Phase III targets.[11] Table 7 provides a summary of the Phase II carryover savings and Phase III compliance targets.

Table 7: Summary of EDC Phase II Carryover Savings

EDC	Phase III Compliance Targets (MWh)			Phase II Carryover (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	-	-	-
PPL	1,443,035	79,367	50,507	-	-	-
Duquesne Light	440,916	24,250	15,432	100,467	3,266	-
FE: Met-Ed	599,352	32,964	20,977	30,482	5,025	-
FE: Penelec	566,168	31,139	19,816	49,695	7,872	82
FE: Penn Power	157,371	8,655	5,508	13,866	1,805	7,316
FE: West Penn Power	540,986	29,754	18,935	20,540	3,354	-
Statewide	**5,710,488**	**314,075**	**199,868**	**215,050**	**21,322**	**7,398**

[11] Pennsylvania Public Utility Commission. Act 129 Phase II Final Compliance Order. From the Public Meeting held August 3, 2017. Docket No. M-2012-2289411. http://www.puc.pa.gov/pcdocs/1530728.docx

Incremental Annual Accounting

An EDC's progress towards compliance is based on verified new first-year incremental savings delivered in each year of the phase. Each program year, the verified new first-year savings the EDC's EE&C program achieved 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 effective useful life (EUL) before the end of the phase does not impact compliance savings.

Net-to-Gross Ratio (NTGR)

The PUC's Phase III 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.

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 III 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, and completing in early 2022 a review of the entire Phase III program.

Annual Reporting Requirements

This report is the fifth and final annual report from the Phase III SWE team to the Commission. It summarizes the performance of the seven EDCs subject to Act 129 during PY12 and provides a comprehensive summary of Phase III achievements. The Phase III SWE team contract specifies that "*The contractor will provide a Final Five-Year Energy Efficiency and Conservation Program Assessment Report to the Commission by February 28, 2022. This report will include the content for the 2020/2021 program year in lieu of a 2020/2021 Final Annual Report.*"

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 III energy-efficiency and demand response targets. This report also provides information on Act 129 Phase I and II EDC expenditures, MWh and MW savings, and

acquisition costs per first-year kWh saved by program year and EDC. The SWE contract specifies that the SWE final annual report for Phase III be completed by February 28, 2022, and must include, but is not limited to, the following:

- An analysis of each EDC's plan expenditures and an assessment of the programs' expenditures.
- An analysis of each EDC's 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 EDC's expenditures in accordance with the Commission-adopted Total Resource Cost Test.
- A review of the TRM information and savings values with suggestions for possible revisions and additions.
- A review of the Total Resource Cost Test with suggestions for possible revisions and additions.
- A review of any proposed revisions and updates to EDC plans.

PY12 (JUNE 1, 2020-MAY 31, 2021) SUMMARY

EE Performance

Table 8 provides a summary of PY12 verified energy savings by EDC. PECO's PY12 savings accounted for the largest share of the Phase III target of any EDC (29% of Phase III target).

Table 8: Summary of PY12 Verified Savings*

EDC	PY12-Verified Gross Savings (MWh)	LI PY12-Verified Gross Savings (MWh)	GNI PY12-Verified Gross Savings (MWh)
PECO	559,940	14,840	78,208
PPL	246,183	10,852	37,111
Duquesne Light	103,486	6,076	21,936
FE: Met-Ed	102,958	3,688	8,840
FE: Penelec	81,623	2,520	8,493
FE: Penn Power	23,599	755	994
FE: West Penn Power	104,990	2,405	11,623
Statewide	**1,222,779**	**41,136**	**167,204**

*Rows may not sum to statewide totals due to rounding

The SWE found that each EDC complied with the LI proportionality requirement in PY12 (Table 9).

Table 9: LI Measure Proportionality Targets and SWE Verification Results, PY12

EDC	Proportionate Number of Measures, Target	PY12 Proportionate Number of Measures, Reported	PY12 Proportionate Number of Measures, SWE Verified
PECO	8.80%	43.5%	29.1%
PPL	9.95%	18.9%	24.3%
Duquesne Light	8.40%	17.7%	26.9%
FE: Met-Ed	8.79%	37.3%	34.4%
FE: Penelec	10.23%	37.3%	34.4%
FE: Penn Power	10.64%	37.3%	34.4%
FE: West Penn Power	8.79%	37.3%	34.4%

Performance by Customer Segment

Table 10 presents the PY12 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).[12] Residential customers (including LI customers) accounted for 394,563 MWh of verified gross savings in PY12 and 3,424,354 MWh in Phase III verified gross savings (32% and 51%, respectively). Residential savings in PY12 were the smallest share during Phase III, likely due to declining savings from residential lighting (see Appendix J for more details).

Table 10: Summary of PY12 Verified Savings by Customer Segment

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI (MWh)
PECO	180,804	44,199	241,889	78,208	14,840
PPL	40,932	110,634	46,654	37,111	10,852
Duquesne Light	7,934	13,305	55,849	21,936	4,462
FE: Met-Ed	40,911	14,719	34,799	8,840	3,688
FE: Penelec	33,288	14,963	22,360	8,493	2,520
FE: Penn Power	9,752	10,505	1,594	994	755
FE: West Penn Power	41,421	21,651	27,890	11,623	2,405
Statewide	**355,042**	**229,977**	**431,035**	**167,204**	**39,522**

Demand Response Performance

Table 11 shows the verified DR performance by EDC for summer 2020 (PY12). PY12 demand response programs were voluntary due to the COVID-19 pandemic.

[12] 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 in the small C&I or large C&I rate classes but can include a limited number of residential customers.

Table 11: PY12 DR Performance by EDC

EDC	Phase III DR Target	PY12 Average DR Performance
PECO	161	160.5
PPL	92	96.9
Duquesne Light	42	32.4
FE: Met-Ed	49	46.0
FE: Penelec	0	0.0
FE: Penn Power	17	11.6
FE: West Penn Power	64	91.3
Statewide	**425**	**438.7**

Cost-Effectiveness

Table 12 presents TRC Test results by EDC and statewide on a gross basis for PY12. PECO's EE&C plan was not cost-effective in PY12. For the other six EDCs, and statewide, TRC Benefits exceeded TRC Costs.

Table 12: PY12 Portfolio TRC Test Results by EDC

EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC
PECO	$246,620	$269,527	0.92
PPL	$180,625	$106,902	1.69
Duquesne Light	$72,556	$27,965	2.59
FE: Met-Ed	$43,330	$33,495	1.29
FE: Penelec	$29,964	$21,791	1.38
FE: Penn Power	$9,625	$8,677	1.11
FE: West Penn Power	$47,188	$38,277	1.23
Statewide*	**$629,908**	**$506,634**	**1.24**

*Throughout this report, individual columns in tables may not sum to the total due to rounding.

Table 13 shows PY12 TRC Test results separately for EE and DR programs. For PPL and PECO, the SWE team prorates common portfolio costs between EE and DR using programmatic EDC expenditures. Despite the voluntary nature of DR programs for PY12, the DR portfolio was more cost-effective than EE at PECO, Met-Ed, Penn Power, West Penn Power, and statewide. PPL and Duquesne Light showed higher TRC Ratios for EE than DR in PY12.

Table 13: PY12 EE & DR TRC Test Results by EDC

EDC	EE Programs			DR Programs		
	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio
PECO	$237,795	$260,653	0.91	$8,825	$8,874	0.99
PPL	$176,173	$104,282	1.69	$4,452	$2,620	1.70
Duquesne Light	$69,164	$26,284	2.63	$3,392	$1,681	2.02
FE: Met-Ed	$41,082	$32,159	1.28	$2,248	$1,336	1.68
FE: Penelec	$29,964	$21,791	1.38	$0	$0	N/A
FE: Penn Power	$9,087	$8,313	1.09	$538	$364	1.48
FE: West Penn Power	$43,179	$36,339	1.19	$4,009	$1,938	2.07
Statewide	**$606,444**	**$489,821**	**1.24**	**$23,464**	**$16,813**	**1.40**

*Rows may not sum to statewide totals due to rounding.

PHASE III

Performance Against Portfolio Energy Reduction Targets

Phase III performance against EDC Phase III compliance targets ranged from 105% (PECO) to 142% (Penn Power) (see Table 14). Including carryover savings from Phase II, total progress toward Phase III targets ranged from 105% (PECO) to 151% (Penn Power). Phase III carryover savings, equal to Phase III verified energy savings minus the Phase III energy savings targets, range from 28,137 MWh (Duquesne Light) to 306,275 MWh (PPL); each EDC has Phase III carryover savings. More detailed summary tables of progress toward Phase III targets can be found in Appendix A and the EDCs' program-level impacts can be found in Section 1.

Table 14: Phase III EE Performance Against Phase III Compliance Target, by EDC and Statewide

EDC	Phase II Carryover Savings (MWh)	Phase III Verified Gross Savings (MWh)	Phase III Verified Gross Savings + CO (MWh)	Phase III Energy Savings Targets (MWh)	Savings Achieved % of Target	Phase III Carryover Savings (MWh)
PECO	-	2,068,877	2,068,877	1,962,659	105%	106,218
PPL	-	1,749,310	1,749,310	1,443,035	121%	306,275
Duquesne Light	100,467	469,053	569,520	440,916	129%	28,137
FE: Met-Ed	30,482	746,655	777,137	599,352	130%	147,303
FE: Penelec	49,695	696,193	745,888	566,168	132%	130,025
FE: Penn Power	13,866	223,948	237,814	157,371	151%	66,577
FE: West Penn Power	20,540	709,466	730,006	540,986	135%	168,480
Statewide	**215,050**	**6,663,502**	**6,878,552**	**5,710,488**	**120%**	**953,015**

Progress Towards LI and Government, Non-Profit, Institutional (GNI) Targets

Each EDC must obtain at least 5.5% of its consumption reduction requirements from programs solely directed at LI customers or LI-verified participants in multifamily housing programs and at least 3.5% of all consumption reduction requirements from GNI entities. Figure 1 reports EDC Phase III performance against their targets. Progress toward the LI target ranged from 95% (Duquesne Light) to 140% (Penn Power) in Phase III verified gross savings and 103% (PECO) to 161% (Penn Power) when Phase II carryover savings are included.[13] Progress toward the GNI target ranged from 179% (Met-Ed) to 453% (West Penn Power) in Phase III verified gross savings and 179% (Met-Ed) to 453% (West Penn Power) when Phase II carryover savings are included.[14]

Figure 1: Phase III Performance Against Phase III LI and GNI Targets

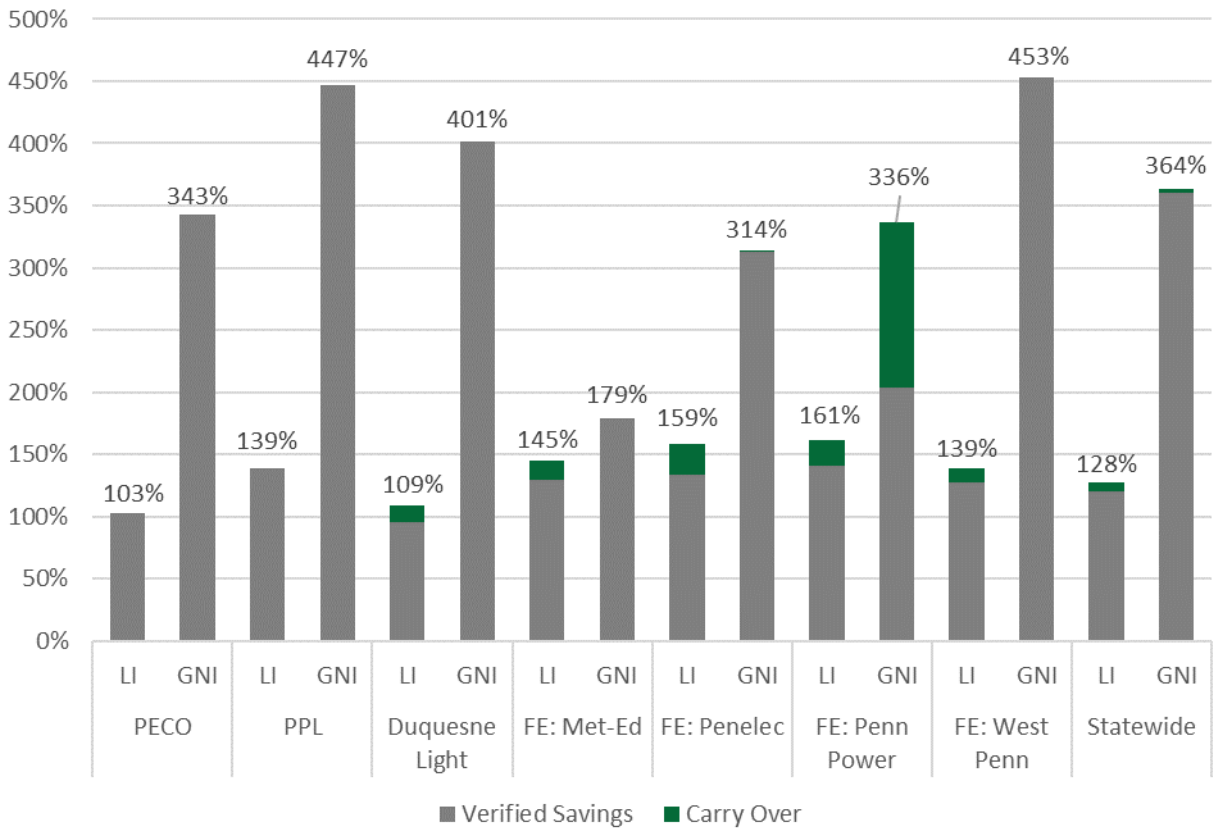


Table 15 and Table 16 provide more details on Phase III performance against EDC Phase III LI and GNI targets, respectively. Phase III carryover savings for the LI target range from 0 MWh (Duquesne Light) to 31,089 MWh (PPL). Because there is no GNI target in Phase IV, there are no Phase III GNI carryover savings.

[13] Note that PECO did not have any Phase II LI carryover savings; all of PECO's LI compliance savings were achieved during Phase III.
[14] Note that Met-Ed and West Penn Power did not have any Phase II GNI carryover savings; all of Met-Ed's and West Penn Power's GNI compliance savings were achieved during Phase III

Table 15: Phase III LI Carve-out Goal Performance by EDC and Statewide

EDC	Phase II LI Carryover Savings (MWh)	Phase III LI Verified Gross Savings (MWh)	Phase III LI Verified Gross Savings + CO (MWh)	Phase III LI Energy Savings Targets (MWh)	Savings Achieved % of Target	Phase III LI Carryover Savings (MWh)
PECO	-	111,398	111,398	107,946	103%	3,452
PPL	-	110,456	110,456	79,367	139%	31,089
Duquesne Light	3,266	23,128	26,394	24,250	109%	0
FE: Met-Ed	5,025	42,746	47,771	32,964	145%	9,782
FE: Penelec	7,872	41,605	49,477	31,139	159%	10,466
FE: Penn Power	1,805	12,159	13,965[1]	8,655	161%	3,504
FE: West Penn Power	3,354	38,024	41,378	29,754	139%	8,270
Statewide	**21,322**	**379,516**	**400,839**	**314,075**	**128%**	**66,563**

[1] Penn Power's Phase III LI verified gross savings + CO of 13,965 MWh is based on Phase III LI verified savings of 12,159.2 MWh and CO of 1,805.4 MWh.

Table 16: Phase III GNI Carve-out Goal Performance by EDC and Statewide

EDC	Phase II GNI Carryover Savings (MWh)	Phase III GNI Verified Gross Savings (MWh)	Phase III GNI Verified Gross Savings + CO (MWh)	Phase III GNI Savings Targets (MWh)	Savings Achieved % of Target
PECO	-	235,437	235,437	68,693	343%
PPL	-	225,541	225,541	50,507	447%
Duquesne Light	-	61,955	61,955	15,432	401%
FE: Met-Ed	-	37,654	37,654	20,977	179%
FE: Penelec	82	62,117	62,200[1]	19,816	314%
FE: Penn Power	7,316	11,214	18,530	5,508	336%
FE: West Penn Power	-	85,757	85,757	18,935	453%
Statewide	**7,398**	**719,675**	**727,073**	**199,868**	**364%**

[1] Penelec's Phase III GNI verified gross saving + CO of 62,200 MWh is based on Phase III GNI verified savings of 62,117.3 MWh and CO of 82.2 MWh.

As noted in LI and GNI Customer Savings, the Phase III Implementation Order directed EDCs to offer conservation measures to the LI customer segment based on the proportion of electric sales attributable to LI households.[15] The SWE found that each EDC complied with the LI proportionality requirement in Phase III. Table 17 reports the required minimum proportions and results of the

[15] Phase III Implementation Order at https://www.puc.pa.gov/pcdocs/1367313.doc, page 63.

SWE's verification analysis for Phase III. The SWE's verification analysis for PY12 can be found in Appendix A.2.

Table 17: LI Measure Proportionality Targets and SWE Verification Results, Phase III

EDC	Proportionate Number of Measures, Target	PY8	PY9	PY10	PY11	PY12
PECO	8.80%	26.3%	29.1%	29.1%	29.1%	29.1%
PPL	9.95%	23.9%	25.4%	26.6%	22.7%	24.3%
Duquesne Light	8.40%	23.1%	23.7%	28.1%	28.1%	26.9%
FE: Met-Ed	8.79%	40.5%	34.4%	34.4%	34.4%	34.4%
FE: Penelec	10.23%	40.5%	34.4%	34.4%	34.4%	34.4%
FE: Penn Power	10.64%	40.5%	34.4%	34.4%	34.4%	34.4%
FE: West Penn Power	8.79%	40.5%	34.4%	34.4%	34.4%	34.4%

Phase III Performance by Customer Segment

Table 18 presents Phase III 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).[16] Residential customers (including LI customers) accounted for 51% of verified gross savings in Phase III.

Table 18: Summary of Phase III Verified Savings by Customer Segment[1]

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI (MWh)
PECO	1,046,282	192,897	482,863	235,437	111,398
PPL	643,285	474,974	295,539	227,967	107,547
Duquesne Light	160,387	83,302	145,140	61,955	18,270
FE: Met-Ed	390,952	117,660	157,644	37,654	42,746
FE: Penelec	343,830	112,720	135,921	62,117	41,605
FE: Penn Power	110,704	61,269	28,603	11,214	12,159
FE: West Penn Power	357,165	128,800	99,721	85,757	38,024
Statewide	**3,052,605**	**1,171,621**	**1,345,430**	**722,101**	**371,749**

[1] Does not include carryover savings.

[16] 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.

Demand Response Performance

Table 19 compares each EDC's average DR performance to its Phase III DR target. EDCs were not required to obtain peak demand reductions in the first program year of Phase III (PY8), and the final program year of Phase III (PY12) was voluntary due to the COVID-19 pandemic.

Table 19: Phase III DR Performance Summary

EDC	Phase III DR Target (MW)	Phase III Average Event Performance (PY9-PY11)	Percent of Target
PECO	161	167.1	104%
PPL	92	112.8	123%
Duquesne Light	42	55.2	131%
FE: Met-Ed	49	53.0	108%
FE: Penelec	0	0.0	N/A
FE: Penn Power	17	39.9	235%
FE: West Penn Power	64	112.4	176%
Statewide	**425**	**540.4**	**127%**

Cost-Effectiveness

Table 20 shows gross portfolio TRC Test results for each EDC and statewide. For Phase III cost-effectiveness summaries, all benefits and costs are expressed in 2016 dollars. Duquesne Light had the highest portfolio TRC Ratio in Phase III and PECO had the lowest TRC Ratio.[17]

Table 20: Phase III Portfolio TRC Test Results by EDC

EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio
PECO	$701,664	$643,362	1.09
PPL	$873,601	$538,436	1.62
Duquesne Light	$228,490	$102,150	2.24
FE: Met-Ed	$259,133	$171,815	1.51
FE: Penelec	$229,776	$170,012	1.35
FE: Penn Power	$81,581	$55,241	1.48
FE: West Penn Power	$247,837	$190,546	1.30
Statewide*	**$2,622,084**	**$1,871,562**	**1.40**

*Rows may not sum to statewide totals due to rounding

Table 21 presents gross TRC Test results separately for EE and DR programs. For each EDC, and statewide, dispatchable demand response programs were more cost-effective than the energy-efficiency portfolio. As discussed in Section 3.1, the TRC Benefits methodology in the

[17] The TRC Test requires EDCs to calculate the net present value of future energy savings and costs. In PY8 "present" was defined as $2016 and each subsequent program year uses a different definition of present. PY9 statistics are expressed in $2017, PY10 statistics are expressed in $2018, PY11 statistics are expressed in $2019, and PY12 statistics are expressed in $2020.

2016 TRC Test Order allocated full avoided capacity costs to demand response. The Commission moved to a more conservative valuation framework in the 2021 TRC Test Order. If we applied the Phase IV perspective on the calculation of dispatchable DR benefits to the Phase III DR impacts, the TRC Ratios for DR portfolios would be lower and comparable to the energy-efficiency TRC Ratios.

Table 21: Phase III EE & DR TRC Test Results by EDC

EDC	EE Programs			DR Programs		
	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio
PECO	$666,597	$611,329	1.09	$35,067	$32,033	1.09
PPL	$856,809	$531,039	1.61	$16,792	$7,397	2.27
Duquesne Light	$211,255	$95,887	2.20	$17,235	$6,263	2.75
FE: Met-Ed	$247,930	$165,636	1.50	$11,203	$6,179	1.81
FE: Penelec	$229,776	$170,012	1.35	$0	$0	N/A
FE: Penn Power	$74,279	$52,995	1.40	$7,302	$2,246	3.25
FE: West Penn Power	$226,025	$183,186	1.23	$21,813	$7,360	2.96
Statewide	**$2,512,672**	**$1,810,084**	**1.39**	**$109,412**	**$61,478**	**1.78**

*Rows may not sum to statewide totals due to rounding.

Figure 2 shows the gross TRC Ratio by EDC for each program year in Phase III. The statewide TRC Ratio was approximately 1.5 for the first three years of Phase III and then began to drop in PY11 and PY12.

Figure 2: Phase III Gross TRC Ratio by EDC and Program Year

Reduction in Emissions

Electric power generation is a major source of carbon emissions, so the energy conservation programs implemented by the Pennsylvania EDCs directly impact the amount of carbon dioxide released into the atmosphere. 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_2 emissions and climate change. Table 22 was compiled using the gross verified first year and lifetime MWh savings for Phase III, EDC-specific line loss factors (LLFs), and an average of the 2020 marginal on-peak and off-peak CO_2 emissions rate in PJM's spring 2020 Emissions Report.[18]

Table 22: Phase III Carbon Dioxide Emission Impacts

Performance Metric	Value
Phase III Verified Gross MWh/yr	6,663,502
Phase III Verified Gross Lifetime MWh	60,331,769
Weighted Average Measure Life (years)	9.05
Average CO2 Emissions Rate (lbs/MWh)	1,113
First-Year Avoided Tons of CO_2	3,989,754
Lifetime Avoided Tons of CO_2	36,099,775

The lifetime emission impacts in Table 22 are calculated using the 2020 CO_2 emission rates and do not include the emissions associated with secondary fossil fuel impacts caused by EE&C measures. Early in Phase III, the marginal emissions rate was higher than 1,113 lbs/MWh. Similarly, we expect the generation fuel mix of the region to become cleaner over the remaining life of the measures installed in Phase III, leading to a lower marginal emissions rate and less avoided CO_2 per MWh saved. If the Act 129 TRC Test valued CO_2 emissions at the Biden administration's interim social cost of carbon – $46 per short ton – the present value of statewide Phase III avoided emissions benefits would total over $1 billion and the statewide Phase III TRC Ratio would increase from 1.4 to approximately 2.1.

SUMMARY OF SWE FINDINGS AND RECOMMENDATIONS

A primary purpose of program evaluation is to identify opportunities for program improvement. Because the SWE reviews program performance data and evaluation findings from all seven EDCs subject to Act 129, we are in a unique position to observe what is working well and where challenges occur across the Commonwealth. This section summarizes key findings and recommendations from the SWE team's Phase III audit activities. We chose to focus our recommendations on actionable steps for the EDCs and their evaluation contractors, given the fact that Phase IV EE&C Plans have been approved by the Commission and are currently being

[18] 2016–2020 CO_2, SO_2 and NO_x Emission Rates. https://www.pjm.com/-/media/library/reports-notices/special-reports/2020/2020-emissions-report.ashx

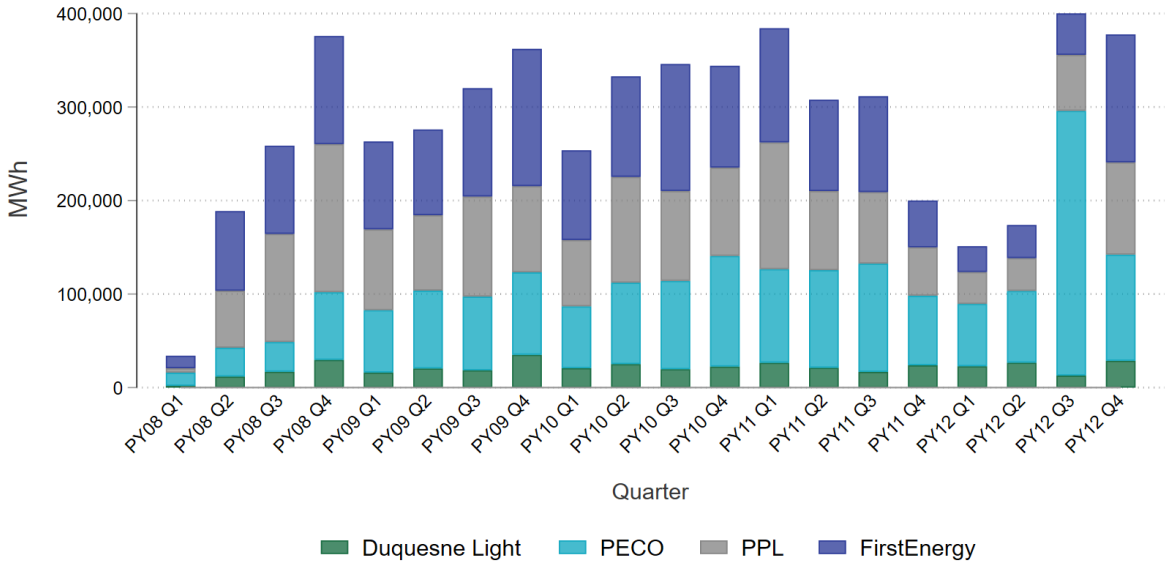
delivered by the EDCs and their ICSPs. For example, Phase IV EE&C plans do not include dispatchable demand response programs for any EDC, so we do not offer recommendations with respect to DR program delivery or evaluation methods. NMR Group, as the Phase IV SWE, recently completed a comprehensive review of each EDC evaluation contractor's Phase IV EM&V plan. Many of our detailed prospective methodological recommendations were addressed via that process. PY12 was a light year in terms of impact, NTG, and process evaluation for the EDCs as attention shifted to Phase IV planning and launch. The EDCs and their evaluation contractors were generally responsive to audit findings and recommendations in PY8-PY11, which helped to further streamline PY12 audit activities.

- All seven EDCs met their Phase III portfolio consumption reduction target. Although the Commission allowed carryover from Phase II of Act 129 to count towards compliance, each EDC met their Phase III target with Phase III savings and did not require carryover savings at the portfolio level to be in compliance.
    - All seven EDCs met their Phase III LI savings target. Six of the seven EDCs met their target with Phase III savings and will have LI carryover savings from Phase III into Phase IV, ranging from 4% to 47% of their Phase IV LI savings target. Duquesne Light met their Phase III LI savings target with carryover savings from Phase II and therefore will not have carryover from Phase III into Phase IV.
    - All seven EDCs met their Phase III GNI savings target with Phase III savings and did not require carryover savings to be compliant. Because there is no GNI target in Phase IV, there are no Phase III GNI carryover savings.
- The EDCs also met their primary dispatchable demand response targets for Phase III. Compliance with the primary target was based on the average performance across all events in PY9, PY10, and PY11 after the Commission elected to make PY12 DR programs voluntary in response to the COVID-19 pandemic.
    - The Phase III Implementation Order also required EDCs to obtain no less than 85% of the target for any one event. PECO and West Penn Power each missed this goal on a single Phase III event day, although the margin of error around the verified gross impact estimate included the 85% threshold.
- Looking ahead to Phase IV of Act 129, we estimate 953,015 MWh of carryover savings from Phase III to Phase IV. This represents 21% of Phase IV consumption reduction targets statewide, so the EDCs should be well-positioned entering Phase IV with respect to energy savings. Phase IV also includes a peak demand reduction target from energy-efficiency. No comparable target existed in Phase III so there are no carryover savings; therefore, the EDCs will have to comply with this target without the benefit of carryover savings.
    - As a percent of Phase IV energy savings targets, Phase III carryover savings range from 8% (PECO) to 52% (Penn Power) of Phase IV targets (see Table 25).
- Three initiatives – Residential Lighting, Home Energy Reports, and Commercial & Industrial Lighting – contributed over three quarters (77%) of verified gross energy savings in the Commonwealth during Phase III. A fourth measure, CHP, contributed another 5% of savings during Phase III.
    - Commercial & Industrial Lighting was the single largest initiative during Phase III, accounting for 32% of Phase III verified savings.

- Residential lighting, the second-largest initiative, accounted for 30% of Phase III verified savings. Notably, savings from residential lighting declined dramatically over the course of Phase III, from 42% of verified savings in PY8 to 12% in PY12. Starting in PY12, the baseline for residential general service lamps became 45 lumens per watt to comply with the EISA 2020 "backstop" provision. Opportunities for compliance savings from residential lighting are limited for Phase IV, so the SWE anticipates the decline in residential lighting to continue in Phase IV.

- The effects of the COVID-19 pandemic lingered through much of PY12 as the Commonwealth slowly reopened businesses and schools. Figure 3 shows the reported gross MWh savings by EDC and quarter for Phase III with the four FirstEnergy EDCs consolidated. The pandemic disruption is most evident from PY11Q4 to PY12Q2 (March 1, 2020 to November 30, 2020). Most EDC programs suspended temporarily at the onset of the pandemic were reactivated during summer 2020, but program delivery processes were modified to reduce in-person contact and prioritize safety.

Figure 3: Reported Gross MWh by Program Year and Quarter



Energy savings attributable to HER programs are not included.

- PY12Q1 had the lowest reported gross MWh savings since PY8Q1, when Phase III programs were just ramping up. Other contributing factors to low energy savings totals in early PY12 could be the winding down of upstream lighting programs at PPL and Duquesne Light, a non-residential CSP change for the FirstEnergy EDCs, and six of seven EDCs reaching their Phase III compliance target by the end of PY11.
- Despite the pandemic, statewide verified energy savings in PY12 accounted for 18% of Phase III savings and the fourth highest annual savings of the five-year phase (higher than PY8). However, the SWE also notes that PY12 totals are influenced heavily by a large PECO CHP project claimed in PY12Q3.

  - EDC programs continued to experience disruptions in program delivery, supply chains, and reduced participation from commercial businesses in affected industries. EDCs and their CSPs adapted to the pandemic by offering virtual services, such as outreach, auditing, and presentations.
- COVID-19 also affected Evaluation, Measurement, and Verification (EM&V) processes in PY11 and PY12. The SWE developed a guidance memo for the EDCs and their evaluators, for evaluation activities and verification requirements in the wake of the coronavirus outbreak. The memo outlined procedures for using virtual verification methodology in lieu of on-site verification for projects above and below the TRM metering threshold. Virtual verification activities include video conferencing and submission of detailed images taken by facility staff and/or contractors. These virtual techniques were supported by the SWE and allowed EM&V activities to continue during the COVID-19 pandemic and period of in-person restrictions. For a selection of non-residential projects, the SWE attended and observed these virtual verification activities for each EDC as a component of the SWE's Ride-Along Site Visit activity for PY11 and PY12. These same virtual verification activities will continue in Phase IV.
- The EDCs acquired verified gross energy savings at a lower cost than projected in their Phase III EE&C Plans.
  - Overall, total actual EDC expenditures were 14% lower than planned. Six of seven EDCs had expenditures between 14% and 33% less than planned, while PECO had expenditures 4% greater than planned (PECO remained within the total budget approved for the Phase).
  - Six of seven EDCs delivered energy savings at a lower cost than projected for Phase III, with FirstEnergy companies delivering energy-efficiency savings at approximately 58% of the projected cost in their Phase III EE&C plans.
  - Statewide portfolio acquisition costs have been stable over the 12 program years of Act 129, ranging from $0.08 to $0.16 per first year kWh ($2021). The SWE notes that statewide residential (non-LI) acquisition costs increased in PY12, corresponding with a decrease in savings from residential lighting programs.
- The MWh contribution from behavioral Home Energy Reports declined over the course of Phase III. HER cohorts lose 5-8% of recipients annually due to account closures and move-outs. Unless new cohorts of homes are added, we expect to observe a gradual decline in aggregate HER savings due to declining participant counts. While MWh savings were down in PY12, HER savings as a percentage of residential and residential LI sector savings were up compared to prior years of Phase III. This finding is less about Home Energy Reports and more a function of diminished opportunities for residential lighting savings.
  - The accounting rules for Home Energy Reports changed for Phase IV of Act 129 as the Commission adopted new persistence assumptions for HERs in the 2021 TRM. This change discourages EDCs from treating the same households with HERs year-after-year and encourages them to expose new households to behavioral messaging.
- Benefit-cost ratios, as measured by the TRC Test, declined from Phase II to Phase III and across program years within Phase III. The economic analysis included in the EDCs'

Phase IV EE&C plans project this trend to continue. TRC Costs include the full incremental measure cost of incented measures, not just the incentive amount paid by the EDC. In PY12, incremental measure costs represented 72.6% of all TRC Costs statewide and incentives covered less than 20% of the estimated measure costs. We refer to the incremental measure costs as “estimated” because, unlike incentives, the incremental cost of an efficient measure compared to the baseline option is not tracked and must be estimated. As the economics of Act 129 programs become increasingly thin, accurate estimation of incremental measure costs will grow increasingly important. Since Phase II, the SWE team has maintained an Incremental Cost Database to support the EDCs and their evaluation contractors in this area. Enhanced tracking of project costs (material and labor) should be a point of emphasis for the EDCs and their ICSPs in Phase IV.

Section 1 Energy and Peak Demand Savings from EE – PY12 and Phase III

1.1 Phase III Energy Reduction Targets for Each EDC

The PUC's June 2015 Implementation Order explained that it was required to establish electric energy consumption reduction compliance targets for Phase III of Act 129. Table 23 contains these targets as percentages and five-year cumulative totals in MWh/year for each of the seven EDCs.

Table 23: Act 129 Phase III Five-Year Energy-Efficiency Reduction Compliance Targets[1]

EDC	Portfolio Energy-Efficiency Budget Allocation (Million $)	Program Acquisition Costs ($/1st-YR MWh Saved)	Five-Year Value of Reductions (MWh)	% of 2010 Forecast
PECO	$384.3	$195.8	1,962,659	5.0%
PPL	$292.1	$202.4	1,443,035	3.8%
Duquesne Light	$88.0	$199.5	440,916	3.1%
FE: Met-Ed	$114.4	$190.9	599,352	4.0%
FE: Penelec	$114.9	$202.9	566,168	3.9%
FE: Penn Power	$30.0	$190.4	157,371	3.3%
FE: West Penn Power	$106.0	$196.0	540,986	2.6%
Statewide	**$1,129.6**	**$197.8**	**5,710,488**	**3.9%**

[1] Note that the statewide values reported in this table are from the 2nd Addendum to the 2015 SWE Market Potential Studies. https://www.puc.pa.gov/pcdocs/1367057.docx

1.2 ENERGY COMPLIANCE SUMMARY BY EDC

Phase III performance against EDC Phase III compliance targets ranged from 105% (PECO) to 142% (Penn Power) (see Table 24). Including carryover savings from Phase II, total progress toward Phase III targets ranged from 105% (PECO) to 151% (Penn Power).

Table 24: Phase III EE Compliance Summary by EDC

EDC	Phase II Carryover Savings (MWh)	Phase III Verified Gross Savings (MWh)	Phase III Verified Gross Savings + CO (MWh)	Phase III Energy Savings Targets (MWh)	Savings Achieved % of Target	Phase III Carryover Savings (MWh)
PECO	-	2,068,877	2,068,877	1,962,659	105%	106,218
PPL	-	1,749,310	1,749,310	1,443,035	121%	306,275
Duquesne Light	100,467	469,053	569,520	440,916	129%	28,137
FE: Met-Ed	30,482	746,655	777,137	599,352	130%	147,303
FE: Penelec	49,695	696,193	745,888	566,168	132%	130,025
FE: Penn Power	13,866	223,948	237,814	157,371	151%	66,577
FE: West Penn Power	20,540	709,466	730,006	540,986	135%	168,480
Statewide	**215,050**	**6,663,502**	**6,878,552**	**5,710,488**	**120%**	**953,015**

Phase III carryover savings range from 28,137 MWh (Duquesne Light) to 306,275 MWh (PPL) (see Table 25). As a percent of Phase IV energy savings targets, Phase III carryover ranges from 7.7% (PECO) to 51.6% (Penn Power) of Phase IV targets. Statewide, Phase III carryover accounts for 21.1% of Phase IV targets.

Table 25: Estimated Phase III Carryover by EDC

EDC	Phase III Carryover Savings (MWh)	Phase IV Energy Savings Targets (MWh)	Phase III Carryover, % of Phase IV Target
PECO	106,218	1,380,837	7.7%
PPL	306,275	1,250,157	24.5%
Duquesne Light	28,137	348,126	8.1%
FE: Met-Ed	147,303	463,215	31.8%
FE: Penelec	130,025	437,676	29.7%
FE: Penn Power	66,577	128,909	51.6%
FE: West Penn Power	168,480	504,951	33.4%
Statewide	**953,015**	**4,513,871**	**21.1%**

Table 26 provides more details on Phase III performance against EDC Phase III low-income (LI) targets. Phase III carryover savings for the LI target range from 0 MWh (Duquesne Light) to 31,089 MWh (PPL).

Table 26: Phase III LI Carve-out Goal Performance by EDC

EDC	Phase II LI Carryover Savings (MWh)	Phase III LI Verified Gross Savings (MWh)	Phase III LI Verified Gross Savings + CO (MWh)	Phase III LI Savings Targets (MWh)	Savings Achieved % of Target	Phase III Carryover Savings (MWh)
PECO	-	111,398	111,398	107,946	103%	3,452
PPL	-	110,456	110,456	79,367	139%	31,089
Duquesne Light	3,266	23,128	26,394	24,250	109%	0
FE: Met-Ed	5,025	42,746	47,771	32,964	145%	9,782
FE: Penelec	7,872	41,605	49,477	31,139	159%	10,466
FE: Penn Power	1,805	12,159	13,965[1]	8,655	161%	3,504
FE: West Penn Power	3,354	38,024	41,378	29,754	139%	8,270
Statewide	**21,322**	**379,516**	**400,839**	**314,075**	**128%**	**66,563**

[1] Penn Power's Phase III LI verified gross savings + CO of 13,965 MWh is based on Phase III LI verified savings of 12,159.2 MWh and CO of 1,805.4 MWh.

As a percent of Phase IV LI targets, Phase III carryover ranges from 0% (Duquesne Light) to 46.9% (Penn Power) of Phase IV LI targets (see Table 27). Statewide, Phase III carryover accounts for 25.6% of Phase IV LI targets.

Table 27: Estimated Phase III LI Carryover by EDC

EDC	Phase III LI Carryover Savings (MWh)	Phase IV LI Energy Savings Targets (MWh)	Phase III LI Carryover, % of Phase IV LI Target
PECO	3,452	80,089	4.3%
PPL	31,089	72,509	42.9%
Duquesne Light	0	18,566	0.0%
FE: Met-Ed	9,782	26,866	36.4%
FE: Penelec	10,466	25,385	41.2%
FE: Penn Power	3,504	7,477	46.9%
FE: West Penn Power	8,270	29,287	28.2%
Statewide	**66,563**	**260,179**	**25.6%**

Table 28 provides more details on Phase III performance against EDC Phase III GNI targets. Because there is no GNI target in Phase IV, there are no Phase III GNI carryover savings.

Table 28: Phase III GNI Carve-out Goal Performance by EDC

EDC	Phase II GNI Carryover Savings (MWh)	Phase III GNI Verified Gross Savings (MWh)	Phase III GNI Verified Gross Savings + CO (MWh)	Phase III GNI Savings Targets (MWh)	Savings Achieved % of Target
PECO	-	235,437	235,437	68,693	343%
PPL	-	225,541	225,541	50,507	447%
Duquesne Light	-	61,955	61,955	15,432	401%
FE: Met-Ed	-	37,654	37,654	20,977	179%
FE: Penelec	82	62,117	62,200[1]	19,816	314%
FE: Penn Power	7,316	11,214	18,530	5,508	336%
FE: West Penn Power	-	85,757	85,757	18,935	453%
Statewide	**7,398**	**719,675**	**727,073**	**199,868**	**364%**

[1] Penelec's Phase III GNI verified gross saving + CO of 62,200 MWh is based on Phase III GNI verified savings of 62,117.3 MWh and CO of 82.2 MWh.

As noted in LI and GNI Customer Savings, the Phase III Implementation Order directed EDCs to offer conservation measures to the LI customer segment based on the proportion of electric sales attributable to LI households.[19] The SWE found that each EDC complied with the LI proportionality requirement in Phase III. Table 29 reports the required minimum proportions and results of the SWE's verification analysis for Phase III. The SWE's verification analysis for PY12 can be found in Appendix A.2.

Table 29: LI Measure Proportionality Targets and SWE Verification Results, Phase III

EDC	Proportionate Number of Measures, Target	PY8	PY9	PY10	PY11	PY12
PECO	8.80%	26.3%	29.1%	29.1%	29.1%	29.1%
PPL	9.95%	23.9%	25.4%	26.6%	22.7%	24.3%
Duquesne Light	8.40%	23.1%	23.7%	28.1%	28.1%	26.9%
FE: Met-Ed	8.79%	40.5%	34.4%	34.4%	34.4%	34.4%
FE: Penelec	10.23%	40.5%	34.4%	34.4%	34.4%	34.4%
FE: Penn Power	10.64%	40.5%	34.4%	34.4%	34.4%	34.4%
FE: West Penn Power	8.79%	40.5%	34.4%	34.4%	34.4%	34.4%

[19] Phase III Implementation Order at https://www.puc.pa.gov/pcdocs/1367313.doc, page 63.

1.3 RESULTS FOR PROGRAM YEAR 12 (JUNE 1, 2020-MAY 31, 2021) BY EDC

1.3.1 Summary of PY12 Energy Savings Statewide and by EDC

Table 30 provides a summary of Program Year 12 (PY12) reported and verified energy savings by EDC. PECO's PY12 savings accounted for the largest share of the Phase III target of any EDC (29% of Phase III target). Realization rates in PY12 ranged from 91% (PECO) to 107% (PPL).

Table 30: Summary of PY12 Reported and Verified Energy Savings by EDC

EDC	PY12 Reported (MWh/yr)	PY12 Verified Gross (MWh/yr)	Realization Rate
PECO	614,060	559,940	91%
PPL	229,309	246,183	107%
Duquesne Light	99,859	103,486	104%
FE: Met-Ed	101,591	102,958	101%
FE: Penelec	81,808	81,623	100%
FE: Penn Power	22,607	23,599	104%
FE: West Penn Power	106,330	104,990	99%
Statewide	**1,255,563**	**1,222,779**	**97%**

1.3.2 Summary of PY12 Energy Savings by Sector

Table 31 presents the PY12 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).[20] Residential customers (including LI customers) accounted for 394,563 MWh of verified gross savings in PY12 (32% of PY12 energy savings). Residential savings in PY12 were the smallest share during Phase III, likely due to declining savings from residential lighting (see Appendix J for more details).

[20] 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 31: Summary of PY12 Verified Savings by Customer Segment[1]

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI (MWh)
PECO	180,804	44,199	241,889	78,208	14,840
PPL	40,932	110,634	46,654	37,111	10,852
Duquesne Light	7,934	13,305	55,849	21,936	4,462
FE: Met-Ed	40,911	14,719	34,799	8,840	3,688
FE: Penelec	33,288	14,963	22,360	8,493	2,520
FE: Penn Power	9,752	10,505	1,594	994	755
FE: West Penn Power	41,421	21,651	27,890	11,623	2,405
Statewide	**355,042**	**229,977**	**431,035**	**167,204**	**39,522**

[1] Does not include carryover savings.

1.3.3 Comparison of the PY12 Expenditures and Approved EE&C Plan Budget Estimates

Table 32 provides an overview of the EDC's planned and actual expenditures for energy-efficiency programs in PY12. In PY12, all EDCs spent less than their approved budget. This could be due in part to EDC programs shut down in response to the COVID-19 pandemic, or because six of seven EDCs had exceeded their compliance target at the end of PY11.

Table 32: Comparison of PY12 Statewide Energy-Efficiency Budgets and Expenditures[1]

EDC	Actual PY12 Expenditures ($1000)	Approved Budget for PY12 ($1000)	Difference Between Actual and EE&C Plan	Percent Difference from EE&C Plan
PECO	$67,044	$72,632	($5,588)	(8%)
PPL	$44,123	$52,657	($8,534)	(16%)
Duquesne Light	$16,757	$17,510	($753)	(4%)
FE: Met-Ed	$10,323	$19,375	($9,052)	(47%)
FE: Penelec	$8,245	$19,088	($10,843)	(57%)
FE: Penn Power	$2,639	$5,140	($2,501)	(49%)
FE: West Penn Power	$11,602	$19,013	($7,410)	(39%)
Statewide	**$160,733**	**$205,415**	**($44,682)**	**(22%)**

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

Table 33 provides an overview of the EDC's planned and actual energy-efficiency acquisition costs in PY12.

Table 33: Planned Versus Actual Energy-Efficiency Acquisition Costs in PY12

EDC	PY12 Verified Savings (MWh/yr)	Forecasted PY12 Acquisition Cost per First-Year kWh Saved	Actual PY12 Acquisition Cost per First-Year kWh Saved	Percent Change from Forecasted Acquisition Cost
PECO	559,940	$0.19	$0.12	(36%)
PPL	246,183	$0.18	$0.18	(1%)
Duquesne Light	103,486	$0.20	$0.16	(19%)
FE: Met-Ed	102,958	$0.19	$0.10	(48%)
FE: Penelec	81,623	$0.21	$0.10	(53%)
FE: Penn Power	23,599	$0.21	$0.11	(46%)
FE: West Penn Power	104,990	$0.20	$0.11	(44%)
Statewide	**1,222,779**	**$0.19**	**$0.13**	**(31%)**

1.3.3.1 Summary of Statewide Portfolio Finances, PY12

Table 34 presents an overview of statewide EDC spending on incentives and program overhead costs and overall benefits in PY12.

Table 34: Summary of PY12 Statewide Portfolio Finances**

Row #	Element	PY ($1000)
1	EDC Incentives to Participants [1]	$71,768
2	EDC Incentives to Trade Allies	$0
3	Participant Costs (net of incentives/rebates paid by utilities)	$296,375
4	**Incremental Measure Costs (Sum of rows 1 through 3)**	**$368,144**
5	Design and Development [2]	$746
6	Administration, Management, and Technical Assistance [3]	$9,718
7	Marketing [4]	$14,968
8	Program Delivery [5]	$76,209
9	EDC Evaluation Costs	$5,677
10	SWE Audit Costs	$1,200
11*	**Program Overhead Costs (Sum of rows 5 through 10)**	**$108,519**
12	Net Present Value (NPV) of increases in costs of natural gas (or other fuels) for fuel-switching programs	$29,972
13	**Total NPV TRC Costs [6] (NPV of sum of rows 4, 11, and 12)**	**$506,635**
14	Total NPV Lifetime Electric Energy Benefits	$447,340
15	Total NPV Lifetime Electric Capacity Benefits	$145,479
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$34,219
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$2,871
18	**Total NPV TRC Benefits [7] (Sum of rows 14 through 17)**	**$629,908**
19	**Statewide TRC Ratio [8]**	**1.24**

[1] Includes direct install equipment costs and costs for EE&C kits.
[2] Includes direct costs attributable to plan and advance the programs. Note that the design of the HERs program should be included here, while the actual development and mailing of HERs would be attributable to Program Delivery.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance. Any common portfolio costs that are allocated across programs should be shown in this row.
[4] Includes the marketing CSP and marketing costs by program CSPs.
[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs. For behavioral programs, this includes the printing and postage of HERs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include avoided supply costs, including the reduction in costs of electric energy, generation, transmission, distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. Note that savings carried over from Phase II are not to be included in Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
* Rows 1-11 are presented in nominal dollars.
** Totals will not equal sum of the rows due to rounding when aggregating costs and benefits across the seven EDCs.

1.3.4 PECO Impact Evaluation

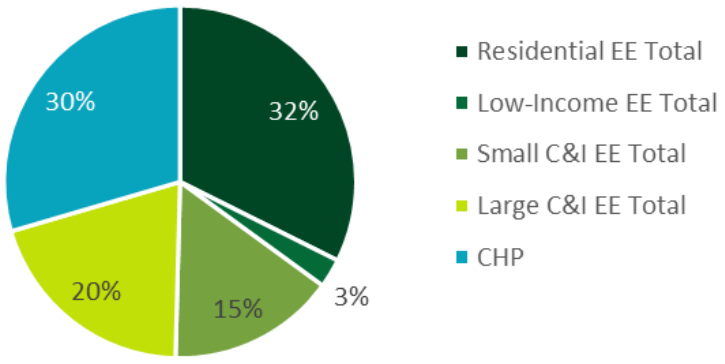
A summary of energy impacts by program for PY12 is presented in Table 35. Nearly one-third of the savings (32%) are attributable to the Residential Energy-Efficiency Program, an umbrella program containing solutions for lighting, appliances, and Heating, Ventilation, and Air Conditioning (HVAC); appliance recycling; whole home; new construction; multifamily; and behavioral solutions. Another 30% of savings are attributable to CHP projects (see Figure 4). This marks a change since PY11 in which the Residential Energy-Efficiency Program comprised 51% of savings and CHP projects were less than 1% of savings.

Table 35: PY12 Incremental Annual Energy Savings by Program (MWh/Year)* – PECO

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
Res. Energy-Efficiency	189,355	96%	181,154	0.73	132,494
LI Energy-Efficiency	19,850	75%	14,840	1.00	14,840
Small C&I Energy-Efficiency	84,865	102%	86,306	0.76	65,687
Large C&I Energy-Efficiency	117,556	96%	112,341	0.60	67,654
CHP	202,434	82%	165,298	0.87	143,810
Portfolio Total	**614,060**	**91%**	**559,940**	**0.76**	**424,486**

* Rows may not sum to totals due to rounding.

Figure 4: Percent of Portfolio PY12 Gross Savings, by Program – PECO



A summary of the peak demand impacts by energy-efficiency program for PY12 is presented in Table 36.

Table 36: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year)* – PECO

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
Res. Energy-Efficiency	16.36	147%	23.99	0.73	17.74
LI Energy-Efficiency	2.28	76%	1.73	1.00	1.73
Small C&I Energy-Efficiency	11.92	105%	12.48	0.76	9.42
Large C&I Energy-Efficiency	31.51	85%	26.78	0.64	17.18
CHP	10.06	196%	19.67	0.87	17.11
Portfolio Total	**72.14**	**117%**	**84.65**	**0.75**	**63.19**

* Rows may not sum to totals due to rounding.

1.3.5 PPL Impact Evaluation

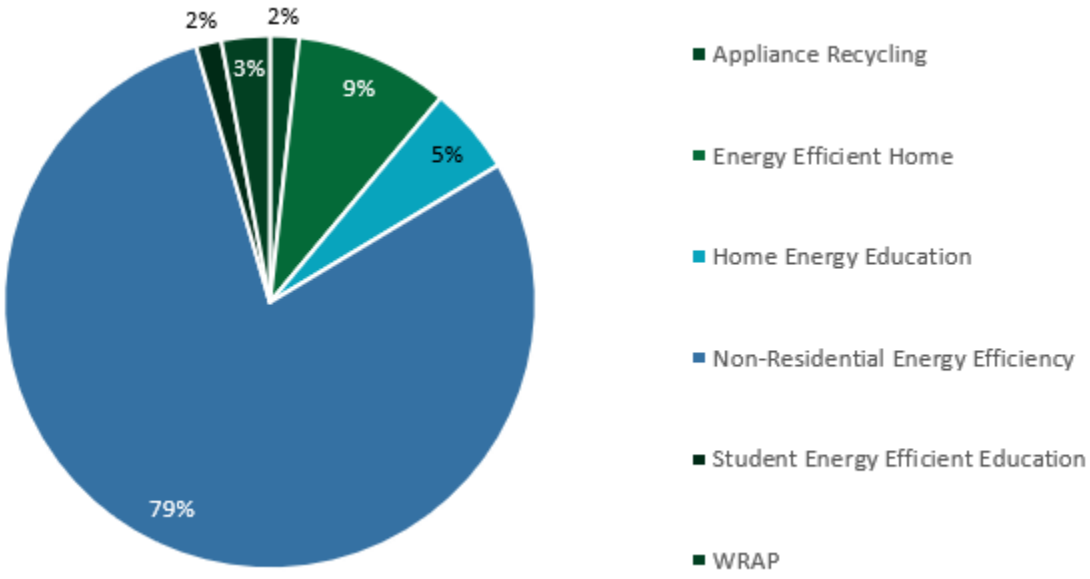
A summary of energy impacts by program for PY12 is presented in Table 37. The largest portion of savings (79%) is attributable to the Non-Residential Energy-Efficiency Program, a combination of the previous C&I custom and efficient-equipment programs (see also Figure 5). PPL did not implement the Efficient Lighting or Energy-Efficiency Kits and Education programs in PY12.

Table 37: PY12 Incremental Annual Energy Savings by Program (MWh/Year) – PPL

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
Appliance Recycling	4,111	105%	4,332	0.66	2,859
Efficient Lighting	-	-	-	-	-
Energy-Efficiency Kits and Education	-	-	-	-	-
Energy-Efficient Home	21,199	108%	22,966	0.46	10,579
Home Energy Education*	1,534	854%	13,097	1.00	13,097
Non-Residential Energy Efficiency	189,359	103%	194,768	0.66	128,521
Student Energy-Efficient Education (SEEE)	4,075	93%	3,806	1.00	3,806
WRAP	9,031	80%	7,215	1.00	7,215
Total	**229,309**	**107%**	**246,183**	**0.68**	**166,077**

* Verified savings were adjusted to account for uplift (double counting) in the Home Energy Education Program.

Figure 5: Percent of Portfolio PY12 Gross Savings, by Program – PPL



A summary of the peak demand impacts by energy-efficiency program for PY12 are presented in Table 38.

Table 38: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – PPL

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
Appliance Recycling	0.67	104%	0.70	0.66	0.46
Efficient Lighting	-	-	-	-	-
Energy-Efficiency Kits and Education	-	-	-	-	-
Energy-Efficiency Home	4.60	90%	4.14	0.46	1.85
Home Energy Education*	0.27	1,878%	5.07	1.00	5.07
Non-Res Energy Efficiency	28.49	93%	26.59	0.66	17.55
SEEE	0.33	110%	0.36	1.00	0.36
WRAP	0.85	81%	0.69	1.00	0.69
Portfolio Total	**35.20**	**106%**	**37.54**	**0.69**	**25.98**

*Verified demand savings were adjusted to account for uplift (double counting) in the Home Energy Education Program.

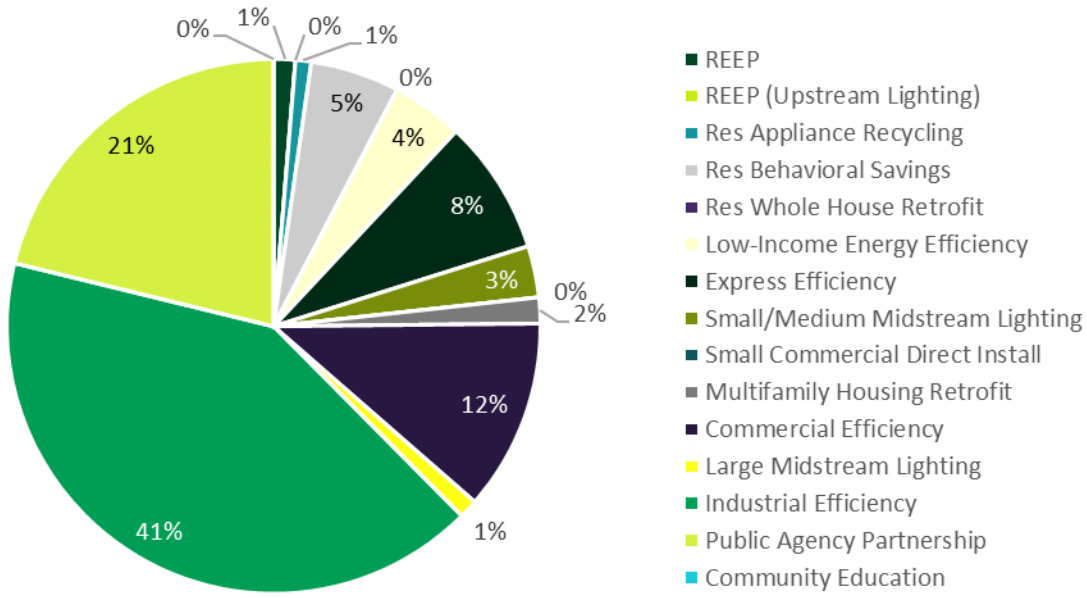
1.3.6 Duquesne Light Impact Evaluation

A summary of energy impacts by program for PY12 is presented in Table 39. The largest share of savings (41%) is attributable to the Industrial Efficiency program (see also Figure 6). This is a change from PY11 in which the upstream lighting portion of the REEP program comprised the largest share of savings and the Industrial Efficiency program was only 14% of savings.

Table 39: PY12 Incremental Annual Energy Savings by Program (MWh/Year) – Duquesne Light

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
REEP	1,175	115%	1,352	0.66	893
REEP (Upstream Lighting)	-	-	-	-	-
Res. Appliance Recycling	1,101	90%	988	0.47	461
Res. Behavioral Savings	7,452	75%	5,594	1.00	5,594
Res. Whole House Retrofit	-	-	-	-	-
LI Energy Efficiency	4,285	104%	4,462	1.00	4,462
Express Efficiency	6,339	133%	8,456	0.79	6,660
Small/Medium Midstream Lighting	2,626	123%	3,224	0.88	2,834
Small Commercial Direct Install	-	-	-	-	-
Multifamily Housing Retrofit	1,506	108%	1,625	0.45	739
Commercial Efficiency	10,552	114%	11,978	0.79	9,433
Large Midstream Lighting	1,365	87%	1,182	0.88	1,039
Industrial Efficiency	44,576	96%	42,690	0.61	25,948
Public Agency Partnership	18,882	116%	21,936	0.86	18,777
Community Education	-	-	-	-	-
Portfolio Total	**99,859**	**104%**	**103,486**	**0.74**	**76,839**

Figure 6: Percent of Portfolio PY12 Gross Savings, by Program – Duquesne Light



A summary of the peak demand impacts by energy-efficiency program for PY12 are presented in Table 40.

Table 40: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Duquesne Light

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
REEP	0.30	103%	0.31	0.61	0.19
REEP (Upstream Lighting)	0.00	-	0.00	-	0.00
Res. Appliance Recycling	0.12	92%	0.11	0.45	0.05
Res. Behavioral Savings	0.85	75%	0.64	1.00	0.64
Res. Whole House Retrofit	0.00	-	0.00	-	0.00
LI Energy Efficiency	0.41	107%	0.44	1.00	0.44
Express Efficiency	0.96	194%	1.86	0.79	1.47
Small/Medium Midstream Lighting	0.48	129%	0.62	0.87	0.54
Small Commercial Direct Install	0.00	-	0.00	-	0.00
Multifamily Housing Retrofit	0.16	113%	0.18	0.44	0.08
Commercial Efficiency	1.52	111%	1.68	0.79	1.32
Large Midstream Lighting	0.25	76%	0.19	0.89	0.17
Industrial Efficiency	6.12	82%	4.99	0.61	3.03
Public Agency Partnership	2.98	131%	3.91	0.86	3.35
Community Education	0.00	-	0.00	-	0.00
Portfolio Total	**14.16**	**105%**	**14.93**	**0.76**	**11.29**

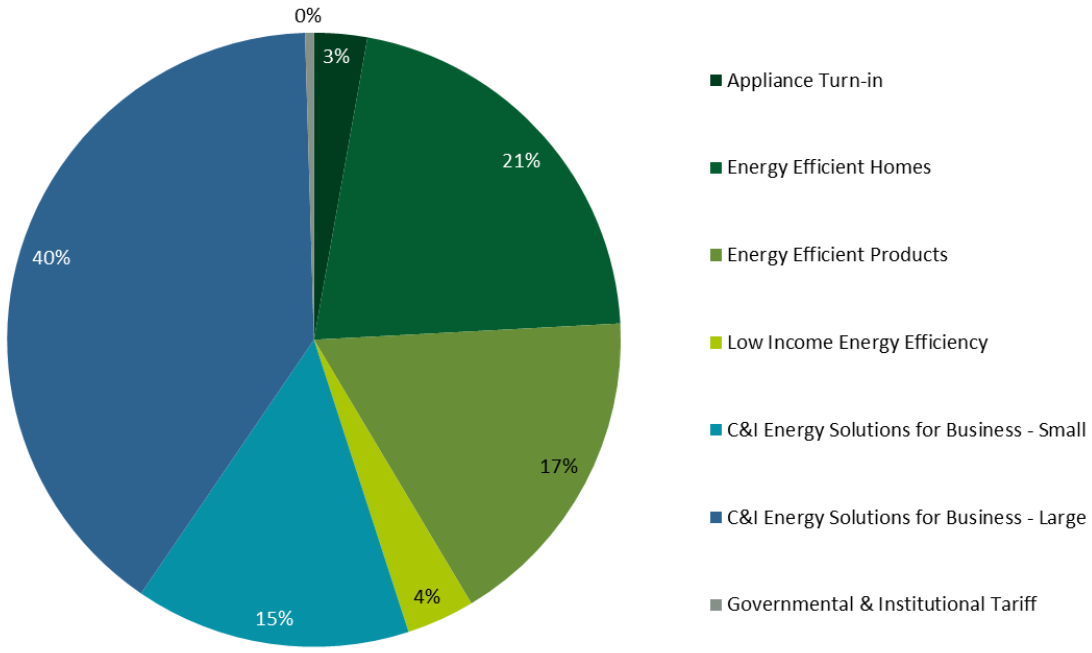
1.3.7 FirstEnergy: Metropolitan Edison Company Impact Evaluation

A summary of energy impacts by program for PY12 is presented in Table 41. The bulk of savings is attributable to the Large C&I Energy Solutions for Business Program (40%), Energy-Efficient Products Program (21%), and Small C&I Energy Solutions for Business Program (15%; see also Figure 7).

Table 41: PY12 Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
Appliance Turn-In	2,883	100%	2,877	0.45	1,295
Energy-Efficient Homes	22,781	97%	21,991	0.98	21,599
Energy-Efficient Products	13,797	129%	17,784	0.35	6,293
LI Energy Efficiency	3,275	113%	3,688	1.00	3,688
C&I Energy Solutions for Business – Small	15,540	96%	14,952	0.60	9,026
C&I Energy Solutions for Business – Large	42,809	96%	41,186	0.60	24,722
Governmental & Institutional Tariff	506	95%	478	0.62	297
Portfolio Total	**101,591**	**101%**	**102,958**	**0.65**	**66,919**

Figure 7: Percent of Portfolio PY12 Gross Savings, by Program – Met-Ed



A summary of the peak demand impacts by energy-efficiency program for PY12 are presented in Table 42.

Table 42: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Met-Ed

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
Appliance Turn-In	0.42	93%	0.39	0.45	0.18
Energy-Efficient Homes	4.49	69%	3.08	0.93	2.88
Energy-Efficient Products	1.97	130%	2.56	0.37	0.95
LI Energy Efficiency	0.49	86%	0.42	1.00	0.42
C&I Energy Solutions for Business – Small	2.35	91%	2.14	0.60	1.29
C&I Energy Solutions for Business – Large	6.11	91%	5.56	0.60	3.36
Governmental & Institutional Tariff	-	-	-	-	-
Portfolio Total	15.84	89%	14.15	0.64	9.07

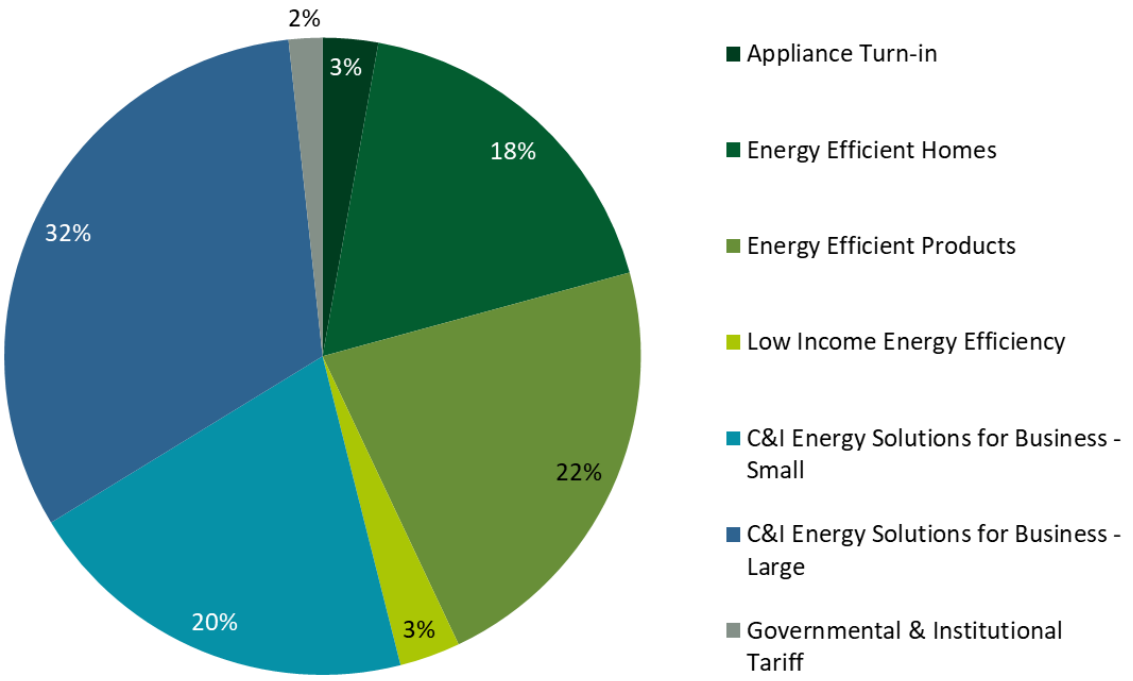
1.3.8 FirstEnergy: Pennsylvania Electric Company Impact Evaluation

A summary of energy impacts by program for PY12 is presented in Table 43. The bulk of savings is attributable to the Large C&I Energy Solutions for Business Program (32%), Energy-Efficient Products Program (22%), and Small C&I Solutions for Business Program (20%; see also Figure 8).

Table 43: PY12 Incremental Annual Energy Savings by Program (MWh/Year) – Penelec

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
Appliance Turn-In	2,573	89%	2,295	0.47	1,078
Energy-Efficient Homes	15,286	96%	14,653	0.99	14,578
Energy-Efficient Products	14,303	127%	18,128	0.37	6,692
LI Energy Efficiency	2,792	90%	2,520	1.00	2,520
C&I Energy Solutions for Business – Small	17,588	94%	16,490	0.81	13,322
C&I Energy Solutions for Business – Large	27,757	94%	26,142	0.81	21,258
Governmental & Institutional Tariff	1,509	92%	1,396	0.81	1,136
Portfolio Total	**81,808**	**100%**	**81,623**	**0.74**	**60,584**

Figure 8: Percent of Portfolio PY12 Gross Savings, by Program – Penelec



A summary of the peak demand impacts by energy-efficiency program for PY12 are presented in Table 44.

Table 44: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penelec

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
Appliance Turn-In	0.36	87%	0.32	0.47	0.15
Energy-Efficient Homes	2.20	80%	1.76	0.98	1.72
Energy-Efficient Products	1.87	121%	2.27	0.38	0.87
LI Energy Efficiency	0.36	79%	0.29	1.00	0.29
C&I Energy Solutions for Business – Small	2.61	106%	2.75	0.81	2.23
C&I Energy Solutions for Business – Large	4.25	105%	4.45	0.81	3.62
Governmental & Institutional Tariff	0.00	75%	0.00	0.47	0.00
Portfolio Total	**11.64**	**102%**	**11.83**	**0.75**	**8.87**

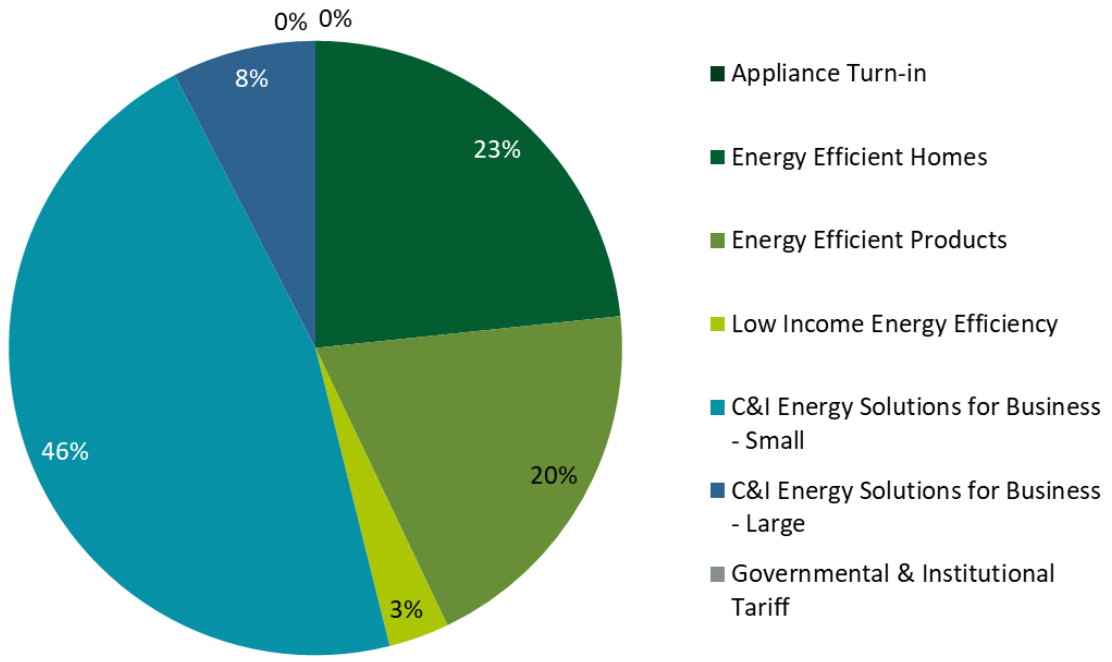
1.3.9 FirstEnergy: Pennsylvania Power Company Impact Evaluation

A summary of energy impacts by program for PY12 is presented in Table 45. The bulk of savings is attributable to the Small C&I Energy Solutions for Business Program (46%) and Energy-Efficient Homes Program (23%; see also Figure 9).

Table 45: PY12 Incremental Annual Energy Savings, by Program (MWh/Year) – Penn Power

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
Appliance Turn-In	-	-	-	-	-
Energy-Efficient Homes	5,404	102%	5,509	0.97	5,349
Energy-Efficient Products	3,334	139%	4,618	0.37	1,713
LI Energy Efficiency	691	109%	755	1.00	755
C&I Energy Solutions for Business – Small	11,315	97%	10,925	0.73	7,974
C&I Energy Solutions for Business – Large	1,863	96%	1,792	0.76	1,361
Governmental & Institutional Tariff	-	-	-	-	-
Portfolio Total	**22,607**	**104%**	**23,599**	**0.73**	**17,151**

Figure 9: Percent of Portfolio PY12 Gross Savings, by Program – Penn Power



A summary of the peak demand impacts by energy-efficiency program for PY12 are presented in Table 46.

Table 46: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penn Power

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
Appliance Turn-In	-	-	-	-	-
Energy-Efficient Homes	1.24	77%	0.95	0.89	0.84
Energy-Efficient Products	0.47	140%	0.66	0.39	0.26
LI Energy Efficiency	0.11	80%	0.09	1.00	0.09
C&I Energy Solutions for Business – Small	1.39	96%	1.34	0.74	0.99
C&I Energy Solutions for Business – Large	0.28	97%	0.27	0.72	0.19
Governmental & Institutional Tariff	-	-	-	-	-
Portfolio Total	**3.49**	**95%**	**3.30**	**0.72**	**2.37**

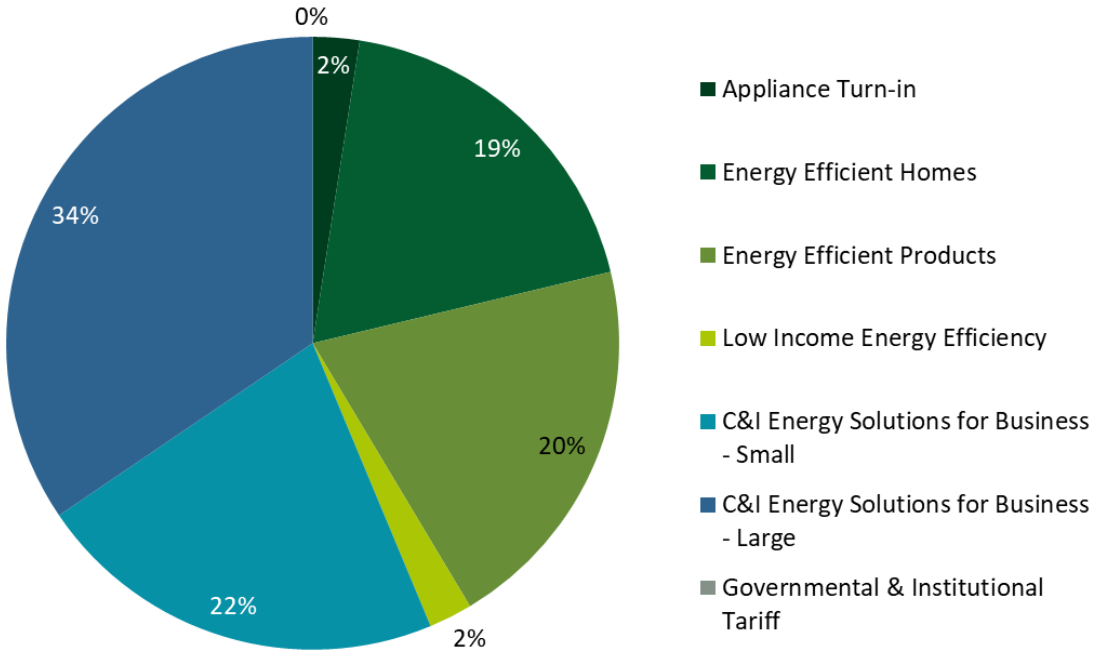
1.3.10 FirstEnergy: West Penn Power Impact Evaluation

A summary of energy impacts by program for PY12 is presented in Table 47. The bulk of savings is attributable to Large and Small C&I Energy Solutions for Business Programs (56%; see also Figure 10).

Table 47: PY12 Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power

Program	PYRTD (MWh/yr)	Realization Rate	PY12 Verified Gross (MWh/yr)	NTG	PY12 Verified Net (MWh/yr)
Appliance Turn-In	2,883	90%	2,581	0.48	1,239
Energy-Efficient Homes	24,797	80%	19,734	0.98	19,270
Energy-Efficient Products	16,823	126%	21,173	0.32	6,791
LI Energy Efficiency	3,164	76%	2,405	1.00	2,405
C&I Energy Solutions for Business – Small	23,063	99%	22,885	0.61	14,043
C&I Energy Solutions for Business – Large	35,600	102%	36,212	0.60	21,829
Governmental & Institutional Tariff	1	96%	1	0.48	0
Portfolio Total	**106,330**	**99%**	**104,990**	**0.62**	**65,577**

Figure 10: Percent of Portfolio PY12 Gross Savings, by Program – West Penn Power



A summary of the peak demand impacts by energy-efficiency program for PY12 are presented in Table 48.

Table 48: PY12 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – West Penn Power

Program	PYRTD (MW/yr)	Realization Rate	PY12 Verified Gross (MW/yr)	NTG	PY12 Verified Net (MW/yr)
Appliance Turn-In	0.38	89%	0.34	0.48	0.16
Energy-Efficient Homes	5.01	57%	2.86	0.92	2.62
Energy-Efficient Products	2.58	129%	3.32	0.35	1.17
LI Energy Efficiency	0.48	54%	0.26	1.00	0.26
C&I Energy Solutions for Business – Small	3.50	99%	3.48	0.61	2.12
C&I Energy Solutions for Business – Large	5.00	100%	5.00	0.60	3.02
Governmental & Institutional Tariff	0.00	85%	0.00	0.48	0.00
Portfolio Total	**16.95**	**90%**	**15.26**	**0.61**	**9.36**

1.4 RESULTS FOR PHASE III BY EDC

Table 49 provides a summary of Phase III reported and verified energy savings by EDC. Realization rates for Phase III increased from 97% (PECO and PPL) to 114% (Penn Power).

1.4.1 Summary of Phase III Energy Savings Statewide and by EDC

Table 49: Summary of Phase III Reported and Verified Energy Savings by EDC

EDC	Phase III Reported Gross (MWh/yr))	Phase III Verified Gross (MWh/yr)	Realization Rate
PECO	2,134,509	2,068,877	97%
PPL	1,810,935	1,749,310	97%
Duquesne Light	462,765	469,053	101%
FE: Met-Ed	681,682	746,655	110%
FE: Penelec	640,214	696,193	109%
FE: Penn Power	196,276	223,948	114%
FE: West Penn Power	657,746	709,466	108%
Statewide	**6,584,127**	**6,663,502**	**101%**

1.4.2 Summary of Phase III Energy Savings by Sector

Table 50 presents Phase III 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).[21] Residential customers (including LI customers) accounted for 51% of verified gross savings in Phase III.

Table 50: Summary of Phase III Verified Savings by Customer Segment[1]

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI (MWh)
PECO	1,046,282	192,897	482,863	235,437	111,398
PPL	643,285	474,974	295,539	227,967	107,547
Duquesne Light	160,387	83,302	145,140	61,955	18,270
FE: Met-Ed	390,952	117,660	157,644	37,654	42,746
FE: Penelec	343,830	112,720	135,921	62,117	41,605
FE: Penn Power	110,704	61,269	28,603	11,214	12,159
FE: West Penn Power	357,165	128,800	99,721	85,757	38,024
Statewide	**3,052,605**	**1,171,621**	**1,345,430**	**722,101**	**371,749**

[1] Does not include carryover savings.

[21] 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.

1.4.3 Comparison of the Phase III Expenditures and Approved EE&C Plan Budget Estimates

Table 51 provides an overview of the EDC's planned and actual expenditures for Phase III energy-efficiency programs. Overall, all actual EDC expenditures were 14% lower than planned. All EDCs had expenditures between 14% and 33% less than planned, except for PECO which had expenditures 4% greater than planned.

Table 51: Comparison of Phase III Statewide Energy-Efficiency Budgets and Expenditures[1]

EDC	Actual Phase III Expenditures ($1000)	Approved Budget for Phase III ($1000)	Difference Between Actual and EE&C Plan	Percent Difference from EE&C Plan
PECO	$306,861	$296,193	$10,668	4%
PPL	$251,528	$295,996	($44,469)	(15%)
Duquesne Light	$73,784	$85,671	($11,887)	(14%)
FE: Met-Ed	$79,135	$114,028	($34,893)	(31%)
FE: Penelec	$76,097	$113,865	($37,767)	(33%)
FE: Penn Power	$23,414	$29,658	($6,244)	(21%)
FE: West Penn Power	$80,518	$104,972	($24,455)	(23%)
Statewide	**$891,337**	**$1,040,383**	**($149,047)**	**(14%)**

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

In preparation for Phase III, each EDC filed an EE&C plan to the PUC 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 P3TD expenditures and verified gross energy savings to the EE&C plan projections for the first three years of the phase. DR programs do not achieve energy savings but do have program spending, so the SWE removed all DR expenditures and calculated ratios (actual/planned) to develop the values shown in Figure 11. PPL, Duquesne Light, and the four FirstEnergy companies finished Phase III ahead of projected energy savings totals despite spending less than projected. PECO met the Phase III savings target but finished Phase III below their EE&C plan's projected savings while spending slightly more than planned.

Figure 11: Phase III Energy-Efficiency Spending and Savings Compared to EE&C Plan

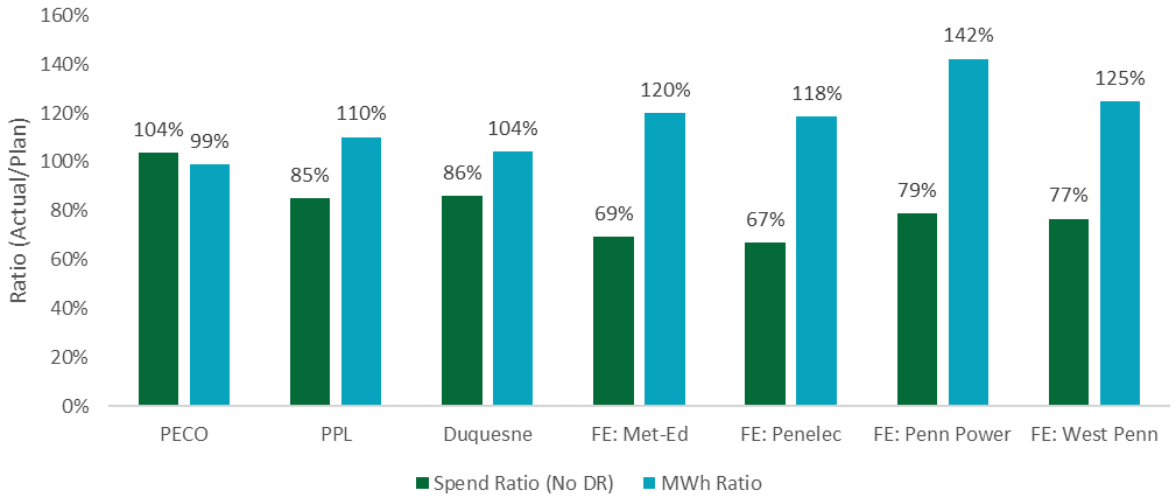


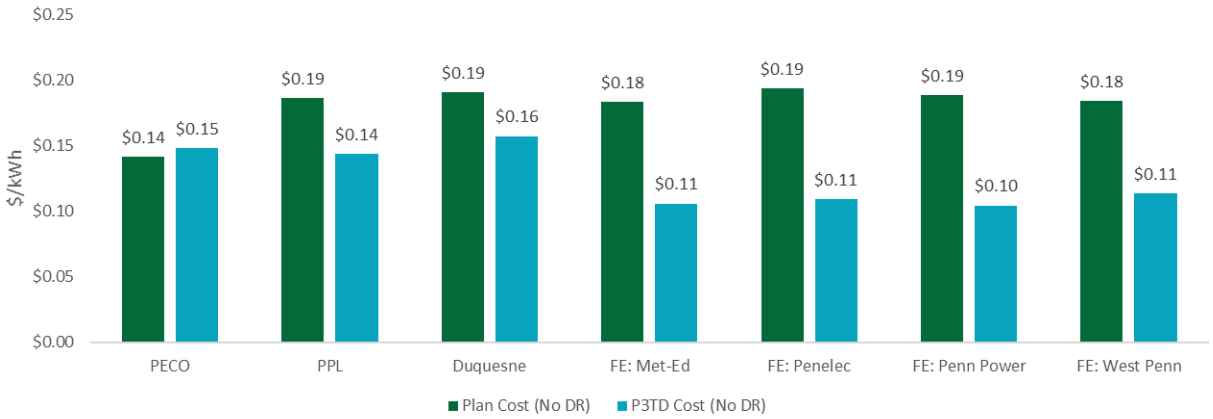
Table 52 provides an overview of the EDCs' planned and actual energy-efficiency acquisition costs for Phase III.

Table 52: Planned Versus Actual Energy-Efficiency Acquisition Costs, Phase III

EDC	Phase III Verified Savings (MWh/yr)	Forecasted Phase III Acquisition Cost per First-Year kWh Saved	Actual Phase III Acquisition Cost per First-Year kWh Saved	Percent Change from Forecasted Acquisition Cost
PECO	2,068,877	$0.14	$0.15	5%
PPL	1,749,310	$0.19	$0.14	(23%)
Duquesne Light	469,053	$0.19	$0.16	(17%)
FE: Met-Ed	746,655	$0.18	$0.11	(42%)
FE: Penelec	696,193	$0.19	$0.11	(44%)
FE: Penn Power	223,948	$0.19	$0.10	(44%)
FE: West Penn Power	709,466	$0.18	$0.11	(38%)
Statewide	**6,663,502**	**$0.17**	**$0.13**	**(22%)**

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 – or spending divided by verified gross savings. Figure 12 compares the projected phase-to-date energy-efficiency acquisition cost from the Phase III EE&C plan to actual phase-to-date energy-efficiency acquisition costs. All DR expenditures are removed from the numerator of the calculations. All EDCs except PECO delivered energy savings at a lower cost than projected for Phase III, with the FirstEnergy companies delivering energy-efficiency savings at approximately 58% of the projected cost in their Phase III EE&C plans.

Figure 12: Planned vs. Actual Phase III Energy-Efficiency Acquisition Cost



1.4.3.1 Summary of Statewide Portfolio Finances, Phase III

Table 53 presents an overview of statewide EDC spending on incentives and program overhead costs and overall benefits in Phase III.

Table 53: Summary of Phase III Statewide Portfolio Finances*

Row #	Element	PY ($1000)
1	EDC Incentives to Participants [1]	$332,818
2	EDC Incentives to Trade Allies	$0
3	Participant Costs (net of incentives/rebates paid by utilities)	$961,619
4	**Incremental Measure Costs (Sum of rows 1 through 3)**	**$1,294,437**
5	Design and Development [2]	$7,073
6	Administration, Management, and Technical Assistance [3]	$63,848
7	Marketing [4]	$68,598
8	Program Delivery [5]	$349,205
9	EDC Evaluation Costs	$26,456
10	SWE Audit Costs	$7,921
11	**Program Overhead Costs (Sum of rows 5 through 10)**	**$523,101**
12	Net Present Value (NPV) of increases in costs of natural gas (or other fuels) for fuel-switching programs	$54,025
13	**Total NPV TRC Costs [6] (NPV of sum of rows 4, 11, and 12)**	**$1,871,562**
14	Total NPV Lifetime Electric Energy Benefits	$1,785,063
15	Total NPV Lifetime Electric Capacity Benefits	$574,508
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$267,403
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	($4,890)
18	**Total NPV TRC Benefits [7] (Sum of rows 14 through 17)**	**$2,622,084**
19	**Statewide TRC Ratio [8]**	**1.40**

[1] Includes direct install equipment costs and costs for EE&C kits.
[2] Includes direct costs attributable to plan and advance the programs. Note that the design of the HERs program should be included here, while the actual development and mailing of HERs would be attributable to Program Delivery.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance. Any common portfolio costs allocated across programs should be shown in this row.
[4] Includes the marketing CSP and marketing costs by program CSPs.
[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs. For behavioral programs, this includes the printing and postage of HERs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. Note that savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
* Totals will not equal sum of the rows due to rounding when aggregating costs and benefits across the seven EDCs.

1.4.4 PECO Impact Evaluation

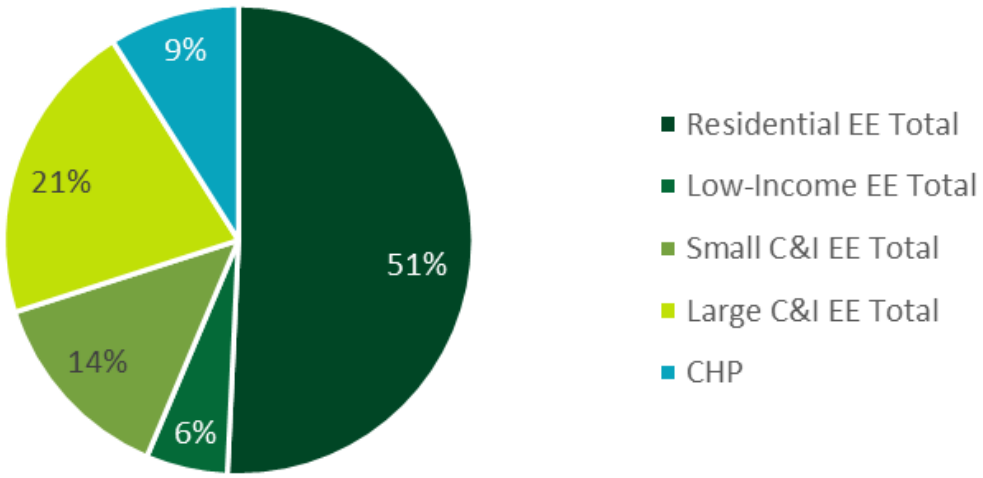
A summary of phase-to-date energy impacts by program is presented in Table 54. Just over half of the Phase III savings (51%) are attributable to the Residential Energy-Efficiency Program (Figure 13).

Table 54: Phase III Incremental Annual Energy Savings by Program (MWh/Year)* – PECO

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
Res. Energy-Efficiency	1,067,655	98%	1,049,133	0.68	714,967
LI Energy-Efficiency	130,422	90%	117,791	1.00	117,791
Small C&I Energy-Efficiency	274,627	103%	282,848	0.76	214,885
Large C&I Energy-Efficiency	432,921	100%	433,366	0.66	287,501
CHP	228,883	81%	185,738	0.87	161,721
Portfolio Total	**2,134,509**	**97%**	**2,068,877**	**0.72**	**1,496,865**

* Rows may not sum to totals due to rounding.

Figure 13: Percent of Portfolio Phase III Gross Savings, by Program – PECO



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 55.

Table 55: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year)* – PECO

Program	RTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
Res. Energy-Efficiency	94.12	1.44	135.53	0.67	91.19
LI Energy-Efficiency	15.28	0.90	13.80	1.00	13.80
Small C&I Energy-Efficiency	40.51	1.06	43.14	0.76	32.62
Large C&I Energy-Efficiency	76.01	1.00	75.82	0.66	50.28
CHP	12.86	1.72	22.12	0.87	19.26
Portfolio Total	**238.78**	**1.22**	**290.40**	**0.71**	**207.15**

* Rows may not sum to totals due to rounding.

1.4.5 PPL Impact Evaluation

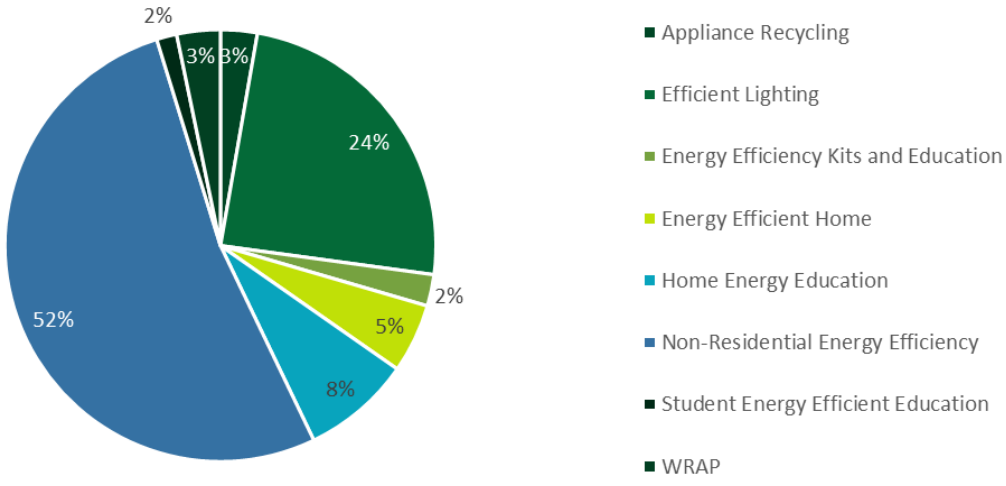
A summary of energy impacts by program for Phase III is presented in Table 56. The largest portion of savings (52%) is attributable to the Non-Residential Energy-Efficiency Program, a combination of the previous C&I custom and efficient-equipment programs, followed by the Efficient Lighting program (see also Figure 14).

Table 56: Phase III Incremental Annual Energy Savings by Program (MWh/Year) – PPL

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
Appliance Recycling	54,014	89%	48,215	0.66	31,822
Efficient Lighting	438,501	97%	426,752	0.83	354,204
Energy-Efficiency Kits and Education	48,719	85%	41,240	1.00	41,240
Energy-Efficiency Home	94,220	96%	90,459	0.60	54,248
Home Energy Education*	154,101	93%	143,307	1.00	143,307
Non-Res Energy Efficiency	927,856	99%	915,650	0.72	656,297
SEEE	27,125	98%	26,536	1.00	26,536
WRAP	66,399	86%	57,152	1.00	57,152
Portfolio Total	**1,810,935**	**97%**	**1,749,310**	**0.78**	**1,364,806**

* Verified savings were adjusted to account for uplift (double counting) in the Home Energy Education Program.

Figure 14: Percent of Portfolio Phase III Verified Gross Savings, by Program – PPL



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 57.

Table 57: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year) – PPL

Program	RTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
Appliance Recycling	8.22	92%	7.57	0.66	5
Efficient Lighting	61.68	92%	56.83	0.83	47.17
Energy-Efficiency Kits and Education	3.43	120%	4.13	1.00	4.13
Energy-Efficiency Home	17.77	90%	15.91	0.57	9.12
Home Energy Education*	74.72	40%	29.27	1.00	29.81
Non-Res Energy Efficiency	129.19	97%	125.31	0.72	90.20
SEEE	2.56	107%	2.73	1.00	2.73
WRAP	6.47	91%	5.91	1.00	5.91
Portfolio Total	**304.04**	**82%**	**247.66**	**0.78**	**193.53**

*Verified demand savings were adjusted to account for uplift (double counting) in the Home Energy Education program.

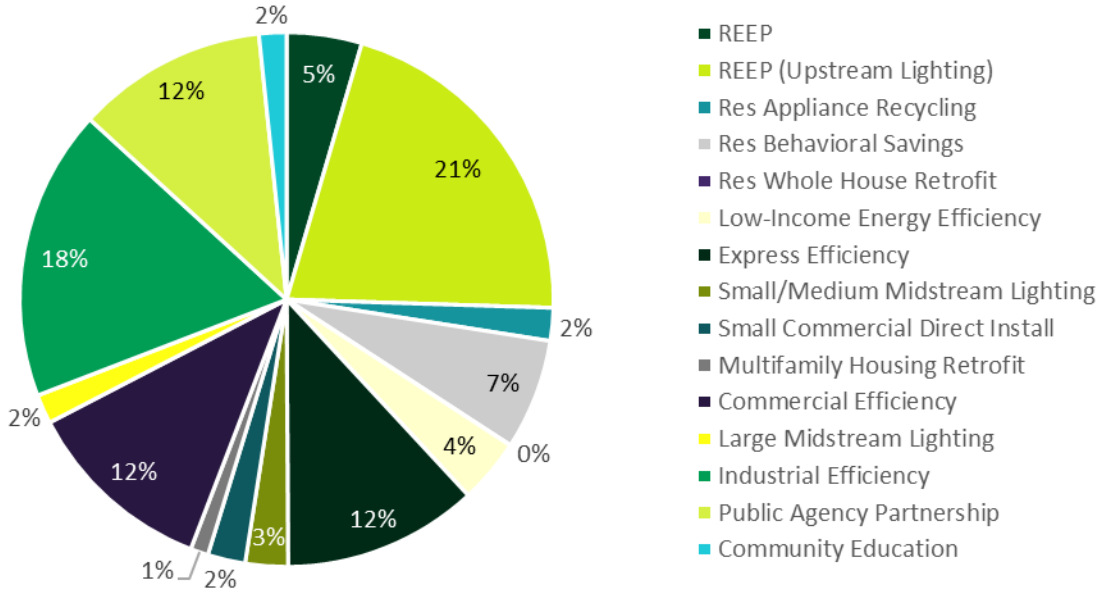
1.4.6 Duquesne Light Impact Evaluation

A summary of energy impacts by program for Phase III is presented in Table 58. The largest share of savings (21%) is attributable to the upstream lighting portion of the REEP Program, where retailers received incentives to discount prices of light-emitting diode (LED) bulbs sold at local retail stores, followed by the Industrial Efficiency Program (18%; see also Figure 15).

Table 58: Phase III Incremental Annual Energy Savings by Program (MWh/Year) – Duquesne Light

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
REEP	25,983	82%	21,371	0.72	15,304
REEP (Upstream Lighting)	97,895	100%	98,210	0.52	51,488
Res. Appliance Recycling	9,894	94%	9,310	0.47	4,338
Res. Behavioral Savings	37,955	83%	31,383	1.00	31,383
Res. Whole House Retrofit	134	85%	114	1.00	114
LI Energy Efficiency	19,303	95%	18,270	0.99	18,176
Express Efficiency	39,126	142%	55,463	0.64	35,322
Small/Medium Midstream Lighting	10,335	117%	12,114	0.81	9,781
Small Commercial Direct Install	10,934	98%	10,688	0.99	10,613
Multifamily Housing Retrofit	4,953	102%	5,036	0.46	2,330
Commercial Efficiency	53,831	101%	54,155	0.68	37,033
Large Midstream Lighting	7,628	109%	8,282	0.82	6,771
Industrial Efficiency	86,799	95%	82,703	0.53	44,000
Public Agency Partnership	50,339	108%	54,165	0.64	34,783
Community Education	7,655	102%	7,789	0.50	3,933
Portfolio Total	**462,765**	**101%**	**469,053**	**0.65**	**305,368**

Figure 15: Percent of Portfolio Phase III Verified Gross Savings, by Program – Duquesne Light



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 59.

Table 59: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Duquesne Light

Program	RTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
REEP	3.63	89%	3.22	0.64	2.06
REEP (Upstream Lighting)	9.92	100%	9.94	0.52	5.21
Res. Appliance Recycling	1.11	94%	1.04	0.47	0.49
Res. Behavioral Savings	4.33	83%	3.58	1.00	3.58
Res. Whole House Retrofit	0.01	100%	0.01	1.00	0.01
LI Energy Efficiency	1.90	97%	1.85	0.99	1.84
Express Efficiency	5.84	154%	9.02	0.65	5.83
Small/Medium Midstream Lighting	1.83	117%	2.15	0.80	1.73
Small Commercial Direct Install	1.36	102%	1.39	0.99	1.38
Multifamily Housing Retrofit	0.48	104%	0.50	0.46	0.23
Commercial Efficiency	7.28	103%	7.48	0.70	5.21
Large Midstream Lighting	1.38	107%	1.47	0.82	1.20
Industrial Efficiency	10.87	90%	9.76	0.55	5.35
Public Agency Partnership	7.38	97%	7.16	0.69	4.94
Community Education	1.31	102%	1.34	0.51	0.69
Portfolio Total	**58.61**	**102%**	**59.90**	**0.66**	**39.75**

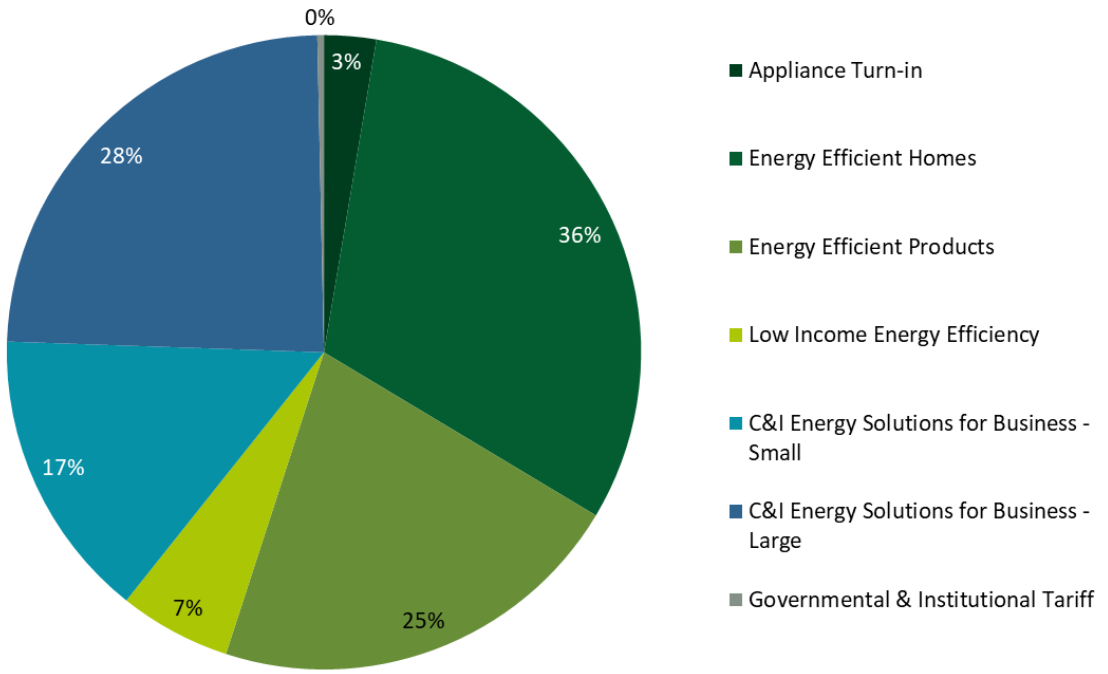
1.4.7 FirstEnergy: Metropolitan Edison Company Impact Evaluation

A summary of energy impacts by program for Phase III is presented in Table 60. The bulk of savings are attributable to the Energy-Efficient Homes Program (31%), Large C&I Energy Solutions for Business Program (24%), and Energy-Efficient Products Program (21%; see also Figure 16).

Table 60: Phase III Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
Appliance Turn-In	20,092	98%	19,786	0.47	9,288
Energy-Efficient Homes	218,193	106%	231,070	0.93	213,762
Energy-Efficient Products	104,730	153%	159,814	0.34	54,972
LI Energy Efficiency	37,394	114%	42,563	1.00	42,563
C&I Energy Solutions for Business – Small	113,671	97%	110,788	0.62	69,135
C&I Energy Solutions for Business – Large	185,036	97%	180,135	0.59	106,420
Governmental & Institutional Tariff	2,567	97%	2,498	0.64	1,589
Portfolio Total	**681,682**	**110%**	**746,655**	**0.67**	**497,728**

Figure 16: Percent of Portfolio Phase III Verified Gross Savings, by Program – Met-Ed



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 61.

Table 61: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Met-Ed

Program	RTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
Appliance Turn-In	2.86	95%	2.72	0.47	1.28
Energy-Efficient Homes	31.45	91%	28.47	0.90	25.74
Energy-Efficient Products	13.69	159%	21.72	0.35	7.64
LI Energy Efficiency	4.74	104%	4.92	1.00	4.92
C&I Energy Solutions for Business – Small	17.09	97%	16.52	0.63	10.36
C&I Energy Solutions for Business – Large	25.55	96%	24.49	0.59	14.40
Governmental & Institutional Tariff	0.04	95%	0.03	0.64	0.02
Portfolio Total	**95.41**	**104%**	**98.88**	**0.65**	**64.37**

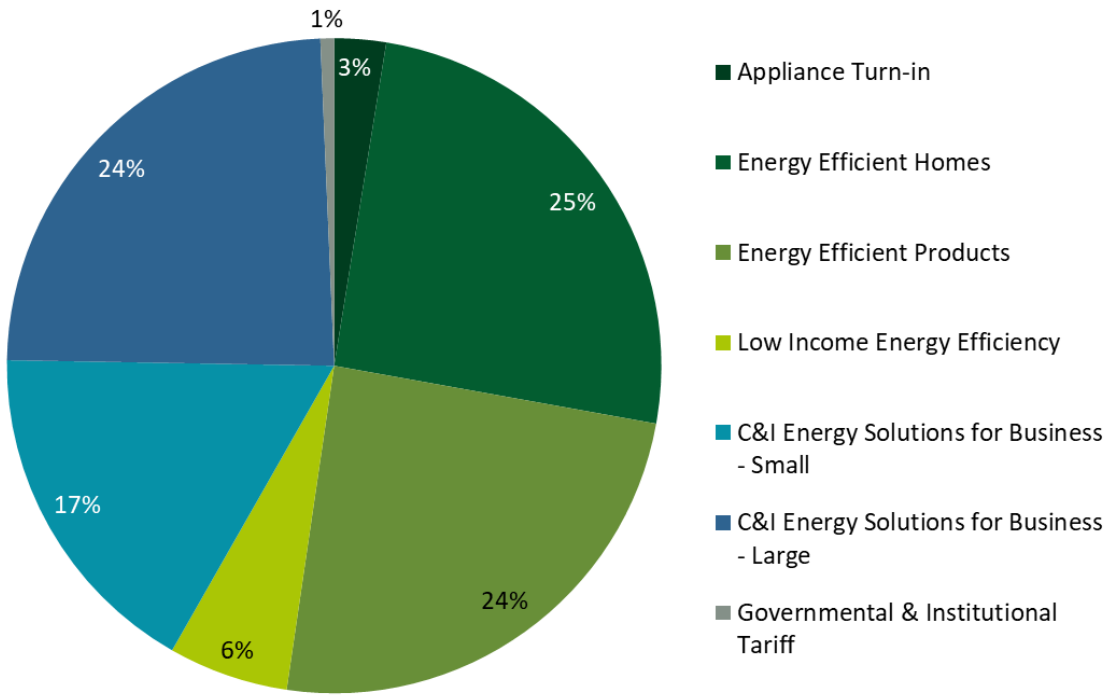
1.4.8 FirstEnergy: Pennsylvania Electric Company Impact Evaluation

A summary of energy impacts by program for Phase III is presented in Table 62. The bulk of savings is attributable to the Energy-Efficient Homes Program (25%), Energy-Efficient Products Program (24%), and Large C&I Energy Solutions for Business Program (24%; see also Figure 17).

Table 62: Phase III Incremental Annual Energy Savings by Program (MWh/Year) – Penelec

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
Appliance Turn-In	19,087	93%	17,792	0.46	8,140
Energy-Efficient Homes	165,406	106%	175,945	0.91	159,827
Energy-Efficient Products	116,910	146%	170,517	0.34	58,149
LI Energy Efficiency	37,935	109%	41,250	1.00	41,250
C&I Energy Solutions for Business – Small	121,689	97%	118,519	0.78	93,011
C&I Energy Solutions for Business – Large	174,250	96%	167,484	0.79	133,083
Governmental & Institutional Tariff	4,936	95%	4,687	0.81	3,784
Portfolio Total	**640,214**	**109%**	**696,193**	**0.71**	**497,244**

Figure 17: Percent of Portfolio Phase III Verified Gross Savings, by Program – Penelec



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 63.

Table 63: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penelec

Program	RTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
Appliance Turn-In	2.59	92%	2.38	0.46	1.09
Energy-Efficient Homes	21.05	92%	19.31	0.91	17.52
Energy-Efficient Products	13.62	152%	20.74	0.35	7.22
LI Energy Efficiency	4.46	99%	4.43	1.00	4.43
C&I Energy Solutions for Business – Small	18.21	96%	17.49	0.79	13.89
C&I Energy Solutions for Business – Large	22.16	94%	20.89	0.80	16.74
Governmental & Institutional Tariff	0.07	96%	0.06	0.79	0.05
Portfolio Total	**82.15**	**104%**	**85.31**	**0.71**	**60.94**

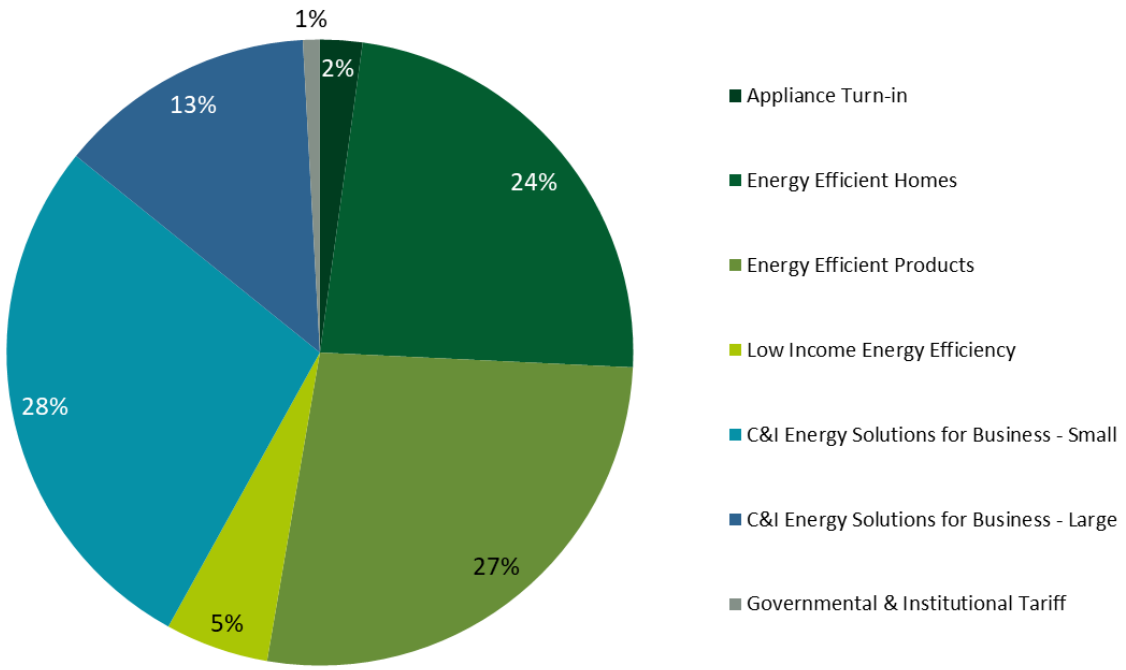
1.4.9 FirstEnergy: Pennsylvania Power Company Impact Evaluation

A summary of energy impacts by program for Phase III is presented in Table 64. The bulk of savings is attributable to the Small C&I Energy Solutions for Business Program (28%), Energy-Efficient Products Program (27%), and Energy-Efficient Homes Program (24%; see also Figure 18).

Table 64: Phase III Incremental Annual Energy Savings, by Program (MWh/Year) – Penn Power

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
Appliance Turn-In	5,635	87%	4,890	0.53	2,583
Energy-Efficient Homes	47,755	111%	52,788	0.91	48,139
Energy-Efficient Products	34,954	173%	60,345	0.33	19,808
LI Energy Efficiency	11,692	102%	11,953	1.00	11,953
C&I Energy Solutions for Business – Small	63,767	98%	62,185	0.74	46,276
C&I Energy Solutions for Business – Large	30,439	98%	29,838	0.69	20,712
Governmental & Institutional Tariff	2,034	96%	1,948	0.75	1,464
Portfolio Total	**196,276**	**114%**	**223,948**	**0.67**	**150,936**

Figure 18: Percent of Portfolio Phase III Verified Gross Savings, by Program – Penn Power



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 65.

Table 65: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penn Power

Program	PYRTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
Appliance Turn-In	0.72	87%	0.63	0.53	0.33
Energy-Efficient Homes	8.08	95%	7.70	0.85	6.57
Energy-Efficient Products	4.49	181%	8.11	0.34	2.78
LI Energy Efficiency	1.49	93%	1.39	1.00	1.39
C&I Energy Solutions for Business – Small	8.91	97%	8.66	0.75	6.46
C&I Energy Solutions for Business – Large	3.58	95%	3.40	0.69	2.36
Governmental & Institutional Tariff	0.07	104%	0.07	0.75	0.05
Portfolio Total	**27.33**	**110%**	**29.95**	**0.67**	**19.95**

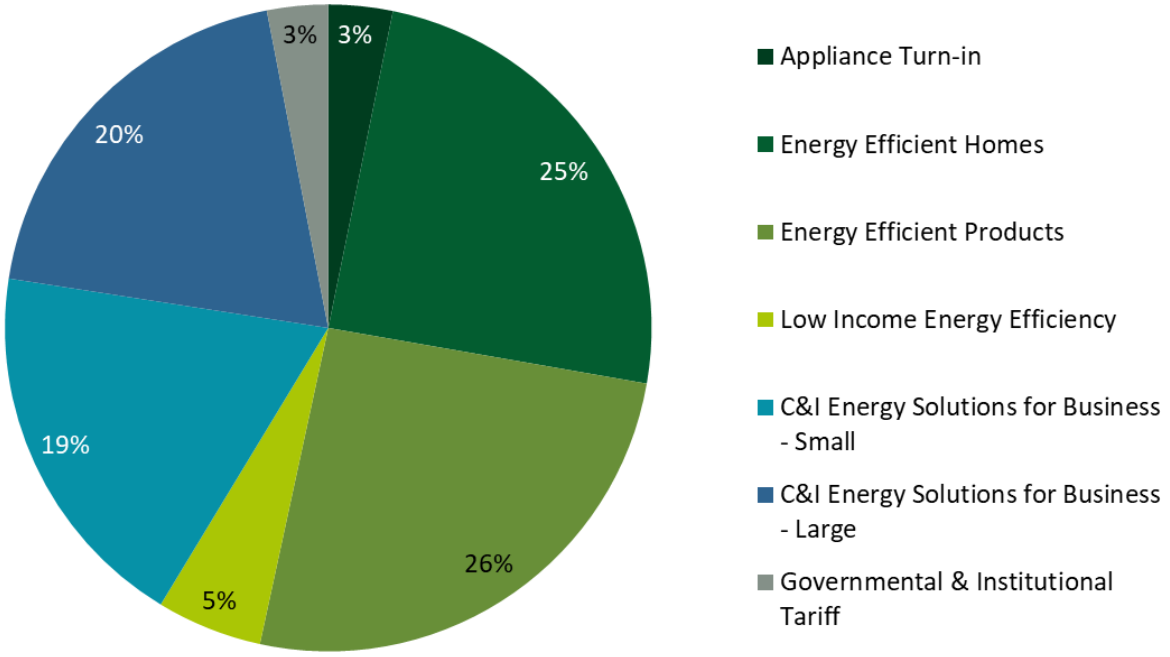
1.4.10 FirstEnergy: West Penn Power Impact Evaluation

A summary of energy impacts by program for Phase III is presented in Table 66. The bulk of savings are attributable to the Energy-Efficient Products Program (26%), Energy-Efficient Homes Program (25%) and Large C&I Energy Solutions for Business Program (20%; see also Figure 19).

Table 66: Phase III Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power

Program	RTD (MWh/yr)	Realization Rate	Phase III Verified Gross (MWh/yr)	NTG	Phase III Verified Net (MWh/yr)
Appliance Turn-In	23,620	96%	22,769	0.48	10,967
Energy-Efficient Homes	183,818	95%	174,136	0.94	164,243
Energy-Efficient Products	121,924	149%	181,896	0.28	51,010
LI Energy Efficiency	36,883	102%	37,447	1.00	37,447
C&I Energy Solutions for Business – Small	131,811	101%	133,184	0.70	93,852
C&I Energy Solutions for Business – Large	139,222	99%	138,410	0.64	88,676
Governmental & Institutional Tariff	20,468	106%	21,624	0.79	17,131
Portfolio Total	**657,746**	**108%**	**709,466**	**0.65**	**463,324**

Figure 19: Percent of Portfolio Phase III Verified Gross Savings, by Program – West Penn Power



A summary of the peak demand impacts by energy-efficiency program for Phase III are presented in Table 67.

Table 67: Phase III Peak Demand Savings by Energy-Efficiency Program (MW/Year) – West Penn Power

Program	RTD (MW/yr)	Realization Rate	Phase III Verified Gross (MW/yr)	NTG	Phase III Verified Net (MW/yr)
Appliance Turn-In	3.07	96%	2.97	0.48	1.43
Energy-Efficient Homes	31.18	73%	22.82	0.90	20.62
Energy-Efficient Products	17.14	151%	25.93	0.29	7.59
LI Energy Efficiency	5.01	87%	4.38	1.00	4.38
C&I Energy Solutions for Business – Small	19.15	99%	18.93	0.71	13.39
C&I Energy Solutions for Business – Large	17.73	97%	17.13	0.66	11.28
Governmental & Institutional Tariff	0.20	104%	0.21	0.81	0.17
Portfolio Total	**93.49**	**99%**	**92.36**	**0.64**	**58.86**

Section 2 Demand Response Savings – PY12 and Phase III

Unlike energy-efficiency measures, which seek to reduce overall electric consumption, DR programs are dispatchable, or event-based, offerings designed to reduce peak loads when the electric grid is most constrained. The Phase III demand reduction requirements are specific to dispatchable demand response and cannot be satisfied with coincident demand reductions from energy-efficiency measures. The Phase III Implementation Order and subsequent Phase III Clarification Order[22] provided the following instructions to EDCs about which hours would be used to measure DR performance (e.g., when to call DR events):

1) Curtailment events shall be limited to the months of June through September.
2) Curtailment events shall be called for the first six days in which the peak hour of PJM's day-ahead forecast for the PJM RTO is greater than 96% of the PJM RTO summer peak demand forecast for the months of June through September each year of the program.
3) Each curtailment event shall last four consecutive hours.[23]
4) Each curtailment event shall be called such that it will occur during the day's forecasted peak hour(s) above 96% of PJM's RTO summer peak demand forecast.
5) Once six curtailment events have been called in a program year, the peak demand reduction program shall be suspended for that program year.
6) The reductions attributable to a four-consecutive-hour curtailment event will be based on the average MW reduction achieved during each hour of an event.
7) Compliance will be determined based on the average MW reductions achieved from events called in the last four years of the program.
8) The EDCs, in their plans, must demonstrate that the cost to acquire MWs from customers who participate in PJM's ELRP is no more than half the cost to acquire MWs from customers in the same rate class that are not participating in PJM's ELRP.

Compliance with Phase III DR targets was originally intended to span the summers of 2017-2020, or Act 129 PY9-PY12. EDCs were not required to obtain peak demand reductions in the first program year of Phase III (PY8) to allow adequate time for CSP selection and customer recruitment. Following the outbreak of the COVID-19 pandemic, the Commission's Phase III

[22] Pennsylvania Public Utility Commission, Phase III Clarification Order. From the Public Meeting of August 20, 2015. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1378016.doc

[23] Given the voluntary nature of PY12 DR, PECO elected to dispatch its Residential and Small C&I DR programs for two hours per event day rather than four during summer 2020.

Modification Order[24] permitted EDCs to operate DR programs on a voluntary basis in PY12. As a result, performance during PY12 DR events does not affect compliance with Phase III DR targets.

2.1 PHASE III DR REDUCTION COMPLIANCE TARGETS

The final Phase III Implementation Order established DR targets for each EDC covered by Act 129 (with no DR target for Penelec). The percentage reduction targets, as well as the value of reductions in MW, are reported in Table 68. The targets reported in Table 68 are for the average system-level load reduction across all events called in PY9, PY10, and PY11.

Table 68: Act 129 Phase III Five-Year Energy DR Reduction Compliance Targets[1]

EDC	Five-Year DR Spending Allocation (Million $)	Program Acquisition Costs ($/MW/year)	Average Annual Potential Savings (MW)	% Reduction (Relative to 2007-2008 Peak Demand)
PECO	$42.70	$66,370	161	2.0%
PPL	$15.38	$41,622	92	1.4%
Duquesne Light	$9.77	$57,976	42	1.7%
FE: Met-Ed	$9.95	$51,210	49	1.8%
FE: Penelec	$0.00	$50,782	0	0.0%
FE: Penn Power	$3.33	$49,349	17	1.7%
FE: West Penn Power	$11.78	$46,203	64	1.8%
Statewide	**$92.90**	**$54,714**	**425**	**1.6%**

[1] Note that the statewide values reported in this table are from the 2nd Addendum to the 2015 SWE Market Potential Studies. https://www.puc.pa.gov/pcdocs/1367057.docx

2.2 PHASE III DR COMPLIANCE

The final Phase III Implementation Order[25] established DR targets for each EDC covered by Act 129 (with no DR target for Penelec). Table 69 presents the peak demand reduction targets, in MW, along with the average performance across the five PY12 DR events and the average performance for the thirteen Phase III DR events days in the years that will be used for compliance. Act 129 DR events are triggered on non-holiday summer weekdays when PJM Interconnection's (PJM) day-ahead load forecast for the Regional Transmission Organization (RTO) is greater than or equal to 96% of the peak load forecast for the summer.[26] Each event is

[24] Pennsylvania Public Utility Commission, Phase III Modification Order. From the Public Meeting of May 21, 2020. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1665150.docx
[25] Pennsylvania Public Utility Commission, Phase III Implementation Order. From the Public Meeting of June 11, 2015. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1367313.doc
[26] PJM Interconnection is an RTO that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia. https://www.pjm.com/about-pjm/who-we-are

four hours in length.[27] The Phase III verified performance estimates reported in Table 69 are for the average performance across events in PY9 through PY11. EDCs were not required to obtain peak demand reductions in the first program year of Phase III (PY8) and the final program year of Phase III (PY12) was voluntary due to the COVID-19 pandemic.

Table 69: Performance Against Phase III DR Compliance Targets

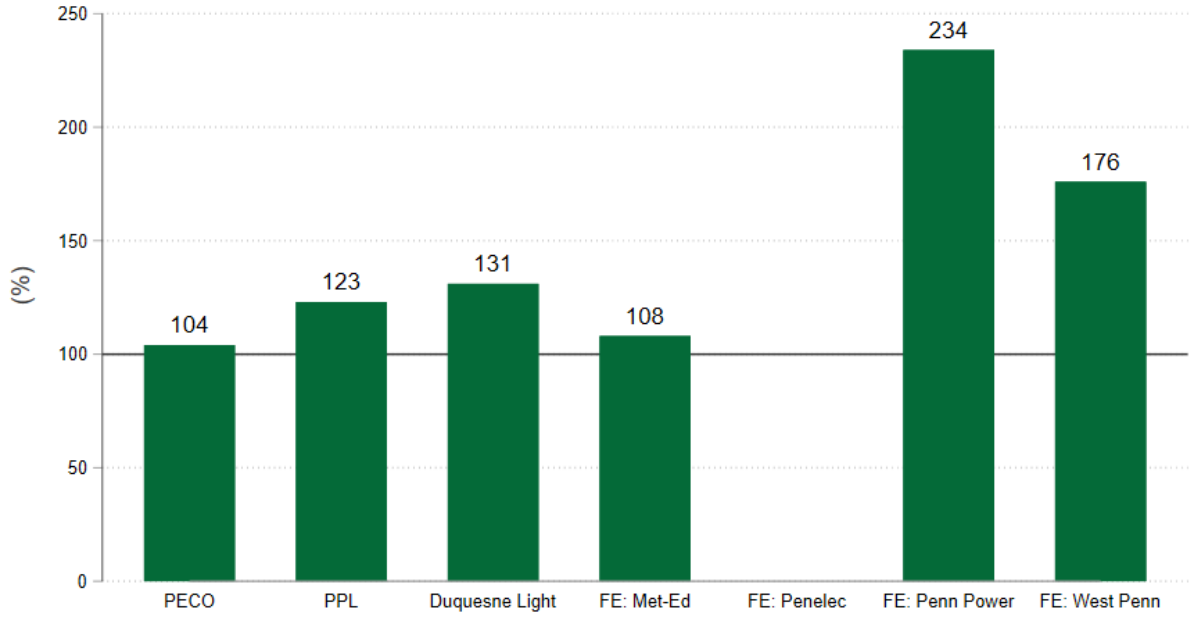
EDC	Phase III DR Target (MW)	PY12 Average Event Performance (MW)	PY9-PY11 Average Event Performance (Compliance Value)	Percent of Target
PECO	161	160.5	167.1	104%
PPL	92	96.9	112.8	123%
Duquesne Light	42	32.4	55.2	131%
FE: Met-Ed	49	46.0	53.0	108%
FE: Penelec	0	0.0	0.0	N/A
FE: Penn Power	17	11.6	39.9	235%
FE: West Penn Power	64	91.3	112.4	176%
Statewide	**425**	**438.7**	**540.4**	**127%**

Compliance with Phase III DR targets is based on average performance across all Phase III DR events. In June 2020, the Commission deemed DR programs voluntary in PY12 due to the COVID-19 pandemic,[28] so the VTD values in Table 69 are the final compliance totals for Phase III. Each EDC with a Phase III DR target shows VTD performance greater than their goal and should be determined compliant with the primary Phase III DR target (Figure 20). However, the Commission's Phase III Implementation Order also established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. The EDC-specific DR discussions in Section 2.3 compare DR performance on individual event days to this 85% threshold. The average performance across PY9, PY10, and PY11 events is shown in "Compliance Value" totals row of the EDC-specific tables in the following sections.

[27] Given the voluntary nature of PY12 DR, PECO elected to dispatch its Residential and Small C&I DR programs for two hours per event day rather than four during summer 2020.

[28] The Commission granted the Energy Association of Pennsylvania's (EAP's) petition to modify compliance with peak demand reduction targets because of the COVID-19 pandemic. The EAP requested that the Commission modify the Phase III Implementation Order to measure compliance with peak demand reduction targets based on EDC performance during the second, third, and fourth program years of Phase III (June 1, 2017 through May 31, 2020) and permit EDCs to implement approved demand reduction programs on a voluntary basis for the fifth and final program year (June 1, 2020 through May 31, 2021). EAP sought expedited consideration of this Petition.
See *Petition to Amend the Commission's June 19, 2015 Implementation Order* at Docket No. M-2014-2424864, (Phase III Implementation Order) Phase III Modification Order entered June 3, 2020.
http://www.puc.pa.gov/pcdocs/1665150.docx

Figure 20: Average Percentage of Target Phase III by EDC



**Percentages reflect the average performance for all events PY9 – PY11. PY12 was voluntary and excluded from the calculations.*

Customers receive incentives for participating in Act 129 DR programs. Some of the customers enrolled in Act 129 DR programs are also involved in the PJM ELRP program. If customers in the ELRP program are enrolled in the Act 129 DR program, then their acquisition costs are required to be 50% or less of the non-PJM customers. The EDC's have not submitted customer-level data on acquisition cost for verification of this requirement, and all but PPL, who only enrolls ELRP participants, have not mentioned their cost structures in their Phase III annual reports.

2.3 PHASE III 5 COINCIDENT PEAK PERFORMANCE

The Five Coincident Peak (5CP) hours are the five highest daily unrestricted RTO peak loads for each summer (June 1 through September 30). They are identified and published by PJM, usually in mid-October. One metric for the effectiveness of Act 129 DR programming is the percentage of PJM's 5CP hours covered by DR events. Table 70 shows that over the four summers Phase III DR programs were active, Act 129 events were initiated on 12 of the 20 5CP days. This means that events were called on 60% of the possible 5CP days. Eighteen events were called over Phase III which means that the events were called on a 5CP day 67% of the time.

Table 70: Act 129 Phase III 5 CP Hours

Day	Date	Hour Ending	Event Called?
Monday	6/12/2017	18:00	No
Tuesday	6/13/2017	17:00	Yes
Wednesday	7/19/2017	18:00	No
Thursday	7/20/2017	17:00	Yes
Friday	7/21/2017	17:00	Yes
Monday	6/18/2018	17:00	No
Monday	8/27/2018	17:00	No
Tuesday	8/28/2018	17:00	Yes
Tuesday	9/4/2018	17:00	Yes
Wednesday	9/5/2018	17:00	Yes
Wednesday	7/10/2019	18:00	No
Wednesday	7/17/2019	17:00	Yes
Friday	7/19/2019	18:00	Yes
Monday	7/29/2019	17:00	No
Monday	8/19/2019	17:00	Yes
Monday	7/6/2020	18:00	No
Thursday	7/9/2020	18:00	No
Monday	7/20/2020	17:00	Yes
Monday	7/27/2020	17:00	Yes
Wednesday	7/29/2020	18:00	Yes

2.4 Results for PY12 (June 1, 2020-May 31, 2021) by EDC

2.4.1 PECO Demand Response

PECO has three DR Programs: Residential, Small Commercial and Industrial (C&I), and Large C&I. Each of these programs defines participation differently due to variations in delivery and/or data tracking methodologies. Table 71 provides the definitions used and the counts of PY12 participation for each included DR program.

Table 71: PECO Participation by Program

Program	Definition of Participant	PY12 Participation
Residential DR	For Residential Direct Load Control (DLC), a participant is defined as a unique account number where device status is recorded in the PECO database as installed or swapped and the measure code is CACS (central air conditioner switch). One participant may have more than one DLC device installed at the home. Customers whose accounts are disconnected, who have opted out of the program, or for whom the DLC device was removed are not counted as participants.	50,919

Program	Definition of Participant	PY12 Participation
Small C&I DR	A participant is defined as a unique account number where device status is recorded in the PECO database as installed or swapped and the measure code is PCT (programmable communicating thermostat). One participant may have more than one DLC device installed on the premise. Customers whose accounts are disconnected, who have opted out of the program, or for whom the DLC device was removed are not counted as participants.	1,517
Large C&I DR	A participant is defined as a large C&I customer (defined by PECO account number) enrolled with a DR program CSP for at least one hour of at least one event occurring in any given program year.	356

*DR participation is not additive like other programs because the same participants tend to remain in the program with only small attrition. Therefore, total participation in the DR programs for Phase III is equal to the highest program year participation count for each of the three programs.

PECO's three Demand Response programs – Residential DR, Small C&I DR, and Large C&I DR – had five event days in PY12. The Phase III DR performance target for PECO is 161.0 MW. Table 72 shows the DR savings for each program, as well as the portfolio average for each event day. The bottom of the table includes average performance for PY12 events.

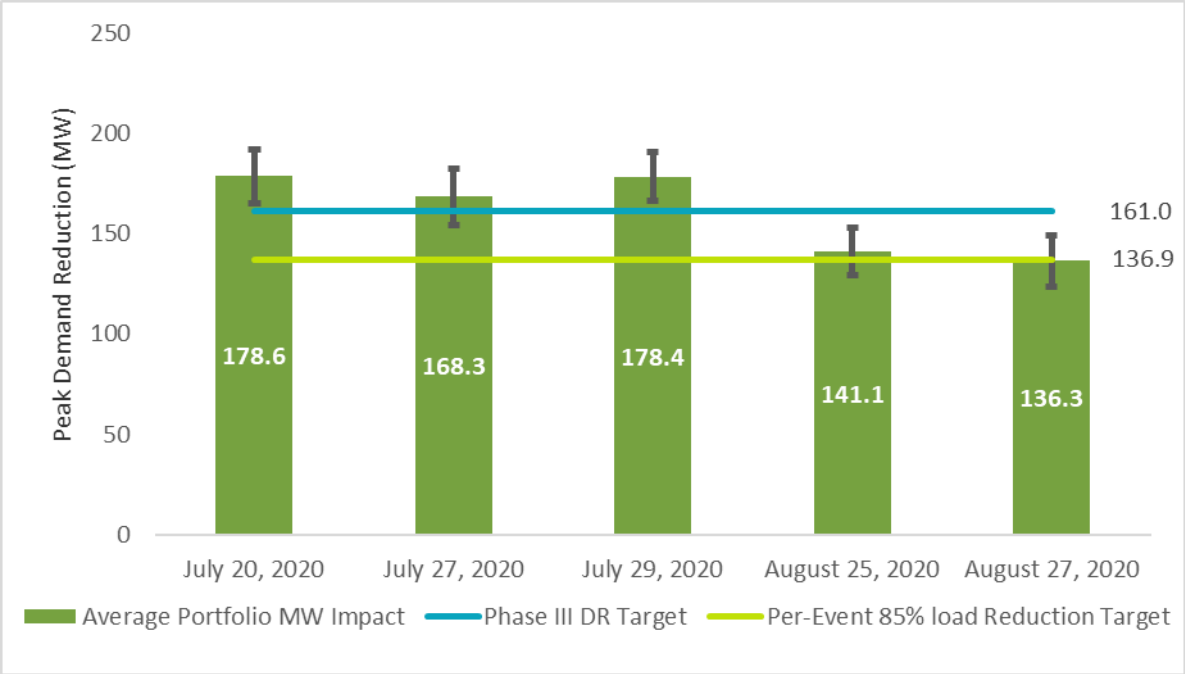
Table 72: PECO Demand Response Performance by Program

Event Date	*Start Hour (Hour Ending)	*End Hour (Hour Ending)	Residential DR Program (Verified MW)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	30.2	1.1	147.3	178.6±13.4
July 27, 2020	15	18	28.6	0.7	139.0	168.3±13.8
July 29, 2020	16	19	27.5	0.5	150.5	178.4±12.0
August 25, 2020	15	18	23.1	0.9	117.1	141.1±11.8
August 27, 2020	16	19	25.8	0.3	110.2	136.3±12.5
Average PY12 DR Event Performance						**160.5±12.7**

* Start and End times are for the Large C&I DR Program. Residential and Small C&I DR events were two hours in length due to the voluntary nature of DR in PY12.

The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For PECO, this translates to a 136.9 MW minimum for each DR event. Figure 21 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For four of five events, PECO exceeded the 85% threshold. For the event which did not meet the 85% threshold, the threshold fell within the margin of error for the event.

Figure 21: PECO PY12 Event Performance Compared to Per-Event Target



PY12 was the last year of Phase III, and the Demand Response programs were deemed voluntary due to the COVID-19 pandemic. This means that the above information is strictly informational and will not be used to determine compliance for PECO.

2.4.2 PPL Demand Response

PPL has one DR Program with participants from three sectors: Small C&I, Large C&I, and GNI. Table 73 provides the definition used and the counts of PY12 participation for the DR program.

Table 73: PPL Participation by Program

Program	Definition of Participant	PY12 Participation
DR	Unique account number; corresponds to a customer that enrolled in the program, not the number who participated in at least one event.	118

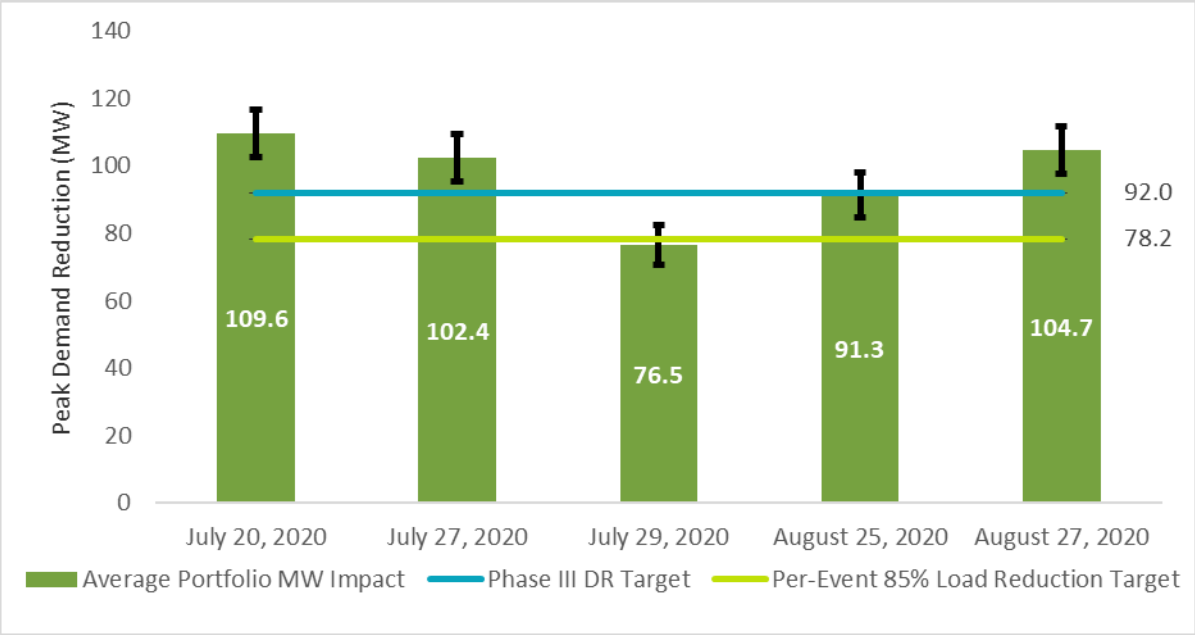
PPL's DR program had five event days in PY12. The Phase III DR performance target for PPL is 92.0 MW. Table 74 shows the DR savings for the program and the portfolio average for each event day. The bottom of the table includes average performance for PY12 events.

Table 74: PPL Demand Response Performance by Program

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	GNE Load Curtailment (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	2.1	103.1	4.5	109.6±7.0
July 27, 2020	15	18	1.6	97.5	3.2	102.4±7.0
July 29, 2020	16	19	2.0	71.2	3.3	76.5±5.8
August 25, 2020	15	18	2.9	87.6	0.9	91.3±6.8
August 27, 2020	16	19	1.9	101.5	1.3	104.7±7.0
PYVTD - Average PY12 DR Event Performance						**96.9±3.0**

The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For PPL, this translates to a 78.2 MW minimum for each DR event. Figure 22 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For four of the five events, PPL exceeded the 85% threshold and three of the events exceeded the target of 92 MW. PY12 DR programs were voluntary, so the comparison of per-event performance to the 85% target is strictly informational.

Figure 22: PPL Event Performance Compared to Per-Event Target



PY12 was the last year of Phase III, and the Demand Response programs were deemed voluntary due to the COVID-19 pandemic. This means that the above information is strictly informational and will not be used to determine compliance for PPL.

2.4.3 Duquesne Light Demand Response

Duquesne Light Company has one DR Program – the Large Curtailable Load Program – which operates over two sectors: Small C&I and Large C&I. Table 75 provides the definition used and the counts of PY12 participation for the DR program.

Table 75: Duquesne Light Participation by Program

Program	Definition of Participant	PY12 Participation
Large Curtailable Load Program	A participant is a customer participating in the program within the event period for the program year (e.g., June-September 2020), represented by a unique participant account number. The count represents the summation of the unique customer participant account numbers in the tracking system for the program year.	195

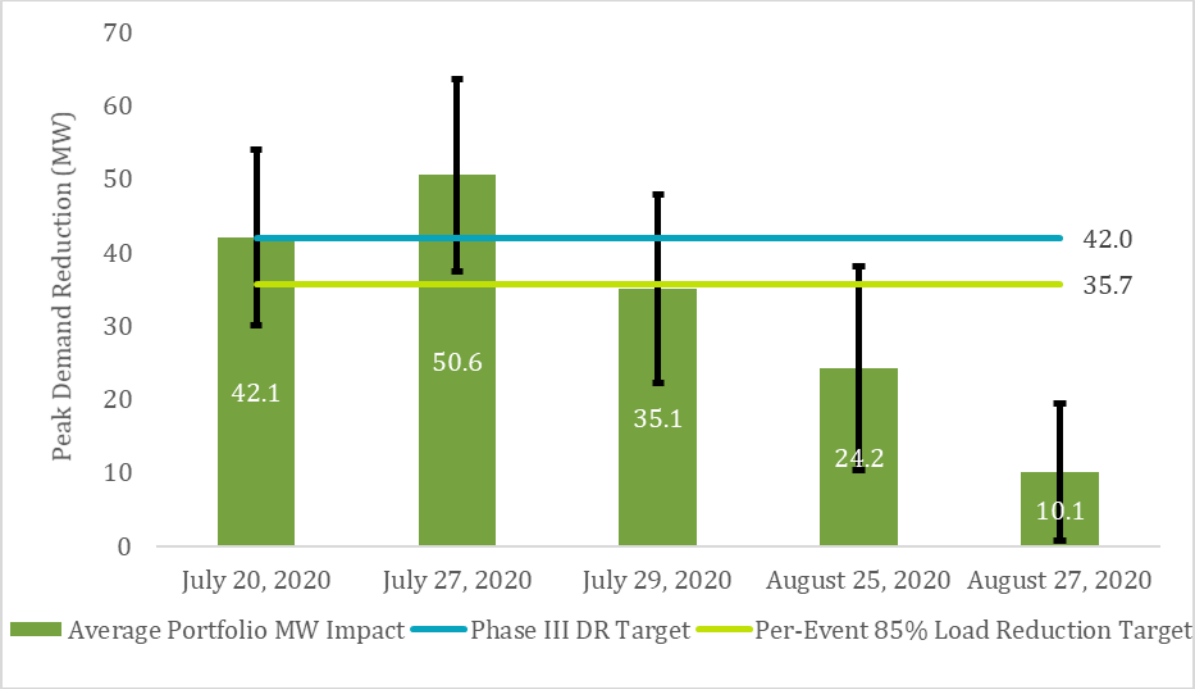
Duquesne Light's Large Curtailable Load program had five event days in PY12. The Phase III DR performance target for Duquesne Light is 42.0 MW. Table 76 shows the DR savings for the program, as well as the portfolio average for each event day. The bottom of the table includes average performance for PY12 events.

Table 76: Duquesne Light Demand Response Performance by Sector

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	2.8	39.3	42.1±11.9
July 27, 2020	15	18	2.3	48.3	50.6±13.1
July 29, 2020	16	19	2.1	32.9	35.1±12.8
August 25, 2020	15	18	1.4	22.8	24.2±13.9
August 27, 2020	16	19	0.7	9.4	10.1±9.4
PYVTD - Average PY12 DR Event Performance					32.4±15.8

The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For Duquesne Light, this translates to a 35.7 MW minimum for each DR event. Figure 23 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. Duquesne Light met or exceeded the 85% per-event reduction target in two of the five events. PY12 DR programs were voluntary, so the comparison of per-event performance to the 85% target is strictly informational.

Figure 23: Duquesne Light Event Performance Compared to Per-Event Target



PY12 was the last year of Phase III, and the Demand Response programs were deemed voluntary due to the COVID-19 pandemic. This means that the above information is strictly informational and will not be used to determine compliance for Duquesne Light.

2.4.4 FirstEnergy: Metropolitan Edison Company Demand Response

In PY12, Met-Ed had active DR Programs in both the residential and C&I customer classes. Met-Ed's Behavioral Demand Response (BDR) offering is a sub-program within the Energy-Efficient Homes Program. Each of these programs defines participation slightly differently due to variations in delivery and/or data tracking methodologies. Table 77 provides the definitions used and the counts of PY12 participation for each included DR program.

Table 77: Met-Ed Participation by Program

Program	Definition of Participant	PY12 Participation
Energy-Efficient Homes – BDR	The number of individual accounts in Oracle's treatment group.	193,835
C&I DR Program – Small	The number of participants who participated in one or more DR events.	62
C&I DR Program – Large	The number of participants who participated in one or more DR events.	94

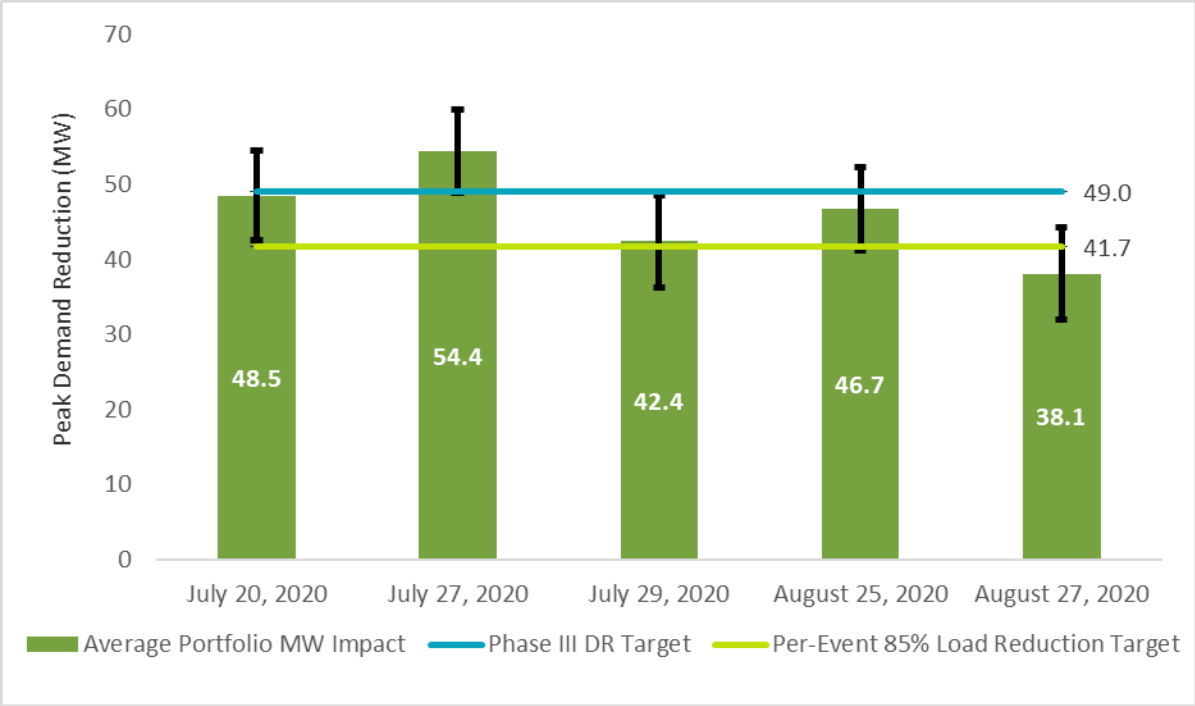
Met-Ed's three DR programs had five event days in PY12. The Phase III DR performance target for Met-Ed is 49.0 MW. Table 78 shows the DR savings for each program, as well as the portfolio average for each event day. Average performance for PY12 events is included at the bottom of the table.

Table 78: Met-Ed Demand Response Performance by Program

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Energy-Efficient Homes (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	1.7	37.0	9.9	48.5±6.0
July 27, 2020	15	18	2.1	41.5	10.7	54.4±5.6
July 29, 2020	16	19	2.2	32.9	7.3	42.4±6.1
August 25, 2020	15	18	1.8	35.9	9.0	46.7±5.5
August 27, 2020	16	19	1.1	29.2	7.8	38.1±6.1
PYVTD - Average PY12 DR Event Performance						**46.0±2.6**

The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For Met-Ed, this translates to a 41.7 MW minimum for each DR event. Figure 24 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For four of the five events, Met-Ed exceeded the 85% threshold. PY12 DR programs were voluntary, so the comparison of per-event performance to the 85% target is strictly informational.

Figure 24: Met-Ed Event Performance Compared to Per-Event Target



PY12 was the last year of Phase III, and the Demand Response programs were deemed voluntary due to the COVID-19 pandemic. This means that the above information is strictly informational and will not be used to determine compliance for Met-Ed.

2.4.5 FirstEnergy: Pennsylvania Electric Company Demand Response

Penelec does not have a Phase III DR target.

2.4.6 FirstEnergy: Pennsylvania Power Company Demand Response

Penn Power has three DR Programs: C&I DR – Small, C&I DR – Large, and Energy-Efficient Homes – BDR. Penn Power's BDR offering is a sub-program within the Energy-Efficient Homes Program. Each of these programs defines participation slightly differently due to variations in delivery and/or data tracking methodologies. Table 79 provides the definitions used and the counts of PY12 participation for each included DR program.

Table 79: Penn Power Participation by Program

Program	Definition of Participant	PY12 Participation
Energy-Efficient Homes – BDR	The number of individual accounts in Oracle's treatment group.	30,626
C&I DR Program – Small	The number of participants who participated in one or more DR events.	0
C&I DR Program – Large	The number of participants who participated in one or more DR events.	9

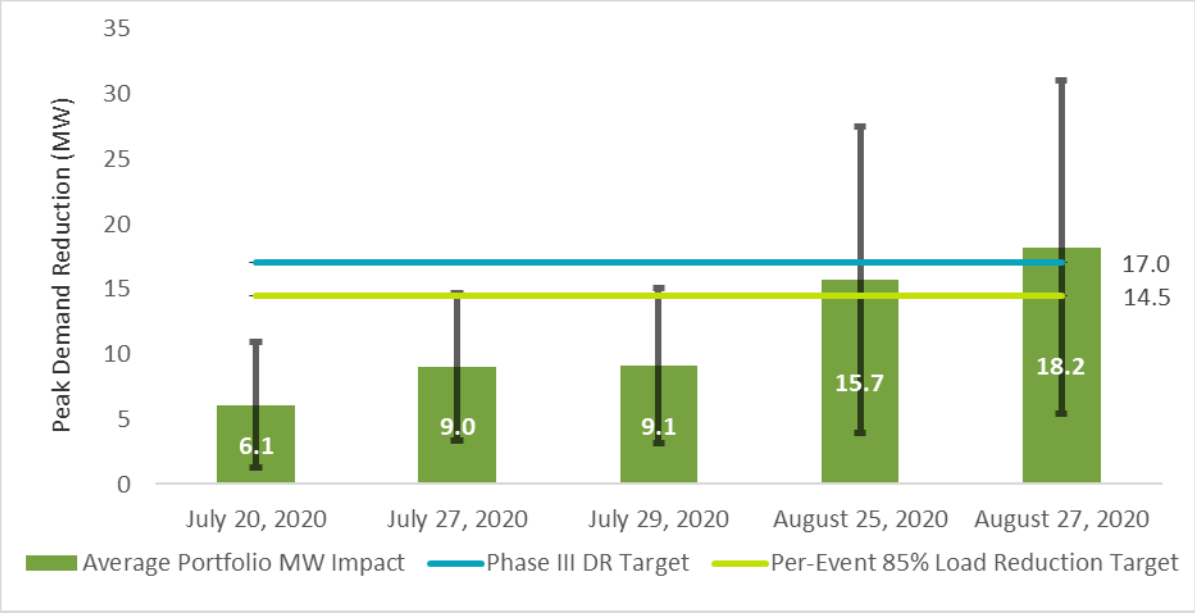
Penn Power's three DR programs had five event days in PY12. The Phase III DR performance target for Penn Power is 17.0 MW. Table 80 shows the DR savings for each program, as well as the portfolio average for each event day. The bottom of the table includes average performance for PY12 events.

Table 80: Penn Power Demand Response Performance by Program

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Energy-Efficient Homes (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	0.0	4.5	1.6	6.1±4.8
July 27, 2020	15	18	0.0	7.3	1.7	9.0±5.7
July 29, 2020	16	19	0.0	7.5	1.6	9.1±6.0
August 25, 2020	15	18	0.0	14.3	1.4	15.7±11.8
August 27, 2020	16	19	0.0	16.8	1.5	18.2±12.8
PYVTD - Average PY12 DR Event Performance						**11.6±4.0**

The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For Penn Power, this translates to a 14.5 MW minimum for each DR event. Figure 25 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For two events, Penn Power exceeded the 85% threshold, and for one of the five events, Penn Power exceeded the Phase III target of 17 MW. PY12 DR programs were voluntary, so the comparison of per-event performance to the 85% target is strictly informational.

Figure 25: Penn Power Event Performance Compared to Per-Event Target



PY12 was the last year of Phase III, and the Demand Response programs were deemed voluntary due to the COVID-19 pandemic. This means that the above information is strictly informational and will not be used to determine compliance for Penn Power.

2.4.7 FirstEnergy: West Penn Power Demand Response

In PY12, West Penn Power had three active DR Programs: C&I DR Program – Small, C&I DR Program – Large, and the BDR Program. West Penn Power's BDR offering is a sub-program within the Energy-Efficient Homes Program. Each of these programs define participation slightly differently due to variations in delivery and/or data-tracking methodologies. Table 81 provides the definitions used and the counts of PY12 participation for each included DR program.

Table 81: West Penn Power Participation by Program

Program	Definition of Participant	PY12 Participation
Energy-Efficient Homes – BDR	The number of individual accounts in Oracle's treatment group.	57,467
C&I DR Program – Small	The number of participants who participated in one or more DR events.	50
C&I DR Program – Large	The number of participants who participated in one or more DR events.	29

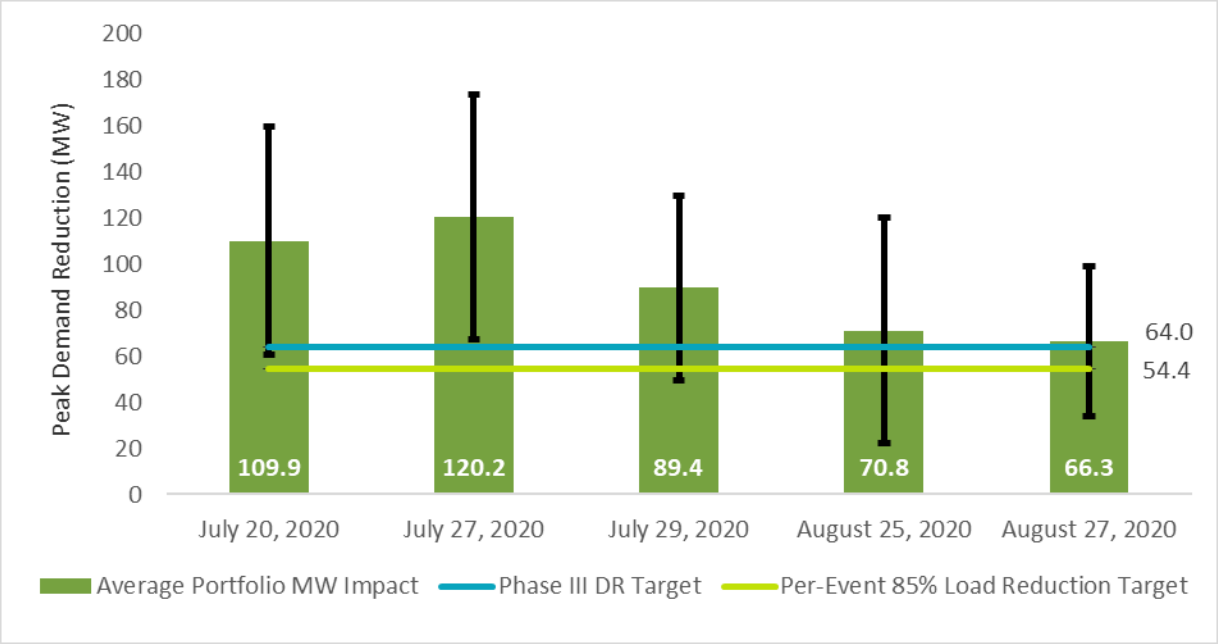
West Penn Power's three DR programs had five event days in PY12. The Phase III DR performance target for West Penn Power is 64.0 MW. Table 82 shows the DR savings for each program, as well as the portfolio average for each event day. The bottom of the table includes average performance for PY12 events.

Table 82: West Penn Power Demand Response Performance by Program

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Residential Energy-Efficient Homes (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	1.6	105.5	2.8	109.9±49.5
July 27, 2020	15	18	0.9	116.2	3.2	120.2±52.8
July 29, 2020	16	19	1.1	85.4	2.8	89.4±40.2
August 25, 2020	15	18	1.3	66.6	2.9	70.8±48.9
August 27, 2020	16	19	0.9	62.9	2.6	66.3±32.5
PYVTD - Average PY12 DR Event Performance						**91.3±20.3**

The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For West Penn Power, this translates to a 54.4 MW minimum for each DR event. Figure 26 compares the performance of each DR event in PY12 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For each event, West Penn Power exceeded the 85% threshold and the target of 64 MW. PY12 DR programs were voluntary, so the comparison of per-event performance to the 85% target is strictly informational.

Figure 26: West Penn Power Event Performance Compared to Per-Event Target



PY12 was the last year of Phase III, and the Demand Response programs were deemed voluntary due to the COVID-19 pandemic. This means that the above information is strictly informational and will not be used to determine compliance for West Penn Power.

2.5 RESULTS FOR PHASE III BY EDC

2.5.1 PECO Demand Response

PECO has three DR Programs: Residential, Small C&I, and Large C&I. Each of these programs defines participation differently due to variations in delivery and/or data-tracking methodologies. Table 83 provides the definitions used and the counts of Phase III participation for each included DR program.

Table 83: PECO Participation by Program

Program	Definition of Participant	Phase III Participation
Residential DR	For Residential Direct Load Control (DLC), a participant is defined as a unique account number where device status is recorded in the PECO database as installed or swapped and the measure code is CACS (central air conditioner switch). One participant may have more than one DLC device installed at the home. Customers whose accounts are disconnected, who have opted out of the program, or for whom the DLC device was removed are not counted as participants.	*61,440
Small C&I DR	A participant is defined as a unique account number where device status is recorded in the PECO database as installed or swapped and the measure code is PCT (programmable communicating thermostat). One participant may have more than one DLC device installed on the premise. Customers whose accounts are disconnected, who have opted out of the program, or for whom the DLC device was removed are not counted as participants.	*1,586
Large C&I DR	A participant is defined as a large C&I customer (defined by PECO account number) enrolled with a DR program CSP for at least one hour of at least one event occurring in any given program year.	*356

*DR participation is not additive like other programs because the same participants tend to remain in the program with only small attrition. Therefore, total participation in the DR programs for Phase III is equal to the highest program year participation count for each of the three programs.

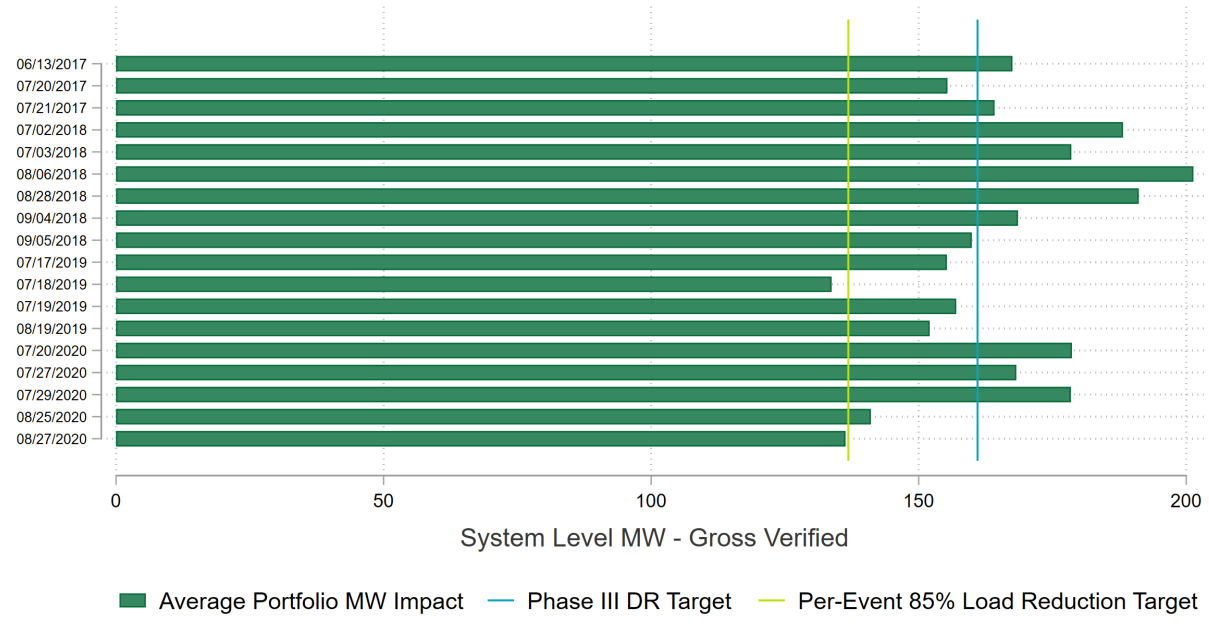
The Phase III DR performance target for PECO is 161.0 MW. Table 84 shows the average DR savings for each program year in Phase III. Figure 27 compares the performance of each of the DR events for all of Phase III and includes the overall target and per-event target. The event on July 18, 2019, was the only event used for compliance purposes that missed the 85% target of 137 MW. On that day, there was a sharp and unexpected decrease in temperature due to thunderstorms which caused decreased demand for air conditioning. Excluding July 18, 2019, PECO's Residential DR program has averaged approximately 30 MW per event in Phase III. On July 18, 2019, however, the Residential program only produced 11 MW. If the Residential DR program had contributed 15 MW (half of its Phase III average), the July 18th event day would have reached the 85% threshold. The upper bound of the 90% confidence interval for the estimated event impact is 142 MW, so the per-event performance target is within the margin of error of the verified savings analysis.

Table 84: PECO Demand Response Performance by Program Year

Program Year	Number of Events	Average Portfolio Performance (Verified MW)
PY9	3	162.3
PY10	6	181.3
PY11	4	149.5
PY12*	5	160.5
Phase III DR Event Performance	18	165.3
Compliance Value (PY9-PY11)	13	167.1

**PY12 deemed voluntary*

Figure 27: PECO Event Performance Compared to Per-Event Target Phase III



2.5.2 PPL Demand Response

PPL has one DR Program with participants from three sectors: Small C&I, Large C&I, and GNI. Table 85 provides the definition used and the count of Phase III participation for the DR program.

Table 85: PPL Participation by Program

Program	Definition of Participant	Phase III Participation
DR	Unique account number; corresponds to a customer that enrolled in the program, not the number who participated in at least one event	227

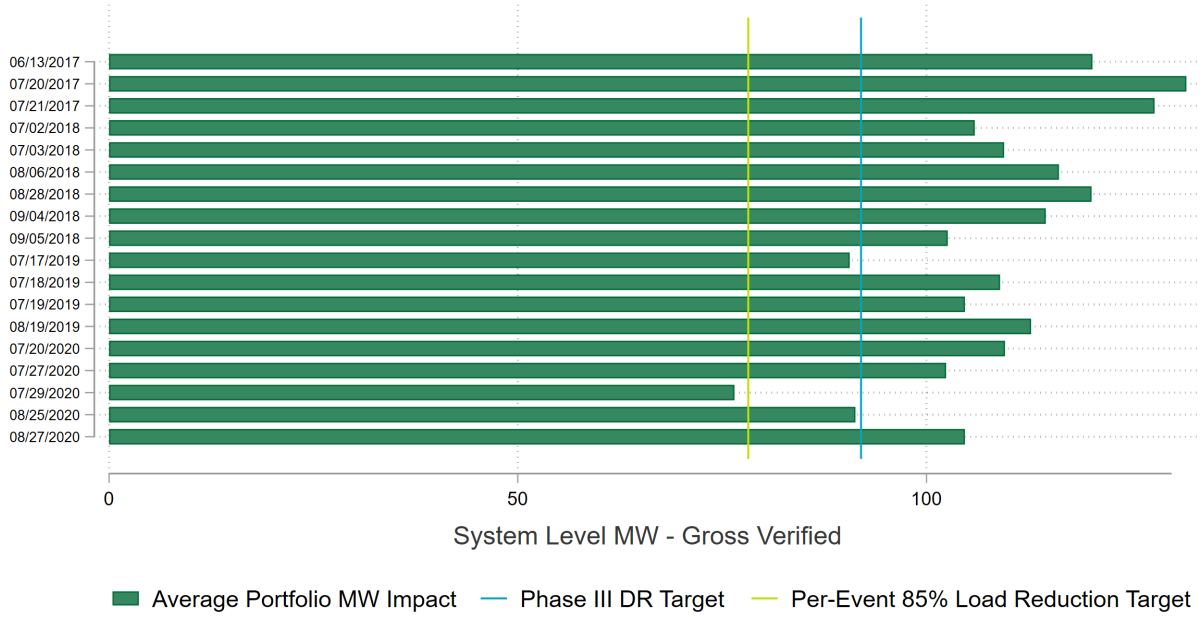
PPL's DR program had four event days in PY12. The Phase III DR performance target for PPL is 92.0 MW. Table 86 shows average DR savings for each program year. Figure 28 compares the performance of each DR event for all of Phase III.

Table 86: PPL Demand Response Performance by Program Year

Program Year	Number of Events	Average Portfolio Performance (Verified MW)
PY9	3	126.7
PY10	6	111.5
PY11	4	104.3
PY12*	5	96.9
Phase III DR Event Performance	18	108.4
Compliance Value (PY9-PY11)	13	112.8

**PY12 deemed voluntary*

Figure 28: PPL Event Performance Compared to Per-Event Target Phase III



2.5.3 Duquesne Light Demand Response

Duquesne Light Company has one DR Program – the Large Curtailable Load Program – which operates over two sectors: Small C&I and Large C&I. Table 87 provides the definition used and the count of Phase III participation for the DR program.

Table 87: Duquesne Light Participation by Program

Program	Definition of Participant	Phase III Participation
Large Curtailable Load Program	A participant is a customer participating in the program within the program event period for the program year (e.g., June-September 2018), represented by a unique participant account number. The count represents the summation of the unique customer participant account numbers in the tracking system for the program year. The P3TD count is not cumulative, but instead represent the maximum number of annual participants during the phase.	195

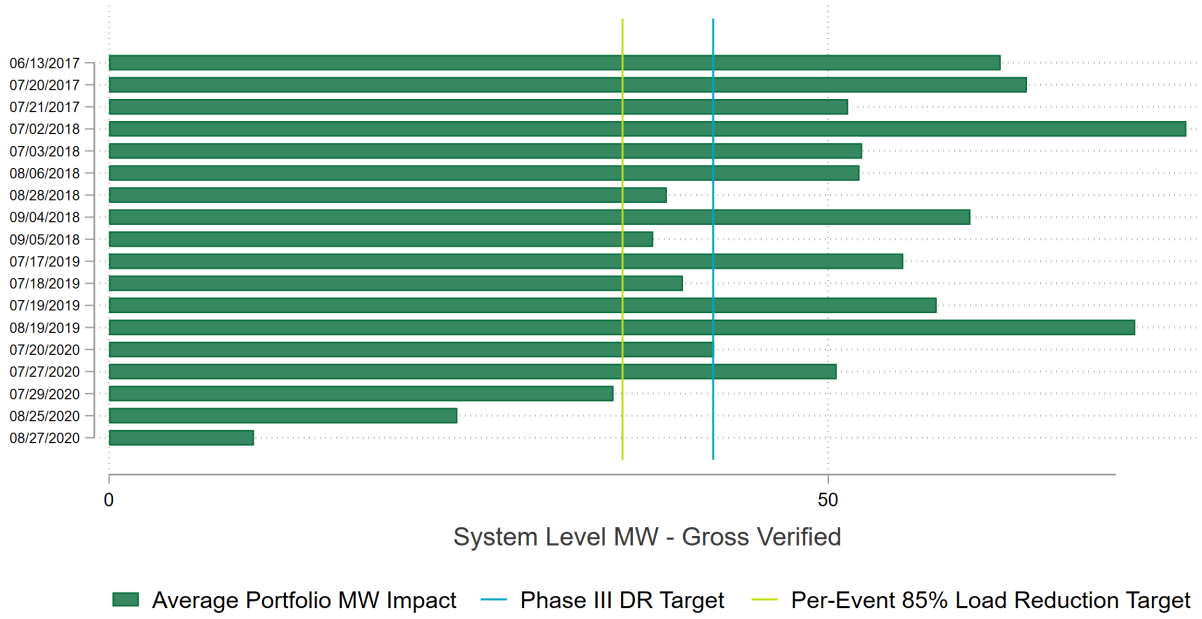
Duquesne Light's Large Curtailable Load program had five event days in PY12. The Phase III DR performance target for Duquesne Light is 42.0 MW. Table 88 shows the average DR savings for each program year. Figure 29 compares the performance of each of the DR events for all of Phase III.

Table 88: Duquesne Light Demand Response Performance by Program Year

Program Year	Number of Events	Average Portfolio Performance (Verified MW)
PY9	3	59.1
PY10	6	52.7
PY11	4	56.0
PY12*	5	32.4
Phase III DR Event Performance	18	48.8
Compliance Value (PY9-PY11)	13	55.2

**PY12 deemed voluntary*

Figure 29: Duquesne Light Event Performance Compared to Per-Event Target Phase III



2.5.4 FirstEnergy: Metropolitan Edison Company Demand Response

In PY12, Met-Ed had active DR Programs in both the residential and C&I customer classes. Met-Ed's Behavioral Demand Response (BDR) offering is a sub-program within the Energy-Efficient Homes Program which became active in PY10. Each of these programs defines participation slightly differently due to variations in delivery and/or data-tracking methodologies. Table 89 provides definitions used and counts of Phase III participation to date for each included DR program.

Table 89: Met-Ed Participation by Program

Program	Definition of Participant	Phase III Participation
Energy-Efficient Homes – BDR	The number of individual accounts in Oracle's treatment group. Phase III participation numbers reflect the total number of customers that participated in the program since the beginning of Phase III.	193,835
C&I DR Program – Small	The number of participants who participated in one or more DR events.	139
C&I DR Program – Large	The number of participants who participated in one or more DR events.	247

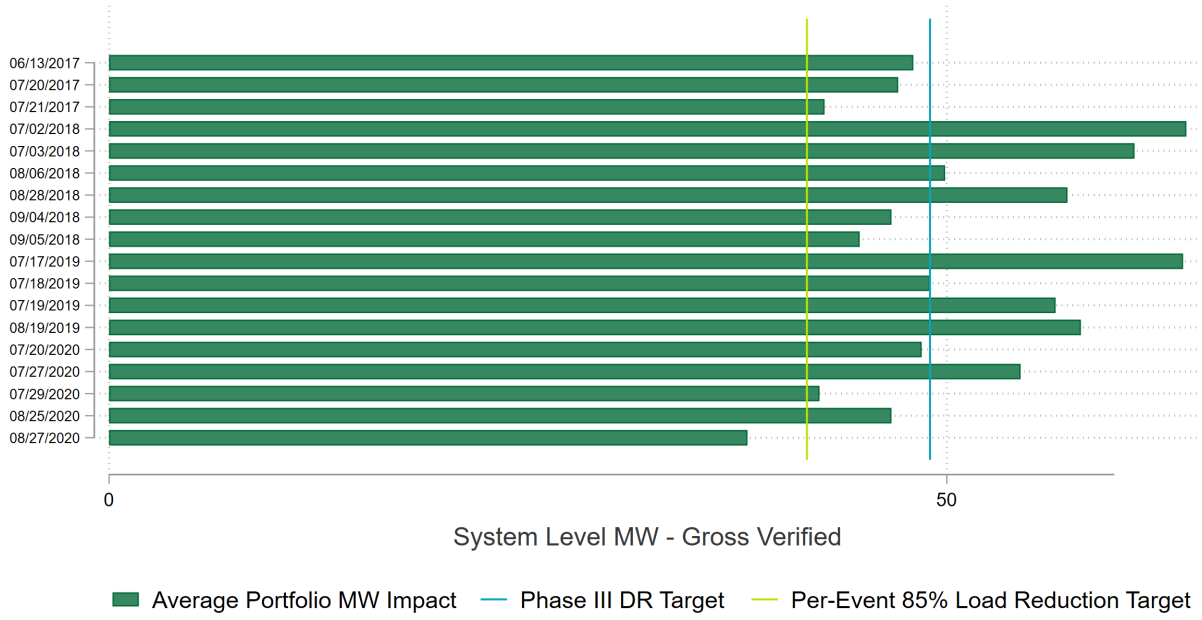
Met-Ed's three DR programs had five event days in PY12. The Phase III DR performance target for Met-Ed is 49.0 MW. Table 90 shows the average DR savings for each program year. Figure 30 compares the performance of each DR event for all of Phase III.

Table 90: Met-Ed Demand Response Performance by Program Year

Program Year	Number of Events	Average Portfolio Performance (Verified MW)
PY9	3	45.9
PY10	6	54.0
PY11	4	56.9
PY12*	5	46.0
Phase III DR Event Performance	18	51.1
Compliance Value (PY9-PY11)	13	53.0

**PY12 deemed voluntary*

Figure 30: Met-Ed Event Performance Compared to Per-Event Target Phase III



2.5.5 FirstEnergy: Pennsylvania Electric Company Demand Response

Penelec does not have a Phase III DR target.

2.5.6 FirstEnergy: Pennsylvania Power Company Demand Response

Penn Power has three DR Programs: C&I DR – Small, C&I DR – Large, and Energy-Efficient Homes – BDR. Penn Power's BDR offering is a sub-program within the Energy-Efficient Homes Program. Each of these programs defines participation slightly differently due to variations in delivery and/or data-tracking methodologies. Table 91 provides definitions used and the counts of Phase III participation for each included DR program.

Table 91: Penn Power Participation by Program

Program	Definition of Participant	Phase III Participation
Energy-Efficient Homes – BDR	The number of individual accounts in Oracle's treatment group. P3TD participation numbers reflect the total number of customers that participated in the program since the beginning of Phase III.	30,626
C&I DR Program – Small	The number of participants who participated in one or more DR events.	3
C&I DR Program – Large	The number of participants who participated in one or more DR events.	24

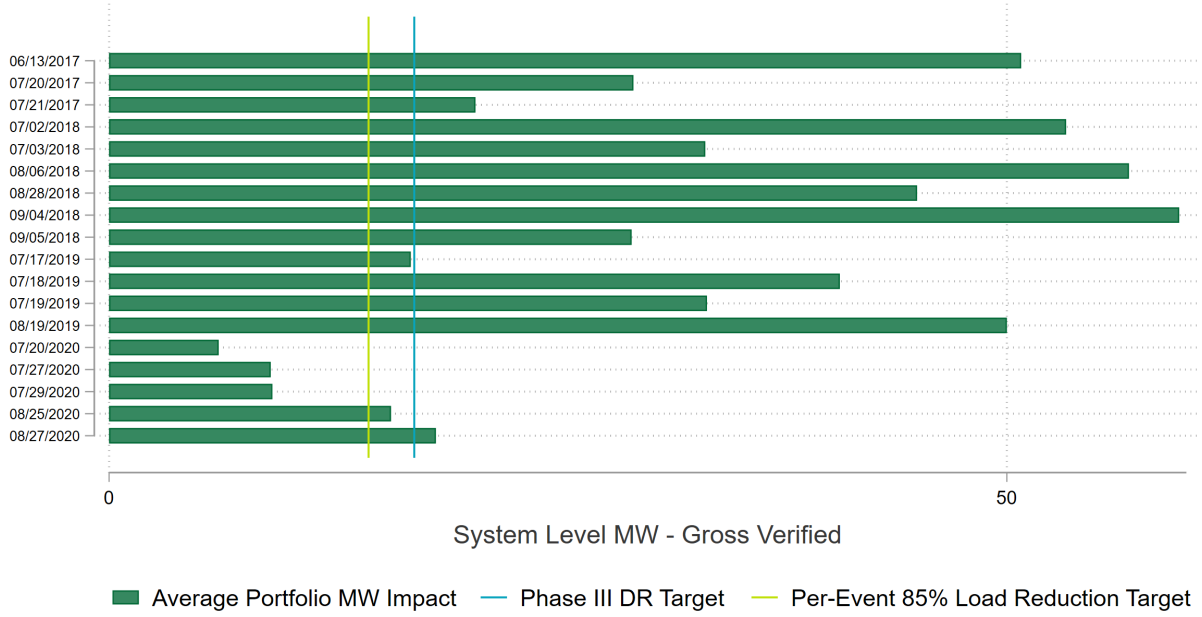
Penn Power's three DR programs had five event days in PY12. The Phase III DR performance target for Penn Power is 17.0 MW. Table 92 shows the average DR savings for each program year. Figure 31 compares the performance of each DR event for all of Phase III.

Table 92: Penn Power Demand Response Performance by Program Year

Program Year	Number of Events	Average Portfolio Performance (Verified MW)
PY9	3	33.5
PY10	6	46.1
PY11	4	35.2
PY12*	5	11.6
Phase III DR Event Performance	18	32.0
Compliance Value (PY9-PY11)	13	39.9

**PY12 deemed voluntary*

Figure 31: Penn Power Event Performance Compared to Per-Event Target Phase III



2.5.7 FirstEnergy: West Penn Power Demand Response

In PY12, West Penn Power had three active DR Programs: C&I DR Program – Small, C&I DR Program – Large, and the BDR Program. West Penn Power's BDR offering is a sub-program within the Energy-Efficient Homes Program. PY10 was the first active year for the BDR Program in West Penn Power's service territory. Each of these programs define participation slightly differently due to variations in delivery and/or data-tracking methodologies. Table 93 provides definitions used and counts of Phase III participation for each included DR program.

Table 93: West Penn Power Participation by Program

Program	Definition of Participant	Phase III Participation
Energy-Efficient Homes – BDR	The number of individual accounts in Oracle's treatment group. P3TD participation numbers reflect the total number of customers that participated in the program since the beginning of Phase III.	57,467
C&I DR Program – Small	The number of participants who participated in one or more DR events.	50
C&I DR Program – Large	The number of participants who participated in one or more DR events.	79

West Penn Power's three DR programs had five event days in PY12. The Phase III DR performance target for West Penn Power is 64.0 MW. Table 94 shows the average DR savings for each program year. Figure 32 compares the performance of each DR event for all of Phase III. Despite showing an average Phase III DR performance of 176% of goal, West Penn Power

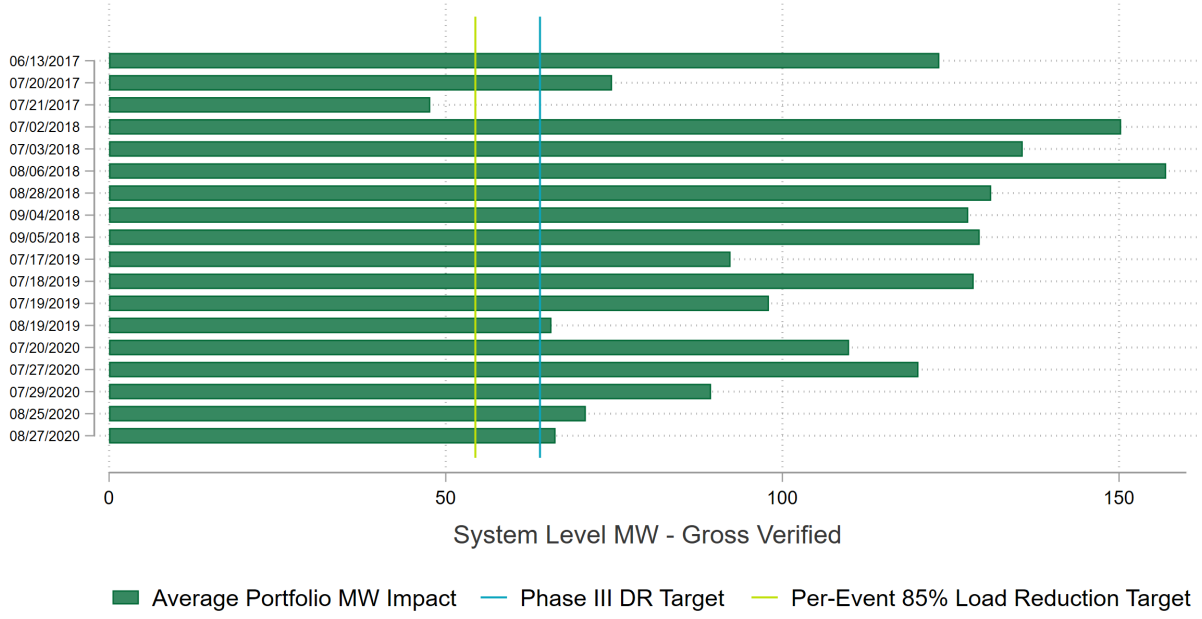
missed the 85% per-event load reduction target during the event on July 21, 2017. This was the second day of consecutive events being called, and the largest participant in the West Penn Power Large C&I DR Program showed notably lower MW reductions than other Phase III DR events. The 85% per-event threshold is within the margin of error of the verified savings estimate for July 21, 2017, but margin of error is extremely wide (ranging from 1 MW to 95 MW). The poor precision of the West Penn Power DR impact estimates is due to most load reduction coming from a small number of large manufacturing facilities with highly variable load patterns that lead to noisy baselines.

Table 94: West Penn Power Demand Response Performance by Program Year

Program Year	Number of Events	Average Portfolio Performance (Verified MW)
PY9	3	81.9
PY10	6	138.5
PY11	4	96.1
PY12*	5	91.3
Phase III DR Event Performance	18	106.5
Compliance Value (PY9-PY11)	13	112.4

**PY12 deemed voluntary*

Figure 32: West Penn Power Event Performance Compared to Per-Event Target Phase III

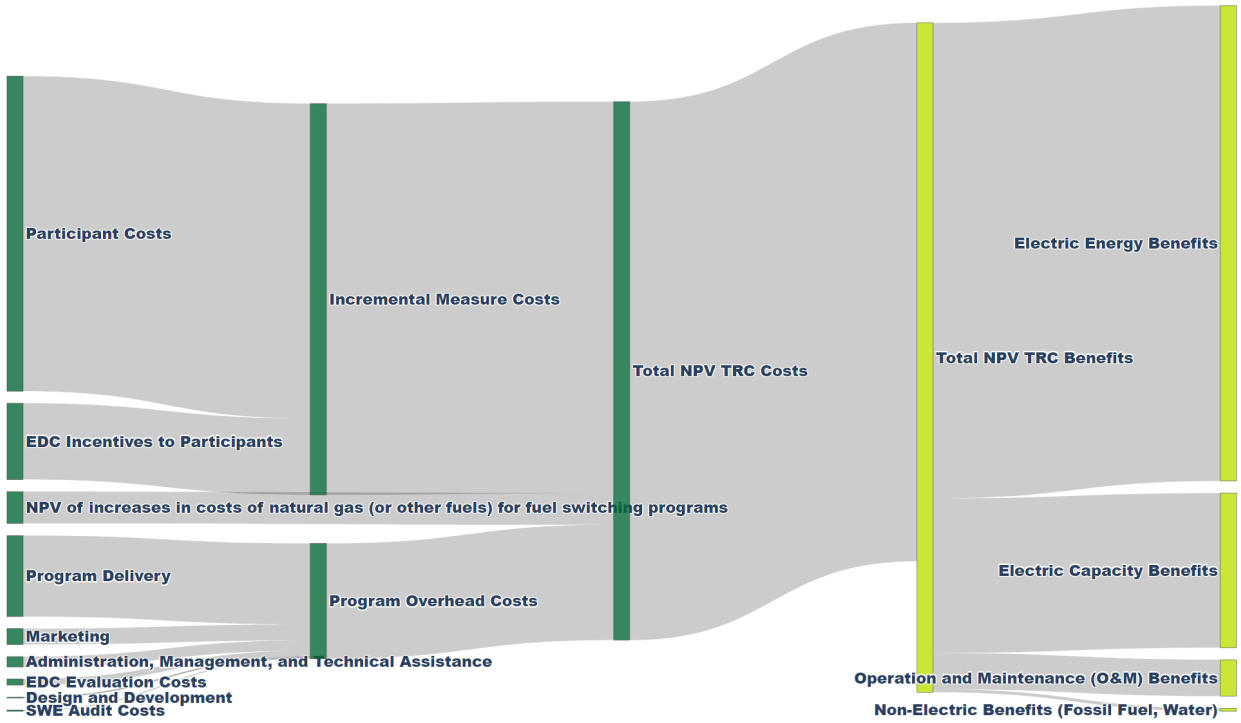


Section 3 Act 129 Benefits and Costs

3.1 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. In preparation for Phase III, the PUC issued the 2016 TRC Test Order[29] to document the methodology and assumptions EDCs should use when calculating the costs and benefits of Phase III EE&C portfolios. Figure 33 shows the breakdown of total TRC Benefits and costs across all EDCs in PY12. The comparison of Total Gross Net Present Value (NPV) TRC Benefits to Total Gross NPV TRC Costs is the statewide TRC Ratio, which was 1.24 in PY12.

Figure 33: PY12 Statewide TRC Breakdown



[29] Pennsylvania Public Utility Commission, *Final 2016 TRC Test Order*. From the Public Meeting of June 11, 2015, at Docket No. M-2015-2468992 (*2016 TRC Test Order)*. Entered June 22, 2015. http://www.puc.pa.gov/pcdocs/1367195.docx

Table 95 shows the NPV costs and benefits for each EDC portfolio in PY12, as well as the TRC Ratio (benefits divided by costs). TRC results are presented on both a gross and net savings basis. Per the 2016 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 the EDC weighted average cost of capital (WACC) as a discount rate. The use of WACC is based on the Commission's instructions in the 2016 TRC Test Order, which stated, "*The EDC's weighted average cost of capital is the correct basis for the discount rate so that supply-side and demand-side alternatives are placed on a level playing field. Accordingly, EDCs shall continue to use the EDC's weighted average cost of capital as the discount rate used in TRC calculations for all measures and programs that are eligible for Act 129 funding.*"[30] On a gross basis, PY12 programs saved the Commonwealth an estimated $123.3 million dollars (benefits minus costs). On a net basis, statewide savings from PY12 programs are estimated at $55.8 million dollars.

Table 95: PY12 TRC Test Results by EDC

EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio	Net Benefits ($1000)	Net Costs ($1000)	Net TRC Ratio
PECO	$246,620	$269,527	0.92	$185,308	$215,648	0.86
PPL	$180,625	$106,902	1.69	$120,269	$76,905	1.56
Duquesne Light	$72,556	$27,965	2.59	$53,697	$23,421	2.29
FE: Met-Ed	$43,330	$33,495	1.29	$26,411	$22,620	1.17
FE: Penelec	$29,964	$21,791	1.38	$22,048	$17,147	1.29
FE: Penn Power	$9,625	$8,677	1.11	$6,796	$6,577	1.03
FE: West Penn Power	$47,188	$38,277	1.23	$29,879	$26,287	1.14
Statewide*	**$629,908**	**$506,634**	**1.24**	**$444,408**	**$388,605**	**1.14**

*Throughout this report, individual columns in tables may not sum to the total due to rounding.

Table 96 shows TRC results for energy-efficiency programs and Table 97 presents the results for DR. The SWE team used program expenditures to allocate common portfolio costs between the energy-efficiency and DR portfolios for PECO and PPL. FirstEnergy and Duquesne Light do not have a common portfolio cost category.

[30] Pennsylvania Public Utility Commission, *Final 2016 TRC Test Order*. Page 66.

Table 96: PY12 TRC Results by EDC: Energy-Efficiency Programs Only

EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio	Net Benefits ($1000)	Net Costs ($1000)	Net TRC Ratio
PECO*	$237,795	$260,653	0.91	$176,483	$206,774	0.85
PPL*	$176,173	$104,282	1.69	$115,817	$74,285	1.56
Duquesne Light	$69,164	$26,284	2.63	$50,305	$21,740	2.31
FE: Met-Ed	$41,082	$32,159	1.28	$24,163	$21,284	1.14
FE: Penelec	$29,964	$21,791	1.38	$22,048	$17,147	1.29
FE: Penn Power	$9,087	$8,313	1.09	$6,258	$6,213	1.01
FE: West Penn Power	$43,179	$36,339	1.19	$25,870	$24,349	1.06
Statewide	**$606,444**	**$489,821**	**1.24**	**$420,944**	**$371,792**	**1.13**

* Costs include cross-cutting or common costs allocated proportionately to Energy-Efficiency and DR Programs.

Table 97: PY12 TRC Results by EDC: DR Programs Only

EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio	Net Benefits ($1000)	Net Costs ($1000)	Net TRC Ratio
PECO*	$8,825	$8,874	0.99	$8,825	$8,874	0.99
PPL*	$4,452	$2,620	1.70	$4,452	$2,620	1.70
Duquesne Light	$3,392	$1,681	2.02	$3,392	$1,681	2.02
FE: Met-Ed	$2,248	$1,336	1.68	$2,248	$1,336	1.68
FE: Penelec	$0	$0	N/A	$0	$0	N/A
FE: Penn Power	$538	$364	1.48	$538	$364	1.48
FE: West Penn Power	$4,009	$1,938	2.07	$4,009	$1,938	2.07
Statewide	**$23,464**	**$16,813**	**1.40**	**$23,464**	**$16,813**	**1.40**

* Costs include cross-cutting or common costs allocated proportionately to energy-efficiency and DR programs.

In PY12, statewide cost-effectiveness decreased across both energy-efficiency and DR programs from PY11, which were lower than PY10 TRC Ratios. A comparison of the values in Table 96 and Table 97 suggests that DR programs were more cost-effective than energy-efficiency programs in PY12. The SWE audit of EDC cost-effectiveness and comparison with previous program years revealed several insights about energy-efficiency and DR programs:

- In PY12, each EDC delivered a cost-effective portfolio of energy-efficiency and demand response programs except for PECO and Penelec. Neither PECO's EE or DR offerings passed the TRC Test in PY12 and Penelec does not offer Phase III DR programs. Due to a slow start to Phase III, PECO needed to deliver a large amount of MWh savings in PY12 to meet its Phase III compliance target. It is understandable that an EDC in PECO's position would ramp up marketing efforts and be less selective in its pursuit of energy savings. PECO offers three non-residential energy-efficiency programs in Phase III (Small C&I EE, Large C&I EE, and Combined Heat and Power). While each program was not cost-effective according to the gross TRC Test, they delivered 363,945 MWh of gross

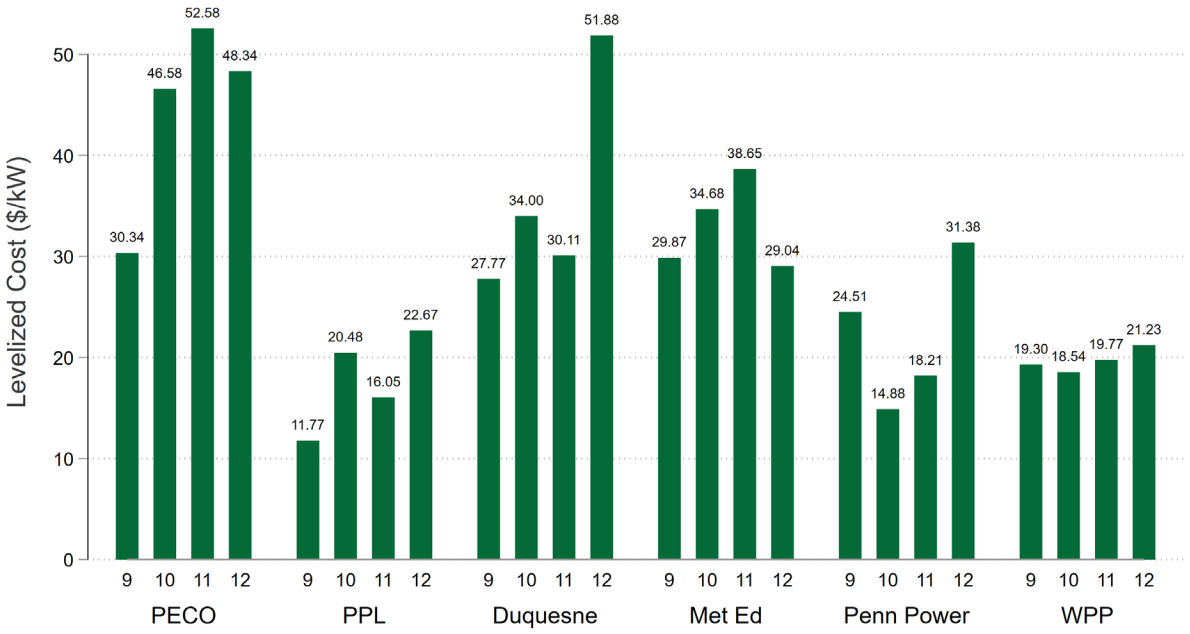
verified savings in PY12 – or almost 19% of PECO's Phase III compliance target. The acquisition cost of PECO's non-residential EE programs was just $0.083 per first-year kWh, so while the TRC Ratios were poor, the programs were quite effective for PECO in terms of meeting its compliance target within the approved EE&C budget.

- In general, the SWE found the EDCs' cost-effectiveness reporting well-documented and properly aligned with the 2016 TRC Test Order. EDCs resolved issues revealed in previous program years and largely followed the SWE's guidance issued in 2020 regarding dual baseline assumptions used in the calculation of lighting effective useful lives (EULs).
- EDC Cost categorization is clearly an area of emphasis for the Commission as its 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.*"[31] In PY12, the statewide share of spending on incentives as a percentage of total EDC expenditures was 39.8%. Incentive shares ranged from 34.7% at Penelec to 42.4% at Met-Ed. EDCs will need to reduce administrative costs or increase incentive levels in Phase IV to comply with the Commission's directive regarding program expenditures.
- Incremental measure costs make up the majority of TRC Costs at 72.6% statewide. EDC incentives paid for 19.5% of incremental measure costs in PY12 and the other 80.5% of incremental measure costs were borne by program participants. Added fuel costs from fuel-switching measures are also borne by program participants and represented 6% of all TRC Costs in PY12 due to several large CHP projects. Program delivery and other overhead costs accounted for the remaining 21.4% of TRC Costs in PY12.
- As shown in Figure 33, TRC Benefits primarily come from the avoided costs of energy and capacity, which account for nearly 94% of total TRC Benefits. DR programs only contribute to capacity benefits, while energy-efficiency programs can contribute to both energy and capacity benefits. The benefits from the avoided costs of energy and capacity are followed by Operation and Maintenance benefits at 5% and Non-Electric Benefits, which constitute less than 1% of overall benefits. The Non-Electric Benefits category includes both positive benefits from measures that save fuel or water and a reduction in benefits associated with increased fuel consumption due to the lighting waste heat penalty. This benefits category was negative in aggregate for PECO, Duquesne Light, and Penelec in PY12.
- Figure 34 shows the levelized cost of DR for each EDC over the four program years. We calculate DR levelized cost as the Gross Program Year Verified to Date (PYVTD) TRC Cost over the Gross PYVTD kW savings for each EDC. TRC Costs incurred in PY8 are not reflected in the calculations. The TRC Cost per delivered kW is a useful metric but does not consider the varying avoided capacity costs across EDCs and sectors. Because C&I DR programs include a mix of "reservation" payments for enrollment and volumetric

[31] Phase IV Implementation Order at page 121. Entered June 18, 2020. Docket No. M-2020-3015228. https://www.puc.pa.gov/pcdocs/1666981.docx

payments for load shed during an event, volumetric costs are likely higher in years like PY10 and PY12 with more events (n=6 and n=5, respectively). Levelized costs increased noticeably for Duquesne Light and Penn Power in PY12. Both EDCs showed reduced MW performance in PY12, so the increased levelized cost is likely a function of spreading similar fixed costs over fewer kW.

Figure 34: Levelized Cost of DR by EDC and Program Year



- The 2016 TRC Test Order assumes a 1:1 reduction in avoided generation capacity for the average MW reduction each program year. This planning assumption now appears to be overstated based on discussions in PJM's Summer-Only DR Senior Task Force.[32] Modeling efforts by PJM indicate that 1 MW of summer peak shaving from programs like Act 129 produce a *less than 1 MW* reduction in the peak load forecast and zonal capacity obligations. While consistent with the 2016 TRC Test Order, TRC Benefits from the avoided cost of generation capacity likely overstate the true benefit to the Commonwealth.
    - In the 2021 TRC Test Order,[33] the Commission imposed a de-rating methodology for the calculation of avoided capacity benefits from DR. The avoided cost of generation capacity values is reduced by EDC-specific values based on modeling conducted by PJM's load forecasting division. The avoided cost of transmission and distribution capacity (where applicable) is de-rated using a multiplier of 60% for all EDCs.

[32] https://www.pjm.com/committees-and-groups/closed-groups/sodrstf
[33] Final order on the TRC Test for Phase IV of Act 129. From the Public Meeting of December 19, 2019, at Docket No. M-2019-3006868. Entered December 19, 2019. https://www.puc.pa.gov/pcdocs/1648126.docx Page 94-97

- The SWE's Phase IV Energy Efficiency and Peak Demand Reduction Market Potential Study (EEPDR MPS) relied on the methodology and assumptions called for in the 2021 TRC Test Order and included a section evaluating Phase IV metrics with and without funding for dispatchable DR programming.[34] Although the DR Potential Study found the benefits of a Phase IV Dispatchable Demand Response (DDR) program would exceed the costs, the dispatchable DR potential identified was less cost-effective (TRC Ratio = 1.54) than the EEPDR potential (TRC Ratio = 1.62). The SWE estimated that a Phase IV design that pursues both energy-efficiency and peak demand reductions without utilizing dispatchable DR would achieve $35 million more net benefits to the Commonwealth than a Phase IV design that includes DDR. As a result, the Commission decided to exclude dispatchable DR and implement a peak demand reduction program in Phase IV.
- If the Phase IV perspective on the calculation of dispatchable DR benefits were applied to the PY12 DR impacts, the TRC Ratios for DR portfolios would be lower and would be comparable to the energy-efficiency TRC Ratios.

3.2 PHASE III TRC TEST RESULTS

3.2.1 TRC Test Results by Program Year

Table 98 shows the TRC Benefits, TRC Costs, and TRC Ratio for each EDC by program year. The TRC Test requires EDCs to calculate the net present value of future energy savings and costs. In PY8, "present" was defined as 2016 dollars and each subsequent program year uses a different definition of present. PY9 statistics are expressed in 2017 dollars, PY10 in 2018 dollars, PY11 in 2019 dollars, and PY12 in 2020 dollars. In each program year of Phase III, Duquesne Light had the highest portfolio TRC Ratio and PECO had the lowest portfolio TRC Ratio.

[34] Phase IV Energy Efficiency and Peak Demand Reduction Potential Study at page 57. Dated February 28, 2020. Released via Secretarial Letter on March 2, 2020, at Docket No. M-2020-3015229.

Table 98: Gross TRC Test Results by EDC and Year

Program Year	Element	PECO	PPL	Duquesne Light	FE: Met-Ed	FE: Penelec	FE: Penn Power	FE: West Penn	Statewide
PY8	Benefits ($1,000)	$75,535	$160,299	$34,195	$48,755	$45,964	$13,339	$40,069	$418,156
	Costs ($1,000)	$68,836	$95,804	$16,418	$33,712	$30,041	$8,600	$31,752	$285,164
	Ratio	1.10	1.67	2.08	1.45	1.53	1.55	1.26	1.47
PY9	Benefits ($1,000)	$159,898	$201,533	$53,703	$69,451	$57,169	$24,252	$76,355	$642,361
	Costs ($1,000)	$126,609	$129,012	$20,675	$36,930	$44,386	$16,224	$59,608	$433,444
	Ratio	1.26	1.56	2.60	1.88	1.29	1.49	1.28	1.48
PY10	Benefits ($1,000)	$173,845	$225,373	$54,025	$75,522	$75,745	$26,205	$64,399	$695,114
	Costs ($1,000)	$145,031	$131,215	$28,044	$47,810	$54,862	$15,625	$42,189	$464,777
	Ratio	1.20	1.72	1.93	1.58	1.38	1.68	1.53	1.50
PY11	Benefits ($1,000)	$177,663	$223,782	$49,815	$54,929	$49,617	$18,618	$52,411	$626,835
	Costs ($1,000)	$160,431	$139,766	$24,759	$43,322	$40,784	$13,605	$44,063	$466,730
	Ratio	1.11	1.60	2.01	1.27	1.22	1.37	1.19	1.34
PY12	Benefits ($1,000)	$246,620	$180,625	$72,556	$43,330	$29,964	$9,625	$47,188	$629,908
	Costs ($1,000)	$269,527	$106,902	$27,965	$33,495	$21,791	$8,677	$38,277	$506,634
	Ratio	0.92	1.69	2.59	1.29	1.38	1.11	1.23	1.24

3.2.2 TRC Test Results for Phase III – All Years Combined

Table 99 shows the TRC Benefits, TRC Costs, and TRC Ratio for Phase III on gross basis, by EDC. All costs and benefits are expressed in 2016 dollars in the table. NPV benefits and costs from PY9-PY12 are converted to 2016 dollars using EDC-specific discount rates.

Table 99: Phase III Gross TRC Test Results by EDC

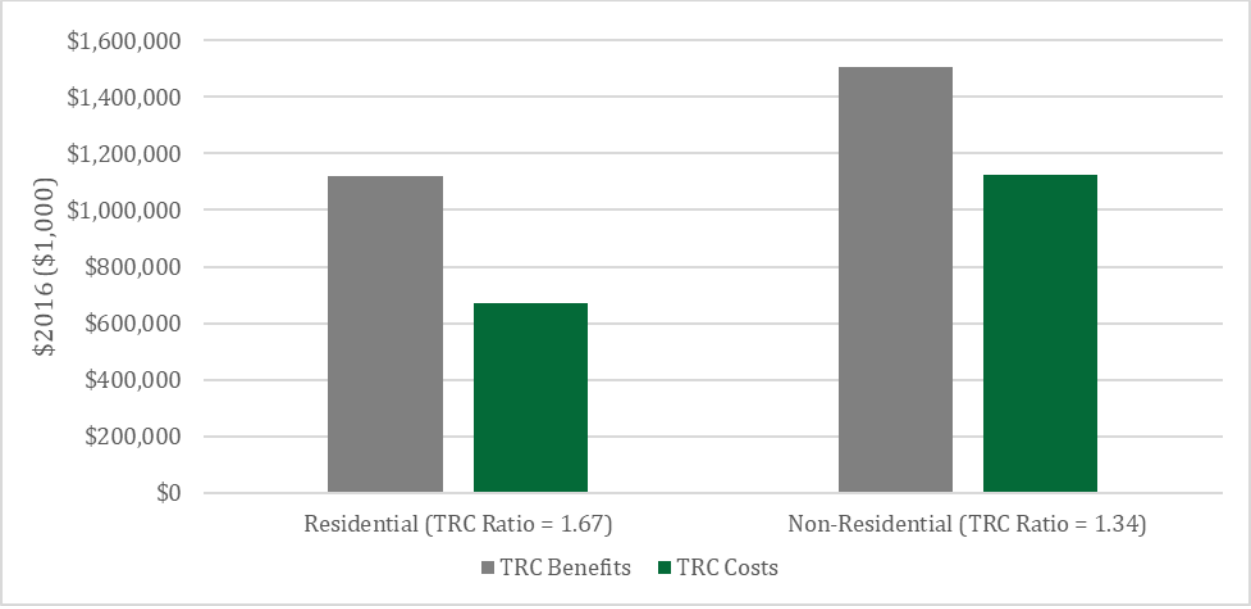
EDC	Gross Benefits ($1000)	Gross Costs ($1000)	Gross TRC Ratio
PECO	$701,664	$643,362	1.09
PPL	$873,601	$538,436	1.62
Duquesne Light	$228,490	$102,150	2.24
FE: Met-Ed	$259,133	$171,815	1.51
FE: Penelec	$229,776	$170,012	1.35
FE: Penn Power	$81,581	$55,241	1.48
FE: West Penn Power	$247,837	$190,546	1.30
Statewide*	**$2,622,084**	**$1,871,562**	**1.40**

*Rows may not sum to statewide totals due to rounding

3.2.3 Phase III TRC Test Results by Sector

Figure 35 summarizes Phase III TRC Test results by sector. The residential sector is inclusive of LI programs and the non-residential sector is inclusive of GNI offerings. The residential portfolio had a higher benefit-cost ratio in Phase III and generated more net benefits (benefits minus costs) for the Commonwealth.

Figure 35: Phase III TRC Results by Sector



This result mirrors Phase II of Act 129 when the residential portfolio had a gross TRC Ratio of 2.0 and the non-residential portfolio had a TRC Ratio of 1.6 statewide. The following section examines benefit-cost result since the inception of Act 129 EE&C programs.

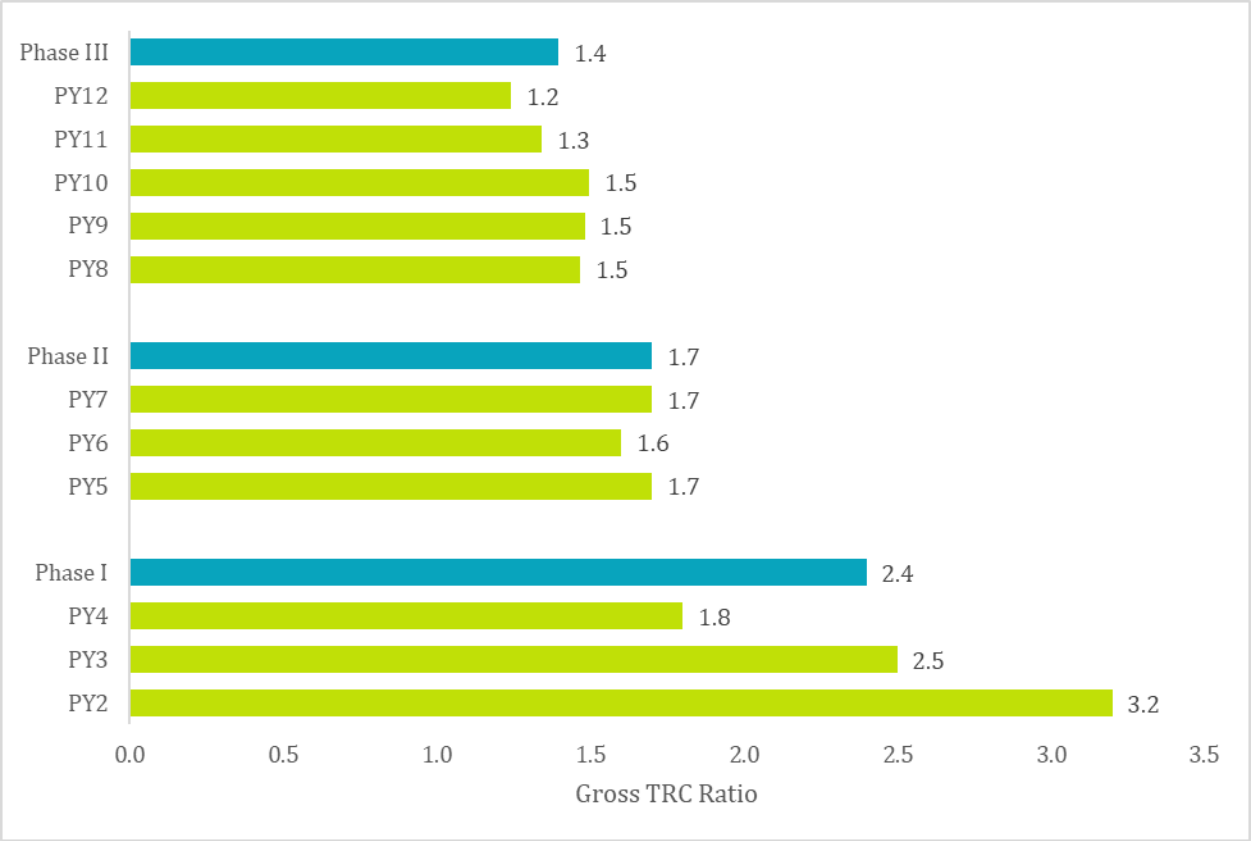
3.2.4 TRC Test Results by Phase

Figure 36 shows the statewide gross TRC Ratios by Act 129 program year and Phase. TRC Ratios have generally declined over time. The SWE team offers the following observations to help explain the reduced cost-effectiveness of Act 129 programs over time:

- Avoided costs have declined. One of the key drivers of the initial Act 129 legislation was high wholesale energy prices. Rapid expansion of natural gas production in Pennsylvania and neighboring states has led to sharp reductions in wholesale gas prices and caused avoided energy costs ($/kWh saved) to decline since Phase I of Act 129.
- Much of low-hanging fruit has been harvested. Inexpensive compact fluorescent lamps (CFLs) and later LED light bulbs dominated residential program offerings through PY10. In PY11, and especially PY12, the savings opportunity from residential lighting declined and placed downward pressure on portfolio TRC Ratios. Cost-effectiveness of residential light-emitting diode (LED) measures dropped throughout Phase III due to the dual baseline assumptions used in the calculation of lifetime energy savings, resulting in lower TRC Benefits each year.
- The Pennsylvania TRM has become more conservative. Equipment baselines have become more efficient in the TRM as codes and standards become more stringent at the state and federal level and the efficiency of installed equipment in homes and businesses improves. Impact evaluation results and statewide studies such as the 2014 Lighting Metering Study[35] have also led to more conservative equipment operating assumptions in the TRM.
- Phase I benefit-cost ratios were buoyed by conservation voltage reduction programs at PECO and West Penn Power. No EDC has operated a CVR program in Phase II or Phase III of Act 129.

[35]Pennsylvania Statewide Act 129 2014 Commercial & Residential Light Metering Study. https://www.puc.pa.gov/pcdocs/1340978.pdf

Figure 36: Phase I, II, and III Gross TRC Ratios



3.3 Phase III TRC Audit Overview

Each program year, the SWE team audits the cost-effectiveness calculations and results produced by the EDCs and their evaluation contractors. In addition to validating that the appropriate energy and peak demand savings are used as the foundation of the benefits calculations, the SWE teams confirms that all formulas and assumptions are consistent with the 2016 TRC Test Order.[36] Item #7 of the SWE's annual data request to the EDCs calls for an electronic version of the model(s) used to calculate the gross and net TRC Ratios in the EDC final annual report.

The SWE reviews the following key inputs and assumptions on an annual basis:

- **Discount rate**: expressed on a nominal basis and must align with the EDC weighted average cost of capital approved in the Phase III EE&C Plan. The discount rate is used to calculate the Net Present Value (NPV) of program benefits that will occur over a measure's lifetime.

[36] Pennsylvania Public Utility Commission. *Final Order on the TRC Test for Phase III of Act 129*. From the public meeting held June 11, 2015. Docket No. M-2015-2468992. https://www.puc.pa.gov/pcdocs/1367195.docx

- **Line loss factors**: should align with the sector-specific values in Table 1-4 of the 2016 TRM. Line loss factors account for the energy lost during transmission and distribution due to electric resistance and adjust electricity savings from the meter-level to the generation-level prior to computing TRC Benefits.
- **Avoided costs of energy and capacity:** expressed on a nominal basis. These values should match the avoided-cost forecast submitted by the EDC in 2015 when their Phase III EE&C Plan was approved by the Commission.
- **Incremental measure costs**: are assumptions for most measures. For large projects, the actual project costs may be known. Although EDCs are not required to use it, the SWE team prepared an Incremental Cost Database to promote consistency across EDCs. The SWE audit confirms that reasonable assumptions were used, and the cost vintage (early replacement versus replace-on-burnout) mirrors the energy and demand savings calculations.
- **Program administration costs**: actual values that should match other EDC financial reporting.
- **Verified savings figures**: were the correct quantity of MWh and MW used to compute TRC Benefits? Were realization rates and net-to-gross ratios applied correctly in the model?
- **Effective useful life of measures or measure groups**: the effective useful life (EUL) of a measure determines how many years of TRC Benefits are assigned to a measure. The SWE checks the EUL assumptions in the TRC models against the values given in Appendix A of the 2016 TRM.
- **End-use load shapes**: since EDCs have time-differentiated avoided energy costs, we need assumptions regarding the distribution of energy savings across the year. The SWE reviews these load shapes for reasonableness.

Benefit-cost models are complex tools. To validate that the TRC model formulas and calculations, the SWE team independently replicates the calculation of TRC Benefits using the same inputs and assumptions. If the two separate processes return the same outputs, we feel confident that the calculations within the EDC benefit-cost model are sound. We explored cases where the models returned different outputs with the EDCs and their evaluation contractors to understand where the logic differed and determine whether the result was an error by one party or a difference in interpretation of the 2016 TRC Test Order instructions

The EDC-specific appendices of this report summarize the SWE's TRC audit for PY12.

3.4 PECO

3.4.1 PECO Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 100 shows the TRC Ratios by program and for the portfolio. The

benefits in Table 100 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 100: PY12 Gross TRC Ratios by Program ($1,000) – PECO

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Residential EE	$44,851	$38,176	1.17	$6,675
LI EE	$9,096	$3,742	2.43	$5,354
Residential DR	$2,499	$2,667	0.94	($169)
Residential Total	**$56,446**	**$44,585**	**1.27**	**$11,860**
Small C&I EE	$35,174	$38,156	0.92	($2,983)
Large C&I EE	$58,726	$64,439	0.91	($5,714)
CHP	$89,948	$108,256	0.83	($18,308)
Small C&I DR	$63	$94	0.67	($31)
Large C&I DR	$6,263	$4,997	1.25	$1,267
Non-Residential Subtotal	**$190,174**	**$215,942**	**0.84**	**($35,314)**
Cross-Cutting	-	$9,000	-	($9,000
Portfolio Total	**$246,620**	**$269,527**	**0.92**	**($22,908)**

3.5 PPL

3.5.1 PPL Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 101 shows the TRC Ratios by program and for the portfolio. The benefits in Table 101 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 101: PY12 Gross TRC Ratios by Program ($1,000) – PPL

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Appliance Recycling	$1,135	$1,749	0.65	(($614)
Efficient Lighting	$0	$177	0.00	($177)
Energy-Efficiency Kits and Education	$0	$46	0.00	($46)
Energy-Efficient Home	$25,564	$17,806	1.44	$7,759
Home Energy Education	$1,015	$2,388	0.43	($1,372)
SEEE	$7,463	$1,676	4.45	$5,787
WRAP	$3,530	$5,106	0.69	($1,576)
Residential (Including LI) Subtotal	**$38,707**	**$28,948**	**1.34**	**$9,760**
Non-Residential Subtotal	**$137,466**	**$68,760**	**2.00**	**$68,705**
DR	$4,452	$2,197	2.03	$2,255
Common Portfolio Costs	$0	$6,997	N/A	($6,997)
Portfolio Total	**$180,625**	**$106,902**	**1.69**	**$73,723**

3.6 DUQUESNE LIGHT

3.6.1 Duquesne Light Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 102 shows the TRC Ratios by program and for the portfolio. The benefits in Table 102 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 102: PY12 Gross TRC Ratios by Program ($1,000) – Duquesne Light

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
REEP	$986	$1,667	0.59	($681)
Res. Appliance Recycling	$338	$229	1.48	$109
Res. Behavioral Savings	$321	$139	2.31	$182
Res. Whole House Retrofit	$0	$636	0.00	($636)
LI Energy Efficiency	$964	$1,233	0.78	$90
Residential Subtotal	**$2,610**	**$3,904**	**0.67**	**($935)**
Express Efficiency	$6,904	$2,034	3.39	$4,870
Small/Medium Midstream Lighting	$951	$746	1.27	$205
Small Commercial Direct Install	$0	$40	0.00	($40)
Multifamily Housing Retrofit	$779	$1,717	0.45	($920)
Commercial Efficiency	$8,758	$2,375	3.69	$6,383
Large Midstream Lighting	$348	$365	0.95	($16)
Industrial Efficiency	$29,838	$9,501	3.14	$20,337
Public Agency Partnership	$18,975	$5,359	3.54	$13,615
Community Education	$0	$242	0.00	($242)
Large C&I DR Curtailable	$3,392	$1,686	2.02	$1,711
Non-Residential Subtotal	**$69,945**	**$24,060**	**2.91**	**$45,903**
Portfolio Total	**$72,556**	**$27,965**	**2.59**	**$44,968**

3.7 FIRSTENERGY: METROPOLITAN EDISON COMPANY

3.7.1 Met-Ed Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 103 shows the TRC Ratios by program and for the portfolio. The benefits in Table 103 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 103: PY12 Gross TRC Ratios by Program ($1,000) – Met-Ed

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Appliance Turn-In	$977	$534	1.83	$443
Energy-Efficient Homes	$4,635	$2,924	1.59	$1,711
Energy-Efficient Products	$6,494	$7,151	0.91	($657)
LI Energy Efficiency	$527	$1,921	0.27	($1,394)
Residential Subtotal	**$12,633**	**$12,530**	**1.01**	**$103**
C&I Energy Solutions for Business – Small	$7,771	$5,763	1.35	$2,009
C&I Energy Solutions for Business - Large	$21,111	$14,215	1.49	$6,896
Governmental & Institutional Tariff	$184	$195	0.94	($11)
C&I DR Program – Small	$123	$63	1.96	$60
C&I DR Program – Large	$1,508	$730	2.07	$778
Non-Residential Subtotal	**$30,697**	**$20,965**	**1.46**	**$9,732**
Portfolio Total	**$43,330**	**$33,495**	**1.29**	**$9,835**

3.8 FIRSTENERGY: PENNSYLVANIA ELECTRIC COMPANY

3.8.1 Penelec Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 104 shows the TRC Ratios by program and for the portfolio. The benefits in Table 104 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 104: PY12 Gross TRC Ratios by Program ($1,000) – Penelec

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Appliance Turn-In	$740	$479	1.54	$260
Energy-Efficient Homes	$1,823	$993	1.84	$830
Energy-Efficient Products	$5,743	$5,370	1.07	$374
LI Energy Efficiency	$445	$1,536	0.29	($1,091)
Residential Subtotal	**$8,751**	**$8,379**	**1.04**	**$373**
C&I Energy Solutions for Business – Small	$8,117	$5,641	1.44	$2,476
C&I Energy Solutions for Business – Large	$12,610	$7,339	1.72	$5,271
Governmental & Institutional Tariff	$486	$433	1.12	$53
Non-Residential Subtotal	**$21,213**	**$13,412**	**1.58**	**$7,801**
Portfolio Total	**$29,964**	**$21,791**	**1.38**	**$8,173**

3.9 FIRSTENERGY: PENNSYLVANIA POWER COMPANY

3.9.1 Penn Power Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 105 shows the TRC Ratios by program and for the portfolio. The benefits in Table 105 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 105: PY12 Gross TRC Ratios by Program ($1,000) – Penn Power

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Appliance Turn-In	$0	($3)	-	$3
Energy-Efficient Homes	$1,670	$1,124	1.49	$547
Energy-Efficient Products	$1,679	$1,676	1.00	$3
LI Energy Efficiency	$73	$300	0.24	($227)
Residential Subtotal	**$3,423**	**$3,096**	**1.11**	**$327**
C&I Energy Solutions for Business – Small	$4,961	$4,495	1.10	$466
C&I Energy Solutions for Business – Large	$810	$814	1.00	($4)
Governmental & Institutional Tariff	$0	$18	-	($18)
C&I DR Program – Small	$0	$6	-	($6)
C&I DR Program – Large	$431	$248	1.74	$183
Non-Residential Subtotal	**$6,202**	**$5,581**	**1.11**	**$621**
Portfolio Total	**$9,625**	**$8,677**	**1.11**	**$947**

3.10 FIRSTENERGY: WEST PENN POWER

3.10.1 West Penn Power Cost-Effectiveness

TRC Benefit-cost ratios are calculated by comparing total NPV TRC Benefits and 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 106 shows the TRC Ratios by program and for the portfolio. The benefits in Table 106 were calculated using gross verified impacts. Costs and benefits are expressed in 2020 dollars.

Table 106: PY12 Gross TRC Ratios by Program ($1,000) – West Penn Power

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits– Costs)
Appliance Turn-In	$830	$506	1.64	$324
Energy-Efficient Homes	$5,500	$3,130	1.76	$2,370
Energy-Efficient Products	$7,101	$8,154	0.87	($1,052)
LI Energy Efficiency	$435	$1,535	0.28	($1,101)
Residential Subtotal	**$13,866**	**$13,325**	**1.04**	**$541**
C&I Energy Solutions for Business – Small	$11,526	$9,863	1.17	$1,663
C&I Energy Solutions for Business – Large	$17,984	$13,287	1.35	$4,697
Governmental & Institutional Tariff	$0	$48	0.00	($48)
C&I DR Program – Small	$80	$54	1.46	$25
C&I DR Program – Large	$3,733	$1,700	2.20	$2,032
Non-Residential Subtotal	**$33,323**	**$24,953**	**1.34**	**$8,370**
Portfolio Total	**$47,188**	**$38,277**	**1.23**	**$8,911**

Section 4 SWE Analysis of PY12 and Phase III Program Delivery

This chapter presents the key findings of the Phase III SWE analysis of process evaluations and NTG research as well as opportunities for program improvement. More details of the SWE's PY12 audit and cross-cutting activities, including a review/audit of EDC program delivery mechanisms and all evaluation processes and results submitted by each EDC's evaluation contractor, are available in the Appendices.

4.1 Process Evaluation Summary for PY12 (June 1, 2020 – May 31, 2021)

Table 107 provides an overview of the PY12 process evaluations conducted by each EDC.

Table 107: PY12 Process Evaluations by EDC

EDC	# of PY12 Programs	# Evaluated	# of Process Findings	# of Process Recommen-dations	% of Satisfied Residential Customers*	% of Satisfied C&I Customers*
PECO**	8	0	0	0	N/A	N/A
PPL	8	6	22	5	90%	92%
Duquesne Light	14	2	14	4	N/A	89%
FirstEnergy EDCs***	9	1	6	3	88%	NA

* Average across all programs for which participant surveys were conducted. Average is weighted by number of PY12 participants in each program.
** The eight programs include 21 program solutions and targeted market segments within eight PECO energy-efficiency target areas: residential, LI, small C&I, large C&I, CHP, residential DR, small C&I DR, and large C&I DR.
*** The four FirstEnergy EDCs (Met-Ed, Penelec, Penn Power, and West Penn Power) operate an identical set of nine programs, two of which are DR programs. The evaluation contractor took unified process evaluation approaches to these programs and reported process evaluation results across all four EDCs.

4.2 PROCESS EVALUATION

4.2.1 Role of Process Evaluation in Phase III

The Final Phase III Implementation Order specified that EDC final annual reports were required to include findings from process evaluations.[37] The Phase III Evaluation Framework[38] provides the EDCs and their evaluators with guidance for process evaluations, including:

- The key purpose of process evaluation: to determine if there are ways to alter the program to improve cost-effectiveness or the program's efficiency in acquiring resources.
- The ways decision-makers can use the results of process evaluations
- The recommended approaches and methodologies to process evaluations

The framework also includes two specific process evaluation requirements for the EDCs in Phase III:

1. Each process evaluation should have a detailed plan that describes the objectives, sampling plan (for surveys, interviews, or focus groups), research activities, and specific issues to be addressed, along with a schedule of milestones and deliverables.
2. Every program should have at least one process evaluation during Phase III.

4.2.2 SWE Analysis of Phase III Process Evaluation, by EDC

In general, for the EDCs' process evaluations, the SWE determined that the reporting followed its guidelines. The annual reports included descriptions of the methods, summary of findings, and a table of recommendations with a description of whether the EDC was implementing or considering those recommendations. The reports included sufficient detail to assess the methods, findings, and recommendations. The evaluation methods were largely consistent with those described in the Phase III Evaluation Plan. Overall, the process evaluations discussion was succinct and highlighted findings of likely value to the administrator and implementer. The recommendations were clear and actionable, supported by the findings, and drawn from key findings.

Examples of key topics addressed by process evaluations during Phase III include, but are not limited to, the following:

- Drivers and barriers of program success
- Barriers to program delivery
- Satisfaction levels and reasons for dissatisfaction with the program
- Primary sources of program information
- Awareness of other EDC efficiency program and offerings
- Strengths and weaknesses in program outreach

[37] Pennsylvania Public Utility Commission, Phase III Final Implementation Order. From the Public Meeting of June 11, 2015, at page 101. Docket No. M-2014-2424864, (Phase III Implementation Order). http://www.puc.pa.gov/pcdocs/1367313.doc

[38] Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework050818.pdf

- Uptake of program measures and customer perception of program measures
- Customer or trade-ally perceptions of incentive amounts or processing time
- Assessment of program paperwork requirements and program application systems
- Suggestions for program improvement
- Suggested improvements in program administration
- Assessment of trained trade-ally availability
- Opportunities to improve trade-ally communications and assist them with marketing
- Customer energy-saving habits
- Customer purchase decision drivers
- Benchmarking of program relative to other jurisdictions

Table 108 through Table 110 provide an overview of the Phase III process evaluations conducted by each EDC.

Table 108: Phase III Summary of Number of Program-level Process Evaluations by Program Year

EDC	PY8		PY9		PY10		PY11		PY12	
	# of Programs	# Evaluated	# of Programs	# Evaluated	# of Programs	# Evaluated	# of Programs	# Evaluated	# of Programs	# Evaluated
PECO*	8	4	8	4	8	4	8	3	8	0
PPL	10	9	9	9	9	9	9	8	9	6
Duquesne Light	13	3	13	9	14	4	14	10	14	2
FirstEnergy EDCs**	9	7	9	5	9	6	9	6	9	1

* The eight programs include 21 program solutions

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

Table 109: Phase III Summary of Number of Program-level Process Evaluation Findings and Recommendations by Program Year

EDC	PY8		PY9		PY10		PY11		PY12	
	# of Findings	# of Recomme-ndations	# of Findings	# of Recomme-ndations	# of Findings	# of Recomme-ndations	# of Findings	# of Recomme-ndations	# of Findings	# of Recomme-ndations
PECO	296	25	16	16	4	4	4	4	0	0
PPL	29	18	49	24	37	21	4	7	22	5
Duquesne Light	19	10	23	13	6	5	16	16	14	4
FirstEnergy EDCs**	30	22	15	15	61	23	21	17	6	3

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

Table 110: Phase III Summary of Participant Satisfaction by Program Year

EDC	PY8		PY9		PY10		PY11		PY12	
	% of Satisfied Res. Cust.*	% of Satisfied C&I Cust. *	% of Satisfied Res. Cust. *	% of Satisfied C&I Cust. *	% of Satisfied Res. Cust. *	% of Satisfied C&I Cust. *	% of Satisfied Res. Cust. *	% of Satisfied C&I Cust. *	% of Satisfied Res. Cust. *	% of Satisfied C&I Cust. *
PECO	89%	83%	87%	84%	71%	88%	91%	92%	N/A	N/A
PPL	87%	97%	94%	96%	74%	91%	92%	95%	90%	92%
Duquesne Light	N/A	N/A	N/A	N/A	95%***	N/A	79%	97%	N/A	89%
FirstEnergy EDCs**	N/A	N/A	95%	100%	88%	95%	92%	N/A	88%	N/A

* Average across all programs for which participant surveys were conducted. Average is weighted by number of participants in each program and program year.

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

*** The SWE calculated these values from the distribution of satisfaction scores for the WHRP presented in the PY10 Duquesne Light Residential Report (Table 5-6). On a scale of 1 to 10, where 10 is “extremely satisfied”, the SWE considered ratings of 6 and above “satisfied” for the purposes of the above calculation.

4.2.3 Results for Act 129 Phase III PY12 (June 1, 2020-May 31, 2020)

4.2.3.1 PECO

Guidehouse did not conduct in-depth process evaluation activities for the PECO Residential, LI, Small C&I or Large C&I EE Programs. Instead, the Guidehouse team interviewed the PECO program managers and CSP staff and identified significant implementation changes to inform the impact evaluation activities. No significant changes were found.

4.2.3.2 PPL

Cadmus reported on PY12 process evaluations for the following PPL programs (Table 111).

Table 111: PY12 Process Evaluations

Residential and C&I Programs	
Residential Programs	**C&I Programs**
Appliance Recycling	Efficient Equipment
Energy-Efficient Home	Midstream Lighting
Home Energy Education	Demand Response
Student Energy-Efficient Education	Custom
Residential LI Programs	
Weatherization Relief Assistance (WRAP)	

For PY12, Cadmus evaluated and reported on a total of six programs within the PPL residential, LI, and C&I sectors; note that the non-residential program has four distinct program components (Efficient Equipment, Midstream Lighting, Custom, and Continuous Energy Improvement) with separate evaluations. These evaluations generated a total of 22 process evaluation findings, which resulted in five recommendations, two of which were accepted and three of which are under consideration.[39] A key cross-program finding was on program satisfaction from participant surveys, which were conducted for all programs. On average, across all participant surveys, 92% of residential and LI participants and 90% of C&I participants were satisfied with the programs or program measures overall.[40]

For the *PPL Residential programs* and the *PPL Residential LI programs*, the PY12 process evaluation provided a total of ten findings and three recommendations. One recommendation was accepted, and the other two recommendations are under consideration. A key cross-program finding was on program satisfaction from participant surveys. On average, across all residential program solutions, 92% of the participants were satisfied with the programs or program measures

[39] There are additional findings and recommendations in the PY12 report; however, this section reports only findings and recommendations specifically related to the process evaluation.
[40] Weighted by the number of PY12 participants in each program.

overall.[41] Program-specific findings for these residential program solutions addressed a broad range of topics, including the following:[42]

- Program satisfaction
- Program efforts to promote program success
- Products available through the program
- Drivers and barriers of program success

For the *PPL C&I programs*, the PY12 process evaluation provided a total of 12 findings and two recommendations. Two recommendations are under consideration. A key cross-program finding was on program satisfaction from participant surveys. On average, across both the Efficient Equipment and Custom programs, 90% of the participants were satisfied with the program overall.[43] Program-specific findings for the C&I programs primarily addressed program awareness and issues with program-related communication.

4.2.3.3 Duquesne Light

Guidehouse reported on PY12 process evaluations for the following Duquesne Light programs (Table 112).

Table 112: Duquesne Light PY12 Process Evaluations

Residential and C&I Programs	
Residential Programs[44]	**C&I Programs**[45]
	Midstream Lighting
	Public Agency Partnership (PAPP)

For PY12, Guidehouse evaluated and reported on a total of two programs, both in the Duquesne Light C&I sector.

For the Duquesne Light *C&I* Midstream Lighting and Public Agency Partnership Program, the PY12 process evaluation provided a total of four recommendations between the programs. Two were accepted by Duquesne Light and two are under consideration.

[41] Weighted by the number of PY12 participants in each program.
[42] The PPL annual report provides further detail regarding these topics.
[43] Weighted by the number of PY12 participants in each program.
[44] Guidehouse did not conduct a PY12 process evaluation for any of the residential programs: Residential Energy-Efficiency Program (REEP), Residential Appliance Recycling Program (RARP), Residential Behavioral Savings Program, Residential Whole House Retrofit Program (WHRP), or the Low-Income Energy-Efficiency Program (LIEEP).
[45] Guidehouse did not conduct a PY12 process evaluation for Express Efficiency (EXP), Commercial Efficiency (CEP), Industrial Efficiency (IEP), Multifamily Housing Retrofit (MFHR), Community Education (CEEP), Small Commercial Direct Install Program (SCDI), or the Large Curtailable Load (LCL). SCDI reached its savings goals in PY9 and there were no new projects after Q1 of PY10.

A key cross-program finding was on program satisfaction from participant surveys. Satisfaction among program participants was 87% for the Public Agency Partnership Program and 89% for Midstream Lighting.

Program-specific findings addressed topics that included the following:

- Program awareness, outreach, and marketing
- Program satisfaction
- Program barriers and challenges

4.2.3.4 FirstEnergy: Metropolitan Edison Company

Four EDCs – Met-Ed, Penelec, Penn Power, and West Penn Power – operate an identical set of nine 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. Therefore, the SWE's audit summary described in this section pertains to all four FirstEnergy utilities.

For PY12, ADM/Tetra Tech evaluated and reported on one program within the Met-Ed residential sector: the Behavioral Demand Response (BDR) program. This evaluation generated six process findings and resulted in three recommendations, all of which were accepted.[46] Nearly nine in ten participants (88%) in the BDR program were satisfied.

Findings addressed the following topics:

- Satisfaction
- Ease of participation
- Customer follow-through
- Effective customer engagement strategies

4.2.3.5 FirstEnergy: Pennsylvania Electric Company

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penelec, so the annual evaluation reports of the four FirstEnergy EDCs provide identical information about the process evaluation. Therefore, the SWE's audit summary described for Met-Ed previously applies to all four FirstEnergy utilities, including Penelec.

4.2.3.6 FirstEnergy: Pennsylvania Power Company

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penelec, so the annual evaluation reports of the four FirstEnergy EDCs provide identical information about the process evaluation.

[46] The Behavioral Demand Response program will not be renewed in Phase IV, so the team provided recommendations should the program be administered in the future.

Therefore, the SWE's audit summary described for Met-Ed previously applies to all four FirstEnergy utilities, including Penn Power.

4.2.3.7 FirstEnergy: West Penn Power

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penelec, so the annual evaluation reports of the four FirstEnergy EDCs provide identical information about the process evaluation. Therefore, the SWE's audit summary described for Met-Ed previously applies to all four FirstEnergy utilities, including West Penn Power.

4.3 PHASE III NET-TO-GROSS AUDIT RESULTS

4.3.1 Purpose of Net-to-Gross Reporting

The Commission's Phase III Implementation Order specified that EDCs continue to perform NTG research to inform program modifications, program planning, and determinations of cost-effectiveness despite compliance being based on gross verified savings. Program design, modification of program incentive levels, and eligibility requirements should all be guided by the programs evaluated NTG value.

4.3.2 SWE Analysis of Phase III Net-to-Gross Reporting

The SWE evaluated the EDC's NTG evaluations to ensure the formulation of the NTG was theoretically and mathematically correct regarding the program under evaluation. The most common method of NTG evaluation involved conducting a survey of program participants and collecting data regarding free-ridership and spillover (SO) activity by the participants. These activities were then operationalized and included in a NTG formula (1-free-ridership + spillover). The SWE analysis of the participant self-reported NTG evaluations included a review of the survey instruments used to collect data on free-ridership and spillover for theoretical correctness and comprehensiveness, inspection of survey data for the correctness and consistency of free-ridership and spillover values, a review of any code used to calculate the NTG formula, and a review of the formula enaction for NTG result replicability.

Other less common NTG estimation methods included econometric approaches that modeled participant and non-participant data to estimate net savings and literature reviews that assessed recent NTG values for similar programs and use an average of reviewed values as the program NTG. The SWE reviewed the code and data for the econometric approaches to NTG estimation to determine the accuracy of values being used. The statistical code was reviewed to ensure that the model being used to estimate NTG was mathematically sound. When literature reviews were employed by the EDCs to estimate NTG, the SWE also reviewed the original sources to ensure that the program NTG values from the larger body of literature were estimated using best practices and that the programs resembled the EDC program under evaluation.

EDC annual portfolio NTG values ranged from 0.57 to 0.83 (see Table 113 through Table 120). Comparing program-level NTG values across EDCs is challenging because of the different ways in which EDCs package their program offerings. However, the SWE notes that within residential offerings, appliance recycling, lighting, and efficient home programs and initiatives tend to have

slightly lower NTG values. While among non-residential offerings, large C&I and custom programs and initiatives tend to have slightly lower NTG values. More details about the EDCs' PY12 NTG evaluations can be found in Appendix B through Appendix H.

4.3.3 Results for Act 129 Phase III PY12 (June1, 2020-May 31, 2021)

Table 113: Summary of Portfolio NTG Ratios by EDC, Phase III

EDC	PY8	PY9	PY10	PY11	PY12
PECO	0.73	0.73	0.71	0.69	0.76
PPL	0.83	0.80	0.82	0.78	0.67
Duquesne Light	0.74	0.57	0.58	0.64	0.74
FE: Met-Ed	0.69	0.69	0.67	0.62	0.65
FE: Penelec	0.71	0.73	0.72	0.68	0.74
FE: Penn Power	0.72	0.69	0.66	0.61	0.73
FE: West Penn Power	0.71	0.72	0.62	0.57	0.62

Table 114: PECO NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
Res. Energy-Efficiency	0.70	0.68	0.65	0.67	0.73
LI Energy-Efficiency	1.00	1.00	1.00	1.00	1.00
Small C&I Energy-Efficiency	0.75	0.75	0.76	0.76	0.76
Large C&I Energy-Efficiency	0.64	0.77	0.74	0.60	0.60
CHP	N/A	0.89	0.87	0.87	0.87
Portfolio Total	**0.73**	**0.73**	**0.71**	**0.69**	**0.76**

Table 115: PPL NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
Appliance Recycling	0.66	0.66	0.66	0.66	0.66
Efficient Lighting	0.83	0.83	0.83	0.83	N/A
Energy-Efficiency Kits and Education	1.00	1.00	1.00	1.00	N/A
Energy-Efficient Home**	0.66	0.75	0.66	0.66	0.46
Home Energy Education*	1.00	1.00	1.00	1.00	1.00
Non-Residential Energy-Efficiency	0.79	0.71	0.74	0.71	0.66
Student Energy-Efficient Education (SEEE)	1.00	1.00	1.00	1.00	1.00
WRAP	1.00	1.00	1.00	1.00	1.00
Total	**0.83**	**0.80**	**0.82**	**0.78**	**0.68**

Table 116: Duquesne Light NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
REEP	0.58	0.72	0.72	0.76	0.66
REEP (Upstream Lighting)	0.69	0.43	0.43	0.43	N/A
Res. Appliance Recycling	0.47	0.47	0.46	0.47	0.47
Res. Behavioral Savings	1.00	1.00	1.00	1.00	1.00
Res. Whole House Retrofit	N/A	1.00	1.00	N/A	N/A
LI Energy Efficiency	0.96	1.00	1.00	1.00	1.00
Express Efficiency	0.56	0.55	0.58	0.72	0.79
Small/Medium Midstream Lighting	0.88	0.88	0.72	0.72	0.88
Small Commercial Direct Install	0.99	0.99	0.99	N/A	N/A
Multifamily Housing Retrofit	0.71	0.45	0.45	0.45	0.45
Commercial Efficiency	0.56	0.60	0.60	0.79	0.79
Large Midstream Lighting	0.88	0.88	0.72	0.72	0.88
Industrial Efficiency	0.68	0.31	0.31	0.61	0.61
Public Agency Partnership	0.80	0.45	0.45	0.45	0.86
Community Education	0.80	0.45	0.45	0.45	N/A
Portfolio Total	**0.74**	**0.57**	**0.58**	**0.64**	**0.74**

Table 117: Met-Ed Light NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
Appliance Turn-In	0.50	0.49	0.45	0.45	0.45
Energy-Efficient Homes	0.92	0.92	0.91	0.93	0.98
Energy-Efficient Products	0.38	0.38	0.32	0.31	0.35
LI Energy Efficiency	1.00	1.00	1.00	1.00	1.00
C&I Energy Solutions for Business – Small	0.65	0.62	0.63	0.63	0.60
C&I Energy Solutions for Business – Large	0.55	0.56	0.63	0.60	0.60
Governmental & Institutional Tariff	0.66	0.63	0.64	0.63	0.62
Portfolio Total	**0.69**	**0.69**	**0.67**	**0.62**	**0.65**

Table 118: Penelec Light NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
Appliance Turn-In	0.43	0.45	0.47	0.47	0.47
Energy-Efficient Homes	0.91	0.91	0.88	0.91	0.99
Energy-Efficient Products	0.34	0.35	0.33	0.33	0.37
LI Energy Efficiency	1.00	1.00	1.00	1.00	1.00
C&I Energy Solutions for Business – Small	0.82	0.79	0.75	0.78	0.81
C&I Energy Solutions for Business – Large	0.76	0.78	0.80	0.80	0.81
Governmental & Institutional Tariff	0.85	0.84	0.76	0.77	0.81
Portfolio Total	**0.71**	**0.73**	**0.72**	**0.68**	**0.74**

Table 119: Penn Power Light NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
Appliance Turn-In	0.50	0.58	0.51	0.51	N/A
Energy-Efficient Homes	0.90	0.89	0.90	0.96	0.97
Energy-Efficient Products	0.40	0.40	0.28	0.28	0.37
LI Energy Efficiency	1.00	1.00	1.00	1.00	1.00
C&I Energy Solutions for Business – Small	0.72	0.73	0.75	0.77	0.73
C&I Energy Solutions for Business – Large	0.60	0.67	0.73	0.72	0.76
Governmental & Institutional Tariff	0.75	0.75	0.77	0.79	N/A
Portfolio Total	**0.72**	**0.69**	**0.66**	**0.61**	**0.73**

Table 120: West Penn Power Light NTG Ratios by Program, Phase III

Program	PY8	PY9	PY10	PY11	PY12
Appliance Turn-In	0.45	0.51	0.48	0.48	0.48
Energy-Efficient Homes	0.94	0.92	0.96	0.98	0.98
Energy-Efficient Products	0.28	0.29	0.27	0.26	0.32
LI Energy Efficiency	1.00	1.00	1.00	1.00	1.00
C&I Energy Solutions for Business – Small	0.82	0.82	0.65	0.63	0.61
C&I Energy Solutions for Business – Large	0.74	0.64	0.66	0.65	0.60
Governmental & Institutional Tariff	0.83	0.83	0.67	0.66	0.48
Portfolio Total	**0.71**	**0.72**	**0.62**	**0.57**	**0.62**

4.4 Technical Reference Manual

The 2016 TRM remained in effect during PY12. There was one interim measure protocol (IMP) reviewed and approved to be effective during PY12, for cold climate air source heat pumps. Note that there was also a PY12 Midstream Lighting IMP, approved during PY11.

For the 2021 TRM (Phase IV), the SWE received inquiries from several EDC evaluators about developing IMPs for nearly 30 measures that either (1) were not covered by the 2021 TRM or (2) did not have protocols for midstream program delivery. The SWE worked with TUS staff and the EDCs to prioritize IMPs and finalized residential and commercial HVAC midstream delivery IMPs during PY12, effective for Phase IV.

In addition, the SWE developed several guidance memos pertaining to ENERGY STAR dehumidifiers, cross-reference errors in the 2021 TRM Volume 2, and 2021 TRM Section 2.4.3 (Refrigerator / Freezer Recycling with and without Replacement). See Appendix K for more details.

4.5 Recommendations for Program Improvements for Subsequent Act 129 Phases

A primary purpose of program evaluation is to identify opportunities for program improvement. Because the SWE reviews program performance data and evaluation findings from all seven EDCs subject to Act 129, we are in a unique position to observe what is working well and where there are challenges across the Commonwealth. SWE team members also conduct evaluation research and policy support in many states across the country and can compare Act 129 program delivery with broader industry trends. This section offers our suggestions from program improvement in Phase IV and beyond. We recognize that Phase IV EE&C Plans have been approved by the PUC and implementation contracts awarded. Program delivery is ongoing, so EDCs may have limited flexibility to implement these recommendations. In some cases, our recommendations are policy-based and effectively recommendations to the PUC on a potential Phase V of Act 129.

- In Phase III of Act 129, EDCs delivered highly efficient programs in terms of utility cost per first-year kWh saved with a statewide average for Phase III under 14 cents. This optimization is not surprising given the fixed EE&C budgets and statutory compliance penalties. Lean acquisition costs are generally a function of efficient program delivery and focusing programs on measures with lower capital costs, that in turn require smaller incentives to drive participation. For Phase IV of Act 129, EDC targets are less aggressive on a $/kWh basis and should allow EDCs to encourage measures with higher upfront capital costs (the Phase IV EEPDR MPS estimated statewide acquisition costs are $0.27/kWh compared to $0.20 in the Phase III EE MPS). Opportunities for compliance savings from LED lighting in the residential sector are limited for Phase IV, so we expect this transition to happen sooner in the residential sector than non-residential.
- Phase III of Act 129 saw EDCs increasingly pursue midstream program delivery models where program incentives flow through distributors and other market actors rather than directly to program participants. The SWE team recommends EDCs test this delivery model across end uses in Phase IV to determine which markets work well and which markets do not. For example, both the agricultural sector and commercial cooking equipment have historically seen minimal participation in Act 129 programs. Offering agricultural and commercial cooking EE&C measures directly to farm or restaurant supply distributors and contractors may help EDCs tap into these customers through existing points in the supply chain. Midstream programming is a more market-based approach to program delivery, so it will be incumbent on EDC evaluation contractors to monitor market transformation.
- The Commission's establishment of peak demand savings targets from energy efficiency underscores two important trends in the industry. Capital investments in infrastructure have become an increasing share of utility costs. These are fixed costs, rather than variable ones, and are driven by peak loads rather than total consumption. As renewables represent an increasing share of the generation mix in the region, we expect to see the time-differentiation of avoided energy costs become more pronounced. For Phase IV of Act 129, we recommend EDCs focus on the timing of energy savings as much as the volume of energy savings and target load-following measures like air conditioning, space

heating, and domestic hot water as well as building shell measures, which predominantly reduce HVAC consumption.

- Pay-for-performance program offerings, which rely on meter-based measurements of energy and peak demand savings, are becoming more ubiquitous nationally as AMI spreads and modeling methods become standardized. Several EDCs included virtual commissioning offerings in their Phase IV EE&C Plans. This type of offering has several attractive features for the EDC and participant but presents measurement and verification challenges. Unlike TRM measures, which offer a fixed quantity of kWh and kW savings per unit, the volume of savings from meter-based methods is not known for many months. The SWE team offers the following recommendations and observations for this type of program offering in Phase IV.
    - This type of analysis often returns erratic savings estimates at the customer level because of variation in building occupancy, production schedules, and other operating patterns. Over-stated and under-stated estimates of individual customer savings even out at the program level with aggregation across program participants, but there is settlement risk to individual participants when their incentive is determined via meter-based methods of energy savings.
    - Be mindful of replace-on-burnout measures where the appropriate baseline is not the pre-retrofit condition of the home or business. Most regression methods make a "pre versus post" comparison that assumes the existing condition of the home or business as the baseline and are poorly suited to perspectives where the replaced equipment is assumed to have reached the end of its useful life, so the baseline is a new code-minimum piece of equipment.
    - As Pennsylvania rebounds from the COVID-19 pandemic, it may be difficult to baseline some business types as they return to in-person work. Adjusting for non-routine events could help, but this works against the automation benefits of meter-based methods.
- The COVID-19 pandemic forced EDCs to transition certain program delivery processes from in-person to virtual for safety reasons. In many cases, these virtual processes worked well and can be leveraged for Phase IV to make processes more efficient. Specifically, we see opportunities to combine remote audits with AMI analytics to identify opportunities for EE&C measure offerings more efficiently.
- Equitable program offerings for low- to moderate-income communities is a topic at the forefront of policy discussions in most jurisdictions. With opportunities for residential lighting savings waning in Pennsylvania, the SWE team recommends EDCs look for ways to achieve deeper retrofits of LI housing stock in Phase IV. Collaboration with state weatherization efforts and natural gas EE&C programs are two strategies that work well in other states to serve disadvantaged communities.
- Increasingly, the driving force behind energy-efficiency and conservation programs nationwide is mitigation of CO_2 emissions and climate change. States like New York, California, and Massachusetts have begun to actively pursue "beneficial electrification" programming to displace fossil fuel consumption with electric loads that can, in theory, become carbon neutral. This type of offering does not fit cleanly within the Act 129 legislative construct because Pennsylvania places no monetary value on avoided CO_2

emissions and EE&C goals focus on MWh and MW reductions. While there are non-trivial policy barriers to overcome, the direction of the industry is clear and ultimately Act 129 programming will need to adapt to expand beyond simple reductions in electric consumption. We recommend EDCs work to build strong networks of program contractors in the HVAC and plumbing trades as space heating and water heating are the primary targets for building electrification.

Section 5 Phases I, II, and III Savings

This chapter provides a summary of the statewide PY12 and Phase III energy impacts as well as a summary of the acquisition costs per first-year kWh saved. 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, or spending divided by verified gross savings.

Table 121 presents a statewide overview of PY12 and Phase III savings.

Table 121: Summary of Statewide PY12 and Phase III Impacts: Gross and Net Annual and Lifetime Savings

Savings Category	Statewide Total
Phase III Reported Gross Savings (MWh/yr)	6,584,127
Phase III Verified Gross Savings (MWh/yr)	6,663,502
Phase III Net Savings (MWh/yr)	4,776,270
Phase III Gross Lifetime Savings (MWh)	60,331,769
Phase III Net Lifetime Savings (MWh)	41,843,279
PY12 Reported Gross Savings (MWh/yr)	1,255,563
PY12 Verified Gross Savings (MWh/yr)	1,222,779
PY12 Net Savings (MWh/yr)	877,632
PY12 Gross Lifetime Savings (MWh)	13,125,310
PY12 Net Lifetime Savings (MWh)	9,210,645

5.1 Cost Per kWh

This section provides a summary of the acquisition costs per first-year kWh saved for all program years for all phases of Act 129. All acquisition costs have been adjusted to real 2021 dollars for comparability across time and to account for the impacts of inflation.[47] Table 122 presents statewide acquisition costs by program year while Table 123 to Table 129 present acquisition costs by EDC. There are several overarching observations and findings from this analysis (note that the SWE focused on acquisitions costs beginning in PY2 due to the highly variable acquisitions costs in PY1 during which the EDCs established their Act 129 Programs):

[47] In the 2016 TRC Test Order, the PUC endorsed the use of the 5-year rolling average of the Bureau of Labor Statistics Electric Power Generation Transmission Distribution (GTD) sector price index (BLS factor: NAICS 221110) as a proxy rate for escalation of transmission, distribution, capacity, and ancillary service costs, and we have used this same price index to adjust program costs for inflation. Because this is a retrospective analysis and the actual BLS producer price indices (PPI) for each historical program year are known, we have multiplied the reported program costs for each program year (expressed in nominal dollars) by the ratio of the annual average 2021 PPI and the annual average PPI for the appropriate program year to calculate costs in real dollars. Because only partial PPI data was available for 2021 at the time the analysis was conducted, we used the 5-year rolling annual compound rate of growth for 2016-2020 to estimate the 2021 PPI.

- Statewide portfolio acquisition costs have been stable over the 12 program years, ranging from $0.08 to $0.16 per first year kWh, with little indication of either trending towards increasing or decreasing over time.
- Statewide residential LI programs have consistently had the highest and most varied acquisition costs, generally three to four times the acquisition costs of non-residential and non-LI residential savings. However, there is little indication of a trend towards increasing acquisition costs for residential LI energy savings.
- Statewide residential non-LI and non-residential acquisition costs have been fairly comparable over the three phases, ranging from $0.08 to $0.16 for residential savings and $0.10 to $0.17 for non-residential savings.
    - Residential acquisition costs have increased modestly over time, with a notable decrease during the early part of Phase III, likely due to the decreasing costs of LED lighting and the high levels of residential savings attributable to lighting. The recent increase in PY12 likely reflects the decrease in residential lighting savings. PPL and Duquesne Light, which stopped their upstream lighting programs in PY2, experienced the largest increase in residential acquisition costs from PY11 to PY12 (see Figure 39).
    - Non-residential acquisition costs have decreased modestly over time, perhaps attributable to the decreasing costs of LED lighting over Phase III and the continued high level of non-residential savings attributable to lighting.
- EDC acquisition costs for residential LI and non-residential savings were relatively stable and clustered during Phase III but more varied during Phases I and II (see Figure 40 and Figure 41).
- EDC acquisition costs for non-LI residential savings were relatively stable and clustered for most of Phase III but more varied in PY12, with notable increases for PPL and Duquesne Light, both of which ended their upstream lighting programs in PY12 (see Figure 39).
- Comparing PY12 acquisition costs to those reported in the Phase IV Energy Efficiency and Peak Demand Reduction Market Potential Study (EEPDR MPS),[48] statewide acquisition costs are lower, though residential acquisition costs for the EDCs that stopped their upstream lighting programs were nearly identical (Duquesne Light) or higher than the EEPDR MPS (PPL). This suggests that Phase IV residential acquisitions costs may be very similar to the EEPDR MPS estimate (see Table 130 and Figure 39).

[48] Pennsylvania Act 129 - Phase IV Energy Efficiency and Peak Demand Reduction Market Potential Study Report. https://www.puc.pa.gov/pcdocs/1656474.pdf

Table 122: Costs, Energy Savings, and Cost per First-Year kWh Saved – All EDCs ($2021)

Category	Sector	PY1	PY2*	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$21,394	$81,788	$75,194	$68,803	$77,733	$81,203	$95,747	$92,562	$90,977	$82,331	$71,062	$57,996
	Residential LI	$5,187	$24,862	$24,821	$21,089	$21,143	$22,809	$25,507	$29,700	$35,149	$32,326	$27,201	$17,106
	Residential Total	$26,581	$106,650	$100,015	$89,891	$98,877	$104,011	$121,253	$122,263	$126,126	$114,657	$98,263	$75,102
	Non-Residential Total	$10,053	$82,739	$98,527	$130,726	$68,184	$80,348	$103,148	$52,050	$67,533	$75,621	$76,728	$87,956
	Total	**$36,634**	**$189,389**	**$198,541**	**$220,617**	**$167,060**	**$184,359**	**$224,401**	**$174,313**	**$193,659**	**$190,278**	**$174,991**	**$163,058**
First-Year GWh Saved	Residential Non-LI	223.0	987.7	647.5	709.8	560.8	523.2	714.0	634.7	724.1	726.5	606.3	355.0
	Residential LI	6.2	81.8	51.2	57.0	53.8	36.6	47.1	66.5	87.7	96.3	82.4	39.5
	Residential Total	229.2	1,069.5	698.6	766.8	614.5	559.8	761.1	701.2	811.8	822.8	688.7	394.6
	Non-Residential Total	57.6	708.8	728.4	961.2	404.6	552.0	745.2	351.2	646.1	670.4	717.9	828.2
	Total	**286.8**	**1,778.3**	**1,427.0**	**1,728.0**	**1,019.2**	**1,111.8**	**1,506.3**	**1,052.4**	**1,457.9**	**1,493.3**	**1,406.6**	**1,222.8**
Utility $/kWh Saved	**Residential Non-LI**	**$0.10**	**$0.08**	**$0.12**	**$0.10**	**$0.14**	**$0.16**	**$0.13**	**$0.15**	**$0.13**	**$0.11**	**$0.12**	**$0.16**
	Residential LI	**$0.84**	**$0.30**	**$0.49**	**$0.37**	**$0.39**	**$0.62**	**$0.54**	**$0.45**	**$0.40**	**$0.34**	**$0.33**	**$0.43**
	Residential Total	**$0.12**	**$0.10**	**$0.14**	**$0.12**	**$0.16**	**$0.19**	**$0.16**	**$0.17**	**$0.16**	**$0.14**	**$0.14**	**$0.19**
	Non-Residential Total	**$0.17**	**$0.12**	**$0.14**	**$0.14**	**$0.17**	**$0.15**	**$0.14**	**$0.15**	**$0.10**	**$0.11**	**$0.11**	**$0.11**
	Total	**$0.13**	**$0.11**	**$0.14**	**$0.13**	**$0.16**	**$0.17**	**$0.15**	**$0.17**	**$0.13**	**$0.13**	**$0.12**	**$0.13**

*PY2 acquisition costs are likely affected by a large volume of inexpensive MWh of savings attributable to conservation voltage reduction programs at PECO and West Penn Power. No EDC has operated a CVR program in Phase II or Phase III.

Table 123: Costs, Energy Savings, and Cost per First-Year kWh Saved – PECO ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$9,873	$29,274	$12,263	$8,253	$15,150	$30,799	$37,472	$26,906	$29,870	$28,927	$28,741	$28,833
	Residential LI	$1,227	$5,910	$6,120	$6,432	$7,396	$9,400	$8,923	$9,436	$10,714	$8,783	$9,103	$4,436
	Residential Total	$11,100	$35,184	$18,383	$14,685	$22,546	$40,199	$46,395	$36,342	$40,584	$37,711	$37,845	$33,269
	Non-Residential Total	$2,673	$17,260	$17,469	$29,981	$29,470	$24,391	$39,026	$14,065	$21,017	$23,672	$26,502	$34,997
	Total	**$13,772**	**$52,444**	**$35,852**	**$44,666**	**$52,016**	**$64,590**	**$85,422**	**$50,407**	**$61,601**	**$61,383**	**$64,347**	**$68,266**
First-Year MWh Saved	Residential Non-LI	140,676	502,843	61,708	26,412	95,834	115,379	235,720	146,622	234,414	239,873	243,548	180,804
	Residential LI	3,286	24,543	24,652	30,320	23,268	18,716	18,304	17,174	22,152	21,342	35,888	14,840
	Residential Total	143,962	527,386	86,360	56,732	119,102	134,095	254,024	163,796	256,566	261,215	279,436	195,644
	Non-Residential Total	15,857	185,927	107,949	152,093	154,263	173,532	274,276	46,893	133,585	167,180	200,266	364,296
	Total	**159,819**	**713,313**	**194,309**	**208,825**	**273,365**	**307,627**	**528,300**	**210,689**	**390,151**	**428,394**	**479,702**	**559,940**
Utility $/kWh Saved	**Residential Non-LI**	**$0.07**	**$0.06**	**$0.20**	**$0.31**	**$0.16**	**$0.27**	**$0.16**	**$0.18**	**$0.13**	**$0.12**	**$0.12**	**$0.16**
	Residential LI	**$0.37**	**$0.24**	**$0.25**	**$0.21**	**$0.32**	**$0.50**	**$0.49**	**$0.55**	**$0.48**	**$0.41**	**$0.25**	**$0.30**
	Residential Total	**$0.08**	**$0.07**	**$0.21**	**$0.26**	**$0.19**	**$0.30**	**$0.18**	**$0.22**	**$0.16**	**$0.14**	**$0.14**	**$0.17**
	Non-Residential Total	**$0.17**	**$0.09**	**$0.16**	**$0.20**	**$0.19**	**$0.14**	**$0.14**	**$0.30**	**$0.16**	**$0.14**	**$0.13**	**$0.10**
	Total	**$0.09**	**$0.07**	**$0.18**	**$0.21**	**$0.19**	**$0.21**	**$0.16**	**$0.24**	**$0.16**	**$0.14**	**$0.13**	**$0.12**

Table 124: Costs, Energy Savings, and Cost per First-Year kWh Saved – PPL ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$3,275	$17,828	$20,202	$14,672	$16,519	$16,403	$27,506	$28,034	$27,128	$18,210	$15,717	$15,146
	Residential LI	$3,126	$11,201	$9,798	$7,704	$5,028	$6,958	$9,010	$7,597	$12,054	$10,922	$9,717	$6,116
	Residential Total	$6,401	$29,029	$30,000	$22,376	$21,547	$23,362	$36,515	$35,631	$39,181	$29,131	$25,434	$21,262
	Non-Residential Total	$2,571	$31,851	$46,017	$51,048	$16,291	$25,126	$29,233	$18,819	$17,815	$23,765	$21,567	$23,666
	Total	**$8,972**	**$60,880**	**$76,017**	**$73,424**	**$37,839**	**$48,488**	**$65,748**	**$54,450**	**$56,996**	**$52,896**	**$47,001**	**$44,928**
First-Year MWh Saved	Residential Non-LI	51,370	194,618	203,533	290,719	109,480	99,605	130,743	169,199	165,734	159,765	103,406	40,932
	Residential LI	1,471	25,194	9,038	6,772	6,374	8,145	19,870	11,655	25,218	30,119	29,692	10,852
	Residential Total	52,841	219,812	212,571	297,491	115,854	107,750	150,613	180,854	190,952	189,884	133,098	51,784
	Non-Residential Total	29,461	193,610	291,661	372,062	84,210	109,610	163,363	150,490	191,568	199,600	236,224	194,399
	Total	**82,302**	**413,422**	**504,232**	**669,553**	**200,064**	**217,360**	**313,976**	**331,344**	**382,520**	**389,484**	**369,322**	**246,183**
Utility $/kWh Saved	**Residential Non-LI**	**$0.06**	**$0.09**	**$0.10**	**$0.05**	**$0.15**	**$0.16**	**$0.21**	**$0.17**	**$0.16**	**$0.11**	**$0.15**	**$0.37**
	Residential LI	**$2.12**	**$0.44**	**$1.08**	**$1.14**	**$0.79**	**$0.85**	**$0.45**	**$0.65**	**$0.48**	**$0.36**	**$0.33**	**$0.56**
	Residential Total	**$0.12**	**$0.13**	**$0.14**	**$0.08**	**$0.19**	**$0.22**	**$0.24**	**$0.20**	**$0.21**	**$0.15**	**$0.19**	**$0.41**
	Non-Residential Total	**$0.09**	**$0.16**	**$0.16**	**$0.14**	**$0.19**	**$0.23**	**$0.18**	**$0.13**	**$0.09**	**$0.12**	**$0.09**	**$0.12**
	Total	$0.11	$0.15	$0.15	$0.11	$0.19	$0.22	$0.21	$0.16	$0.15	$0.14	$0.13	$0.18

Table 125: Costs, Energy Savings, and Cost per First-Year kWh Saved – Duquesne Light ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$800	$4,183	$8,307	$8,416	$6,343	$7,855	$6,127	$4,426	$4,984	$4,294	$4,766	$2,065
	Residential LI	$211	$801	$805	$610	$1,753	$771	$346	$267	$1,121	$1,516	$1,519	$1,320
	Residential Total	$1,011	$4,984	$9,112	$9,026	$8,096	$8,626	$6,473	$4,693	$6,105	$5,810	$6,285	$3,385
	Non-Residential Total	($3)	$11,552	$15,851	$13,017	$7,187	$12,530	$9,356	$4,742	$8,220	$9,659	$10,926	$13,072
	Total	**$1,009**	**$16,537**	**$24,963**	**$22,043**	**$15,283**	**$21,156**	**$15,828**	**$9,435**	**$14,325**	**$15,469**	**$17,211**	**$16,457**
First-Year MWh Saved	Residential Non-LI	2,124	47,499	80,834	59,458	51,077	36,817	62,571	45,429	40,342	36,755	30,044	7,934
	Residential LI	414	15,649	7,403	13,713	12,798	2,293	3,976	1,208	3,787	4,864	3,831	4,462
	Residential Total	2,537	63,148	88,237	73,171	63,875	39,110	66,547	46,637	44,129	41,619	33,875	12,396
	Non-Residential Total	-	101,711	51,832	131,880	64,546	67,443	75,639	22,955	56,936	55,831	63,474	91,090
	Total	**2,537**	**164,859**	**140,069**	**205,051**	**128,421**	**106,553**	**142,186**	**69,592**	**101,065**	**97,450**	**97,349**	**103,486**
Utility $/kWh Saved	**Residential Non-LI**	**$0.38**	**$0.09**	**$0.10**	**$0.14**	**$0.12**	**$0.21**	**$0.10**	**$0.10**	**$0.12**	**$0.12**	**$0.16**	**$0.26**
	Residential LI	**$0.51**	**$0.05**	**$0.11**	**$0.04**	**$0.14**	**$0.34**	**$0.09**	**$0.22**	**$0.30**	**$0.31**	**$0.40**	**$0.30**
	Residential Total	**$0.40**	**$0.08**	**$0.10**	**$0.12**	**$0.13**	**$0.22**	**$0.10**	**$0.10**	**$0.14**	**$0.14**	**$0.19**	**$0.27**
	Non-Residential Total	**$0.00**	**$0.11**	**$0.31**	**$0.10**	**$0.11**	**$0.19**	**$0.12**	**$0.21**	**$0.14**	**$0.17**	**$0.17**	**$0.14**
	Total	**$0.40**	**$0.10**	**$0.18**	**$0.11**	**$0.12**	**$0.20**	**$0.11**	**$0.14**	**$0.14**	**$0.16**	**$0.18**	**$0.16**

Table 126: Costs, Energy Savings, and Cost per First-Year kWh Saved – Met-Ed ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$2,429	$12,090	$9,743	$15,047	$12,626	$9,035	$8,848	$10,171	$8,982	$10,164	$7,240	$3,826
	Residential LI	$183	$1,142	$1,190	$1,376	$1,761	$1,470	$1,685	$3,676	$3,521	$3,514	$1,463	$1,906
	Residential Total	$2,612	$13,232	$10,933	$16,423	$14,387	$10,505	$10,533	$13,847	$12,503	$13,679	$8,703	$5,732
	Non-Residential Total	$1,010	$12,023	$3,990	$8,183	$4,391	$4,673	$8,735	$4,819	$5,344	$5,285	$5,082	$4,780
	Total	**$3,622**	**$25,255**	**$14,922**	**$24,606**	**$18,778**	**$15,178**	**$19,268**	**$18,666**	**$17,847**	**$18,963**	**$13,786**	**$10,511**
First-Year MWh Saved	Residential Non-LI	11,426	82,037	71,908	109,822	96,883	90,954	97,572	84,402	91,450	98,390	75,755	40,911
	Residential LI	65	3,772	799	1,096	3,391	1,949	1,123	10,105	11,577	13,254	4,159	3,688
	Residential Total	11,491	85,808	72,707	110,918	100,274	92,903	98,695	94,507	103,027	111,643	79,913	44,599
	Non-Residential Total	5,784	80,929	47,011	80,821	33,792	40,826	72,724	45,368	73,638	72,436	63,164	58,359
	Total	**17,275**	**166,738**	**119,718**	**191,739**	**134,066**	**133,729**	**171,419**	**139,875**	**176,665**	**184,080**	**143,078**	**102,958**
Utility $/kWh Saved	**Residential Non-LI**	**$0.21**	**$0.15**	**$0.14**	**$0.14**	**$0.13**	**$0.10**	**$0.09**	**$0.12**	**$0.10**	**$0.10**	**$0.10**	**$0.09**
	Residential LI	**$2.82**	**$0.30**	**$1.49**	**$1.26**	**$0.52**	**$0.75**	**$1.50**	**$0.36**	**$0.30**	**$0.27**	**$0.35**	**$0.52**
	Residential Total	**$0.23**	**$0.15**	**$0.15**	**$0.15**	**$0.14**	**$0.11**	**$0.11**	**$0.15**	**$0.12**	**$0.12**	**$0.11**	**$0.13**
	Non-Residential Total	**$0.17**	**$0.15**	**$0.08**	**$0.10**	**$0.13**	**$0.11**	**$0.12**	**$0.11**	**$0.07**	**$0.07**	**$0.08**	**$0.08**
	Total	**$0.21**	**$0.15**	**$0.12**	**$0.13**	**$0.14**	**$0.11**	**$0.11**	**$0.13**	**$0.10**	**$0.10**	**$0.10**	**$0.10**

Table 127: Costs, Energy Savings, and Cost per First-Year kWh Saved – Penelec ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$2,346	$9,321	$8,488	$10,517	$11,344	$7,874	$7,338	$10,120	$7,482	$9,597	$6,485	$2,817
	Residential LI	$135	$1,652	$1,621	$1,682	$2,552	$1,860	$2,260	$3,788	$3,403	$3,474	$1,631	$1,514
	Residential Total	$2,480	$10,973	$10,108	$12,199	$13,896	$9,734	$9,598	$13,909	$10,885	$13,071	$8,116	$4,332
	Non-Residential Total	$1,095	$3,478	$6,257	$7,873	$4,041	$5,277	$7,151	$4,268	$6,324	$6,047	$5,335	$4,064
	Total	**$3,576**	**$14,450**	**$16,365**	**$20,072**	**$17,938**	**$15,011**	**$16,750**	**$18,177**	**$17,209**	**$19,119**	**$13,451**	**$8,395**
First-Year MWh Saved	Residential Non-LI	10,168	78,457	66,991	92,973	81,449	74,944	89,114	82,862	74,345	87,291	65,715	33,288
	Residential LI	81	4,618	1,357	1,324	5,051	2,755	1,982	12,359	10,839	12,264	3,942	2,520
	Residential Total	10,250	83,076	68,348	94,297	86,500	77,699	91,096	95,221	85,184	99,556	69,658	35,808
	Non-Residential Total	3,245	88,288	57,368	54,510	28,231	56,275	73,302	37,228	69,454	91,038	67,231	45,815
	Total	13,495	171,364	125,716	148,807	114,731	133,974	164,398	132,449	154,637	190,594	136,889	81,623
Utility $/kWh Saved	**Residential Non-LI**	**$0.23**	**$0.12**	**$0.13**	**$0.11**	**$0.14**	**$0.11**	**$0.08**	**$0.12**	**$0.10**	**$0.11**	**$0.10**	**$0.08**
	Residential LI	**$1.65**	**$0.36**	**$1.19**	**$1.27**	**$0.51**	**$0.68**	**$1.14**	**$0.31**	**$0.31**	**$0.28**	**$0.41**	**$0.60**
	Residential Total	**$0.24**	**$0.13**	**$0.15**	**$0.13**	**$0.16**	**$0.13**	**$0.11**	**$0.15**	**$0.13**	**$0.13**	**$0.12**	**$0.12**
	Non-Residential Total	**$0.34**	**$0.04**	**$0.11**	**$0.14**	**$0.14**	**$0.09**	**$0.10**	**$0.11**	**$0.09**	**$0.07**	**$0.08**	**$0.09**
	Total	**$0.26**	**$0.08**	**$0.13**	**$0.13**	**$0.16**	**$0.11**	**$0.10**	**$0.14**	**$0.11**	**$0.10**	**$0.10**	**$0.10**

Table 128: Costs, Energy Savings, and Cost per First-Year kWh Saved – Penn Power ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$534	$2,731	$2,701	$3,905	$4,218	$2,381	$1,405	$2,697	$3,000	$3,138	$1,763	$951
	Residential LI	$30	$557	$275	$45	$824	$443	$681	$1,051	$1,214	$928	$476	$290
	Residential Total	$564	$3,288	$2,976	$3,950	$5,042	$2,823	$2,086	$3,748	$4,214	$4,066	$2,239	$1,241
	Non-Residential Total	$306	$3,478	$871	$2,808	$1,318	$2,021	$1,894	$1,428	$2,025	$1,740	$1,725	$1,446
	Total	**$871**	**$6,766**	**$3,847**	**$6,758**	**$6,360**	**$4,844**	**$3,979**	**$5,176**	**$6,239**	**$5,806**	**$3,964**	**$2,687**
First-Year MWh Saved	Residential Non-LI	5,451	27,346	25,038	35,383	29,105	22,252	12,471	20,825	26,558	30,558	23,121	9,752
	Residential LI	19	2,086	163	-	1,168	1,010	550	3,080	3,533	3,567	1,114	755
	Residential Total	5,471	29,432	25,201	35,383	30,273	23,262	13,021	23,905	30,091	34,125	24,235	10,507
	Non-Residential Total	652	31,611	15,980	22,573	7,797	34,252	14,260	13,224	27,263	23,592	23,913	13,092
	Total	**6,122**	**61,043**	**41,181**	**57,956**	**38,070**	**57,514**	**27,281**	**37,130**	**57,354**	**57,717**	**48,148**	**23,599**
Utility $/kWh Saved	**Residential Non-LI**	**$0.10**	**$0.10**	**$0.11**	**$0.11**	**$0.14**	**$0.11**	**$0.11**	**$0.13**	**$0.11**	**$0.10**	**$0.08**	**$0.10**
	Residential LI	**$1.57**	**$0.27**	**$1.69**	**N/A**	**$0.71**	**$0.44**	**$1.24**	**$0.34**	**$0.34**	**$0.26**	**$0.43**	**$0.38**
	Residential Total	**$0.10**	**$0.11**	**$0.12**	**$0.11**	**$0.17**	**$0.12**	**$0.16**	**$0.16**	**$0.14**	**$0.12**	**$0.09**	**$0.12**
	Non-Residential Total	**$0.47**	**$0.11**	**$0.05**	**$0.12**	**$0.17**	**$0.06**	**$0.13**	**$0.11**	**$0.07**	**$0.07**	**$0.07**	**$0.11**
	Total	**$0.14**	**$0.11**	**$0.09**	**$0.12**	**$0.17**	**$0.08**	**$0.15**	**$0.14**	**$0.11**	**$0.10**	**$0.08**	**$0.11**

Table 129: Costs, Energy Savings, and Cost per First-Year kWh Saved – West Penn Power ($2021)

Category	Sector	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	PY12
Total Utility Costs ($1000)	Residential Non-LI	$2,136	$6,361	$13,490	$7,993	$11,533	$6,856	$7,051	$10,208	$9,532	$8,000	$6,350	$4,358
	Residential LI	$276	$3,599	$5,012	$3,240	$1,828	$1,907	$2,602	$3,884	$3,122	$3,189	$3,291	$1,523
	Residential Total	$2,413	$9,960	$18,502	$11,233	$13,361	$8,763	$9,653	$14,093	$12,653	$11,189	$9,641	$5,881
	Non-Residential Total	$2,400	$3,098	$8,073	$17,816	$5,485	$6,330	$7,753	$3,910	$6,788	$5,452	$5,590	$5,932
	Total	**$4,812**	**$13,058**	**$26,575**	**$29,049**	**$18,846**	**$15,093**	**$17,406**	**$18,003**	**$19,442**	**$16,641**	**$15,230**	**$11,814**
First-Year MWh Saved	Residential Non-LI	1,801	54,857	137,460	95,007	96,924	83,244	85,814	85,375	91,275	73,850	64,669	41,421
	Residential LI	844	5,979	7,760	3,788	1,722	1,743	1,261	10,915	10,556	10,919	3,800	2,405
	Residential Total	2,645	60,836	145,220	98,795	98,646	84,987	87,075	96,290	101,831	84,769	68,469	43,825
	Non-Residential Total	2,634	26,730	156,563	147,293	31,792	70,039	71,685	35,040	93,667	60,771	63,641	61,165
	Total	**5,279**	**87,566**	**301,783**	**246,088**	**130,438**	**155,026**	**158,760**	**131,330**	**195,498**	**145,540**	**132,110**	**104,990**
Utility $/kWh Saved	**Residential Non-LI**	**$1.19**	**$0.12**	**$0.10**	**$0.08**	**$0.12**	**$0.08**	**$0.08**	**$0.12**	**$0.10**	**$0.11**	**$0.10**	**$0.11**
	Residential LI	**$0.33**	**$0.60**	**$0.65**	**$0.86**	**$1.06**	**$1.09**	**$2.06**	**$0.36**	**$0.30**	**$0.29**	**$0.87**	**$0.63**
	Residential Total	**$0.91**	**$0.16**	**$0.13**	**$0.11**	**$0.14**	**$0.10**	**$0.11**	**$0.15**	**$0.12**	**$0.13**	**$0.14**	**$0.13**
	Non-Residential Total	**$0.91**	**$0.12**	**$0.05**	**$0.12**	**$0.17**	**$0.09**	**$0.11**	**$0.11**	**$0.07**	**$0.09**	**$0.09**	**$0.10**
	Total	$0.91	$0.15	$0.09	$0.12	$0.14	$0.10	$0.11	$0.14	$0.10	$0.11	$0.12	$0.11

Figure 37: Statewide Acquisition Costs per First-Year kWh Saved by Sector

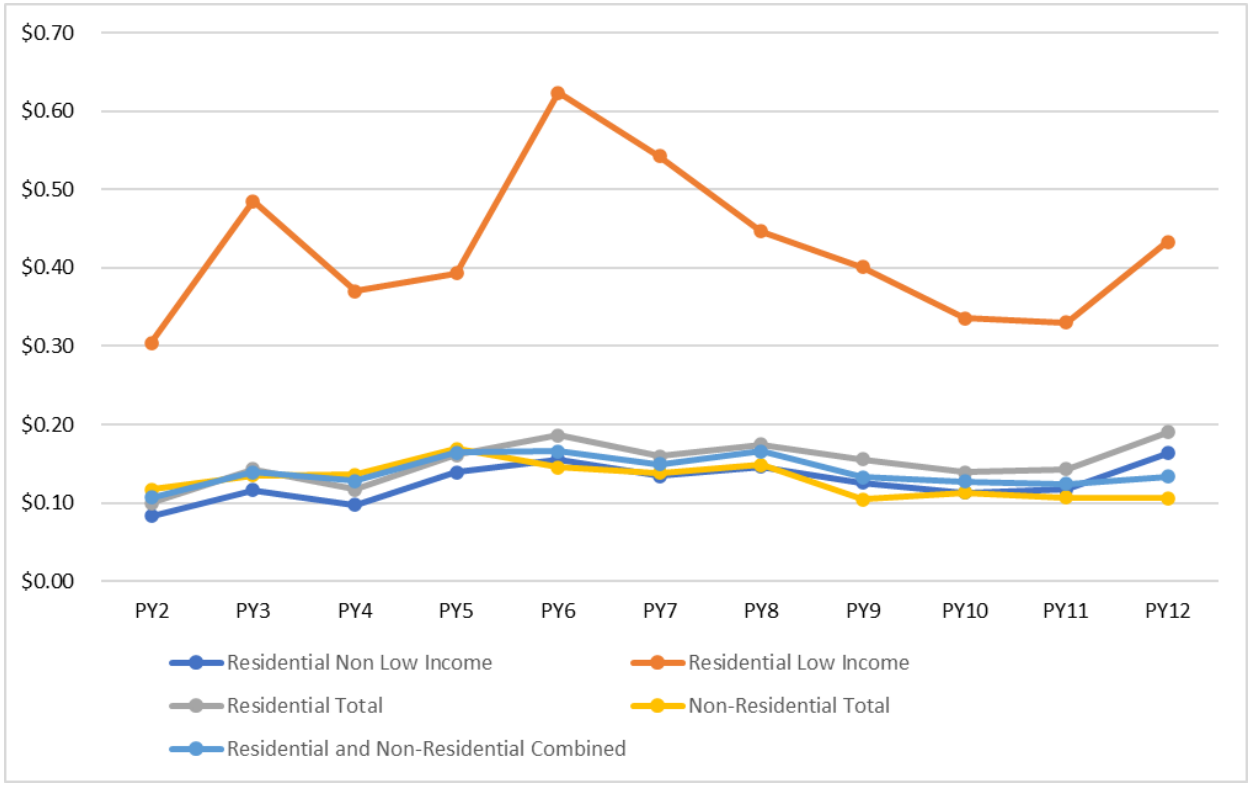


Figure 38: Acquisition Costs per First-Year kWh Saved by EDC: Portfolio

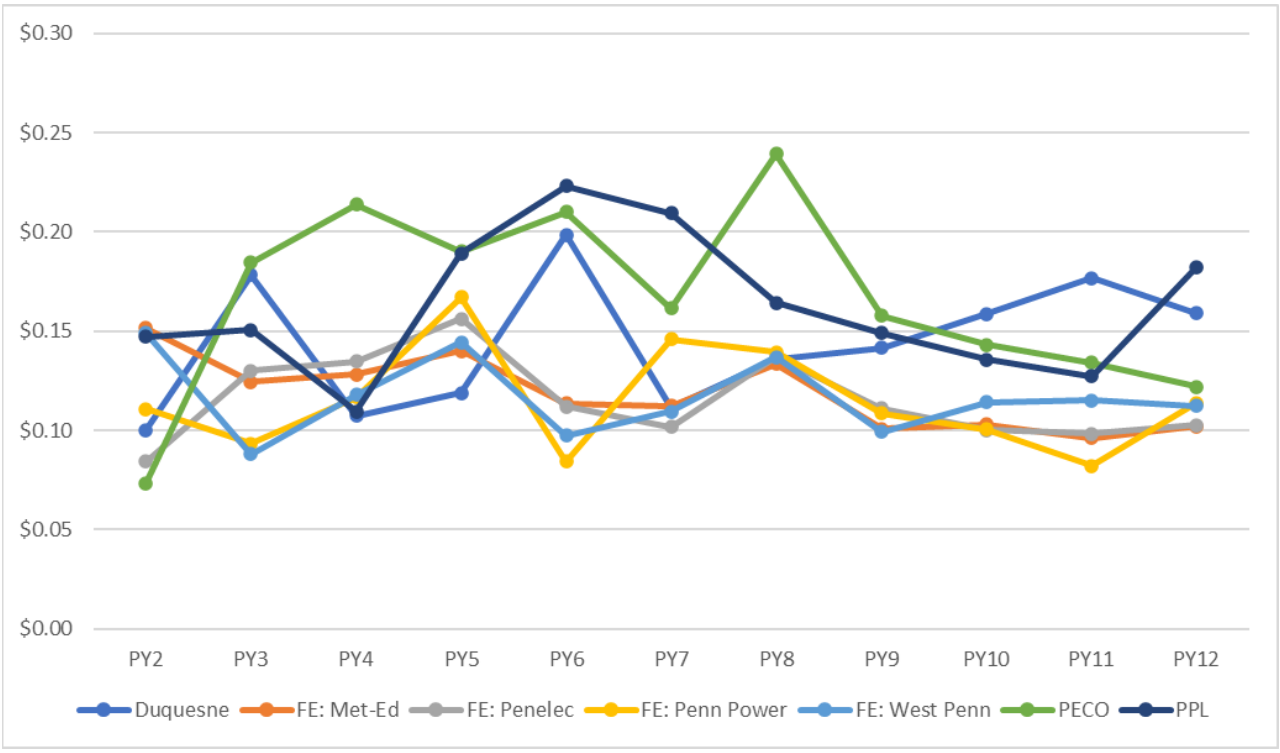


Figure 39: Acquisition Costs per First-Year kWh Saved by EDC: Residential Non-LI

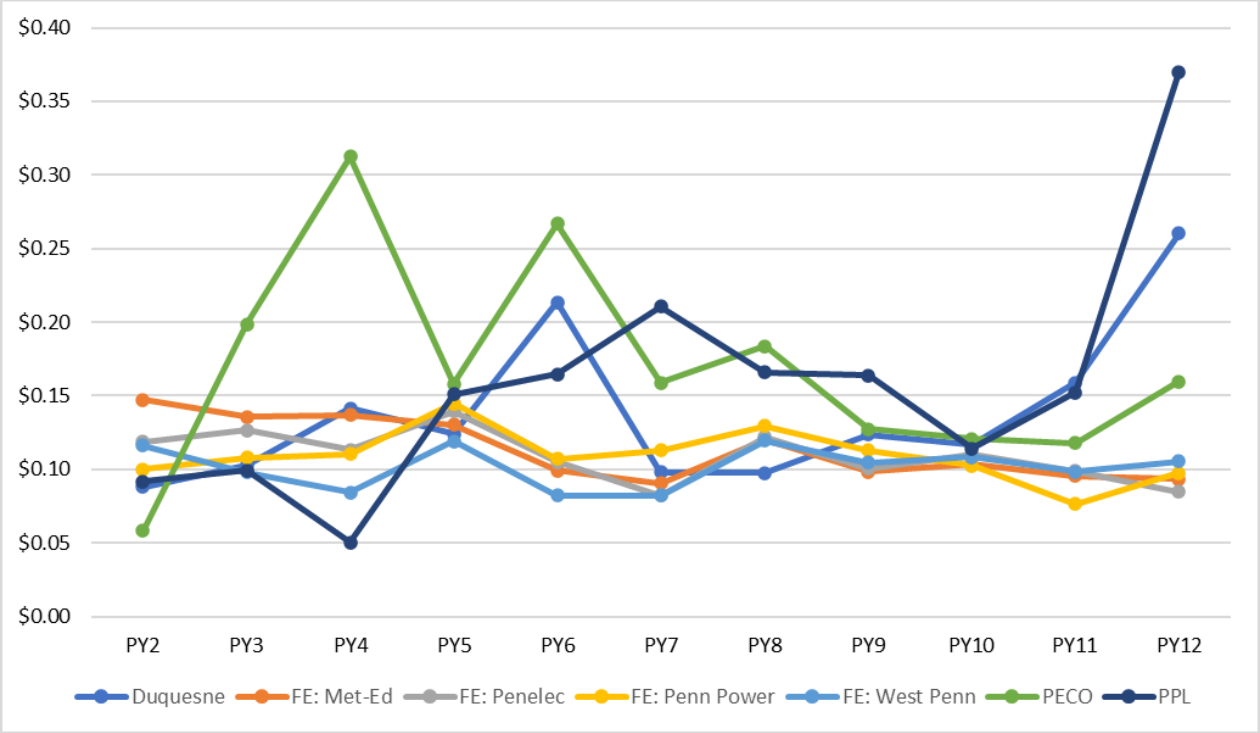


Figure 40: Acquisition Costs per First-Year kWh Saved by EDC: Residential LI

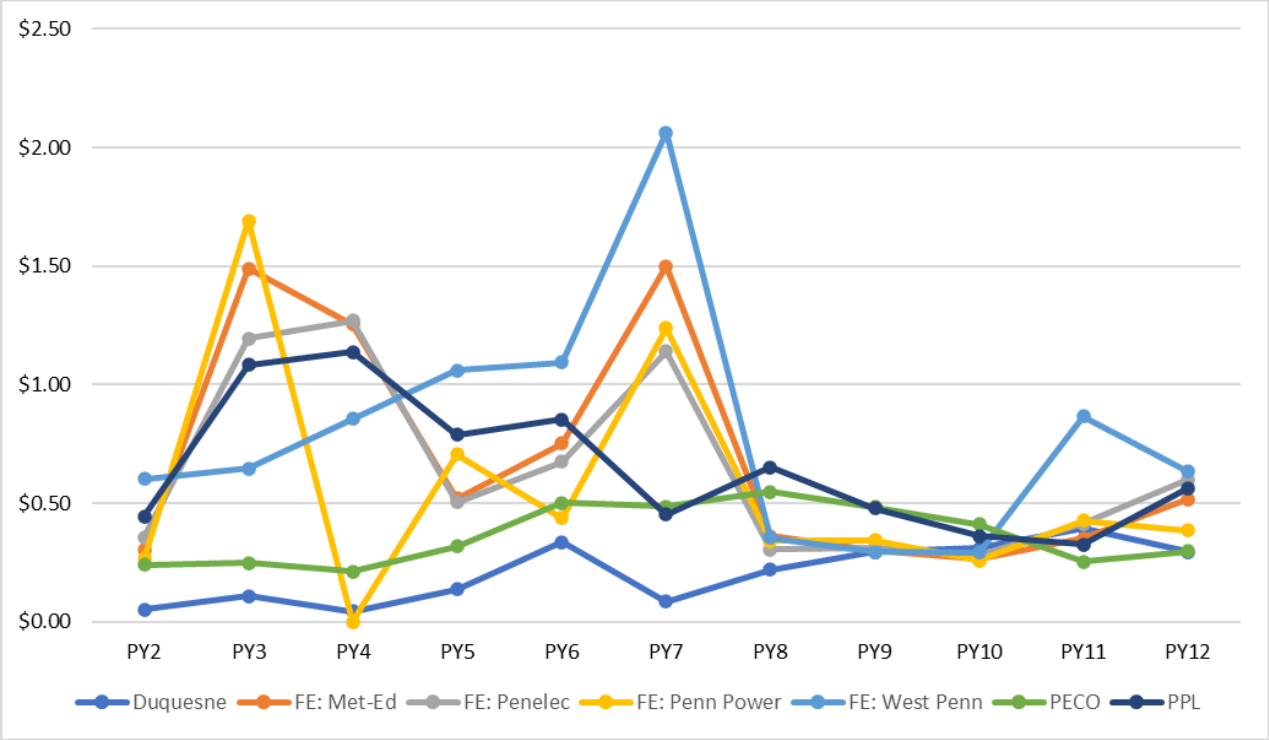


Figure 41: Acquisition Costs per First-Year kWh Saved by EDC: Non-Residential

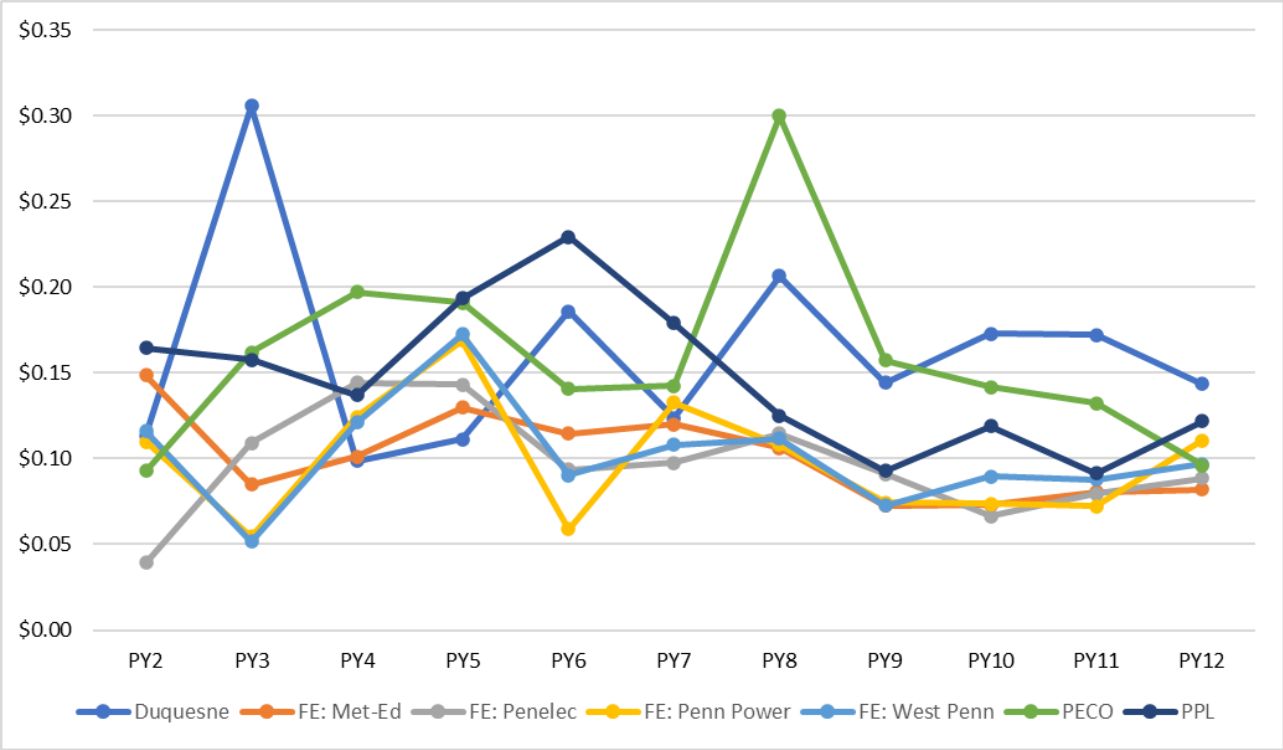


Table 130: PY12 Acquisition Costs Compared to the Phase IV EEPDR MPS

Category	PY12 ($ per kWh)	EEPDR MPS ($ per kWh)
Portfolio	$0.13	$0.27
Res, non-LI	$0.16	$0.22
Res, LI	$0.43	$0.53
Large C&I	$0.11	$0.29
Small C&I	$0.11	$0.26

Section 6 PY12 Findings, Conclusions, and Recommendations

6.1 Findings & Recommendations

The SWE conducted a review/audit of PY12 EDC program delivery mechanisms, tracking data, project and program files and provides the following key findings and recommendations:

6.1.1 Program Delivery

- The effects of the COVID-19 pandemic lingered through much of PY12 as the Commonwealth slowly reopened businesses and schools. Most EDC programs suspended temporarily at the onset of the pandemic were reactivated during summer 2020. Many program delivery processes were modified to reduce in-person contact and prioritize safety.
- At the June 3, 2020 Public Meeting, the Commission issued its Phase III Modification Order[49] granting the Petition of the Energy Association to exclude PY12 demand response events from the measurement of compliance with Phase III demand response targets. The Order permitted EDCs to implement approved DR programs on a voluntary basis for PY12. DR program operations were largely unchanged from prior years and a total of five events were called in July and August. PECO elected to call two-hour events for its Residential and Small C&I DR programs instead of the four-hour duration used for all other Phase III events.
- Program activity shifted sharply towards the non-residential sector in PY12 with 68% of all verified gross savings coming from non-residential participants. This transition was driven by the reduced opportunity for screw-based lighting savings in the residential sector and several large CHP projects in the non-residential sector. SWE analysis of Phase IV EE&C Plans reveals this trend is expected to continue with 25.3% of Phase IV MWh savings planned to come from the residential sector and 74.7% of energy savings forecasted to come from non-residential programs.
- In PY12, each EDC delivered a cost-effective portfolio of energy-efficiency and demand response programs except for PECO and Penelec. Neither PECO's EE or DR offerings passed the TRC Test in PY12 and Penelec does not offer Phase III DR programs. Due to a slow start to Phase III, PECO needed to deliver a large amount of MWh savings in PY12 to meet its Phase III compliance target. It is understandable that an EDC in PECO's position would ramp up marketing efforts and be less selective in its pursuit of energy savings. PECO offers three non-residential energy-efficiency programs in Phase III (Small

[49] Pennsylvania Public Utility Commission, Phase III Modification Order. From the Public Meeting of May 21, 2020. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1665150.docx

C&I EE, Large C&I EE, and Combined Heat and Power). While each program was not cost-effective according to the gross TRC Test, they delivered 363,945 MWh of gross verified savings in PY12 – or almost 19% of PECO's Phase III compliance target. The acquisition cost of PECO's non-residential EE programs was just $0.083 per first-year kWh, so while the TRC Ratios were poor, the programs were quite effective for PECO in terms of meeting its compliance target within the approved EE&C budget.

6.1.2 Evaluation

The Pennsylvania EDCs and their evaluation contractors conducted fewer impact, NTG, and process evaluations in PY12 than prior years in Phase III as attention shifted to Phase IV program planning and launch. Even in a light year, the EDC EM&V contractors perform a significant number of project and program verification analyses. Some of the key findings and recommendations from their research – and the SWE audit activities – included the following:

- The effect of the COVID-19 pandemic on participating customer peak loads during summer 2020 varied by industry. These load patterns are important for dispatchable demand response programs with the "down from" measurement approaches used for Act 129, because a participating home or business can only reduce load relative to its available demand in surrounding days. A closed business will have a very low baseline and therefore limited ability to reduce demand when dispatched.
    - PECO's Small C&I DR program showed drastically reduced baselines from PY11 to PY12 presumably because many participating businesses were closed or operating at reduced capacity. Large DR participants such as universities and public assembly buildings showed similarly reduced loads during summer 2020. Conversely, some participating manufacturing facilities in essential industries had peak load levels at or above prior summers during summer 2020. Residential loads were up slightly during summer 2020, presumably due to the increased prevalence of "work from home" behaviors.
    - Despite the voluntary nature of PY12 DR, Act 129 programs hit three of the 5CP hours during summer 2020 and delivered approximately 475 MW of system-level reduction on those key system peak hours.
- The SWE's review of verified savings for residential and non-residential programs for all EDCs 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 III Evaluation Framework.
- Overall, for all process evaluations, the SWE determined that the reporting followed the SWE guidelines.
- The benefit-cost models developed by the EDCs and their evaluation contractors for PY12 were well-organized and consistent with the directives of the 2016 TRC Test Order. The gross TRC Ratio for PY12 was 1.24 statewide, which means programs returned $1.24 of benefits for each dollar invested. The PY12 TRC Ratio was the lowest of Phase III and

largely stemmed from the reduced contribution of residential lighting and prominence of CHP. CHP projects deliver large MWh savings at a low acquisition cost, but typically do not pass the TRC Test.

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

A.1 EDC Performance Against Portfolio Targets

The following tables provide a summary of progress toward the individual EDC Phase III compliance targets and PY12 verified gross savings by customer segment.

Table 131: Summary of PY12 Verified Savings and Phase III Portfolio Targets*

EDC	Phase III Compliance Targets (MWh)			PY12 Verified Gross Savings (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	559,940	14,840	78,208
PPL	1,443,035	79,367	50,507	246,183	10,852	37,111
Duquesne Light	440,916	24,250	15,432	103,486	6,076	21,936
FE: Met-Ed	599,352	32,964	20,977	102,958	3,688	8,840
FE: Penelec	566,168	31,139	19,816	81,623	2,520	8,493
FE: Penn Power	157,371	8,655	5,508	23,599	755	994
FE: West Penn Power	540,986	29,754	18,935	104,990	2,405	11,623
Statewide	**5,710,488**	**314,075**	**199,868**	**1,222,779**	**41,136**	**167,204**

*Rows may not sum to statewide totals due to rounding

Table 132: Summary of Phase III Verified Savings and Phase III Portfolio Targets*

EDC	Phase III Compliance Targets (MWh)			Phase III Verified Gross Savings (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	2,068,877	111,398	235,437
PPL	1,443,035	79,367	50,507	1,749,310	110,456	225,541
Duquesne Light	440,916	24,250	15,432	469,053	23,128	61,955
FE: Met-Ed	599,352	32,964	20,977	746,655	42,746	37,654
FE: Penelec	566,168	31,139	19,816	696,193	41,605	62,117
FE: Penn Power	157,371	8,655	5,508	223,948	12,159	11,214
FE: West Penn Power	540,986	29,754	18,935	709,466	38,024	85,757
Statewide	**5,710,488**	**314,075**	**199,868**	**6,663,502**	**379,516**	**719,675**

* Rows may not sum to statewide totals due to rounding.

Table 133: Summary of EDC Phase II Carryover Savings

EDC	Phase III Compliance Targets (MWh)			Phase II Carryover (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	-	-	-
PPL	1,443,035	79,367	50,507	-	-	-
Duquesne Light	440,916	24,250	15,432	100,467	3,266	-
FE: Met-Ed	599,352	32,964	20,977	30,482	5,025	-
FE: Penelec	566,168	31,139	19,816	49,695	7,872	82
FE: Penn Power	157,371	8,655	5,508	13,866	1,805	7,316
FE: West Penn Power	540,986	29,754	18,935	20,540	3,354	-
Statewide	**5,710,488**	**314,075**	**199,868**	**215,050**	**21,322**	**7,398**

Table 134: Summary of Phase III Verified Savings and Phase II Carryover*

EDC	Phase III Compliance Targets (MWh)			Phase III Verified Gross Savings + CO (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	2,068,877	111,398	235,437
PPL	1,443,035	79,367	50,507	1,749,310	110,456	225,541
Duquesne Light	440,916	24,250	15,432	569,520	26,394	61,955
FE: Met-Ed	599,352	32,964	20,977	777,137	47,771	37,654
FE: Penelec	566,168	31,139	19,816	745,888	49,477	62,200
FE: Penn Power	157,371	8,655	5,508	237,814	13,965	18,530
FE: West Penn Power	540,986	29,754	18,935	730,006	41,378	85,757
Statewide	**5,710,488**	**314,075**	**199,868**	**6,878,552**	**400,839**	**727,073**

* Rows may not sum to statewide totals due to rounding.

Table 135: Summary of PY12 Verified Savings by Customer Segment[1]

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI (MWh)
PECO	180,804	44,199	241,889	78,208	14,840
PPL	40,932	110,634	46,654	37,111	10,852
Duquesne Light	7,934	13,305	55,849	21,936	4,462
FE: Met-Ed	40,911	14,719	34,799	8,840	3,688
FE: Penelec	33,288	14,963	22,360	8,493	2,520
FE: Penn Power	9,752	10,505	1,594	994	755
FE: West Penn Power	41,421	21,651	27,890	11,623	2,405
Statewide	**355,042**	**229,977**	**431,035**	**167,204**	**39,522**

[1] Does not include carryover savings.

Table 136: Summary of Phase III Verified Savings by Customer Segment[1]

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI (MWh)
PECO	1,046,282	192,897	482,863	235,437	111,398
PPL	643,285	474,974	295,539	227,967	107,547
Duquesne Light	160,387	83,302	145,140	61,955	18,270
FE: Met-Ed	390,952	117,660	157,644	37,654	42,746
FE: Penelec	343,830	112,720	135,921	62,117	41,605
FE: Penn Power	110,704	61,269	28,603	11,214	12,159
FE: West Penn Power	357,165	128,800	99,721	85,757	38,024
Statewide	**3,052,605**	**1,171,621**	**1,345,430**	**722,101**	**371,749**

[1] Does not include carryover savings.

Table 137: PY12 Costs, kWh Savings, and Cost per First-Year kWh Saved

Category	Sector	PY12 Performance
Total Utility Costs ($1000)	Residential Non-LI	$57,033
	Residential LI	$16,847
	Residential Total	$73,880
	Non-Residential Total	$86,853
	Total	$160,733
First-Year kWh Saved	Residential Non-LI	355,042
	Residential LI	39,522
	Residential Total	394,563
	Non-Residential Total	828,216
	Total	1,222,779
Utility $/kWh Saved	**Residential Non-LI**	**$0.16**
	Residential LI	**$0.43**
	Residential Total	**$0.19**
	Non-Residential Total	**$0.10**
	Total	**$0.13**

A.2 Low- Income Measure Proportionality Analysis

As noted in Section 1.2, the "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 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 targeted to LI customers and available at no cost to LI customers. The SWE found that each EDC complied with the LI proportionality requirement.

Table 138 reports the required minimum proportions and results of the SWE's verification analysis.

Table 138: LI Measure Proportionality Targets and SWE Verification Results

EDC	Proportionate Number of Measures Target	PY12 Proportionate Number of Measures, Reported	PY12 Proportionate Number of Measures, SWE Verified
PECO	8.80%	43.5%	29.1%
PPL	9.95%	18.9%	24.3%
Duquesne Light	8.40%	17.7%	26.9%
FE: Met-Ed	8.79%	37.3%	34.4%
FE: Penelec	10.23%	37.3%	34.4%
FE: Penn Power	10.64%	37.3%	34.4%
FE: West Penn Power	8.79%	37.3%	34.4%

A.2.1 Matching Measures to TRM Algorithms

EDCs reported compliance with the proportionate number of measures targeted in their individual PY12 Annual Reports and provided supporting lists of measures from their Phase III EE&C plans and classifications of measures to the SWE. However, upon analysis of the EDC measure classifications, the SWE found inconsistencies in how EDCs defined measures. 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 compact fluorescent light 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 not addressed in the PA TRM."[50]

The SWE matched measures as reported by the EDCs to TRM algorithm sections. Doing so identified when (1) multiple EDC-reported measures should be considered a single measure because they corresponded with a single algorithm section, or (2) a single EDC-reported measure could possibly be split into multiple measures because the name of the measure was general enough to encapsulate multiple algorithm sections.

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

- **Definition of *algorithm section*:** *Algorithm section* is not a clear-cut definition. Some subsections of the TRM have a single algorithm, which can easily be considered a single algorithm section. Other subsections have multiple algorithms split by text headings but without any additional numbering. This occurs in *Section 2.2.1 Electric HVAC* of the TRM,

[50] Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs. https://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework050818.pdf

which has different algorithms for different types of measures or actions (e.g., installing different types of efficient equipment, performing maintenance, or installing proper capacities). In these instances, each text heading was considered an individual algorithm section (e.g., *Section 2.2.1* has six algorithm sections). Still, other sections have multiple text headings but the algorithms under each heading are functionally identical. This occurs in *Section 2.4.1 ENERGY STAR Refrigerators,* which has headings for "ENERGY STAR Refrigerator" and "ENERGY STAR Most Efficient Refrigerator." The headings have identical equations except for different labeling for the variable representing the efficiency of the "new" refrigerator. Most EDCs combined these measures into a single measure and the SWE's analysis does the same.

- **Ambiguous measure names:** The EDCs provided comprehensive lists [51] of their conservation measures; measure terminology varied across EDCs. Measure names had to be interpreted and matched to a TRM algorithm section by the SWE. Sometimes measures did not match exactly to an algorithm section of the TRM. This occurred when (1) measure names were too generalized, (2) measure names used wording not included in the TRM but could be linked to a TRM section or algorithm (e.g., a multitude of measures can contribute to the "air sealing" measure in the TRM and could thus be matched to an algorithm even if the individual measure names were not present in the TRM), or (3) measure names were clear but the measure was not discussed in the TRM (e.g., "clothes line installation," "electric drying venting," and "water heater timer"). When an EDC had unmatchable measure names, compliance was assessed by categorizing the measures into logical measure groups and including them as individual measures. The number of unmatchable measures ranged from 11% of an EDC's reported measures to 40%. The specific counts of unmatchable measures are provided in each EDC's result summary below.

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.

[51] The measure lists from the FirstEnergy Companies were taken from Tables 8, 10, 12, and 14 of their Phase III EE&C plans. PECO, Duquesne Light, and PPL provided separate workbooks to the SWE.

A.2.2 Consistency with PY11

PECO and the FirstEnergy companies reported no changes in the measures offered to LI and non-LI customers. While participation by measure may vary from year-to-year, PECO and the FirstEnergy companies offered the same measures to customers in PY12 as they did in PY11. Therefore, the LI proportionality analysis from PY12 is identical to that in PY11.

A.2.3 Common Themes

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

- **Residential and Commercial Lighting:** The TRM includes a section each for residential (*2.1.1*) and commercial (*3.1.1*) efficient lamps and fixtures. The algorithm for both sections is "a straightforward algorithm that calculates the difference between baseline and new wattage" regardless of bulb type and location. However, EDCs consistently split out measures by bulb type and location. The analysis used in this report combines these measures into one section each for residential and commercial sectors to be consistent with the SWE recommendation.
- **"Most Efficient" Appliances:** As discussed above, some TRM sections, such as *2.4.1 ENERGY STAR Refrigerators*, include two different algorithms that are functionally the same. Both algorithms calculate the difference in efficiency between the old and new units. One EDC considered these as separate measures, which would technically match the SWE recommendation. However, the other EDCs did not separate these measures since the algorithms are functionally the same. The SWE's analysis groups them as well.
- **Air Sealing Methods:** The TRM has one algorithm section, *2.6.6*, that addresses air sealing measures. The main inputs to the algorithm are overall air leakage measurements. The difference in the air leakage measurements is the combined effect of many different air leakage methods (e.g., weather stripping, caulking) that EDCs often report as separate measures but that do not have their own savings algorithms. In the SWE's analysis, these measures are deemed as part of the *Section 2.6.6* algorithm.
- **Smart Power Strips:** The TRM has two algorithm sections for "Smart Strips" to accommodate two different tiers of smart strip technology. A few EDCs only include a single measure for smart strips. If the EDCs provide both Tier 1 and Tier 2 smart strips, then two measures should be counted. When EDCs specified the Tier 1 and Tier 2 measures separately, the analysis counts them separately. When EDCs did not specify, the analysis only counts a single measure.
- **Refrigerator/Freezer Replacement and Recycling:** Section *2.4.3* in the TRM encapsulates all refrigerator and freezer early replacement (replacing an inefficient appliance that has remaining working life with a more efficient model) and recycling (removing an inefficient appliance and preventing it from being used again with or without replacing it). Some EDCs counted this as just a single measure, while others broke out the measure by freezer/refrigerator and early replacement/recycling. While the TRM does not have different algorithm sections with separate headings for freezers and refrigerators, the inputs for each are substantially different. Given these differences and that multiple

EDCs reported refrigerators and freezers as separate measures, the SWE analysis treats them as separate measures. Additionally, the SWE analysis considers recycling and early replacement as separate measures. This matches some of the EDC reporting and reflects the difference in benefits generated from replacing an inefficient refrigerator (early replacement) and safely decommissioning an inefficient refrigerator (recycling).

- **Double Counting Measures:** The SWE guides the EDCs to count measures that are offered both as LI (meaning the customer incurs none of the measure cost and is a LI customer) and non-LI (meaning the customer incurs some of the measure cost and/or is not a LI customer) twice in the denominator of the compliance equation. Some EDCs followed this guidance and others did not. The SWE analysis sought to identify EDC-reported measures that should be double counted and incorporated the double counting into its overall measure counts for each EDC.

A.2.4 Results

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

A.2.4.1 PECO

PECO reported that 43.5% of its 269 conservation measures qualified as LI measures, which surpasses its 8.8% requirement. By the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, 29.1% qualify as LI measures with measures unmatched to the TRM included. When unmatched measures are excluded, 32.9% qualify as LI. The reduction in compliance is partially attributable to PECO's reported compliance not including measures offered both as LI and non-LI twice in the denominator of the compliance equation. The SWE analysis found 51 measures that should be counted twice in the denominator. Matching measures to the TRM and double counting the proper measures resulted in 206 individual measures, 38 of which do not match to individual TRM sections and algorithms.

A.2.4.2 PPL

PPL reported that 18.9% of its 132 conservation measures qualified as LI measures, which surpasses it 9.95% requirement. By the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, 24.3% qualify as LI measures. The SWE notes that in PPL's PY12 reporting of low-income proportionality, PPL did a better job following the SWE's guidance for measure mapping than the SWE has seen from any EDC for the entire phase. The SWE analysis includes the double counting of measures offered to both LI and non-LI customers. The PPL reported compliance also properly double counted such measures.

A.2.4.3 Duquesne Light

Duquesne Light reported that 17.7% of its 113 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, 26.9% qualify as LI measures with measures unmatched to the TRM included. When unmatched measures are excluded, 26.2% qualify as LI. Matching measures to the TRM resulted in 64 individual measures, six of which do not match to individual

TRM sections and algorithms. The SWE analysis counted thirteen individual measures twice in the denominator of the compliance equation because they were offered to both LI and non-LI customers. The Duquesne Light reported compliance had also correctly double counted those measures.

A.2.4.4 FirstEnergy Companies

While the FirstEnergy EDCs were all assessed as a group since their measure counts are identical, the SWE reports the findings by individual EDC. In their Phase III plans, the FirstEnergy Companies reported that 37.3% of their 158 conservation measures qualified as LI measures, which surpasses every FirstEnergy EDC's requirement. By the SWE's analysis, when EDC-reported measures are matched to TRM algorithm sections, 34.4% of measures are LI with measures unmatched to the TRM included. When unmatched measures are excluded, 25.0% of measures are LI. Matching measures to the TRM resulted in 154 individual measures, 38 of which do not match individual TRM sections and algorithms. The SWE analysis counted 14 individual measures twice in the denominator of the compliance equation because they were offered to both LI and non-LI customers. The FirstEnergy EDCs had not double counted these measures.

A.2.5 LI Measure Offerings

Table 139 shows a list of the individual measures provided by the EDCs to the LI community. Since EDC-reported measure names were inconsistent between EDCs, measures are reported by TRM algorithm section. A check mark indicates that the corresponding EDC had at least one LI EDC-reported measure that was matched to the TRM algorithm section. All the FirstEnergy EDCs (Met-Ed, Penelec, Penn Power, and West Penn Power) had identical LI measures and are included as a single column: "FirstEnergy EDCs."

The "TRM Algorithm Section" column shows the section number for each algorithm. As discussed above, some algorithms did not have unique section numbers. Letters were appended to such algorithm section numbers to create unique identifiers. Additional measures are not in the current TRM but were matched to approved IMPs. Those measures are labeled "IMPs." Measures that could not be matched to a TRM algorithm section are labeled as "unmatched," and the measure name provided is the EDC-reported measure name.

Table 139: Summary of LI Measures Provided by EDCs

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs[1]
N	*85*	*60*	*28*	*18*	*53*
ENERGY STAR Lighting	2.1.1	✓	✓	✓	✓
Residential Occupancy Sensors	2.1.2	✓			✓
Electroluminescent Nightlight	2.1.3	✓			
LED Nightlight	2.1.4	✓	✓	✓	✓
Electric HVAC | CAC and ASHP	2.2.1a	✓	✓		✓
Electric HVAC | CAC and ASHP Maintenance	2.2.1c	✓	✓		✓

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs[1]
Electric HVAC | Furnace High Efficiency Fan	2.2.1f	✓			
Fuel Switch | Electric Furnace to Fossil	2.2.2a	✓			
Fuel Switch | Electric Baseboards to Fossil	2.2.2b	✓			
Ductless Mini-Split Heat Pumps	2.2.3				✓
ENERGY STAR Room Air Conditioner	2.2.4				✓
Room Air Conditioner Retirement	2.2.5	✓	✓		
Duct Sealing	2.2.6	✓	✓	✓	✓
Furnace Whistle	2.2.7	✓	✓		✓
Programmable Thermostat	2.2.8	✓	✓	✓	✓
Packaged Terminal AC	2.2.10a	✓			
Heat Pump Water Heaters	2.3.1	✓	✓	✓	✓
Fuel Switch | Electric Resistance to Fossil	2.3.3		✓		
Water Heater Tank Wrap	2.3.5	✓	✓	✓	
Water Heater Temperature Set Back	2.3.6	✓	✓		✓
Water Heater Pipe Insulation	2.3.7	✓	✓	✓	✓
Low Flow Faucet Aerators	2.3.8	✓	✓	✓	✓
Low Flow Showerheads	2.3.9	✓	✓	✓	✓
Thermostatic Shower Restriction Valve	2.3.10	✓	✓		
Refrigerator Recycling	2.4.3a	✓	✓	✓	✓
Refrigerator Early Replacement	2.4.3b	✓	✓		
Freezer Recycling	2.4.3c	✓	✓		✓
Freezer Early Replacement	2.4.3d	✓	✓		
ENERGY STAR Clothes Washers	2.4.4				✓
ENERGY STAR Electric Clothes Dryer	2.4.5				✓
ENERGY STAR Dehumidifier	2.4.8		✓		✓
Smart Strip Plug Outlets General	2.5.3			✓	✓
Smart Strip Plug Outlets Tier 1	2.5.3a	✓			
Smart Strip Plug Outlets Tier 2	2.5.3b	✓	✓		
Ceiling/Attic and Wall Insulation	2.6.1	✓	✓	✓	✓
ENERGY STAR Windows	2.6.2	✓			✓
Residential Air Sealing	2.6.6	✓	✓	✓	✓
Crawl Space Wall Insulation	2.6.7	✓			
Rim Joist Insulation	2.6.8	✓	✓		
Lighting Improvements	3.1.1	✓		✓	
Lighting Controls	3.1.3	✓			
Traffic Lights	3.1.4				
LED Exit Signs	3.1.5	✓			
LED Channel Signage	3.1.6	✓			
HVAC Systems	3.2.1	✓			

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs[1]
Electric Chillers	3.2.2	✓			
Controls: Economizer	3.2.9	✓			
Premium Efficiency Motors	3.3.1	✓			
ECM Circulating Fan	3.3.3	✓			
Variable Speed Refrigeration Compressor	3.5.8	✓			
Controls: Beverage Machine Controls	3.7.2	✓			
Controls: Snack Machine Controls	3.7.3	✓			
ENERGY STAR Refrigerated Beverage Machine	3.7.5	✓			
Smart Strip Plug Outlets	3.9.3			✓	
High Efficiency Ventilation Fan	4.1.3	✓			
Behavioral/Energy Education	5.2		✓	✓	
Basement Wall Insulation	IMP	✓			
ECM Circulator Pump	IMP	✓			
Furnace Maintenance	IMP	✓			✓
Permanent Fixture Removal	IMP	✓			
Permanent Lamp Removal	IMP	✓			
Residential Thermostats	IMP	✓	✓	✓	
Window Film	IMP	✓			✓
Window Repair	IMP	✓			✓
Weather Stripping	IMP			✓	✓
“Water Heater Timer”	Unmatched	✓			
“HVAC Controls EMS	Unmatched	✓			
“Retrocommissioning”	Unmatched	✓			
“Interior Lighting Controls Combination”	Unmatched	✓			
“Interior Daylighting Controls”	Unmatched	✓			
“Setback Thermostat”	Unmatched		✓		
“DI crawler and heater insulation”	Unmatched			✓	
“Electric Heating Repair or Replacements”	Unmatched			✓	
“Clothes Line Installation”	Unmatched				✓
“Room Air Conditioner Cover”	Unmatched				✓
“Water Heater Replacement”	Unmatched				✓
“Electric Furnace”	Unmatched				✓
“Electric Dryer Venting Repair or Replacement”	Unmatched				✓
“Electrical Repairs”	Unmatched				✓
“Exhaust Fan Repair and Replacement”	Unmatched				✓
“Furnace Filter”	Unmatched				✓

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs[1]
"Gravity Film Exchange (DWHRS)"	Unmatched				✓
"Health and Safety Measures"	Unmatched				✓
"Heated Waterbed Mattress Replacement"	Unmatched				✓
"Plumbing Repairs"	Unmatched				✓
"Refrigerator/Freezer Thermometers"	Unmatched				✓
"Roof Coating"	Unmatched				✓
"Room Thermometer"	Unmatched				✓
"Storm Windows and Doors"	Unmatched				✓
"Vapor Barrier"	Unmatched				✓
"Vents (Roof, Gable, Soffit and Ridge)"	Unmatched				✓
"Appliance Timers"	Unmatched				✓
"Well Pump"	Unmatched				✓
"Window Quilt"	Unmatched				✓
"Window Tint"	Unmatched				✓
"Door Repair or Replacement"	Unmatched				✓
"Electric Baseboard Heater Replacement"	Unmatched				✓

[1] All of the FirstEnergy EDCs (Met-Ed, Penelec, Penn Power, and West Penn Power) had identical LI measures, and are included as a single column: "FirstEnergy EDCs."

A.3 NTG

Overall, the EDCs estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework. The highest NTG ratios for residential programs were consistently reported for HER programs as they are based on a randomized control trial (RCT) design and the only difference between the treatment and control group are the reports themselves (and thus the analysis directly calculates net savings). Appliance Recycling and Turn-in Program NTG values were consistently among the lowest NTG values for residential programs. There was less consistency across NTG values for C&I programs. C&I lighting continues to be among the higher NTG C&I values and lower C&I NTG values for Custom and Prescriptive programs

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. The companies should attempt to consistently quantify spillover based on survey responses to consistently measure NTG across program years.

Appendix B PECO PY12 Audit Detail

B.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of PECO's PY12 Annual Report and the supporting detail provided by PECO's evaluation contractor, Guidehouse.

- Despite the voluntary of DR programs in PY12, PECO showed consistent performance across the five DR events called during summer 2020. The average verified MW performance was 160.5 MW, which is 99.7% of PECO's compliance target for Phase III. Performance was strong in the Residential DR and Large C&I DR program, while the Small C&I DR program showed significantly reduced reference loads and load impacts due to the COVID-19 pandemic. PECO elected to dispatch the Residential DR and Small C&I programs for two hours per event day rather than the four-hour duration in prior years of Phase III. This operational decision makes sense given the voluntary nature of PY12 DR events and increased prevalence of "work from home" behaviors during the pandemic, but the overall estimate of DR portfolio performance becomes sensitive to the procedure used to combine impacts across programs and hours with varying dispatch.
- In the Tracking Data Review audit activity, the SWE was able to replicate reported gross energy savings, reported gross demand savings, and incentive amounts for all programs in PECO's portfolio. Our independent calculations of participant counts were either identical or extremely similar to the participant counts reported in PECO's PY12 annual report.
- Adequate numbers of project files were submitted for the residential solutions in PY12, and the sampled project file packages included the requested number of project files and supporting details.
- The SWE's review of verified savings for non-HER residential solutions found that, overall, the verified savings followed proper TRM protocols and that the verified savings are accurate for PY12. The SWE found that verified savings were underestimated by 1,205 MWh due to mischaracterization of several upstream lighting measures. The impact of the discrepancies the SWE identified on portfolio-level savings is minor, around 0.2%. The SWE also notes that for the Residential Appliance Recycling program (RARP), the SWE uncovered several categories of error in the implementor's records including equipment with the same model number being recorded with different properties or different equipment types and repeats of the same serial number.
- Approximately 12% of PECO's PY12 verified gross savings came from Home Energy Reports. The HER contribution, as a percentage of portfolio savings, decreased each year of Phase III from 30% in PY8, 20% in PY9, 16% in PY10, and 14% in PY11.
    - Guidehouse's HER data management and reporting processes were clear and repeatable and the SWE was able to confirm the verified savings estimates by independently constructing the cleaned data and regression model.

- 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's review of PY12 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, including adherence to the COVID-19 EM&V Guidance Memo; 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 PECO to include all suggested changes in their annual report.
- The SWE closely tracked and reviewed the PECO CHP offering in PY12, which accounted for about 30% of PECO's PY12 gross verified savings through savings achieved at a single facility. Guidehouse and the SWE conducted a virtual site visit, including video tour, for this project. Guidehouse used trended measurements collected at the facility to determine the project's verified savings, and the SWE's review of Guidehouse's analysis confirmed all energy streams were correctly accounted for, including parasitic loads.
- Guidehouse did not conduct primary NTG research for any residential or non-residential programs during PY12 and applied prior program year NTG values.
- Guidehouse did not conduct in-depth process evaluation activities during PY12.

B.2 EM&V Plan Reviews

PECO's evaluation contractor, Guidehouse (formerly Navigant), submitted a redline version of their PY12 EM&V plan with relatively minor adjustments to the evaluation approach. The SWE reviewed and provided feedback to Guidehouse and approved a revised version of the PY12 EM&V plan.

In addition, Guidehouse submitted several memos updating their sampling approach for several solutions and programs, including PECO's residential new construction solution, the Lighting, Appliances, and HVAC (LAH) and Appliance Recycling solutions, the LI Energy-Efficiency (LI EE) Whole Home solution, and the Small and Large C&I Energy-Efficiency programs. The SWE reviewed and approved the memos, generally with minor revisions.

In addition to reviewing PECO's revised evaluation and sampling plans, the SWE reviewed several survey instruments, primarily impact verification surveys, for the appliance recycling solution, LAH solution, and LI EE Whole Home solution.

B.3 Sample Design Review

To reduce the time and cost of verifying savings, evaluators commonly sample projects and then estimate total verified savings based on the sample. However, sampling introduces uncertainty into the calculation. The uncertainty is derived from the fact that the sample may not be representative of the entire population. Thus, the amount of uncertainty is based on the size of the sample and the correlation between reported and verified savings within the sample. The sampling error, or margin of error, is reported by the relative precision of verified savings at a

given confidence level. For example, if an offering has verified savings of 1,000 MWh/year and a relative precision of ±10% at the 85% confidence level then there is an 85% chance that the true value of the savings is between 900 MWh/year and 1,100 MWh/year. All programs that rely on sampling to calculate verified savings must include the relative precision to quantify the sampling uncertainty.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at 85% confidence level for each "initiative." This constrains the sample design to ensure reliable estimates of verified savings. For Phase III 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 "solution." Within some solutions, multiple strata are used to ensure robust sampling. The Guidehouse evaluation activities for PECO were broken down by sector (residential or non-residential) and program (Large C&I, Small C&I, Residential, Residential LI), and reported in the PECO PY12 Annual Report by solution. Samples were devised to meet the 85/15 sampling requirement for each solution. Table 140 shows the relative precision of the energy savings for each solution evaluated in PY12. The SWE reproduced the precision values in Table 140 with the project-level sample dispositions furnished in response to the SWE annual data request.

Table 140: Relative Precision of PY12 Gross Verified Energy Savings by Program

Program	Solution/Initiative	Relative Precision at 85% Confidence Level (±)
Residential Energy-Efficiency	Lighting, Appliances, and HVAC	0.0%
Residential Energy-Efficiency	Appliance Recycling	5.8%
Residential Energy-Efficiency	New Construction	8.5%
LI Energy-Efficiency	Whole Home	4.3%
Small C&I Energy-Efficiency	Equipment and Systems	8.7%
Large C&I Energy-Efficiency	Equipment and Systems	13.1%

The Whole Home, Multifamily Targeted, Whole Building, C&I New Construction, and Data Centers initiatives were not evaluated in PY12. Guidehouse estimated verified gross savings for these initiatives using historic realization rates.

During PY12, Guidehouse continued to adjust some evaluation activities in response to health concerns arising from the COVID-19 pandemic. Guidehouse followed the recommendations provided by the SWE in its June 2020 memo regarding the pandemic and consulted with the SWE on a case-by-case basis for situations where the memo's guidance was not applicable. In some cases, Guidehouse used phone survey verification when the pandemic prevented certain evaluation activities, such as onsite verification and metering.

The sample design for the Equipment and Systems solution assumed a higher coefficient of variation (C_v) in PY12 based on challenges in PY11. This proved to be a wise decision for the Large C&I component, which showed a 0.65 energy C_v in PY12.

Sampling uncertainty does not consider the level of rigor of verification activities. Results from a sampled project that receives a quick desk review from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of Guidehouse's PY11 verification activities is discussed in detail in Appendix B.5.

Not all solutions rely on sampling to estimate verified savings. For the Behavioral Solution within the Residential Energy-Efficiency Program, the impact evaluation relies on a statistical billing analysis of all participants, so there is no uncertainty associated with sampling. The precision requirements for the behavioral program are unique, with the Phase III Evaluation Framework requiring the solution-level verification to achieve an *absolute* precision of ±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 ±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 Behavioral Solution analysis examines the solution'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 by cohort month, with overall program totals well below the threshold.

Like the Behavioral Program, the DR evaluations do not rely on sampling because a census is used. PECO's DR Programs include Residential DR, Small C&I DR, and Large C&I DR. Impact analysis employed econometric regression methods to estimate the demand savings from the program by utilizing AMI data at hourly or sub-hourly intervals. These regressions do not capture all the variation in the data; as a result, the impacts include estimation error. This error is captured in the relative precision values in Table 141.

Table 141: Gross DR Savings Impact Evaluation Relative Precision by Program

DR Program	Relative Precision at 90% Confidence Interval (±)
Residential	3%
Small C&I	19%
Large C&I	10%

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 PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)

- Reported gross peak demand savings (MW)
- 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 PY12 quarterly data request. Also note that DR and 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 PECO's DR programs can be found in Appendix B.6, and our findings regarding the behavioral component of PECO's Residential Energy-Efficiency Program can be found in Appendix B.5.1.3.

Table 142 summarizes our findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the values in PECO's PY12 Annual Report and "No" otherwise. The tracking data supports the Annual Report for all programs.

Table 142: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Energy-Efficiency	115,220	115,220	Yes*
LI Energy-Efficiency	19,850	19,850	Yes
Small C&I Program	84,865	84,865	Yes
Large C&I Program	117,556	117,556	Yes
CHP	202,434	202,434	Yes
Portfolio Total	**539,925**	**539,925**	**Yes**

*The Residential Energy-Efficiency Program has an HER component not represented in this table.

Table 143 summarizes the SWE's findings regarding reported gross peak demand savings, by program. 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
Residential Energy-Efficiency	16.36	16.36	Yes*
LI Energy-Efficiency	2.28	2.28	Yes
Small C&I Program	11.92	11.92	Yes
Large C&I Program	31.51	31.51	Yes
CHP	10.06	10.06	Yes
Portfolio Total	**72.13**	**72.13**	**Yes**

*The Residential Energy-Efficiency Program has an HER component, but it does have reported demand savings.

Table 144 shows participation counts for each of PECO's programs. The SWE was able to replicate the participation count for the CHP program. For the four other programs, the SWE calculated directionally similar counts via the tracking data. The portfolio totals, though not exactly equal, line up well: 864,604 in the Annual Report and 864,585 in the tracking data.

Table 144: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Residential Energy-Efficiency	850,494	850,548	No*
LI Energy-Efficiency	8,133	8,084	No
Small C&I Program	3,944	3,932	No
Large C&I Program	2,031	2,019	No
CHP	2	2	Yes
Portfolio Total	**864,604**	**864,585**	**No**

*The Residential Energy-Efficiency Program has an HER component not represented in this table.

Finally, Table 145 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE was able to replicate incentives shown in PECO's Annual Report for all programs.

Table 145: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Residential Energy-Efficiency	$7,790	$7,790	Yes
LI Energy-Efficiency	$103	$103	Yes
Small C&I Program	$5,875	$5,875	Yes
Large C&I Program	$8,134	$8,134	Yes
CHP	$2,028	$2,028	Yes
Portfolio Total	**$23,929**	**$23,929**	**Yes**

B.4.2 Project File Reviews

B.4.2.1 Residential

The SWE conducted a project file review for a sample of PECO's residential and LI solutions in PY12 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 146 presents an overview of the results of the SWE's residential project file reviews. Guidehouse has continued to work with the SWE to clarify questions and processes, both general and specific, that resulted from the ex-ante review for PY12. Improvements were made to quarterly data submissions, such as providing specified bulb or pack (unit of sale) quantity, which allowed the SWE auditors to conduct thorough reviews of upstream lighting files and the tracking data.

Table 146: PECO PY12 Residential Project File Review Summary

Program	Solution	Number of Files Reviewed	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[1]
Residential Energy-Efficiency	Upstream Lighting	23	✓	✓	✓	✓
Residential Energy-Efficiency	Appliance and HVAC	9	✓	✓	✓	✓
Residential Energy-Efficiency	Appliance Recycling	24	✓	✓	✓	✓
Residential Energy-Efficiency	Whole Home Solutions	16	✓	✓	✓	✓
Residential Energy-Efficiency	New Construction	48	✓	✓	✓	✓
Residential Energy-Efficiency	Multifamily Targeted Segment	24	✓	✓	✓	✓
LI Energy-Efficiency	LI-WHS	13	✓	✓	✓	✓

[1] 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.

Lighting, Appliance, and HVAC (LAH) Solution

The upstream lighting project file review included manufacturer invoices. Invoices specified bulb or pack (unit of sale) quantity, but many discrepancies were found between the total quantities sold on invoices and the tracking data. Rebate amounts typically matched up with tracking data. Additionally, no invoice files were included for Q2 despite records of rebates in the tracking data. As in PY11, the base wattage values corresponded with appropriate lumen ranges and bulb types specified in the TRM. However, the SWE notes that model numbers for lightbulbs continue to be excluded from the tracking data and recommends their inclusion in the tracking data moving forward in PY13.

Appliance and HVAC project files generally matched the quarterly tracking data.

The SWE also established in PY10 that PECO's evaluator, Guidehouse, conducts annual reviews to identify similar discrepancies in a sample of project files for their ex-post, verified savings analysis and adjusts realization rates when these types of issues are found.

New Construction Solution

The residential New Construction Solution project files reviewed matched the tracking data. The savings for the New Construction Solution were aggregated into batch invoice amounts, which were verified to match between project files and the tracking data. In addition, the SWE was provided with the individual project files contained within the batched invoice. In all reviewed cases, project files consisted of REM/Rate files, an export of the REM/Rate data, and an excel file that detailed hot water and appliance information for individual projects.

The reported kWh savings in the tracking data corresponded to those in the REM/Rate building files in all reviewed files of Q2, Q3, and Q4. For all reviewed Q1 files, the kWh savings from the REM/Rate building files differed from the reported kWh savings in the tracker.

Most reported savings in the tracking data matched REM/Rate results and included savings from lighting and appliance end-uses. Many of the REM/Rate building files in Q2, Q3, and Q4 generated a percent savings 1% lower than the reported percent savings in the tracker. The percent savings from the reviewed REM/Rate building files in Q1 matched with the reported percent savings in Q1, except for one instance in which the REM/Rate building file percent savings was 1% lower than the reported percent savings in the tracker.

During the PY10 and PY11 EM&V plan review Guidehouse agreed with the SWE's recommendation to follow the TRM protocol for residential new construction for verified savings.[52]

[52] The TRM specifies that savings "of high-efficiency electric water heaters, lighting, and other appliances will be based on the algorithms presented for these measures … [elsewhere in] this Manual," rather than those provided by the software used for building shell savings calculations.

Appliance Recycling Solution

The SWE reviewed the requested records for recycled units in Q1 through Q4 for PY12 and found only one discrepancy within the tracking data. There was a freezer measure reported in an electronic project file that was missing from the project file data.

Multifamily Targeted Segment

The SWE determined that project files matched the tracking data for the residential Multifamily Targeted Segment projects.

Whole Home Solution

The SWE determined most reviewed project files matched the tracking database for the Whole Home Solution. Dates matched between sets of documents, and brand/model, capacity, and other specifications tended to match as well. The SWE observed four cases where weatherization measures occurred, but the additional direct installation measures (lighting, showerhead, aerators, and pipe insulation) detailed in the project files were not included in the tracking data. The SWE also observed two cases where weatherization measures were reported in the tracking data but not included in the project files. In those two instances, other direct installation measures (such as lighting, showerheads, and pipe insulation) were indicated in the project files but not included in the program tracking data. Additionally, the SWE observed seven cases where HVAC maintenance occurred but was not included in the tracking data.

Low-Income Whole Home Solution (LI-WHS)

The SWE found that the reviewed project files matched the tracking database for the LI-WHS. The project files included details on the direct installation measures that occurred and additional audit details about the participant projects.

B.4.2.2 Non-Residential

As part of its audit process, the SWE conducts a review of ICSP savings values and methodologies. This review involves assessing specific project files for a sample of PECO's non-residential solutions in PY12. Throughout the program year, PECO, 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 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.

Table 147 presents a summary of SWE's non-residential project file reviews. Generally, the SWE found most of the project file packages for sampled projects to be complete. Most solutions provided a data key that allowed for easy identification of project file packages, especially for solutions that participate in both the residential and non-residential sectors. However, the SWE identified discrepancies between the information in the invoices and the information in the project energy savings calculator for some of the program solutions. The findings for each solution are discussed in detail below.

Table 147: PECO PY12 C&I Project File Review Summary Checklist

Program	Project Description	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for the SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
Large CI EE Program	HVAC	1 / 2	0 / 2	1 / 2	1 / 2	0 / 2	-
Large CI EE Program	HVAC & Lighting	✓	✓	✓	✓	✓	-
Large CI EE Program	Lighting	5 / 7	✓	4 / 7	6 / 7	✓	-
Large CI EE Program	Lighting & Custom	1 / 2	1 / 2	1 / 2	1 / 2	✓	✓
Small CI EE Program	Appliances	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	-
Small CI EE Program	HVAC	✓	✓	✓	✓	✓	-
Small CI EE Program	HVAC, Lighting, Refrigeration, & Custom	0 / 1	✓	0 / 1	0 / 1	✓	0 / 1
Small CI EE Program	Lighting	10 / 12	8 / 12	8 / 12	10 / 12	✓	-

Equipment & Systems (E&S) Solution

The E&S solution incents a wide range of measures; however, this solution track primarily included lighting retrofit projects during PY12. The SWE completed reviews on a sample of 27 projects across both the Large C&I and Small C&I programs for the E&S solution. These 27 projects were selected as a random sub-sample of each quarterly sample. The SWE found the project file packages for most of these projects to be very thorough, while all project file packages contained enough information to understand the basic scope of work.

Projects that relied on TRM algorithms generally included documentation that cited the input parameters used to calculate savings. Project PECLPS1544770234 did not include a calculation file, so this could not be verified.

B.5 Verified Gross Savings Audits

B.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of verified gross savings attributed to PECO's portfolio of residential programs. PECO's residential portfolio encompasses two umbrella programs, the Residential Energy-Efficiency Program and the Residential LI Energy-Efficiency Program, broken out into different solutions. The Residential Energy-Efficiency Program solutions include the following: LAH, Appliance Recycling, Whole Home, New Construction, Multifamily Targeted Market Segment, and Behavioral. The Residential LI Energy-Efficiency Program includes a Whole Home Solution. The LI lighting solution was discontinued. Note that the SWE

reports the residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

Overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. 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 PECO in their PY12 verified savings calculations. The "Applied RR" column indicates whether a previous year's realization rate was applied to the reported savings

Table 148: Residential Program Evaluation Activities (by Solution) – PECO

Solution	Surveys	Site Visits	Desk Review[a]	Billing Analysis	Applied RR
Lighting, Appliances, and HVAC Solution	✓	-	✓	-	-
Appliance Recycling Solution	✓	-	✓	-	-
Whole Home Solution	-	-	-	-	PY11
New Construction Solution	-	-	✓	-	-
Multifamily Targeted Market Segment	-	-	-	-	PY10
Behavioral solution	-	-	-	✓	-
LI – Whole Homes	-	-	✓	-	PY11

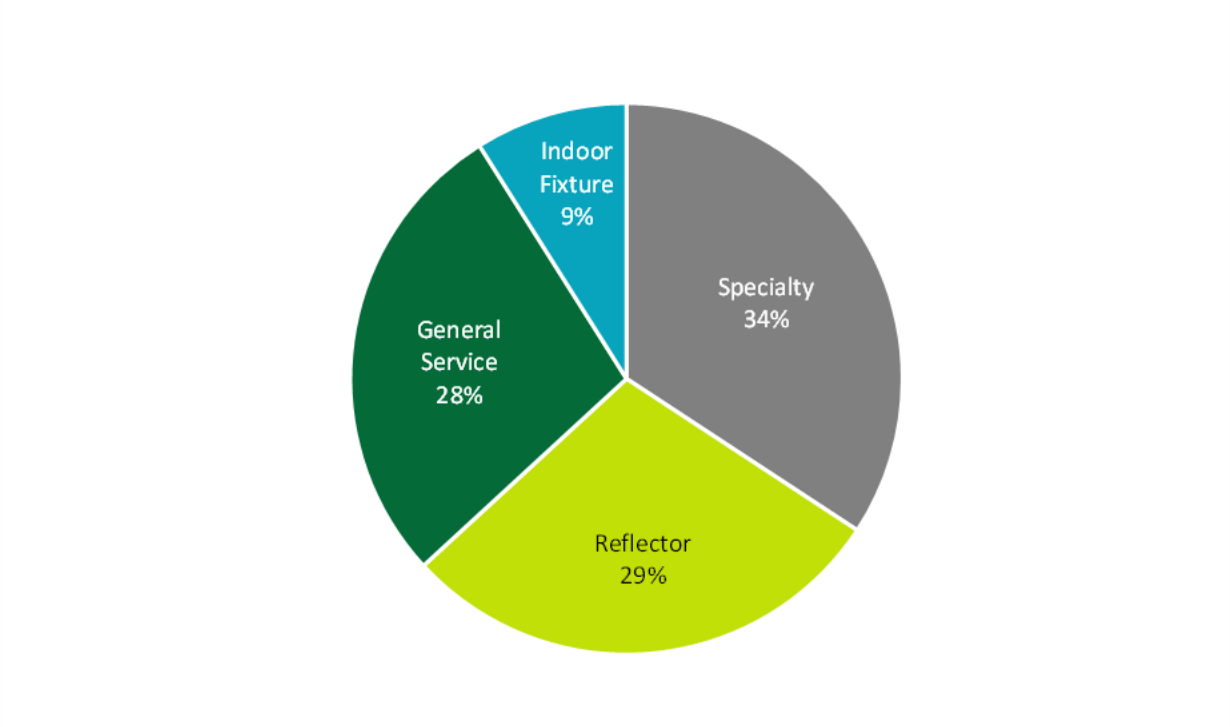
[a] The Desk Review Column includes database reviews, application reviews, and engineering desk reviews, TRM savings calculations, or a combination of these activities.

B.5.1.1 Upstream Lighting & Cross-Sector Sales

Customers purchased over two million efficient light bulbs and fixtures through PECO's PY12 upstream lighting program. Figure 42 displays the distribution of sales by product type. Around

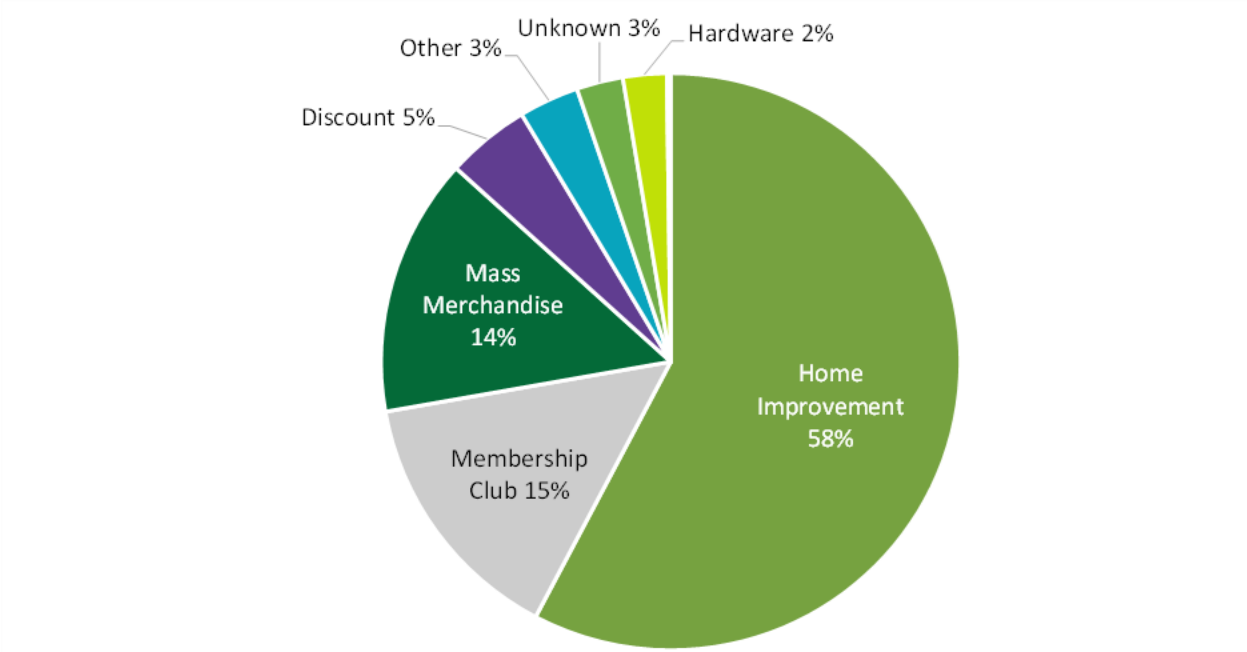
one-third (34%) were specialty bulbs, followed by reflectors (29%), general service lamps (28%), and indoor fixtures (9%).

Figure 42: PECO PY12 Upstream Lighting Sales by Product Type



Over one-half (58%) of PECO's PY12 upstream light bulbs and fixtures were sold through home improvement stores, followed by membership clubs (15%) and mass merchandise stores (14%, Figure 43).

Figure 43: PECO PY12 Upstream Lighting Sales by Retail Channel



Audit Findings

The SWE reviewed the data in PECO's tracking system to verify that Guidehouse used the appropriate values and algorithms from the 2016 TRM to calculate verified gross savings. Although the team identified some minor discrepancies (described in the review below), the SWE generally agrees with Guidehouse's verified gross savings for upstream lighting but has adjusted verified savings for the errors detailed below.

The SWE observed 805 unique lighting model numbers in the PY12 tracking system and was able to verify that all are ENERGY STAR certified. The SWE compared the product descriptions, lumens, and wattages in the tracking system to those in the ENERGY STAR certified products lists and found that they aligned for all but 40 models. The team confirmed that Guidehouse used the appropriate algorithms to calculate kWh and kW savings and verified that Guidehouse used the correct interactive effects, in-service rate (ISR), hours of use (HOU), and coincidence factors in the calculations. The SWE found that Guidehouse assigned baseline wattages in accordance with TRM protocol *2.1.1* for most of the models. Exceptions include:

- 48 candelabra-based bulbs that should have been assigned the EISA-exempt baseline
- 52 high-lumen models that should have been assigned the manufacturer rated wattage equivalency
- 82 directional fixtures that should have used the 'All other R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"' category in TRM table 2-4

- 14 omnidirectional fixtures that should have used the baseline wattages in TRM table 2-2

Overall, verified savings were underestimated by 1,205 MWh. The impact of the discrepancies the SWE identified on portfolio-level savings is minor, around 0.2%.

Cross-Sector Sales

Guidehouse did not conduct cross-sector sales research in PY12 but applied the PY8 cross-sector sales rates of 0.73% for standard LEDs and 2.0% for specialty LEDs.

Recommendations

The SWE noticed that five fixture models had negative delta watts following the shift to the post-backstop baseline. The model numbers are 5562B1131, 5520B1131, AL-3162, 544511##, and 544516##. The team recommends that PECO stop incentivizing these models going forward.

Additionally, the SWE makes the following recommendations based on its review:

- Utilize the EISA-exempt baseline wattage for candelabra-based bulbs.
- Utilize the manufacturer rated wattage equivalency for models with lumens that exceed the lookup tables in the TRM.
- Apply the 'All other R, PAR, ER, BR, BPAR, or similar bulb shapes, with diameter >2.5"' baseline wattages in TRM table 2-4 for directional downlight fixtures and retrofit kits.
- Apply the general service lamp baseline wattages in TRM table 2-2 for omnidirectional fixtures.

B.5.1.2 Residential Non-Lighting

The SWE's review of verified savings for residential non-lighting and non-HER solutions found that, overall, the verified savings followed proper TRM protocols and that most of the verified savings are accurate. The SWE in coordination with PECO evaluator, Guidehouse, was able to conduct a preliminary review of the programs prior to the annual report. Guidehouse incorporated feedback from the SWE's preliminary review prior to the EDC annual report submission. The SWE was able to confirm that the gross verified savings calculations incorporated SWE feedback and were correct in the EDC annual filing. The SWE will continue to work with Guidehouse to develop preliminary review processes that allow the SWE findings and recommendations to be incorporated into gross verified savings calculations prior to filing the EDC annual report.

Lighting, Appliances, & HVAC Solution

The LAH solution offers rebates on the residential customer purchase of qualified equipment, such as ENERGY STAR appliances, as well as upstream lighting incentives. The LAH solution also includes measures supported through the online marketplace, an online retail that provides customers with efficient smart strips, thermostats, and lighting products. The SWE audited each component of the LAH solution. Note that the SWE audit of lighting is reported in Section B.5.1.1 of this appendix.

The SWE audit of the HVAC component of the LAH solution included air-source heat pumps, central A/C, central A/C maintenance, ductless mini-split heat pumps, ECM furnace fans, and

various other HVAC measures. The SWE determined that sample sizes were correct and savings were calculated in accordance with TRM protocols.

The SWE audit of the online marketplace included smart strips, smart thermostats, and lighting. The SWE determined that population sizes were correct and savings were calculated in accordance with TRM and IMP protocols.

The SWE audit of the appliance component of the LAH solution included ENERGY STAR Air Purifiers, Clothes Washers, Dehumidifiers, Refrigerators, and various other appliances. The SWE determined that sample and population sizes were correct. Verified savings were calculated in accordance with TRM protocols, and that realization rates were properly calculated and applied for all measures.

Appliance Recycling Solution

The Residential Appliance Recycling program (RARP) covers the recycling of older model refrigerators, freezers and room air conditioners.

Guidehouse provided the PY12 impact analysis for RARP early, which allowed the SWE ample time to conduct its review. PECO's RARP implementor tracks make, model and serial numbers for most of the recycled equipment, which the SWE used in conjunction with an internal database of equipment information to audit the accuracy of equipment classifications used in calculating verified savings. Through this analysis, and internal consistency checks of the tracking data the SWE uncovered several categories of error in the implementor's records including:

- Equipment with the same model number being recorded with different properties. For example, a refrigerator model number that had eight different volumes, ranging from seven to 20 cubic feet.
- Entries recorded as the wrong equipment type such as a refrigerator recorded as a freezer, chest freezer as an upright freezer, or refrigerator as an air conditioner
- Repeats of the same serial number, which should be unique for each device.
- Fifty-five refrigerators and freezers below the 10 cubic foot threshold of the TRM's requirements.[53]

However, using the implementor data as is, the audit showed that the proper TRM protocols were followed, and that verified savings and sample sizes were correct for all measures.

Whole Home Solution

The PY12 evaluation for the Whole Home Solution applied PY11 realization rates, per the evaluation plan for PY12. The SWE found no issues with the application of PY11 realization rates to the PY12 reported savings values.

[53] Although 16 of these were a model of refrigerator with an official volume of 9.9 ft^3 and would be permissible with rounding.

New Construction Solution

In accordance with the program's evaluation plan, the New Construction Solution was evaluated in PY12. The PY12 evaluation plan followed the SWE's recommendation from previous years to calculate the non-weather sensitive measures using the TRM protocol. In addition, the SWE-approved EM&V plan stated that average measure-level savings values from the LAH program would be used to calculate savings where data was either not collected by the CSP or not available in the REM/Rate models.

The SWE preliminarily reviewed PECO's New Construction Solution and resolved any questions outstanding prior to the EDC annual report. The SWE confirmed that the New Construction Solutions impact evaluation was updated, and that the EDC annual report reflected SWE recommendations and considerations.

Multifamily Targeted Market Segment

The Multifamily Targeted Market Segment provided low-flow faucet aerators; low-flow showerheads; ENERGY Star LED bulbs; and several additional measures, such as smart strips and insulation. The evaluator conducted engineering desk reviews for a sample of projects across all savings strata to verify that there were no discrepancies between reported savings values, measure quantities, etc. The evaluator then applied realization rates from the PY10 evaluation. The SWE found that the algorithms and calculations followed the correct TRM protocols and agreed with the verified savings and realization rates for the program. The SWE noted that for aerator and showerhead measures, the tracking data states that water heater fuel type is "unknown" despite the program only being offered to customers with electric water heaters – Guidehouse confirmed for the SWE that electric water heating fuel is required for program participation. In addition, the SWE determined the sample sizes and population sizes were correct.

Low-Income Whole Home Solution

The LI-WHS is comprised of multiple strata within the solution, which include product giveaways, in-home audits, and direct install measures. PECO discontinued their LI Lighting Solution in PY9. Various measures are offered in each stratum based on job type, which was tracked by the EDC. Note that LI appliance recycling customers use Residential EE – Appliance Recycling Solution, and the associated savings with LI customers are compiled into the LI Whole Home Solution. Guidehouse conducted a full review of the tracking data to ensure that correct TRM algorithms were being applied and sampled projects for engineering file reviews and phone surveys. The verified savings for the entire solution were calculated using the sampled measures, to obtain a realization rate that was in turn applied to the entire reported savings population. Guidehouse also applied reported savings adjustments from the tracking data review to the realization rate. The SWE audited the tracking and sampled measures using EDC-provided data.

The SWE preliminarily reviewed the LI Whole Home Solution and resolved any questions outstanding prior to the EDC annual report. The SWE confirmed that sample sizes and population sizes were accurate, as well as TRM specified algorithms were properly administered to calculate gross verified savings.

B.5.1.3 Behavior

Approximately 12.2% of the PY12 verified gross energy savings listed in PECO's PY12 Annual Report came from Home Energy Reports issued to over 380,000 households. PECO was the only EDC who did not claim HER energy savings towards its LI compliance target in PY12. PECO's Behavioral Solution consists of the nine different waves, or cohorts, of homes summarized in Table 149. Home counts are rounded to the nearest thousand and represent the number of active households at the beginning of PY12.

Table 149: PECO HER Cohort Summary

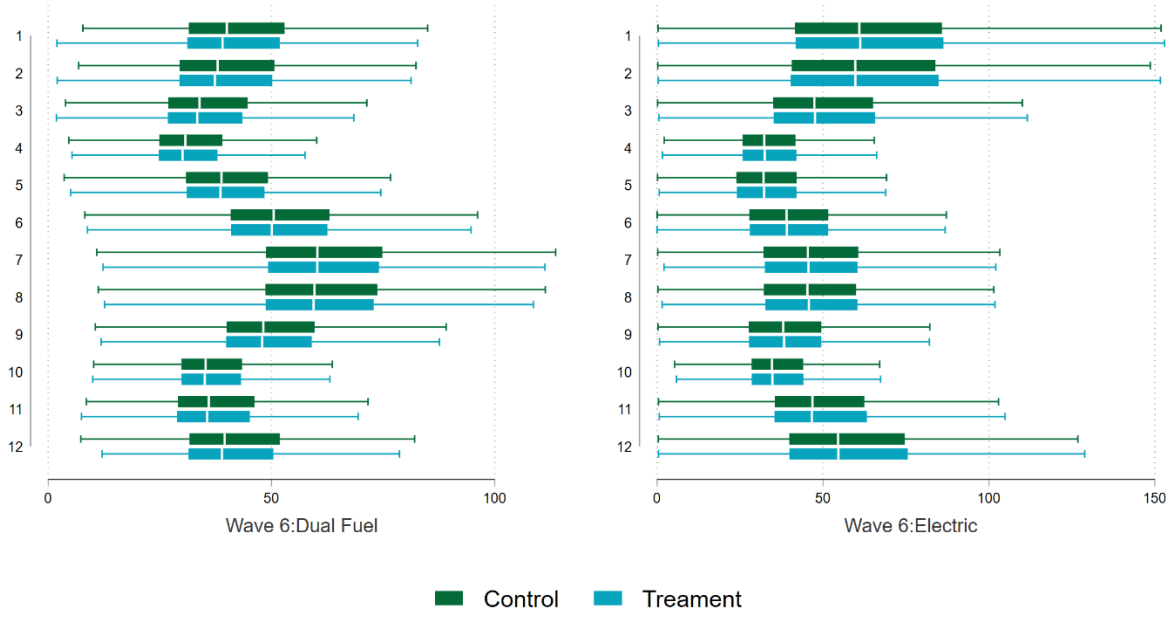
Wave	Wave Start Date	Treatment Group Homes	Control Group Homes
Wave 1	August 2013	23,000	14,000
Wave 2	March 2014	29,000	12,000
Wave 3	June 2015	51,000	15,000
Wave 4	June 2016	161,000	15,000
Wave 5 Electric	June 2017	21,000	9,000
Wave 5 Dual Fuel	June 2017	13,000	5,000
Wave 6 Electric	July 2019	17,000	13,000
Wave 6 Dual Fuel	July 2019	5,000	4,000
AC Saver*	June 2016	31,000	27,000

*AC Saver: All residential DR participants. Control group is matched with replacement.

The program ICSP Oracle implemented Waves 1-6 as randomized control trials (RCTs) where the eligible households were identified and then randomly assigned to either a treatment or control group. Following randomization, Guidehouse conducted statistical tests on participant billing data and confirmed that pre-treatment energy usage patterns were similar for the treatment and control groups.

Waves 5 and 6, though randomized in the same manner as the previous waves, have been split into Electric Heat and Dual Fuel sub-cohorts. Following randomization, Guidehouse conducted statistical tests on participant billing data and confirmed that Wave 5 and 6's pre-treatment energy usage patterns were similar for the treatment and control group. Pre-treatment comparisons of the wave 6 cohort can be seen in Figure 44. After the randomization occurred, treatment and control group customers were split into the Electric and Dual Fuel groups. Splitting these groups provides further insight into the types of savings without affecting the overall MWh impact.

Figure 44: Wave 6 Cohort Pre-Treatment Daily kWh Comparison



The AC Saver wave was not an RCT. This wave consists of participants in PECO's Residential DR program (AC Saver) who were given HERs as a type of compensation for reduced incentives in the AC Saver program. Although there was no true experimental control group, Guidehouse created a quasi-control group using matching for the impact analysis.

The SWE performed a detailed audit of the experimental design for both the RCT, and the AC Saver waves, regression-based HER savings estimates, and recipient household counts using data provided by Guidehouse. The SWE first used the Guidehouse data and regression model to confirm the savings estimates provided by Guidehouse, shown in Table 150. The model is a lagged dependent variable model. This means that it is a post-only model that includes information on the average consumption for each home in the same month of the pre-period as an explanatory variable. Second, the SWE independently constructed the cleaned data by following the procedures indicated by Guidehouse. This data was then used to estimate the savings, which matched Guidehouse's estimates. For comparison across waves, the average annual kWh savings per home and the average percent savings attributed to the behavioral program are provided. Average values in the Total row are calculated using a weighted average of the number of PY12 homes.

Table 150: PY12 HER Energy Savings Before Dual Participation Adjustment

Wave	PY12 Gross Savings MWh	Average kWh per Home	Average Percent Savings
1	6,869	302	1.9%
2	12,141	412	1.7%
3	21,027	413	2.6%
4	23,873	148	1.3%
5 – Electric	4,965	233	1.8%
5 – Dual Fuel	1,436	106	0.9%
6 – Electric	3,173	200	1.2%
6 – Dual Fuel	1,133	228	1.4%
AC Saver	2,967	94	1.1%
Total	**77,583**	**221**	**1.7%**

AC Saver Matched Control Group

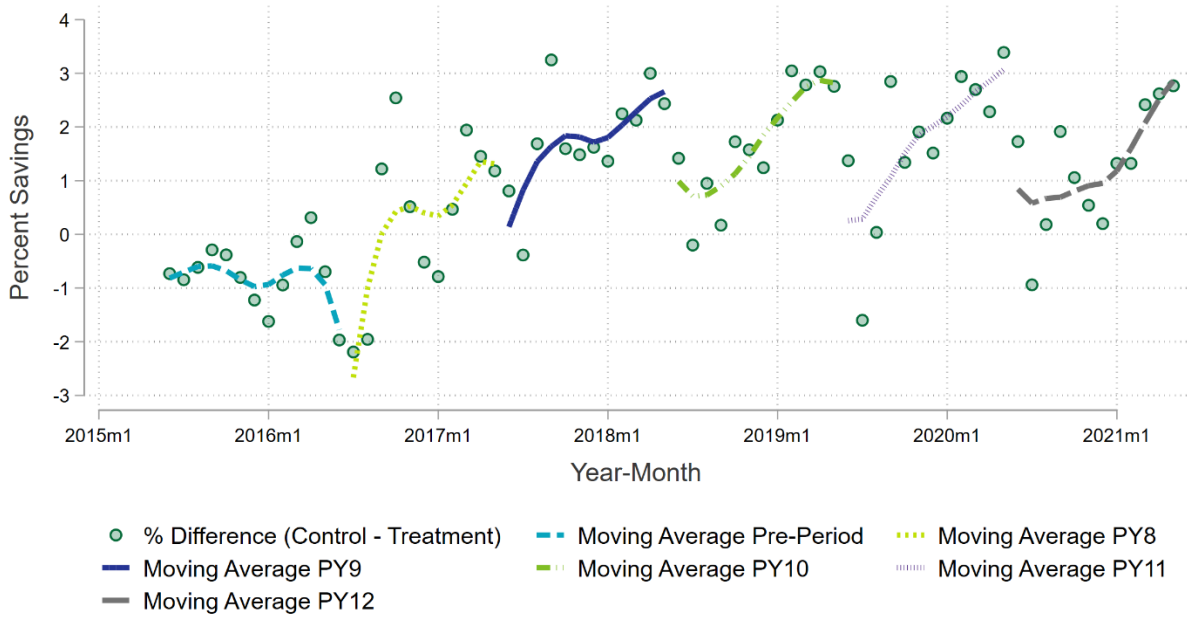
The AC Saver wave implementation was not an RCT with an experimental control group. This creates an evaluation challenge that is not present in Waves 1-6 because Guidehouse needed to create a control group via matching. They used Euclidian distance matching with replacement to select the PECO residential account that most closely resembled the energy usage of AC Saver participants from June 2015 through May 2016. The homes eligible for matching do not receive HERs from PECO. “With replacement” means a control group home could match with more than one treatment group household. If a control group home matches with more than one treatment group home, their consumption data is weighted more heavily in the model. Guidehouse uses a technique called frequency weighting in their model to account for the control homes that are selected as the best match for more than one treatment group household. For example, if a control group home was the best match for six treatment group homes, their billing data is weighted six times in the analysis model. This is illustrated in Table 151 below for the month of June 2020.

Table 151: PY12 June, 2020 AC Saver Frequency of Matched Controls

Number of times matched	Frequency
1	23,731
2	3,023
3	610
4	140
5	22
6	6
7	3
Total	**27,535**

Figure 45 shows the monthly percent difference in average kWh usage between the treatment and matched control group prior to treatment and since the beginning of HER exposure. The matches were reasonably good. The treatment group used slightly more energy than the matched control group, on average, but the difference is less than 1% for most months of the pre-period. The treatment effect for this cohort is somewhat erratic by season with little or no savings in summer months and large savings in the winter and shoulder months. However, the average treatment effect over PY12 was significant and similar in magnitude to PY10 and PY11.

Figure 45: AC Saver Percent Impacts over Time



Dual Participation

In Table 150, calculated savings were 77,583 MWh. It is important to note that Home Energy Reports advertise other residential EE&C programs and measures, such as ENERGY STAR appliances, efficient lighting, HVAC, etc. If a household participates in one of those solutions, the savings from that participation is counted by the specific program but is also 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. Participation is not tracked for upstream lighting, so PECO used the default reduction percentages for each wave, by age, to arrive at the gross verified savings of 68,367 MWh, reported in Table 152.

The PY12 dual participation adjustment levels were typical for all cohorts other than the AC Saver wave, which had its saving reduced by around 82%. This is atypically high until we consider the fact that the AC Saver treatment group is composed exclusively of homes that participate in another EE&C program, so they are clearly pre-disposed to participate in programs. Over Phase III, the AC Saver treatment group has accumulated significantly more EE participation than its matched control group and the result is a significant dual participation adjustment. The SWE

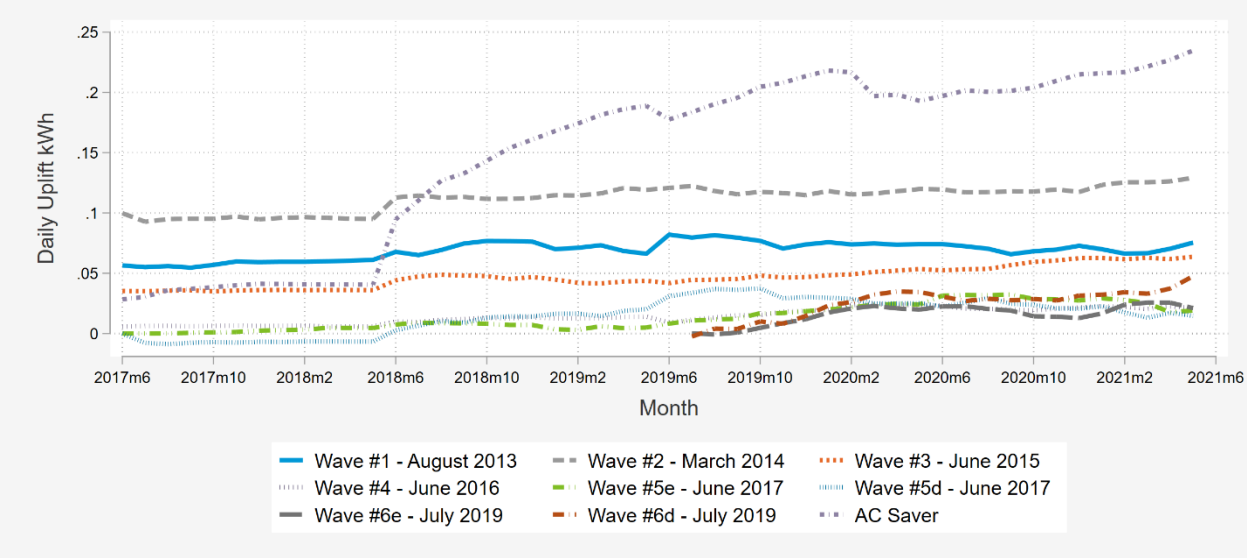
recommends Guidehouse double-check that frequency weights are applied to the dual participation analysis as well as the regression analysis.

Table 152: PY12 HER Energy Savings - Dual Participation Adjustment

Wave	PY12 Gross Savings MWh	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Net Savings (MWh)
1	6,869	583	189	6,097
2	12,141	1,303	325	10,513
3	21,027	1,100	598	19,329
4	23,873	1,252	679	21,942
5 – Electric	4,965	215	142	4,607
5 – Dual Fuel	1,436	104	40	1,292
6 – Electric	3,173	115	46	3,012
6 – Dual Fuel	1,133	58	16	1,058
AC Saver	2,967	2,435	16	516
Total	**77,583**	**7,166**	**2,051**	**68,367**

In Figure 46 the daily uplift in kWh is plotted over time for all HER cohorts. This is the measure that we use to quantify the amount of savings for the treatment group that can be attributed to other EE programs. The slight rise over time that can be seen in most of the cohorts is to be expected. As time goes on, treatment customers would be expected to take up other programs at a faster rate than the control group because they are exposed to other programs more HER marketing and may have increased propensity to participate thanks to the energy awareness fostered by HERs. The AC Saver group, however, has a large spike between PY9 and PY10. The SWE hypothesis is that this was caused by development of a new matched control group for the PY10 evaluation. The AC Saver wave will be disbanded in Phase IV so the SWE is not requesting further investigation of this issue.

Figure 46: Daily Uplift (kWh) over time by Cohort



Peak Demand Impacts

Using the flat load shape assumption that assumes savings occur equally in each hour of the year, Guidehouse calculated gross verified demand savings of 7.80 MW for the Behavioral Solution.

$$Verified\ MW\ Savings = \frac{68{,}367\ MWh}{8{,}760\ hours} = 7.80\ MW$$

Conclusion

Guidehouse's data management and reporting processes are clear and repeatable. The SWE was able to confirm the savings estimates provided by Guidehouse both by using Guidehouse data and regression model, and by independently constructing the cleaned data and savings estimates by following the procedures indicated by Guidehouse. The SWE team agrees with and was able to replicate all PY12 verified savings results for PECO's Behavioral Solution.

B.5.2 Non-Residential Audit Activities

As noted in Section 1.3.4, PECO's non-residential portfolio consists of the CHP program and five solutions within the Small C&I and Large C&I programs:

- E&S
- New Construction
- Whole Building
- Data Centers
- Multifamily

The SWE conducted various review and audit activities of the program solutions. These activities included a review of the evaluation efforts and an audit of the savings verification completed by

PECO's evaluation contractor, Guidehouse. Additionally, the SWE reviewed project files used by PECO's program implementers to assess the reported savings.

Guidehouse used multiple approaches to verify the gross impact estimates for each non-residential program. This section discusses the results of the SWE's review of Guidehouse's approach in applying various levels of rigor to assessing and estimating project impacts from their evaluation sample. The SWE completed this review based on evaluation sample population extracts provided by Guidehouse, which detailed how each sampled project was evaluated regarding evaluation activity and M&V approach. The purpose of this review is to affirm that the evaluator conducted the evaluation in compliance with the EM&V framework and followed the approved evaluation plan. Table 153 presents the list of evaluation activities by project count.

Table 153: PECO Evaluation Activities by Project Count

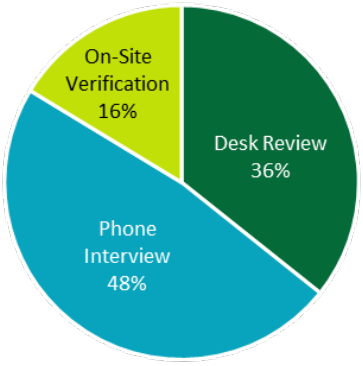
Program/Solution	Sample Quantity	RR– Energy	Desk Review	Phone Interview	On-Site Verification
Small C&I	**44**	**102%**	**19**	**21**	**4**
E&S	44	103%	19	21	4
New Construction	0	104%	0	0	0
Multifamily	0	98%	0	0	0
Whole Building	0	92%	0	0	0
Data Centers	N/A	-	-	-	-
Large C&I	**52**	**96%**	**16**	**26**	**10**
E&S	52	92%	16	26	10
New Construction	0	136%	0	0	0
Multifamily	0	99%	0	0	0
Data Centers	0	61%	0	0	0
Combined Heat & Power	**2**	**82%**	**0**	**0**	**2**
Total	**98**	**90%**	**35**	**47**	**16**

The SWE calculated project split between the different evaluation methods using data submitted by Guidehouse for their evaluation sample.

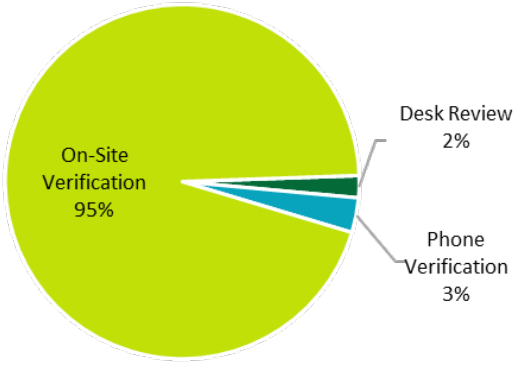
Figure 47 provides a summary of the evaluation activities and M&V approaches utilized by Guidehouse for the PY12 verified savings calculations across the non-residential portfolio. Each figure reflects evaluation activities for all programs and solutions combined. Fourteen site visits were completed within the evaluation sample, which includes one (1) virtual on-site verification. Guidehouse predominantly used Basic Rigor as its M&V approach; however, Guidehouse did target International Performance Measurement and Verification Protocol (IPMVP) M&V approaches for the larger projects using metering methods. Like their approach in PY11, Guidehouse reserved IPMVP Options A and B for primarily projects in the Large C&I E&S Solution Program. IMPVP Option C was utilized for one project under the Small C&I E&S Solution Program.

Figure 47: Summary of PECO's PY12 C&I Evaluation Activities

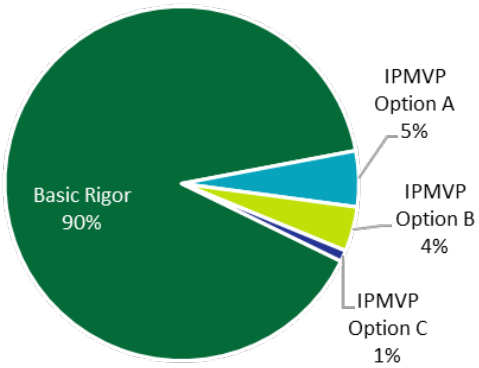
Evaluation Activity by Project Count



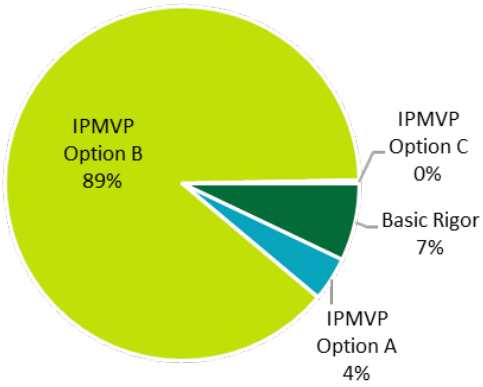
Evaluation Activity by kWh Contribution



M&V Method by Project Count



M&V Method by kWh Contribution



B.5.2.1 E&S

The E&S solution comprised the majority of the non-CHP energy savings within the PECO non-residential portfolio. Guidehouse derived a sample of 96 projects from the Large and Small C&I programs and allocated them to multiple strata based on project type and size.

For Small C&I E&S, of the 44 projects evaluated, 41 included lighting or lighting control retrofits, one was classified as custom HVAC, one was classified as HVAC, and one was classified as Lighting and Refrigeration. For Large C&I E&S, of the 52 projects evaluated, 39 included lighting or lighting control retrofits, five were classified as RCx, three were classified as Custom, three were classified as custom motors, and two were classified as HVAC.

The SWE attended Guidehouse's virtual and in-person site visits for six of the sampled projects and conducted desk reviews for an additional seven projects.

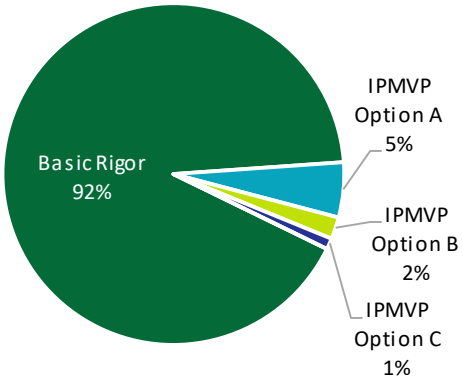
Guidehouse conducted desk reviews for all projects in the evaluation sample. The desk reviews used project applications, project-specific analysis files and associated calculation sheets, measure invoices, measure specification sheets, construction plans, and other construction documents provided by PECO. Guidehouse supplemented desk reviews with phone verification, on-site verification, and metering. Most sampled projects from the Equipment and Systems Solution achieved realization rates for both demand and energy within 20% of the expected values. Eighteen of the projects had verified energy savings values above 120% of the reported values, while none of the projects fell below 80% of reported values. Diving further into projects with higher or lower than expected realization rates, Guidehouse observed the following reasons for discrepancy:

- Annual HOU for lighting measures – verified lighting HOUs were 10% different from the deemed HOUs.
- Incorporation of additional post-retrofit billing data in RCx projects to more accurately predict savings estimates.
- Unsupported calculations including a chiller with nearly double the TRM-deemed EFLHs and a custom cooling system that included a custom baseline condition.

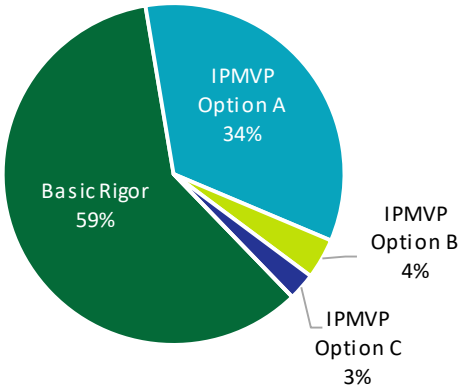
Figure 48 displays the share of M&V methods performed under the Equipment and Systems. IPMVP methods accounted for 41% of the evaluated savings, and only represented 8% of projects. The targeted relative precision for the solution is 15% at the 85% confidence interval. Guidehouse met this goal for both energy and demand verified savings in both the Small and Large C&I programs.

Figure 48: Summary of PECO's PY12 E&S Solution M&V Methods

M&V Method by Project Count



M&V Method by kWh Contribution



B.5.2.2 Data Centers

The Data Center solution operates under both the Small and Large C&I programs. The Data Center segment represented only one of the 1,999 Large C&I program projects. The resulting energy savings comes out to less than 0.01% of the Large C&I Program total energy savings. Guidehouse did not sample any projects from this solution in PY12 and applied the realization rates from PY10 for energy and demand to the PY12 gross savings.

B.5.2.3 Non-Residential New Construction

The New Construction solution contributed approximately 3% of reported savings to PECO's non-residential portfolio. This program operates under both the Large and Small C&I programs. Guidehouse did not sample any projects from this solution in PY12 and applied the realization rates from PY11 for energy and demand to the PY12 gross savings.

B.5.2.4 Non-Residential Whole Building

The Non-Residential Whole Building solution operates under Small C&I program. The whole building segment represented approximately 11% of PECO's Small C&I program savings portfolio and approximately 2% of PECO's non-residential savings portfolio. Guidehouse did not sample any projects from this solution in PY12 and applied the realization rates from PY11 for energy and demand to the PY12 gross savings.

B.5.2.5 Non-Residential Multifamily

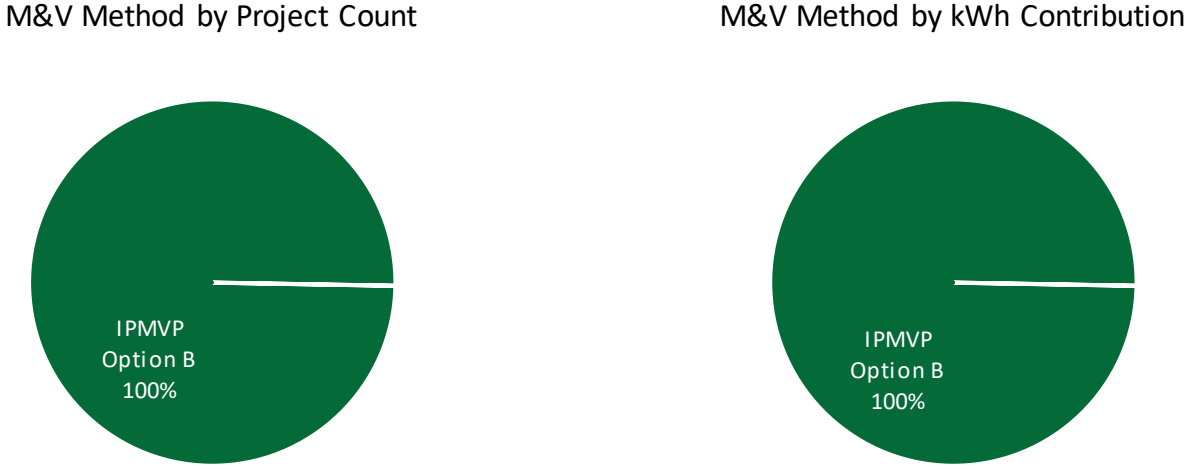
The Non-Residential Multifamily solution operates under both the Small and Large C&I programs but also heavily overlaps with the Residential program. The multifamily segment represented approximately 2% of PECO's non-residential savings portfolio. Guidehouse did not sample any projects from this solution in PY12 and applied the realization rates from PY10 for energy and demand to the PY12 gross savings.

B.5.2.6 CHP

The CHP program included two projects for PY12 and contributed 50% of the non-residential portfolio reported savings at 202,434 MWh. Gross impact evaluation activities included a thorough desk review of the projects using interval data and system trend data as well as a virtual site visit. A demand realization rate of 195% was achieved, while the energy realization rate fell short at 82%. The energy realization rate resulted from the implementer's use of data from the abnormally high production period for ex ante savings calculations. The demand realization rate was largely because the tracked MW value was actually the demand incentive cap level, rather than a value specific to the installed CHP system.

Figure 49 displays the share of M&V methods performed under the Equipment and Systems. IPMVP Option B was used for a census of projects in this program.

Figure 49: Summary of PECO's CHP Program M&V Methods



B.5.2.7 Ride-Along Site Visits

The SWE audited the activities above through a combination of Ride-Along Site Visits (conducted both in person and virtual) and Desk Reviews. The details of the SWE's findings are presented in the following subsections.

Table 154 provides an overview of the SWE milestones for the audit of PECO's site inspection efforts.

Table 154: PECO Ride-Along Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	kWh Attainment Percentage
6	171,125,563	4	6	99.6%

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. Minor changes to energy and demand savings calculations were suggested by the SWE for two projects.

B.5.2.8 Verified Savings Desk Reviews

Table 155 provides an overview of the SWE milestones for the verified savings review of evaluated PECO projects.

Table 155: PECO Verified Savings Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
7	5,139,379	805.0	100.0%	100.0%

Overall, the SWE found that PECO's evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods to evaluate custom projects. Supporting verification reports and calculation files provided to the SWE were able to accurately provide an overview of the project and approach taken by the evaluator to verify energy savings. The SWE did not propose any savings calculation changes for the review projects, resulting in an attainment percentage of 100%.

B.6 DR

According to the Phase III Implementation Order, PECO's Phase III demand response (DR) compliance target is 161 MW. Compliance is determined based on the average MW performance across all DR event hours for the Phase and DR goals are assessed at the system level, meaning that line loss adjustments are applied to the load impacts measured at the customer meter. Additionally, the Implementation Order directs EDCs to obtain no less than 85% of the target in any single event. For PECO, this translates to a 137 MW minimum performance level for any given DR event. Decisions about which day(s) DR events are called are guided by a set of prescriptive directions issued by the PUC in the Phase III Implementation Order and Clarification Order. PECO called DR events on the five days those guidelines required during summer 2020. Due to the COVID-19 pandemic, demand response activities at all EDCs were implemented on a voluntary basis for the summer of 2020[54]. PECO elected to dispatch the Residential and Small C&I DR program for two hours per event day rather than the four-hour duration in prior years of Phase III. Per the Phase IV Final Implementation Order, PY12 was the last year of PECO's demand response programs[55].

In March 2021, the PECO team filed its PY12 semi-annual report along with a standalone DR evaluation report. As a result of the COVID-19 pandemic, the SWE team notes that the amount of curtailable load for the C&I programs dropped substantially, likely resulting in lower portfolio impacts. Nevertheless, PECO's average performance across events was 160.5 MW, or 99.7% of

[54] Phase III Modification Order. https://www.puc.pa.gov/pcdocs/1665150.docx
[55] Phase IV Implementation Order. https://www.puc.pa.gov/pcdocs/1666981.docx

the Phase III target. PECO's DR portfolio exceeded the performance threshold of 137 MW for four of the five DR events and fell short of the minimum performance level for one of the five DR events in PY12. PECO had three Demand Response programs active in PY12: Residential, Small C&I, and Large C&I. Discussion of the analysis and participation is separately provided for each of these programs, and aggregated impact estimates are jointly discussed.

B.6.1 Impact Estimates

This section describes the impacts of the three DR programs, and the subsequent sections discuss the different methods of implementation and analysis used for each program.

B.6.1.1 Application of LLFs

Guidehouse used an LLF of 1.0799, to adjust DR performance estimates calculated at the meter to the system level for comparison with Act 129 targets. These values are consistent with the residential and commercial values of Table 1-4 of the 2016 PA TRM. The same LLF applies to all three programs.

B.6.1.2 Findings

Due to differences in data availability and size, the three programs are analyzed with distinct methodologies as described in detail by section. Guidehouse's impact estimates are provided in Table 156.The largest impact of the PY12 season occurred during the July 29, 2020 event for the Large C&I program, but the portfolio experienced the aggregate greatest savings on July 20, 2020. Combined, the DR programs produced 160.54 MW of savings in PY12.

Table 156: Average Event Impacts, by Program

Event Date	Residential DR (Verified MW)	Small C&I DR (Verified MW)	Large C&I DR (Verified MW)	Portfolio (Verified MW)
July 20, 2020	30.24	1.08	147.31	178.63
July 27, 2020	28.58	0.66	139.01	168.25
July 29, 2020	27.48	0.46	150.48	178.42
August 25, 2020	23.07	0.90	117.09	141.06
August 27, 2020	25.82	0.33	110.17	136.32
Average PY12 Event	**27.04**	**0.69**	**132.81**	**160.54**

B.6.2 Residential DR Program

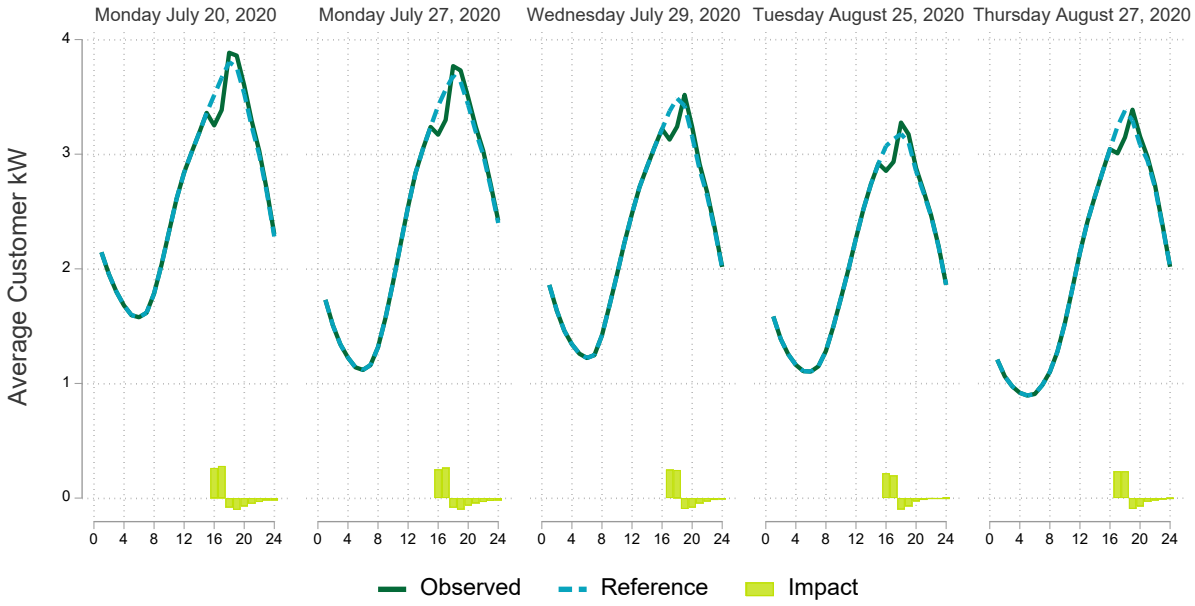
PECO's Residential DR program consists of direct load control switches installed on central air conditioners across approximately 51,000 residential households. Guidehouse utilized a matched control group with a lagged dependent variable regression to estimate savings. The baseline is estimated using event-day consumption patterns of non-participants. This approach involves matching participants to control customers based on the shortest Euclidean distance calculated from non-event day hourly consumption values. Matching occurred with replacement, indicating that some control customers were matched to multiple participants. In the case that a control was matched to multiple participants, their data was weighted respectively in the regression analysis. Baseline energy use is estimated through the use of a mathematical model of metered hourly

load as a function of various explanatory variables (hour of day, weather conditions). The model also includes a series of indicator variables equal to 1 for a specific DR event hour and zero otherwise. These event-hour indicators are interacted with event participation to capture the difference in average household demand (kW) during each event-hour relative to what the prediction would have been absent DR (e.g., if the participation-event-hour interaction variable were equal to 0 instead of 1).

The SWE team was able to replicate Guidehouse's Residential impact estimates within ± 0.91% in each hour and within ± 0.72% in each event. These differences are due entirely to rounding as Guidehouse rounded per-participant values to the nearest hundredth before applying line losses or expanding by the number of participating households.

Figure 50 shows the per-customer impacts, observed load, and counterfactual for each event day.

Figure 50: Residential Demand Response by Date



B.6.2.1 Participation

The regression model returns the average kW savings per participating household. This gets multiplied by the number of participating households and escalated by the assumed line loss factor to calculate aggregate system-level performance in MW. Guidehouse provided two sets of data: load data and participation data. Using the participation data, the SWE was able to replicate the Guidehouse participant count of 50,919 for the Residential DR program. However, not all participating accounts had interval load data, and therefore these accounts were not included in the regression analysis. Table 157 shows the number of participating accounts with load data by event date as well as the replicated counts from the participation data. The implicit assumption in the analysis is that DR impacts among the 4,000 homes without interval data are the same as the homes with interval data.

Table 157: Participating Households

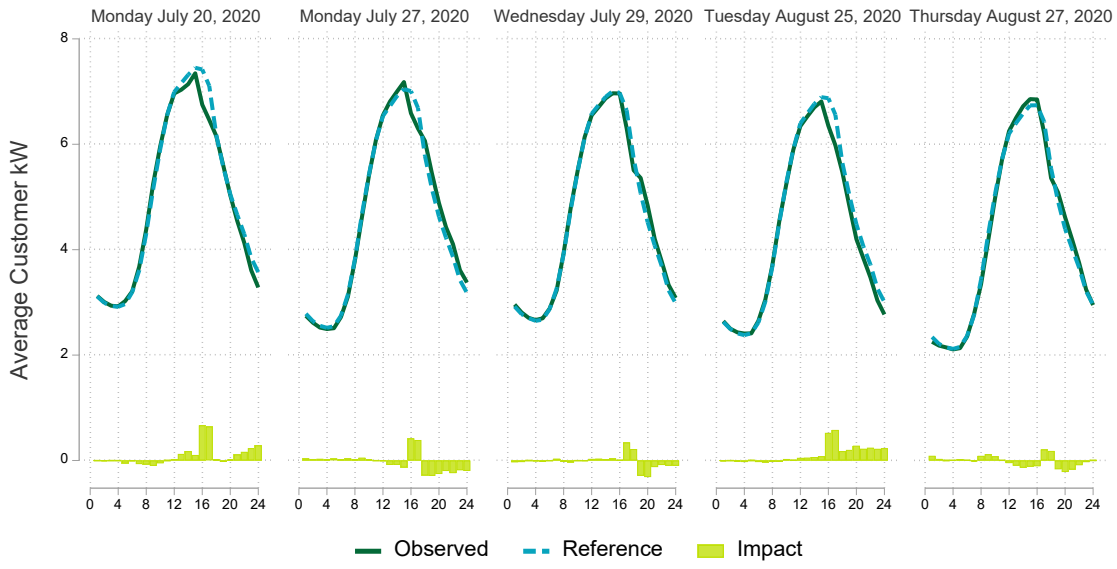
Event Date	Accounts with Interval Load Data	Count of Accounts in Participation Data
7/20/2020	46,940	50,919
7/27/2020	46,861	50,899
7/29/2020	46,886	50,887
8/25/2020	46,803	50,869
8/27/2020	46,729	50,866

B.6.3 Small C&I DR Program

Small C&I DR program used a "within-subjects", fixed-effects regression methodology to estimate savings. The baseline is estimated from non-event day consumption patterns of the included participants. This approach involves creation of a mathematical model of metered hourly load as a function of various explanatory variables (hour of day, weather conditions). The model also includes a series of indicator variables equal to one for a specific DR event hour and zero otherwise. This series of indicator variables captures the difference in average demand (kW) during each event hour relative to what the prediction would have been absent DR (e.g., if the indicator variable were equal to 0 instead of 1).

The SWE team was able to replicate the Guidehouse impact estimates for seven of the ten PY12 event hours. The remaining event hours were estimated within 0.01 MW of Guidehouse's estimates. Figure 51 shows the per-customer impacts, observed load, and counterfactual for each event day.

Figure 51: Small Commercial Demand Response by Date



B.6.3.1 Participation

The fixed-effects regression model returns the average kW savings per participating business. This gets multiplied by the number of participating businesses and escalated by the assumed line loss factor to calculate aggregate system-level performance in MW. Using the participation data, the SWE was able to replicate the Guidehouse participant count of 1,517 for the Small Commercial DR program. However, not all participating accounts had interval load data, and therefore these accounts were not included in the regression analysis. Table 158 shows the number of participating accounts with load data by event date as well as the replicated counts from the participation data. The implicit assumption in the analysis is that DR impacts among the 165 customers without interval data are the same as the homes with interval data.

Table 158: Small C&I Participants

Event Date	Accounts with Interval Load Data	Count of Accounts in Participation Data
7/20/2020	1,356	1,517
7/27/2020	1,351	1,517
7/29/2020	1,353	1,516
8/25/2020	1,344	1,515
8/27/2020	1,351	1,515

B.6.4 Large C&I DR Program

PECO's PY12 Large C&I program, 356 unique customers participated in the DR program. The participant count by event date is provided in Table 159.

Table 159: Large C&I Participants

Event Date	Participants
7/20/2020	336
7/27/2020	343
7/29/2020	336
8/25/2020	331
8/27/2020	336

The SWE team requested data to implement the audit analysis. The PECO/Guidehouse team submitted the following in response to this SWE DR data request.

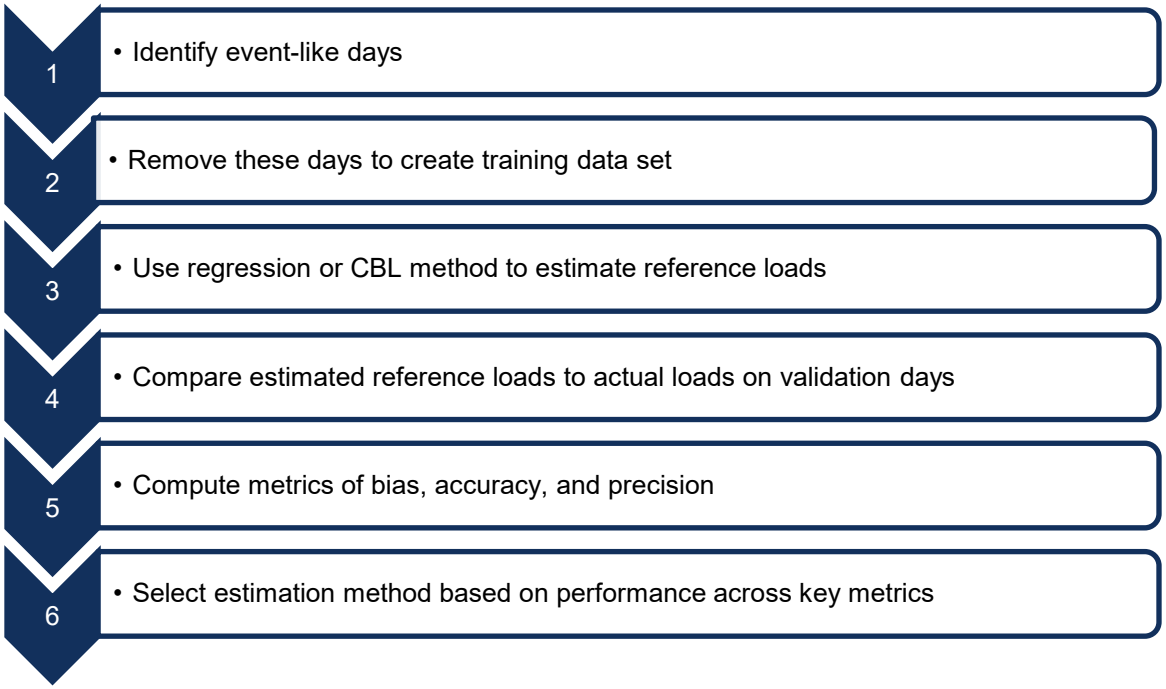
- A list of participating facilities and the reference load method used to estimate its gross verified performance
- For each event hour, a record of which facilities participated, their reference load, metered load, and verified DR impact
- For the 20 sites selected by the SWE, the hourly load and weather data needed to replicate the Guidehouse impact estimates
    - These 20 sites represented approximately 23% of the gross verified PY12 DR impacts

Following the initial total savings comparison, 20 sites were reviewed in detail. Guidehouse provided the SWE team with hourly load data and information on the applicable model to estimate the savings for each of these specific sites.

B.6.4.1 Reference Load Selection

The approach Guidehouse used to determine reference loads for Large C&I DR participants was consistent with the process shown in Figure 52, which is taken from the Evaluation Framework. Guidehouse used hold-out test days to rank the accuracy of the alternative approaches and to select the most accurate method to calculate PY12 impacts.

Figure 52: Baseline Selection Steps



Guidehouse tested, and ultimately used, a mixture of CBL and regression models. The site reported as "Missing" for the baseline method has persistent metering issues, so the impacts are calculated at the event level based on the CSP reported impacts and the realization rate for all other sites. Most sites were analyzed using individual regression analysis, and these sites made up 79% of the DR impacts.

Table 160: PY12 Reference Load Frequency Table

Baseline Method	Number of Sites Used	Share of DR Impacts (at Meter)
Missing	1	1.1%
CBL	60	20.0%
Individual Customer Regression	295	78.9%

Guidehouse has effectively implemented the testing of multiple models on each customer and selected the specific model that excels in terms of accuracy, bias, and precision.

The SWE team was able to closely reproduce Guidehouse's aggregated findings, excluding the impacts from the "Missing" baseline customer method.

B.6.5 Aggregation of Program Results

SWE notes in the following section explore several reporting choices that affect the aggregate estimates of portfolio performance.

Differing Event Hours

PY12 was the first year to call 2-hour events for the Residential and Small C&I demand response programs. To add up the portfolio program impacts, however, the SWE team notes that PECO simply combines the average impact for each program, regardless of the coincidence of those impacts. An example of the effect of this approach is shown in Table 161. To accurately summarize the ability of the program, it is appropriate to average all program hours for the portfolio summed across all three sectors (resulting in 160.64 MW of reduction) or to average only the hours in which all programs are operating (resulting in 181.14 MW of reduction). This distinction matters: in this example, the results for only HE16 & HE17 (when all programs were dispatched) portfolio reduction and the reduction estimated and reported by Guidehouse both meet the 161 MW performance target, while averaging across all hours means the average portfolio impact falls just shy of this target on July 20th.

Table 161: Example Portfolio Aggregation of Impacts on July 20, 2020

Event Hour	Res. MW	Small C&I MW	Large C&I MW	Portfolio MW
HE15	-	-	141.17	141.17
HE16	29.14	1.10	151.22	181.46
HE17	30.79	1.05	148.97	180.81
HE18	-	-	139.13	139.13
Portfolio Average (All Hours)	-	-	-	160.64
Program Average (All Hours)*	29.97	1.08	145.12	176.16
Program Average (HE16-17 Only)	29.97	1.08	150.10	181.14

** Note that the average impacts listed in Table A-1 of the PECO PY12 Demand Response Performance Report differ from the values listed here. The SWE team confirmed with Guidehouse that the difference in results is due to rounding order of operations when combining the results from individual hours.*

The Effect of Snap-Back

The residential and Small C&I programs in PECO's demand response portfolio are air conditioning load control programs. These programs reduce cooling demand during event hours; however, most also exhibit increased load during the hours after the event as AC units run more frequently to cool the buildings that warmed during an event. This post event load increase is

known as snapback. Because PECO's residential and small commercial programs ran for only two of the four hours, a portfolio estimate of demand response should arguably include the effect of snapback in HE18. From the impact estimation of the residential program, impacts in HE18 should be approximately -10MW, representing a load increase relative to the counterfactual and the portfolio MW value in that hour should be closer to 130 MW.

Managing of Significant Digits in Reporting

A simple average of the hourly aggregate event impacts in Table 161 do not match the reported average event values listed in Table A-1 of PECO's PY12 Demand Response Performance Report. In conversations with Guidehouse, the SWE discovered that this was due to the way in which the event average impacts were calculated. In compiling Table A-1, they neglected significant digits and prematurely rounded the per-customer impacts:

- Individual hour aggregate results were constructed by taking the per-customer impacts, truncating them to the hundredths decimal, then applying the line losses and number of participants
- The average event impacts were calculated by averaging the two hours of per-customer impacts, truncating the result to the hundredths decimal, then applying the line loss value and number of participants.

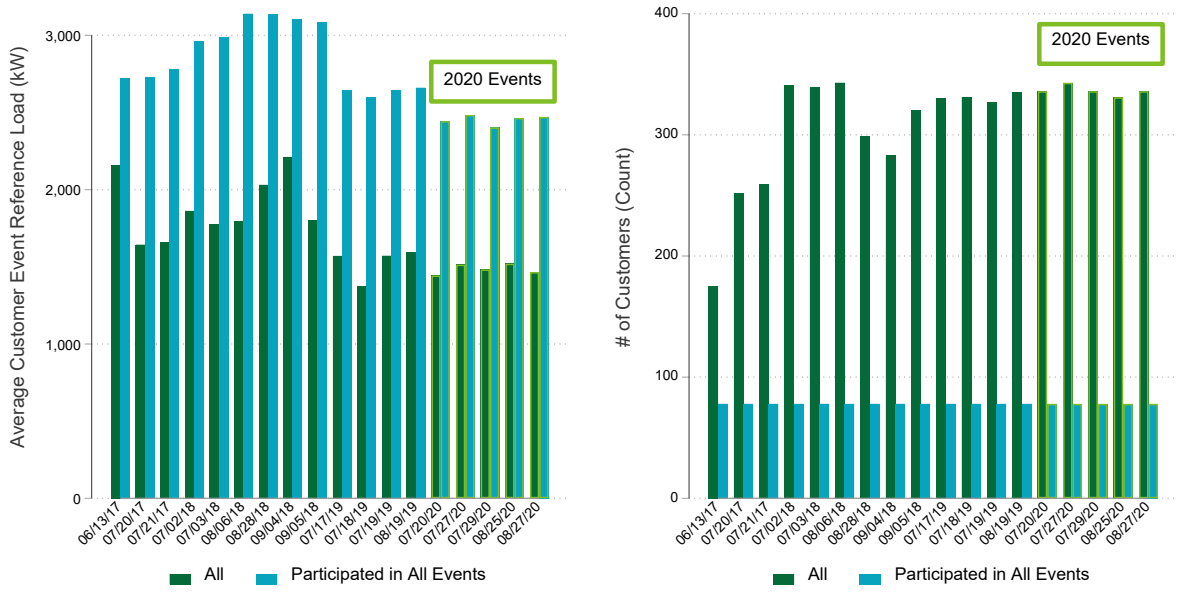
The SWE suggests a review of significant digits for future Act 129 applications. To retain precision in the estimate in these examples, the method should be to take the per-customer impacts, multiply by the line loss value and number of participants, and then truncate to two digits for reporting.

B.6.6 Discussion

The vast majority of PECO's demand response performance comes from the Residential and Large C&I programs. On August 25th and 27th, the portfolio did not achieve the 161 MW target, and on August 27th, the program fell short of the 85% threshold (137 MW). While performance in both the Residential and C&I programs dropped on those days, the focus in the following discussion is on the Large C&I program as it provides nearly 83% of the aggregate portfolio reductions.

For these customers, load reductions were more challenging this year as a result of the ongoing COVID-19 pandemic and the related changes in economic conditions. Per-customer reference loads declined in 2020, shown below in Figure 53. This figure shows both per-customer and aggregate average reference loads for all Phase III events for customers who are active on the program in 2020. When reference loads drop, the amount of load shed available during an event may be reduced as processes that would have been curtailed are already off or reduced in capacity. As the figure indicates, available load at Large C&I sites dropped in 2020 relative to the prior year and may explain the reduced performance.

Figure 53: Large C&I Reference Load Changes



B.6.7 Conclusion

Despite the voluntary nature of PECO's PY12 demand response programs, PECO's average performance across events was 160.5 MW, or 99.7% of the Phase III target. PY12 was the first year that PECO called two-hour events for the Residential and Small C&I programs instead of four-hour events. The overall estimate of DR portfolio performance is sensitive to the procedure used to combine impacts across programs and hours with varying dispatch.

B.7 NTG

B.7.1 Residential Programs

Guidehouse did not conduct primary NTG research for any residential programs during PY12 and applied prior program year NTG values to the residential programs. The SWE found that Guidehouse utilized data collection methods, question bevies, and the common NTG formula recommended in the Phase III Evaluation Framework during the previous program year NTG estimation.

Guidehouse assigned an NTG of one to the Behavioral Solution, in accordance with the Evaluation Framework recommendations for RCT program designs.

Table 162: Summary of NTG Estimates for PECO Residential Program

Approach	Solution or Program	Free-Ridership	SO	NTG	Sample Size
PY11	Lighting, Appliances & HVAC	0.55	0.08	0.53	-
PY11	Appliance Recycling	0.48	0.0	0.52	-
PY11	Whole Home	0.21	0.15	0.95	-
PY11	New Construction	0.08	0.00	0.92	-
PY10	Multifamily Targeted Market Segment	0.08	0.00	0.92	-
RCT	Behavioral	-	-	1.0	-
Combination of Program component NTGs	Residential Program Total	0.32	0.05	0.73	-

B.7.2 Residential LI Energy-Efficiency Programs

In compliance with the Phase III Evaluation Framework, Guidehouse did not conduct NTG evaluations for the LI-WHS for PY12.

B.7.3 C&I Energy-Efficiency Programs

Guidehouse did not conduct primary NTG research for any C&I programs during PY12 but applied prior program year NTG values to the C&I programs. The SWE found that Guidehouse utilized data collection methods, question bevies, and the common NTG formula recommended in the Phase III Evaluation Framework during the previous program year NTG estimation (Table 163).

Table 163: Summary of NTG Estimates for PECO C&I Energy-Efficiency Programs

Approach	Solution or Program	Free-Ridership	SO	NTG	Sample Size
PY11	Small C&I Equipment and Systems	0.33	0.11	0.78	-
PY11	Small C&I New Construction	0.67	0.0	0.33	-
PY11	Small C&I Whole Building	0.16	0.04	0.88	-
PY10	Small C&I Multifamily Targeted Market	0.19	0.0	0.81	-
Combination of Program component NTGs	**Small C&I Program Total**	**0.33**	**0.09**	**0.76**	**-**
PY11	Large C&I Equipment and Systems	0.42	0.03	0.61	-
PY11	Large C&I New Construction	0.58	0.06	0.48	-
PY10	Large C&I Multifamily Targeted Market	0.19	0.0	0.81	-
Combination of Program component NTGs	**Large C&I Program Total**	**0.43**	**0.03**	**0.60**	**-**
PY10	**CHP**	**0.13**	**0.00**	**0.87**	**-**

B.8 TRC

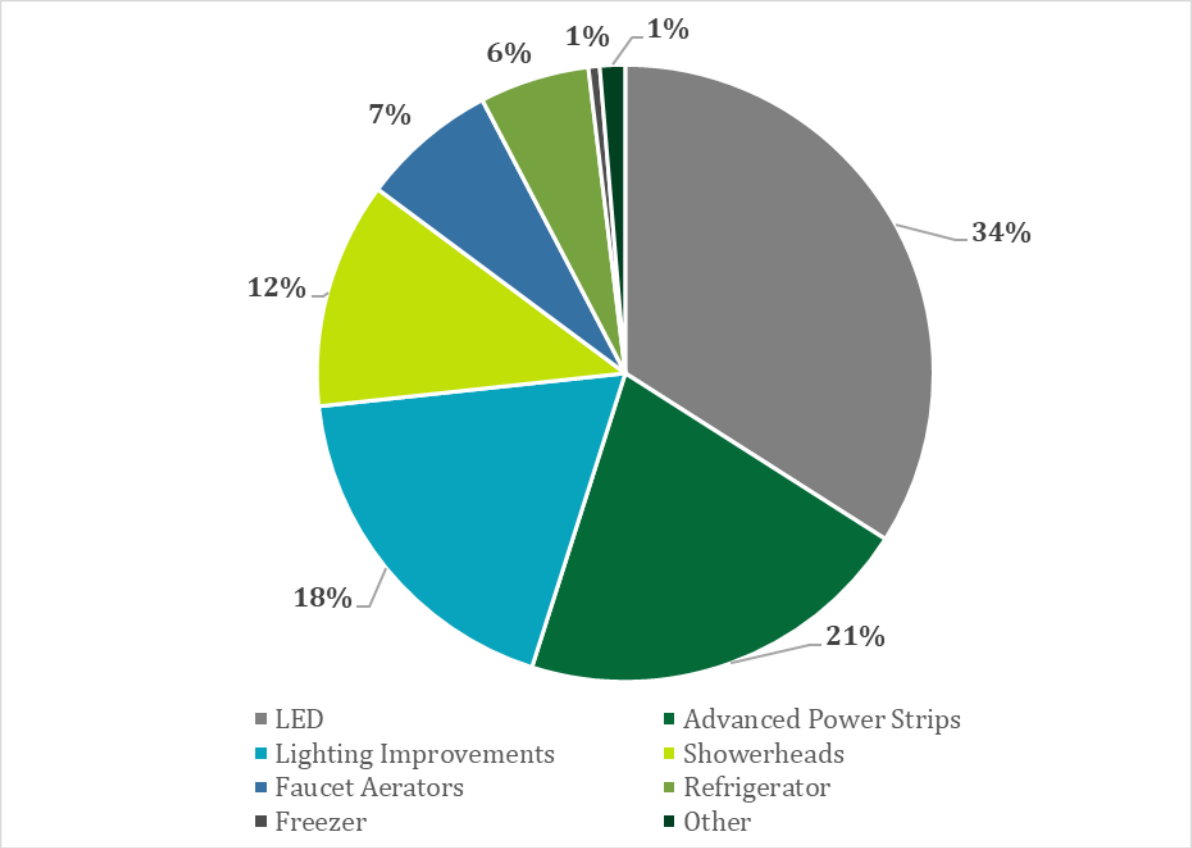
Table 164 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for PECO's PY12 individual EE&C programs and overall portfolio. The SWE found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY12 annual report. The gross and net TRC Ratios improved for the Low-Income EE, Residential DR, and CHP programs from PY11. In fact, the Low-Income EE program was the PECO's most cost-effective program in PY12. The Residential EE, Small C&I EE, Large C&I EE, Small C&I DR, and Large C&I DR program TRC Ratios all decreased from PY11.

Table 164: Summary of PECO PY12 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
Low-Income EE	$9,096	$3,742	2.43	$9,096	$3,742	2.43
Residential EE	$44,851	$38,176	1.17	$27,367	$29,483	0.93
Small C&I EE	$35,174	$38,156	0.92	$26,669	$30,845	0.86
Large C&I EE	$58,726	$64,439	0.91	$35,097	$40,637	0.86
CHP	$89,948	$108,256	0.83	$78,254	$94,183	0.83
Residential DR	$2,499	$2,667	0.94	$2,499	$2,667	0.94
Small C&I DR	$63	$94	0.67	$63	$94	0.67
Large C&I DR	$6,263	$4,997	1.25	$6,263	$4,997	1.25
Common Portfolio Costs	$0	$9,000	0.00	$0	$9,000	0.00
Portfolio	**$246,620**	**$269,527**	**0.92**	**$185,308**	**$215,648**	**0.86**

Three of PECO's eight EE&C programs were found to be cost-effective when estimating the TRC Test using gross verified savings. Using net verified savings, the two programs (Low-Income EE and Large C&I DR) were found to be cost-effective. The strong cost-effectiveness for the Low-Income EE program is driven by a focus on low-cost measures lighting measures like LED lighting, advanced power strips, low-flow showerheads, and faucet aerators. Figure 54 below shows the distribution of PY12 MWh impacts for the Low-Income EE program.

Figure 54: Low-Income EE Energy Impacts by Measure Category



B.8.1 Notes from the TRC Model Review

The PY12 TRC model was developed by Guidehouse using the Analytica software. However, due to how the Analytica model handles costs from fuel switching projects, the final TRC calculations were performed outside the model. Below is a summary of the assumptions and inputs verified by the SWE.

- The PY12 TRC model used a nominal discount rate of 7.6%, which matches PECO's Phase III EE&C plan.
- None of PECO's three non-residential EE programs were cost-effective in PY12. The Small C&I EE and Large C&I EE programs had 84% and 90% of total TRC Costs coming from incremental measure costs, respectively. The SWE recommends a thorough review of the mapping of non-residential measures incremental measure cost assumptions in Phase IV. It is critical that the units and vintage used in the energy and demand savings analysis are aligned with the per-unit cost assumptions. Below are simple checks that can help identify cost:
    - Calculate the percent of incremental measure cost accounted for by incentives. If the incentive is a tiny fraction of incremental measure cost, review the cost values.

  - Compute the incremental measure cost on a per kWh saved basis. Measures with multiple dollars of incremental cost per kWh saved likely warrant further review.

- 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 2016 TRM.
- Measure lives were reported at the measure-level. The SWE spot-checked the measure life assumptions in the PY12 TRC model and found them to be consistent with the 2016 TRM.
- The SWE checked measure quantities against the quarterly data request responses used to populate our statewide tracking database and found them to be consistent.
- The PY12 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 PY12 Annual Report.
- The application of the NTG results in the calculation of net TRC Benefits and costs were handled consistently with the 2016 TRC Test Order directive for Phase III. All NTG ratios appear to be consistent with PECO's PY12 Annual Report.
- The PY12 TRC Model uses the approved avoided costs of energy and capacity approved in PECO's Phase III EE&C Plan and the SWE was able to independent replicate the calculation of all TRC Benefits.
  - PECO used an avoided cost of capacity of $47.30 per kW-year for the Large C&I DR program to reflect a lack of distribution capacity benefits in the Large C&I sector where customers take service at primary voltage.
- Similar to prior years, the assignment of direct install and kit programs was correct, but poorly documented in the model. Direct install and kit costs (which were correctly classified as incentives) and program administration costs were provided only at the program level. As a result, there is little transparency into cost-effectiveness at the solution level.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Non-Electric Benefits in accordance with the Guidance on Inclusion of Fossil Fuel and Water Benefits in TRC Test memo issued in March 2018. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative TRC Benefit.
- Similar to prior years, we recommend Guidehouse and PECO follow the EDC annual report template and include separate rows for O&M Benefits and Fossil Fuel/Water Benefits instead of creating a Non-Electric Benefits category that combines the benefit streams. Table 165 provides a breakdown of O&M, Water and Fossil Fuel Benefits by for PY12.

Table 165: Summary of PY12 PECO Non-Electric Benefits

Fossil Fuel	Water	O&M	Total Non-Electric
($9,754,567)	$6,714,081	$19,121,771	$16,081,286

B.9 PROCESS

Guidehouse did not conduct in-depth process evaluation activities for the PECO Residential, LI, Small C&I or Large C&I EE Programs. Instead, the team interviewed the PECO program managers and CSP staff to identify significant implementation changes to inform the impact evaluation activities. No significant changes were found.

Appendix C PPL PY12 Audit Detail

C.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of PPL's PY12 Annual Report and the supporting detail provided by PPL's evaluation contractor.

- Despite the voluntary of DR programs in PY12, PPL showed strong performance across the five DR events called during summer 2020. The average verified MW performance was 96.9 MW, which is above PPL's Phase III target of 92 MW. During four of the five PY12 events, PPL obtained at least 85% of their Phase III DR target. On a MW basis, most of PPL's Phase III DR portfolio came from a small number of large industrial accounts. Electric loads in these large facilities during summer 2020 were comparable to prior program years. This suggests that the businesses were "essential" in nature and faced limited economic disruption during the COVID-19 pandemic.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in PPL's 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 participation counts. We were unable to replicate incentives using the tracking data, but we did not expect to be able to do so.
- Overall, the verified savings for residential non-lighting programs followed proper TRM protocols and the verified savings are accurate. A mismatch of appliance model numbers and data in the Efficient Equipment offering of the Energy-Efficient Home Program could result in a small overestimate of savings (up to 1.4 MWh).
- Adequate number of project files were submitted for most residential solutions in PY12.
- Cadmus followed methodologies in the approved EMV plan when calculating NTG values
- The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan with one exception, which was noted in the annual report. The evaluation pan for PY12 called for an interview with the ICSP's new contractor, but Cadmus conducted an interview with the ICSP's program staff to discuss participant satisfaction and review the overall status of program implementation, considering the changes the program made in response to COVID-19.
- PPL largely discontinued its Behavioral Home Energy Report offering in PY12 and does not plan to offer HERs in Phase IV. As a result, PY12 showed the smallest contribution from HERs of Phase III on both a MWh basis and percent of portfolio savings. The SWE agrees with PPL's decision to claim five months of PY12 savings for waves that received their last HER in October 2019, as the approach is consistent with the one-year measure life assumed for HERs. The five-month treatment period creates some nuance in the peak

demand savings calculations, which was handled appropriately in the verified demand savings calculations.

- 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's review of PY12 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, including adherence to the COVID-19 EM&V Guidance Memo; and are generally accurate.
- Overall, for all process evaluations, the SWE determined that the reporting followed the SWE guidelines. PPL's PY12 Annual Report included descriptions of the methods, summary of findings, and a table of recommendations with a description of whether PPL was implementing or considering those recommendations. The report included sufficient detail to assess the methods, findings, and recommendations. The evaluation methods were largely consistent with those described in the Phase III Evaluation Plan. Wherever there were deviations from the Phase III Evaluation Plan, Cadmus provided a satisfactory explanation for those deviations. Overall, the process evaluation discussion was succinct and highlighted findings that should be of value to the administrator and implementer. The recommendations were clear and actionable and were supported by the findings. Recommendations were drawn from key findings.
- Overall, Cadmus estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- PPL's PY12 TRC model was well-organized and included clear documentation of all assumptions and inputs. For several residential HVAC measures, EUL assumptions matched the 2021 Pennsylvania TRM rather than the 2016 TRM. An EUL difference of 1-3 years has a minimal effect on TRC Ratios at the program or portfolio level. The SWE also notes that the P3TD net TRC values in PPL's annual report were incorrect and only apply NTG findings to PY12 and based PY8-PY11 financials on gross TRC results. Correcting this error has a limited impact on the P3TD net TRC Ratio (1.58 vs. the 1.61) but lowers the net benefits (TRC Benefits minus TRC Costs) by approximately $80 million for Phase III. PPL's non-residential incentives as a percentage of the estimated incremental measure costs was the second highest in the Commonwealth for PY12 at 21.8%.

C.2 EM&V Plan Reviews

PPL's evaluation contractor, Cadmus, submitted redline versions for each program in PPL's Phase III EE&C plan with relatively minor adjustments to the evaluation approach. In addition, Cadmus submitted a memo providing a summary of the changes made to the evaluation plans. The SWE reviewed and approved the plans.

In addition to reviewing PPL's revised evaluation plans, the SWE reviewed and approved several surveys and interview guides for the Energy-Efficient Home Program (Efficient Equipment and In

Home Audit Components), Appliance Recycling Program, Energy-Efficient Home Online Marketplace, LI WRAP program (participants and contractors), and Non-Residential Program.

C.3 Sample Design Review EM&V

A common technique to reduce the time and cost of verifying savings is to sample projects and then estimate total verified savings based on the sample. However, sampling introduces uncertainty into the calculation. The uncertainty is derived from the fact that the sample may not be representative of the entire population. Thus, the amount of uncertainty is based on the size of the sample and the correlation between reported and verified savings. The sampling error, or margin of error, is reported by the relative precision of verified savings at a given confidence level. For example, if an offering has verified savings of 1,000 MWh/year and a relative precision of ±10% at the 85% confidence level, then there is an 85% chance that the true value of the savings is between 900 MWh/year and 1,100 MWh/year.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at the 85% confidence level for each "initiative." This constrains the sample design to ensure reliable estimates of verified savings. For Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. As a result, PPL's Non-Residential Energy-Efficiency program is divided into several components for evaluation purposes. As part of their evaluation activities for PPL, Cadmus developed samples to meet the 85/15 requirement for each program. Table 166 shows the relative precision of the verified energy savings by program. The SWE reviewed the realization rate function Cadmus uses to the compute realization rates and precision estimates and found the calculations to be sound. The SWE's independent calculations replicated the realization rates and produced virtually identical precision estimates.

Table 166: Relative Precision of PY12 Gross Verified Energy Savings Estimates for Programs with Sampling Error

Program/Initiative	Relative Precision at 85% Confidence Level (±)
Efficient Equipment (Lighting)	4.8%
Efficient Equipment (Equipment)	0.2%
Midstream Lighting	20.1%
Custom	4.5%
Energy-Efficient Home	10.9%
Winter Relief Assistance Program	2.6%
Appliance Recycling	10.0%
Student Energy-Efficient Education	3.5%

The relative precision values present in Table 166 represent sampling uncertainty for just PY12 verified savings because Cadmus verifies each program annually. All initiatives met the ±15% precision requirement in PY12 except for Midstream Lighting. Cadmus found high variability between reported and verified savings due to evaluation updates to facility types and other key

variables. While the sample size of 50 projects for Midstream Lighting exceeded the planned values for PY12, it could not overcome the high coefficient of variation (C_v). The SWE recommends PPL and Cadmus work with the Phase IV ICSP to improve data collection on facility type and base PY13 sample size calculations on the observed C_v values from PY12.

PPL adjusted some of its evaluation procedures in response to the ongoing COVID-19 pandemic. Where on-sites were not feasible due to COVID-19 restrictions, PPL conducted virtual site visits with customer representatives through a combination of video calls, phone interviews, and customer-reported data and photos. For the New Homes component of the Energy-Efficient Homes program, Cadmus was able to complete on-site visits during PY12 that were originally scheduled for PY11 but were postponed due to the pandemic. The results of the PY12 site visits were applied to both PY12 and PY11.

Sampling uncertainty does not consider the level of rigor of the verification activities. Results from a sampled project that receives a quick desk review from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of Cadmus' PY12 verification activities is discussed in detail in Appendix C.5.

The Home Energy Education and DR program evaluations do not rely on sampling. Instead, consumption data for a census of program participations is analyzed. The savings associated with Home Energy Education are verified using a regression model that estimates the program treatment effect using a treatment and control group to isolate program impacts from external noise. The DR savings calculations were based on comparison to an estimated baseline for each customer and event day. While there is no sampling error for these initiatives, there is estimation error because the modeling techniques used do not explain all the variation in the data set. In other words, because we are not able to observe participant consumption data in the absence of program, a counterfactual is estimated to derive savings, but this estimate includes uncertainty.

The relative precision for programs with estimation-based uncertainty are shown in Table 167 . The DR relative precision is based on demand savings as opposed to energy savings, which were displayed for all other programs. The precision requirements for behavioral programs are unique, with the Phase III Evaluation Framework requiring the solution-level verification to achieve an *absolute* precision of ±0.5% at the 95% confidence level (two-tailed). The PY12 Home Energy Education results met this requirement.

Table 167: Relative Precision of PY12 Gross Verified Savings Estimates for Programs with Estimation Error

Program/Initiative	Confidence Level	Relative Precision at Confidence Level (±)
Home Energy Education Program	85%	19.9%
DR	90%	3.1%

C.4 Reported Gross Savings Audits

C.4.1 Tracking Data Review

This section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in PPL's PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)
- Reported gross peak demand savings (MW)
- Participation counts
- Incentive dollars

The SWE leveraged PPL's Q1-Q4 Appendix A tracking data to audit these values. Note that the Appendix A tracking data is a subset of the full tracking data set (which PPL Electric 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 PY12 quarterly data request. Any references to "tracking data" herein refer to tracking data in Appendix A, not the tracking data in Appendix Z. Also note that DR 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 PPL's DR program can be found in Appendix C.6.

Table 168 summarizes our findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the Annual Report and "No" otherwise. For all programs, the tracking data supports the value shown in PPL Electric's Annual Report.

Table 168: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Recycling	4,111	4,111	Yes
Home Energy Education	1,534	1,534	Yes
Energy-Efficient Home	21,199	21,199	Yes
LI WRAP	9,031	9,031	Yes
Non-Residential Energy Efficiency	189,359	189,359	Yes
Student Energy-Efficient Education	4,075	4,075	Yes
Portfolio Total	**229,309**	**229,309**	**Yes**

Table 169 summarizes the SWE's ex-ante findings regarding peak demand savings by program. Like with energy savings, demand savings in the Annual Report matched demand savings in the tracking data for every program.

Table 169: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Recycling	0.67	0.67	Yes
Home Energy Education	0.27	0.27	Yes
Energy-Efficient Home	4.60	4.60	Yes
LI WRAP	0.85	0.85	Yes
Non-Residential Energy Efficiency	28.49	28.49	Yes
Student Energy-Efficient Education	0.33	0.33	Yes
Portfolio Total	**35.21**	**35.21**	**Yes**

Table 170 summarizes the SWE's findings regarding program participation. The SWE was able to replicate participation counts perfectly for all programs except LI WRAP. The slight difference for LI WRAP comes from the SWE counting distinct project numbers and PPL counting distinct account numbers. The practical interpretation of the difference is that 27 accounts were visited twice in PY12 and assigned two distinct project numbers.

Table 170: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Recycling	5,395	5,395	Yes
Home Energy Education	14,944	14,944	Yes
Energy-Efficient Home	16,368	16,368	Yes
LI WRAP	5,379	5,406	No
Non-Residential Energy Efficiency	8,236	8,236	Yes
Student Energy-Efficient Education	24,357	24,357	Yes
Portfolio Total	**74,679**	**74,706**	**No**

Finally, Table 171 summarizes the SWE's comparison of incentive dollars listed in program tracking data to the program totals in PPL's Annual Report. The Annual Report incentives and tracking data incentives are directionally similar (though unequal) within any given program. Also note that PPL Electric 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 annual report values are pulled from a financial system as opposed to program tracking data.

Table 171: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Recycling	$177	$162	No
Home Energy Education	$0	$0	Yes
Energy-Efficient Home	$3,537	$3,377	No
LI WRAP	$0	$0	Yes
Non-Residential Energy Efficiency	$12,783	$10,093	No
Student Energy-Efficient Education	$0	$0	Yes
Portfolio Total	**$16,497**	**$13,362**	**No**

C.4.2 Project File Reviews

C.4.2.1 Residential

The SWE conducted a project file review for a sample of PPL's residential and LI solutions in PY12 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 most of the documentation requested. For the sample files provided, a sample key and sample memo were included that allowed for consistent matching between files and the tracking data.

Table 172 presents a summary of SWE's residential project file reviews.

Table 172: PPL PY12 Residential Project File Review Summary

Program	Solution	Number of Files Reviewed	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[1]
Appliance Recycling	n/a	8	✓	✓	✓	✓
Energy-Efficient Homes	New Homes	8	✓	×	✓	✓[1]
Energy-Efficient Homes	Audits and Energy-Savings Kits	8	✓	✓	✓	✓
Energy-Efficient Homes	Weatherization	8	✓	✓	✓	✓
Energy-Efficient Homes	Efficient Equipment	17	✓	✓	✓	✓
Energy-Efficient Kits	n/a	0	-	-	-	-
Energy-Efficient Lighting	n/a	0	-	-	-	-
Winter Relief Assistance	n/a	8	✓	✓	✓	✓[1]
Student EE Education	n/a	3	✓[2]	✓	✓	✓

[1] It should be noted that while the data typically matches, minor discrepancies were found and are detailed in the paragraphs below.
[2] The data for Q1 through Q4 are provided entirely in Q4.

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

Appliance Recycling Program

The SWE located the Appliance Recycling project files within the tracking database. The quarterly data report noted that the Appliance Recycling program had no participants during the first quarter of PY12 due to the program being on hold due to COVID-19. The SWE observed a few instances where the project documentation included multiple appliances and required looking beyond the project ID provided to the account number. 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 room air conditioners were recycled, while the tracking data listed four room air conditioners and one refrigerator. While there were no additional discrepancies between the tracking database and the project files reviewed, the photographs provided by the CSP do not clearly capture the nameplates of the recycled equipment. Additionally, some project files did not include a photo of the appliance being recycled. Consequently, the SWE could not independently confirm the values in the tracking data.

Energy-Efficient Homes: New Homes Solution

The SWE observed most of the sample files were conducted in v16.0.4 of the REM/Rate software though a few were applying older versions v16.0.2; this represents an update from the PY11 review which found most files used v15. The v16.0.4 was the most recent REM/rate version at the start of PY12; therefore, raters were using the appropriate REM/rate version. The SWE ran the sample files under the respected REM/Rate version used for calculated savings. The SWE found one case where the savings provided in the REM/Rate file did not match the reported savings in the tracking data. The tracking data reported 8,313 kwh compared to the files provided which calculated the homes savings at 7467 kwh.

The SWE notes that the reported savings are based on REM/Rate reports and do not account for the calculation of non-weather sensitive measure savings calculated using TRM algorithms. The process of adjusting savings from these measures is done by the evaluator during the annual reporting process.

Energy-Efficient Homes: Audits and Energy Saving Kits

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. Some included a complete PPL “In-Home Audit” form, and/or itemized invoice, but most were simple receipts or non-itemized invoices with missing audit forms. The SWE observed that only five projects per were sampled each for Q1 through Q3 for this sub-program compared to the requested ten. Q4 included had 18 files and included some dated for Q2 and Q3. The files for Q4 also varied greatly. The SWE notes that some project files submitted online included a limited amount of documentation to verify.

Energy-Efficient Homes: Weatherization

Contractor invoices and other proofs of payment were provided for PY12. The SWE observed eight projects verifying each project with the quarterly request workbook. The invoices submitted matched the information provided in the quarterly request workbook. There is no tracking data available for this project.

Energy-Efficient Homes: Efficient Equipment

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 SWE observed in two instances the project files only included a receipt of purchase for a heat pump water heater (HPWH) without indication of the location of the installation. While the tracking data listed the installation occurred in an unconditioned basement the location was not able to be verified through project documentation.

Efficient Lighting

The evaluator noted in their quarterly data submission memo that this program was no longer applicable as it had ended during PY11.

Energy Efficiency Kits and Education

The evaluator noted in their quarterly data submission memo that this program was no longer applicable as it had ended during PY11

Winter Relief Assistance Program

The SWE located the Winter Relief Assistance project files within the tracking database. A review of the sampled files did not reveal any discrepancies. The SWE noted that in one instance the tracking data listed a lower amount of LED bulbs retrofitted compared to the audit. The audit showed opportunity for 67 bulbs, however the tracking data only retrofitted 61 bulbs no further explanation was given.

Student Energy-Efficient Education Program

The SWE located the Student Energy-Efficient Education Program project files within the tracking database. There are three different student cohorts contained in this program “Bright Kids”, “Innovation” and “Take Action.” Each project folder contains a sample survey and two datasets with full results and transcriptions of the survey. The ICSP uses a census approach to gather installation rate data from students in the form of Home Energy Worksheets (HEWs) and the evaluator provides the entire data file to the SWE in Q4 when they receive it from the ICSP. There is no additional information pertaining the projects or the sample. The SWE had little to verify regarding this program.

C.4.2.2 Non-Residential

The SWE reviewed PPL’s C&I projects for PY12 using the project documentation provided by the ICSPs. During the program year, the evaluation contractor sends ICSP project documentation to the SWE on a quarterly basis. The project file packages included savings calculation worksheets, rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. The project file packages were well organized and sufficient to support a comprehensive review of the projects. Table 173 presents an overview of the results of the SWE’s C&I project file reviews.

Table 173: PPL PY12 C&I Project File Review Summary

Program	Project Description	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 the SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
Non-Residential Lighting	Lighting	23	21/23	20/23	22/23	✓	✓	N/A
Efficient Equipment	Compressed Air	2	×	✓	×	×	×	×
Efficient Equipment	Heating/Cooling	7	5/7	2/7	6/7	5/7	5/6	1/3
Efficient Equipment	Refrigeration	10	✓	7/10	9/10	6/10	✓	3/3

The SWE conducted project file reviews for 42 PPL C&I projects for PY12. During the review of the project files, the SWE was able to locate project files with ease and found most of the projects to have sufficient documentation to conduct a review.

The SWE found that the project files from the ICSP for three projects (two Motor, one Heating/Cooling) did not include a calculation sheet to compare the equipment types shown in invoices/spec sheets and what was used in the savings calculation sheet. Along with these projects, the SWE was unable to determine what was installed, what equipment was there prior, and ultimately how the savings are being generated for 12 projects total. Minor discrepancies between tracked savings values and savings calculations were observed for 11 projects total.

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: Efficient Lighting Program, Home Energy Education Program, Energy-Efficient Home Program, WRAP, Energy-Efficiency Kits and Education Program, Appliance Recycling Program, and the Student Energy-Efficient Education Program. Note that the SWE reports the residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior. The Energy-Efficiency Kits and Education program did not run in PY12.

Table 174 provides a summary of the EM&V approaches used by Cadmus in their PY12 verified savings calculations. The SWE discovered no discrepancies for non-lighting residential programs.

Table 174: Residential and LI Program Impact Evaluation Activities – PPL

Program	Surveys	Site Visits	Desk Review [a]	Billing Analysis	PY10 Realization Rate
Energy-Efficient Home Program	✓	✓	✓	-	-
WRAP	✓	-	✓	-	-
Energy-Efficiency Kits and Education Program[b]	-	-	-	-	-
Appliance Recycling Program	-	-	✓	-	✓
Student Energy-Efficient Education Program	✓	-	✓	-	-

[a] The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.
[b] The Energy-Efficiency Kits and Education Program did not run in PY12.

C.5.1.1 Upstream Lighting & Cross-Sector Sales

PPL did not offer an upstream lighting program in PY12.

C.5.1.2 Residential Non-Lighting

The SWE's review of verified savings for residential non-lighting solutions, which include LI programs, found that, overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE found only one minor issue in the residential non-lighting savings

estimates resulting from a mismatch of model information in the Energy-Efficient Home ENERGY STAR refrigerator offering. This could result in a small overestimate of savings.

Energy-Efficient Home

The Energy-Efficient Home Program targets both new and existing homes and offers a comprehensive suite of energy-efficient products, rebates, education, and services providing variety of options to customers interested in pursuing efficient improvements in their homes. The SWE audited most program components of the Energy-Efficient Home (EEH) program in PY12, including in-home audits / online assessments, weatherization, efficient equipment, and the online marketplace. Because of the COVID-19 pandemic, the evaluation plan for the New Homes component was adjusted to avoid sending Cadmus technicians to homes for site visits. HERS raters were recruited and offered a stipend for collecting and sharing the necessary data on the home as they performed their energy ratings. There were challenges to using this method and after 10 site visits, Cadmus shifted to using their technicians for on-site data collection, with technicians visiting unoccupied homes to avoid indoor interactions. For the online marketplace lighting measures, Cadmus assigned baseline wattages in accordance with TRM protocol 2.1.1 for all but two models. As a result, verified savings were underestimated by 411 kWh

Savings for the ENERGY STAR Refrigerator aspect of the EEH program are 1.4 MWh (1.6%) higher than expected due to the mismatching of model information for multiple records, and inclusion of a model that is ineligible under ENERY STAR Refrigerator and Freezer / Consumer Refrigeration v 5.0. VFD pool pump savings primarily relied on default values or conservative estimates however,[56] investigation of the pre- and post-upgrade capacities indicates that 57% of new pumps are larger than the original.[57] As a result, calculations that assume the capacity remains unchanged likely overestimate savings.

The SWE audited the desk review activities of the evaluator, including the database-level savings verification and the desk review sampling. The SWE reviewed measure-level savings calculations for all measures to assess accuracy and compliance with the TRM and relevant IMPs and did not find errors in the gross savings verification work performed by the evaluator. The SWE also verified that survey responses from the sampled sites were applied in accordance with the approved EM&V plan and that population sizes, verified savings, and realization rates matched the savings values reported in the PY12 annual report.

LI Winter Relief Assistance Program (WRAP)

The LI WRAP program provides a free energy audit for income-qualified customers and offers direct installation of a range of energy-efficiency products and services based on a preapproved list of products and services and qualifying criteria. Products and services might include HVAC, lighting, weatherization, water saving/heating, appliances, appliance recycling, and home health and safety. In PY12, PPL Electric Utilities limited WRAP program participation to delivered jobs

[56] The customer survey provided insufficient detail about time of use, and therefore no peak savings were claimed.
[57] Post-upgrade capacity is the same in 23% of cases, smaller in 7%, and unknown for the remaining 23%.

in single-family homes and individually metered multifamily buildings (WRAP had previously been available to master-metered multifamily and manufactured homes before the COVID-19 pandemic).

The SWE audited each component of the LI WRAP Program for the two stratum reported: baseline jobs and low-cost jobs in single and multifamily homes. [58] The SWE reviewed the TRM algorithms and protocols that went into the verified savings calculations for every measure included in the sample. Overall, the SWE concluded that TRM values and algorithms were followed and that survey responses from the sampled sites were applied in accordance with the approved EM&V plan. The SWE verified that population sizes, verified savings, and realization rates matched the savings values reported in the PY12 annual report.

Energy-Efficiency Kits and Education

PPL did not run the energy-efficiency kits and education program in PY12.

Appliance Recycling

The Appliance Recycling program covers refrigerator, freezer, dehumidifier, and room air conditioner retirement.

Cadmus' evaluation plan relied on EDC-gathered data from PY10 for refrigerator and freezer characteristics in savings calculations, and defaults for dehumidifiers and air conditioners. The SWE audited the verified savings for each of these measures using the annual request data and found that the correct algorithm was followed for dehumidifiers and room air conditioners. The SWE was also able to verify savings for refrigerator and freezers after incorporating the custom TMY3-based weather data the evaluator's employed in previous years.[59]

Student Energy-Efficiency Education

The Student Energy-Efficiency Education (SEEE) Program provides both classroom energy-efficiency education and take-home energy-savings kits for students to install at home. The SWE conducted a review of Cadmus-provided data and the survey of all Home Energy Worksheets (HEWs) returned by students who received a kit. The SWE determined the correct algorithms, sample sizes, and inputs were implemented in calculating energy savings in accordance with their approved EM&V plan.

C.5.1.3 Behavior

PPL's Home Energy Education Program claimed savings from approximately 139,000 residential and LI households that received Home Energy Reports (HERs). Most of these households, except those in the LI Wave, received their last HER in October 2019 (PY11). Therefore, Cadmus

[58] Full cost job types were not offered during PY12.
[59] These values match neither the 2016 nor 2021 TRM heating and cooling degree day values and contribute to a less than 2% increase in total savings.

considered the four standard waves to have been treated for only the first five months of PY12, from June 2020 to October 2020.

The SWE reviewed Cadmus's methodology and accepts the verified MWh and MW savings values for PPL's HER offering in PY12. Table 175 shows the average kWh savings and average percent savings per participant in PY12 by cohort. The "Reference Load" column represents the total PY12 electricity usage for treatment group households for the period the wave was active in the program year (indicated by the PY12 Months column) with the HER effect added back. Specifically, the reference loads for the four standard waves are based on a five-month period.

PY12 is the second year where savings from the Home Energy Education program were counted towards PPL's LI compliance target for Phase III.

Table 175: Average PY12 kWh Savings per Participant

Wave	Wave Start Date	PY12 Months	Reference Load (kWh)	Average PY12 Savings (kWh)	Average PY12 % Savings
Legacy Wave 1	April 2010	5	6,876	108.7	1.58%
Legacy Wave 2	June 2011	5	8,039	146.2	1.82%
Expansion Wave 1	October 2014	5	7,104	114.6	1.61%
LI Wave 1	October 2014	12	12,533	98.8	0.79%
Expansion Wave 2	June 2016	5	6,149	43.8	0.71%

The following sections describe the SWE's auditing efforts. The calculations herein are based on calendarized billing data and HER program tracking data provided to the SWE by Cadmus in response to the SWE Annual Data Request.

Group Equivalence

The Home Energy Education program uses a randomized control trial (RCT) design to enable estimates of savings post-implementation. In each cohort, participants are randomly divided into treatment and control groups. When using large sample sizes and correctly implementing randomization, the control and treatment groups should be statistically indistinguishable in their energy usage. Given group equivalence, the only plausible explanation for differences in energy consumption in the post treatment period is exposure to the HER. For households active in PY12 (i.e., had not changed ownership prior to PY12), the SWE compared average daily consumption (kWh) between the treatment and control groups during the pre-treatment period. Note that calendarized data was used to calculate the averages. Table 176 shows the averages for each wave, as well as p-values for a comparison of means t-test. A p-value less than 0.05 indicates that the difference in average consumption between the two groups is statistically significant. No waves were found to have statistically significant pre-treatment differences between the treatment and control groups.

The SWE recommends that Cadmus report the pre-treatment averages, segmented by wave, for active households rather than the original treatment and control group for the wave.

Table 176: Group Equivalence in the Pre-Period

Wave	Average Daily kWh – Control	Average Daily kWh – Treated	*p*-value
Legacy Wave 1	50.71	50.88	0.27
Legacy Wave 2	75.21	75.18	0.88
Expansion Wave 1	63.20	63.18	0.89
LI Wave 1	36.73	36.29	0.20
Expansion Wave 2	41.62	41.73	0.45

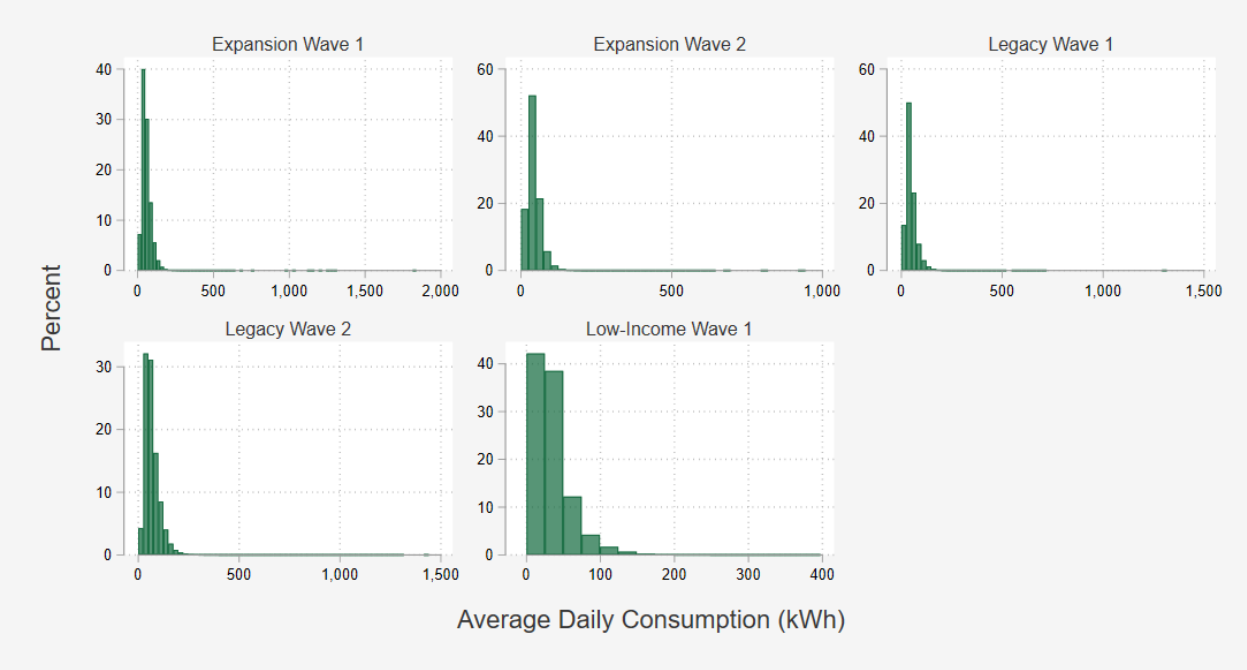
Data Checks

Before estimating HER impacts, the SWE ran a set of checks on the data. These checks include counting the number of pre-treatment months per customer, checking the coding of the treatment indicator variable, looking for anomalous data points, and verifying that the lagged seasonal terms were calculated correctly. Regarding the first two points, the SWE found that all households had at least eleven months of pre-treatment data. Additionally, the SWE did not find any issues with the coding of the treatment indicator variables.

Regarding anomalous data points, the SWE found some values that appeared implausibly high for a residential customer and some stretches of zero consumption. Figure 55 shows a histogram of average daily consumption by wave. Though they are hard to see, the right tails of each distribution contain calendarized billings records where average daily consumption exceeds 400 kWh per day – in some instances, more than 1,000 kWh per day.

Cadmus followed the SWE's recommendation from PY11, by removing potential outliers before estimating HER impacts. Cadmus flagged values both more than four standard deviations away from the seasonal average and larger than 300 kWh per day.

Figure 55: Distribution of Average Daily Consumption (kWh), by Wave



As a final data check, the SWE reviewed the three lagged seasonal variables employed by the lagged seasonal (LS) model: average daily consumption in the pre-period, average daily consumption during summer months in the pre-period, and average daily consumption during winter months in the pre-period. The SWE was able to independently replicate all the lagged seasonal terms used by Cadmus.

Participation Counts

Using the tracking data, the SWE was able to replicate Cadmus's participation counts without issue. The calendarized billing data showed fewer participants than the tracking data, but this difference could potentially be explained by the calendarization process itself, which decreases the number of bills per participant by removing any estimated reads that follow the last actual read. That said, a customer would need to have only estimated reads in PY12 (i.e., no actual reads) to not show up in the calendarized billing data. Table 177 shows the number of active PY12 treatment group households per the tracking data and calendarized billing data (where "active" implies no change in occupancy). The SWE is not concerned about the differences, but we would recommend that Cadmus validate tracking data participation counts using the raw billing data. If the raw data cannot be used to validate tracking data counts, then either some bills are missing, or the tracking data is missing some inactive dates.

Table 177: PY12 Active Treatment Accounts

Wave	Tracking Data	Calendarized Billing Data
Legacy Wave 1	30,494	30,446
Legacy Wave 2	35,266	35,202
Expansion Wave 1	34,504	34,447
LI Wave 1	15,447	15,389
Expansion Wave 2	23,665	23,610

The tracking data also had a "legacy_inactive" field which flagged customers who were inactive when PPL changed implementers for Phase III. Any such customers were not included in the treatment group counts.

Impact Coefficients

The SWE was able to replicate the impact coefficients from both the lagged seasonal model and the difference-in-differences fixed effects regression model. The results are displayed in Table 178. An impact of -0.71 for Legacy Wave 1 means that average daily consumption in treatment group households was 0.71 kWh less in PY12 than average daily consumption in control group households, on average, after controlling for the effects of weather, time, and pre-period consumption patterns.

Table 178: PY12 Impact Coefficients

Wave	Lagged Seasonal Coefficient
Legacy Wave 1	(0.71)
Legacy Wave 2	(0.96)
Expansion Wave 1	(0.75)
LI Wave 1	(0.27)
Expansion Wave 2	(0.29)

Figure 56 through Figure 60 compare average daily usage between control group households and treatment group households. The figures show usage in both the pre-period and in PY12. Only households active in PY12 are included in the "pre-period" portion of the figures. The regression model used to estimate HER impacts controls for potential pre-period differences between the treatment and control groups.

Figure 56: Legacy Wave 1 Usage Comparison

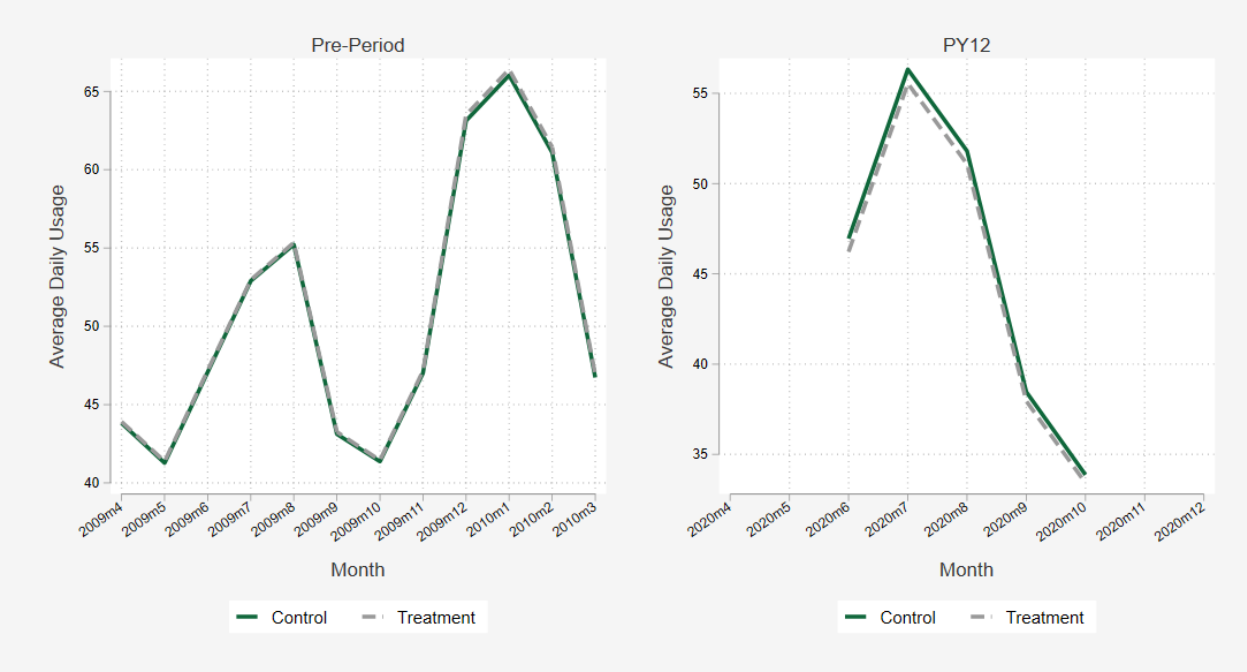


Figure 57: Legacy Wave 2 Usage Comparison

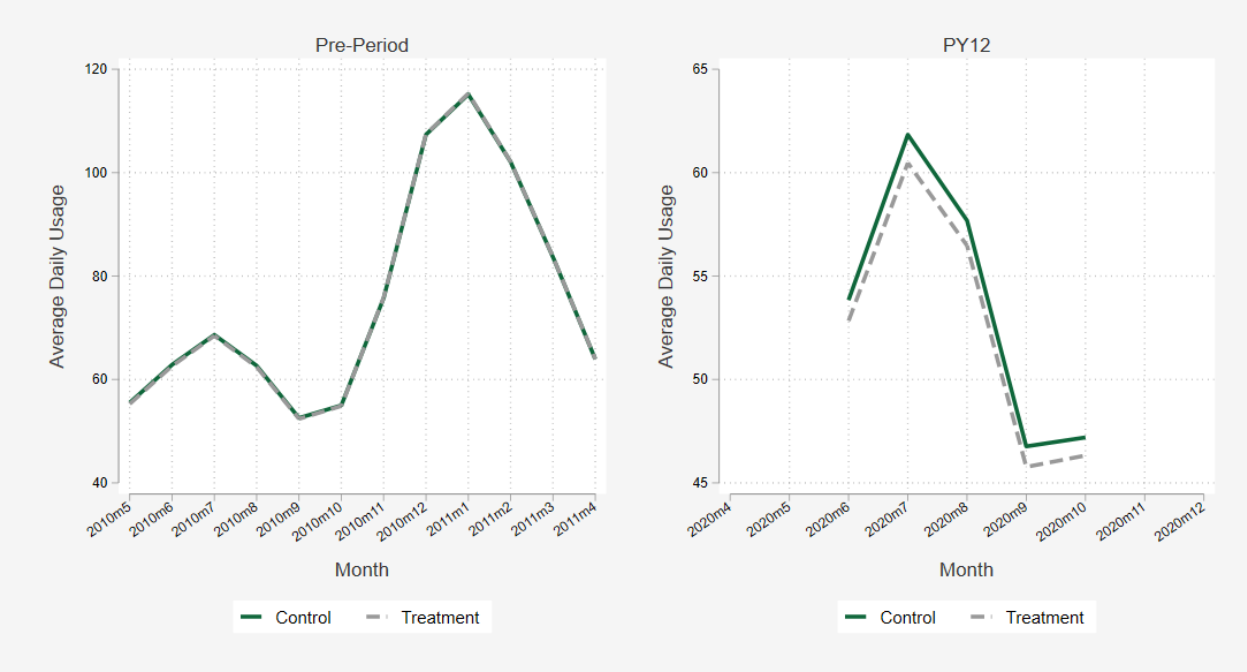


Figure 58: Expansion Wave 1 Usage Comparison

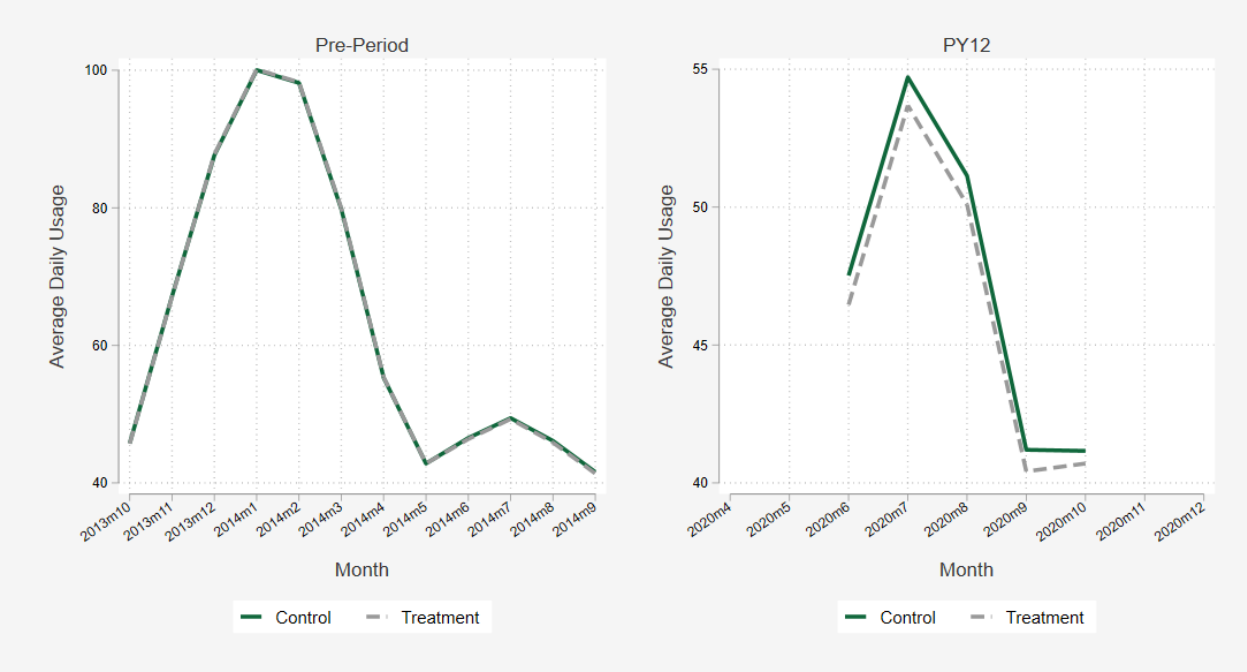


Figure 59: LI Wave 1 Usage Comparison

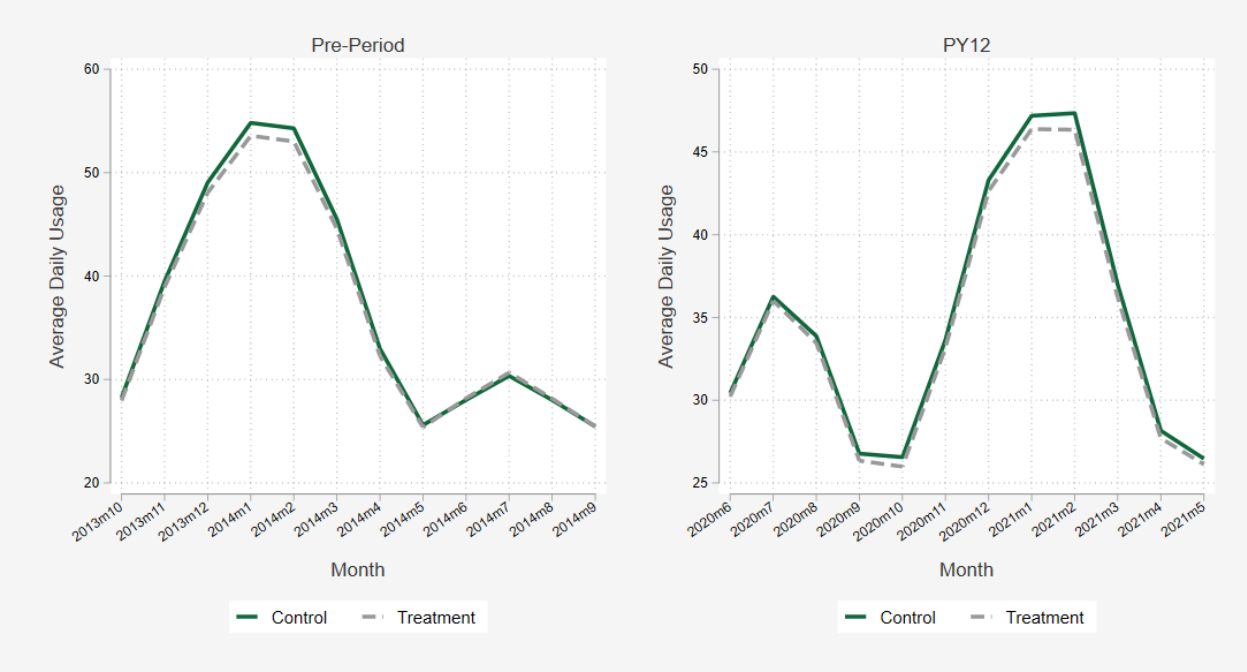
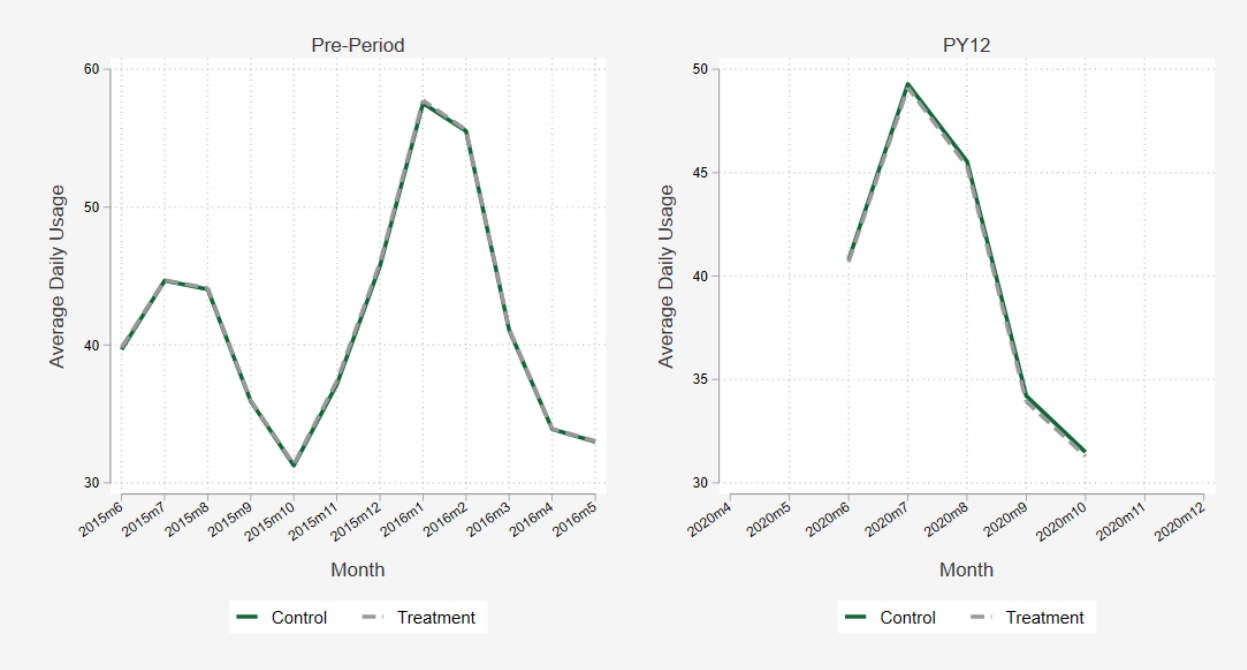


Figure 60: Expansion Wave 2 Usage Comparison



Annual Energy Savings

To calculate the incremental annual energy savings, the HER impact coefficients must be multiplied by the number of treatment days. Total treatment days are composed of the treatment days per account and scaled by the number of active accounts. Such households were counted only once in the aggregation of savings. Table 179 shows the results. The "Equivalent Accounts" column is the number of treatment days divided by eligible days in PY12 for each wave (365 days for the LI Wave, 153 days for the four standard waves totaling calendar days from June 2020 to October 2020) and enables the generation of an average savings per customer. Note that these results do not account for uplift. Cadmus subtracted upstream and downstream savings uplift from PPL's residential portfolio total (not the HER program total). The uplift process is described in a later section.

Table 179: Annual MWh Savings by Cohort

Wave	PY12 Total Savings (MWh)	PY12 Months	Total Treatment Days	Equivalent Accounts	Average Account Savings (kWh)
Legacy Wave 1	3,282	5	4,620,916	30,202	108.7
Legacy Wave 2	5,104	5	5,340,881	34,908	146.2
Expansion Wave 1	3,906	5	5,215,717	34,090	114.6
LI Wave 1	1,468	12	5,424,020	14,860	98.8
Expansion Wave 2	1,024	5	3,576,884	23,378	43.8
Total	**14,784**		**24,178,418**	**137,438**	

Demand Savings

As in previous program years, Cadmus converted each wave's average energy savings into demand reductions using the evaluated PY4 ratio of peak demand reduction values to average per-customer energy savings per hour. In PY4 across Legacy Wave 1 and Legacy Wave 2, Cadmus estimated average per-customer demand reductions of 0.041 kW and 0.056 kW for each wave, or 193% and 108% of each wave's average per-customer energy savings per hour, respectively. Cadmus used the weighted average of these ratios (148%) to convert PY12 program energy savings into demand reductions.

The PY12 peak demand savings for the waves claiming savings from just five months require special attention because four of the five months analyzed are included in the Act 129 peak demand definition. The SWE worked with Cadmus to customize the peak demand savings calculations for the market rate waves. Accordingly, the SWE and Cadmus agreed that the ratio of kW to kWh should be higher. Cadmus calculated the PY12 peak demand savings by dividing the PY12 energy savings by the 3,672 hours in June through October, for the four standard waves with only five PY12 months, instead of dividing the PY12 energy savings by the full 8,760 hours in a year, for the LI wave with all twelve PY12 months. Using this method, the SWE was able to replicate Cadmus's verified peak demand savings estimates. These values are shown in Table 180 (without accounting for uplift).

Table 180: Peak Demand Savings

Wave	PY12 Total Savings (MWh)	Total Treatment Hours	Conversion Ratio (%)	Total Peak Demand Savings (MW)
Legacy Wave 1	3,282	3,672	148%	1.32
Legacy Wave 2	5,104	3,672	148%	2.06
Expansion Wave 1	3,906	3,672	148%	1.57
LI Wave 1	1,468	8,760	148%	0.25
Expansion Wave 2	1,024	3,672	148%	0.41
Total	**14,784**			**5.61**

Mirroring energy savings, Cadmus subtracted upstream and downstream peak demand savings uplift from PPL's residential portfolio total (not the HER program total). The uplift process is described in the following section.

Downstream and Upstream Uplift

The SWE reviewed the methods Cadmus used in calculating downstream and upstream uplift savings and believes that they are sound. For each wave, Table 181 shows the downstream and upstream uplift energy savings and Table 182 shows the same for peak demand. In total, Cadmus calculated 1,011.51 MWh and 413.17 MWh in downstream and upstream uplift savings, respectively, and 0.36 MW and 0.16 MW in downstream and uplift peak demand savings, respectively. Additionally, Cadmus included a 262.43 MWh adjustment and a 0.03 MW adjustment for LEDs installed in PY7 as part of the LI Energy-Efficiency Behavior Program. Combined, these adjustments total up to 1,687.11 MWh and 0.54 MW. Rather than subtracting

these values from the Home Energy Education program total, Cadmus subtracts them from PPL's portfolio total. All SWE reporting deducts the uplift from the program total.

Table 181: Downstream and Upstream Uplift – Energy

Wave	PY12 Savings (MWh)	Downstream Uplift (MWh)	Adjusted Savings (MWh)	Upstream Adjustment Factor	Upstream Uplift (MWh)	LED Bulb Giveaway (MWh)	Total Uplift Savings (MWh)
Legacy Wave 1	3,282.16	91.92	3,190.23	3.00%	95.71	-	187.63
Legacy Wave 2	5,103.71	309.10	4,794.62	3.00%	143.84	-	452.93
Expansion Wave 1	3,906.28	143.83	3,762.45	3.00%	112.87	-	256.71
LI Wave 1	1,468.04	350.27	1,117.77	3.00%	33.53	262.43	646.22
Expansion Wave 2	1,023.60	116.40	907.20	3.00%	27.22	-	143.61
Total	**14,783.79**	**1,011.51**	**13,772.28**	**-**	**413.17**	**262.43**	**1,687.11**

Table 182: Downstream and Upstream Uplift – Peak Demand

Wave	PY12 Peak Demand Savings (MW)	Downstream Uplift (MW)	Adjusted Peak Demand Savings (MW)	Upstream Adjustment Factor	Upstream Uplift (MW)	LED Bulb Giveaway (MW)	Total Uplift Peak Demand Savings (MW)
Legacy Wave 1	1.32	0.01	1.31	3.00%	0.04	-	0.05
Legacy Wave 2	2.06	0.14	1.92	3.00%	0.06	-	0.19
Expansion Wave 1	1.57	0.07	1.50	3.00%	0.05	-	0.12
LI Wave 1	0.25	0.06	0.18	3.00%	0.01	0.03	0.10
Expansion Wave 2	0.41	0.07	0.34	3.00%	0.01	-	0.08
Total	**5.61**	**0.36**	**5.26**	**-**	**0.16**	**0.03**	**0.54**

The PY12 Home Energy Education verified savings analysis was robust and well-documented. The SWE agrees with PPL's decision to claim five months of PY12 savings for waves that received their last HER in October 2019, as the approach is consistent with the one-year measure life assumed for HERs. The five-month treatment period creates some nuance in the peak demand savings calculations, which was handled appropriately in the verified demand savings calculations. PPL's Phase IV EE&C Plan does not include a Home Energy Report program in PY13, although PPL notes the possibility of adding HERs at some point in Phase IV. Given the plan to discontinue the offering in PY13, the SWE team offers no prospective evaluation recommendations.

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 61 provides a summary of the evaluation activities and M&V approaches utilized by PPL's evaluation contractor in their PY12 verified savings calculations summarized by total project counts and evaluated savings. For PY12, PPL's evaluation contractor completed site visits to 34% of projects corresponding to a total of 136 projects. Due to COVID-19, some of these site-visits were virtual site-visits for which Cadmus conducted a video conference with the customer and the customer provided supplemental pictures to verify project specific information. In assessing savings, enhanced M&V techniques (IPMVP Options A, B, C, and D) were employed for the majority (62%) 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 61 provides a summary of the share of projects, which underwent Cadmus' evaluation activities by quantity of projects and evaluated savings. Figure 61 also displays the share of projects which were reviewed using basic rigor methods and IPMVP methods.

Figure 61: Summary of PPL's C&I Evaluation Activities

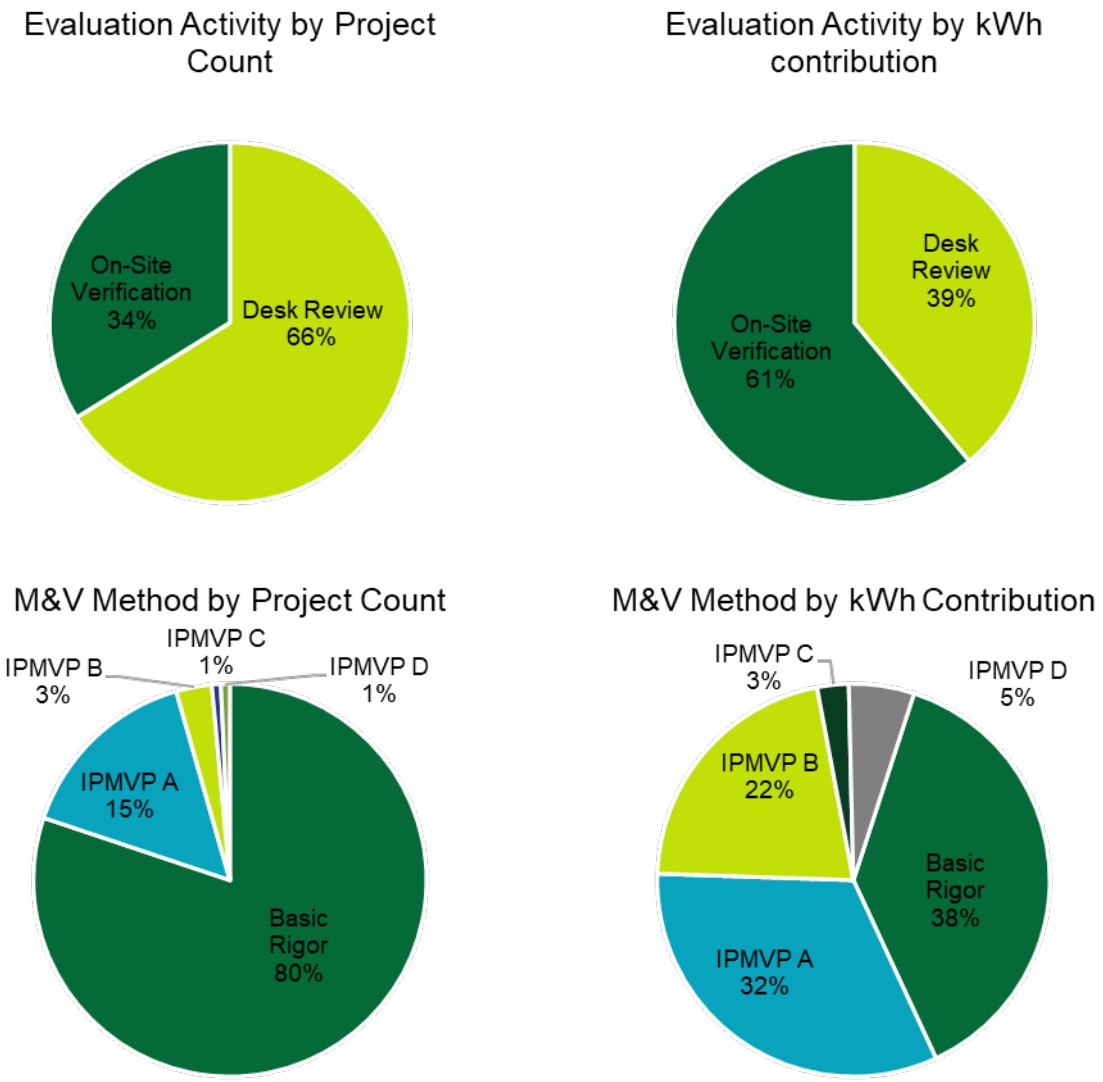


Table 183 provides a summary of the evaluation activities and M&V approaches PPL's evaluation contractor used across strata for all projects stratified by program.

Table 183: Summary of PPL's PY12 C&I Evaluation Activities by Program

Program / Strata	Sample Quantity	Realization Rate %	Desk Review	On-Site Verification
Non-Res Efficient Equipment Program	**58**	**101%**	**50**	**8**
Prescriptive and Direct Discount Lighting	42	98%	36	6
Prescriptive and Direct Discount Equipment	16	101%	14	2
Midstream Lighting Program	**50**	**113%**	**35**	**15**
Small	17	108%	17	-
Medium	16	78%	15	-
Large	3	164%	3	-
Threshold (> 20 kW)	4	92%	-	4
Convenience	11	117%	-	11
Custom Program	**28**	**105%**	**7**	**21**
Large	17	100%	6	11
Small	10	116%	1	9
CHP	1	100%	-	1
Total	**136**	**103%**	**92**	**44**

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 Energy-Efficiency Program

In PY12, Cadmus grouped the direct discount and the prescriptive lighting projects into one stratum and the equipment component in a separate stratum. The PY12 evaluation sampling plan was designed to meet 90% confidence and ±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 both lighting and equipment.

Cadmus evaluated all lighting projects (prescriptive and direct discount) below the metering threshold (750,000 kWh) at a basic level of rigor and all lighting projects at or above the threshold at an enhanced level of rigor, as stipulated in the PA TRM. All sampled non-lighting equipment projects were evaluated at a basic level of rigor (36 by desk review, 6 by site visit).

Cadmus divided lighting projects further into four substrata: small, medium, large, and threshold (>20 kW). These boundaries were established by the substratum's contribution to total gross reported, following the methods in Chapter 13: Sampling in The California Evaluation

Framework.[60] In PY12, Cadmus conducted site visits to verify six lighting projects, one VFD project, and one occupancy sensors project. Some of those site-visits were conducted virtually due to COVID-19.

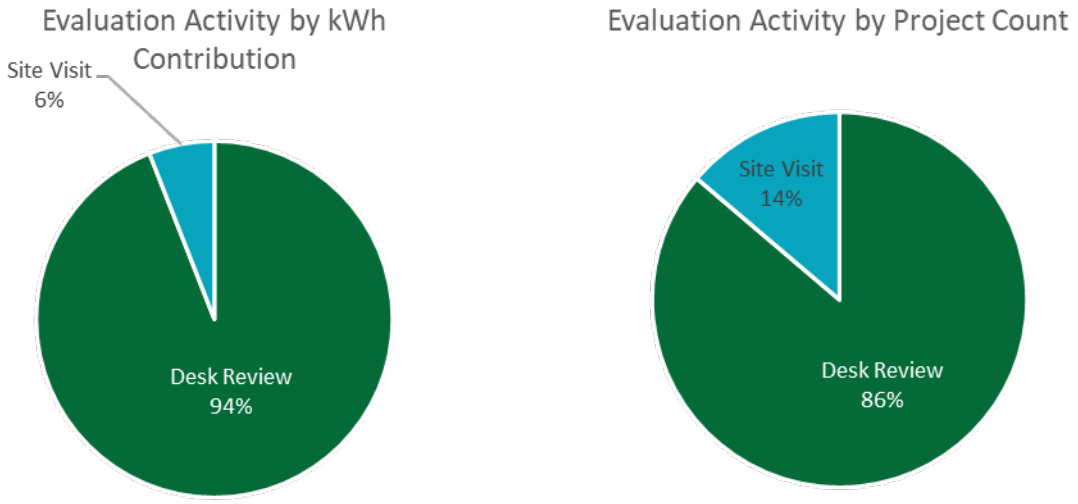
In summary, the strata and substrata for the Non-Residential Efficient Equipment program were as follows:

- Prescriptive and Discount Lighting
  - Threshold (projects larger than 750 MWh)
  - Large
  - Medium
  - Small
- Non-Lighting Equipment
  - HVAC
  - Motors
  - Refrigeration
  - Other

As shown in Figure 62, PPL's evaluation contractor verified approximately 86% of projects via desk reviews and the rest of projects via on-site verification. In PY12, only 6% of evaluated savings were verified through an on-site visit.

[60] TecMarket Works. *The California Evaluation Framework*. 2004. Pages 368-371. http://www.calmac.org/publications/California_Evaluation_Framework_June_2004.pdf

Figure 62: Summary of PPL's PY12 Efficient Equipment Program Evaluation Activities



C.5.2.2 Midstream Lighting Program

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 PY12 projects. Cadmus conducted 15 site visits and 35 desk audits to evaluate 50 total projects: 11 that Cadmus conveniently sampled. These projects corresponded to 65 jobs, of which 23 were evaluated with on-site or virtual visits and 42 were evaluated using desk audits. The midstream evaluation targeted a confidence level of 85% and 15% precision to report gross verification savings. The program met this target for demand with a relative precision of 14.21% but fell short for energy, with a relative precision of 20.1%. The sample was stratified by reported annual energy savings to estimate realization rates, verified savings, and relative precision. The midstream lighting strata are listed below.

- Convenience Sample
- Threshold (> 20 kW)
- Large
- Medium
- Small

C.5.2.3 Custom Program

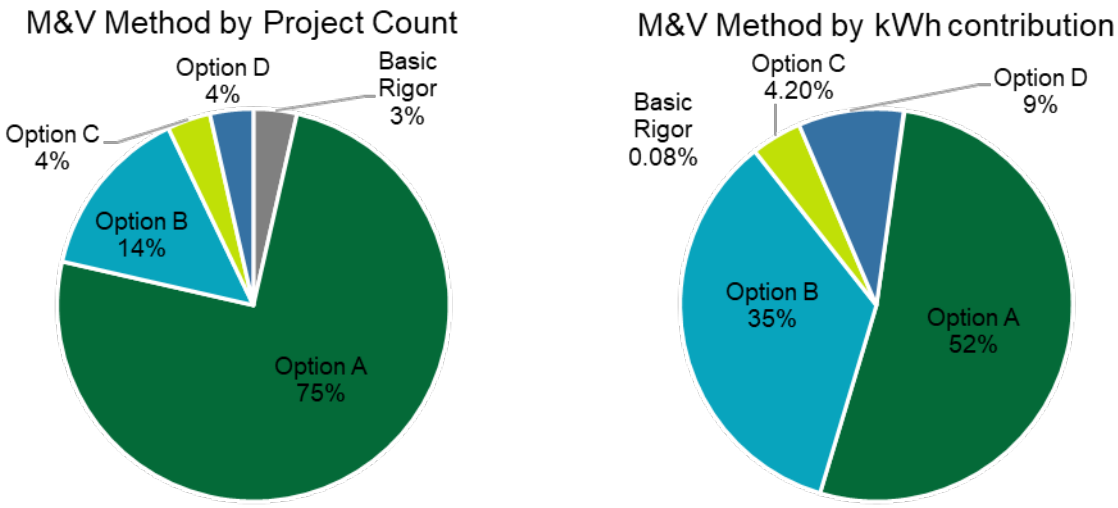
The SWE found that the evaluation contractor defined projects in three strata:

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

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

The large project and CHP project verification strata were a census of the participation population, with Cadmus conducting pre- and post-retrofit M&V so that TRM guidelines are met, and the reported values are corrected to match evaluated results. Therefore, the projects in these strata achieved realization rates of 100%. Cadmus randomly selected projects to include in the small project stratum. Cadmus prepared SSMVPs for each project and then conducted post-installation inspections and verified savings. A total of ten small stratum projects were inspected. In the CHP stratum, production data was collected for three to six months to determine electricity generation, parasitic loads, useful heat recovery from the CHP, and net gas usage (CHP gas consumption less gas usage offset by heat recovery). IPMVP Option A and B were used to calculate the first-year energy savings for the CHP project. Figure 63 provides a summary of the quantity and annual energy savings contribution of the custom projects reviewed by Cadmus for each level of rigor. IPMVP Options A and B encompass 87% of the evaluated energy savings in PY12.

Figure 63: Summary of PPL's PY12 Custom Program M&V Methods



C.5.2.4 Ride-Along Site Visits

The SWE audited the activities above through a combination of Ride-Along Site Visits (conducted both in person and virtually) and Desk Reviews. The details of the SWE's findings are presented in the following subsections.

Table 184 provides an overview of the SWE milestones for the audit of PPL's site inspection efforts in PY12.

Table 184: PPL Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Energy Attainment Percentage
6	12,205,035	3	5	100%

The SWE attended ride-along site visits for six projects, which included a CHP project, VFD controls, and four lighting projects. Overall, the SWE agreed with the calculation methods utilized by PPL's evaluation contractors and therefore reached a 100% attainment percentage for both energy and demand. The savings calculations and accompanying reports were easy to follow and showed evidence that the contractor utilized the TRM for appropriate measures. The SWE agreed with the evaluators' engineering decisions for custom calculations.

C.5.2.5 Verified Savings Desk Reviews

Table 185 provides an overview of the SWE milestones for the verified savings review of evaluated PPL projects conducted via desk review.

Table 185: PPL Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
4	2,993,786	357	100%	100%

Overall, the SWE found that PPL's evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods to evaluate custom projects. Supporting verification reports and calculation files provided to the SWE accurately provided an overview of the project and approach taken by the evaluator to verify energy savings. The SWE had no further recommendations for reviewed projects and therefore reached attainment percentages of 100% for both energy and demand.

C.6 DR

Phase III demand response compliance target is 92 MW. DR goals are assessed at the system level, meaning that line loss adjustments are applied to the load impacts measured at the customer meter. In addition to the 92 MW target, which is an average of all Phase III DR events, EDCs are required to achieve at least 85% of their overall target in each event. For PPL, this translates to a 78.2 MW minimum performance level for any given DR event. Due to the COVID-19 pandemic, the PUC made PY12 DR voluntary, so performance does not count towards PPL's Phase III demand response compliance target.

Decisions about which day DR events are called are guided by a set of prescriptive directions issued by the PUC in the Phase III Implementation Order and Clarification Order. PPL called DR events on the five days those guidelines required.

On March 15, 2021, the PPL/Cadmus team filed its PY12 semi-annual report and a detailed DR evaluation report. These filings reported the PY12 verified gross impacts as calculated by Cadmus. Table 186 summarizes the five PY12 DR events. PPL's gross verified performance was comfortably above the 85% Phase III minimum performance target for each event, except the July 29 event, despite the voluntary nature of the program for PY12.

Table 186: PY12 DR Impacts by Event

Event Date	Event Time	Average Performance (MW)	% of Phase III Target
July 20, 2020	2pm – 6pm	109.6	119%
July 27, 2020	2pm – 6pm	102.4	111%
July 29, 2020	3pm – 7pm	76.5	83%
August 25, 2020	2pm – 6pm	91.3	99%
August 27, 2020	3pm – 7pm	104.7	114%
PY12 Average	**N/A**	**96.9**	**105%**

The PPL/Cadmus team also submitted a response to the SWE DR data request. The data elements of this request included the following:

- A list of participating facilities and the reference load method used to estimate its gross verified performance
- For each event hour, a record of which facilities participated, their reference load, metered load, line loss factor, and verified DR impact
- For 20 sites selected by the SWE, the hourly load data and PJM participation records needed to replicate the Cadmus impact estimates
    - These 20 sites represented approximately 39% of the gross verified PY12 DR impacts.

The data request response and DR evaluation report formed the basis of the SWE audit activities – which are described in this memo. The SWE found the approaches implemented by Cadmus to be well-aligned with the Evaluation Framework and consistent with industry best-practice. The execution of the analysis was thorough, but the SWE did find an issue in the execution of constructing the baseline window and selecting the baseline days for the "high 3 of 5" and the "high 7 of 10" day-matching baselines. This issue effected four customers in the sample, and the magnitude of the differences between the Cadmus results and SWE estimates differed between them. Because the SWE team only has hourly load data for a sample of the customers we were not able to produce independent estimates of program totals. Given that the difference in these baseline calculations remained fairly small for the incorrectly specified days, the SWE team does not believe there would be a significant impact on the DR program total savings.

C.6.1 Replicate Program Totals

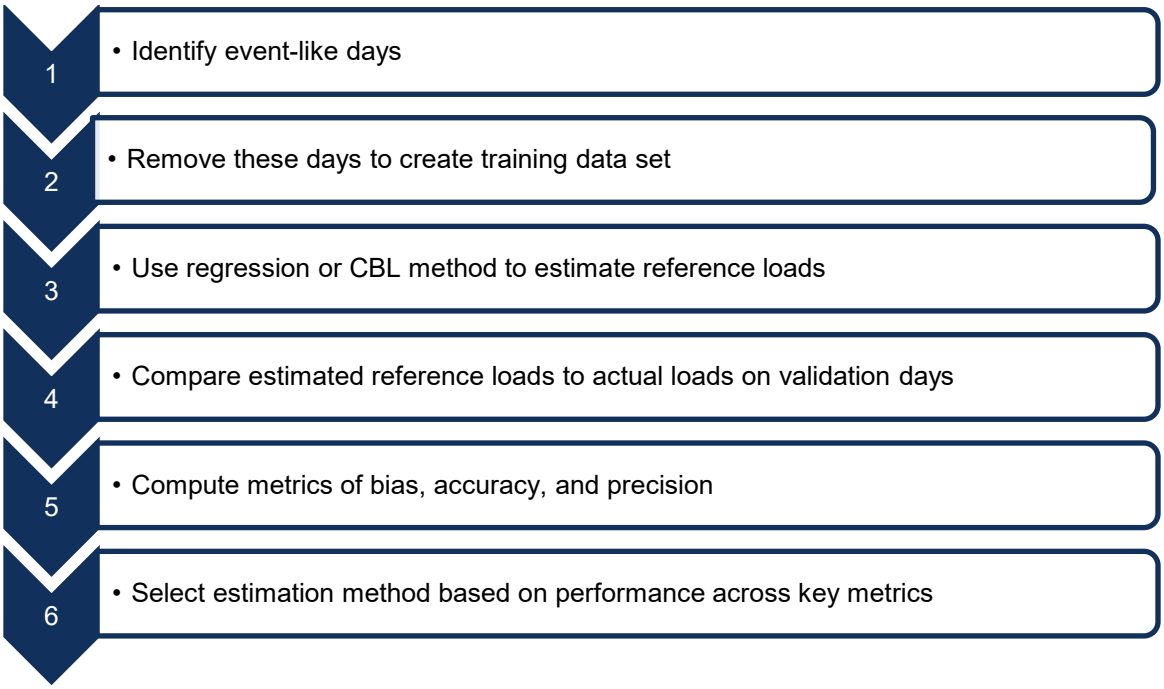
The first step in the SWE audit was to replicate the program performance totals from the site-level estimates. The DR performance table was filtered to include only hours where sites were listed as participating. The PY12 data request included sector information – which determines the line

loss factor applied to a site's impact estimates – allowing the SWE team to calculate DR savings from each site at the generator level. The site level impact estimates then summed by date and hour. The SWE team was able to replicate the totals presented in the PPL PY12 semi-annual report exactly.

C.6.2 Reference Load Selection

Cadmus submitted a DR Program EM&V Plan for PY12 to the SWE documenting the approach that was used to select site-specific baselines. The approach was consistent with the process shown in Figure 64, which is taken from the Evaluation Framework.

Figure 64: Baseline Selection Steps



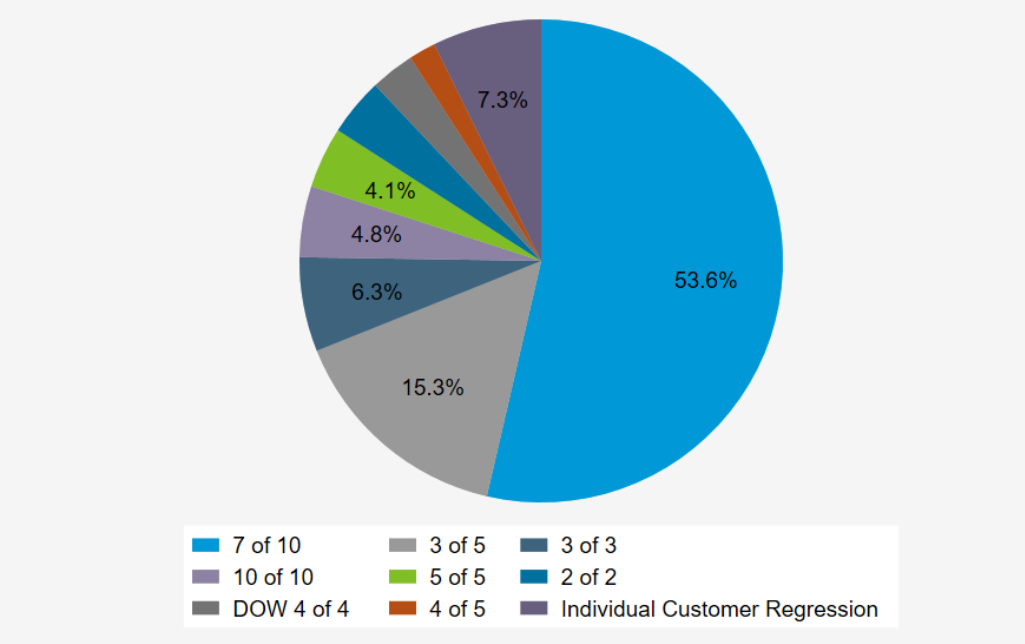
Cadmus tested, and ultimately used a variety of baseline methods in PY12. Table 187 shows the distribution of baseline approaches across the PY12 program population. Individual customer regression analysis was by far the most common approach (78% of sites), but the model specification differed across customers.

Table 187: PY12 Baseline Frequency Table

Baseline	Number of Sites Used
10 of 10	3
2 of 2	4
3 of 3	1
3 of 5	4
4 of 5	4
5 of 5	2
7 of 10	5
DOW 4 of 4	3
Individual Customer Regression	92

Figure 65 looks at the distribution of baseline methods by gross verified MW. While regression analysis was the most common approach, it only accounted for just over 7% of the MW performance. Conversely, a high 7-of-10 baseline was selected for just six sites but accounted for over half of the program impacts. This distribution makes sense because regression analysis tends to be well-suited for weather-dependent sites, and those sites are often smaller than the large industrial facilities with little or no weather-dependence.

Figure 65: Distribution of Gross Verified MW by Baseline



In PY9, Cadmus tested the accuracy of different customer baseline calculation methods for 93 facilities and for each facility identified the method that predicted with the highest accuracy. In PY12, Cadmus did not repeat this exercise for returning participant facilities that use CBLs. Instead, Cadmus used the same baseline calculation method used to estimate the PY9, PY10, and PY11 impacts, with two exceptions. In PY9, Keystone Cement had two participating facilities, one of which used a 2-of-2 day-matching method and the other used an individual customer regression, but in PY12, both facilities used the 2-of-2 day-matching method. In addition, the Hercules Cement Company used an individual customer regression in PY9 but a 7-of-10 day-matching method in PY12. For regression sites, Cadmus reassigned individual customer model specification between PY11 and PY12.

For new PY12 participating facilities, Cadmus tested the accuracy of each day-matching and regression-based CBL method on summer, non-holiday weekdays between 2PM and 6PM using 2019 facility interval consumption data. Cadmus compared estimated baseline to metered consumption and chose the day matching or regression technique that performed the best in terms of accuracy, bias, and variability (risk). The new participants used a mix of day-matching and individual customer regressions.

C.6.3 Day-Matching Baselines

Of the 20 sites for which the SWE team received hourly load data, 10 had their baselines estimated through a day-matching technique. Table 188 shows the Cadmus ID, methodology, average size of the DR impact as calculated by Cadmus, and the average size of the DR impact as estimated by the SWE team for those 10 sites.

Table 188: Day-Matching Audit Sites

Cadmus ID	Baseline	Cadmus Average DR Impact (kW)	SWE Average DR Impact (kW)
CAD000942416	7 of 10	18,140	18,163
CAD000310201	7 of 10	12,952	12,978
CAD000233703	3 of 3	6,120	6,120
CAD000000505	2 of 2	5,048	5,048
CAD000419613	DOW 4 of 4	3,692	3,692
CAD000030393	4 of 5	1,007	1,007
CAD001244824	3 of 5	559	562
CAD001270053	10 of 10	442	442
CAD001213141	3 of 5	12	12
CAD001314702	2 of 2	(291)	(291)

The SWE team was able to exactly replicate the Cadmus' DR impact estimates for six of the ten customer's site-event-hour combinations in the sample which utilized a day-matching technique. The four customers for which estimates were not exactly replicated created their baseline using the high 3-of-5 and the high 7-of-10 methodologies. The primary issue that was identified had to do with a constant set of hours being used to select the baseline days from the basis window, which caused an issue as the event hours did fluctuate across event days. two customers

exclusively used the hours of 2PM to 6PM to select the high days within the basis window, while the two other customers exclusively used 3PM to 7PM to select the high days within the basis window. In addition, these four customers that used a high 7-of-10 baseline and a high 3-of-5 baseline did not implement the exclusion of days with average load between 2PM and 6PM less than 25% of the average load of all days in the basis window. This problem cannot be generalized to all day-matching customers, as no other customer within the sample encountered these abnormally low consumption days.

Due to the large size and fairly stable consumption of the customers who use a high 3-of-5 and a high 7-of-10 baseline, the baseline day selection issue did not result in meaningful differences in terms of kW savings for these customers. Table 188 highlights the nominal differences in the average impact for these four customers. One customer had such a small difference that it did not affect its average impacts.

Since the day-matching baseline methodologies for these customers were selected based on data from 2016, the SWE team tested the selected methodologies for each of the 10 sample customers on 2020 summer data to assess if the chosen CBL methods were still appropriate. The SWE team used the 30 non-holiday, summer weekdays in 2020 with highest PJM day-ahead forecasts as proxy test days. The SWE team then used the Cadmus selected method for each customer to predict loads during 2PM – 6PM each day, to simulate the typical event window, and then compared these predicted loads to actual load data on these days.

The SWE team found that prediction errors were generally normally distributed for each sample customer. Figure 66 shows the distribution of errors for each sample customer, with errors expressed as a percentage of average verified PY12 Demand Response performance. Percent errors are capped at +/- 100%. The average DR performance was calculated with negative performance hours removed, to represent a typical DR event. Customers with erratic load patterns or small percent reductions during DR events will always show larger percent errors in this type of analysis. Although the size of the errors varies by customer, the errors are generally evenly distributed around zero, and do not appear to systematically over or under-predict.

Figure 66: Distribution of Errors as Percentage of Avg. DR Performance

The SWE team determined that the PY9 day-matching methods were still appropriate for the ten sample customers. The Cadmus approach of advance baseline selection based on empirical metrics of accuracy and precision on placebo days is the recommended approach from the SWE.

C.6.4 Regression Analysis

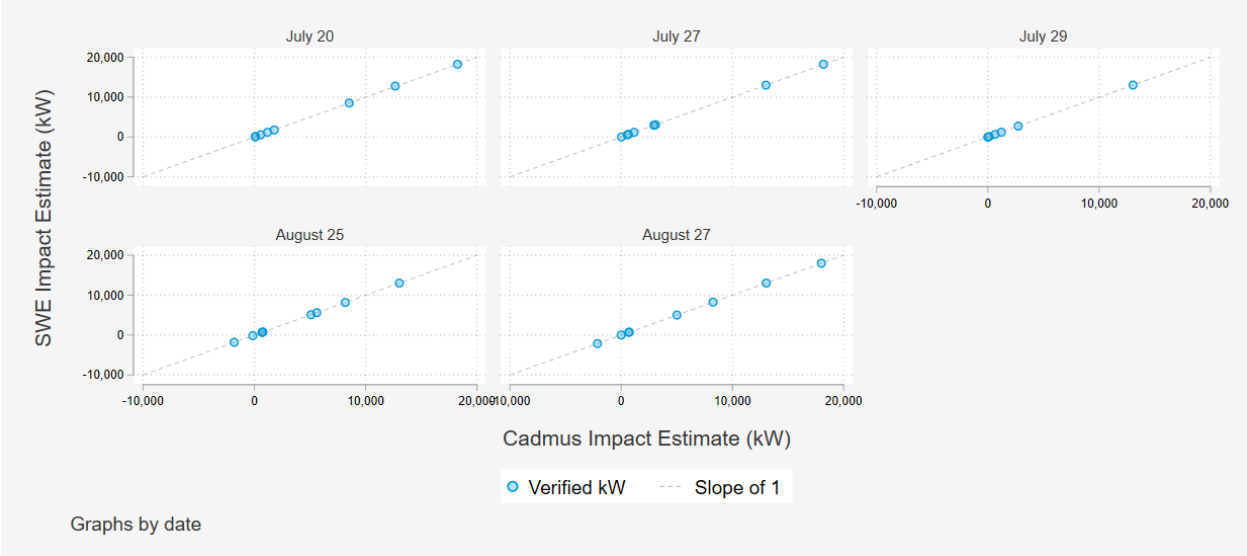
Cadmus used regression analysis for all Small CI and GNE participants as well a few of the Large CI sites where regression methods out-performed day-matching in out-of-sample testing. The SWE agrees with this approach as the Small CI and GNE sites are typically more weather-dependent, which makes regression approaches more suitable. Cadmus tested a set of 81 regression models which included various combinations of date, time, and weather variables and selected the model that predicted most accurately in out-of-sample testing. This matches the approach the SWE team hoped to see from EDC evaluation contractors.

Cadmus also excluded the notification day from baseline calculations, a decision the SWE team supports. We agree that the “day-ahead” event notification tends to influence participant loads (some up and some down) and the safest approach is to exclude these days from the analysis so as not to bias the calculations. In PY12, Cadmus excluded all event hours from the reference loads in the regression models, even if a customer was not participating in certain event hours.

C.6.5 Independent Verification of Calculations

The SWE team independently calculated reference loads and load impacts for each event hour for the 10 sites whose baselines were calculated using day-matching techniques. The SWE identified four sites where the “high X of Y” baseline days were selected incorrectly. Two of the sites used the high 7-of-10 baseline and the other two used the high 3-of-5 baseline. These differences in calculated reference loads were isolated to specific days and did not span across all five event days. Figure 67 contains scatter plots of the SWE and Cadmus impact estimates for all day-matching sites in the sample. The differences between the Cadmus and SWE estimates are visually unidentifiable.

Figure 67: Impact Estimate Comparison for Day Matching Sites



The SWE team was able to perfectly replicate the demand response impact estimates for all 10 sites where regression was the baseline calculation methodology. Figure 68 contains scatter plots of the SWE and Cadmus impact estimates for regressions sites in the sample. The trends are perfect diagonal lines with a slope = 1.

Figure 68: Impact Estimate Comparison for Regression Sites

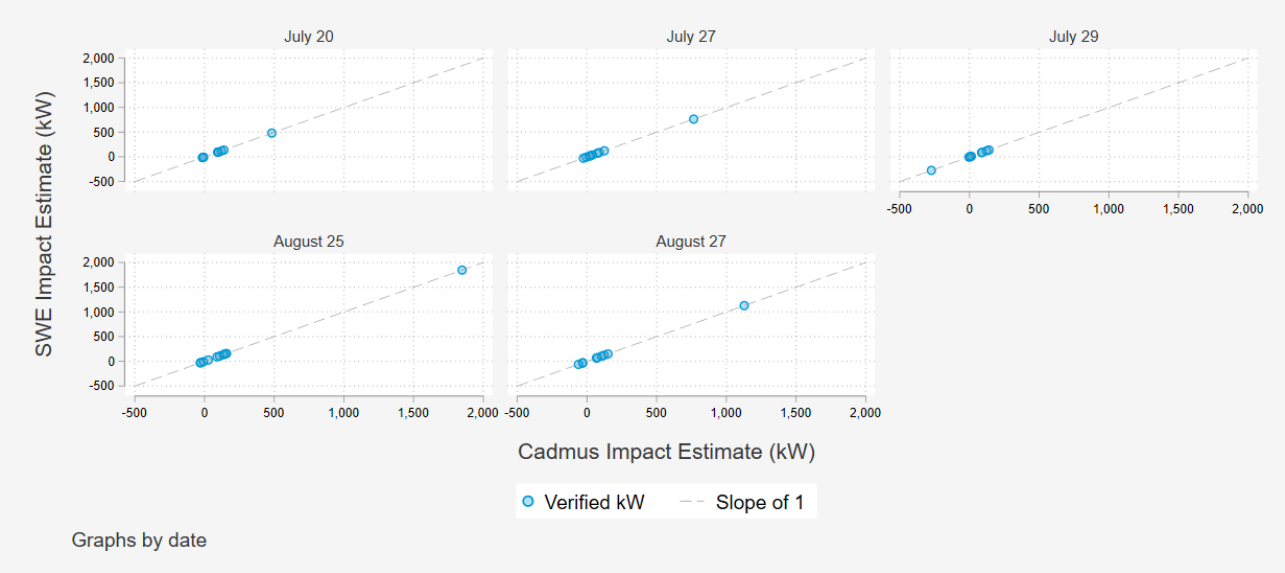


Table 189 compares the SWE load impact estimates with the Cadmus calculations for the 20 sites in the SWE sample. The differences are solely attributable to the four sites that used the high 7-of-10 and the high 3-of-5 day-matching baselines. On average, the SWE estimates were slightly larger than the Cadmus estimates.

Table 189: Impact Comparison – All Sites in SWE Sample

Date	Hour	SWE kW Estimate	Cadmus Verified kW	Difference (kW)	Sites Participating
7/20/2020	15	44,840	44,721	119	14
7/20/2020	16	45,104	44,970	133	15
7/20/2020	17	44,089	43,965	124	17
7/20/2020	18	42,163	42,043	121	17
7/27/2020	15	40,750	40,708	42	14
7/27/2020	16	40,965	40,709	257	15
7/27/2020	17	40,419	40,370	49	17
7/27/2020	18	40,082	40,100	(18)	17
7/29/2020	16	18,327	18,334	(6)	13
7/29/2020	17	17,841	17,843	(2)	13
7/29/2020	18	18,235	18,230	6	15
7/29/2020	19	17,171	17,164	7	15
8/25/2020	15	32,900	32,900	0	15
8/25/2020	16	36,023	36,023	0	16
8/25/2020	17	32,348	32,348	0	18
8/25/2020	18	32,993	32,993	0	18
8/27/2020	16	46,452	46,452	0	15
8/27/2020	17	44,882	44,882	0	15
8/27/2020	18	43,801	43,799	2	16
8/27/2020	19	43,137	43,129	8	15

For PY12, Cadmus analyzed five customers using a high 7-of-10 baseline and four with a high 3-of-5 baseline. While this only accounts for 7% of customers, it accounts for 69% of gross verified MW. With that being said, the results seem to be marginally affected by the day selection issues due to the size and stability of these large customers.

C.6.6 Conclusion

The SWE team found the Cadmus verified savings analysis to be thorough and well-documented for PY12. The PPL/Cadmus evaluation procedures were well aligned with the Evaluation Framework. The SWE agrees with the baseline selection procedures and found no errors in the calculations for the individual customer regressions. There was a small error in the calculation of day-matching baselines for the high 3-of-5 and the high 7-of-10 baselines, but the magnitude of the discrepancy is minute in comparison with program totals. Corrected program totals could not be calculated since only 20 sites were examined by the SWE team.

C.7 NTG

C.7.1 Residential Programs

Cadmus conducted new NTG research for the ductless heat pump, air source heat pump (ASHP), HPWH, Smart Thermostat and New Homes categories of the Energy-Efficient Home Program in PY12, applied PY11 NTG values to the online marketplace (a component of the EE Home

Program), and applied the PY9 and PY8 NTG values to the remaining categories of the program. The evaluators utilized a participant survey with dedicated free-ridership and spillover sections to gather PY12 NTG data. They then used the common NTG formula outlined in the Evaluation Framework to estimate a weighted PY12 Energy-Efficient Home NTG that incorporates the PY12 NTG data and the component NTG values from PY11, PY9 and PY8. Cadmus assigned a PY10 NTG value for the Appliance Recycling Program (Table 190).

Cadmus assigned an NTG of one to the Home Energy Education, in accordance with the Evaluation Framework recommendations for RCT program designs. Cadmus assigned a NTG ratio of one to the Student Energy-Efficient Education Program, reasoning that there is no free-ridership for this classroom-based program (and Cadmus did not estimate SO). This method is in keeping with Cadmus' approved EMV plan.

Table 190: Summary of NTG Estimates for PPL Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
Program not active in PY12	Efficient Lighting	-	-	-	-
PY10	Appliance Recycling	-	-	0.66	-
Evaluated, PY11, PY9, PY8	Energy-Efficient Home	0.56	0.02	0.46	218
RCT	Home Energy Education	0.0	0.0	1	-
Assigned Value	Student Energy-Efficient Education	0.0	0.0	1	-

C.7.2 LI Residential Programs

Cadmus did not conduct NTG research for any LI program during PY12.

Cadmus assigned an NTG of one to the Energy-Efficiency Kits and Education Program and the WRAP, citing the LI status of the participants as the reason free-ridership would not be possible. This method adheres to Cadmus' approved EMV plan.

C.7.3 C&I Programs

Cadmus utilized the methodology outlined in the Phase III Evaluation Framework to calculate PY12 NTG values for the C&I Efficient Equipment (lighting and equipment) and Total Custom Programs. Data for Efficient Equipment (lighting and equipment) and Custom NTG calculations were gathered from participants using online and phone surveys. Spillover data for the Efficient Equipment program could not be quantified in a way that was useable in the NTG calculation, and the SWE recommends that future NTG spillover survey batteries be modified to allow for the quantification of spillover values (Table 191).

Cadmus did not conduct NTG research for the Midstream Lighting Program and applied the PY11 NTG values to the program.

The SWE determined that Cadmus utilized data collection, question bevies, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 191: Summary of NTG Estimates for PPL C&I Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
Estimated	Total Custom	0.39	0.0	0.61	13
PY11	Midstream Lighting	0.38	0.0	0.62	-
Estimated	Efficient Equipment (lighting)	0.28	0.0	0.72	61
Estimated	Efficient Equipment (equipment)	0.37	0.0	0.63	5

C.8 TRC

Table 192 shows the high-level TRC Test results for PPL in PY12 at the program level. The table shows benefits and costs, both gross and net, for each program in the PPL portfolio and overall, as well as the resultant TRC Ratios. The values shown in Table 192 differ slightly from PPL's PY12 Final Annual Report for two reasons. First, the SWE breaks out the non-residential EE program into its underlying components. We can do so because PPL's TRC model provides separate administrative costs for each program component. Second, the table reflects the reduction in TRC Benefits due to uplift within the Home Energy Education program results rather than at the portfolio-level. There may also be slight differences due to rounding.

Table 192: Summary of PPL's PY12 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
Appliance Recycling	$1,135	$1,749	0.65	$749	$1,749	0.43
Efficient Lighting	$0	$177	0.00	$0	$177	0.00
Energy-Efficiency Kits and Education	$0	$46	0.00	$0	$46	0.00
Energy-Efficient Home	$25,564	$17,807	1.44	$12,227	$9,527	1.28
Home Energy Education	$1,015	$2,388	0.43	$1,015	$2,388	0.43
Student Energy-Efficient Education	$7,463	$1,676	4.45	$7,463	$1,676	4.45
Low-Income WRAP	$3,530	$5,106	0.69	$3,530	$5,106	0.69
Custom	$48,804	$34,534	1.41	$29,771	$22,027	1.35
Efficient Equipment	$62,500	$24,101	2.59	$44,842	$18,299	2.45
Midstream Lighting	$26,160	$10,125	2.58	$16,219	$6,716	2.41
Demand Response	$4,452	$2,197	2.03	$4,452	$2,197	2.03
Portfolio Costs	$0	$6,997	N/A	$0	$6,997	N/A
Portfolio	**$180,625**	**$106,902**	**1.69**	**$120,269**	**$76,905**	**1.56**

PY12 benefit-cost results varied with some programs cost-effective and others not. Appliance Recycling, Home Energy Education, and Low-Income WRAP were all not cost-effective programs according to the gross and net TRC Test. The Efficient Lighting and Energy-Efficiency Kits and Education programs were both winding down in PY12, which is why they had no benefits, but still had costs associated with them. All other programs in PY12 saw benefits outweigh costs in PY12. The non-residential sectors accounted for 79% of the total TRC Benefits in PY12.

C.8.1 Notes from the Review of the TRC Model

Review of the TRC model finds that PPL correctly applied the EE&C plan discount rate (7.63%) and line-loss multipliers (1.042 for industrial applications and 1.0875 otherwise). NTG factors, including free-ridership and spillover, are applied appropriately in the net verified savings model. None of the items listed below are cause for concern about the material results of the TRC model and are noted here as comments or recommendations for adjustments to be made in future annual reporting.

- The SWE used the granular TRC measure impacts and assumptions to independently recreate the PY12 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 PY12 fossil fuel benefits through a similar process as described for the electric benefits. The derivation of these non-electric impacts was well-documented in PY12 with supporting workbooks for each program.
- The PY12 gross TRC model includes $6.7 million of O&M benefit, which is approximately 4% of all gross TRC Benefits. The O&M benefits have been reduced by half since PY11 when there were $12.8 million of O&M benefit. This is the result of the Efficient Lighting program winding down, which produced most of the O&M benefits in the form of avoided future lamp replacements.
- The SWE identified two minor inconsistencies while reviewing the PY12 TRC model. The residential CAC and ASHP measures both had their EULs set as 15 years while the 2016 TRM calls for EULs of 14 years and 12 years respectively. Since the 2021 TRM has the EUL for both measures set as 15 years, it may be the case that Cadmus relied on the 2021 TRM instead of the 2016 TRM.
- The calculation of demand response benefits was handled consistently with the directives of the 2016 TRC Test Order. Separate avoided cost of capacity assumptions was applied to the Small C&I and Large C&I sector and 75% of incentives to participants were included as TRC Cost.
- PPL followed SWE guidance regarding the dual baseline calculation for residential lighting. Specialty lamps were assigned one year of savings at the “pre-shift” savings level and 14 years of lower post-shift savings. The PPL model handles the dual baseline calculations expertly by including two distinct measures that overlap during the pre-shift period.

C.9 PROCESS

C.9.1 Residential Programs

Cadmus reported on PY12 process evaluations for four residential programs: The Appliance Recycling Program, the Energy-Efficient Home Program, the Home Energy Education Program, and the Student Energy-Efficiency Education Program.

Cadmus conducted limited process evaluations of these programs in PY12. Cadmus reviewed program materials, interviewed PPL and implementation staff, and surveyed program participants. The research issues addressed by the primary data-collection activities (in-depth interviews (IDIs) and surveys) varied by program, but generally included the effectiveness of program administration, implementation, and delivery; program satisfaction, participation, and challenges; and recommendations.

Cadmus followed the evaluation plan for each program’s process evaluation. In the case of deviations from the evaluation plan, Cadmus gave satisfactory explanations for why this happened, and, when possible, explained how the problem could be resolved in future evaluations.

The findings were clearly presented, and the conclusions were well supported by the findings overall. The conclusions were concise and informative, and the recommendations followed from the conclusions.

C.9.1.1 Appliance Recycling Program

Summary of Process Evaluation Findings

In PY12, Cadmus conducted a limited process evaluation that included one interview with ICSP program staff and an online participant survey.[61] The process evaluation findings for PY12 are summarized below:

- The Appliance Recycling Program experienced high levels of customer satisfaction despite changes to program operations due to COVID 19. Overall, 96% of survey respondents were satisfied with the program (n=172) and 96% were satisfied with the contractor who picked up their appliances (n=153).
- One-third of respondents (33%) provided suggestions for how PPL could improve the Appliance Recycling Program. The most common suggestions were about scheduling (34%).

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan with one exception, which was noted in the annual report. The evaluation plan for PY12 called for an interview with the ICSP's new contractor, but Cadmus conducted an interview with the ICSP's program staff to discuss participant satisfaction and review the overall status of program implementation, considering the changes the program made in response to COVID-19. For participant surveys, Cadmus contacted the entire sample with the goal of targeting as many completes as possible, achieving a final sample size of 166.

The methodology sections adequately explained the evaluation and included the required sampling and disposition information and tables.

The program findings were clearly summarized and presented in tables and figures and drew directly from the process evaluation activities. Cadmus found that the program functioned well in PY12 and did not have any recommendations.

C.9.1.2 Energy-Efficient Home Program

Summary of Process Evaluation Findings

Cadmus conducted a full process evaluation of the Energy-Efficient Home Program earlier in Phase III. In PY12, Cadmus conducted a limited process evaluation to assess participant

[61] Cadmus conducted a limited process evaluation of the Appliance Recycling Program in PY12. Cadmus conducted a full process evaluation earlier in Phase III. The PY12 limited process evaluation of the Appliance Recycling Program assessed participant satisfaction with the program.

satisfaction using data collected through online participant surveys. The findings from the process evaluation are detailed below.

- In PY12, 88% of respondents said they were satisfied with the Energy-Efficient Home Program. Compared to PY11 (91%), the satisfaction results are significantly lower; if the New Homes builders from PY11 are removed, the PY11 satisfaction score is 90%, which is more comparable. PY12 component-level satisfaction results were not significantly different from PY11.
- *PPL Electric Utilities has an opportunity to expand the reach of the Online Marketplace through an increase in the variety of products in the portfolio.* Respondents were highly satisfied with all but one aspect of their experience on the Online Marketplace: the selection of products available (71% satisfaction compared to over 80% for other factors). Of the 26 Online Marketplace respondents providing feedback, 12 requested a greater selection of rebate-eligible products. Though most did not specify what types of products they wanted to see, three respondents specifically suggested additional energy-efficient appliances, a wider selection of brands, and a wider selection of value-priced products.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan, except for stakeholder interviews. Cadmus originally planned to conduct three stakeholder interviews with PPL Electric Utilities, its ICSP, and the ICSP's subcontractor. Because the program did not experience major changes or updates in PY12, Cadmus conducted only one interview with PPL Electric Utilities.

For participant surveys, Cadmus targeted the entire population of 10,839 participants and achieved 715 completes across five strata. Tables included in the annual report also clarify the mode of the survey as it pertains to each sample size detailed in the table, which the SWE found helpful. The program findings were clearly summarized and presented in tables and figures, and while they drew from a mix of process and impact evaluation activities, the link to process evaluation activities was clear. There was one recommendation that followed from the process evaluation, which is under consideration.

C.9.1.3 Home Energy Education Program

Summary of Process Evaluation Findings

A full process evaluation of the Home Energy Education Program was conducted earlier in Phase III. In PY12, Cadmus conducted a limited process evaluation. Cadmus received updates about program delivery via email from the PPL Electric Utilities program manager, the ICSP, and the home energy reports vendor. As program delivery did not change between PY11 and PY12, Cadmus did not conduct formal staff interviews. Cadmus also completed a review of home energy reports. There were no key findings from the process evaluation. Cadmus noted that the program will be discontinued at the beginning of Phase IV.

Summary of Process Evaluation Audit

PPL Electric Utilities treated only LI waves in PY12. Because of the change in program design and the fact that Cadmus completed a full process evaluation with satisfaction for all waves in PY10, Cadmus did not conduct customer surveys in PY12. The process evaluation was consistent with the evaluation plan.

No process recommendations were made for program improvement in PY12.

C.9.1.4 Student Energy-Efficient Education Program

Summary of Process Evaluation Findings

Cadmus conducted a full process evaluation of the SEEE program in PY11. A limited process evaluation in PY12 assessed student participant satisfaction and teacher satisfaction with the program. Process evaluation activities undertaken by Cadmus included analysis of the home energy worksheets (HEWs) returned from kit recipients and one interview with program staff or implementers.[62] The program has three cohorts: Bright Kids (2nd-3rd grades), Take Action (5th-7th grades), and Innovation (9th-12th grades). In PY12, the ICSP and the ICSP's subcontractor continued the Innovation Pilot, which Cadmus evaluated as a separate cohort. The Innovation Pilot, for 9th-12th grade students, provided Tier 2 advanced power strips in place of Tier 1 smart strips for a subset of Innovation cohort classrooms. There findings from the process evaluation are detailed below.

- Of the 10,860 students who responded to the question, 79% said they were *very satisfied* (52%) or *somewhat satisfied* (27%) with the program overall, which was lower than the satisfaction level in PY11 (83% *very satisfied* or *somewhat satisfied*).
- Of the 50 survey teachers (six percent of participating teachers), 98% rated the program as *excellent* (18%) or *good* (18%). Bright Kids teachers rated their impression of the program as *Excellent* more often than the other cohorts.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan with the exception of fewer program staff interviews. The evaluation planned to complete three interviews with program and ICSP staff but only one was completed because there were no major program changes.

There were no planned sample sizes for the number of HEWs returned from students or teachers. A total of 10,860 student HEWs and 50 teacher HEWs were returned. The methodology sections adequately explained the evaluation and included the required sampling and disposition information and tables.

[62] Cadmus conducted a full process evaluation of the Student Energy-Efficient Education Program earlier in Phase III. For PY12, a limited process evaluation assessed participant satisfaction with the program.

The process evaluation findings were clearly summarized and presented in tables and figures. The key findings presented in the recommendation section were related to impact evaluation activities only. No process recommendations were made for program improvement in PY12.

C.9.1.5 Efficient Lighting

No process evaluation was conducted in PY12 because this program is no longer being offered.

C.9.2 LI WRAP Program

Summary of Process Evaluation Findings

Cadmus conducted a full process evaluation of the Winter Relief Assistance Program earlier in Phase III. In PY12, Cadmus conducted a limited process evaluation to assess participants' and multifamily building property managers' satisfaction with the WRAP. Cadmus conducted a telephone survey with participants, three interviews with PPL program staff and ICSP staff, and five interviews with home energy auditors and inspectors. The findings of the process evaluation are summarized below.

- 97% of PY12 survey respondents were satisfied (83% were *very satisfied* and 14% were *somewhat satisfied*).
- Despite the switch from in-home to remote home energy audits in PY12, Cadmus found that the ICSP continued to deliver WRAP well in PY12. The ICSP created a phone script for the home energy auditor to use during the remote energy assessment.
- Three of the five home energy auditors interviewed said the virtual format allowed them to complete more assessments per day because there were no travel requirements.
- Program participants, the ICSP coordinator, and home energy auditors provided suggestions for program improvements, including providing more customer education about the program and the products installed and improving communication with customers.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan, with one exception. Cadmus did not conduct interviews with master-metered multifamily property managers because no jobs were completed in master-metered multifamily units in PY12.

Sample sizes in the final process evaluation matched the evaluation plan for interviews with EDC staff and market actors. Cadmus also included useful detail in the tables, breaking down sample sizes and research activities within the annual report, including the mode of the survey.

The program findings were clearly summarized and presented in tables and figures in the annual report. Findings drew from a mix of process and impact evaluation activities, but the link to process evaluation activities was clear. Cadmus provided two recommendations that followed from the process evaluation; one recommendation was implemented and the other is under consideration.

C.9.2.1 Energy-Efficiency Kits and Education Program

Cadmus did not conduct a process evaluation of this program in PY12 because the program is no longer being offered.

C.9.3 C&I Programs

The revised EE&C plan in October 2017 combined the Custom and Efficient Equipment programs into a single program called the Non-Residential Energy-Efficiency program. For purposes of the PY12 evaluation, Cadmus treated each component of this program as individual program offerings and evaluated them separately. Cadmus reported on PY12 process evaluations for three non-residential program offerings: Non-Residential Custom Program, DR Program, and the Non-Residential Energy-Efficiency Program, which has four distinct components: Efficient Equipment, Midstream Lighting, Custom, and CEI.[63]

For the process evaluations of the above program offerings, Cadmus reviewed program materials, interviewed PPL and implementation staff, surveyed program participants, and conducted market actor interviews with distributors and contractors. The document and program data review helped to clarify program goals, activities, and updates. The research issues addressed by the primary data-collection activities (IDIs and surveys) varied by program, but generally included the effectiveness of program administration, implementation, and delivery; program awareness; customer and market actor program satisfaction, participation, and challenges; and recommendations.

Cadmus followed the evaluation plan for each program's process evaluation for the most part, though there were some exceptions to this, centered around sample size issues for various research activities. These will be covered in each program's respective process evaluation audit summary below. In the case of deviations from the evaluation plan, Cadmus provided satisfactory explanations for why this happened, and, when possible, explained how the problem could be resolved in future evaluations.

The findings were clearly presented, and the conclusions were well supported by the findings overall. The conclusions were mostly concise and informative, and the recommendations followed from the conclusions.

C.9.3.1 Efficient Equipment Program

Summary of Process Evaluation Results

Cadmus performed the process evaluation for the Efficient Equipment Program, which included interviews with PPL and ICSP program managers and a mix of phone and online participant surveys.[64] The results of the overall process evaluation are summarized below:

[63] In PY12, the CEI component of the Non-Residential Energy-Efficiency Program was not evaluated because it is no longer being offered.
[64] Cadmus conducted a full process evaluation of the Efficient Equipment Program earlier in Phase III. The PY12 limited process evaluation of the program assessed participant satisfaction with the program.

- 91% of PY12 respondents were satisfied with the overall program (71% were *very satisfied* and 20% were *somewhat satisfied*).
- In PY12, respondents were most satisfied with the professionalism of the program representatives (98%). Satisfaction with information about the application process decreased from 94% in PY11 to 84% in PY12, a statistically significant change. Satisfaction with all other program components increased from PY11 to PY12.
- When asked what could be changed about program-related communication, 27% of respondents provided suggestions to change program-related communication. The most common suggestion was to provide more information and updates about available programs and rebates (n=5).
- 39% of respondents said their project was impacted by the COVID-19 pandemic, with impacts on their project timing and/or scope.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan. The target for 69 participant surveys was achieved: five equipment prescriptive and direct discount participants, 37 prescriptive lighting participants, and 27 direct discount lighting participants. Cadmus also conducted two interviews with PPL Electric Utilities and ICSP staff.

Cadmus included useful detail in the tables, breaking down sample groups, sample sizes, and research activities within the annual report, including the mode of the survey. All process evaluation research activities included in the evaluation plan for PY12 were performed as planned.

The program findings were clearly summarized and presented in tables and figures, and, while they drew from a mix of process and impact evaluation activities, the link to process evaluation data was clear. The program functioned well in PY12 and there were no process recommendations made for program improvement.

C.9.3.2 Midstream Lighting Program

Summary of Process Evaluation Results

Cadmus conducted a full process evaluation of the Midstream Lighting Program in PY12. The process evaluation included interviews with PPL Electric Utilities Program and ICSP staff, telephone interviews with participating distributors, and telephone interviews with purchasers (including end users and contractors). The findings of the process evaluation are summarized below.

- 92% of distributors were satisfied with the Midstream Lighting component.
- Distributors are the core drivers of awareness for the program. All eight contractors said they first learned about the program, either verbally or through marketing materials, from their distributor.

- Due to COVID-19, the ICSP had moved to a fully virtual distributor outreach and audit process, which it found was effective. Distributors agreed, as evidenced by similar distributor satisfaction ratings in PY12 as in PY11.
- *Distributors and contractors are not fully aware of the full set of products offered through the program.*
    - The most common request was to add more products to the program, with six of seven distributors specifically mentioning area or outdoor lighting. This request is consistent with feedback from prior program years, and several distributors noted they have provided this feedback multiple times. One distributor specifically mentioned adding more products that are common in the commercial sector, such as additional SKUs for tubes, flat panels, and high bays, as opposed to BR30s and PAR38s.
    - Two contractors offered suggestions for how to improve the program, and both requested that more products be added. One contractor said eight-foot fluorescent lamps should be covered through the program. Cadmus confirmed that these products are already offered by the program. Another contractor asked for panel boards and switch gears to be added to the program.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan with one exception. Cadmus indicated that it would not complete end-user segmentation analysis or benchmarking in PY12 unless it is requested by PPL Electric Utilities. Cadmus conducted 12 distributor interviews, short of the target of 15 interviews.

Cadmus included useful detail in the tables, breaking down sample groups, sample sizes, and research activities within the annual report, including the mode of the survey. Cadmus conducted 12 distributor interviews, short of the target of 15 interviews, despite contacting all 23 distributors multiple times. Cadmus targeted up to 15 interviews with contractor purchasers and achieved eight.

The program findings were clearly summarized and presented in tables and figures, and, while they drew from a mix of process and impact evaluation activities, the link to process evaluation data was clear. There was one recommendation that followed from the process evaluation, which is under consideration.

C.9.3.3 Continuous Energy Improvement

No process evaluation was conducted in PY12 because the program is no longer being offered.

C.9.3.4 Custom Program

Summary of Process Evaluation Results

The process evaluation for the Custom Program included two interviews with PPL and ICSP program managers and a mix of phone and online participant surveys.[65] The findings of the process evaluation are summarized below.

- 92% of PY12 respondents were satisfied with the program (42% were *very satisfied* and 50% were *somewhat satisfied*).
- All participants were satisfied with the professionalism of program representatives (58% *very satisfied* and 42% *somewhat satisfied*).
- *Despite high satisfaction with the program, some respondents reported difficulty with program-related communication.*
    - Three respondents (n=12) suggested more proactive or clearer communication, one suggested sending communication to more than one contact, and one suggested assigned an account manager to customers with multiple accounts.
    - When asked about satisfaction with the Custom Program, 25% (n=12) of respondents reported being *very satisfied* and 58% reported being *somewhat satisfied* with the information provided about the rebate process (the lowest-scoring satisfaction category).
    - While 83% of respondents were satisfied with the ability to track their rebate in the portal, one suggested more clarity on how to review project status through the portal.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan.

Cadmus included useful detail in the tables, breaking down sample groups, sample sizes, and research activities within the annual report, including the mode of the survey. Cadmus aimed to complete participant surveys with as many participants as possible; of 37 participants selected for the sample frame, Cadmus completed interviews with 12 participants. All process evaluation research activities included in the evaluation plan for PY12 were performed as planned.

The program findings were clearly summarized and presented in tables and figures, and, while they drew from a mix of process and impact evaluation activities, the link to process evaluation

[65] Cadmus conducted a full process evaluation of the Custom Program earlier in Phase III. The PY12 limited process evaluation of the program assessed participant satisfaction with the program.

data was clear. There was one process recommendations made for program improvement in PY12; the recommendation was implemented.

C.9.3.5 DR Program

Summary of Process Evaluation Results

During Phase III, PPL Electric Utilities is operating the DR Program for C&I customers and for government, nonprofit, and education (GNE) customers. CPower, the ICSP, enrolls and contracts with customers to reduce electricity demand during Act 129 DR events. In PY12, PPL initiated five load curtailment events. Cadmus performed the process evaluation, which included interviews with PPL Electric Utilities and ICSP program managers and surveys with participants. The findings of the process evaluation are summarized below.

In PY12, five of six respondents were satisfied with the Demand Response Program – two were *very satisfied* and three were *somewhat satisfied*.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were mostly consistent with the Phase III Evaluation Plan, except for fewer completed participant surveys than targeted. Despite multiple attempts, Cadmus gathered data for six completed surveys, which was less than the target of 12 completed surveys.

Cadmus included useful detail in the tables, breaking down sample groups, sample sizes, and research activities within the annual report, including the mode of the survey. All process evaluation research activities included in the evaluation plan for PY12 were performed as planned except for the sample target issue mentioned above.

The program findings were clearly summarized and presented in tables and figures, and, while they drew from a mix of process and impact evaluation activities, the link to process evaluation data was clear. Because the program did well in PY12 and will not be delivered in Phase IV, there were no process recommendations made for program improvement.

Appendix D Duquesne Light PY12 Audit Detail

D.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of Duquesne Light's PY12 Annual Report and the supporting detail provided by Duquesne's evaluation contractor.

- Duquesne Light's DR performance in PY12 was approximately 40% lower than the first three summers of Phase III dispatchable demand response. Impacts were especially low during the two August 2020 events as the number of active participants shrank. The roster of enrolled C&I customers at Duquesne Light included several universities and public assembly facilities clearly affected by economic shutdown activities in the region. This finding supports the Commission's decision to make PY12 DR performance voluntary and base Phase III compliance on the average performance PY9 through PY11.
- Duquesne Light is among the least HER-reliant EDCs in Pennsylvania and the PY12 contribution was the lowest of Phase III on both a MWh and percent of portfolio basis. The SWE's HER audit uncovered some issues with the data exchange procedures between Duquesne Light and the ICSP, which should be refined in Phase IV. Duquesne Light launched a dedicated LI cohort in July 2018 that has failed to deliver MWh savings to date and dwindled in size to approximately 2,000 treatment group and 2,000 control group. Given the poor performance to date and lack of statistical power for measurement of impacts, the SWE recommends Duquesne Light discontinue this cohort in Phase IV. The active households could be randomized into a new cohort.
- PY12 residential project files responses were adequate and the supporting details were provided.
- The SWE's review of verified savings for non-HER residential programs found that, overall, the verified savings followed proper TRM protocols and that 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 only noted a few minor discrepancies.
- The SWE's review of PY12 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, including adherence to the COVID-19 EM&V Guidance Memo; and were generally accurate.
- The SWE team found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY12 annual report. The SWE notes that Duquesne Light used the TRM EUL of 15.0 years for early replacement (ER)/retrofit Whole Home A-lamps as

part of the Multifamily Housing Retrofit and LI Whole House Retrofit programs. However, per the memo *Dual Baseline Assumptions for Screw-In LED Lighting in PY11 and PY12 TRC Test*, the bulbs' first- and second-years' wattages (post-EISA 2007 Watts) should be used as the baseline and adjusted to Post-2020 Watts for 13 years. The adjustment reduces the EUL to 3.1 years for 9 Watt and 15 Watt Whole Home LEDs and 3.3 years for 11 Watt Whole Home LEDs. The reduction in EUL lowers the gross benefits of the two programs.

    - Duquesne Light's non-residential EE incentives as a share of estimated incremental cost was by far the highest statewide in PY12 at 38.6%.

- Overall, Guidehouse estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- The SWE determined that the reporting for the process evaluations followed the SWE guidelines. In PY12, Guidehouse conducted process evaluations for two C&I programs: the Public Agency Partnership Program (PAPP) and the Midstream Lighting Program (ML). Evaluation activities conformed with the evaluation plan, and customer survey sample design and attempts to contact participants were well-documented.

D.2 EM&V Plan Reviews

Duquesne Light's evaluation contractor, Guidehouse (formerly Navigant), submitted a redline version of their PY12 EM&V plan with minor adjustments to the evaluation approach. In addition, Guidehouse submitted a sampling plan memo that provided more details on their sampling plans for PY12 evaluation activities. The SWE reviewed and approved the plans and memos.

In addition to reviewing Duquesne Light's revised evaluation and sampling plans, the SWE reviewed and approved survey instruments and interview guides for the Midstream Lighting program and the Public Agency Partnership Program.

D.3 Sample Design Review

Each program in Duquesne Light's portfolio is not evaluated in every program year. As approved by the SWE in the EM&V Plan, some programs rely on the verification results from a previous year's evaluation and some programs rely on "rolling" samples where projects from multiple program years are combined to calculate the realization rates used to compute verified gross energy and demand savings.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at 85% confidence level for each "initiative." For Phase III of Act 129, the SWE established precision requirements at the initiative level instead of by program. This change did not affect Guidehouse's evaluation because Duquesne Light's Phase III EE&C plan already defined programs narrowly into logical initiatives. Guidehouse's evaluation activities for Duquesne Light were grouped by program and samples were designed to meet or exceed the 85/15 sampling requirement for each program. The REEP included multiple initiatives (kits, rebates, and upstream lighting), which were sampled separately. The LIEEP was similarly composed of

discrete initiatives (whole house retrofit, behavioral, multifamily housing retrofits, and kits). Table 193 shows the relative precision at the 85% confidence level of the PY12 energy savings for each program. Table 193 also includes notes about how data collection activities from multiple program years are synthesized to develop the PY12 realization rates and associated uncertainty.

Table 193: Relative Precision of PY12 Gross Verified Energy Savings Estimates by Initiative

Program / Initiative	RP at 85% Confidence Level (±)	Notes
Residential Energy-Efficiency	12.1%	Leverages PY11 online participant surveys and PY12 file reviews.
Residential Appliance Recycling	0.6%	PY11 surveys + PY12 tracking data review
LI Energy-Efficiency	4.9%	PY11 realization rates applied to PY12.
Commercial/Express Efficiency	7.4%[1]	PY11-PY12 rolling sample
Midstream Lighting	16.3%	PY10-PY12 combined sample.
Multifamily Housing Retrofit	5.8%	PY10 realization rates applied to PY12.
Industrial	4.0%[1]	PY11-PY12 rolling sample
Public Agency Partnership	10.5%	PY11-PY12 rolling sample

[1]SWE converted Guidehouse's reported RP from 90% to 85% confidence level for consistency in this table. Guidehouse reports these initiatives at 90% confidence based on a prior SWE request.

The only evaluation initiative that does not meet the ±15% relative precision requirement in Table 193 is Midstream Lighting. Precision has been a challenge for this program throughout Phase III due to significant variation between reported and verified savings. For Phase IV of Act 129, EDCs are not allowed to utilize historic realization rates that failed to meet precision requirements. As a result, Guidehouse will either need to conduct an impact evaluation of the Midstream Lighting program in PY13 or classify the savings as unverified until an impact evaluation can be completed in PY14.

Duquesne Light adjusted some of its sampling procedures in response to the COVID-19 pandemic. Several programs used phone interviews in place of on-site visits. In some cases, on-site visits were still conducted with COVID-19 safety protocols in place. Sampling uncertainty does not consider the level of rigor of the verification activities. Results from a sampled project that receives a desk review with phone interview from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of Guidehouse's PY12 verification activities is discussed in detail in Appendix D.5.

Not all programs rely on sampling to estimate verified savings. For the Residential Behavioral Savings program, the impact evaluation relies on a statistical billing analysis of all participants, so there is no uncertainty associated with sampling. The precision requirements for the behavioral

program are unique, with the Phase III Evaluation Framework requiring the solution-level verification achieve an *absolute* precision of ±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 ±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 program and found the treatment and control group sizes were adequate to achieve ±0.5 absolute precision at the 95% confidence level in aggregate.

For the Large Curtailable Load program, DR savings calculations are based on comparison to an estimated baseline a customer event-day. While there is no sampling error for these initiatives, there is estimation error because the CBLs and regression models are unable to perfectly fit the data. The variation that is not captured by the model produces estimation uncertainty. The relative precision of the PY12 verified DR MW savings from the Large Curtailable Load program was ±49% at the 90% confidence level.

D.4 Reported Gross Savings Audits

D.4.1 Tracking Data Review

This section of the memo summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Duquesne Light's PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)
- Reported gross peak demand savings (MW)
- Participation
- Incentive dollars

The SWE leveraged Duquesne Light's Q1-Q4 tracking data submissions 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 PY12 quarterly data request. Also note that DR or 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 DR program can be found in Appendix D.6, and our findings regarding Duquesne Light's Residential Behavioral Savings program (and the HER component of the LIEEP) can be found in Appendix D.5.1.3.

Table 194 summarizes our ex-ante findings regarding energy savings. The "Match" column contains "Yes" if the tracking data supports the Annual Report and "No" otherwise. Note that the Residential Appliance Recycling program is called "RRP Refrigerator Recycling" in the tracking data. For each program, the SWE was able to replicate Duquesne Light's reported gross energy savings. The totals shown for the LIEEP do not include the HER component.

Table 194: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Commercial Efficiency	10,552	10,552	Yes
Express Efficiency	6,339	6,339	Yes
Industrial Efficiency	44,576	44,576	Yes
Large Midstream Lighting	1,365	1,365	Yes
LI Energy Efficiency (LIEEP)	3,160	3,160	Yes*
Multifamily Housing Retrofit	1,506	1,506	Yes
Public Agency Partnership	18,882	18,882	Yes
REEP: Residential Energy Efficiency	1,175	1,175	Yes
Residential Appliance Recycling	1,101	1,101	Yes
Small/Medium Midstream Lighting	2,626	2,626	Yes
Portfolio Total	**91,282**	**91,282**	**Yes***

*The LIEE program has an HER component that is excluded from this table.

Table 195 summarizes the SWE's findings regarding reported gross peak demand savings by program. For each program, we were able to replicate the values reported by Duquesne Light.

Table 195: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Commercial Efficiency	1.52	1.52	Yes
Express Efficiency	0.96	0.96	Yes
Industrial Efficiency	6.12	6.12	Yes
Large Midstream Lighting	0.25	0.25	Yes
LI Energy Efficiency (LIEEP)	0.28	0.28	Yes*
Multifamily Housing Retrofit	0.16	0.16	Yes
Public Agency Partnership	2.98	2.98	Yes
REEP: Residential Energy Efficiency	0.30	0.30	Yes
Residential Appliance Recycling	0.12	0.12	Yes
Small/Medium Midstream Lighting	0.48	0.48	Yes
Portfolio Total	**13.17**	**13.17**	**Yes***

*The LIEE program has an HER component that is excluded from this table.

Table 196 summarizes the SWE's ex-ante findings regarding program participation. For all programs except for Small/Medium and Large Midstream Lighting, the SWE was able to replicate the participation count provided by Duquesne Light or calculate a directionally similar value. The

tracking data cannot be used to duplicate participation for the two Midstream Lighting programs because the SWE is not provided the service account number for participants, which is needed to perform the calculations. We recognize the need to protect personally identifiable information and do not view our inability to count participants as a concern for this offering.

Table 196: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Commercial Efficiency	43	43	Yes
Express Efficiency	237	237	Yes
Industrial Efficiency	32	32	Yes
Large Midstream Lighting	75	0	No
LI Energy Efficiency	656	656	Yes*
Multifamily Housing Retrofit	26	26	Yes
Public Agency Partnership	190	190	Yes
REEP: Residential Energy Efficiency	4,839	4,839	Yes
Residential Appliance Recycling	1,022	1,022	Yes
Small/Medium Midstream Lighting	158	0	No
Portfolio Total	**7,278**	**7,045**	**No**

*The LIEE program has an HER component that is excluded from this table.

Finally, Table 197 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE was able to produce directionally similar (if not equal) incentives for each of Duquesne Light's programs. 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 197: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Commercial Efficiency	$920	$637	No
Express Efficiency	$572	$473	No
Industrial Efficiency	$2690	$2306	No
Large Midstream Lighting	$250	$241	No
LI Energy Efficiency	$195	$31	No
Multifamily Housing Retrofit	$441	$285	No
Public Agency Partnership	$1,633	$1,659	No
REEP: Residential Energy Efficiency	$278	$278	Yes
Residential Appliance Recycling	$38	$27	No
Small/Medium Midstream Lighting	$473	$384	No
Portfolio Total	**$7,490**	**$6,321**	**No**

D.4.2 Project File Reviews

D.4.2.1 Residential

The SWE conducted a project file review for a sample of Duquesne Light's residential programs in PY12 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 198 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 198: Duquesne Light PY12 Residential Project File Review Summary

Program	Sub Program	Number of Files Reviewed	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[1]
Residential Energy-Efficiency	Appliance Rebates	8	✓	✓	✓	✓
Residential Energy-Efficiency	Efficiency Kits	16	✓	✓	✓	✓
Residential Appliance Recycling	N/A[2]	N/A	✓[2]	✓[2]	✓	✓[2]
Residential WHRP	Direct Install	8	✓	✓	✓	✓[3]

[1] It should be noted that while the data typically matches, minor discrepancies were found and are detailed in the paragraphs below.
[2] Appliance Recycling data was provided in a spreadsheet, but no accompanying files were available to confirm values in tracking data. As noted in the Duquesne Light PY10 Final Annual Report, the CSP does not provide nameplate photographs of recycled equipment (and is not required to do so by the contract with Duquesne Light).
[3] The provided data covered projects where individual tenant occupants were engaged, and others where a landlord/building manager was engaged. It should be noted that individually metered tenants in multifamily houses are reported under this program (rather than the Multifamily Housing program).

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.

Appliance Rebate Subprogram

The Appliance Rebate Subprogram had project files containing invoices for ten projects performed as part of the subprogram for each quarterly submission. The SWE was not concerned with the listed installation dates in the project files not matching the tracking data, as Guidehouse had previously explained that the installation date as listed in tracking data reflects the project receipt date in their system. The SWE verified that almost all reviewed project files matched the tracking data. There was one observed instance where the tracking data reported a lower quantity for an appliance then what appeared in the files. Similar to the previous program years, the SWE observed a continued trend of rounding HVAC capacity data to the nearest whole value in the tracking data. For example, the SWE observed a two-and-a-half-ton system being rounded to three tons. The SWE notes that any deviation to reported savings as a result of this rounding is accounted for in the evaluated realization rate and therefore verified savings are adjusted accordingly. Efficiency of HVAC equipment was coded into the measure name in the quarterly tracking data, and values were hardcoded in data files, making it difficult to verify exactly what values were used for tracking savings calculations, and if the original, exact values from project files had been uploaded in their correct form at any point before possibly being rounded.

Efficiency Kits Subprogram

The Efficiency Kit Subprogram project files included compiled invoices that detail the quantity of purchased kits, and notes detailing the distribution of kits for each quarter including the excess kits. The SWE verified that the contents and total count of kits in the project file invoice documentation, considering kits that appeared on the invoices but had not yet been distributed. The SWE observed that the quantity of kits covered in the tracking data had a slight discrepancy with the project file documentation, but the evaluator corrected values in subsequent follow-up quarterly data submissions. The SWE reviews the specs and savings calculations for kit packages during the verified savings review when that information is provided.

Upstream Lighting Subprogram

The Upstream Lighting Subprogram had no activity for PY12. This program concluded in PY11. The SWE had no files to review for this program.

Appliance Recycling Program

For the Appliance Recycling Program, a list of projects was provided in the quarterly tracking data upload. The list of projects included information such as: age, cubic feet, configuration, etc. The projects were found in the residential downstream database and were applied a default savings value in the reported savings. There were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance.

Whole Home Retrofit Program (WHRP)

The Whole Home Retrofit Program project file packages included documentation for measures directly installed during the audit. The evaluator, Guidehouse, provided substantial data covering both audit-based and building-level WHRP projects.

In an improvement from PY11, Guidehouse provided measure-level tracking data for individual projects, which allowed the SWE to verify project file documentation in the tracking database. Overall, the SWE found that tracking data matched the measures and quantities in project documentation. Occasionally an invoice was missing for a particular unit; however, this was a minor issue, and such units were often documented elsewhere. Overall, the SWE was impressed with the thoroughness of the documentation provided by Guidehouse.

D.4.2.2 Non-Residential

The SWE reviewed a sample of Duquesne Light's Small C&I, Large C&I, and GNI projects for PY12 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 199 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 199: Duquesne Light PY12 C&I Project File Review Summary

Program	Number of Files Reviewed	Are all files included?	Do the dates, kWh, kW, and rebate amounts match?	Does scope of work match between invoices and calculations?	Is there sufficient informati-on for the SWE to follow?	For TRM measures, are correct algorithms and inputs used?	Does the data in the files match the tracking data?
Express Efficiency	10	✓	6/10*	9/10*	✓	✓	✓
Multifamily Housing Retrofit	3	✓	2/3*	✓	✓	✓	✓
Industrial Efficiency	8	✓	✓	✓	✓	✓	✓
Commercial Efficiency	6	✓	5/6*	✓	✓	✓	✓
Public Agency Partnership Program	14	✓	11/14*	12/14*	✓	✓	✓

*Number of satisfactory files out of total reviewed. See program specific notes below.

Express Efficiency

The SWE reviewed ten projects for the Express Efficiency program and found most projects to be accurate. The SWE noted four projects in which the rebate incentives listed in the tracking data did not match the provided calculation workbooks and/or rebate applications. For one project, the scope of work did not match between invoices and calculations.

Multifamily Housing Retrofit

In total, three project files were reviewed by the SWE for this program. Of these three projects, one project had date discrepancies between the tracking data and calculation workbooks or rebate applications.

Industrial Efficiency

The SWE reviewed eight project files from the Industrial Efficiency program. From this review, the SWE found all project files to be complete and mostly accurate.

Commercial Efficiency

The SWE reviewed six project files and found all to be complete and mostly accurate. For one project there was a date discrepancy between the tracking data and rebate application.

Public Agency Partnership Program (PAPP)

The SWE reviewed a total of 14 project files for this program. Of those reviewed files, three had date discrepancies between the tracking data and calculation workbooks or rebate applications.

The SWE found two projects where quantities of fixtures did not match between invoices and calculations provided.

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: REEP, Residential Appliance Recycling Program (RARP), Residential Behavioral Program, WHRP, and the LIEEP. Note that the SWE reports the residential savings in the following three sections: upstream lighting, residential non-lighting, and behavior.

Table 200 provides a summary of the evaluation and M&V approaches used by Duquesne Light in their PY12 verified savings calculations.

Table 200: Residential Program Evaluation Activities – Duquesne Light Company

Program/ Subprogram	Surveys	Site Visits	Desk Review[a]	Billing Analysis	Applied Historic RR
Residential Energy-Efficiency Rebate Program (REEP)	-	-	✓	-	✓
REEP: Energy-Efficiency Kits	-	-	✓	-	✓
Residential Appliance Recycling[b]	-	-	✓	-	✓
Residential Behavioral Savings	-	-	-	✓	
LI Energy-Efficiency Program (LIEEP)	-	-	✓	-	✓

[a] The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.
[b] The Residential Appliance Recycling Program used survey results from PY11.

D.5.1.1 Upstream Lighting & Cross-Sector Sales

Duquesne Light did not offer an upstream lighting program in PY12.

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 Energy-Efficiency Program (REEP)

The SWE audited both components – rebates and energy-efficiency kits – of the REEP. The rebate component comprises several HVAC and ENERGY STAR appliance measures, including air source heat pumps, central air conditioners, dehumidifiers, ductless mini splits, room air

conditioners, freezers, refrigerators, programmable thermostats, and high-efficiency heating fans. The kit portion of the REEP program comprises three energy-efficiency kits:

- Apogee LED Kit – distributed to those who completed an online home energy audit:
  - Four 9-watt bulbs
  - Two 11-watt bulbs
  - Two 15-watt bulbs
  - Two LED nightlights
- Four bulb LED kit – distributed through Duquesne Light's targeted community outreach programs:
  - Two 9-watt bulbs
  - One 11-watt bulb
  - One 15-watt bulb
- LED lamp giveaways – distributed at outreach events:
  - One 9-watt LED
  - One LED night light

The SWE found that the sample sizes and participation counts matched what was reported in the PY12 annual report, and that verified savings and realization rates for rebated measures were correct.

Residential Appliance Recycling Program

The Residential Appliance Recycling program covers the recycling of older model refrigerators and freezers.

Guidehouse again provided the PY12 impact analysis for the Residential Appliance Recycling program early. This afforded the SWE ample time to conduct its audit. Following the approved PY12 Evaluation Plan, Guidehouse reviewed the program tracking data to verify measure eligibility and determine realization rates. The SWE verified the savings calculations and realization rate were correct.

LI Energy-Efficiency Program

Duquesne Light offers REEP kits to LI customers and attributes savings to the LIEEP Program. The SWE's review of these kits found that that the realization rates and verified savings were accurate.

In PY12 the WHRP served LI residential customers, providing them with a low or no-cost energy audit and a range of directly installed energy saving measures. The SWE's review of WHRP found that proper TRM protocols were followed by the evaluator, and that the realization rates and verified savings were accurate.

D.5.1.3 Behavior

Approximately 7% of Duquesne Light's verified gross energy savings for PY12 came from Home Energy Reports issued to around 60,000 residential and residential-LI households. While

Duquesne Light was among the least HER-reliant EDCs for portfolio energy savings in PY12, 28.2% of Duquesne Light's progress toward its LI target in PY12 came from HERs. Duquesne Light's behavioral portfolio consists of the four different waves, or cohorts, of homes. The average number of active households during PY12 are summarized in Table 201, by cohort. Duquesne Light has two market rate cohorts which began receiving HERs in 2012 and 2015, and two cohorts targeting LI households. The LI cohorts began receiving HERs in March 2015 and July 2018. A portion of savings from the market rate cohorts are assigned to the low-income sector based on market research conducted in 2016.

Table 201: Duquesne Light HER Cohort Summary

Wave	First HER Mailing	Treatment Group Homes	Control Group Homes	Percent Low-Income
2012 Market Rate	July 2012[66]	12,759	33,487	3.5%
2015 Market Rate	March 2015	34,394	12,510	4.2%
2015 Low-Income	March 2015	8,698	4,369	100%
2018 Low-Income	July 2018	2,201	2,183	100%

The program ICSP Oracle implemented each of the four waves as a randomized control trial (RCT) where the eligible households were identified and then randomly assigned to either a treatment or control group. Following randomization, Guidehouse conducted statistical tests on the pre-treatment energy usage patterns to confirm they are similar for the treatment and control groups.

The SWE team performed a detailed audit of the experimental design for the RCT cohorts, regression-based HER savings estimates, and recipient household counts using data provided by Guidehouse. The SWE team first used Guidehouse's prepared data and regression model to confirm the savings estimates provided by Guidehouse. To ensure the PY12 data processing was sound, the SWE conducted an independent analysis following industry standard data preparation procedures of the raw billing data and the same regression model specification. The SWE team successfully replicated the savings values produced by Guidehouse within a few MWh. The cleaned data was used to estimate the per-home average daily impacts by month using regression analysis and the coefficient estimates were multiplied by the number of days in the month and number of active customers in the month to arrive at aggregate monthly MWh savings.

Regression Analysis

Duquesne Light used a lagged dependent variable (LDV) regression model for the PY12 impact analysis as called for in the PY12 EM&V plan and the model specification implemented matches the specification called for in the EM&V plan exactly.

[66] The 2012 Market Rate cohort did not receive HERs from June 2013 to February 2015.

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 study period. 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. In this way, regardless of if a household received a bill during a given month, each customer that has some represented consumption in a given month or a month later in the program year will be counted toward the active participants in that month.

A customer does not necessarily need to be included in the regression analysis to be considered an active customer. For example, if a customer does not have pre-treatment representation for a given month, the household cannot be included in the LDV regression, but will count toward the customer count because they were active during the evaluation month. As a result, the number of households used to estimate impacts in Guidehouse's prepared dataset is slightly lower than the participation count used to compute aggregate MWh savings. This difference is expected with the LDV model specification and SWE team was able to reproduce Guidehouse's customer counts exactly.

Inconsistent Active Dates

The original dataset from Oracle showed roughly 7,400 customers that had an "account start date" listed after their cohort start date. The SWE flagged this as anomalous because accounts must exist to be assigned to the program. The Guidehouse team worked with Oracle and Duquesne Light to investigate and resolve the issue for the majority of affected the customers. When there is a gap in the billing data transfer from Duquesne Light, Oracle assigns placeholder account start and inactive dates in these edge cases. Following an investigation of the affected accounts, Oracle provided the Guidehouse team with an update billing data extract, which was used to produce the final verified results for PY12.

Impacts

The MWh savings, calculated by the SWE team from regression analysis and active participant counts, match Guidehouse's estimates and are shown in Table 202. It is important to keep in mind that these values still face further processing due to adjustment for dual participation in other programs and LI reclassification which are described in further detail below.

Table 202 shows the aggregate PY12 pre-adjustment MWh savings by wave. Aggregate savings align with the size of the cohort, with the largest savings coming from the 2015 Market Rate cohort and the 2018 cohort smallest savings in the LI cohorts. The 2012 Market Rate cohort had the largest per-home average kWh savings in PY12. The LI cohorts are smaller than the market rate cohorts in terms of number of treatment group homes. By looking at the average percentage savings, the savings can be more directly compared across cohorts. The 2015 Low-Income cohort has the largest percent savings. Average kWh savings per home and percent savings are calculated before dual participation adjustment.

Table 202: PY12 HER Energy Savings

Wave	Pre-Adjustment Savings (MWh)	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Gross Verified Savings (MWh)	Average kWh Savings per Home	Average % Savings
2012 Market Rate	3,053	564	75	2,415	234	1.9%
2015 Market Rate	5,101	1,589	105	3,407	144	1.5%
2015 Low-Income	1,961	275	51	1,635	215	2.2%
2018 Low-Income	(105)	48	(3)	(149)	(45)	(0.5%)
Total	**10,010**	**2,476**	**227**	**7,308**	**167**	**1.6%**

Dual Participation

In Table 202, calculated pre-adjustment savings were 10,010 MWh. It is important to note that Home Energy Reports advertise other Duquesne Light residential EE&C programs and measures such as ENERGY STAR appliances, efficient lighting, HVAC etc. To the extent that treatment group households participate in these programs more frequently than control group homes, the incremental savings is captured in the regression estimates for the HER analysis. To avoid double-counting, the HER savings are reduced to account for the incremental program participation observed in the treatment group compared to the control group.

The downstream dual participation was heavily influenced in PY10 and PY11 by a strong push of energy-efficiency kits. In PY10 the realization rates for the energy-efficiency kits were 75%. To mitigate for the large impact these energy-efficiency kits had on the HER impacts, Guidehouse developed logic to ensure downstream programs are fairly and accurately represented in the uplift adjustment. The logic implemented for downstream savings is as follows:

- Use reported values for most cases. This is consistent with the guidance in the Evaluation Framework which characterizes the use of gross verified or net verified values as option. "*Evaluation contractors can choose to apply the realization rate and NTGR for the relevant program year if those values are available at the time of the analysis*."[67]
- If downstream savings exceed 5% of gross verified HER savings, Guidehouse will examine savings by program, initiative, or measure to identify the primary contributors.

[67] Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs https://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework050818.pdf Page 129

- If downstream savings for a single program, initiative, or measure exceed 20% of total downstream savings and if the realization rate for that program, initiative, or measure is outside the range of 90%-110%, then gross verified savings will be used.

Participation is not tracked for upstream lighting, so Duquesne Light used the default reduction percentages provided in the Evaluation Framework for each wave, by age. Following the upstream and downstream adjustments, the gross verified savings for the PY12 HER program is 7,308 MWh. These values are all reported in Table 203.

Low-Income

In PY8, Duquesne Light re-allocated a subset of homes from the market rate cohorts to LI based on the results of the 2016 LI status rescreening effort. This effort is not conducted yearly, so the PY12 evaluation maintains the classifications and savings re-distribution strategy from PY8. Since the homes have been randomized with their original cohorts, the regression analysis keeps the homes with the original group. Following regression analysis, savings are estimated by moving a portion of the market rate savings into the LI results. For the 2012 and 2015 market rate waves, 3.5% and 4.2% of the savings are removed, respectively, and added to the LI savings. These adjustments, along with the impacts from the 2018 cohort, are added to the 2015 LI cohort to arrive at the final impacts for the LI category. The market rate savings are reduced by the adjustments and the final adjusted savings are provided in Table 203.

Table 203: PY12 Behavioral Energy Savings by Sector

Sector	PY12 MWh
Market Rate	5,594
LI	1,714
Total	**7,308**

Peak Demand Impacts

The behavioral protocol of the Evaluation Framework provided evaluation contractors several options for estimating peak demand savings for HER programs. Guidehouse utilized the flat load assumption which assumes HER savings occur equally in each hour of the year. Gross verified demand savings are calculated as follows for the Residential Behavioral Savings program:

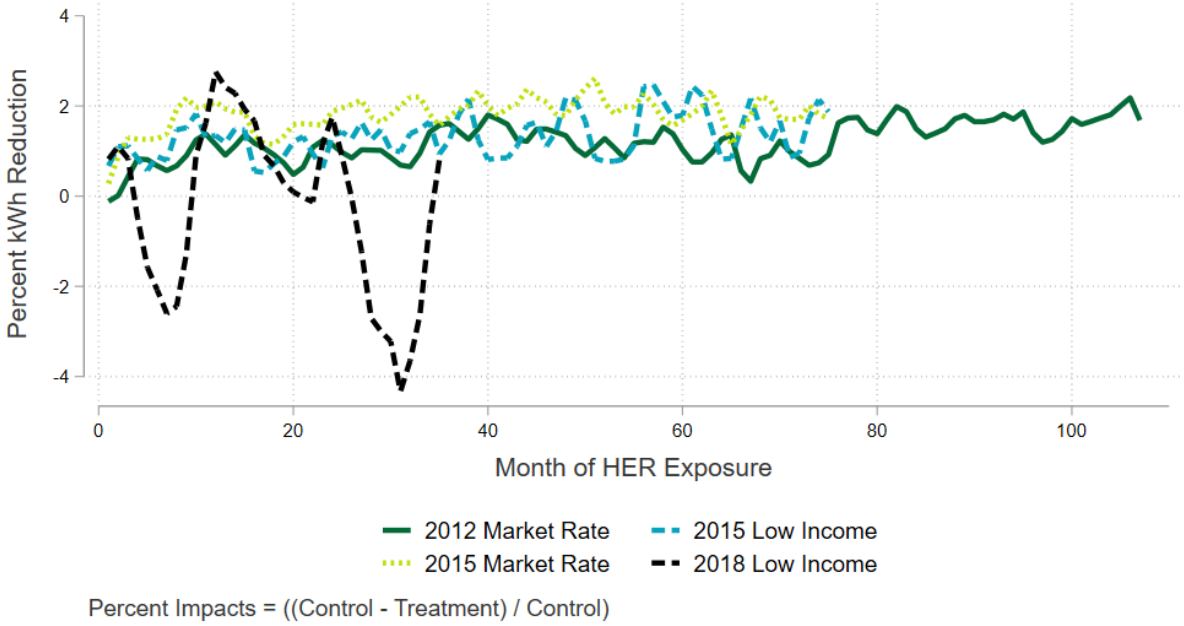
$$Verified\ MW\ Savings = \frac{7{,}308\ MWh}{8{,}760\ hours} = 0.834\ MW$$

Conclusion

Figure 69 shows trends over time for each of the four RCT waves. The graph shows the calculated percent reduction in kWh for the treatment group, relative to the control group, on the y-axis and the number of months since initial HER exposure on the x-axis. As can be seen in the 2012 and 2015 cohorts, HER savings take some time to ramp up, then exhibit a consistent level of savings around 1.0% to 2.0%, with seasonal fluctuations.

The 2018 low-income cohort is unique in that impacts have fluctuated between negative and positive impacts for the three years of exposure. In PY12, aggregate MWh savings for the wave were negative and thus cost Duquesne Light progress toward its Phase III compliance target. Because the treatment and control group for this cohort are so small, the impacts are not statistically significant. HER cohorts can take several years of exposure for savings to stabilize, but since this cohort is still not generating savings after three years, the SWE recommends Duquesne Light discontinue treatment for the 2018 low-income wave.

Figure 69: Percent Impacts Over Time



When reviewing Figure 69, readers should note that Duquesne Light paused the distribution of HERs from May 2013 to March 2015. Though there was no program activity for the 2012 Market Rate cohort during this time, the differences are still shown to present a complete time series. PY12 shows a continued improvement in the data processing and analysis for Duquesne Light's HER offering. The SWE team was able to independently replicate the energy and demand impacts provided by Guidehouse in the PY12 annual report.

The SWE have a few prospective recommendations. In the updated PY12 data files, there were still approximately 2,800 accounts with account active dates after the launch date of their wave. Moving into Phase IV we recommend Duquesne Light and Oracle refine their data exchange procedures to minimize this phenomenon. The 3.5% and 4.2% low-income allocation factors for the 2012 and 2015 market rate cohorts are based on research conducted in 2016. If Duquesne Light plans to claim savings from market rate cohorts towards its Phase IV LI compliance target, the research will need to be updated.

D.5.2 Non-Residential Audit Activities

The SWE conducted various review and audit activities for Duquesne Light's programs. These activities included a review of the evaluation efforts and an audit of the savings verification

completed by Duquesne Light's evaluation contractor, Guidehouse. The remainder of this section presents the SWE's findings from these activities.

Guidehouse used various approaches to verify the gross impact estimates for each non-residential program. This section discusses the results of the SWE's review of Guidehouse's approach in applying various levels of rigor to assessing and estimating project impacts from their evaluation sample. The SWE completed this review based on evaluation sample population extracts provided by Guidehouse, which detailed how each sampled project was evaluated regarding evaluation activity and the level of rigor applied. The purpose of this review is to affirm that the evaluator conducted the evaluation in compliance with the EM&V framework and followed the approved evaluation plan.

Table 204 outlines the evaluation activities by project count for each of Duquesne Light's non-residential programs, along with the evaluation realization rates. No evaluation activities were conducted for the Small Commercial Direct Install (SCDI) because no program activity was reported in PY12. For the Community Education program, evaluation activities were not conducted for PY12 per Guidehouse's evaluation plan.

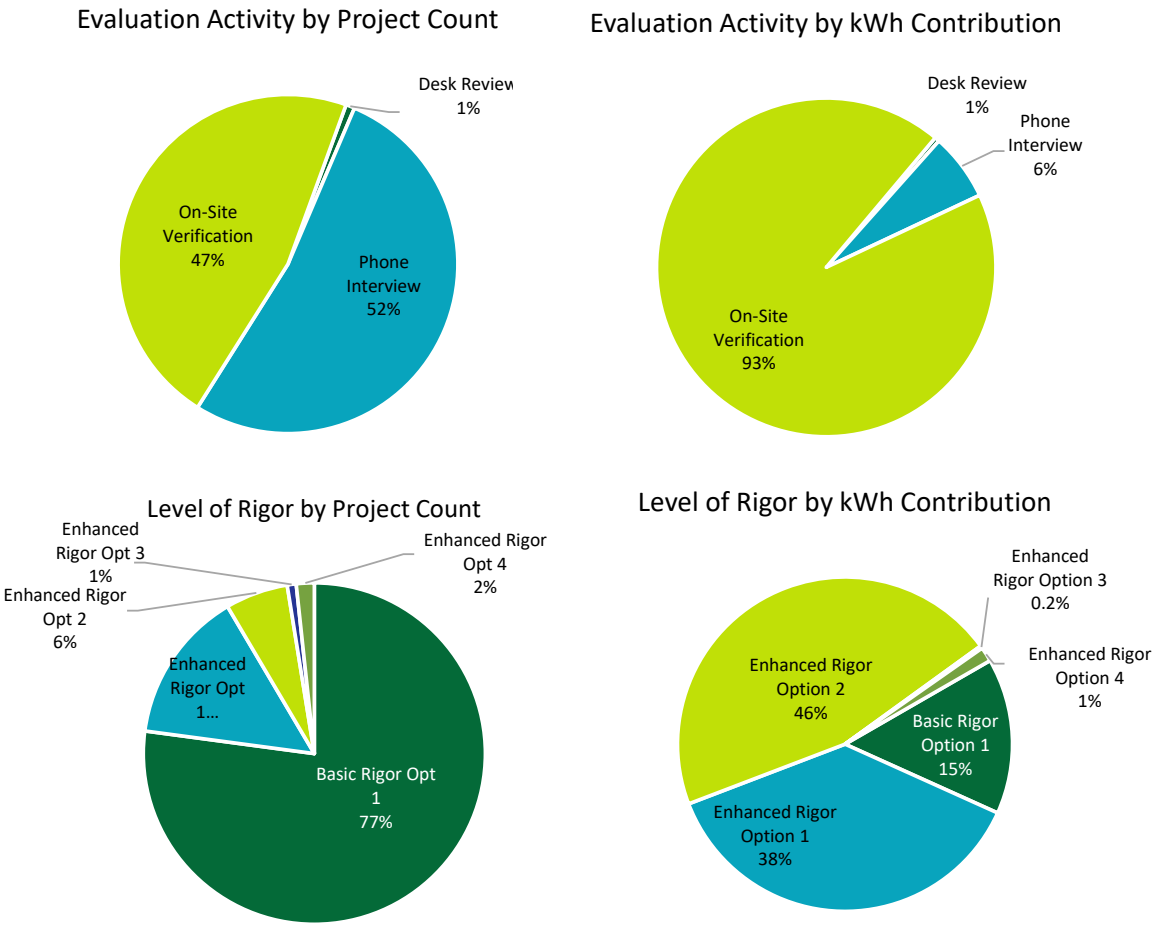
Table 204: Duquesne Light Evaluation Activities by Project Count

Program / Strata	Sample Quantity (PY11/PY12)	RR	Desk Review	Phone Interview	On-Site Verification
Commercial Efficiency / Express Efficiency	**21**	**121%**	**-**	**9**	**12**
Commercial – Large	4	113%	-	-	4
Express – Large	-		-	-	-
Commercial – Medium	4	106%	-	-	4
Express – Medium	6		-	2	4
Commercial – Small	-	144%	-	-	-
Express – Small	7		-	7	-
Small/Medium and Large Midstream Lighting	**35**	**110%**	**-**	**21**	**14**
SNUP – Extra Large	2	133%	-	-	2
SNUP – Large	7	121%	-	3	4
SNUP – Small	5	116%	-	2	3
LNUP – Extra Large	2	70%	-	-	2
LNUP – Large	11	84%	-	8	3
LNUP – Small	8	159%	-	8	-
SCDI	**-**	**N/A**	**-**	**-**	**-**
Multifamily House Retrofit	**8**	**108%**	**-**	**8**	**-**
MFHR – Large	5	99%	-	5	-
MFHR – Small	3	113%	-	3	-
Industrial	**24**	**96%**	**1**	**7**	**16**
Small	8	99%	-	-	8
Medium	8	79%	1	1	6
Large	8	99%	-	6	2
Public Agency Partnership	**30**	**116%**	**-**	**17**	**13**
PAPP – Certainty	2	96%	-	-	2
PAPP – Large	8	96%	-	2	6
PAPP – Small	20	148%	-	15	5
Community Education	**-**	**N/A**	**-**	**-**	**-**
Total	**118**		**1**	**62**	**55**

Figure 70 provides a summary of the evaluation activities and M&V approaches utilized by Duquesne Light's evaluation contractor in their PY12 verified savings calculations. Guidehouse

conducted site verification for approximately half of the PY12 evaluation sample, and this is most pronounced from the perspective of verified savings. However, most of these site visits encompassed verification only.

Figure 70: Summary of Duquesne Light's C&I 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. The following subsections outline the evaluation activities for each of Duquesne Light's non-residential programs in PY12.

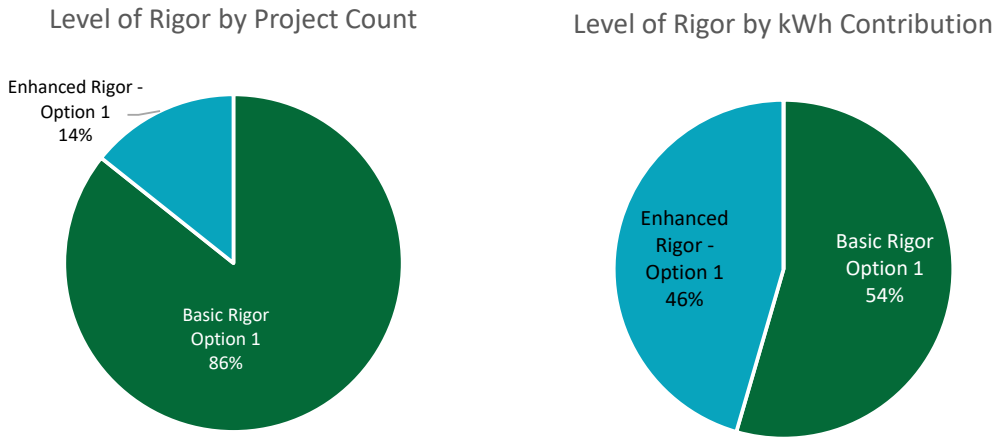
D.5.2.1 Commercial Efficiency/Express Efficiency

Guidehouse grouped the Commercial Efficiency and Express Efficiency programs to conduct the evaluation as these programs share common measure offerings and a similar overall program structure. Guidehouse conducted its gross verified savings evaluation of each program based on a sample frame inclusive of both PY11 and PY12 projects. The combined Commercial Efficiency and Express Efficiency programs comprised approximately 12% of the PY12 verified energy savings for the non-residential portfolio. Guidehouse sampled 21 projects across both programs

from its PY11-PY12 sample frame to complete its evaluation of program impacts. This sample was allocated amongst three strata for each program: Large, Medium, and Small. Guidehouse used various evaluation methods, including Basic Rigor Option 1 (simple engineering model without onsite measurement), Enhanced Rigor Option 1 (equivalent to IPMVP Option A), and Enhanced Rigor Option 2 (equivalent to IPMVP Option B), as illustrated in Figure 71. Guidehouse evaluated 14% of the program sample using Enhanced Rigor methods; this accounted for approximately 46% of verified program savings.

For PY12, Guidehouse targeted a relative precision of 15% at the 90% confidence interval. The achieved precision at 8.5% met this target.

Figure 71: Summary of Duquesne Light's PY12 Commercial and Express Efficiency Program by Level of Rigor

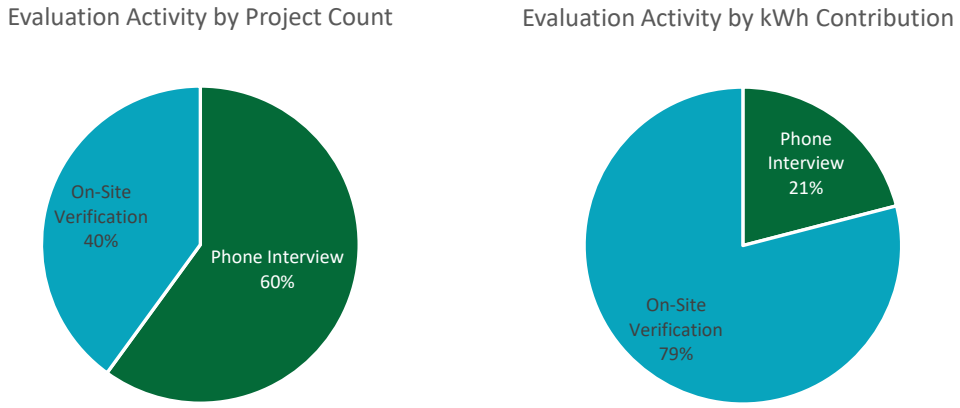


D.5.2.2 Small/Medium and Large Midstream Non-Residential Lighting

The Midstream Lighting program consists of two strata: Small and Large. Both strata are further divided into Extra Large, Large, and Small sub-strata. Extra Large projects are those projects that claim demand savings of 20 kW or greater.

Thirty-five Midstream projects are included in the cumulative PY10-PY12 sample: 14 Small/Medium projects and 21 Large projects. Of the sampled projects, 40% were evaluated through an on-site verification which accounted for 79% of verified savings, as presented in Figure 72. All sampled projects used a Basic Rigor – Option 1 method to calculate savings.

Figure 72: Summary of Duquesne Light's PY12 Midstream Lighting Program Evaluation Activities



Guidehouse achieved realization rates for the Midstream program of 110% for energy and 110% for demand. No Midstream lighting projects exceeded the 750,000 kWh TRM threshold, so no projects required metering and a simple phone interview or site-verification was sufficient for the sample paired with a Basic Rigor method to quantify savings.

The sampling plan for the Midstream program targeted an 85/15 confidence interval for this program. Energy relative precision fell just short of this target at 16.3%.

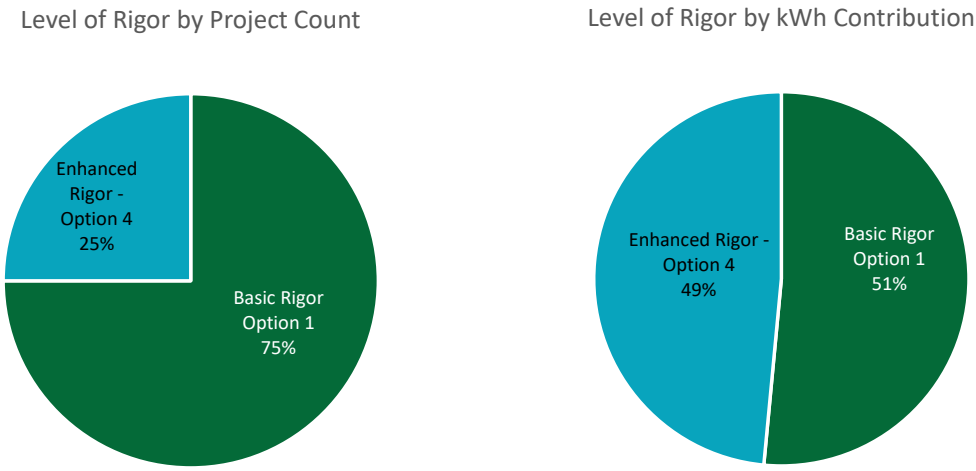
D.5.2.3 SCDI

The SCDI program was not active in PY12.

D.5.2.4 Multifamily House Retrofit

For PY12, Guidehouse applied results from PY11 gross impact evaluation research. The MFHR program is stratified into Large and Small projects. The sample consists of projects completed solely in PY10. Guidehouse estimated a program realization rate of 108% for energy and 112% for demand. Three-quarters of the sampled projects were evaluated using a Basic Rigor Option 1 method, while two projects were evaluated using Enhanced Rigor Option 4, as depicted in Figure 73.

Figure 73: Summary of Duquesne Light's PY12 Multifamily House Retrofit Program by Level of Rigor

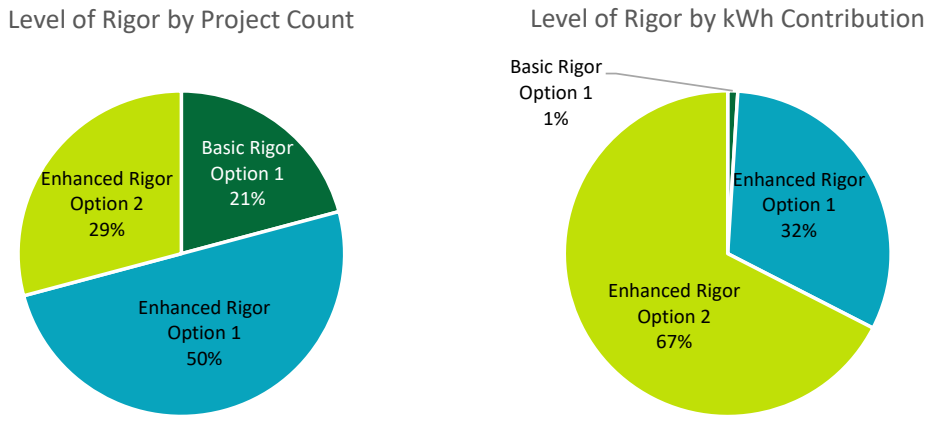


For PY12, Guidehouse targeted a relative precision of 15% at the 85% confidence interval for the MFHR program. Guidehouse met this goal for energy and demand verified savings with relative precisions of 2.3% and 5.6%, respectively.

D.5.2.5 Industrial Efficiency

Guidehouse conducted its gross impact analysis of the Industrial Efficiency program across three pre-defined strata: Small, Medium, and Large. Sampling was conducted at the measure level based on a rolling sample inclusive of PY11 and PY12. Guidehouse reviewed a total of 24 measures across both program years. Relying on the previously analyzed PY11 measures combined with the PY12 sampled measures, Guidehouse estimated a program realization rate of 96% for energy savings. Guidehouse used various evaluation methods, including Basic Rigor Option 1 (simple engineering model without onsite measurement), Enhanced Rigor Option 1 (equivalent to IPMVP Option A), and Enhanced Rigor Option 2 (equivalent to IPMVP Option B), as illustrated in Figure 74. Guidehouse evaluated approximately 79% of the program sample using Enhanced Rigor methods; this accounted for approximately 99% of verified program savings. Eight Large stratum measures were evaluated in PY12.

Figure 74: Summary of Duquesne Light's PY12 Industrial Efficiency Program by Level of Rigor



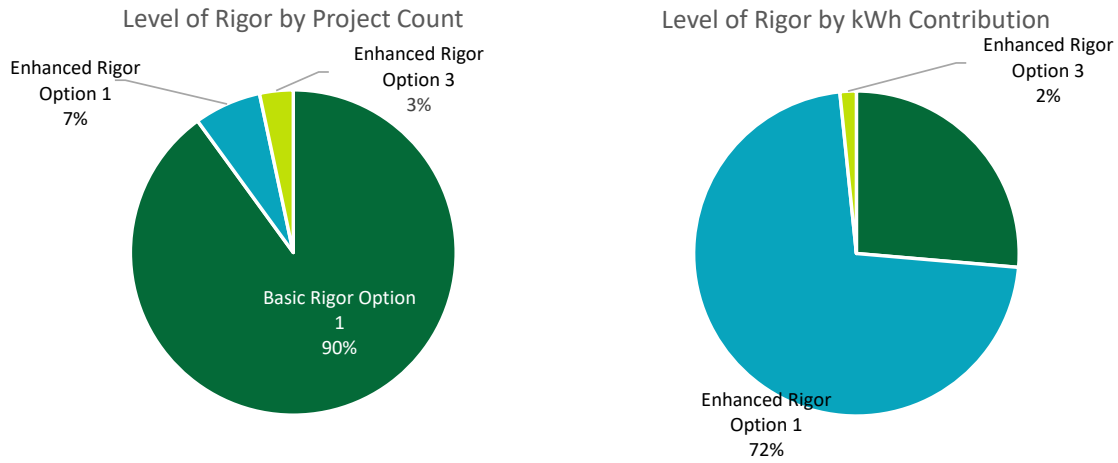
For PY12, Guidehouse targeted a relative precision of 15% at the 90% confidence interval. Guidehouse met this goal for both energy and demand verified savings, at 4.6% and 7.2% relative precision for energy and demand respectively.

D.5.2.6 Public Agency Partnership Program (PAPP)

Using the same rolling sampling approach as with the Commercial/Express and Industrial Efficiency programs, Guidehouse assessed gross savings for the PAPP by estimating realization rates based on sample projects analyzed from PY12, as well as projects in PY11. Across both program years, Guidehouse completed analysis on 30 sites, of which ten were from PY12. Guidehouse segmented its sample into two three strata: Certainty, Large, and Small. Relying on the previously analyzed PY11 measures combined with the PY12 sampled measures, Guidehouse estimated a program realization rate of 116% for energy savings and an 131% realization rate for demand savings.

Guidehouse used the Basic Rigor Option 1 (TRM deemed savings) evaluation method for all PY11 and PY12 sampled projects except for three projects, which were evaluated using Enhanced Rigor Option 1 (equivalent to IPMVP Option A) and Enhanced Rigor Option 3, as illustrated in Figure 75.

Figure 75: Summary of Duquesne Light's PY12 PAPP Program by Level of Rigor



For PY12, Guidehouse targeted a relative precision of 15% at the 85% confidence interval. Guidehouse met this goal for energy and demand verified savings, at 10.5% and 10.8% respectively.

D.5.2.7 Community Education Program

The Community Education Program was not active in PY12.

D.5.2.8 Ride-Along Site Visits

The SWE audited the activities above through a combination of Ride-Along Site Visits (conducted both in person and virtually) and Desk Reviews. The details of the SWE's findings are presented in the following subsections.

Table 205 provides an overview of the SWE milestones for the audit of Duquesne Light's site inspection efforts.

Table 205: Duquesne Light Ride-Along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)*	Field Engineers Observed	Measure Types Observed	Attainment Percentage
3	22,376,497	1	2	100%

*Savings reported by evaluation contractor.

The SWE conducted a total of three ride-alongs and project reviews that included Horticulture lighting and Horticulture Ventilation measure types. The SWE generally agreed with the methodology and calculations submitted by Duquesne Light's evaluation contractors.

The SWE did not find any issues with the evaluator's savings and these projects achieved 100% attainment percentages. In general, the evaluation contractor's submitted reports and calculations show evidence that the TRM and Evaluation Framework are followed appropriately.

D.5.2.9 Verified Savings Desk Reviews

Table 206 provides an overview of the SWE milestones for the verified savings review of evaluated Duquesne Light projects.

Table 206: Duquesne Light Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)*	Measure Types Observed	kWh Attainment Percentage
6	7,442,160	5	100%

*Savings reported by evaluation contractor.

The SWE conducted a total of six project reviews: two LED lighting projects, a HVAC C&I project, air compressor customization project, downstream lighting project and a custom interior lighting project. Overall, the SWE found that Duquesne Light's evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods to evaluate custom projects. The SWE asserts that Guidehouse conducted appropriate M&V efforts and that sufficient documentation supporting savings analyses was provided.

Only one project resulted in an attainment percentage other than 100%. For this lighting project, a less than 1% error arose from varying efficient wattages used in savings calculations. Guidehouse incorporated those recommendations into final verified savings estimates for that project.

D.6 DR

Duquesne Light's Phase III demand response compliance target is 42 MW. DR goals are assessed at the system level, meaning that line loss adjustment factors are applied to the load impacts measured at the customer meter. In addition to the 42 MW target, which is an average of all Phase III DR events, EDCs are required to achieve at least 85% of their overall target in each event. For Duquesne Light, this translates to a 35.7 MW minimum performance level for any given DR event. Decisions about which days DR events are called are guided by a set of prescriptive directions issued by the PUC in the Phase III Implementation Order and Clarification Order. Duquesne Light called DR events on the five days those guidelines required in PY12. Due to the COVID-19 pandemic, demand response activities at all EDCs were implemented on a voluntary basis for the summer of 2020[68]. Per the Phase IV Final Implementation Order, PY12 will be the last year of Duquesne Light's dispatchable demand response programs[69].

Duquesne Light voluntarily implemented PY12 DR activities, and the SWE team notes that the amount of curtailable load available on event days dropped noticeably because of the COVID-19 pandemic, likely resulting in lower portfolio impacts. On March 12, 2021 the Duquesne Light/Guidehouse team filed its PY12 semi-annual report which included a summary of gross

[68] Pennsylvania Public Utility Commission, Phase III Modification Order. From the Public Meeting of May 21, 2020. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1665150.docx
[69] Phase IV Implementation Order. Entered June 18, 2020. Docket No. M-2020-3015228. https://www.puc.pa.gov/pcdocs/1666981.docx

verified DR impacts. Table 207 summarizes impacts for the five PY12 DR events as calculated by Guidehouse and the average event impact for PY12.

Table 207: PY12 DR Impacts by Event

Event Date	Event Time	Average Performance (MW)	% of Phase III Target
July 20, 2020	2pm – 6pm	42.07	100%
July 27, 2020	2pm – 6pm	50.59	120%
July 29, 2020	3pm – 7pm	35.07	86%
August 25, 2020	2pm – 6pm	24.22	58%
August 27, 2020	3pm – 7pm	10.07	24%
PY12 Average Event		**32.41**	**77%**

The Duquesne Light/Guidehouse team also submitted a response to the SWE DR data request. The data elements of this request included:

- A list of participating facilities and the reference load method used to estimate its gross verified performance
    - The initial data request response listed an incorrect baseline for 29 sites. Upon request, the Duquesne Light/Guidehouse team furnished the SWE with a corrected list
- For each event hour, a record of which facilities participated, their reference load, metered load, and verified DR impact
- For 15 sites selected by the SWE, the hourly load and weather data needed to replicate the Guidehouse impact estimates
    - These 15 sites represented approximately 46% of the gross verified PY12 DR impacts
- The Weather Sensitive Adjustment (WSA) slopes for sites that used a “high 4 of 5 with WSA” baseline method

The SWE team was able to replicate hourly impacts for the 15 sampled customers after a series of discussions with the Duquesne Light/Guidehouse team to clarify which baseline approach was used for each site and the exact exclusion rules for low-usage days.

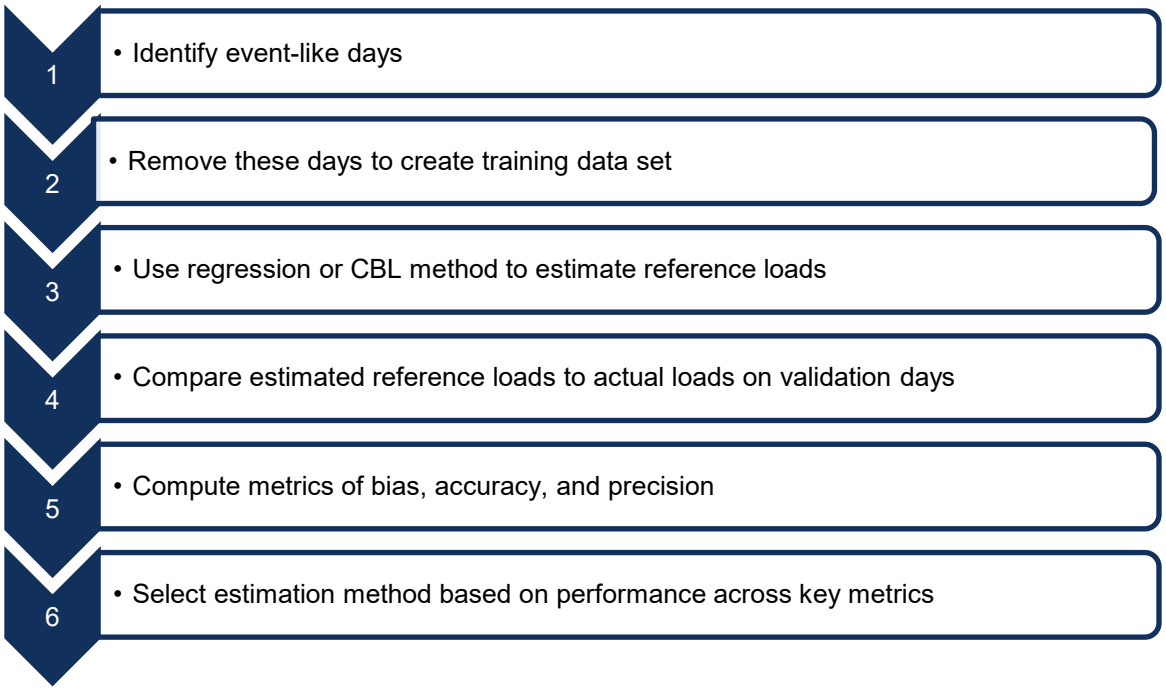
D.6.1 Application of LLFs

Guidehouse used a commercial line loss factor (LLF) of 6.9%, or 1.0741, for most participants and an industrial LLF of 0.8%, or 1.0081, for two large manufacturing sites to adjust DR performance estimates calculated at the meter to the system level for comparison with Act 129 targets. These values are consistent with the residential and commercial and industrial values of Table 1-4 of the 2016 Technical Reference Manual.

D.6.2 Reference Load Selection

The approach Guidehouse used to determine reference loads for C&I DR participants was consistent with the process shown in Figure 76, which is taken from the Evaluation Framework. Guidehouse used hold-out test days to rank the accuracy of the alternative approaches and to select the most accurate method to calculate PY12 impacts.

Figure 76: Baseline Selection Steps



Guidehouse tested a "High 4-of-5" CBL with and without weather sensitive adjustment (WSA) and 170 regression baselines in order to select the best model for each customer. Table 208 shows the distribution of baseline approaches across the PY12 program population per Guidehouse. Individual customer regression analysis was used for 167 sites and 89% of the DR impacts.

Table 208: PY12 Reference Load Frequency Table

Baseline Method	Number of Sites Used	Share of DR Impacts (at Meter)
High 4 of 5 with or without WSA	28	11%
Individual Customer Regression	167	89%

The model selection process employed by Guidehouse requires selection of the winning model on the basis of the lowest Mean Absolute Error (MAE) on three hold-out days. The SWE team did not attempt to validate whether the models employed to estimate program impacts were in fact the lowest MAE options for each customer.

D.6.3 Independent Verification of Calculations

In an initial check of the data, the SWE team used Guidehouse's verified kW estimates to replicate the event day savings totals presented in the March 2021 results. After the totals were confirmed, the SWE team independently calculated reference loads and load impacts for each event hour for each of the 15 sites where hourly load data was requested. For all event hours for the 15 sites the SWE estimates matched the Guidehouse values exactly. For the PY12 analysis, Guidehouse provided the WSA slopes. The SWE team did not independently reproduce these values, only that they were applied correctly in the CBL calculations.

D.6.4 Data Management

The PY9 SWE audit noted issues with data completeness for the last day of each month. The load data provided for PY10 was clean and exhibited no evidence of data quality issues. The PY11 analysis again noted issues with data completeness for the last day of each month as well as the months of June and September for some customers. While the PY12 analysis did not find any evidence of issues with data completeness, the SWE team notes the following data management issues and resolution:

1. The final regression models selected for one third of the sampled customers were incorrectly specified in the initial DR Data Request Response to the SWE. The Guidehouse team noted that the misrepresented model was run for these customers but excluded from the candidate model selection process as it was not an eligible model in the PY12 evaluation plan.
    - Guidehouse provided the correct classifications to the SWE, which resolved the issue. Although the "reg_PY9" model appears to perform well for many sites, the model was not included in the PY12 model roster and was therefore not a candidate for load impact analysis.

Table 209: Original and Corrected Final Models

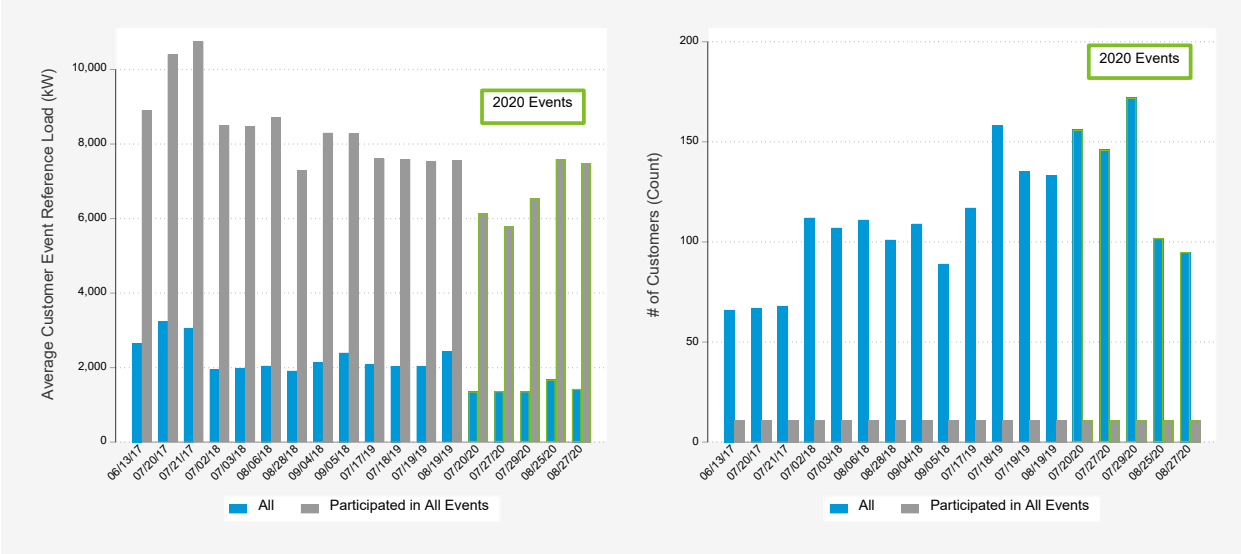
Baseline Method	Corrected Count	Original Count	Change
cbl_4_of_5	17	15	2
cbl_wsa_4_of_5	11	8	3
reg_PY12_base	10	8	2
reg_PY12_base_simple	3	2	1
reg_PY9	0	29	(29)
reg_PY12_01	7	5	2
reg_PY12_02	6	4	2
reg_PY12_03	6	5	1
reg_PY12_04	2	2	0
reg_PY12_05	2	2	0
reg_PY12_06	10	10	0
reg_PY12_07	8	7	1
reg_PY12_08	2	2	0
reg_PY12_09	8	6	2
reg_PY12_10	2	2	0
reg_PY12_11	5	3	2
reg_PY12_12	2	2	0
reg_PY12_13	2	2	0
reg_PY12_14	1	1	0
reg_PY12_15	2	2	0
reg_PY12_16	2	2	0
reg_PY12_17	1	1	0
reg_PY12_22	1	1	0
reg_PY12_25	8	6	2
reg_PY12_26	2	2	0
reg_PY12_27	10	9	1
reg_PY12_28	6	5	1
reg_PY12_29	9	8	1
reg_PY12_30	5	3	2
reg_PY12_31	2	2	0
reg_PY12_32	4	4	0

2. Regression methods included screening criteria for low-usage days; in some cases, dropping out the lowest 10, 20, 30 or 40% of days based on customer loads. Guidehouse's evaluation plan states that the criteria for determining the rank of customer days depends on average customer load during 12pm-8pm (HE13-HE20). However, Guidehouse in fact used HE13-HE23 to determine the candidate day list.
    - While this error does change the days included in the model for some customers, the SWE team investigated the effect and determined that the impact of the error was minimal.

D.6.5 Data Management

Duquesne Light exceeded the 85% event-specific target for the first two PY12 events and fell short for the last three events. The COVID-19 pandemic and the voluntary nature of PY12 demand response activities likely played a part in the lower impacts during the second half of the summer. For participants, load reductions were more challenging this year as a result of the ongoing COVID-19 pandemic and the related changes in economic conditions. Per-customer reference loads declined in 2020, shown below in Figure 77. This figure shows both per-customer average reference loads and customer counts by event day across Phase III events. Days in PY12 have a green outline. The graph is further divided between all participants and the subset of customers who participated in every event in Phase III. This is shown to highlight year-on-year changes in reference loads unrelated to participant churn. There are several takeaways from this figure. First, customer counts dropped significantly in the last two events of PY12, which will necessarily reduce aggregate impacts for these days. Overall reference loads in PY12 were similarly lower on average. The reference loads earlier in the summer were lower than historical averages for customers who have remained enrolled in the program throughout Phase III. This could be due to economic shutdown activities in the region. While reference loads rebounded for these customers during the second half of the summer, they are still relatively low compared to historical demand for these customers. These are likely reasons for why load impacts were lower in PY12 compared to prior years.

Figure 77: Curtailable Load Program Reference Load Changes



Although inconsistent documentation hampered straightforward replication of program impacts in PY12, the SWE team found the Guidehouse verified savings analysis to be robust and aligned with the protocols established in the Phase III Evaluation Framework for measurement of demand response impacts.

D.7 NTG

D.7.1 Residential Programs

Guidehouse did not conduct primary research to estimate any residential program NTG values for PY12 (Table 210).

Table 210: Summary of NTG Estimates for Duquesne Light Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY11	Residential Appliance Recycling	0.61	0.08	0.47	217
RCT	HER	0.0	0.0	1.0	-
PY11	REEP Rebates	0.46	0.07	0.61	112
PY11	REEP Kits	0.32	0.11	0.79	609
Program not active in PY12	REEP Standard LED	-	-	-	-
Program not active in PY12	REEP Specialty LED	-	-	-	-
Combination of program NTG values	REEP Total	0.42	0.08	0.66	-

D.7.2 LI Residential Programs

Guidehouse did not gather data during PY12 to estimate LI NTG.

Guidehouse assumed that there was no free-ridership or SO activity occurred among LI participants and assumed an NTG of one for LIEEP Kits Program LI Whole House Retrofit and Multifamily Housing Retrofit Programs. The LI HER was assigned an NTG of one, in accordance with the Evaluation Framework. The total LIEEP NTG was then calculated by averaging the LI kit and LIHERS NTG, producing an overall NTG of one (Table 211).

Table 211: Summary of NTG Estimates for Duquesne Light LIEEP

Approach	Program	Free-Ridership	SO	NTG	Sample Size
Assigned Value	LIEEP Kits	0.0	0.0	1	-
RCT	LIEEP HER	0.0	0.0	1	-
Assigned Value	LI Whole House Retrofit	0.0	0.0	1	-
Assigned Value	Multifamily Housing Retrofit	0.0	0.0	1	-

D.7.3 C&I Programs

Guidehouse conducted NTG research in PY12 for the C&I Midstream Lighting Program and the Public Agency Partnership Program. Guidehouse conducted a telephone survey with program participants to gather data for the C&I Midstream Lighting Program. The survey utilized dedicated free-ridership and spillover batteries to determine free-ridership and spillover values and utilized

the common NTG formula recommended in the current Evaluation Framework to determine the C&I Midstream Lighting NTG. Guidehouse administered an online survey with dedicated free-ridership and spillover sections to gather data for PAPP NTG values. Guidehouse was unable to use PAPP respondent spillover values (applies to three of the 32 respondents) due to their inability to quantify the spillover so that the values could be applied to the NTG calculations. Guidehouse utilized the common NTG formula recommended in the current Evaluation Framework to estimate the PAPP NTG. For future NTG batteries the SWE recommends adjusting questions so that spillover batteries result in useable data (Table 212).

Guidehouse applied previous program year NTG values to the Commercial Efficiency/Express Efficiency and Industrial Efficiency, Multifamily Housing Retrofit, Public Agency Partnership, and Community Education Programs.

Table 212: Summary of NTG Estimates for Duquesne Light C&I Programs

Approach	Program	Free-Ridership	SO	NTG	Sample Size
Evaluated	Total Midstream Lighting	0.12	0.00	0.88	27
PY11	Commercial Efficiency/ Express Efficiency	0.21	0.00	0.79	32
Program Not Active in PY12	SCDI	-	-	-	-
PY9	Multifamily Housing Retrofit	0.55	0.00	0.45	-
PY11	Industrial Efficiency	0.39	0.00	0.61	10
Evaluated	Public Agency Partnership	0.14	0.00	0.86	31
PY9	Community Education	0.55	0.00	0.45	-

D.8 TRC

Table 213 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for Duquesne Light's PY12 individual programs and overall portfolio. The SWE team found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY12 annual report.

Table 213: Summary of Duquesne Light's PY12 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
REEP: Residential Energy Efficiency	$986	$1,667	0.59	$652	$1,388	0.47
Residential Appliance Recycling	$338	$229	1.48	$158	$229	0.69
Residential Behavioral Savings	$321	$139	2.31	$321	$139	2.31
Residential Whole House Retrofit	$0	$636	0.00	$0	$636	0.00
LI Energy Efficiency	$964	$1,233	0.78	$964	$1,233	0.78
Express Efficiency	$6,904	$2,034	3.39	$5,437	$1,762	3.09
Small/Medium Midstream Lighting	$951	$746	1.27	$836	$683	1.22
SCDI	$0	$40	0.00	$0	$40	0.00
Multifamily Housing Retrofit	$779	$1,717	0.45	$354	$1,471	0.24
Commercial Efficiency	$8,758	$2,375	3.69	$6,898	$2,051	3.36
Large Midstream Lighting	$348	$365	0.95	$306	$354	0.87
Industrial Efficiency	$29,838	$9,501	3.14	$18,136	$6,777	2.68
Public Agency Partnership	$18,975	$5,359	3.54	$16,243	$4,735	3.43
Community Education	$0	$242	0.00	$0	$242	0.00
Large C&I DR Curtailable	$3,392	$1,681	2.02	$3,392	$1,681	2.02
Portfolio Total	$72,556	$27,965	2.59	$53,697	$23,421	2.29

Of Duquesne Light's 14 energy-efficiency programs offered, seven were found to be cost-effective and seven were non-cost-effective when estimating the TRC using gross verified savings. Using net verified savings, six EE programs were found to be cost-effective and eight were non-cost-effective. Duquesne Light's demand response program was cost-effective on both a gross and net basis. The Residential Appliance Recycling and Large Midstream Lighting programs were cost-effective under gross-verified savings but non-cost-effective under net verified savings. PY12 residential and non-residential programs saw general increases in TRC Ratios resulting in an overall increase in the PY12 Portfolio TRC Ratio compared to the previous PY11 TRC Ratio.

D.8.1 Notes from the Review of the TRC Model

- Duquesne Light used a discount rate of 6.9%, which is used to calculate the net present value of future program benefits, is consistent with what is stated in their EE&C plan. The line loss adjustment factor was 7.41% for the residential and commercial sector and 0.8065% for industrial sites that take service at primary voltage.
- The incremental costs were derived from the PA SWE Database, the Database for Energy-Efficiency Resources (DEER), project/contract cost and invoicing, and potential studies.
- 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. Demand response realization rate excluded line losses.
- 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 TRC Test Order directive for Phase III.
- The SWE team found that the cost categories were handled correctly: incentives were not considered costs but administrative costs, incremental costs, and kits were incorporated as costs. The TRC model followed the protocol specified in the 2016 TRC Test Order pertaining to the treatment of free-rider participant costs; free-ridership participant costs are not included in net program costs.
- The TRC model reports the cost from increase heating usage due to lighting interactive effects from more efficient lighting as a negative Total NPV Lifetime Non-Electric Benefit. The SWE team verified that LED Gas Heating Penalty associated increased heating usage was calculated correctly in accordance with the Guidance on Inclusion of Fossil Fuel and H2O Benefits in TRC Test memorandum issued by the SWE.
- Water savings benefits were accounted for in the TRC model under Total NPV Lifetime Non-Electric Benefits. The SWE team verified that the water savings were calculated in accordance with the Guidance on Inclusion of Fossil Fuel and Water Benefits in TRC Test. The TRC model claimed 16.2 million gallons of water saved over the lifetime (at $0.01 per gallon avoided) or approximately $124.8 thousand in lifetime avoided costs.
- Duquesne Light accounts for the dual baselines for nonresidential lighting by reducing the EULs to adjust lifetime savings. The team found that the EULs for replace on burnout (ROB) were consistent with the *Dual Baseline Assumptions for Screw-In LED Lighting in PY11 and PY12 TRC Test*. For nonresidential ROB specialty lamps, the bulbs' first year wattage (post-EISA 2007 Watts) is used as the baseline and is adjusted to Post-2020 Watts for 14 years. Duquesne Light did not report any residential ROB\New lighting measures.
- The team found Duquesne Light used the TRM EUL of 15.0 years for early replacement (ER)/retrofit Whole Home A-lamps as part of the Multifamily Housing Retrofit and Low-Income Whole House Retrofit programs. However, per the *Dual Baseline Assumptions for Screw-In LED Lighting in PY11 and PY12 TRC Test,* the bulbs' first- and second-years' wattages (post-EISA 2007 Watts) should be used as the baseline and adjusted to Post-

2020 Watts for 13 years. Duquesne Light may have overlooked the adjustment for the Whole Home LEDs since they were the only ER/retrofit LEDs for residential lighting. The adjustment reduces the EUL to 3.1 years for 9 Watt and 15 Watt Whole Home LEDs and 3.3 years for 11 Watt Whole Home LEDs. The reduction in EUL lowers the gross benefits of the two programs. This adjustment is reflected in Table 213.

- The demand response program TRC Ratio met the 75% participant cost assumption where 75% of customer incentive payment is used as a proxy for participant cost.

D.9 PROCESS

The Duquesne Light PY12 update to the Phase III evaluation plan noted that, "Duquesne Light's program effort is somewhat small, and consequently so are the resources earmarked for evaluation. The primary focus of evaluation efforts and resources will be on ensuring that all impact evaluation and compliance research is conducted properly and in a timely manner." This suggests a limited effort for the process evaluations and is reflected in the associated activities and the report for PY12.

D.9.1 Residential Programs

Duquesne Light operates five residential energy-efficiency programs: the REEP; the RARP; the WHRP, also known as the Whole Home Energy Audits Program (WHEAP); the Residential Behavioral Savings Program, also known as the HER Program; and the LIEEP. For PY12, Guidehouse did not conduct any process evaluation activities for the residential programs.

D.9.1.1 Residential Energy-Efficiency Program (REEP)

Guidehouse did not conduct process evaluation research for REEP rebates and kits in PY12. While program manager and implementer interviews were originally planned, the evaluation plan was updated to reflect that the program was thoroughly vetted in previous evaluations and no substantial changes have occurred.

D.9.1.2 Residential Appliance Recycling Program (RARP)

Guidehouse did not conduct process evaluation research for RARP during PY12.

D.9.1.3 Low-Income Energy-Efficiency Program (LIEEP)

Guidehouse did not conduct process evaluation research for LIEEP during PY12.

D.9.1.4 HER Program

Guidehouse did not conduct process evaluation research for the HER program, also known as the Residential Behavioral Savings Program, for PY12. While program manager and implementer interviews were originally planned, the evaluation plan was updated to reflect that the program was thoroughly vetted in previous evaluations and no substantial changes have occurred.

D.9.1.5 WHRP

Guidehouse did not conduct process evaluation research for the residential WHRP during PY12. While participant surveys and audit contractor interviews were planned to be conducted *as needed*, the evaluation plan was updated to reflect that the program was thoroughly vetted in previous evaluations and no substantial changes have occurred.

D.9.2 C&I Programs

Duquesne Light operated nine C&I energy-efficiency programs in PY12:

- The Express Efficiency Program (EXP)
- The Commercial Efficiency Program (CEP)
- The Small Commercial Direct Install Program (SCDI)
- The Nonresidential Midstream Lighting Program (ML)
- The Multifamily Housing Retrofit Program (MFHR)
- The Industrial Efficiency Program (IEP)
- The Public Agency Partnership Program (PAPP)
- The Community Education Energy-Efficiency Program (CEEEP)
- The Large Curtailable Load Program (LCL)

In PY12, Guidehouse conducted process evaluations for two of the programs: the Public Agency Partnership Program (PAPP) and the Midstream Lighting Program (ML). Process evaluation activities for PY12 included participant surveys and interviews with program managers and the CSP.

Four recommendations followed from process evaluation activities. Two recommendations were accepted and two under consideration by Duquesne Light.

D.9.2.1 Express Efficiency Program

Guidehouse did not conduct process evaluation research for the Express Efficiency Program during PY12. While program manager and implementer interviews were originally planned, the evaluation plan was updated to reflect that the program was thoroughly vetted in previous evaluations and no substantial changes have occurred.

D.9.2.2 Midstream Lighting Program

Summary of Process Evaluation Findings

The Midstream Lighting Program was designed to remove barriers by providing point-of-sale incentives to commercial customers. Duquesne Light's electric commercial rate customers and contractors are eligible to participate, with the exclusion of new construction projects.

Key findings included the following:

- *Program Awareness, Outreach, and Marketing.* Most of survey respondents (85%) reported that they were aware that Duquesne Light provided a discount on the LED products purchased prior to the survey.
- *Program Awareness, Outreach, and Marketing.* The most common source of program awareness was lighting equipment distributors (30%).

- *Program Awareness, Outreach, and Marketing.* No respondents indicated hearing about the program online, via website, newsletter, bill insert, email or event.
- *Program Awareness, Outreach, and Marketing.* Although 30% of respondents reported no significant barriers, 19% indicated that the lack of program awareness was a barrier.
- *Satisfaction.* Respondents reported very high satisfaction with the program, rating it on average 9.6 on a scale of 0 to 10, where 0 means not at all satisfied and 10 means very satisfied. All survey respondents rated the program 7 or higher.
- *Satisfaction.* Respondents reported high overall satisfaction with Duquesne Light with 89% of survey respondents providing a rating of 7 or higher.
- *Satisfaction.* Majority (59%) of respondents reported that they view Duquesne Light more favorably because of their participation in the program. The remaining respondents reported their perception stayed the same, and no one reported to view Duquesne Light less favorably.

Summary of Process Evaluation Audit

Evaluation activities conformed with the evaluation plan. Guidehouse conducted customer surveys and interviewed the program manager and CSP. The interviews confirmed that the Midstream Lighting Program processes and implementation has remained consistent since PY11. The customer survey sample design and attempts to contact participants were well-documented.

Two recommendations followed from the process evaluation activities; both are under consideration by Duquesne Light.

D.9.2.3 Small Commercial

There was no process evaluation for the Small Commercial Program in PY12.

D.9.2.4 Multifamily Housing Retrofit Program

Guidehouse did not conduct process evaluation research for the Multifamily Housing Retrofit Program during PY12. While program manager and implementer interviews were originally planned, the evaluation plan was updated to reflect that the program was thoroughly vetted in previous evaluations and no substantial changes have occurred.

D.9.2.5 Commercial Efficiency Program

Guidehouse did not conduct process evaluation research for the Commercial Efficiency Program during PY12.

D.9.2.6 Industrial Efficiency Program

Guidehouse did not conduct process evaluation research for the Industrial Efficiency Program during PY12.

D.9.2.7 Public Agency Partnership Program

Summary of Process Evaluation Findings

The PAPP serves public agency customers such as federal, state, and local governments; municipalities; and school districts. The PAPP may also serve some healthcare systems, institutions of higher education, and other nonprofit entities. The program engages customers in a partnership to implement an Energy-Efficiency Action Plan. Representatives from the agency and Duquesne Light come together form a working group to identify project areas within agency departments and jurisdictional areas.

In PY12, the opportunity presented by pandemic-related school closures enabled Duquesne Light to continue to implement an additional delivery channel with PAPP that targeted schools with direct shipments of linear replacement LEDs. Guidehouse sampled nine of these projects across PY11 and PY12 as part of the scheduled evaluation effort and described anecdotal evidence that found the participants very satisfied with the additional program channel.

Key findings include the following:

- *Program Awareness, Marketing, and Outreach.* Participants reported that their top sources of program awareness were previous knowledge or research about the program (16%), learning about the program from the electrical supplier (16%), email advertisement (13%), and through word of mouth (13%).
- *Program Awareness, Marketing, and Outreach.* Survey respondents suggested that the best method to reach out to customers to get them to participate are through email (55%), distributors/manufacturers (39%), and account representatives (35%).
- *Program Barriers and Challenges.* More than half of survey respondents (55%) see no barriers to program participation.
- *Program Barriers and Challenges.* A quarter of survey respondents (23%) indicated that paperwork is too burdensome, and 16% reported difficulties with qualifying EE equipment.
- *Satisfaction*. Respondents reported very high satisfaction with the program, rating it on average 9 on a scale of 0 to 10, where 0 means not at all satisfied and 10 means very satisfied. Majority (87%) of survey respondents rated the program 7 or higher.
- *Satisfaction*. Respondents reported high overall satisfaction with Duquesne Light with 87% of survey respondents providing a rating of 7 or higher.
- *Satisfaction*. Majority (68%) of respondents reported that they view Duquesne Light more favorably because of their participation in the program. The remaining respondents reported their perception stayed the same, and no one reported to view Duquesne Light less favorably.

Summary of Process Evaluation Audit

Evaluation activities conformed with the evaluation plan. In the PY12 update of the Phase III EM&V plan, Guidehouse indicated that they would not conduct interviews with the largest public agencies to avoid customer fatigue. The PY10 interview effort was a census attempt and exhausted the pool of participants.

Guidehouse conducted customer surveys and interviewed the program manager and the CSP. The sampling design was well-documented. The evaluation team received 31 completed surveys.

Two recommendations followed from the process evaluation; they were both accepted by Duquesne Light.

D.9.2.8 Community Education Program

Guidehouse did not conduct process evaluation research for CEEP during PY12. While program manager and implementer interviews were originally planned, the evaluation plan was updated to reflect that the program was thoroughly vetted in previous evaluations and no substantial changes have occurred.

D.9.2.9 Large Curtailable Load Program

Guidehouse did not conduct process evaluation research for the Large Curtailable Load Program during PY12.

Appendix E FirstEnergy: Metropolitan Edison PY12 Audit Detail

E.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of Met-Ed's PY12 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor.

- Despite the voluntary nature of dispatchable demand response targets due to the COVID-19 pandemic, Met-Ed's DR performance in PY12 stayed relatively constant. The average performance across the five summer 2020 events was 46 MW, or 94% of its Phase III target. The average event day reference load for C&I participants in PY12 only decreased about 4 percent from PY11. Met-Ed's average PY12 DR performance was 0.1 MW higher than PY9, which was the first summer of Phase III demand response events.
- PY12 had the lowest verified gross MWh savings from HERs of any year in Phase III for Met-Ed. However, Home Energy Reports as a percentage of portfolio savings, was the highest value since PY8 at 22%.
    - Met-Ed did not offer energy-efficiency kits in PY12, and upstream lighting was limited to specialty lamps by a baseline change for A-lamps in the TRM. As a result of these changes, Home Energy Reports was the largest residential measure in PY12. Behavioral Home Energy Reports to LI households accounted for 60.5% of all residential LI MWh savings in PY12.
- PY12 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE's review of verified savings for non-HER residential programs found that, overall, the verified savings followed proper TRM protocols and that 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 only noted a few minor discrepancies.
- The SWE's review of PY12 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, including adherence to the COVID-19 EM&V Guidance Memo; and were generally accurate.
- ADM did not conduct primary NTG research for any residential or non-residential programs during PY12 and applied prior program year NTG values.

- The PY12 process evaluation of the Behavioral Demand Response (BDR) program was consistent with the Phase III evaluation plan and the reporting followed the SWE guidelines.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in FirstEnergy's Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE has no major concerns. For all Met-Ed's programs, the SWE was able to replicate reported MWh savings and reported MW savings exactly via the tracking data. We also calculated directionally similar (if not identical) participation counts and incentive amounts for all programs.
- Met-Ed's TRC model was well-organized and consistent with the directives of the 2016 TRC Test Order and the key financial assumptions approved in Met-Ed's Phase III EE&C Plan. ADM uses a sampling approach for non-residential incremental measure costs that is unique to the FirstEnergy companies in Pennsylvania. Rather than apply assumed measure costs to each measure in the tracking data, ADM conducts project-specific cost research on each project in the evaluation sample along with the energy and demand savings analysis. The results from the sample are expanded to the population on a $/kWh basis by sampling initiative and EDC. The SWE appreciates this attention to measure costs in the impact evaluation and believes it returns an unbiased estimate of TRC Costs. Met-Ed's PY12 non-residential incentives as a percentage of estimated incremental cost were among the lowest statewide at 17.2% for Small C&I and 12.6% for Large C&I.

E.2 EM&V Plan Reviews

FirstEnergy's evaluation contractor, ADM Associates, submitted an updated comprehensive evaluation plan for the four FirstEnergy EDCs that addressed evaluation activities for PY11 and PY12. In addition, the ADM team submitted a memo updating their sampling and evaluation approach for the process evaluation of the Behavioral DR program. The SWE reviewed and approved the plan and memo.

E.3 Sample Design Review

Verified savings estimates for most programs 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 ±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 III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at 85% confidence level for each "initiative." For 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 program delivery channel or supported technology.

Grouping projects by equipment type and program delivery method leads to more meaningful evaluation results than tariff-based program definitions, each of which would include the same mix of measures. This evaluation strategy also makes sample design more efficient because the same projects are more likely to share similar characteristics across rates classes (i.e., Small C&I, Large C&I, and Government) than a heterogeneous mixture of measures within a single class. For example, projects from Met-Ed's three non-residential energy programs (C&I Energy Solutions for Business – Small, C&I Energy Solutions for Business – Large, and Government & Institutional Tariff) were assigned to one of four initiatives:

- C&I Lighting
- C&I Custom
- C&I Prescriptive
- C&I Appliance Turn-In

ADM established a series of initiatives and designed the impact evaluation samples for each to meet the 85/15 precision requirement. Table 214 lists each initiative evaluated in PY12 and the corresponding relative precision of the PY12 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 214: Relative Precision of Met-Ed PY12 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (±)
Residential Appliance Turn-In (ATI)	6.5%
LI ATI	8.2%
LI Direct Install	7.9%
Res Upstream Lighting	8.1%
Res Upstream Electronics	0.0%
Res HVAC	5.4%
Residential Appliances	2.1%
LI Appliances	13.2%
C&I Lighting	8.1%
C&I Custom	13.0%
C&I Prescriptive	8.8%

The C&I Appliance Turn-In, Residential Direct Install, and Residential New Construction initiatives were not evaluated in PY12. ADM estimated verified gross savings for these initiatives using historic realization rates. The Energy-Efficiency Kits initiative was not active in PY12.

Each of the sampling initiatives shown in Table 214 yielded verified gross savings estimates with better than ±15% precision at the 85% confidence level. The Residential Upstream Electronics initiative has no sampling uncertainty because all files reviewed showed perfect alignment

between reported and verified savings. PY12 verification processes were impacted by the COVID-19 pandemic. Where appropriate, ADM replaced on-site visits with phone interviews and video conferences.

Sampling uncertainty does not consider the level of rigor of the verification activities. Results from a sampled project that receives a quick desk review from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of ADM's PY12 verification activities is discussed in detail in Appendix E.5.

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 the used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase III Evaluation Framework requiring the solution-level verification achieve an *absolute* precision of ±0.5% at the 95% confidence level (two-tailed). Table 215 shows the absolute precision of the behavioral program components.

Table 215: Absolute Precision of Met-Ed PY12 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (±)
Residential	0.15%
LI	0.54%

DR programs offered by Met-Ed in PY12 included C&I DR Programs for both small and large customers and a BDR Program to residential customers. Gross impact evaluations for the C&I DR Programs do not rely on sampling but instead consist of establishing a customer baseline load (CBL) for each program participant. The relative precision of the PY12 DR impacts is ±5.7% at the 90% confidence level.

E.4 Reported Gross Savings Audits

E.4.1 Tracking Data Review

This section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Met-Ed's PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)
- Reported gross peak demand savings (MW)
- Participation
- 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, rather a subset of the full tracking data set tailored to our PY12 quarterly data request. Also note that DR or 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 Met-Ed's C&I DR programs can be found in Appendix E.6, and our findings regarding the HER components of the Energy-Efficient Homes and LIEEP can be found in Appendix E.5.1.3.

Table 216 summarizes our ex-ante findings regarding energy savings. The "Match" column contains "Yes" if the tracking data supports the values shown in Met-Ed's PY12 Annual Report and "No" otherwise. For each program, the SWE was able to replicate the values reported by Met-Ed.

Table 216: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-In	2,883	2,883	Yes
Energy-Efficient Homes	22,781	22,781	Yes*
Energy-Efficient Products	13,797	13,797	Yes
LI Energy Efficiency	3,275	3,275	Yes*
C&I Energy Solutions for Business – Small	15,540	15,540	Yes
C&I Energy Solutions for Business – Large	42,809	42,809	Yes
Governmental & Institutional Tariff	506	506	Yes
Portfolio Total	**101,591**	**101,591**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 217 summarizes the SWE's ex-ante findings regarding peak demand savings. The SWE replicated peak demand savings for all programs. The SWE was able to replicate savings values for all programs.

Table 217: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-In	0.42	0.42	Yes
Energy-Efficient Homes	4.49	4.49	Yes*
Energy-Efficient Products	1.97	1.97	Yes
LI Energy Efficiency	0.49	0.49	Yes*
C&I Energy Solutions for Business – Small	2.35	2.35	Yes
C&I Energy Solutions for Business – Large	6.11	6.11	Yes
Governmental & Institutional Tariff	0	0	Yes
Portfolio Total	**15.83**	**15.83**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 218 summarizes the SWE's ex-ante findings regarding program participation. For all programs, the SWE calculated directionally similar (if not equal) participation counts. For Energy-Efficiency Homes, note that Residential Behavioral DR and HER participants are removed, as they have no representation in the tracking data.

Table 218: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-In	2,852	2,852	Yes
Energy-Efficient Homes	859	865	No*
Energy-Efficient Products	122,092	122,092	Yes
LI Energy Efficiency	1,728	1,728	Yes*
C&I Energy Solutions for Business – Small	260	260	Yes
C&I Energy Solutions for Business – Large	91	92	No
Governmental & Institutional Tariff	20	20	Yes
Portfolio Total	**127,902**	**127,909**	**No***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table. Behavioral DR participants are not included in this table either.

Finally, Table 219 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE was able to exactly replicate incentive dollars for Appliance Turn-in, LI Energy-Efficiency, Large C&I Energy Solutions, and Governmental & Institutional Tariff. For three other programs, the SWE calculated directionally similar values using the tracking data. For these seven programs, the totals are also directionally similar: $4,330,000 in the Annual Report and $4,307,000 in the tracking data.

Table 219: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-In	$166	$166	Yes
Energy-Efficient Homes	$603	$581	No
Energy-Efficient Products	$1,032	$1,319	No
LI Energy Efficiency	$59	$59	Yes
C&I Energy Solutions for Business – Small	$816	$528	No
C&I Energy Solutions for Business – Large	$1,632	$1,632	Yes
Governmental & Institutional Tariff	$22	$22	Yes
Portfolio Total	**$4,330**	**$4,307**	**No**

E.4.2 Project File Reviews

E.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of Met-Ed's residential project files for PY12 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 uploaded project file packages included a majority of the documentation requested.

Table 220 presents a summary of SWE's residential project file reviews.

Table 220: Met-Ed PY12 Residential Project File Review Summary

Program	Sub Program	Number of Files Reviewed[1]	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[2]
Appliance Turn-In	NA	23	✓	✓	✓	✓
Energy-Efficient Homes	Audits	30	✓	✓	✓	✓
Energy-Efficient Homes	New Homes	16	✓	✓	✓	✓
Energy-Efficient Products	HVAC	32	✓	✓	✓	✓
Energy-Efficient Products	Appliances and Electronics	14	✓	✓	✓	✓
Energy-Efficient Products	Lighting	16	✓	✓	✓	✓
LI Energy-Efficiency	Multifamily/LILU Single-Family	7	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Rebate	8	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Turn-In	11	✓	✓	✓	✓
LI Energy-Efficiency	Weatherization	12	✓	✓	✓	✓

[1] The number of files reviewed reflects the total number for all FirstEnergy EDCs.
[2] 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 programs. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Appliance Turn-In

For the Appliance Turn-In Program, the quarterly upload included a list of projects with information such as: participant signatures, cubic feet, configuration, etc. The projects were found in the residential downstream database and were applied a default savings value in the reported savings. However, the SWE observed that there were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance evaluator (e.g., using captured model and serial numbers).

School Education

The School Education Program was not run in PY12.

Energy-Efficiency Kits

The Energy-Efficiency Kits Program was not run in PY12.

Audits

Project files mostly aligned with tracking data, but the SWE observed minor discrepancies regarding rebate amounts, kWh, and audit dates. Project files did not provide enough information to always verify rebate amount or kWh.

New Homes

REM/Rate reports' kWh savings tended to match tracking but overestimated peak kW by 28% for all FE utilities. Note that reported savings includes lighting and appliance savings; however, the evaluator addresses this during the verified savings review. SWE observed minor discrepancies between the kWh and kW listed in the REM report as compared to the quarterly tracking data.

HVAC

The HVAC project files mostly matched the quarterly tracking data.

However, the SWE observed the same discrepancy as during previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular *tons* variable.[70] That being said, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data.

Starting in PY9, the evaluator, ADM, worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and

[70] For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations. Most project requests did not include an AHRI certificate, which prevented verification of tracking data measures. Additionally, one provided data request was for the wrong energy program.

Appliances and Electronics

The Appliance files typically matched the tracking data. The SWE also encountered issues in tracking projects by account number, likely due to automatic truncation in spreadsheet software (e.g., scientific notation reverted to number formatting).

Many project requests were saved as GIF files, which made them difficult to verify. This limited SWE ability to review projects for Q1 significantly. In Q2, one reviewed project's appliance type did not match the tracking data. There was no available tracking data for Q3 and Q4 requests.

Midstream Appliances

The Midstream Appliances Program was not run in PY12.

Upstream Lighting

The Upstream Lighting files mostly matched the tracking data; however, not all suppliers provided enough information with the invoices to corroborate both incentive amounts and lighting quantities. All incentive amounts matched, and where available, so did lighting quantities.

LI Multifamily / LILU Single-Family

The Multifamily files mostly matched the tracking data, but there were some slight discrepancies with participants' first names and appliances. Additionally, many of the projects had multiple entries in the tracking data that the provided receipts did not include. In Q3, one project had multiple entries, but the provided receipt listed an appliance not found in the quarterly tracking data. The project files contained receipts, WARM program applications, audit forms, etc. There was an overall low amount of data requests for this program and none for Q1 or Q4.

LI Appliance Rebate

LI Appliance Rebate files mostly matched tracking data: however, many project requests contained receipts missing rebate amounts, energy saving metrics, and serial/model numbers. There was no available tracking data for Q3 or Q4 data requests.

LI Appliance Turn-In

The LI Appliance Turn-In files mostly matched the tracking data, and the quarterly upload included a list of projects with information such as: participant signatures, cubic feet, configuration, etc. However, the SWE observed that there were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance evaluator (e.g., using captured model and serial numbers). Overall, there was a low amount of data requests but no requests at all for Q2.

LI Weatherization

LI Weatherization files mostly matched the quarterly tracking data. Some accounts had multiple tracking data entries that did not correspond to the project file invoice. The SWE observed some

project files that included certain measures in the tracking data and left out additional measures listed in the project files. ADM clarified in previous program years that the additional measures listed in these project files are provided by the Low-Income Usage Reduction Program (LIURP) during the same visit, but they are not part of Act 129 and so do not carry any associated savings in the tracking system. There were no data requests for Q4.

E.4.2.2 Non-Residential

As part of its audit process, the SWE conducts a review of ex-ante savings values and methodologies. This review involves assessing specific ICSP project files for a sample of Met-Ed's non-residential programs in PY12. 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 221 presents an overview of the results of the SWE's C&I project file reviews.

Table 221: Met-Ed PY12 C&I Project File Review Summary

Program	Sub-Program	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program – Large	Custom - LCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Custom - SCI	3	✓	✓	2/3	2/3	-	✓
C&I Energy Solutions for Business Program – Small	HVAC-SCI	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Large	Lighting - LCI	3	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	Lighting - 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 that some project files for lighting projects contained multiple Excel workbook calculators that each contained differing final savings values. While the included Appendix C calculator typically contained the corresponding reported savings as listed in the tracking data, the presence of multiple calculators with various savings values obfuscated the review process. In addition to these general issues, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- Custom - SCI
  - Project file missing documentation on installed refrigerator and freezer specifications.
  - Project file missing information to verify the correct number of rooms where thermostats were installed in a custom HVAC project.
- HVAC - SCI
  - Workbook calculator locked; SWE cannot verify calculations.

Despite minor issues with some project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

E.5 VERIFIED GROSS SAVINGS AUDITS

E.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the Met-Ed portfolio of residential programs. Met-Ed's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy-Efficient Homes Initiative, the Energy-Efficient Products Initiative, and the LI Energy-Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings into the three following sections: upstream lighting, residential non-lighting, and behavior.

Overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE identified the evaluation activities used to verify savings for the residential programs. Table 222 provides a summary of the evaluation and M&V approaches used by Met-Ed in their PY12 verified savings calculations.

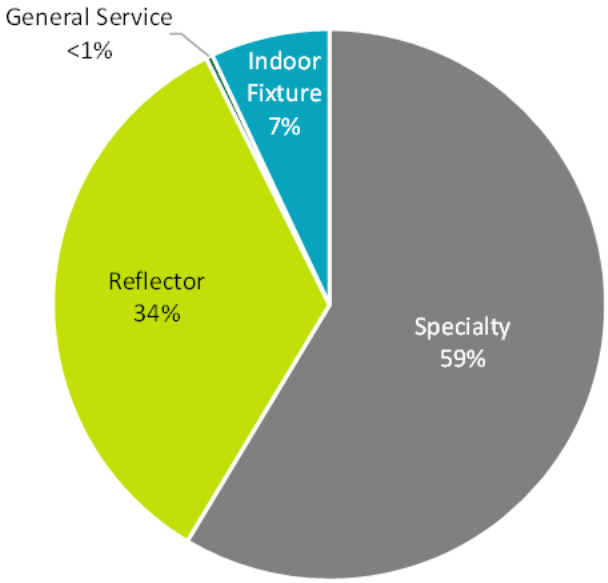
Table 222: Residential Program Evaluation Activities – Met-Ed

Program/ Subprogram	Surveys	Site Visits	Desk Review[a]	Billing Analysis
Appliance Turn-In				
Appliance Turn-In (LI & Non-LI)	✓	-	✓	-
EE Homes				
Energy-Efficiency Kits	-	-	-	-
Energy-Efficiency Kits – LI	-	-	-	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	-	-
Residential New Construction	-	-	-	-
Upstream Lighting				
Upstream Lighting	-	-	✓	-
EE Products				
Upstream Electronics	-	-	✓	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliances – LI	✓	-	✓	-
LI WARM				
LI WARM – Extra Measures	-	✓	✓	✓
LI WARM – Multifamily	-	✓	✓	✓
LI WARM – Plus	-	✓	✓	✓

E.5.1.1 Upstream Lighting & Cross-Sector Sales

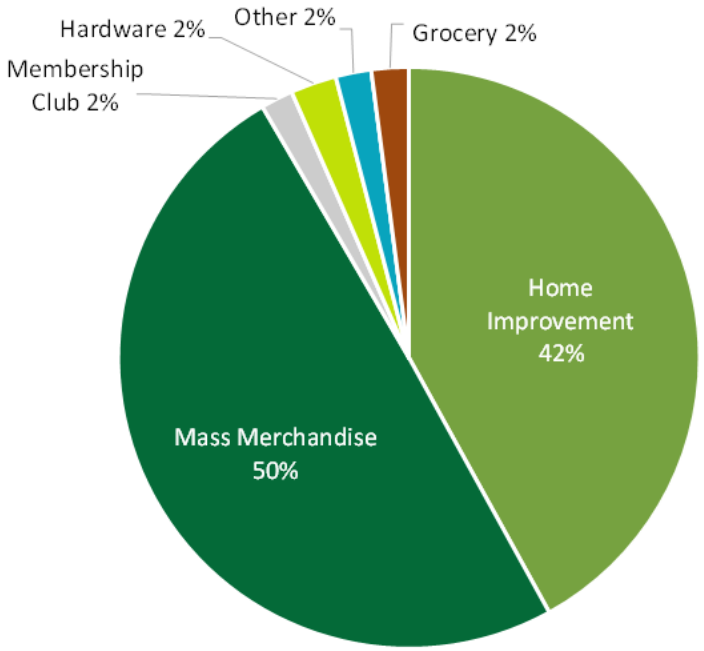
Customers purchased over 291,000 efficient light bulbs and fixtures through Met-Ed's PY12 upstream lighting program. Figure 78 displays the distribution of sales by product type. Nearly three-fifths (59%) of the products were specialty bulbs.

Figure 78: Met-Ed PY12 Upstream Lighting Sales by Product Type



Met-Ed's PY12 upstream light bulbs and fixtures were sold primarily through mass merchandise (50%) and home improvement stores (42%, Figure 79).

Figure 79: Met-Ed PY12 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY12 impact analysis for Met-Ed's Upstream Lighting Initiative before the PY12 Met-Ed Annual Report was submitted to the PUC on November 15, 2021. This allowed time for the SWE to conduct its audit, provide ADM with feedback, and for ADM to adjust the analysis based on this feedback. The SWE agrees with ADM's verified gross savings for upstream lighting.

Cross-Sector Sales

ADM did not conduct cross-sector sales research in PY12 but applied the PY10 cross-sector sales rate 7.1%.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY12 upstream lighting analysis.

E.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.

Energy-Efficient Homes Program

In PY12, the Energy-Efficient Homes program included only the New Homes Initiative. The FirstEnergy Companies did not run the direct install or kit portions of the program in PY12. The

SWE noted that the FirstEnergy Companies used an average of PY10 and PY11 results when calculating savings. The realization rates used for calculation were consistent with PY10 and PY11.

Energy-Efficient Products Program

Each component of the EEP Program was audited by the SWE, including appliances, HVAC equipment, and consumer electronics. Note that the SWE's audit of the upstream lighting portion of the EEP Program is reported in Section E.5.1.1 of this appendix.

Analysis files and data sets included in the gross impact data were reviewed for all HVAC, appliance, and consumer electronics measures included in the program. The SWE found that in all cases the correct TRM values and algorithms were used, the verified savings were correct, and the savings and sample sizes included in the annual request data matched those reported in the PY12 annual report.

The Midstream Appliances subprogram includes two measures: ENERGY STAR dehumidifiers and heat pump water heaters. Verification occurred via a review of distributor invoices and the gross impact calculations followed TRM algorithms with specific equipment capacity and efficiency parameters drawn from the ENERGY STAR Qualified Product Lists. Changes to federal standards and ENERGY STAR qualifying criteria in late 2019 complicated the analysis for dehumidifiers. ADM's PY12 verified savings calculations for dehumidifiers aligned with a March 2021 SWE Guidance Memo on the topic. Realization rates for both measures were well over 100% due to the conservative efficiency assumptions used by Met-Ed to claim reported gross energy and demand savings. The SWE audit found the verified savings were well-organized, free of errors, and consistent with Act 129 guidance documents.

LI WARM Program

The LI WARM Program is a LI direct install initiative offering similar measures across three sub-programs: WARM-Plus, WARM-Extra Measure, and WARM-Multifamily. The WARM program includes LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE audited all measures included in the program using the full downstream dataset and the survey sample subset provided by FirstEnergy. The SWE found that the correct TRM-approved methods were followed, survey sample sizes were correct and survey data correctly incorporated into the verified savings calculations, and the verified savings were correct.

Appliance Turn-In Program (LI and Non-LI)

The SWE performed audits on all measures included in the Appliance Turn-In Program, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

E.5.1.3 Behavior

Approximately 22% of Met-Ed's verified gross energy savings for PY12 came from Home Energy Reports issued to over 125,000 residential and residential-LI households. The SWE reviewed ADM's methodology and accepts their verified MWh and MW savings values for Met-Ed's HER offering in PY12. By cohort, Table 223 shows average kWh savings and average percent savings

per participant in PY12. Note that the 'Average Number of Participants' column shows the average number of participants per month during PY12.

Table 223: Average PY12 kWh Savings per Participant

Sector	Cohort Start Date	Average Number of Participants	Average PY12 kWh Savings	Average PY12 % Savings
Low-Income	July 2012	8,372	220	1.54%
Residential	July 2012	65,618	167	1.21%
Low-Income	January 2014	1,674	231	1.38%
Residential	January 2014	42,062	163	1.19%
Residential	January 2015	8,964	295	2.08%

The following sections highlight some of the more important audit steps and findings: the calendarization of billing data, group equivalence, duplicating participant counts, the calculation of lag terms, missing eligibility filters, and energy and demand savings.

Calendarization

The first step the SWE team took was to review ADM's calendarized data. "Calendarization" is a process that prorates billing data into a common calendar month basis shared by all accounts. Our review of the calendarized data had three primary components:

- Check the coding of the "pre" and "post" indicator variables;
- Confirm that the calendarized average daily usage values are correct; and
- Confirm that the lag terms (average usage in the pre period, average summer usage in the pre period, average winter usage in the pre period) are correct.

Our team found no issues in the coding of the pre and post indicator variables. Table 224 shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.[71] The distribution of average daily kWh is basically identical in the two data sets.

Table 224: Comparison of Calendarized Data

Variable	Mean	5th Percentile	25th Percentile	75th Percentile	95th Percentile
Average Daily kWh – ADM	37.78	12.82	22.11	47.26	81.51
Average Daily kWh – SWE	37.78	12.82	22.11	47.26	81.51

Regarding the lag terms, the SWE found that ADM's calculations were sound. ADM did not calculate summer or winter lag terms in cases where pre period summer or winter data did not exist. Because we found no issues with ADM's calendarized data, the figures, tables, and

[71] The table only summarizes PY12 records.

summary statistics presented herein were created or calculated using ADM's calendarized data rather than our own.

Group Equivalence

After reviewing the calendarization, the SWE compared average daily consumption (kWh) between the treatment and control groups during the pre-treatment period. Table 225 shows the results for each cohort. Note that calendarized data was used to calculate the averages and any customer without at least 12 month of pre-treatment data was dropped. To avoid comparing averages calculated over different time spans (e.g., 14 months and 12 months), averages within each month were calculated before calculating overall averages for each customer. The 'P-value' column indicates the likelihood that the observed differences could happen by chance if the two experimental cells use the same amount of energy, on average. A p-value less than 0.05 indicates that the difference in average consumption between the two groups is statistically significant. The January 2014 Residential cohort was found to have statistically significant pre-treatment differences between the treatment and control groups. In some prior years, differences for this cohort were not statistically significant, but customers move over time and the make-up of the experimental cells changes. The impact estimation method accounts for the differences in pre-treatment consumption.

Table 225: Group Equivalence in the Pre-Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
Low-Income	July 2012	40.3	40.3	0.94
Residential	July 2012	39.2	39.2	0.83
Low-Income	January 2014	48.1	48.2	0.86
Residential	January 2014	38.9	38.5	0.03
Residential	January 2015	37.6	37.4	0.77

Participation Counts

The SWE team leveraged the raw billing data to audit participant counts. Because billing cycles can exceed 31 days in length (meaning bill dates can occasionally skip over a month), the SWE team calculated the number of unique IDs beyond a certain bill date. As an illustrative example, suppose we wanted to compute the number of participants in Met-Ed's 2012 LI cohort for March of 2021. We removed any households with a billing end date prior to 3/1/2021, then counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Table 226: Participant Counts by Cohort and Month

Month	July 2012 LI	July 2012 Residential	January 2014 LI	January 2014 Residential	November 2014 Residential
Jun-20	8,603	67,092	1,730	43,194	9,304
Jul-20	8,550	66,774	1,721	42,963	9,243
Aug-20	8,502	66,486	1,712	42,744	9,172
Sep-20	8,456	66,150	1,697	42,501	9,092
Oct-20	8,422	65,891	1,688	42,289	9,039
Nov-20	8,383	65,623	1,680	42,053	8,974
Dec-20	8,348	65,391	1,669	41,863	8,904
Jan-21	8,319	65,188	1,661	41,717	8,852
Feb-21	8,287	65,013	1,651	41,573	8,815
Mar-21	8,250	64,837	1,640	41,444	8,780
Apr-21	8,198	64,612	1,625	41,291	8,729
May-21	8,144	64,360	1,611	41,117	8,664

Eligibility Filters

The LS regression model is a post-only model – only records from the post period are used in the regression. That said, some of the explanatory variables in the model are calculated based on pre period data: (1) average daily consumption in the pre period, (2) average daily consumption during the summer in the pre period, and (3) average daily consumption during the winter in the pre period. For several homes, there was not enough pre-period data to calculate these lag terms. In PY12, ADM dropped any homes without 12 months of pre period data from the LS model. The monthly impact estimates derived from the model were then applied to the homes with insufficient pre period data. There is no evidence to suggest that homes without sufficient pre period data are systematically different from homes with sufficient pre period data. The SWE believes this is the correct approach.

Impact Coefficients and Energy Savings

Figure 80 through Figure 84 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY12. Only homes active in PY12 are included in the “pre period” portion of the figure. As has been noted, the regression model used to estimate the impact of the HER program has daily usage controls for potential pre period differences.

Figure 80: July 2012 LI Cohort Usage Comparison

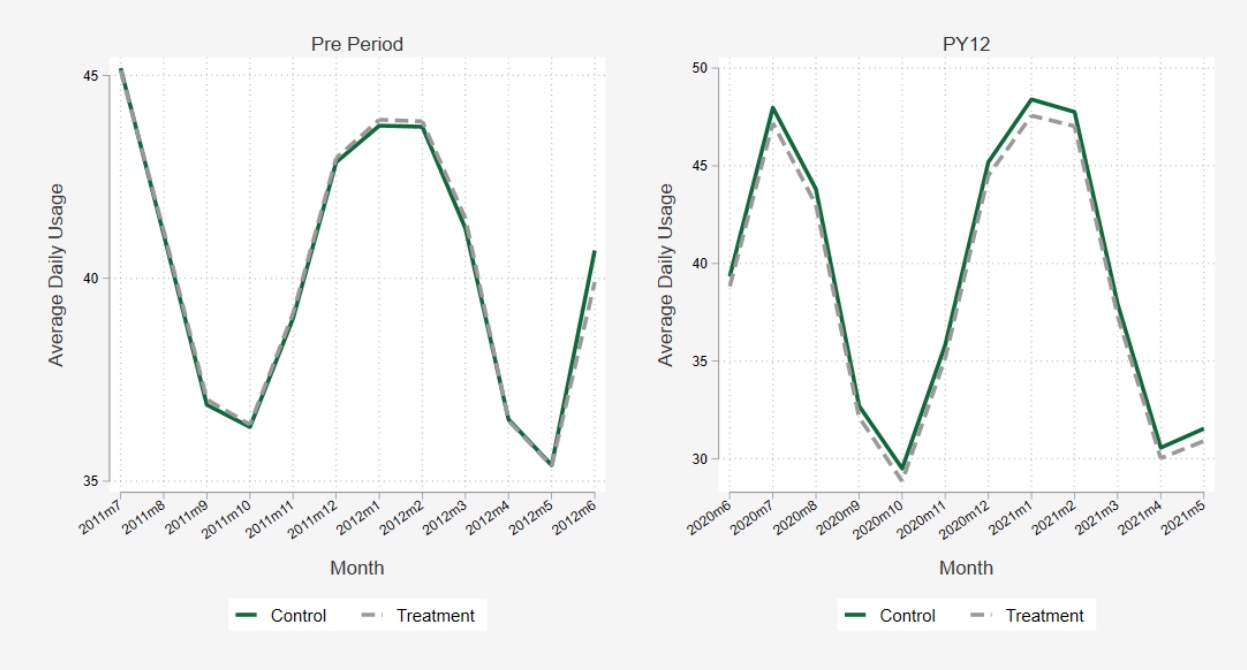


Figure 81: July 2012 Residential Cohort Usage Comparison

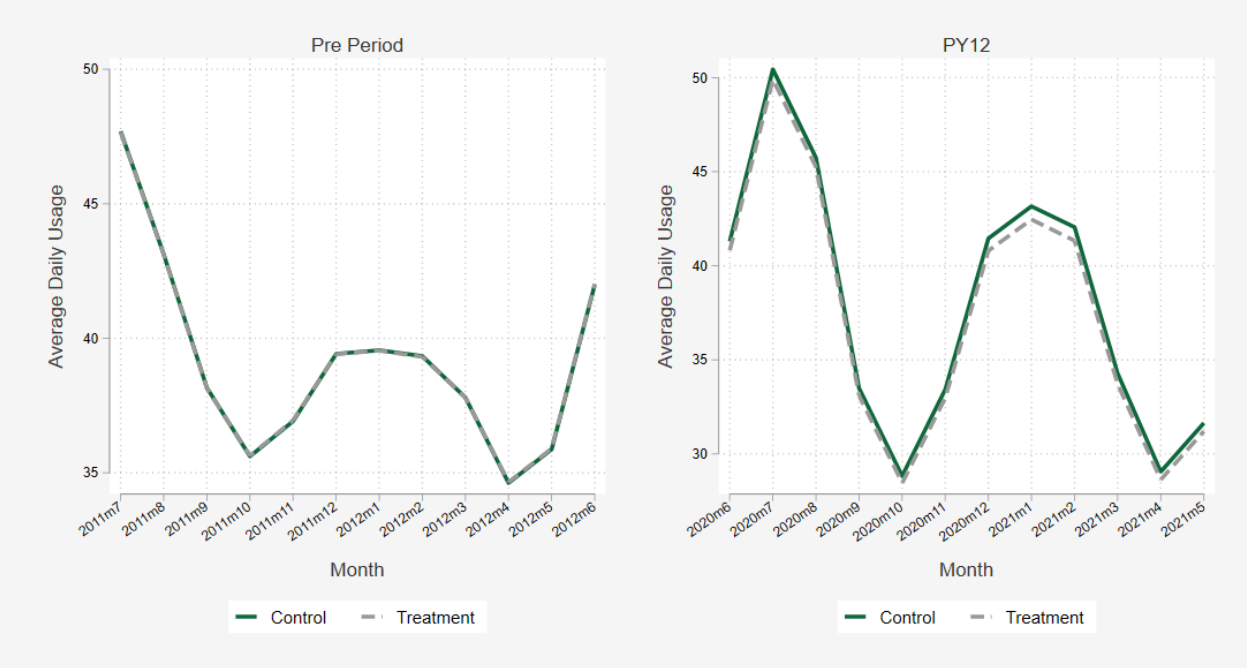


Figure 82: January 2014 LI Cohort Usage Comparison

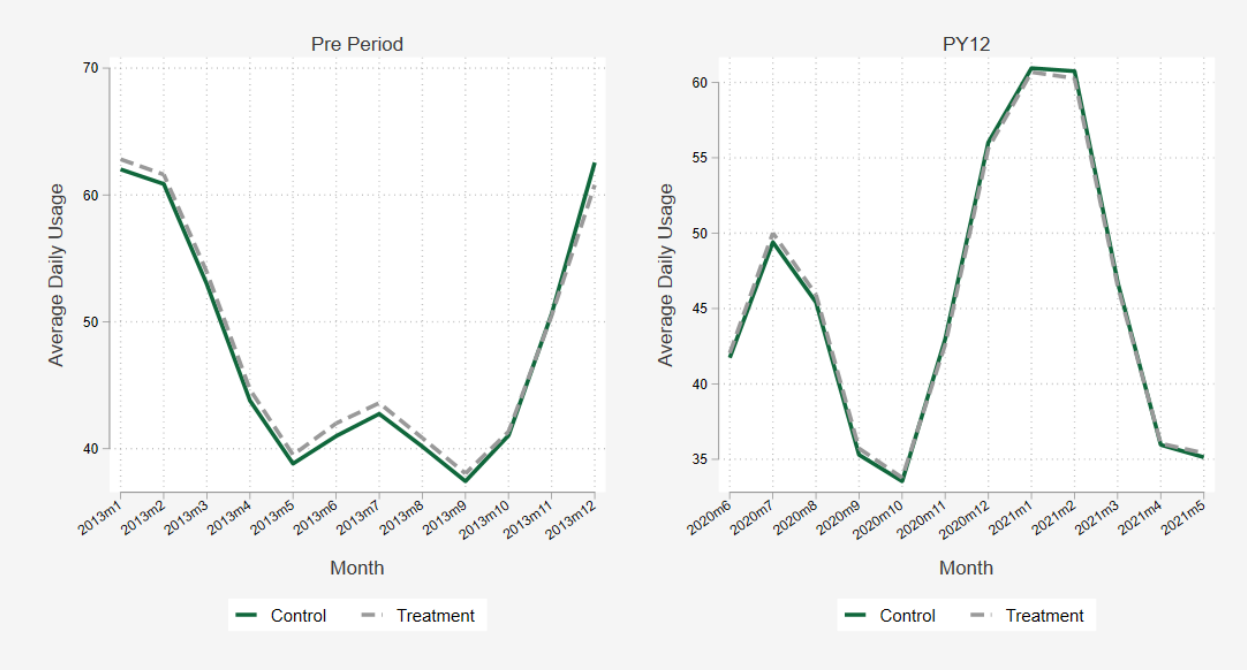


Figure 83: January 2014 Residential Cohort Usage Comparison

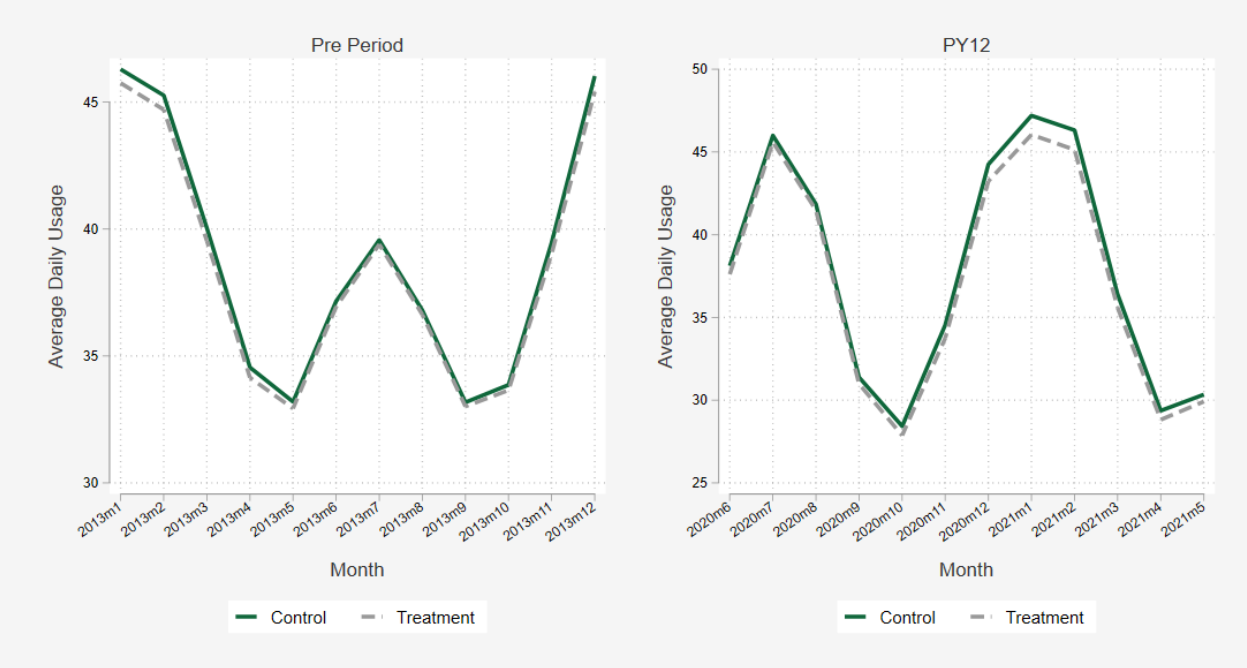


Figure 84: January 2015 Residential Cohort Usage Comparison

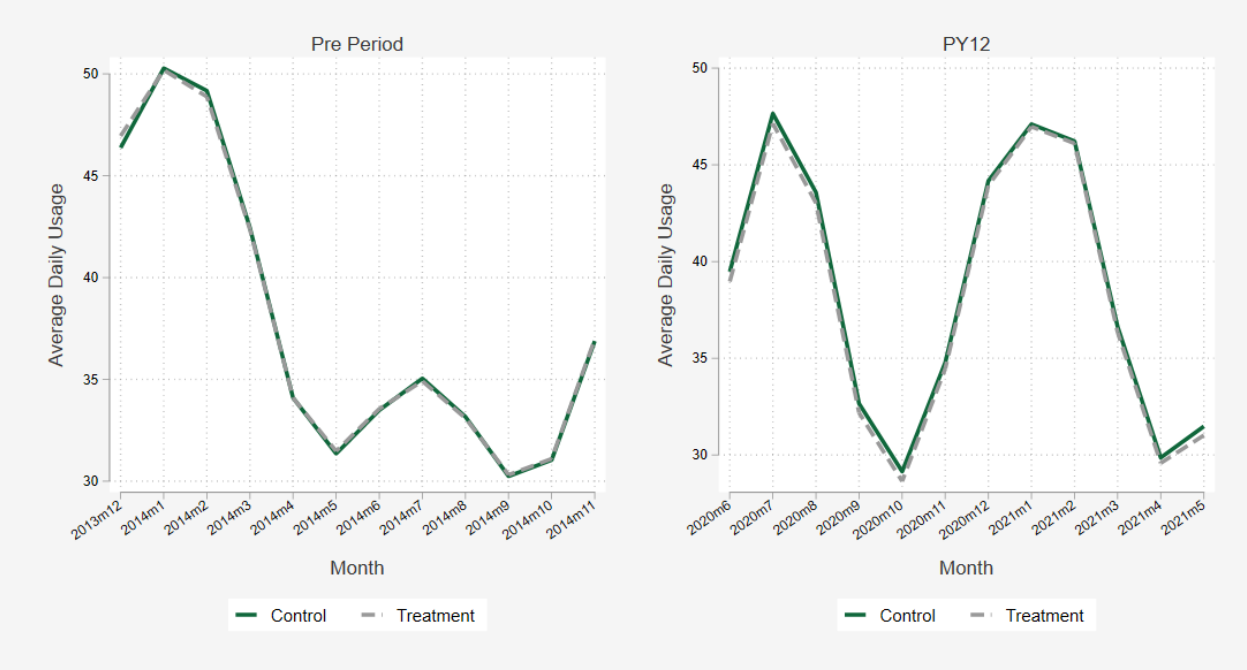


Table 227 shows PY12 impact estimates for each cohort (as calculated by ADM and the SWE). Note that a different impact estimate was calculated for each month in PY12 – the estimates shown in the table reflect the averages of the PY12 monthly estimates. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the LI July 2012 cohort saved 0.97 kWh per day, on average, during PY12.

Table 227: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
Low-Income	July 2012	(0.97)	(0.97)
Residential	July 2012	(0.47)	(0.47)
Low-Income	January 2014	(0.62)	(0.62)
Residential	January 2014	(0.50)	(0.50)
Residential	January 2015	(0.85)	(0.85)

To account for dual participation, savings are reported after adjusting for downstream measures and upstream measures. HER programs promote other energy-efficiency & conservation programs, creating a situation where treatment group homes participate in other energy-efficiency & conservation programs at a higher rate than control group homes. Therefore, there is incremental kWh savings in the regression analysis that must be subtracted from the HER impacts to avoid double-counting. ADM identified energy-efficiency program participation that occurred from each cohort's treatment start date onwards to calculate the downstream adjustment factor. The upstream reduction factor for each cohort varies depending on the number of years passed

since the cohort's respective start date. Because all the cohorts had a start date at least four years before PY12, the upstream reduction factor for all cohorts is 3%.

Using the impact estimates shown above, Table 228 shows ADM's and the SWE's aggregate energy savings (MWh), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 228: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE – ADM)
Low-Income	July 2012	1,844	1,842	(2)
Residential	July 2012	10,939	10,955	16
Low-Income	January 2014	387	387	0
Residential	January 2014	6,874	6,879	6
Residential	January 2015	2,648	2,649	1
Total		**22,692**	**22,713**	**21**

Demand Savings

Table 229 shows ADM's and the SWE's aggregate peak demand savings (MW), after accounting for dual participation, for each cohort. The estimates were nearly identical. The SWE approves of ADM's MW savings estimates.

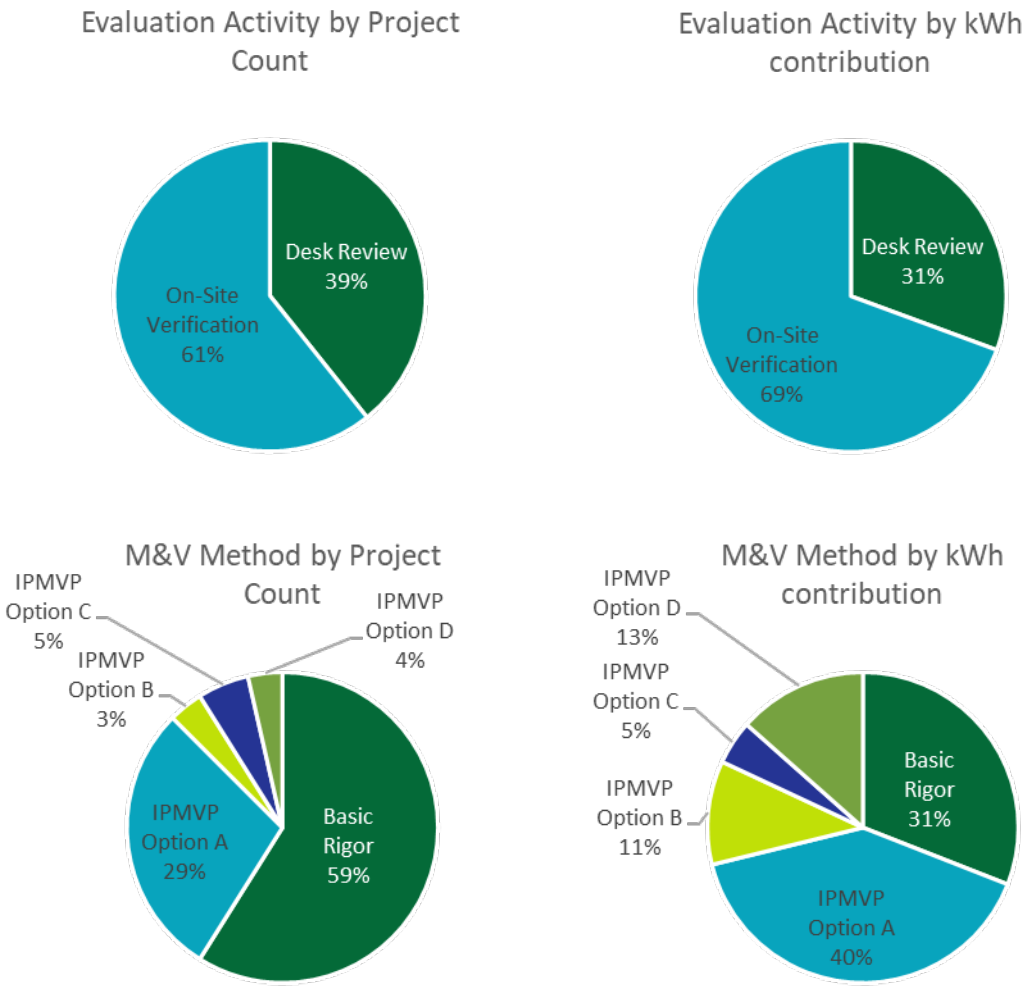
Table 229: Demand Savings Comparison

Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE – ADM)
Low-Income	July 2012	0.21	0.21	0.00
Residential	July 2012	1.23	1.23	0.00
Low-Income	January 2014	0.05	0.05	0.00
Residential	January 2014	0.78	0.78	0.00
Residential	January 2015	0.30	0.30	0.00
Total		**2.57**	**2.57**	**0.00**

E.5.2 Non-Residential Audit Activities

Figure 85 provides a summary of the evaluation activities and M&V approaches utilized by Met-Ed's evaluation contractor, ADM, in their PY12 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY12, Met-Ed's evaluation contractor completed site visits to 61% of evaluated projects, and these projects represented 69% of total evaluated energy savings. In total, 34 site visits were completed. IPMVP Options A, B, C and D were employed for 69% of the total evaluated energy savings. Basic Rigor (verification only) was employed for 31% of the total evaluated savings, including all prescriptive projects and some lighting projects.

Figure 85: Summary of Met-Ed's C&I Evaluation Activities



Met-Ed's evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Met-Ed's C&I programs are assigned to one of five evaluation initiatives, as Met-Ed's programs target specific sectors of C&I customers, but offerings are often identical across the programs. Table 230 provides a summary of the evaluation activities Met-Ed's evaluation contractor used across strata for all projects by initiative.

Table 230: Summary of Met-Ed's PY12 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	On-Site Verification
Appliance Turn-In	**0**	**111%**	**0**	**0**
Custom	**9**	**100%**	**8**	**1**
Custom – 1	1	100%	1	-
Custom – 2	-	-	-	-
Custom – Certainty	8	100%	7	1
Direct Install	**0**	**109%**	**0**	**0**
Lighting	**34**	**95%**	**1**	**33**
Lighting – 1	4	80%	-	4
Lighting – 2	5	82%	-	5
Lighting – 3	9	94%	1	8
Lighting – Certainty	16	100%	-	16
Prescriptive	**13**	**93%**	**13**	**0**
Prescriptive – 1	13	93%	13	-
Prescriptive – 2	-	-	-	-
TOTAL	**56**	**96%**	**22**	**34**

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 Turn-In Initiative

In PY12, Met-Ed's Appliance Turn-In Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the average of respective PY10 and PY11 realization rates.

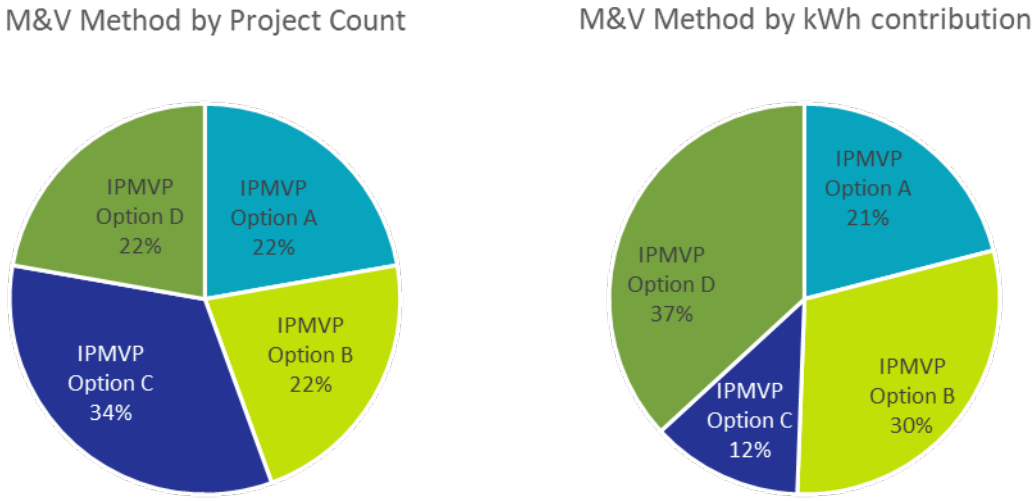
E.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews, site visits, and/or IPMVP evaluation methods for all sampled projects. Only one site visit was conducted for PY12 custom sampled projects. The evaluation was satisfactorily conducted remotely for remaining projects using data provided by the customer (EMS data, billing data, etc.). All sampled projects undergo a full documentation review prior to site visits, and site-specific M&V plans are developed for most.

Met-Ed's evaluation contractor employed three strata for projects in the 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 3-2 of the Phase III Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. Enhanced rigor methods were employed to evaluate all projects, with IPMVP Option D selected as the primary enhanced M&V method for 37% of evaluated custom projects, as shown in Figure 86.

Figure 86: Summary of Met-Ed's C&I Custom Program M&V Methods



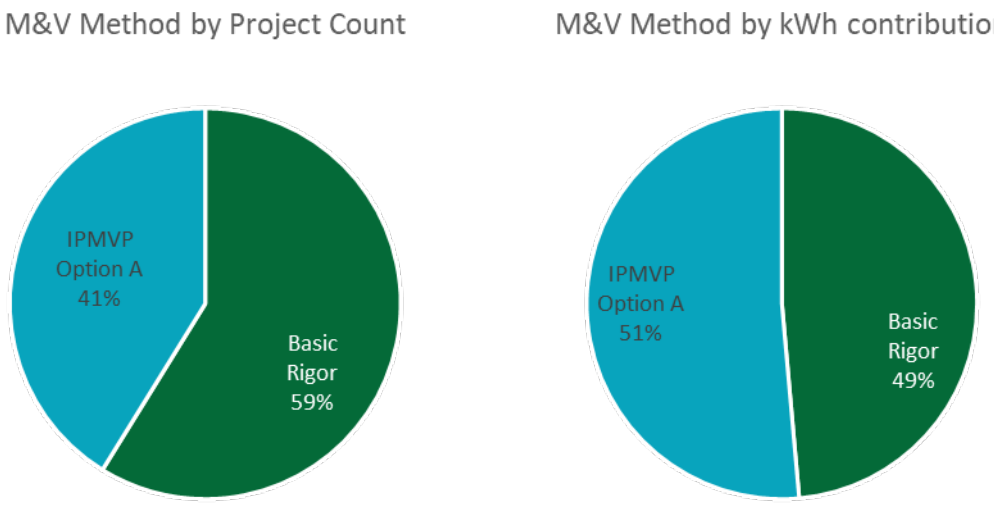
E.5.2.3 Lighting Initiative

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.

Met-Ed's evaluation contractor employed four strata for projects in the Lighting initiative. The largest projects, with ex-ante savings estimates of 750 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.

IPMVP Option A was employed for approximately half of evaluated project savings in this initiative with the remaining half evaluated using basic rigor methods, as seen in Figure 87 below.

Figure 87: Summary of Met-Ed's C&I Lighting Program M&V Methods



E.5.2.4 Prescriptive Initiative

Evaluation activities for this initiative include desk reviews and basic rigor application of TRM-based savings calculation methodologies. None of Met-Ed's prescriptive projects received a site-visit this program year.

Met-Ed's evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 20 MWh of annual energy savings. All the PY12 sampled projects were in the Prescriptive-1 stratum, meaning no sampled project reached the savings threshold.

IPMVP-based methods were not employed for this initiative. All projects were evaluated using desk reviews.

E.5.2.5 Direct Install Initiative

In PY12, Met-Ed's Direct Install Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the PY11 realization rates, as the program had no participation in PY10.

E.5.2.6 Ride-Along Site Visits

In PY12, no ride-along site visits were conducted for Met-Ed.

E.5.2.7 Verified Savings Desk Reviews

Table 231 provides an overview of the SWE milestones for the verified savings review of evaluated Met-Ed projects via desk review.

Table 231: Met-Ed Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
5	14,419,608	2,046	100%	100%

Overall, the SWE found that Met-Ed's evaluation contractor demonstrated general adherence to the TRM for prescriptive measures and employed sound engineering methods for custom measures. The overall energy and demand savings attainment percentages of Met-Ed's reviewed projects were 100% for both energy and demand savings.

E.6 DR

According to the Phase III Implementation Order, Met-Ed's Phase III demand response (DR) compliance target is 49 MW. Note that compliance is determined based on the average MW performance across events during the second, third and fourth program years consistent with the Commission's Phase III Modification Order[72] entered on June 3, 2020 amending the original Implementation Order. This amendment permitted EDCs to operate the approved DR programs on a voluntary basis for the fifth and final year of the program with results not counted toward compliance goals. The PY12 results of the DR program provided below are based on voluntary customer participation. Additionally, DR goals are assessed at the system level, meaning that line loss adjustments are applied to the load impacts measured at the customer meter.

[72] Pennsylvania Public Utility Commission, Phase III Modification Order. From the Public Meeting of May 21, 2020. Docket No. M-2014-2424864. https://www.puc.pa.gov/pcdocs/1665150.docx

Decisions about which day DR events are called are guided by a set of prescriptive directions issued by the PUC in the Phase III Implementation Order[73] and Clarification Order[74]. Met-Ed called DR events on the five days those guidelines required during summer 2020.

In PY12, Met-Ed had active DR programs in both the residential and C&I customer classes. On the C&I side, there were 156 participants – 94 categorized as Large C&I sites and 62 categorized as Small C&I sites. The residential behavioral demand response (BDR) component had approximately 194,000 homes in the treatment group, though this number declined throughout the summer.

Table 232 shows Met-Ed's performance across the five events during the 2020 DR season, as well as the average performance during the season, the Phase III-to-date performance, and the value with which compliance will be evaluated (the average MW performance across events from PY9 to PY11).

Table 232: Met-Ed Event Performance

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Energy-Efficient Homes (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	1.7	37.0	9.9	48.5 ± 6.0
July 27, 2020	15	18	2.1	41.5	10.7	54.4 ± 5.6
July 29, 2020	16	19	2.2	32.9	7.3	42.4 ± 6.1
August 25, 2020	15	18	1.8	35.9	9.0	46.7 ± 5.5
August 27, 2020	16	19	1.1	29.2	7.8	38.1 ± 6.1
PYVTD - Average PY12 DR Event Performance						**46.0 ± 2.6**
VTD - Average Phase III DR Event Performance						**51.1 ± 1.8**
Compliance Value - Average DR Event Performance from PY9 to PY11						**53.0 ± 1.8**

The Met-Ed/ADM team also submitted a response to the SWE DR data request. The elements of this response included the following:

- A data set that provided the top three CBLs for each C&I participant and the relative root mean square error (RRMSE) for each CBL/participant combination;
- For each event hour, a record of which C&I facilities participated, their reference load, metered load, and verified DR impact;
- For eight C&I sites selected by the SWE, the hourly load data needed to replicate the ADM impact estimates. Note that these eight sites accounted for approximately 43% of Met-Ed's C&I gross verified PY12 DR impacts. This workbook also mapped each

[73] Pennsylvania Public Utility Commission, Energy Efficiency and Conservation Program Implementation Order, at Docket No. M-2014-2424864 (Phase III Implementation Order), entered June 11, 2015. https://www.puc.pa.gov/pcdocs/1367313.doc

[74] Pennsylvania Public Utility Commission, Phase III Clarification Order, at Docket No. M-2014-2424864, entered August 20, 2015. https://www.puc.pa.gov/pcdocs/1378016.doc

facility to a weather station and flagged shutdown days and days in which the facilities were active in PJM;
- Historical weather data that was used in creating weather sensitive adjustments;
- Hourly load and weather data for approximately ~231,000 residential accounts (~194,000 treatment group accounts and ~37,000 control group accounts); and
- A map that indicated which residential accounts belonged to which experimental cell.

The data request response and a few follow-up emails formed the basis of the SWE audit activities – which are described in this section. The SWE found the approaches implemented by ADM to be well-aligned with the Evaluation Framework and consistent with industry best-practice. The execution of the analysis was thorough and free of errors. The SWE team agrees with the PY12 gross verified savings estimates.

E.6.1 Replicate Program Totals

Met-Ed's PY12 C&I DR program had 156 participants. ADM's verified gross peak demand savings generated by these sites are shown in Table 233. Note that these values are adjusted for line losses (by a multiplier of 1.072). For each DR event hour during the 2020 DR season, the SWE was provided with the metered load and CBL for each participant. Using this data, the SWE was able to replicate the PYVTD gross MW for both components of the C&I DR program. Table 233 also shows verified gross peak demand savings for the residential BDR program (also adjusted for line losses).

Table 233: Met-Ed DR Savings

Program	PYVTD Gross MW
C&I – Small	1.8
C&I – Large	35.3
Energy-Efficient Homes	8.9
Total	**46.0**

E.6.2 Residential BDR

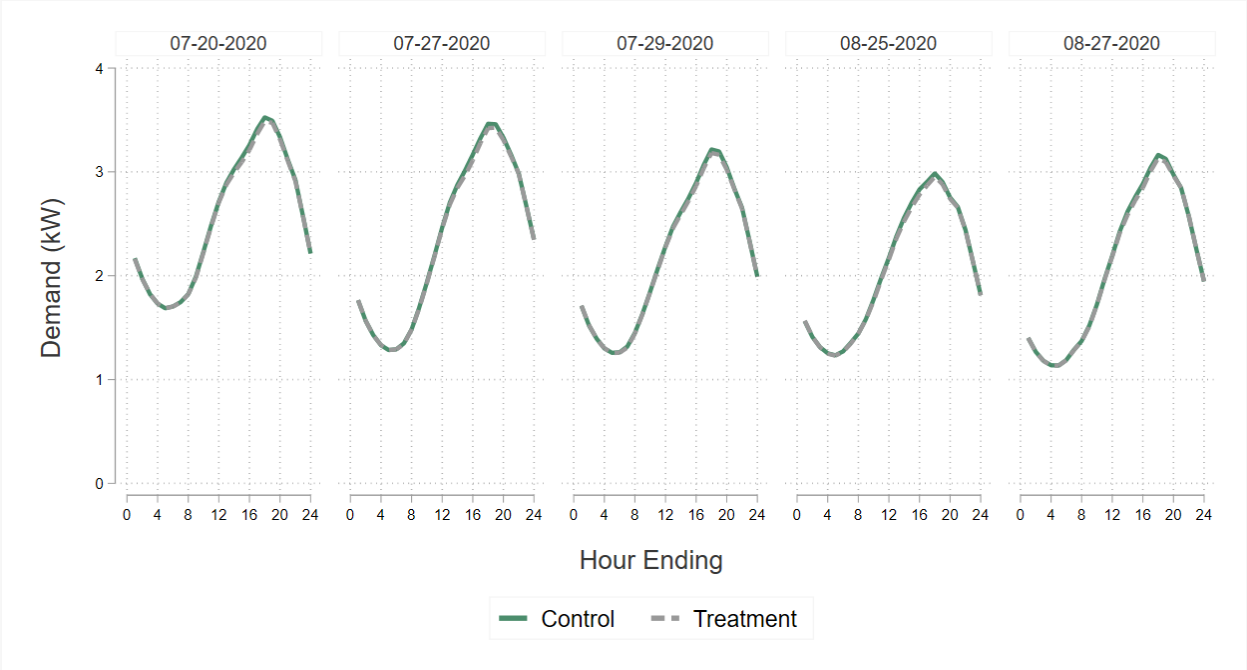
Met-Ed's behavioral DR program operates as a randomized control trial – customers were randomly selected and placed into control and treatment groups. As of the beginning of the 2020 summer DR season, there were 193,835 premises in the treatment group and 36,852 premises in the control group. Some of these homes were added in 2018, some in 2019, and the rest were added in 2020. Table 234 shows counts by start date as of the beginning of the 2020 DR season. At the end of the DR season, these numbers were 188,078 and 35,764 respectively.

Table 234: Residential BDR Customer Counts

Date Added	Active Treatment Accounts	Active Control Accounts
5/22/2018	108,354	20,621
5/22/2019	65,305	12,390
5/18/2020	20,176	3,841
Total	**193,835**	**36,852**

Prior to the DR events, homes in the treatment group are notified of a pending DR event by the program's ICSP with the expectation that customers will curtail load during the event itself. The means by which load curtailment is achieved isn't obvious, though ADM notes that the ICSP is involved in participant education and coaching. On average, load reductions are not very big – approximately 0.05 kW per home, which is about 2% of household demand during peak hours on peak days. For an illustration of the load shed, see Figure 88. In this figure, control group and treatment group loads for each PY12 DR event day are compared. The impact is small but separation between the experimental cells can be seen in the late afternoon. With nearly 194,000 homes in the treatment group, small impacts add up.

Figure 88: Met-Ed Residential BDR



E.6.2.1 Group Equivalence

The first step the SWE team took was to assess the equivalence between the treatment and control groups in the baseline period (the 30 days prior to notifying treatment group homes of their selection). Figure 89 shows the average hourly load profiles for the two experimental cells in each cohort during the baseline periods. Note that the customers added in 2020 have a different baseline period than the customers added in 2018 and 2019, but all periods straddle April and May. As can be seen, the two groups used energy in each baseline period in an approximately identical fashion.

Figure 89: Met-Ed Baseline Equivalence

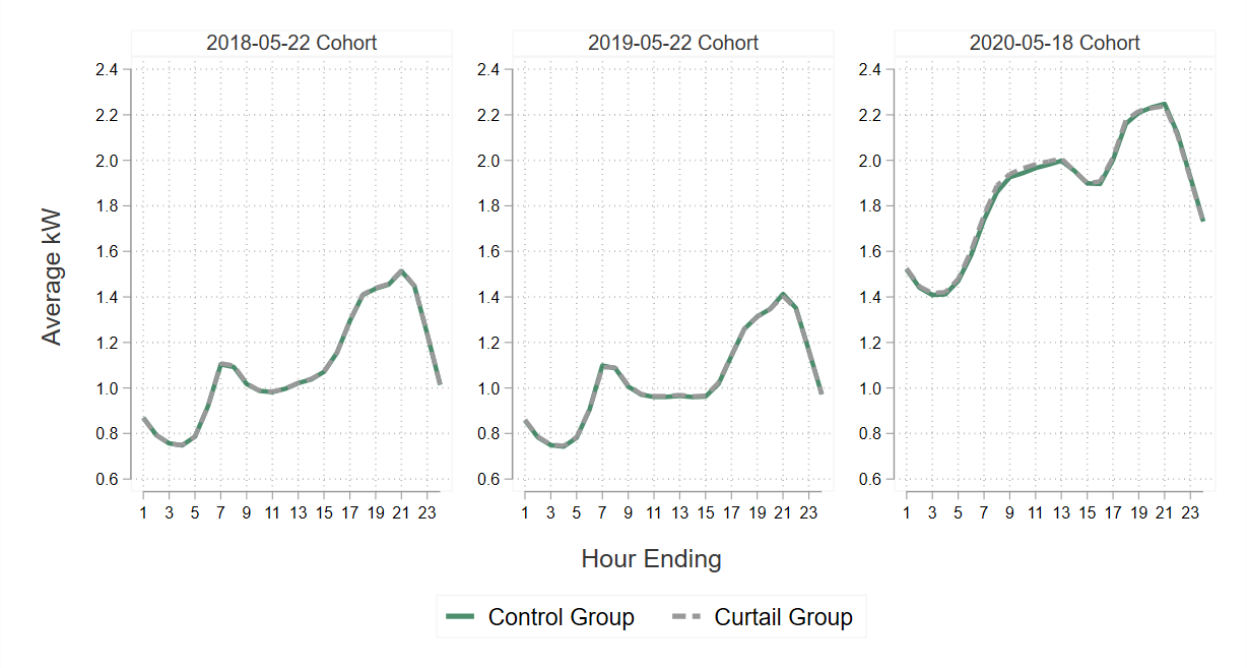


Table 235 shows average daily kWh for the control and treatment groups during the baseline period. A significance test suggests the difference between mean daily consumption values is not statistically significant (p-value = 0.59). The table also shows the average demand for the two groups during common event hours. Like the average daily kWh values, the difference between the average demand values is not statistically significant (p-value = 0.51).

Table 235: Equivalence Check

Group	Average Daily kWh	Average kW During Event Hours
Control	27.25	1.25
Treatment	27.30	1.25
Combined	**27.29**	**1.25**

E.6.2.2 Impact Estimation

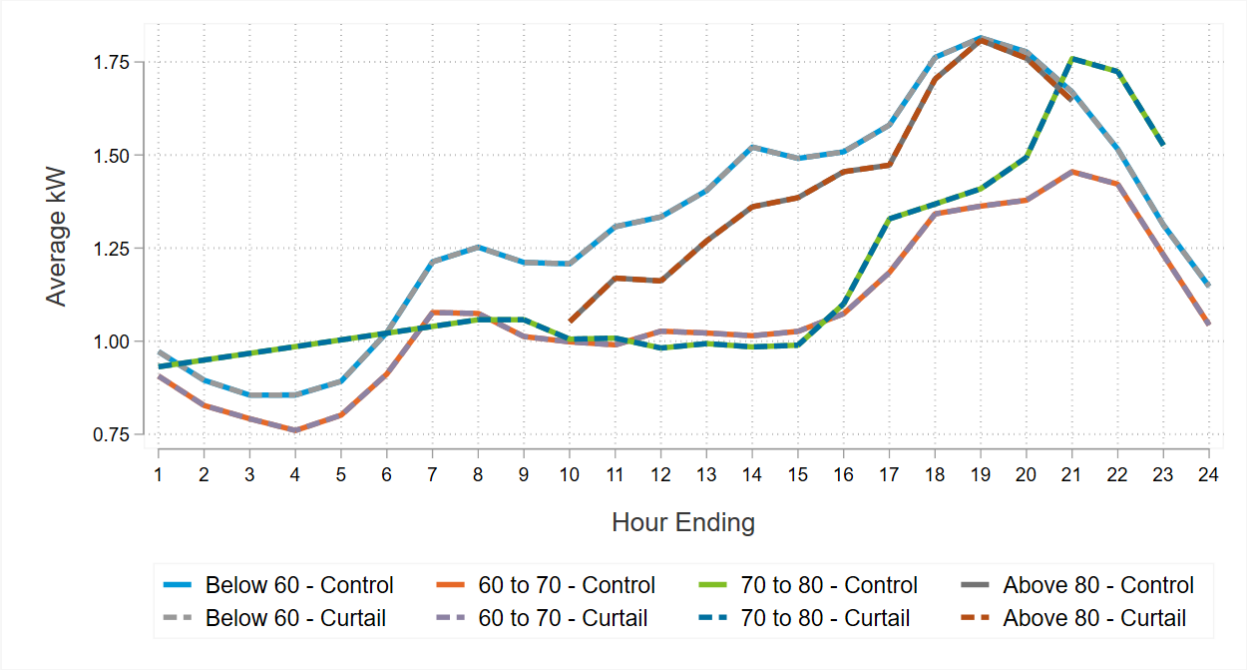
Savings calculations for the residential BDR component relied on a control group comparison and regression modeling. The regression model only used data from event hours on event days. Explanatory variables included date and hour fixed effects, an interaction between the treatment indicator variable and the date/time fixed effects, and three lag variables. The lag variables are customer-specific constants calculated based on consumption over a 30-day period that spanned April and May of 2018 and April and May of 2019 for the first two cohorts. For the 2020 cohort, the baseline period was extended longer than 30 days, from 4/1/2020-5/17/2020, because there were no days in which the 2:00 PM – 6:00 PM window fell into the 70 to 80-degree range. Steps taken in producing these lag variables are as follows:

- Limit the load data to 2:00 PM – 6:00 PM on non-holiday weekdays;

- Create three temperature bins: 60 to 70 (no cooling), 70 to 80 (medium cooling), and above 80 (high cooling); and
- In each temperature bin, calculate average load for each customer.

Figure 90 compares baseline usage in the treatment and control groups for the three bins (plus a fourth bin – temperature below 60) discussed above. The figure shows all hours rather than just common event hours. The main takeaway from this figure is that the treatment and control groups were, on average, hardly distinguishable in terms of hourly load profiles. (Gaps in the plot can be explained by the fact that the temperature never exceeded 80 during some hours of the baseline period.) Additionally, and perhaps as one would expect, overall usage increases in the higher temperature bins. Because the control group homes and treatment group homes were exposed to the same weather conditions, temperature itself was not included as an explanatory variable in the model.

Figure 90: Usage by Temperature Bin



E.6.2.3 Findings

Table 236 shows the relevant per participant impacts (treatment effect by hour and date), participant counts, and aggregate impacts. Note that neither per participant impacts s nor the aggregate impacts are adjusted for line losses in this table. The practical interpretation of the first per participant impact in the table (0.047) is that average demand in the treatment group was 0.047 kW lower than the average control group load (after controlling for date, time, and the customer-specific usage patterns captured by the lagged variables). The SWE tested the robustness of these per participant impacts with several other regression model specifications and found the results to be robust.

Table 236: Regression Output and Participant Counts

Date	Participants	Hour	Per Participant Impact (kW)	Aggregate Impact (MW)
7/20/2020	191,898	15	0.047	9.08
		16	0.052	9.89
		17	0.050	9.61
		18	0.041	7.84
		Event Average	**0.047**	**9.10**
7/27/2020	191,608	15	0.052	9.89
		16	0.059	11.36
		17	0.049	9.45
		18	0.046	8.76
		Event Average	**0.051**	**9.87**
7/29/2020	191,472	16	0.033	6.30
		17	0.036	6.95
		18	0.037	7.13
		19	0.036	6.83
		Event Average	**0.036**	**6.80**
8/25/2020	189,915	15	0.047	9.02
		16	0.054	10.29
		17	0.039	7.46
		18	0.036	6.89
		Event Average	**0.044**	**8.41**
8/27/2020	189,827	16	0.044	8.26
		17	0.039	7.42
		18	0.037	7.06
		19	0.035	6.73
		Event Average	**0.039**	**7.37**

The average aggregate impact across the 20 event hours was -8.31 MW. Multiplying this value by Met-Ed's line loss multiplier for residential customers (1.0945) yields an average savings estimate of 9.09 MW per event hour. This is slightly more than the PYVTD gross MW value calculated by ADM (8.94 MW) but the difference could be attributable to rounding (and the value calculated by ADM is certainly within the confidence bands of the value calculated by the SWE).

E.6.3 C&I

E.6.3.1 Reference Load Selection

ADM's CBL selection method was thoughtful and relied on non-event day testing. At a minimum, the following CBLs were considered for each participant:

- PJM high 4-of-5 with weather sensitive adjustment (WSA) and weekday specific options;
- High 6-of-7 with WSA and weekday specific options; and
- 10-of-10 with WSA and weekday specific options.

From the list above, the top three CBLs for each participant were selected. The basis for "top three" was the lowest relative root mean square error (RRMSE) on non-event, non-holiday, non-shutdown weekdays. On event days, a weighted average of these three CBL types was used in creating the actual CBL. The weights, in this case, were equivalent to the inverse squares of the RRMSEs. For a hypothetical event hour, Table 237 provides an illustration.

Table 237: CBL-of-CBLs Illustration

CBL Type	CBL (kW)	Non-Event Day RRMSE	Inverse Square of RRMSE	Weight
10-of-10	1,100.0	7.1%	198.37	35.7%
10-of-10 with WSA	1,200.0	7.2%	192.90	34.7%
20-of-20	1,300.0	7.8%	164.37	29.6%

Thus, the CBL-of-CBLs value would be: (1,100*0.357) + (1,200*0.347) + (1,300*0.296) = 1,193.90.

E.6.3.2 Weather Sensitive Adjustments (WSAs)

Several of the baseline types ADM considered involved a weather sensitive adjustment (which can be positive or negative). The WSA is a function of three terms: the temperature during the event hour, the average temperature during the same hour across days in the CBL lookback window, and the participant-specific WSA coefficient. Respectively, think of these components as X, Y, and Z. The WSA was then calculated as follows:

$$WSA = Z * (X - Y)$$

Regarding the participant-specific WSA coefficient, this value was derived as follows:

- Map each participant to a weather station. Merge weather data with load data;
- Keep days between 6/1/2020 and the last day of the DR season for PY12 (which occurred on 9/30/2020);
- Drop any holidays, event days, shutdown days, or weekends;
- Keep only the hours when events were called on event days;
- Calculate the average load and average temperature during the event window for each day in the data set. Drop any days where the average temperature during the event window is less than 75 degrees (F);

- Using the averages calculated in the previous step, run a simple linear regression model with load as the response variable and temperature as the explanatory variable; and
- The regression coefficient for the temperature variable is the WSA coefficient. The coefficient represents the expected change in kW per a one-degree increase in temperature (F).

This WSA calculation differed slightly from last year, as previously days were kept between the first day of the DR season and the last event day of the season, instead of the last day of the DR season. Using the whole DR season to construct these WSAs gives a better picture of weather sensitivity and is not a cause for concern.

The WSA is only applied if the outdoor air temperature exceeds 75 degrees. Additionally, two distinct WSA coefficients were calculated for each participant. In PY12, two events (July 29th and August 27th) started and ended an hour later than the others. ADM calculated separate WSA coefficients for the events that started an hour later, with the logic being that the relationship between load and temperature varies by time of day.

E.6.3.3 Findings

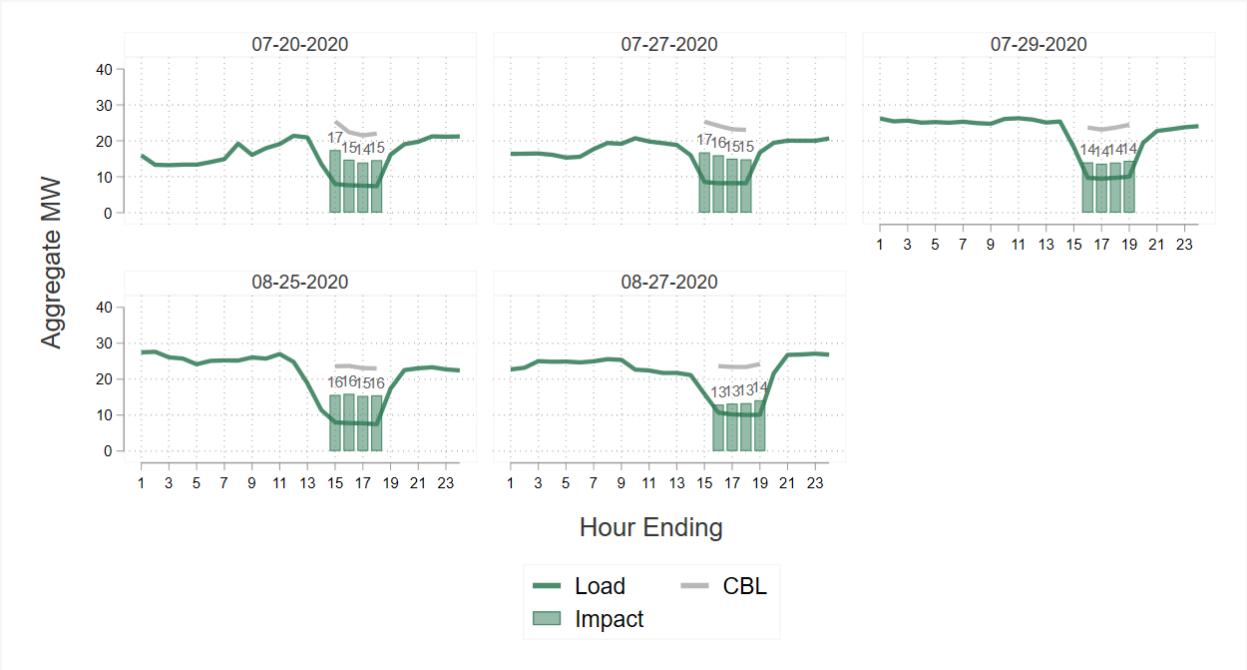
For the eight sites in our sample, the SWE was able to reproduce all inputs that feed into the savings. Table 238 provides a summary of the results.

Table 238: Met-Ed C&I DR Audit Summary

Group	Count	Gross MW Impact - ADM	Gross MW Impact - SWE	% of Total Savings
In SWE Sample	8	15.8	15.8	42.7%
Not in SWE Sample	148	21.2	-	57.3%
Total	**156**	**37.1**	**-**	**100%**

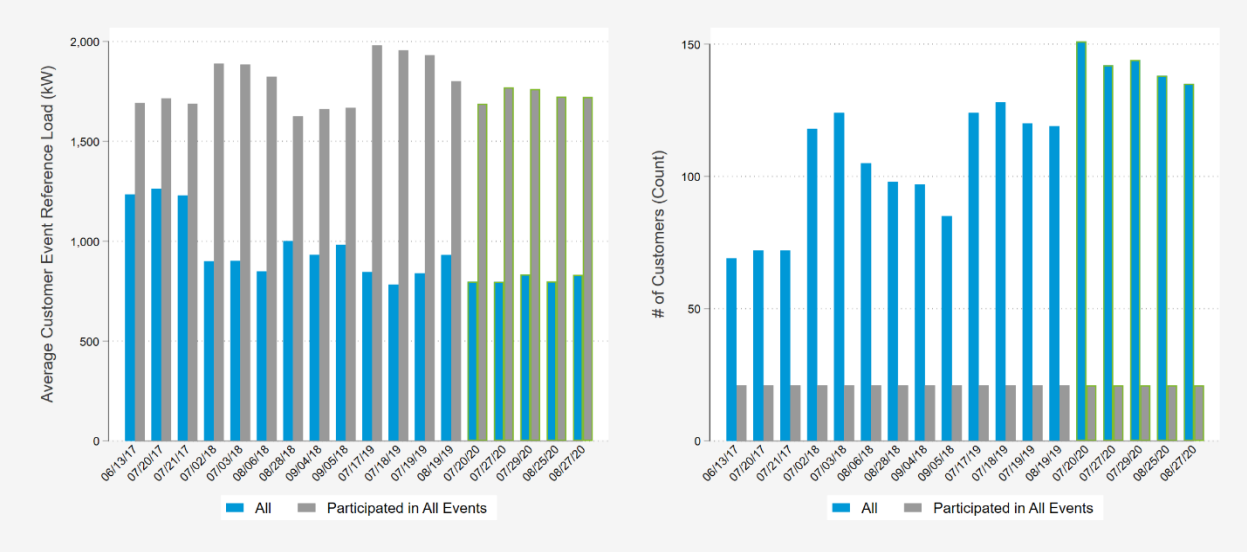
By event day, Figure 91 shows the aggregate load, CBL, and DR impacts (expressed as positive values) for the eight sites in the SWE sample. Note these loads and impacts are not adjusted for line losses. Across all event days, the load shed is obvious and the CBL-of-CBLs is very reasonable.

Figure 91: Aggregate Load, CBL, and Impacts for Sampled Sites



Looking at the average customer reference load on event days in Figure 92, Met-Ed did not appear to have a substantial change due to the COVID-19 pandemic, which is highlighted by the blue bars outlined in green on the left panel. In fact, the average event day reference load for participants in PY12 only decreased about 4 percent from PY11. The same trend is true for the subset of customers that participated in all events across the four program years. This is highlighted by the gray bars outlined in green on the left panel. On the right panel, the number of participants for each event across the four program years is shown. These numbers have steadily increased from program year to program year.

Figure 92: The Impact of COVID on Reference Loads



E.6.4 Residential BDR

The SWE agrees with the baseline selection procedures and found no errors in the calculations for the eight C&I sites examined during the audit process. For the residential BDR component, the ADM team leveraged a lagged seasonal model, which the SWE views as a reasonable approach. Our audit uncovered no issues in ADM's residential BDR analysis. The SWE recommends that the Commission adopt the Met-Ed/ADM verified savings estimates.

E.7 NTG

E.7.1 Residential Programs

ADM and Tetra Tech did not conduct any new NTG research for residential programs during PY12.

Tetra Tech assigned the HERs component of the program an NTG of 1, in accordance with the Evaluation Framework, and was not informed by participant surveys, but assumes that the RCT design eliminates free-ridership and produces negligible SO.

The PY11 NTG was assigned to the HVAC and Residential Appliances Program and the PY10 NTG was assigned to the Appliance Turn-in Program, the Direct Install Program, the New Homes Program, and the Upstream Programs, as was stated in the Evaluation Plan.

Table 239: Summary of NTG Estimates for Met-Ed Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Appliance Turn-In	0.55	0.0	0.45	-
Program Not Active in PY12	Energy-Efficiency Kits	-	-	-	-
RCT	HERs	-	-	1	-
PY10	Direct Install	0.19	0.14	0.95	-
PY10	New Homes	-	-	0.73	-
PY10	Upstream Lighting	0.71	0.0	0.29	-
PY10	Upstream Electronics	-	-	0.58	-
PY11	HVAC	0.50	0.01	0.51	-
PY11	Residential Appliances	0.53	0.03	0.50	-

E.7.2 LI Residential Programs

Tetra Tech assigned LIEEP including LI Residential Appliances and Initiatives, LI Residential Appliance Turn-in, LI Direct Install and LI Energy-Efficiency Kits a NTG of 1, in keeping with the PY12 Evaluation Plan and SWE Phase III Evaluation Framework.

E.7.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY12. C&I NTG values were evaluated in PY10 and PY11 and those values were applied to the C&I Programs for PY12. It has been previously concluded that all PY10 and PY11 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 240: Summary of NTG Estimates for Met-Ed C&I Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Small Energy Solutions for Business Lighting	0.39	0.01	0.62	-
PY10	Small Energy Solutions for Business Custom	0.45	0.0	0.55	-
PY10	Small Energy Solutions for Business Prescriptive	0.26	0.0	0.74	-
PY10	Small Energy Solutions for Business Appliance Turn-In	-	-	0.45	-
PY10	Small Energy Solutions for Business Direct Install	-	-	0.62	-
PY10	Small Energy Solutions for Business Total	-	-	0.60	-
PY10	Large Energy Solutions for Business Lighting	0.37	<0.01	0.62	-
PY10	Large Energy Solutions for Business Custom	0.45	0.0	0.55	-
PY10	Large Energy Solutions for Business Prescriptive	0.26	0.0	0.74	-
PY10	Large Energy Solutions for Business Total	-	-	0.60	-

E.8 TRC

Table 241 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for Met-Ed's PY12 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 PY12 annual report and the model itself was well-organized and documented.

Both gross and net TRC Ratios decreased in the Energy-Efficient Homes, Energy-Efficient Products, Low-Income Energy-Efficiency and C&I Energy Solutions for Business – Small programs from PY11. The largest decreases were observed in the Energy-Efficient Products and Low-Income Energy-Efficiency programs, which did not include energy-efficiency kits in PY12.

Table 241: Summary of Met-Ed's PY12 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
Appliance Turn-In	$977	$534	1.83	$440	$534	0.82
Energy-Efficient Homes	$4,635	$2,924	1.59	$3,823	$2,647	1.44
Energy-Efficient Products	$6,494	$7,151	0.91	$2,565	$3,659	0.70
Low-Income Energy Efficiency	$527	$1,921	0.27	$527	$1,921	0.27
C&I Energy Solutions for Business – Small	$7,771	$5,763	1.35	$4,676	$3,890	1.20
C&I Energy Solutions for Business – Large	$21,111	$14,215	1.49	$12,636	$9,042	1.40
Governmental & Institutional Tariff	$184	$195	0.94	$114	$136	0.84
C&I Demand Response Program – Small	$123	$63	1.96	$123	$63	1.96
C&I Demand Response Program – Large	$1,508	$730	2.07	$1,508	$730	2.07
Portfolio Total	**$43,330**	**$33,495**	**1.29**	**$26,411**	**$22,620**	**1.17**

Six of Met-Ed's nine EE&C programs were found to be cost-effective when estimating the TRC Test using gross verified savings. Using net verified savings, five programs were found to be cost-effective and four were not cost-effective. The Appliance Turn-in program was cost-effective under gross verified savings, but not cost-effective under net verified savings, while the Energy-Efficient Products, LI Energy Efficiency and Governmental & Institutional Tariff programs were not cost-effective on a gross or net basis.

E.8.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- To calculate the avoided cost of natural gas, Met-Ed used the Annual Energy Outlook (AEO) average natural gas price for all users *in the Middle Atlantic* region, as the SWE recommends. The AEO natural gas prices were converted to nominal dollars before the NPV was calculated.
- Met-Ed's annual electric energy savings are calculated and allocated by month and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is broader than the on-peak hours defined in the 2016 TRM (Monday – Friday 8AM-8PM). In the 2021 Pennsylvania TRM, on-peak and off-peak energy periods were adjusted to align with the PJM market definition. The adjusted 2021 TRM peak window (Monday – Friday, 7AM-11PM) will now also match the definition used in FirstEnergy's Phase III TRC model. The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions.
- Met-Ed used a discount rate of 6.63% to calculate the net present value of future program benefits. This discount rate is based on Met-Ed's WACC and 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 PY12 evaluation. The SWE reviewed and spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with Met-Ed's EE&C plan.
- 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 TRC Test Order directive for Phase III.
- The SWE found that the cost categories were handled correctly in the TRC model. Participant incentives were not considered TRC Costs, while administrative costs, and incremental costs were incorporated as costs. The SWE verified that the TRC calculations followed the 75% participant cost assumption where 75% of customer incentive payment is used as a proxy for participant cost.
- According to the Phase III Evaluation Framework, LI measures are required to be provided at no cost to the participants. At first glance, it appears Met-Ed's LI programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the LI Energy-Efficiency Program (Table 106 in FirstEnergy's PY12 Annual Report). However, in its Phase III EE&C Plan, Met-Ed explains that these costs are only being allocated to landlords and owners of LI properties, rather than the LI customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model followed the protocol specified in the 2016 TRC Test Order pertaining to the treatment of free rider participant costs; free-ridership incremental measure costs are not included in net program costs.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Non-Electric Benefits. The SWE verified that the savings were accounted for in accordance with the Guidance on Inclusion of Fossil Fuel and Water Benefits in TRC Test memo issued in March 2018. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative Total NPV Lifetime Non-Electric Benefit. As in previous years, the SWE agrees that the cost should be accounted for as a negative non-electric benefit rather than a fossil fuel switching program cost. The TRC model claimed nearly 2.5 million gallons per year of water savings, which translates to approximately $210,000 in NPV lifetime avoided costs.
- In PY12, the Met-Ed TRC Model incorporated the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures.

Table 242 shows that without the dual baseline included in the TRC model, the gross and net TRCs are higher than when the dual baselines are included.

Table 242: Met-Ed Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.29	1.17
Without Dual Baseline	1.55	1.28

E.9 PROCESS

Four EDCs – Met-Ed, Penn Power, Penelec, and West Penn Power – operate an identical set of nine 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. Therefore, the SWE's audit summary described in this section pertains to all four FirstEnergy utilities.

In summary, for PY12, the evaluation contractor conducted process evaluations for selected programs and program components. In addition to reporting PY11 process evaluation findings, the PY12 final report also incorporated the PY8, PY9, PY10, and PY11 process evaluation results. As the SWE noted in the PY10 and PY11 Annual Reports, this redundancy with the prior process evaluation reports was unnecessary and slightly confusing.

E.9.1 Residential Programs

The four FirstEnergy EDCs operate the following four residential energy-efficiency programs:

- Appliance Turn-In
- Energy-Efficient Homes
- Energy-Efficient Products
- LI Energy Efficiency

For PY12, the ADM/Tetra Tech team reported on process evaluation activities for one of these four residential programs: Residential Energy-Efficient Homes. More specifically, the PY12 process evaluations of the Residential Energy-Efficient Homes program focused on one program component (BDR).

The process evaluation of this program appears to have been mostly consistent with the Phase III evaluation plan.

E.9.1.1 Appliance Turn-In Program

ADM/Tetra Tech did not conduct a process evaluation for this program in PY12.

E.9.1.2 Energy-Efficient Homes Program

Summary of Process Evaluation Findings

For PY12, ADM/Tetra Tech conducted process evaluations for one of seven program components of the Energy-Efficient Homes Program: BDR.[75]

The evaluation team conducted interviews with the FirstEnergy program manager and implementation staff (Oracle), followed by a three-phase customer survey effort. Before the start of peak season, the team recruited a panel of customers who agreed to respond to a survey after each peak day event. These panelists responded to brief event surveys and a post-season survey. The evaluators reported the following key findings:

1. *Customers express high satisfaction with their EDC.* About 88 percent are very satisfied or extremely satisfied with the overall quality of service provided by their EDC. Roughly 54 percent reported that their opinion of the company improved as a result of their participation in the program.
2. *Customers find the requested level of effort to be adequate.* About 75 to 80 percent found the number of peak day events and the peak event duration (the number of hours for which they are asked to reduce energy use) to be very reasonable. In addition, more than half of the respondents to the post-season survey were satisfied with the program the way it was implemented.
3. *Customer engagement with the peak day alerts and performance notifications is high among those who remember receiving them.* At least 75 percent of customers who completed the surveys recall parts of the peak day alerts (e.g., event time and duration, and tips) and remember receiving the performance notifications.
4. *Behavioral follow-through on peak event days is high*. All customers reported taking at least one energy-saving action during the event period. Over 60 percent generally reduced their energy use for the full, four-hour period of the events. At least 80 percent of respondents said that reducing energy use with two events in one week was about the same as trying to reduce energy for one day.
5. *Customers find the peak day alerts and performance notifications useful*. About 50 to 60 percent of customers found the energy-saving tips and the information provided in the performance notifications were *extremely useful* or *very useful*. Close to one-half felt the energy-saving tips were *somewhat useful*. The comparison with similar homes was the most useful piece of information on the performance of notifications (about 50 percent).
6. *Interactive Voice Response (IVR) messages reach more customers*. The Oracle reports show that more IVR event messages than emails are received by customers. This is reflected in the higher proportion of respondents reporting that they hear the IVR

[75] The seven program components include Energy-Efficiency Kits, Online Audits, School Education, Behavioral HERs, BDR, Residential Energy Audits, and New Homes.

messages when a peak day event is called. This may complicate the ability to provide detailed information on the program.

Summary of Process Evaluation Audit

The process evaluation of selected components of the Energy-Efficient Homes Program appears to have been consistent with the Phase III evaluation plan. The team conducted interviews with the FirstEnergy program manager and the program implementer (Oracle), followed by a three-phase customer survey effort.

The process evaluation noted that BDR is not being offered in Phase IV. The team included three recommendations in case the program is considered in the future; all three recommendations were accepted.

E.9.1.3 Energy-Efficient Products Program

ADM/Tetra Tech did not conduct a process evaluation for this program in PY12.

E.9.1.4 LI Program

ADM/Tetra Tech did not conduct a process evaluation for this program in PY12.

E.9.2 C&I Programs

The four FirstEnergy EDCs operate the following five C&I energy-efficiency programs:

- C&I Energy Solutions for Business – Small
- C&I DR – Small
- C&I Energy Solutions for Business – Large
- C&I DR – Large
- Governmental & Institutional Tariff

The ADM/Tetra Tech team did not conduct a process evaluation for any of these C&I programs in PY12.

E.9.2.1 Energy Solutions for Business – Small, Energy Solutions for Business – Large, Government and Institutional

ADM/Tetra Tech did not conduct a process evaluation for these programs in PY12.

E.9.2.2 C&I DR – Small and C&I DR – Large

ADM/Tetra Tech did not conduct a process evaluation for these programs in PY12.

Appendix F FirstEnergy: Pennsylvania Electric Company PY12 Audit Detail

F.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of Penelec's PY12 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor.

- The MWh contribution from behavioral Home Energy Reports in Penelec's service territory was relative flat from PY10 to PY12. However, HERs accounted for a larger share of the portfolio and a much larger share of the residential and residential LI sectors in PY12 with upstream lighting ramping down and FirstEnergy's decision not to distribute energy-efficiency kits.
    - Almost half (47.5%) of Penelec's verified gross LI savings came from Home Energy Reports in PY12. This was the lowest of the FirstEnergy companies in PY12, but an increase from prior years of Phase III.
- PY12 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE's review of verified savings for non-HER residential programs found that, overall, the verified savings followed proper TRM protocols and that 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 only noted a few minor discrepancies.
- The SWE's review of PY12 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, including adherence to the COVID-19 EM&V Guidance Memo; and were generally accurate.
- ADM did not conduct primary NTG research for any residential or non-residential programs during PY12 and applied prior program year NTG values.
- The PY12 process evaluation of the Behavioral Demand Response (BDR) program was consistent with the Phase III evaluation plan and the reporting followed the SWE guidelines.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in FirstEnergy's Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE has no major concerns. For all Penelec's programs, the SWE was able to replicate reported MWh savings and reported MW savings exactly via the tracking data. We also calculated directionally similar (if not identical) participation counts and incentive amounts for all programs.

- Penelec's TRC model was well-organized and consistent with the directives of the 2016 TRC Test Order and the key financial assumptions approved in Penelec's Phase III EE&C Plan. ADM uses a sampling approach for non-residential incremental measure costs that is unique to the FirstEnergy companies in Pennsylvania. Rather than apply assumed measure costs to each measure in the tracking data, ADM conducts project-specific cost research on each project in the evaluation sample along with the energy and demand savings analysis. The results from the sample are expanded to the population on a $/kWh basis by sampling initiative and EDC. The SWE appreciates this attention to measure costs in the impact evaluation and believes it returns an unbiased estimate of TRC Costs. Penelec's PY12 non-residential incentives as a percentage of estimated incremental cost were among the lowest statewide at 19.2% for Small C&I and 14.5% for Large C&I.

F.2 EM&V Plan Reviews

FirstEnergy's evaluation contractor, ADM Associates, submitted an updated comprehensive evaluation plan for the four FirstEnergy EDCs that addressed evaluation activities for PY11 and PY12. In addition, the ADM team submitted a memo updating their sampling and evaluation approach for the process evaluation of the Behavioral DR program. The SWE reviewed and approved the plan and memo.

F.3 Sample Design Review

Verified savings estimates for most programs 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 ±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 III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at 85% confidence level for each "initiative." For 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 program delivery channel or supported technology.

Grouping projects by equipment type and program delivery method leads to more meaningful evaluation results than tariff-based program definitions, each of which would include the same mix of measures. This evaluation strategy also makes sample design more efficient because the same projects are more likely to share similar characteristics across rates classes (i.e., Small C&I, Large C&I, and Government) than a heterogeneous mixture of measures within a single class. For example, projects from Penelec's three non-residential energy programs (C&I Energy

Solutions for Business – Small, C&I Energy Solutions for Business – Large, and Government & Institutional Tariff) were assigned to one of four solutions:

- C&I Lighting
- C&I Custom
- C&I Prescriptive
- C&I Appliance Turn-In

ADM established a series of initiatives and designed the impact evaluation samples for each to meet the 85/15 precision requirement. Table 243 lists each initiative evaluated in PY12 and the corresponding relative precision of the PY12 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 243: Relative Precision of Penelec PY12 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (±)
Residential Appliance Turn-In (ATI)	5.6%
LI ATI	8.2%
LI Direct Install	9.4%
Res Upstream Lighting	8.0%
Res Upstream Electronics	0.0%
Res HVAC	7.2%
Residential Appliances	1.9%
LI Appliances	13.0%
C&I Lighting	8.0%
C&I Custom	9.7%
C&I Prescriptive	6.3%

The C&I Appliance Turn-In, Residential Direct Install, and Residential New Construction initiatives were not evaluated in PY12. ADM estimated verified gross savings for these initiatives using historic realization rates. The Energy-Efficiency Kits initiative was not active in PY12.

Each of the sampling initiatives shown in Table 243 exceeded the requirement of ±15% precision at the 85% confidence level. PY12 verification processes were impacted by the COVID-19 pandemic. Where appropriate, ADM replaced on-site visits with phone interviews and video conferences.

Sampling uncertainty does not consider the level of rigor of the verification activities. Results from a sampled project that receives a quick desk review from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of ADM's PY12 verification activities is discussed in detail in Appendix F.5.

The Behavioral Modification subprogram provides HERs to residential customers in the Penelec service territory. The subprogram is divided between standard residential customers and LI customers, and each is administered as an RCT. Participants are enrolled in experimental cohorts

and a monthly billing analysis regression is used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase III Evaluation Framework requiring the solution-level verification achieve an *absolute* precision of ±0.5% at the 95% confidence level (two-tailed). Table 244 shows the absolute precision of the behavioral program components.

Table 244: Absolute Precision of Penelec PY12 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (±)
Residential	0.18%
LI	0.81%

F.4 Reported Gross Savings Audits

F.4.1 Tracking Data Review

This section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Penelec's PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)
- Reported gross peak demand savings (MW)
- Participation
- 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 PY12 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 LI Energy-Efficiency programs can be found in Appendix F.5.1.3.

Table 245 summarizes the SWE's ex-ante findings regarding reported gross energy savings. The "Match" column contains "Yes" if the tracking data supports the values shown in Penelec's PY12 Annual Report and "No" otherwise. For each program, the SWE was able to replicate the values reported by Penelec.

Table 245: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-In	2,573	2,573	Yes
Energy-Efficient Homes	15,286	15,286	Yes*
Energy-Efficient Products	14,303	14,303	Yes
LI Energy Efficiency	2,792	2,792	Yes*
C&I Energy Solutions for Business – Small	17,588	17,588	Yes
C&I Energy Solutions for Business – Large	27,757	27,757	Yes
Governmental & Institutional Tariff	1,509	1,509	Yes
Portfolio Total	**81,808**	**81,808**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 246 summarizes the SWE's findings regarding peak demand savings by program. The SWE's records matched Penelec's reported peak demand savings for each program.

Table 246: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-In	0.44	0.44	Yes
Energy-Efficient Homes	1.67	1.67	Yes*
Energy-Efficient Products	3.97	3.97	Yes
LI Energy Efficiency	0.23	0.23	Yes*
C&I Energy Solutions for Business – Small	3.75	3.75	Yes
C&I Energy Solutions for Business – Large	4.25	4.25	Yes
Governmental & Institutional Tariff	0.01	0.01	Yes
Portfolio Total	**14.32**	**14.32**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 247 summarizes the SWE's findings regarding program participation. For all programs, the SWE calculated directionally similar (if not equal) participation counts. Portfolio totals differ by three participants.

Table 247: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-In	2,297	2,297	Yes
Energy-Efficient Homes	294	296	No*
Energy-Efficient Products	121,498	121,498	Yes
LI Energy Efficiency	1,952	1,952	Yes*
C&I Energy Solutions for Business – Small	375	375	Yes
C&I Energy Solutions for Business – Large	78	79	No
Governmental & Institutional Tariff	34	34	Yes
Portfolio Total	**126,528**	**126,531**	**Yes***

*The Energy Efficient Homes and LIEEPs have HER components not represented in this table.

Finally, Table 248 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE replicated incentive dollars or calculated directionally similar values for all seven programs.

Table 248: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-In	$133	$133	Yes
Energy-Efficient Homes	$168	$171	No
Energy-Efficient Products	$700	$996	No
LI Energy Efficiency	$61	$61	Yes
C&I Energy Solutions for Business – Small	$841	$545	No
C&I Energy Solutions for Business – Large	$941	$941	Yes
Governmental & Institutional Tariff	$75	$75	Yes
Portfolio Total	**$2,919**	**$2,922**	**No**

F.4.2 Project File Reviews

F.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of Penelec's residential project files for PY12 using the project file documentation provided by Penelec, 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 uploaded project file packages included most of the documentation requested.

Table 249 presents a summary of SWE's residential project file reviews.

Table 249: Penelec PY12 Residential Project File Review Summary

Program	Sub Program	Number of Files Reviewed[1]	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[2]
Appliance Turn-In	NA	23	✓	✓	✓	✓
Energy-Efficient Homes	Audits	30	✓	✓	✓	✓
Energy-Efficient Homes	New Homes	16	✓	✓	✓	✓
Energy-Efficient Products	HVAC	32	✓	✓	✓	✓
Energy-Efficient Products	Appliances and Electronics	14	✓	✓	✓	✓
Energy-Efficient Products	Lighting	16	✓	✓	✓	✓
LI Energy-Efficiency	Multifamily/LILU Single-Family	7	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Rebate	8	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Turn-In	11	✓	✓	✓	✓
LI Energy-Efficiency	Weatherization	12	✓	✓	✓	✓

[1] The number of files reviewed reflects the total number for all FirstEnergy EDCs.
[2] 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 programs. Below, is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Appliance Turn-In

For the Appliance Turn-In Program, the quarterly upload included a list of projects with information such as age, cubic feet, configuration, etc. Project files mostly matched the tracking data. The projects were found in the residential downstream database and were applied a default savings value in the reported savings. However, the SWE observed that there were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance evaluator (e.g., using captured model and serial numbers).

School Education

School Education Program was not run in PY12.

Energy-Efficiency Kits

Energy-Efficiency Kits Program was not run in PY12.

Audits

Project files mostly aligned with tracking data, SWE observed minor discrepancies regarding rebate amounts, kWh, and audit dates. Project files did not provide enough information to always verify rebate amount or kWh.

New Homes

Project files mostly aligned with tracking data, but the SWE observed minor discrepancies between the kWh and kW listed in the REM report as compared to the quarterly tracking data. Some of the files contained blurry, unusable meter pictures. Thus, the SWE was unable to verify energy metrics.

HVAC

The SWE observed the same discrepancy as during previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular *tons* variable.[76] However, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data.

Starting in PY9, the evaluator, ADM, worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations.

[76] For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

There were several instances where the participant surname, provided by the receipt, matched the tracking data but the first name did not. Invoices did not provide rebate information.

Midstream Appliances

The Midstream Appliance Program was not run in PY12.

Appliances and Electronics

The Appliance files typically matched the tracking data. The SWE also encountered issues in tracking projects by account number, likely due to automatic truncation in spreadsheet software (e.g., scientific notation reverted to number formatting). This was a reoccurring issue across program types.

There were several instances where the participant surname, provided by the receipt, matched the tracking data but the first name did not. Most invoices/receipts, failed to provide any relevant or trackable information. One project file only contained a receipt with the last four digits of a credit card and the order's total cost.

There was no available tracking data for Q3 or Q4 requests. Furthermore, the information provided with the requests had little relevant information and would not have corroborated tracking data metrics.

Upstream Lighting

The Upstream Lighting files mostly matched the tracking data; however, not all suppliers provided enough info on invoices to corroborate both incentive amounts and lighting quantities. All incentive amounts matched, and where available, so did lighting quantities

LI Multifamily/LILU Single-Family

The Multifamily files mostly matched the tracking data, but there were some slight discrepancies with participants' first names and appliances. Additionally, many of the projects had multiple entries in the tracking data that the provided receipts did not include. In Q3, one project had multiple entries, but the provided receipt listed an appliance not found in the quarterly tracking data. The project files contained receipts, WARM program applications, audit forms, etc. There was an overall low amount of data requests for this program and none for Q1 or Q4.

LI Appliance Rebate

LI Appliance Rebate files mostly matched tracking data: however, many project requests contained receipts missing relevant information like rebate amounts, energy savings, and serial/model numbers. There was no available tracking data for the data requests for quarters three and four.

LI Appliance Turn-In

The LI Appliance Turn-In files typically matched the tracking data, and the quarterly upload included a list of projects with information such as: participant signatures, cubic feet, configuration, etc. However, the SWE observed that there were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance evaluator (e.g., using

captured model and serial numbers). Overall, there was a low amount of data requests but no requests at all for Q2.

LI Weatherization

LI Weatherization files matched the quarterly tracking data. The SWE observed some project files that included certain measures in the tracking data and left out additional measures listed in the project files. ADM clarified in previous program years that the additional measures listed in these project files are provided by the LIURP program during the same visit, but they are not part of Act 129 and so do not carry any associated savings in the tracking system. There were no data requests for Q4.

F.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 Penelec's non-residential programs in PY12. Project file documentation is 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 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 250 presents an overview of the results of the SWE's C&I project file reviews.

Table 250: Penelec PY12 C&I Project File Review Summary

Program	Sub-Program	Number of Project Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program – Large	Custom - LCI	2	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Food Service	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	HVAC - SCI	2	✓	✓	1/2	1/2	✓	-
C&I Energy Solutions for Business Program – Large	Lighting - LCI	3	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	Lighting - 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 that baseline project data was absent for one Custom - LCI project. While baseline data is often not available, documentation on which baseline assumptions based should be provided. Additionally, savings calculators were locked in three of the reviewed projects: (2) HVAC – SCI and (1) Food Service. In addition to these general observations, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **Custom – LCI**
  - Baseline data missing for a Custom – Refrigeration project.
- **Food Service**
  - Workbook calculator locked for one project reviewed; SWE cannot verify calculations.
- **HVAC – SCI**
  - Workbook calculator locked for both projects reviewed; SWE cannot verify calculations.
  - For one HVAC project, the savings analysis was performed as a new construction project, although a project summary document described the project as an AHU replacement project. Also, for this same project, an invoice was included but was not detailed with model or spec numbers to verify the correct quantities in savings calculations for each AHU ordered.
- **Lighting – LCI**
  - For one lighting project, the implementer chose to use spec sheet wattages instead of rated DLC wattages for replacement linear LED lamps. Use rated DLC wattage for this type of replacement fixture when applicable.

Despite minor issues with some locked calculation workbooks and other small discrepancies, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

F.5 VERIFIED GROSS SAVINGS AUDITS

F.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the Penelec portfolio of residential programs. Penelec's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy-Efficient Homes Initiative, the Energy-Efficient Products Initiative, and the LI Energy-Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed

discrepancies not shared by others in a program). Note that the SWE reports residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

Overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE identified the evaluation activities used to verify savings for the residential programs. Table 251 provides a summary of the evaluation and M&V approaches used by Penelec in their PY11 verified savings calculations.

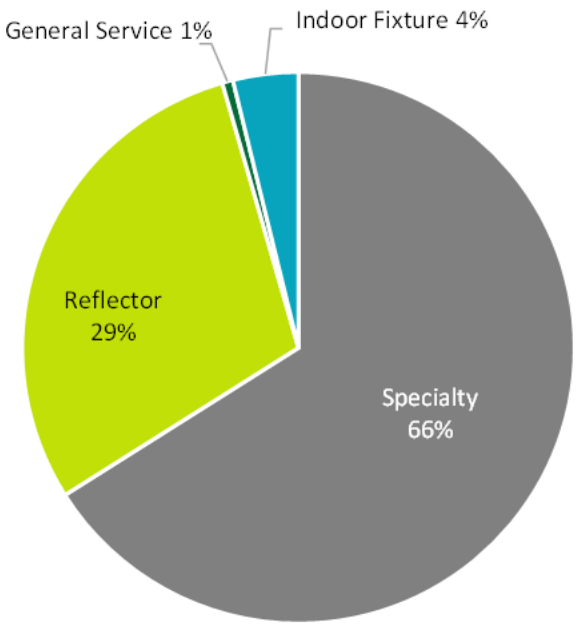
Table 251: Residential Program Evaluation Activities – Penelec

Program/ Subprogram	Surveys	Site Visits	Desk Review[a]	Billing Analysis
Appliance Turn-In				
Appliance Turn-In (LI & Non-LI)	✓	-	✓	-
EE Homes				
Energy-Efficiency Kits	-	-	-	-
Energy-Efficiency Kits – LI	-	-	-	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	-	-
Residential New Construction	-	-	-	-
Upstream Lighting				
Upstream Lighting	-	-	✓	-
EE Products				
Upstream Electronics	-	-	✓	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliances – LI	✓	-	✓	-
LI WARM				
LI WARM – Extra Measures	-	✓	✓	✓
LI WARM – Multifamily	-	✓	✓	✓
LI WARM – Plus	-	✓	✓	✓

F.5.1.1 Upstream Lighting & Cross-Sector Sales

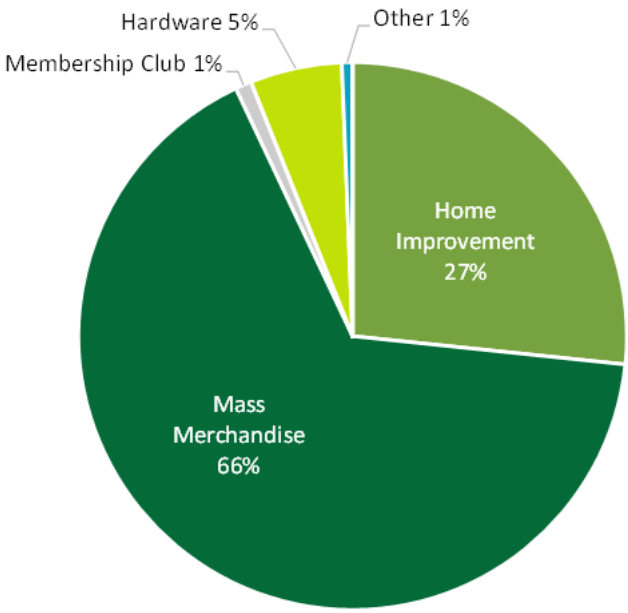
Customers purchased nearly 315,000 efficient light bulbs and fixtures through Penelec's upstream lighting program in PY12. Figure 93 displays the distribution of sales by product type. Almost two-thirds (66%) of the products were specialty bulbs.

Figure 93: Penelec PY12 Upstream Lighting Sales by Product Type



Penelec's PY12 upstream light bulbs and fixtures were sold primarily through mass merchandise (66%) and home improvement stores (27%, Figure 94).

Figure 94: Penelec PY12 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY12 impact analysis for Penelec's Upstream Lighting Initiative before the PY12 Penelec's Annual Report was submitted to the PUC on November 15, 2021. This allowed time for the SWE to conduct its audit, provide ADM with feedback, and for ADM to adjust the analysis based on this feedback. The SWE agrees with ADM's verified gross savings for upstream lighting.

Cross-Sector Sales

ADM did not conduct cross-sector sales research in PY12 but applied the PY10 cross-sector sales rate 7.1%.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY12 upstream lighting analysis.

F.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.

Energy-Efficient Homes Program

In PY12, the Energy-Efficient Homes program included only the New Homes Initiative. The FirstEnergy Companies did not run the direct install or kit portions of the program in PY12. The

SWE noted that the FirstEnergy Companies used an average of PY10 and PY11 results when calculating savings. The realization rates used for calculation were consistent with PY10 and PY11.

Energy-Efficient Products Program

Each component of the EEP Program was audited by the SWE, including appliances, HVAC equipment, and consumer electronics. Note that the SWE's audit of the upstream lighting portion of the EEP Program is reported in Section F.5.1.1 of this appendix.

Analysis files and data sets included in the gross impact data were reviewed for all HVAC, appliance, and consumer electronics measures included in the program. The SWE found that in all cases the correct TRM values and algorithms were used, the verified savings were correct, and the savings and sample sizes included in the annual request data matched those reported in the PY12 annual report.

The Midstream Appliances subprogram includes two measures: ENERGY STAR dehumidifiers and heat pump water heaters. Verification occurred via a review of distributor invoices and the gross impact calculations followed TRM algorithms with specific equipment capacity and efficiency parameters drawn from the ENERGY STAR Qualified Product Lists. Changes to federal standards and ENERGY STAR qualifying criteria in late 2019 complicated the analysis for dehumidifiers. ADM's PY12 verified savings calculations for dehumidifiers aligned with a March 2021 SWE Guidance Memo on the topic. Realization rates for both measures were well over 100% due to the conservative efficiency assumptions used by Penelec to claim reported gross energy and demand savings. The SWE audit found the verified savings were well-organized, free of errors, and consistent with Act 129 guidance documents.

LI WARM Program

The LI WARM Program is a LI direct install initiative offering similar measures across three sub-programs: WARM-Plus, WARM-Extra Measure, and WARM-Multifamily. The WARM program includes LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE audited all measures included in the program using the full downstream dataset and the survey sample subset provided by FirstEnergy. The SWE found that the correct TRM-approved methods were followed, survey sample sizes were correct and survey data correctly incorporated into the verified savings calculations, and the verified savings were correct.

Appliance Turn-In Program (LI and Non-LI)

The SWE performed audits on all measures included in the Appliance Turn-In Program, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

F.5.1.3 Behavior

Approximately 19% of Penelec's verified gross energy savings for PY12 came from Home Energy Reports issued to around 130,000 residential and residential-LI households. The SWE reviewed ADM's methodology and accepts their verified MWh and MW savings values for Penelec's HER offering in PY12. By cohort, Table 252 shows average kWh savings and average percent savings

per participant in PY12. Note that the 'Number of Participants' column shows the average number of participants during PY12.

Table 252: Average PY12 kWh Savings per Participant

Sector	Cohort Start Date	Number of Participants	Average PY12 kWh Savings	Average PY12 % Savings
Low-Income	July 2012	5,406	183	1.47%
Residential	July 2012	43,508	140	1.14%
Low-Income	January 2014	1,263	232	1.77%
Residential	January 2014	55,005	129	1.42%
Low-Income	December 2014	6,556	(13)	(0.17%)
Residential	December 2014	22,537	46	0.62%

The following sections highlight some of the more important audit steps and findings: the calendarization of billing data, group equivalence, duplicating participant counts, the calculation of lag terms, missing eligibility filters, and energy and demand savings.

Calendarization

The first step the SWE team took was to review ADM's calendarized data. "Calendarization" is a process that prorates billing data into a common calendar month basis shared by all accounts. Our review of the calendarized data had three primary components:

- Check the coding of the "pre" and "post" indicator variables;
- Confirm that the calendarized average daily usage values are correct; and
- Confirm that the lag terms (average usage in the pre period, average summer usage in the pre period, average winter usage in the pre period) are correct.

Our team found no issues in the coding of the pre and post indicator variables. Table 253 shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.[77] The distribution of average daily kWh is basically identical in the two data sets.

Table 253: Comparison of Calendarized Data

Variable	Mean	5th Percentile	25th Percentile	75th Percentile	95th Percentile
Average Daily kWh – ADM	27.24	8.14	15.11	34.13	61.61
Average Daily kWh – SWE	27.24	8.15	15.11	34.13	61.61

Regarding the lag terms, the SWE found that ADM's calculations were sound. ADM did not calculate summer or winter lag terms in cases where pre period summer or winter data did not

[77] The table only summarizes PY12 records.

exist. Because we found no issues with ADM's calendarized data, the figures, tables, and summary statistics presented herein were created or calculated using ADM's calendarized data rather than our own.

Group Equivalence

After reviewing the calendarization, the SWE compared average daily consumption (kWh) between the treatment and control groups during the pre-treatment period. Table 254 shows the results for each cohort. Note that calendarized data was used to calculate the averages and any customer without at least 12 month of pre-treatment data was dropped. To avoid comparing averages calculated over different time spans (e.g., 14 months and 12 months), averages within each month were calculated before calculating overall averages for each customer. The 'P-value' column indicates the likelihood that the observed differences could happen by chance if the two experimental cells use the same amount of energy, on average. A p-value less than 0.05 indicates that the difference in average consumption between the two groups is statistically significant. The July 2012 Low-Income cohort was the only group to have statistically significant pre-treatment differences between the treatment and control groups. In some prior years, differences for this cohort were not statistically significant, but customers move over time and the make-up of the experimental cells changes. The impact estimation method accounts for the differences in pre-treatment consumption.

Table 254: Group Equivalence in the Pre-Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
Low-Income	July 2012	37.2	37.8	0.01
Residential	July 2012	37.0	36.9	0.13
Low-Income	January 2014	39.7	40.4	0.22
Residential	January 2014	25.3	25.3	0.79
Low-Income	December 2014	20.3	20.6	0.13
Residential	December 2014	18.8	18.7	0.45

Participation Counts

The SWE team leveraged the raw billing data to audit participant counts. Because billing cycles can exceed 31 days in length (meaning bill dates can occasionally skip over a month), the SWE team calculated the number of unique IDs beyond a certain bill date. As an illustrative example, suppose we wanted to compute the number of participants in Penelec's 2012 LI cohort for March of 2021. We removed any households with a billing end date prior to 3/1/2021, then counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Table 255: Participant Counts by Cohort and Month

Month	July 2012 LI	July 2012 Residential	January 2014 LI	January 2014 Residential	November 2014 LI	November 2014 Residential
Jun-20	5,528	44,258	1,302	56,340	6,798	23,297
Jul-20	5,500	44,092	1,295	56,068	6,737	23,141
Aug-20	5,480	43,951	1,287	55,795	6,697	23,009
Sep-20	5,456	43,784	1,280	55,503	6,653	22,849
Oct-20	5,434	43,657	1,272	55,263	6,612	22,704
Nov-20	5,417	43,518	1,269	55,029	6,571	22,533
Dec-20	5,397	43,397	1,258	54,807	6,534	22,411
Jan-21	5,376	43,293	1,251	54,632	6,503	22,324
Feb-21	5,360	43,208	1,245	54,458	6,465	22,227
Mar-21	5,340	43,124	1,237	54,281	6,424	22,112
Apr-21	5,308	42,980	1,232	54,059	6,373	21,979
May-21	5,276	42,834	1,222	53,827	6,310	21,860

Eligibility Filters

The LS regression model is a post-only model – only records from the post period are used in the regression. That said, some of the explanatory variables in the model are calculated based on pre period data: (1) average daily consumption in the pre period, (2) average daily consumption during the summer in the pre period, and (3) average daily consumption during the winter in the pre period. For a number of homes, there was not enough pre period data to calculate these lag terms. In PY12, ADM dropped any homes without 12 months of pre period data from the LS model. The monthly impact estimates derived from the model were then applied to the homes with insufficient pre period data. There is no evidence to suggest that homes without sufficient pre period data are systematically different from homes with sufficient pre period data. The SWE believes this is the correct approach.

Impact Coefficients and Energy Savings

Figure 95 through Figure 100 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY12. Only homes active in PY12 are included in the “pre period” portion of the figure. As has been noted, the

regression model used to estimate the impact of the HER program has daily usage controls for potential pre period differences.

Figure 95: July 2012 LI Cohort Usage Comparison

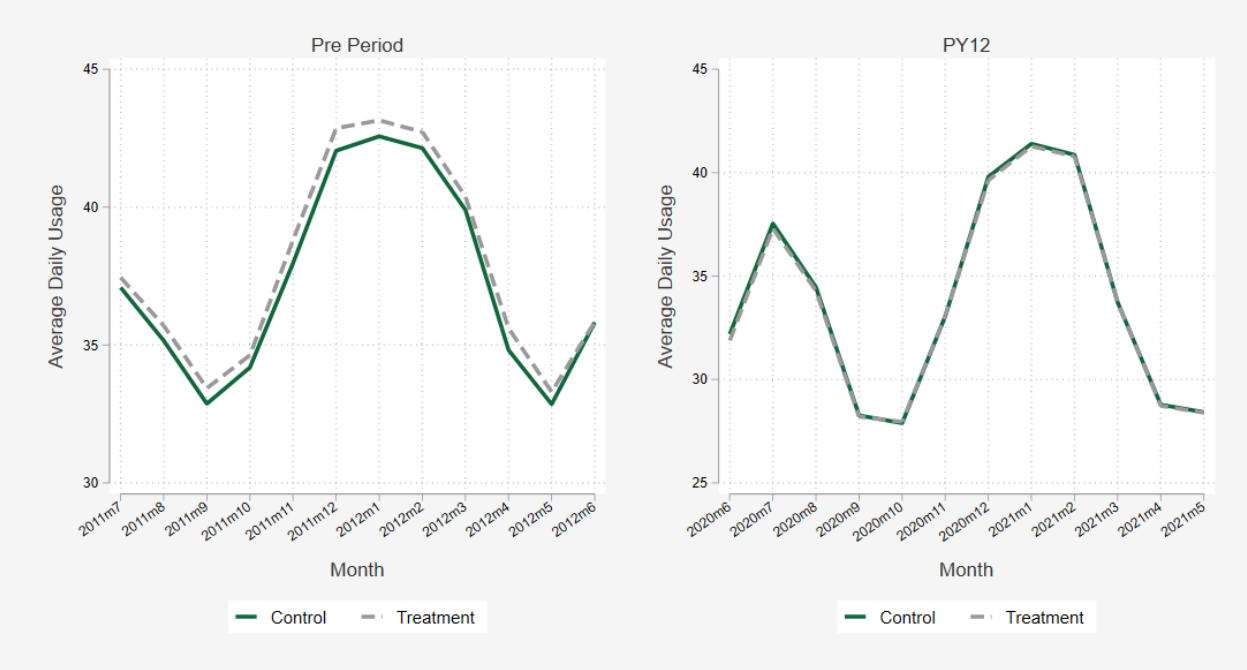


Figure 96: July 2012 Residential Cohort Usage Comparison

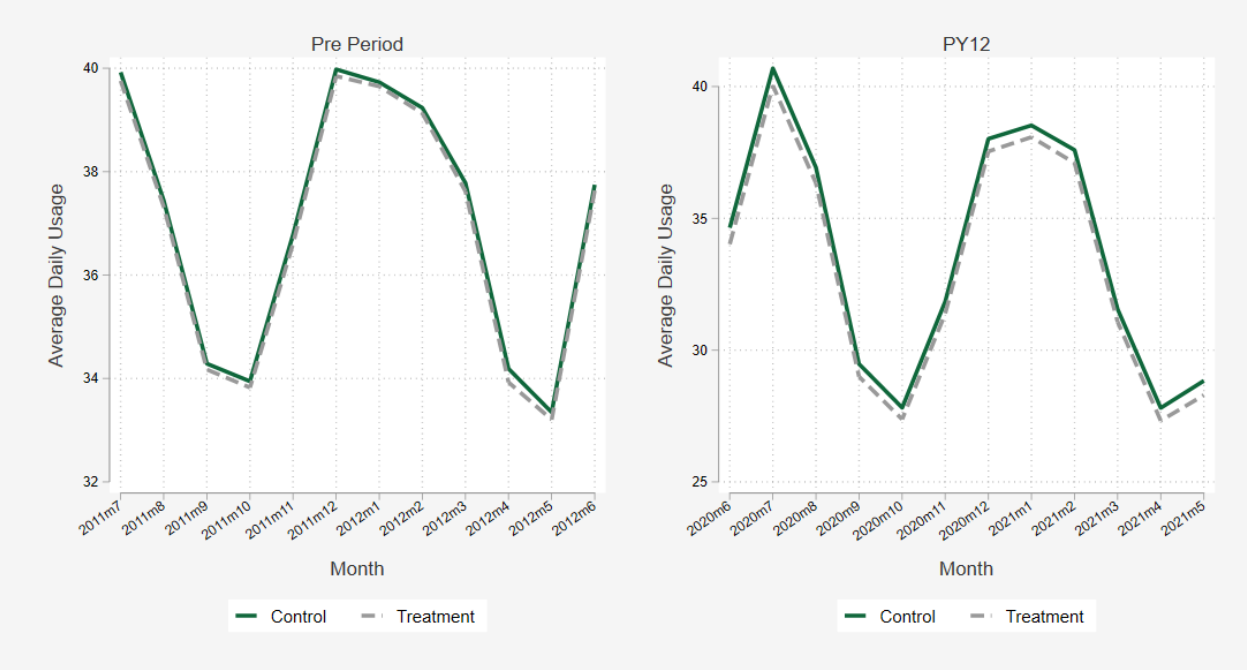


Figure 97: January 2014 LI Cohort Usage Comparison

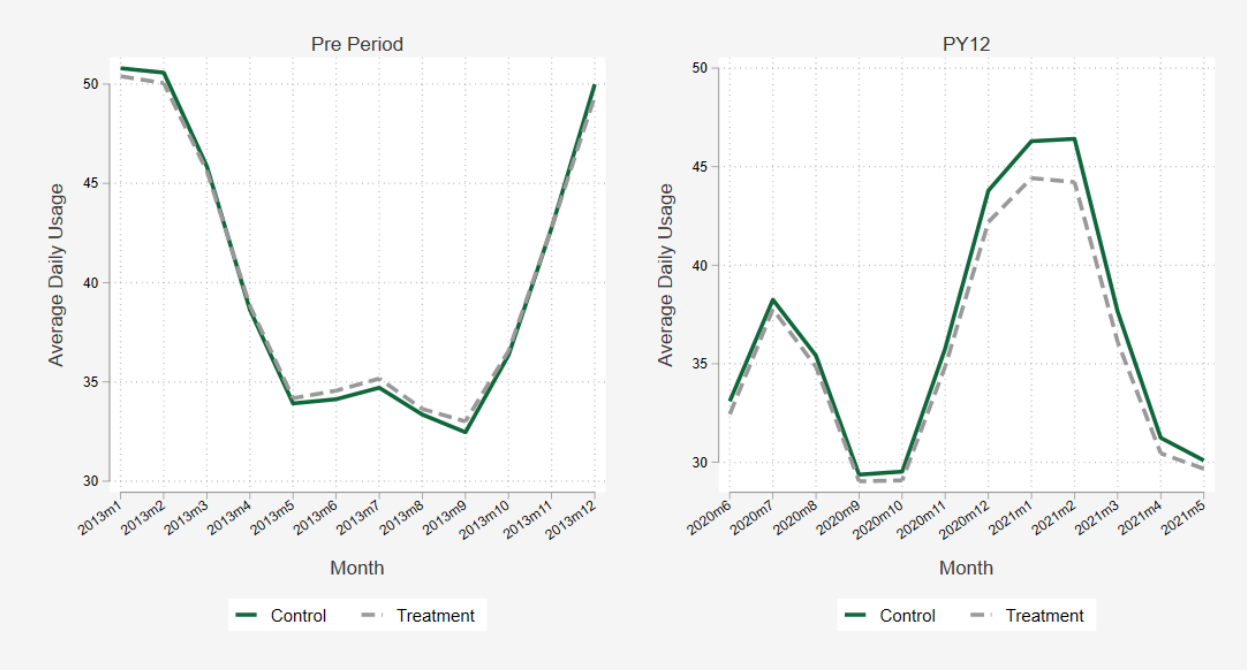


Figure 98: January 2014 Residential Cohort Usage Comparison

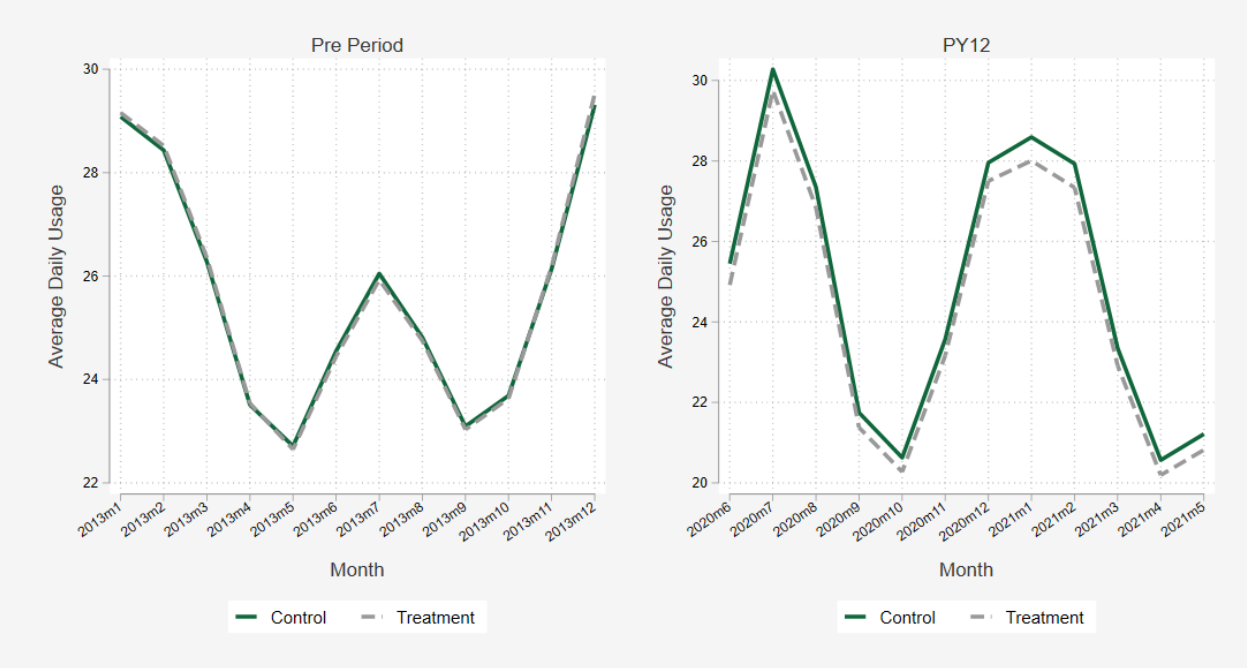


Figure 99: December 2014 LI Cohort Usage Comparison

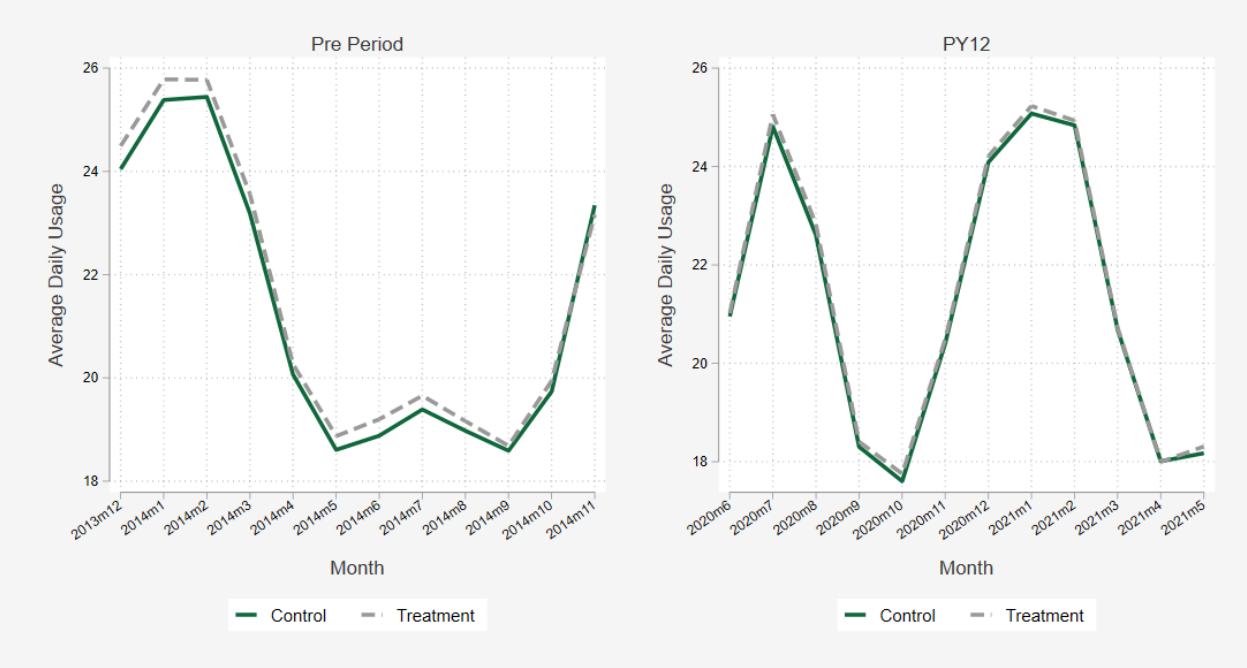


Figure 100: December 2014 Residential Cohort Usage Comparison

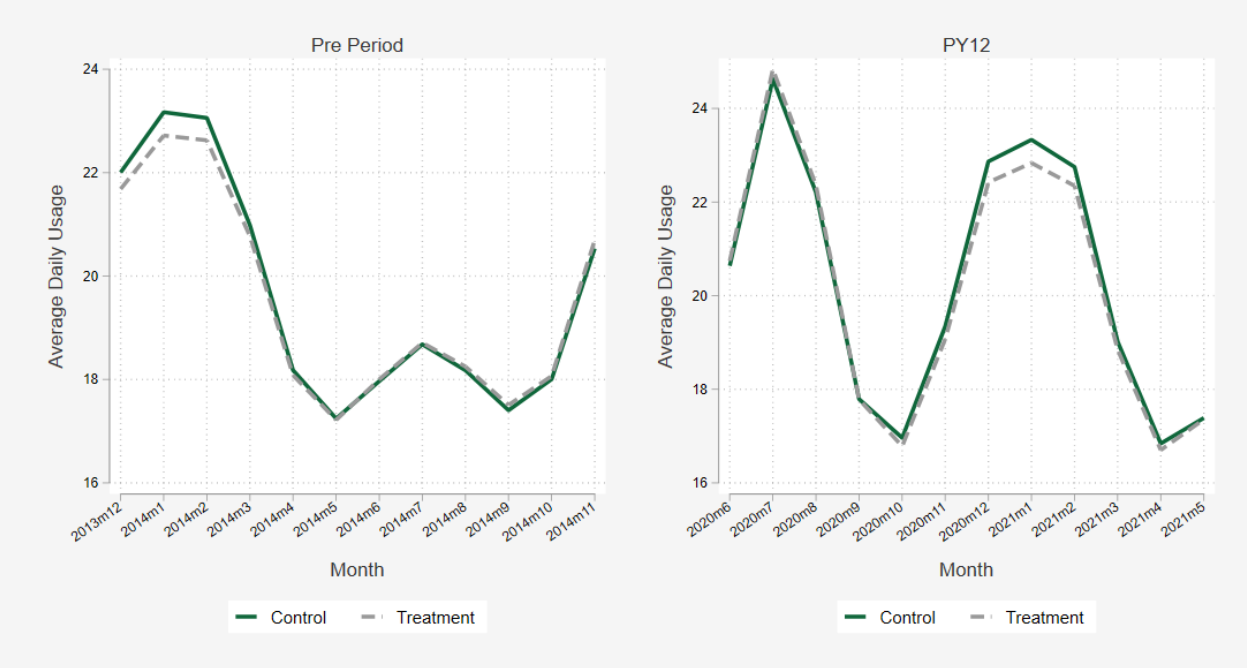


Table 256 shows PY12 impact estimates for each cohort. Note that a different impact estimate was calculated for each month in PY12 – the estimates shown in the table reflect the averages of the PY12 monthly estimates (weighted by month duration). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the LI July 2012 cohort saved 0.55 kWh per day, on average, during PY12.

Table 256: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
Low-Income	July 2012	(0.55)	(0.55)
Residential	July 2012	(0.43)	(0.43)
Low-Income	January 2014	(0.59)	(0.59)
Residential	January 2014	(0.39)	(0.39)
Low-Income	December 2014	0.04	0.04
Residential	December 2014	(0.13)	(0.13)

To account for dual participation, savings are reported after adjusting for downstream measures and upstream measures. HER programs promote other energy-efficiency & conservation programs, creating a situation where treatment group homes participate in other energy-efficiency & conservation programs at a higher rate than control group homes. Therefore, there is incremental kWh savings in the regression analysis that must be subtracted from the HER impacts to avoid double-counting. ADM identified energy-efficiency program participation that occurred from each cohort's treatment start date onwards to calculate the downstream adjustment factor. The upstream reduction factor for each cohort varies depending on the number of years passed since the cohort's respective start date. Because all the cohorts had a start date at least four years before PY12, the upstream reduction factor for all cohorts is 3%.

Using the impact estimates shown above, Table 257 shows ADM's and the SWE's aggregate energy savings (MWh), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 257: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE – ADM)
Low-Income	July 2012	990	989	(2)
Residential	July 2012	6,075	6,078	3
Low-Income	January 2014	293	293	0
Residential	January 2014	7,084	7,084	1
Low-Income	December 2014	(86)	(86)	0
Residential	December 2014	1,040	1,041	0
Total		**15,397**	**15,399**	**2**

Demand Savings

Table 258 shows ADM's and the SWE's aggregate peak demand savings (MW), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

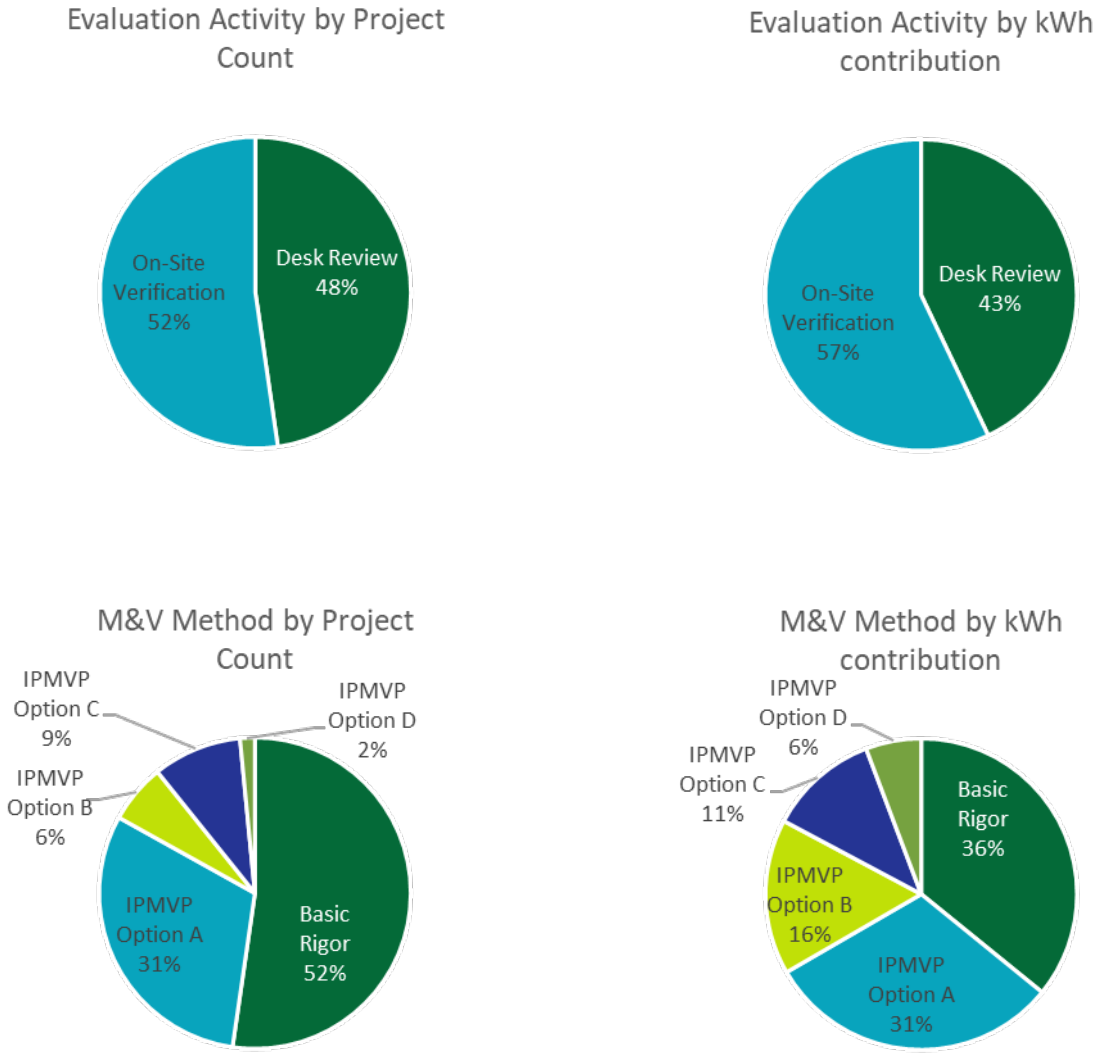
Table 258: Demand Savings Comparison

Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE – ADM)
Low-Income	July 2012	0.11	0.11	0.00
Residential	July 2012	0.67	0.67	0.00
Low-Income	January 2014	0.03	0.03	0.00
Residential	January 2014	0.81	0.81	0.00
Low-Income	December 2014	(0.01)	(0.01)	0.00
Residential	December 2014	0.13	0.13	0.00
Total		**1.74**	**1.74**	**0.00**

F.5.2 Non-Residential Audit Activities

Figure 101 provides a summary of the evaluation activities and M&V approaches utilized by Penelec's evaluation contractor, ADM, in their PY12 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY12, Penelec's evaluation contractor completed site visits to 52% of projects, and these projects represented 57% of total evaluated energy savings. A total of 34 site visits were conducted, a greater number than PY11. IPMVP Options A, B, C and D were employed for the majority (64%) of total evaluated energy savings. Basic Rigor (verification only) was employed for all but one prescriptive project and a small selection of lighting projects.

Figure 101: Summary of Penelec's C&I Evaluation Activities



Penelec's evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Penelec's C&I programs are assigned to one of five evaluation initiatives, as Penelec's programs target specific sectors of C&I customers, but offerings are often identical across the programs. Table 259 provides a summary of the evaluation activities Penelec's evaluation contractor used across strata for all projects by initiative.

Table 259: Summary of Penelec's PY12 C&I Evaluation Activities by Initiative

Initiative/Strata	Sample Quantity	RR	Desk Review	On-Site Verification
Appliance Turn-In	**0**	**85%**	**0**	**0**
Custom	**12**	**98%**	**11**	**1**
Custom – 1	5	93%	4	1
Custom – 2	-	-	-	-
Custom – Certainty	7	100%	7	-
Direct Install	**0**	**104%**	**0**	**0**
Lighting	**36**	**92%**	**3**	**33**
Lighting – 1	2	96%	-	2
Lighting – 2	11	93%	1	10
Lighting – 3	9	84%	1	8
Lighting – Certainty	14	100%	1	13
Prescriptive	**17**	**95%**	**17**	**0**
Prescriptive – 1	17	95%	17	-
Prescriptive – 2	-	-	-	-
TOTAL	**65**	**94%**	**31**	**34**

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

F.5.2.1 Appliance Turn-In Initiative

In PY12, Penelec's Appliance Turn-In Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the average of respective PY10 and PY11 realization rates.

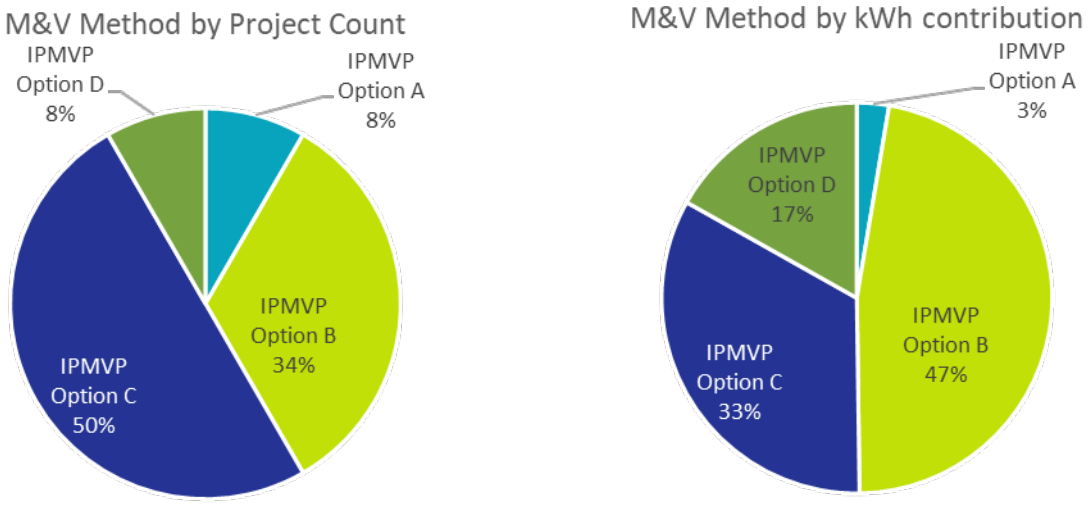
F.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews, site visits, and/or IPMVP evaluation methods for all sampled projects. Only one site visit was conducted for PY12 custom sampled projects. The evaluation was satisfactorily conducted remotely for remaining projects using data provided by the customer (EMS data, billing data, etc.). 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 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 3-2 of the Phase III Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. Enhanced rigor methods were employed to evaluate all projects, with IPMVP Option B selected as the primary M&V enhanced method for 47% of evaluated custom projects, as shown in Figure 102.

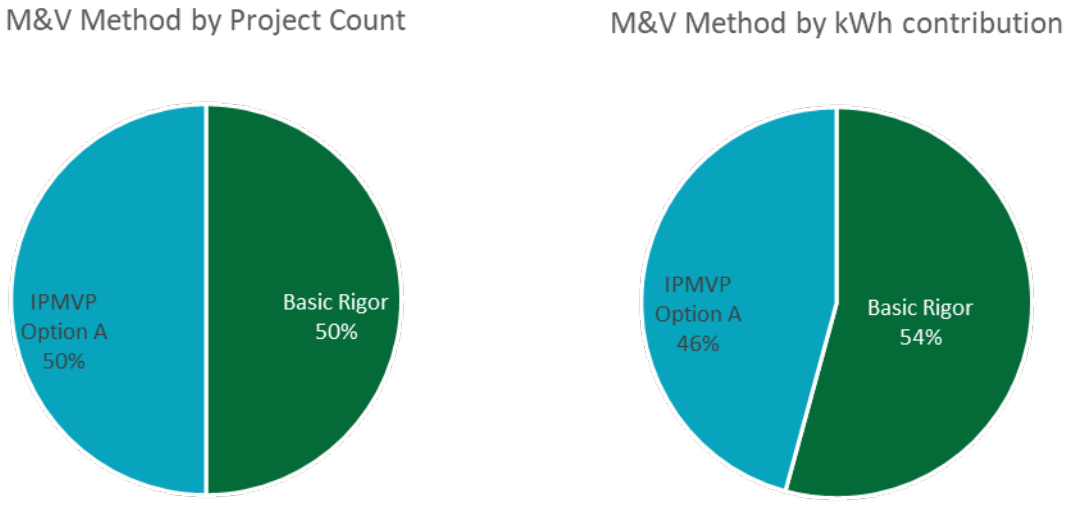
Figure 102: Summary of Penelec's C&I Custom Program M&V Methods



F.5.2.3 Lighting 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 (Figure 103). TRM deemed hours of operation were applied in a basic rigor method 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 four strata for projects in the Lighting initiative. The largest projects, with ex-ante savings estimates of 750 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.

Figure 103: Summary of Penelec's C&I Lighting Program M&V Methods



IPMVP Options A was employed for half of the projects in the PY12 sample.

F.5.2.4 Prescriptive Initiative

Evaluation activities for this initiative include desk reviews and basic rigor application of TRM-based savings calculation methodologies. None of Penelec's prescriptive projects received a site-visit this program year.

Penelec's evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 20 MWh of annual energy savings. All the PY12 sampled projects were in the Prescriptive-1 stratum, meaning no sampled project reached the savings threshold.

IPMVP Option A was employed for only one project in this initiative. All other projects were evaluated using basic rigor desk reviews.

F.5.2.5 Direct Install Initiative

In PY12, Penelec's Direct Install Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the PY11 realization rates, as the program had no participation in PY10.

F.5.2.6 Ride-Along Site Visits

The SWE audited the activities above through a combination of Ride-Along Site Visits (conducted both in person and virtually) and Desk Reviews. The details of the SWE's findings are presented in the following subsections.

Table 260 provides an overview of the SWE milestones for the audit of Penelec's site inspection efforts.

Table 260: Penelec Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Energy Attainment Percentage
1	249,043	1	1	100%

Overall, the SWE agreed with the methods of calculation employed by Penelec's evaluation contractor, ADM. The calculations and accompanying report were easy to follow and showed evidence that the TRM was being followed appropriately. The SWE's energy savings of the one project with a ride-along audit reached an attainment percentage of 100% of the evaluator's energy savings.

F.5.2.7 Verified Savings Desk Reviews

Table 261 provides an overview of the SWE milestones for the verified savings review of evaluated Penelec projects.

Table 261: Penelec Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
4	5,096,099	888	100%	100%

The SWE asserts that ADM conducted appropriate M&V efforts, and that sufficient documentation supporting savings analyses was provided. For the four projects reviewed, the SWE found no basis for recommending adjustments to energy or demand savings.

F.6 DR

Penelec does not have a DR target for Phase III of Act 129.

F.7 NTG

F.7.1 Residential Programs

ADM and Tetra Tech did not conduct any new NTG research for residential programs during PY12.

Tetra Tech assigned the HERs component of the program an NTG of 1, in accordance with the Evaluation Framework, and was not informed by participant surveys, but assumes that the RCT design eliminates free-ridership and produces negligible SO.

The PY11 NTG was assigned to the HVAC and Residential Appliances Program and the PY10 NTG was assigned to the Appliance Turn-in Program, the Direct Install Program, the New Homes Program, and the Upstream Programs, as was stated in the Evaluation Plan.

The SWE determined that Tetra Tech utilized data collection, question bevies, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 262: Summary of NTG Estimates for Penelec Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Appliance Turn-In	0.53	0.0	0.47	-
Program not active in PY12	EE Kits	-	-	-	-
RCT	HERs	-	-	1	-
PY10	Direct Install	0.16	0.19	1.03	-
PY10	New Homes	-	0.0	0.73	-
PY10	Upstream Lighting	0.69	0.0	0.31	-
PY10	Upstream Electronics	-	-	0.58	-
PY11	HVAC	0.49	0.01	0.52	-
PY11	Residential Appliances	0.47	0.07	0.60	-

F.7.2 LI Residential Programs

Tetra Tech assigned LIEEP including LI Residential Appliances and Initiatives, LI Residential Appliance Turn-in, LI Direct Install and LI Energy-Efficiency Kits a NTG of 1, in keeping with the PY12 Evaluation Plan and SWE Phase III Evaluation Framework.

F.7.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY12. C&I NTG values were evaluated in PY10 and those values were applied to the C&I Programs for PY12. It has been previously concluded that all PY10 and PY11 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 263: Summary of NTG Estimates for Penelec C&I Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Small Energy Solutions for Business Lighting	0.22	0.03	0.81	-
PY10	Small Energy Solutions for Business Custom	0.19	<0.01	0.81	-
PY10	Small Energy Solutions for Business Prescriptive	0.58	0.0	0.42	-
PY10	Small Energy Solutions for Business Appliance Turn-In	-	-	0.47	-
PY10	Small Energy Solutions for Business Direct Install	-	-	0.81	-
PY10	Small Energy Solutions for Business Total	-	-	0.80	-
PY10	Large Energy Solutions for Business Lighting	0.22	0.03	0.81	-
PY8	Large Energy Solutions for Business Custom	0.19	<0.01	0.81	-
PY10	Large Energy Solutions for Business Prescriptive	0.58	0.0	0.42	-
PY10	Large Energy Solutions for Business Total	-	-	0.81	-

F.8 TRC

Table 264 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for Penelec's PY12 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 PY12 annual report and the model itself was well-organized and documented.

Both gross and net TRC Ratios were generally higher in PY12 compared to PY11. The only exceptions were the gross/net TRC Ratio for Appliance Turn-In, Energy-Efficient Products, and Low-Income Energy-Efficiency programs. The largest decrease in cost-effectiveness occurred in the LI Energy-Efficiency program, which did not include energy-efficiency kits in PY12.

Table 264: Summary of Penelec's PY12 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
Appliance Turn-In	$740	$479	1.54	$348	$479	0.73
Energy-Efficient Homes	$1,823	$993	1.84	$1,698	$946	1.80
Energy-Efficient Products	$5,743	$5,370	1.07	$2,345	$2,901	0.81
Low-Income Energy Efficiency	$445	$1,536	0.29	$445	$1,536	0.29
C&I Energy Solutions for Business – Small	$8,117	$5,641	1.44	$6,563	$4,793	1.37
C&I Energy Solutions for Business – Large	$12,610	$7,339	1.72	$10,253	$6,128	1.67
Governmental & Institutional Tariff	$486	$433	1.12	$396	$364	1.09
Portfolio Total	**$29,964**	**$21,791**	**1.38**	**$22,048**	**$17,147**	**1.29**

Six of Penelec's seven EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. Using net verified savings, four programs were found to be cost-effective and three were not cost-effective. The Appliance Turn-in and Energy-Efficient Products programs was cost-effective under gross verified savings, but not cost-effective under net verified savings, while the LI Energy-Efficiency program was not cost-effective under gross or net verified savings.

F.8.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- To calculate the avoided cost of natural gas, Penelec used the Annual Energy Outlook (AEO) average natural gas price for all users *in the Middle Atlantic* region, as the SWE recommends. The AEO natural gas prices were converted to nominal dollars before the NPV was calculated.
- Penelec's annual electric energy savings are calculated and allocated by month and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is broader than the on-peak hours defined in the 2016 TRM (Monday – Friday 8AM-8PM). In the 2021 Pennsylvania TRM, on-peak and off-peak energy periods were adjusted to align with the PJM market definition. The adjusted 2021 TRM peak window (Monday – Friday, 7AM-11PM) will now also match the definition used in FirstEnergy's Phase III TRC model. The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions.
- Penelec used a discount rate of 6.77% to calculate the net present value of future program benefits. This discount rate is based on Penelec's WACC and 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).

- 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 TRC Test Order directive for Phase III.
- 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 that the demand response program TRC Ratio meets the 75% participant cost assumption where 75% of customer incentive payment is used as a proxy for participant cost.
- According to the Phase III Evaluation Framework, LI measures are required to be provided at no cost to the participants. At first glance, it appears that Penelec's LI programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the LI Energy-Efficiency Program (Table 107 in FirstEnergy's PY12 Annual Report). However, in their Phase III EE&C Plan, Penelec explains that these costs are only being allocated to landlords and owners of LI properties, rather than the LI customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model followed the protocol specified in the 2016 TRC Test Order pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Non-Electric Benefits. The SWE verified that the savings were accounted for in accordance with the Guidance on Inclusion of Fossil Fuel and Water Benefits in TRC Test memo issued in March 2018. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative Total NPV Lifetime Non-Electric Benefit. As in past years, the SWE agrees that the cost should be accounted for as a negative non-electric benefit rather than a fossil fuel switching program cost. The TRC model claimed nearly 18 million gallons per year of water saving, which translates to approximately $1M in NPV lifetime avoided costs.
- In PY12, the Penelec TRC Model incorporated the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures. Table 265 shows that without the dual baseline included in the TRC model, the gross and net TRCs are higher than when the dual baselines are included.

Table 265: Penelec Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.38	1.29
Without Dual Baseline	1.74	1.43

F.9 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penelec, so the annual evaluation reports of the four FirstEnergy EDCs report identical information about the process evaluation. Therefore, the SWE's audit review, previously described for Met-Ed, pertains to all four FirstEnergy utilities, including Penelec.

Appendix G FirstEnergy: Pennsylvania Power Company PY12 Audit Detail

G.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of Penn Power's PY12 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor.

- Penn Power's dispatchable demand response performance dropped considerably in PY12 compared to PY9-PY11. Verified gross reductions fell short of Penn Power's Phase III DR target of 17 MW in four of five summer 2020 events. The drop in performance appears to come largely from a sharp drop in available load. The average event day reference load for C&I participants in PY12 decreased about 63 percent from PY11. The COVID-19 pandemic affected businesses in complex and varied ways and Penn Power's DR participants appear to have been operating at reduced capacity during summer 2020 relative to previous summers. This finding supports the Commission's decision to make PY12 DR performance voluntary and base Phase III compliance on the average performance PY9 through PY11.
- PY12 had the lowest verified gross MWh savings from HERs of any year in Phase III for Penn Power, the largest year as a percentage of portfolio savings. This finding is more related to the sharp reduction in portfolio savings at Penn Power in PY12 than the HER offerings. HER cohorts lose 5-8% of recipients annually due to account closures and move-outs. Unless a new cohort of homes is added, we expect to observe a gradual decline in aggregate HER savings due to declining participant counts.
    - Without energy-efficiency kits in PY12, Penn Power was especially reliant on Home Energy Reports for LI savings, with 84.6% of progress toward the LI compliance target coming from behavioral HERs.
- PY12 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE's review of verified savings for non-HER residential programs found that, overall, the verified savings followed proper TRM protocols and that the verified savings are accurate.
- Project documentation for the non-residentials program submitted to the SWE for review was generally thorough and complete. The SWE noted only a few minor discrepancies.
- The SWE's review of ADM's verified savings analysis for the non-residential programs found that the recommended procedures outlined in the Phase III evaluation framework were generally followed. TRM protocols were applied correctly, including adherence to the COVID-19 EM&V Guidance Memo, and verified savings calculations were generally appropriate.
- ADM did not conduct primary NTG research for any residential or non-residential programs during PY12 and applied prior program year NTG values.

- The PY12 process evaluation of the Behavioral Demand Response (BDR) program was consistent with the Phase III evaluation plan and the reporting followed the SWE guidelines.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in FirstEnergy's Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE has no major concerns. For all Penn Power's programs, the SWE was able to replicate reported MWh savings and reported MW savings exactly via the tracking data. We also calculated directionally similar (if not identical) participation counts and incentive amounts for all programs.
- Penn Power's TRC model was well-organized and consistent with the directives of the 2016 TRC Test Order and the key financial assumptions approved in Penn Power's Phase III EE&C Plan. ADM uses a sampling approach for non-residential incremental measure costs that is unique to the FirstEnergy companies in Pennsylvania. Rather than apply assumed measure costs to each measure in the tracking data, ADM conducts project-specific cost research on each project in the evaluation sample along with the energy and demand savings analysis. The results from the sample are expanded to the population on a $/kWh basis by sampling initiative and EDC. The SWE appreciates this attention to measure costs in the impact evaluation and believes it returns an unbiased estimate of TRC Costs. Penn Power's PY12 non-residential incentives as a percentage of estimated incremental cost were among the lowest statewide at 12.1% for Small C&I and 13.3% for Large C&I.

G.2 EM&V Plan Reviews

FirstEnergy's evaluation contractor, ADM Associates, submitted an updated comprehensive evaluation plan for the four FirstEnergy EDCs that addressed evaluation activities for PY11 and PY12. In addition, the ADM team submitted a memo updating their sampling and evaluation approach for the process evaluation of the Behavioral DR program. The SWE reviewed and approved the plan and memo.

G.3 Sample Design Review

Verified savings estimates for most programs 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 ±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 III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at 85% confidence level for each "initiative." For 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 program delivery channel or supported technology.

Grouping projects by equipment type and program delivery method leads to more meaningful evaluation results than tariff-based program definitions, each of which would include the same mix of measures. This evaluation strategy also makes sample design more efficient because the same projects are more likely to share similar characteristics across rates classes (i.e., Small C&I, Large C&I, and Government) than a heterogeneous mixture of measures within a single class. For example, projects from Penn Power's three non-residential energy programs (C&I Energy Solutions for Business – Small, C&I Energy Solutions for Business – Large, and Government & Institutional Tariff) were assigned to one of four solutions:

- C&I Lighting
- C&I Custom
- C&I Prescriptive
- C&I Appliance Turn-In

ADM established a series of initiatives and designed the impact evaluation samples for each to meet the 85/15 precision requirement. Table 266 lists each initiative evaluated in PY12 and the corresponding relative precision of the PY12 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 266: Relative Precision of Penn Power PY12 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (±)
LI Direct Install	9.3%
Res Upstream Lighting	8.8%
Res Upstream Electronics	0.0%
Res HVAC	10.2%
Residential Appliances	1.2%
LI Appliances	23.7%
C&I Lighting	9.8%
C&I Custom	8.7%
C&I Prescriptive	0.0%

The C&I Appliance Turn-In, Residential Direct Install, and Residential New Construction initiatives were not evaluated in PY12. ADM estimated verified gross savings for these initiatives using historic realization rates. The Appliance Turn-In and Energy-Efficiency Kits initiatives were not active in PY12.

LI Appliances was the only sampling initiative that failed to meet the requirement of ±15% precision at the 85% confidence level. The poor precision in LI Appliances was a function of variability between reported and verified savings rather than sample size as 31 of 103 projects were surveyed and 16 of 131 received a desk review. With just 11 MWh of verified gross savings

in PY12, the SWE does not view the sample design or resulting precision as an issue. PY12 verification processes were impacted by the COVID-19 pandemic. Where appropriate, ADM replaced on-site visits with phone interviews and video conferences.

Sampling uncertainty does not consider the level of rigor of the verification activities. Results from a sampled project that receives a quick desk review from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of ADM's PY11 verification activities is discussed in detail in Appendix G.5.

The Behavioral Modification subprogram provides HERs to residential customers in the Penn Power service territory. The subprogram is divided between standard 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 the used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase III Evaluation Framework requiring the solution-level verification achieve an *absolute* precision of ±0.5% at the 95% confidence level (two-tailed). Table 267 shows the absolute precisions of the behavioral program components.

Table 267: Absolute Precision of Penn Power PY12 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (±)
Residential	0.25%
LI	0.79%

DR programs offered by Penn Power in PY12 include BDR targeted at residential customers and the DR Program for both small and large C&I customers. The relative precision of the PY12 verified DR savings was ±34.5% at the 90% confidence level for the Penn Power DR portfolio.

G.4 Reported Gross Savings Audits

G.4.1 Tracking Data Review

This section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Penn Power's PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)
- Reported gross peak demand savings (MW)
- Participation
- 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 PY12 quarterly data request. Also note that DR or 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 Penn Power's DR programs can be found in Appendix G.6, and our findings regarding the HER components of the Energy-Efficient Homes and LIEEPs can be found in Appendix G.5.1.3.

Table 268 summarizes our ex-ante findings regarding energy savings. The 'Match' column contains 'Yes' if the tracking data supports the values shown in Penn Power's PY12 Annual Report and 'No' otherwise. For each program, the SWE was able to replicate the values provided by Penn Power.

Table 268: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-In	0	0	Yes
Energy-Efficient Homes	5,404	5,404	Yes*
Energy-Efficient Products	3,334	3,334	Yes
LI Energy Efficiency	691	691	Yes*
C&I Energy Solutions for Business – Small	11,315	11,315	Yes
C&I Energy Solutions for Business – Large	1,863	1,863	Yes
Governmental & Institutional Tariff	0	0	Yes
Portfolio Total	**22,607**	**22,607**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 269 summarizes the SWE's ex-ante findings regarding peak demand savings by program. The SWE's records matched Penn Power's reported peak demand savings for each program.

Table 269: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-In	0.00	0.00	Yes
Energy-Efficient Homes	1.24	1.24	Yes*
Energy-Efficient Products	0.47	0.47	Yes
LI Energy Efficiency	0.11	0.11	Yes*
C&I Energy Solutions for Business – Small	1.39	1.39	Yes
C&I Energy Solutions for Business – Large	0.28	0.28	Yes
Governmental & Institutional Tariff	0.00	0.00	Yes
Portfolio Total	**3.49**	**3.49**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 270 summarizes the SWE's ex-ante findings regarding program participation. For all programs, the SWE calculated directionally similar (if not equal) participation counts. Portfolio totals only differ by three participants. Note that Residential Behavioral DR program participants are removed from the Energy-Efficiency Homes participant counts.

Table 270: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-In	0	0	Yes
Energy-Efficient Homes	463	465	No*
Energy-Efficient Products	27,601	27,602	No
LI Energy Efficiency	420	420	Yes*
C&I Energy Solutions for Business – Small	85	85	Yes
C&I Energy Solutions for Business – Large	9	9	Yes
Governmental & Institutional Tariff	0	0	Yes
Portfolio Total	**28,578**	**28,581**	**No***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table. Behavioral DR participants are not included either.

Finally, Table 271 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE replicated incentive dollars or calculated directionally similar values for all seven programs. The portfolio totals are also directionally similar: $1,094,000 in the Annual Report and $1,081,000 in the tracking data.

Table 271: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-In	$0	$0	Yes
Energy-Efficient Homes	$249	$237	No
Energy-Efficient Products	$292	$352	No
LI Energy Efficiency	$6	$6	Yes
C&I Energy Solutions for Business – Small	$467	$406	No
C&I Energy Solutions for Business – Large	$80	$80	Yes
Governmental & Institutional Tariff	$0	$0	Yes
Portfolio Total	**$1,094**	**$1,081**	**No**

G.4.2 Project File Reviews

G.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of Penn Power's residential project files for PY12 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.

Table 272 presents a summary of SWE's residential project file reviews.

Table 272: Penn Power PY12 Residential Project File Review Summary

Program	Sub Program	Number of Files Reviewed[1]	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[2]
Energy-Efficient Homes	Audits	30	✓	✓	✓	✓
Energy-Efficient Homes	New Homes	16	✓	✓	✓	✓
Energy-Efficient Products	HVAC	32	✓	✓	✓	✓
Energy-Efficient Products	Appliances and Electronics	14	✓	✓	✓	✓
Energy-Efficient Products	Lighting	16	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Rebate	8	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Turn-In	11	✓	✓	✓	✓
LI Energy-Efficiency	Weatherization	12	✓	✓	✓	✓

[1] The number of files reviewed reflects the total number for all FirstEnergy EDCs.
[2] 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 programs. Below, is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Appliance Turn-In

Penn Power did not provide any data requests for PY12 for the Appliance Turn-In program.

School Education

The School Education Program was not run in PY12.

Energy-Efficiency Kits

The Energy-Efficiency Kits Program was not run in PY12.

Audits

Project files mostly aligned with tracking data, but the SWE observed minor discrepancies regarding rebate amounts, kWh, and audit dates. Project files did not provide enough information to always verify rebate amount or kWh. The SWE did not review project files for Q2 as none were reported during those periods.

New Homes

Project files mostly aligned with tracking data, but the SWE observed minor discrepancies between the kWh and kW listed in the REM report as compared to the quarterly tracking data. Some of the files contained blurry, unusable meter pictures. Thus, the SWE was unable to verify energy metrics.

HVAC

The SWE observed the same discrepancy as during previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular *tons* variable.[78] However, there were instances where an individual input for heating capacity was provided, but cooling capacity was completely missing from the tracking data. Could not verify rebate amount with provided information.

Starting in PY9, the evaluator, ADM, worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations.

[78] For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

Midstream Appliances

The Midstream Appliance program was not run in PY12.

Appliances and Electronics

The Appliance files typically matched the tracking data. Many project requests were saved as GIF files, which made them difficult to verify. This limited SWE ability to review projects for Q1 significantly. The SWE also encountered issues in tracking projects by account number, likely due to automatic truncation in spreadsheet software (e.g., scientific notation reverted to number formatting).

There was no available tracking data for Q3 And Q4 requests. Furthermore, the information provided with the requests had little relevant information and would not have corroborated tracking data metrics.

Upstream Lighting

The Upstream Lighting files mostly matched the tracking data; however, not all suppliers provided enough info on invoices to corroborate both incentive amounts and lighting quantities. All incentive amounts matched, and where available, so did lighting quantities

LI Multifamily / LILU Single-Family

Penn Power did not provide any LI Multifamily / LILU Single-Family program data requests for PY12.

LI Appliance Rebate

LI Appliance Rebate files mostly matched tracking data: however, many project requests contained receipts missing relevant information like rebate amounts, energy savings, and serial/model numbers. There was no available tracking data for the data requests for Q3 or Q4.

LI Appliance Turn-In

Penn Power did not provide any LI Appliance Turn-In program data requests for PY12.

LI Weatherization

LI Weatherization files matched the quarterly tracking data. The SWE observed some project files that included certain measures in the tracking data and left out additional measures listed in the project files. ADM clarified in previous program years that the additional measures listed in these project files are provided by the LIURP program during the same visit, but they are not part of Act 129 and so do not carry any associated savings in the tracking system. There were no data requests for Q4.

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 PY12. Project file documentation is provided each quarter of the program year by Penn Power, the program implementors, and the evaluation contractor to the SWE. Project documentation provided typically includes program rebate applications and approvals, letters of attestation,

invoices for installed equipment, equipment specification or “cut” sheets, post-inspection forms, and calculation workbooks. The SWE reviews these documents for completeness and consistency. The SWE also compares the data points in the documentation against the program tracking database to ensure values such as savings, rebate amounts, installation, approval, and invoice dates align.

Of the fifteen project files reviewed, the majority were generally well organized, complete, and accurate. Table 273 presents an overview of the results of the SWE’s C&I project file reviews.

Table 273: Penn Power PY12 C&I Project File Review Summary

Program	Sub-Program	Number of Projects Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program – Small	Custom – SCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Food Service	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Small	HVAC – SCI	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Large	Lighting – LCI	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Large	Lighting – SCI	4	✓	✓	2/4	✓	✓	-

The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were estimated. However, the SWE did note that the savings calculators were locked for one Food Service project and one HVAC – SCI project. Additionally, for a few lighting projects, small discrepancies were found between invoice quantity and wattage used in savings calculators. In addition to these general observations, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **HVAC – SCI**
  - Workbook calculator locked; SWE cannot verify calculations.
  - For the one project reviewed, a slight discrepancy existed between spec sheet capacity and the capacity used in savings calculation.
- **Food Service**
  - Workbook calculator locked; SWE cannot verify calculations.
- **Lighting – SCI**
  - For one project, the invoice showed purchased LED linear lamps as 15.5 W, but the spec sheet wattage was listed as 16.5 W and the savings calculator used 20 W.
  - A second new construction lighting project included more fixtures in COMcheck and invoice documents than were included in savings calculations.

Despite the minor issues discussed with the above project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

G.5 VERIFIED GROSS SAVINGS AUDITS

G.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the Penn Power portfolio of residential programs. Penn Power's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy-Efficient Homes Initiative, the Energy-Efficient Products Initiative, and the LI Energy-Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

Overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE identified the evaluation activities used to verify savings for the residential programs. Table 274 provides a summary of the evaluation and M&V approaches used by Penn Power in their PY11 verified savings calculations.

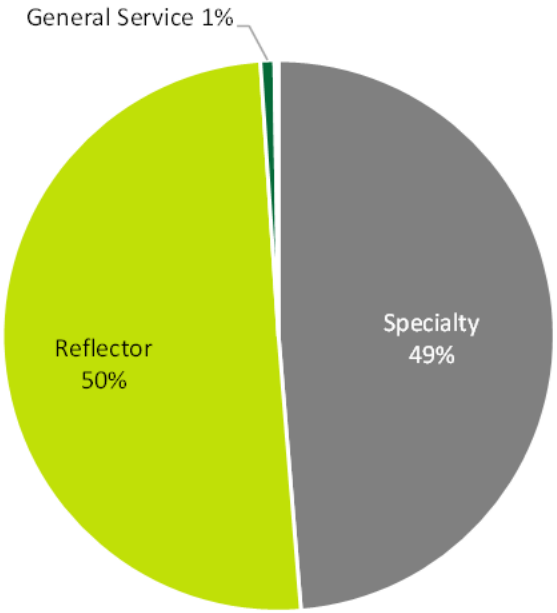
Table 274: Residential Program Evaluation Activities – Penn Power

Program/ Subprogram	Surveys	Site Visits	Desk Review[a]	Billing Analysis
Appliance Turn-In				
Appliance Turn-In (LI & Non-LI)	✓	-	✓	-
EE Homes				
Energy-Efficiency Kits	-	-	-	-
Energy-Efficiency Kits – LI	-	-	-	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	-	-
Residential New Construction	-	-	-	-
Upstream Lighting				
Upstream Lighting	-	-	✓	-
EE Products				
Upstream Electronics	-	-	✓	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliances – LI	✓	-	✓	-
LI WARM				
LI WARM – Extra Measures	-	✓	✓	✓
LI WARM – Multifamily	-	✓	✓	✓
LI WARM – Plus	-	✓	✓	✓

G.5.1.1 Upstream Lighting & Cross-Sector Sales

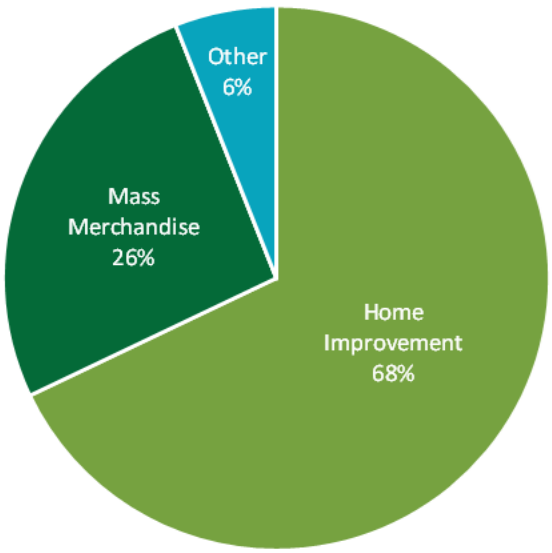
Customers purchased over 56,000 efficient light bulbs and fixtures through Penn Power's PY12 upstream lighting program. Figure 104 displays the distribution of sales by product type. About one-half (49%) of the products were specialty bulbs and the other half were reflectors.

Figure 104: Penn Power PY12 Upstream Lighting Sales by Product Type



Penn Power's PY12 upstream light bulbs and fixtures were sold largely through home improvement (68%) and mass merchandise stores (26%, Figure 105).

Figure 105: Penn Power PY12 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY12 impact analysis for Penn Power's Upstream Lighting Initiative before the PY12 Penn Power Annual Report was submitted to the PUC on November 15, 2021. This allowed time for the SWE to conduct its audit, provide ADM with feedback, and for ADM to adjust the analysis based on this feedback. The SWE agrees with ADM's verified gross savings for upstream lighting.

Cross-Sector Sales

ADM did not conduct cross-sector sales research in PY12 but applied the PY10 cross-sector sales rate 7.1%.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY12 upstream lighting analysis.

G.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.

Energy-Efficient Homes Program

In PY12, the Energy-Efficient Homes program included only the New Homes Initiative. The FirstEnergy Companies did not run the direct install or kit portions of the program in PY12. The SWE noted that the FirstEnergy Companies used an average of PY10 and PY11 results when calculating savings. The realization rates used for calculation were consistent with PY10 and PY11.

Energy-Efficient Products Program

Each component of the EEP Program was audited by the SWE, including appliances, HVAC equipment, and consumer electronics. Note that the SWE's audit of the upstream lighting portion of the EEP Program is reported in Section G.5.1.1 of this appendix.

Analysis files and data sets included in the gross impact data were reviewed for all HVAC, appliance, and consumer electronics measures included in the program. The SWE found that in all cases the correct TRM values and algorithms were used, the verified savings were correct, and the savings and sample sizes included in the annual request data matched those reported in the PY12 annual report.

The Midstream Appliances subprogram includes two measures: ENERGY STAR dehumidifiers and heat pump water heaters. Verification occurred via a review of distributor invoices and the gross impact calculations followed TRM algorithms with specific equipment capacity and efficiency parameters drawn from the ENERGY STAR Qualified Product Lists. Changes to federal standards and ENERGY STAR qualifying criteria in late 2019 complicated the analysis for dehumidifiers. ADM's PY12 verified savings calculations for dehumidifiers aligned with a March 2021 SWE Guidance Memo on the topic. Realization rates for both measures were well over 100% due to the conservative efficiency assumptions used by Penn Power to claim reported gross

energy and demand savings. The SWE audit found the verified savings were well-organized, free of errors, and consistent with Act 129 guidance documents.

LI WARM Program

The LI WARM Program is a LI direct install initiative offering similar measures across three sub-programs: WARM-Plus, WARM-Extra Measure, and WARM-Multifamily. The WARM program includes LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE audited all measures included in the program using the full downstream dataset and the survey sample subset provided by FirstEnergy. The SWE found that the correct TRM-approved methods were followed, survey sample sizes were correct and survey data correctly incorporated into the verified savings calculations, and the verified savings were correct.

Appliance Turn-In Program (LI and Non-LI)

The SWE performed audits on all measures included in the Appliance Turn-In Program, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

G.5.1.3 Behavior

Approximately 23.5% of Penn Power's verified gross energy savings for PY12 came from Home Energy Reports issued to more than 20,000 residential and residential-LI households. The SWE reviewed ADM's methodology and accepts their verified MWh and MW savings values for Penn Power's HER offering in PY12. By cohort, Table 275 shows average kWh savings and average percent savings per participant in PY12. Note that the 'Number of Participants' column shows the average number of participants during PY12.

Table 275: Average PY12 kWh Savings per Participant

Sector	Cohort Start Date	Number of Participants	Average PY12 kWh Savings	Average PY12 % Savings
Low-Income	July 2012	1,713	227	1.88%
Residential	July 2012	15,329	164	1.38%
Low-Income	January 2014	665	376	2.22%
Residential	January 2014	6,163	386	2.26%

The following sections highlight some of the more important audit steps and findings: the calendarization of billing data, group equivalence, duplicating participant counts, the calculation of lag terms, missing eligibility filters, and energy and demand savings.

Calendarization

The first step the SWE team took was to review ADM's calendarized data. "Calendarization" is a process that prorates billing data into a common calendar month basis shared by all accounts. Our review of the calendarized data had three primary components:

- Check the coding of the "pre" and "post" indicator variables;
- Confirm that the calendarized average daily usage values are correct; and

- Confirm that the lag terms (average usage in the pre period, average summer usage in the pre period, average winter usage in the pre period) are correct.

Our team found no issues in the coding of the pre and post indicator variables. Table 276 shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.[79] The distribution of average daily kWh is basically identical in the two data sets.

Table 276: Comparison of Calendarized Data

Variable	Mean	5th Percentile	25th Percentile	75th Percentile	95th Percentile
Average Daily kWh – ADM	36.66	12.21	21.27	45.45	81.00
Average Daily kWh – SWE	36.66	12.21	21.27	45.45	81.00

Regarding the lag terms, the SWE found that ADM's calculations were sound. ADM did not calculate summer or winter lag terms in cases where pre period summer or winter data did not exist. Because we found no issues with ADM's calendarized data, the figures, tables, and summary statistics presented herein were created or calculated using ADM's calendarized data rather than our own.

Group Equivalence

After reviewing the calendarization, the SWE compared average daily consumption (kWh) between the treatment and control groups during the pre-treatment period. Table 277 shows the results for each cohort. Note that calendarized data was used to calculate the averages and any customer without at least 12 month of pre-treatment data was dropped. To avoid comparing averages calculated over different time spans (e.g., 14 months and 12 months), averages within each month were calculated before calculating overall averages for each customer. The 'P-value' column indicates the likelihood that the observed differences could happen by chance if the two experimental cells use the same amount of energy, on average. A p-value less than 0.05 indicates that the difference in average consumption between the two groups is statistically significant. The January 2014 Low-Income cohort was the only group to have statistically significant pre-treatment differences between the treatment and control groups. In some prior years, differences for this cohort were not statistically significant, but customers move over time and the make-up of the experimental cells changes. The impact estimation method accounts for the differences in pre-treatment consumption.

[79] The table only summarizes PY12 records.

Table 277: Group Equivalence in the Pre-Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
Low-Income	July 2012	35.4	35.6	0.59
Residential	July 2012	35.7	35.5	0.21
Low-Income	January 2014	52.5	50.1	0.01
Residential	January 2014	50.4	50.4	0.96

Participation Counts

The SWE team leveraged the raw billing data to audit participant counts. Because billing cycles can exceed 31 days in length (meaning bill dates can occasionally skip over a month), the SWE team calculated the number of unique IDs beyond a certain bill date. As an illustrative example, suppose we wanted to compute the number of participants in Penn Power's 2012 LI cohort for March of 2021. We removed any households with a billing end date prior to 3/1/2021, then counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Table 278: Participant Counts by Month and Cohort

Month	July 2012 LI	July 2012 Residential	January 2014 LI	January 2014 Residential
Jun-20	1,760	15,664	677	6,324
Jul-20	1,748	15,585	674	6,286
Aug-20	1,740	15,525	673	6,254
Sep-20	1,732	15,456	672	6,213
Oct-20	1,719	15,388	671	6,183
Nov-20	1,708	15,330	667	6,162
Dec-20	1,704	15,276	665	6,138
Jan-21	1,698	15,239	659	6,120
Feb-21	1,695	15,194	656	6,105
Mar-21	1,694	15,159	656	6,079
Apr-21	1,682	15,102	653	6,057
May-21	1,670	15,032	651	6,029

Eligibility Filters

The LS regression model is a post-only model – only records from the post period are used in the regression. That said, some of the explanatory variables in the model are calculated based on pre period data: (1) average daily consumption in the pre period, (2) average daily consumption during the summer in the pre period, and (3) average daily consumption during the winter in the pre period. For a number of homes, there was not enough pre period data to calculate these lag terms. In PY12, ADM dropped any homes without 12 months of pre period data from the LS model. The monthly impact estimates derived from the model were then applied to the homes

with insufficient pre period data. There is no evidence to suggest that homes without sufficient pre period data are systematically different from homes with sufficient pre period data. The SWE believes this is the correct approach.

Impact Coefficients and Energy Savings

Figure 106 through Figure 109 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY12. Only homes active in PY12 are included in the "pre period" portion of the figure. As has been noted, the regression model used to estimate the impact of the HER program has daily usage controls for potential pre period differences.

Figure 106: July 2012 LI Cohort Usage Comparison

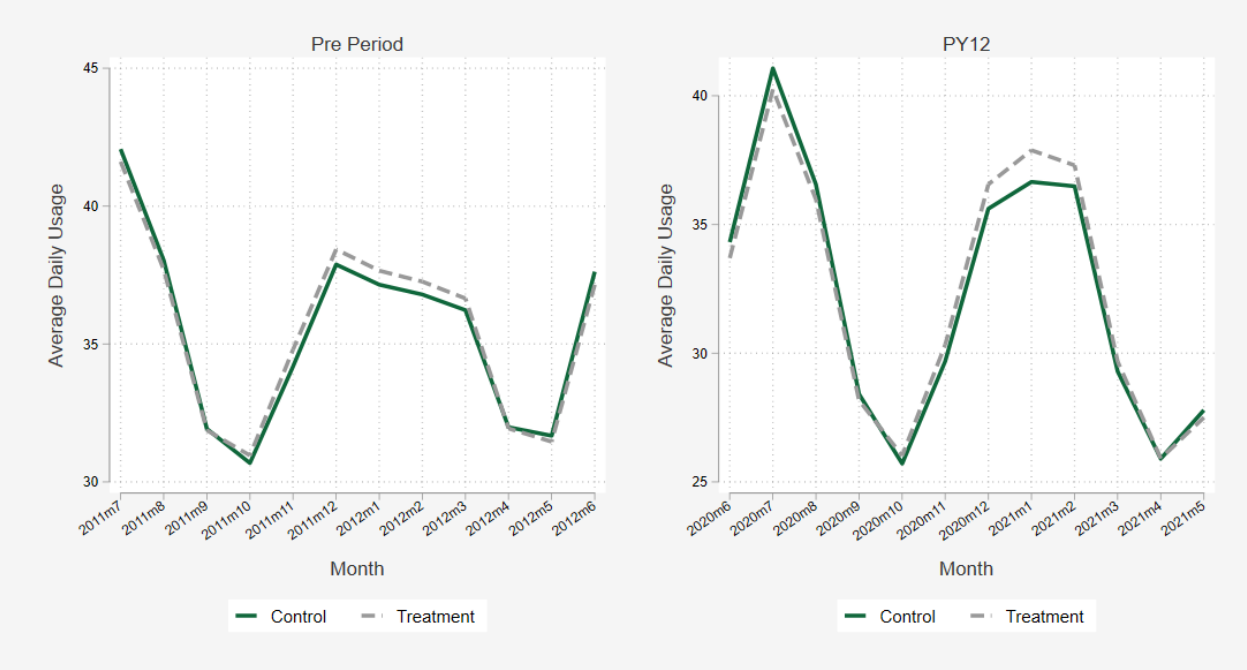


Figure 107: July 2012 Residential Cohort Usage Comparison

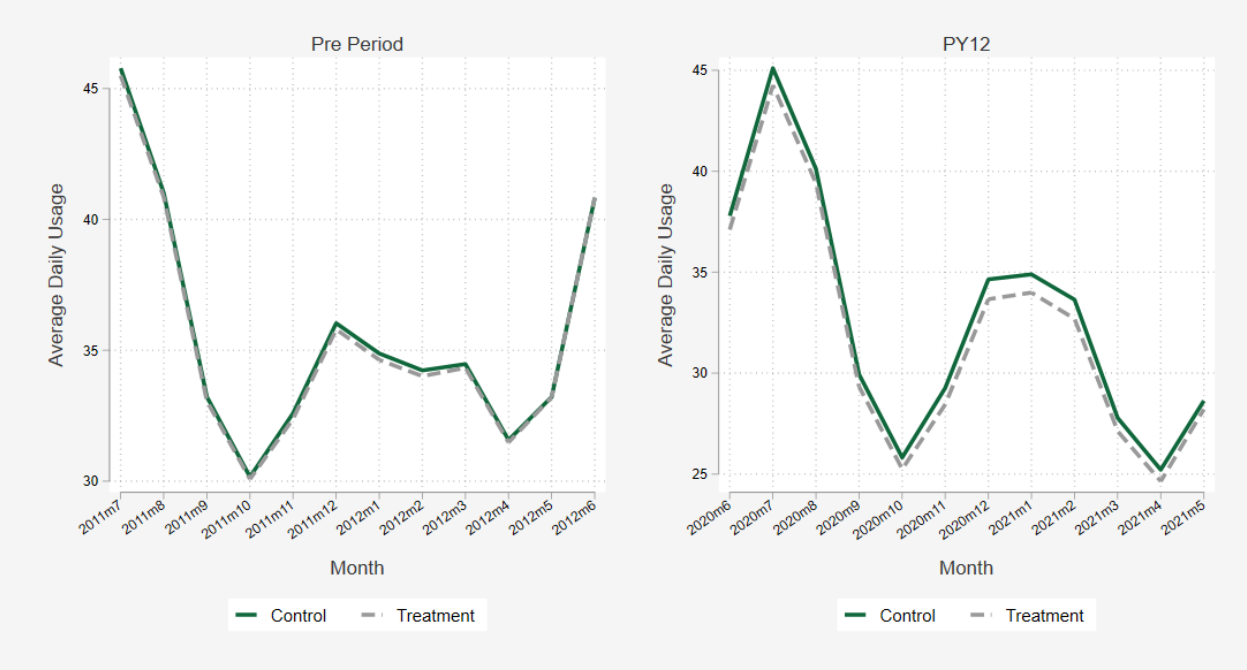


Figure 108: January 2014 LI Cohort Usage Comparison

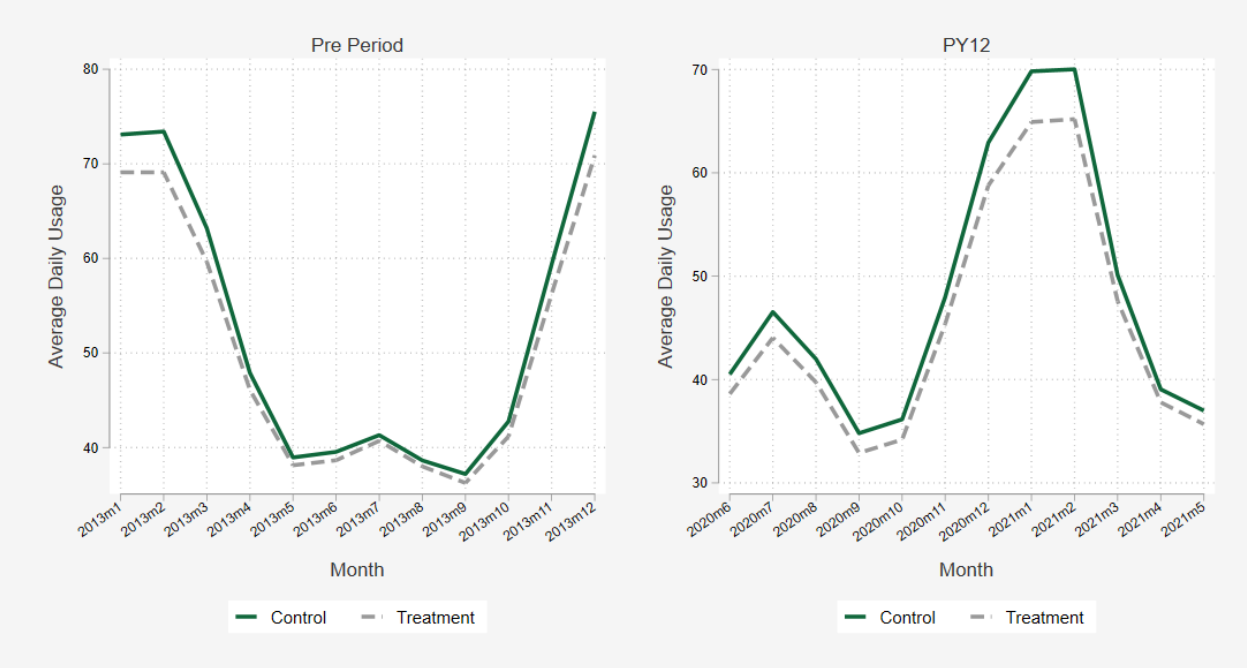


Figure 109: January 2014 Residential Cohort Usage Comparison

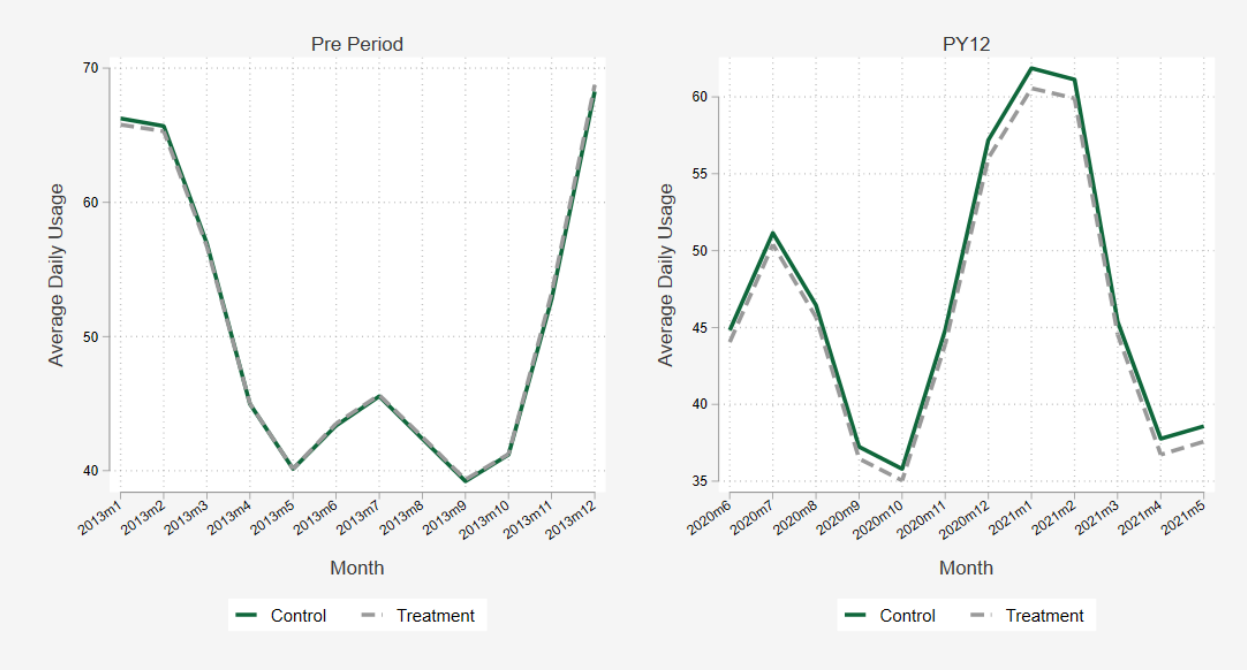


Table 279 shows PY12 impact estimates for each cohort. Note that a different impact estimate was calculated for each month in PY12 – the estimates shown in the table reflect the averages of the PY12 monthly estimates (weighted by month duration). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the LI July 2012 cohort saved 0.17 kWh per day, on average, during PY12.

Table 279: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
Low-Income	July 2012	(0.17)	(0.17)
Residential	July 2012	(0.54)	(0.54)
Low-Income	January 2014	(0.99)	(0.99)
Residential	January 2014	(1.15)	(1.14)

To account for dual participation, savings are reported after adjusting for downstream measures and upstream measures. HER programs promote other energy-efficiency & conservation programs, creating a situation where treatment group homes participate in other energy-efficiency & conservation programs at a higher rate than control group homes. Therefore, there is incremental kWh savings in the regression analysis that must be subtracted from the HER impacts to avoid double-counting. ADM identified energy-efficiency program participation that occurred from each cohort's treatment start date onwards to calculate the downstream adjustment factor. The upstream reduction factor for each cohort varies depending on the number of years passed

since the cohort's respective start date. Because all the cohorts had a start date at least four years before PY12, the upstream reduction factor for all cohorts is 3%.

Using the impact estimates shown above, Table 280 shows ADM's and the SWE's aggregate energy savings (MWh), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 280: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE-ADM)
Low-Income	July 2012	389	388	(1)
Residential	July 2012	2,515	2,516	1
Low-Income	January 2014	250	250	0
Residential	January 2014	2,381	2,379	(2)
Total		**5,535**	**5,533**	**(2)**

Demand Savings

Table 281 shows ADM's and the SWE's aggregate peak demand savings (MW), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

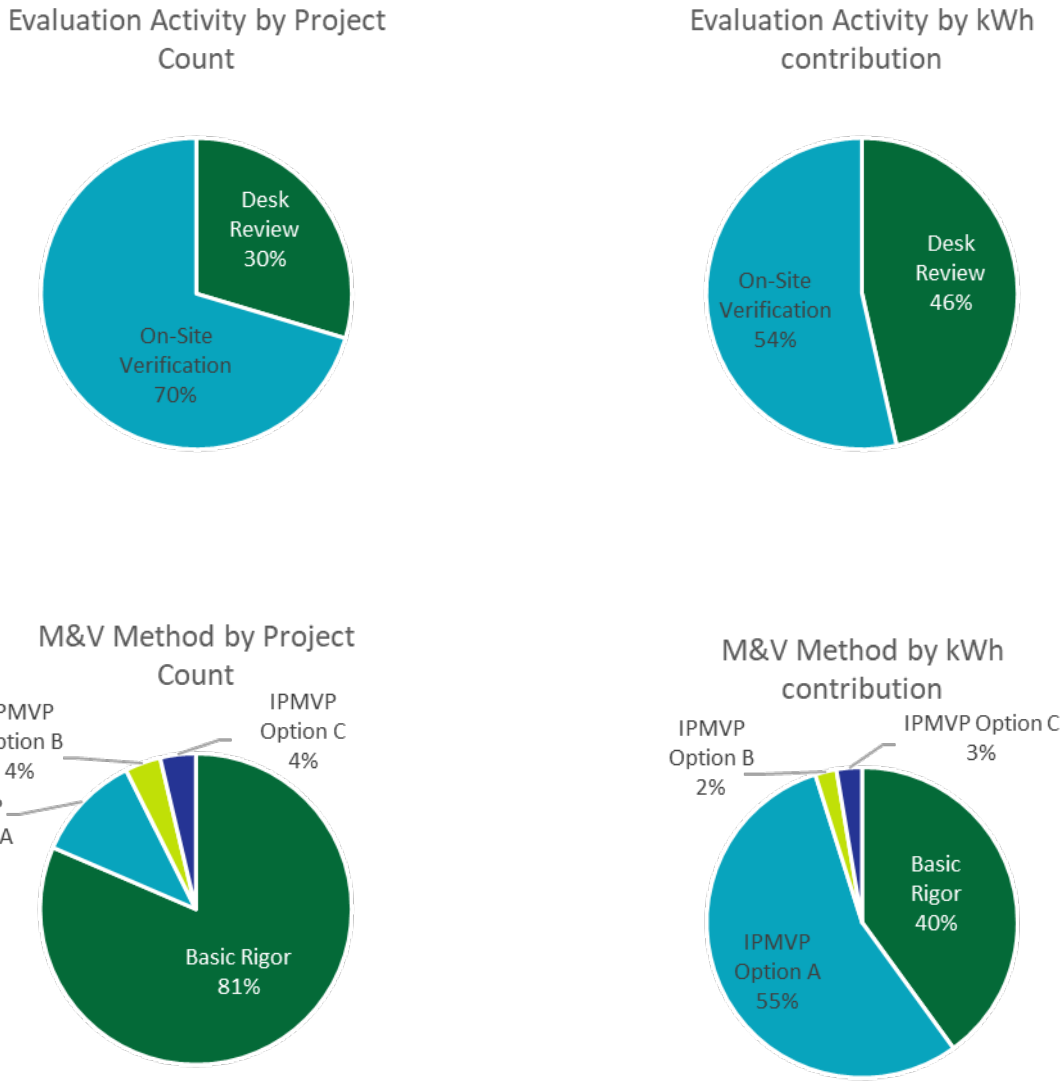
Table 281: Demand Savings Comparison

Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE-ADM)
Low-Income	July 2012	0.04	0.04	0.00
Residential	July 2012	0.28	0.28	0.00
Low-Income	January 2014	0.03	0.03	0.00
Residential	January 2014	0.27	0.27	0.00
Total		**0.62**	**0.62**	**0.00**

G.5.2 Non-Residential Audit Activities

Figure 110 provides a summary of the evaluation activities and M&V approaches utilized by Penn Power's evaluation contractor, ADM, in their PY12 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY12, Penn Power's evaluation contractor completed site visits to 70% of projects, and these projects represented 54% of total evaluated energy savings. A total of 19 site visits were conducted. IPMVP Options A, B, and C were employed for the majority (60%) of total evaluated energy savings. Basic Rigor (verification only) was employed for all prescriptive projects and all but two evaluated lighting projects.

Figure 110: Summary of Penn Power's C&I Evaluation Activities



Penn Power's evaluation contractor conducted sampling within defined evaluation initiatives. Measures across Penn Power's C&I programs are assigned to one of five evaluation initiatives, as Penn Power's programs target specific sectors of C&I customers, but offerings are often identical across the programs. Table 282 provides a summary of the evaluation activities Penn Power's evaluation contractor used across strata for all projects by initiative.

Table 282: Summary of Penn Power's PY12 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	On-Site Verification
Appliance Turn-In	**0**	**100%**	**0**	**0**
Custom	**3**	**98%**	**2**	**1**
Custom – 1	1	89%	-	1
Custom – 2	-	-	-	-
Custom – Certainty	2	100%	2	-
Direct Install	**0**	**95%**	**0**	**0**
Lighting	**18**	**96%**	**0**	**18**
Lighting – 1	5	114%	-	5
Lighting – 2	7	81%	-	7
Lighting – 3	2	108%	-	2
Lighting – Certainty	4	101%	-	4
Prescriptive	**6**	**98%**	**6**	**0**
Prescriptive – 1	6	98%	6	-
Prescriptive – 2	-	-	-	-
TOTAL	**27**	**97%**	**8**	**19**

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

G.5.2.1 Appliance Turn-In Initiative

In PY12, Penn Power's Appliance Turn-In Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the average of respective PY10 and PY11 realization rates.

G.5.2.2 Custom Initiative

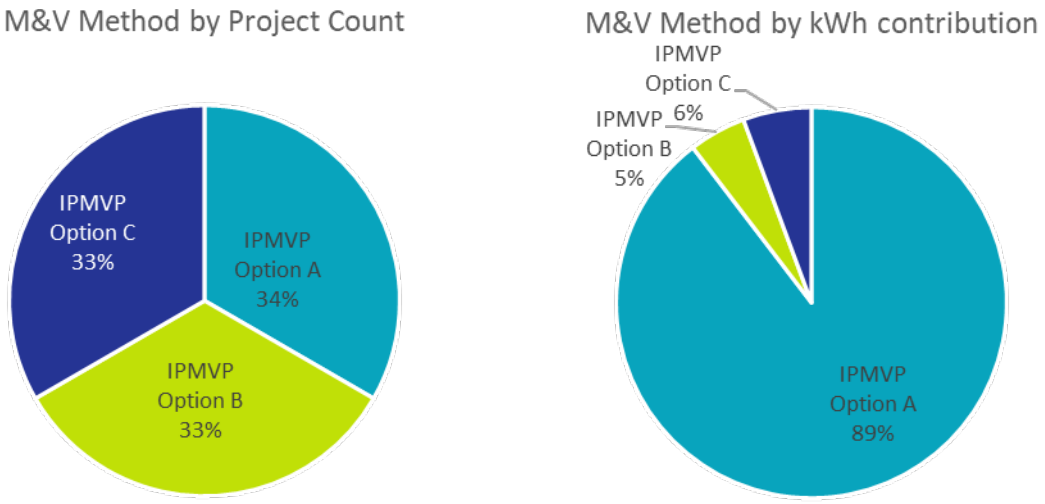
Evaluation activities for this initiative include desk reviews, site visits, and/or IPMVP Options for all sampled projects. Site visits are always conducted for larger projects unless the evaluation can be satisfactorily conducted remotely using data provided by the customer (EMS data, billing data, etc.). 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 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 3-2 of the Phase III Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. IPMVP Option A was employed to evaluate 89% of savings in the sample, as shown in Figure 111.

Figure 111: Summary of Penn Power's C&I Custom Program M&V Methods



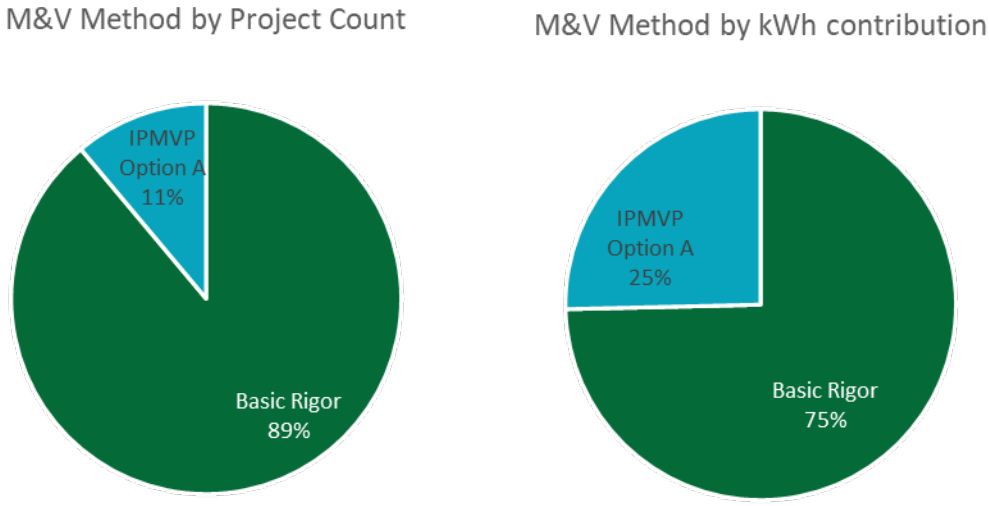
G.5.2.3 Lighting Initiative

Evaluation activities for this initiative include site visits and primary data collection of lighting hours of use for medium and high savings projects. TRM deemed hours of operation and a basic rigor method were applied 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 four strata for projects in the Lighting initiative. The largest projects, with ex-ante savings estimates of 750 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.

Majority of evaluated project savings in the lighting initiative for PY12 were evaluated using basic rigor (75%) while remaining, larger lighting projects were evaluated using IPMVP Option A, as shown in Figure 112.

Figure 112: Summary of Penn Power's C&I Lighting Program M&V Methods



G.5.2.4 Prescriptive Initiative

Evaluation activities for this initiative include desk reviews and basic rigor application of TRM-based savings calculation methodologies. None of Penn Power' prescriptive projects received a site-visit this program year.

Penn Power's evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 20 MWh of annual energy savings. All the PY12 sampled projects were in the Prescriptive-1 stratum, meaning no sampled project reached the savings threshold.

IPMVP-based methods were not employed for this initiative. All projects were evaluated using basic rigor desk reviews.

G.5.2.5 Direct Install Initiative

In PY12, Penn Power's Direct Install Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the PY11 realization rates, as the program had no participation in PY10.

G.5.2.6 Ride-Along Site Visits

The SWE audited the activities above through a combination of Ride-Along Site Visits (conducted both in person and virtually) and Desk Reviews. The details of the SWE's findings are presented in the following subsections.

Table 283 provides an overview of the SWE milestones for the audit of Penn Power's site inspection efforts.

Table 283: Penn Power Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Attainment Percentage
2	440,465	2	2	100%

Overall, the SWE agreed with the methods of calculation employed by Penn Power's evaluation contractor. The calculations and accompanying reports were easy to follow and showed evidence that methods were being reasonably applied. The SWE agreed with all engineering decisions made by the evaluators. The SWE's energy savings of the two projects with ride-along audits reached a 100% attainment percentage of the evaluator's energy savings.

G.5.2.7 Verified Savings Desk Reviews

Table 284 provides an overview of the SWE milestones for the verified savings review of evaluated Penn Power projects.

Table 284: Penn Power Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
2	4,597,167	469	100%	100%

Overall, the SWE found that Penn Power's evaluation contractor, ADM, demonstrated general adherence to the TRM for prescriptive lighting measures and employed sound engineering methods for the custom project in review. The overall energy and demand savings attainment percentages of Penn Power's reviewed projects were 100% for both energy and demand savings.

G.6 DR

According to the Phase III Implementation Order, Penn Power's Phase III demand response (DR) compliance target is 17 MW. Note that compliance is determined based on the average MW performance across events during the second, third and fourth program years consistent with the Commission's Order entered on June 3, 2020 amending the original implementation order. This amendment permitted EDCs to operate the approved DR programs on a voluntary basis for the fifth and final year of the program with results not counted toward compliance goals. The PY12 results of the DR program provided below are based on voluntary customer participation. Additionally, DR goals are assessed at the system level, meaning that line loss adjustments are applied to the load impacts measured at the customer meter.

Decisions about which day DR events are called are guided by a set of prescriptive directions issued by the PUC in the Phase III Implementation Order and Clarification Order[80]. Penn Power called DR events on the five days those guidelines required during summer 2020.

In PY12, Penn Power had active DR programs in both the residential and C&I customer classes. On the C&I side, there were nine participants – all were categorized as large C&I sites. The residential behavioral demand response (BDR) component had approximately 30,000 homes in the treatment group, though this number declined throughout the summer.

Table 285 shows Penn Power's performance across the five events during the 2020 DR season, as well as the average performance during the season, the Phase III-to-date performance, and the value with which compliance will be evaluated (the average MW performance across events from PY9 to PY11). The evaluation team identified a slight error in the Phase III-to-date calculation, that we recommend be adjusted in the July semi-annual report and November final annual report.

Table 285: Penn Power Performance by Event

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Energy-Efficient Homes (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	0.0	4.5	1.6	6.1 ± 4.8
July 27, 2020	15	18	0.0	7.3	1.7	9.0 ± 5.7
July 29, 2020	16	19	0.0	7.5	1.6	9.1 ± 6.0
August 25, 2020	15	18	0.0	14.3	1.4	15.7 ± 11.8
August 27, 2020	16	19	0.0	16.8	1.5	18.2 ± 12.8
PYVTD - Average PY11 DR Event Performance						**11.6 ± 4.0**
VTD - Average Phase III DR Event Performance						**32.0 ± 6.6**
Compliance Value – Average DR Event Performance from PY9 to PY11						**39.9 ± 8.8**

The Penn Power/ADM team also submitted a response to the SWE DR data request. The elements of this response included the following:

- A data set that provided the top three CBLs for each C&I participant and the relative root mean square error (RRMSE) for each CBL/participant combination;
- For each event hour, a record of which C&I facilities participated, their reference load, metered load, and verified DR impact;
- For five C&I sites selected by the SWE, the hourly load data needed to replicate the ADM impact estimates. Note that these five sites accounted for approximately 87%

[80] Pennsylvania Public Utility Commission, Energy Efficiency and Conservation Program Implementation Order, at Docket No. M-2014-2424864 (Phase III Implementation Order), entered June 11, 2015. https://www.puc.pa.gov/pcdocs/1367313.doc
Pennsylvania Public Utility Commission, Phase III Clarification Order, at Docket No. M-2014-2424864, entered August 20, 2015. https://www.puc.pa.gov/pcdocs/1378016.doc

of Penn Power's C&I gross verified PY12 DR impacts. This workbook also mapped each facility to a weather station and flagged shutdown days and days in which the facilities were active in PJM;

- Historical weather data that was used in creating weather sensitive adjustments;
- Hourly load and weather data for approximately ~50,000 residential accounts (~30,000 treatment group accounts and ~20,000 control group accounts); and
- A map that indicated which residential accounts belonged to which experimental cell.

The data request response and a few follow-up emails formed the basis of the SWE audit activities – which are described in this section. The SWE found the approaches implemented by ADM to be well-aligned with the Evaluation Framework and consistent with industry best-practice. The execution of the analysis was thorough and free of errors. The SWE team agrees with the PY12 gross verified savings.

G.6.1 Replicate Program Totals

Penn Power's C&I DR program had nine participants and nearly all the demand savings produced by this program came from five of the nine participants. ADM's verified gross peak demand savings generated by these sites are shown in Table 286. Note that these values are adjusted for line losses (by a multiplier of 1.0545). For each DR event hour during the 2020 DR season, the SWE was provided with the metered load and CBL for each participant. Using this data, the SWE was able to replicate the PYVTD gross MW for both components of the C&I DR program. Table 286 also shows ADM's verified gross peak demand savings for the residential BDR component (adjusted for line losses by a multiplier of 1.0949).

Table 286: Penn Power DR Savings

Program	PYVTD Gross MW
C&I – Small	0.0
C&I – Large	10.1
Energy-Efficient Homes	1.5
Total	**11.6**

G.6.2 Residential BDR

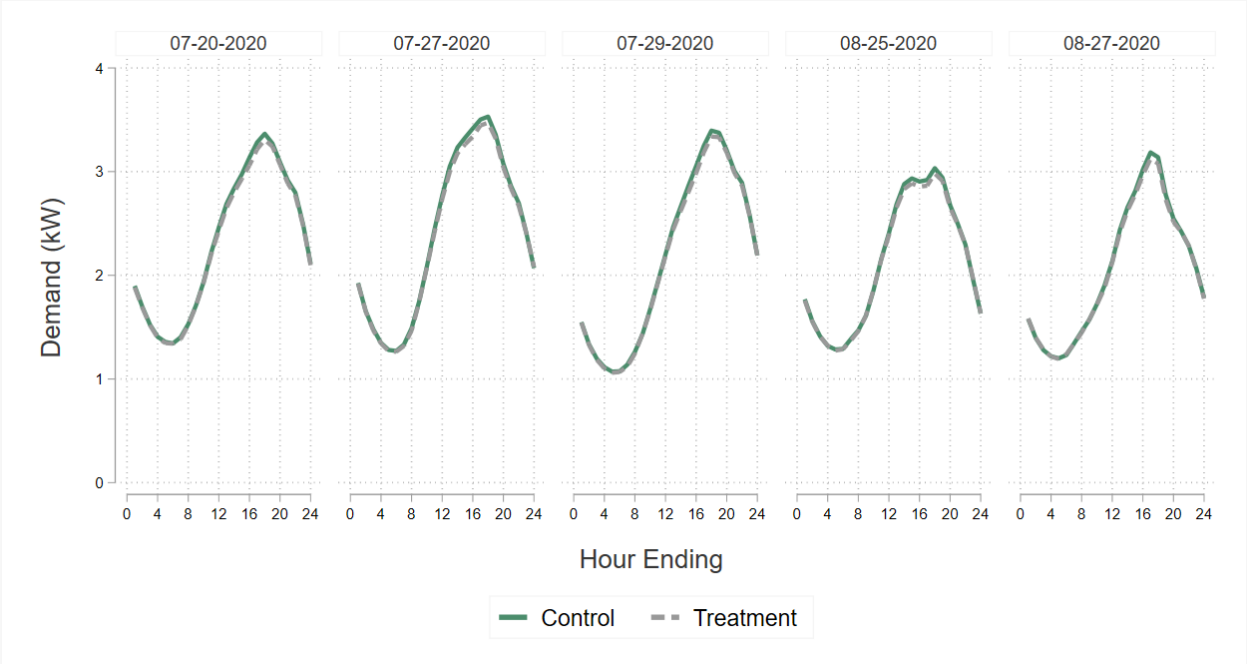
Penn Power's behavioral DR program operates as a randomized control trial – customers were randomly selected and placed into control and treatment groups. As of the beginning of the 2020 summer DR season, there were 30,626 premises in the treatment group and 19,569 premises in the control group. Some of these homes were added in 2017, some in 2019, and the rest were added in 2020. Table 287 shows counts by start date as of the beginning of the 2020 DR season. At the end of the DR season, these numbers were 29,645 and 18,927 respectively.

Table 287: Residential BDR Customer Counts

Date Added	Active Treatment Accounts	Active Control Accounts
5/24/2017	23,862	15,280
5/22/2019	3,600	2,277
5/18/2020	3,164	2,012
Total	**30,626**	**19,569**

Prior to the DR events, homes in the treatment group are notified of a pending DR event by the program's ICSP with the expectation that customers will curtail load during the event itself. The means by which load curtailment is achieved isn't obvious, though ADM notes that the ICSP is involved in participant education and coaching. On average, load reductions are not very big – approximately 0.04 kW per home, which is about 2% of household demand during peak hours on peak days. For an illustration of the load shed in PY12, see Figure 113. In this figure, control group and treatment group loads for each PY12 DR event day are compared. The impact is small but separation between the experimental cells can be seen in the late afternoon. With over 30,000 homes in the treatment group, small impacts add up.

Figure 113: Penn Power Residential BDR



G.6.2.1 Group Equivalence

The first step the SWE team took was to assess the equivalence between the treatment and control groups in the baseline period (the 30 days prior to notifying treatment group homes of their selection). Figure 114 shows the average hourly load profiles for the two experimental cells in each cohort during the baseline periods. Note the customers added in 2020 have a different baseline period than the customers added in 2017 and 2019, but all periods straddle April and

May. As can be seen, the two groups used energy in the baseline period in an approximately identical fashion.

Figure 114: Penn Power Baseline Equivalence

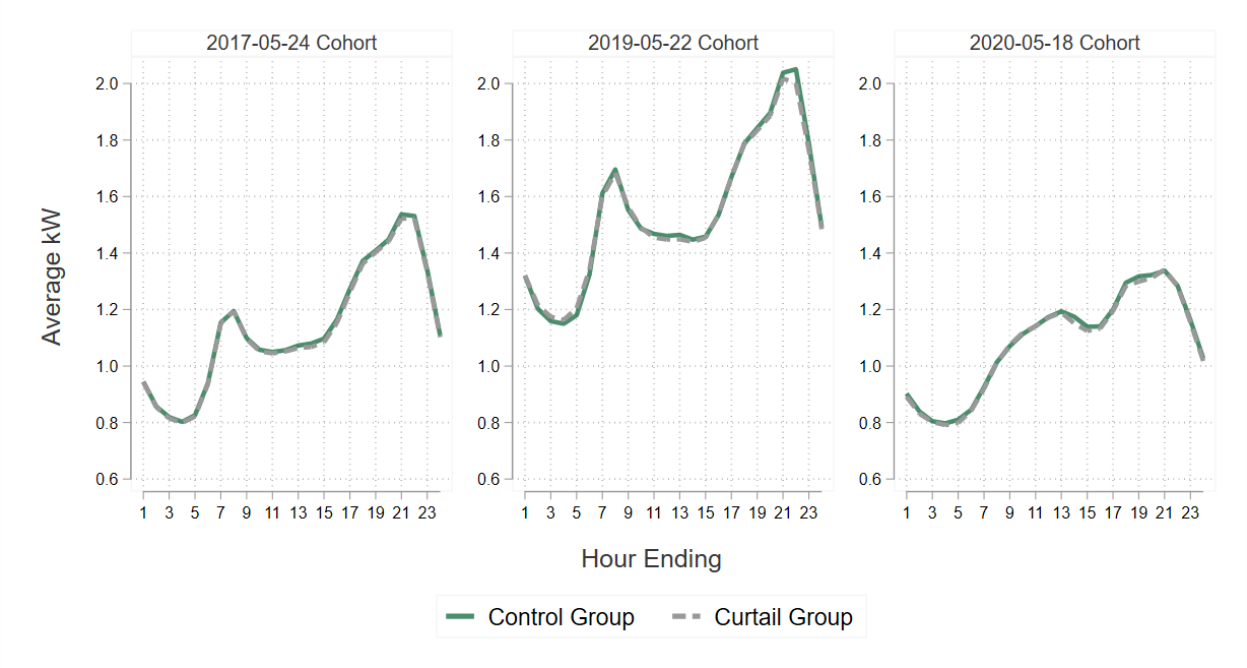


Table 288 shows average daily kWh for the control and treatment groups during the baseline period. A significance test suggests the difference between mean daily consumption values is not statistically significant (p-value = 0.27). The table also shows the average demand for the two groups during common event hours. Like the average daily kWh values, the difference between the average demand values is not statistically significant (p-value = 0.12).

Table 288: Equivalence Check

Group	Average Daily kWh	Average kW During Event Hours
Control	28.12	1.26
Treatment	27.97	1.25
Combined	**28.03**	**1.26**

G.6.2.2 Impact Estimation

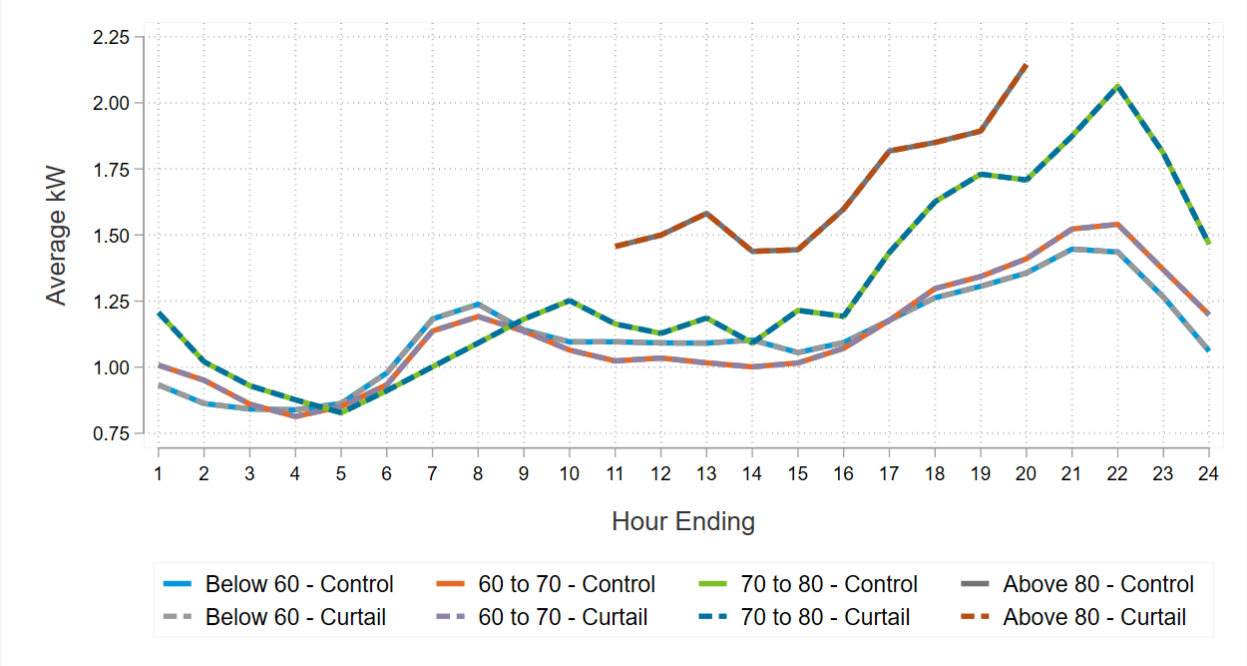
Savings calculations for the residential BDR component relied on a control group comparison and regression modeling. The regression model only used data from event hours on event days. Explanatory variables included date and hour fixed effects, an interaction between the treatment indicator variable and the date/time fixed effects, and three lag variables. The lag variables are customer-specific constants calculated based on consumption over a 30-day period that spanned April and May of 2017 and April and May of 2019 for the first two cohorts. For the 2020 cohort, the baseline period was extended longer than 30 days, from 4/1/2020-5/17/2020, because there

were no days in which the 2:00 PM – 6:00 PM window fell into the 70 to 80-degree range. Steps taken in producing these lag variables are as follows:

- Limit the load data to 2:00 PM – 6:00 PM on non-holiday weekdays;
- Create three temperature bins: 60 to 70 (no cooling), 70 to 80 (medium cooling), and above 80 (high cooling); and
- In each temperature bin, calculate average load for each customer.

Figure 115 compares May weekday (non-holiday) usage in the treatment and control groups for the three bins (plus a fourth bin – temperature below 60) discussed above. The figure shows all hours rather than just common event hours. The main takeaway from this figure is that the treatment and control groups were, on average, hardly distinguishable in terms of hourly load profiles. (Gaps in the plot can be explained by the fact that the temperature never exceeded 80 during some hours of the baseline period.) Additionally, and perhaps as one would expect, overall usage increases in the higher temperature bins. Because the control group homes and treatment group homes were exposed to the same weather conditions, temperature itself was not included as an explanatory variable in the model.

Figure 115: Usage by Temperature Bin



G.6.2.3 Findings

Table 289 shows the relevant per participant impacts s (treatment effect by hour and date), participant counts, and aggregate impacts. Note that neither the per participant impacts nor the aggregate impacts are adjusted for line losses in this table. The practical interpretation of the first per participant impact in the table (0.029) is that average demand in the treatment group was

about 0.03 kW lower than the average control group load (after controlling for date, time, and the customer-specific usage patterns captured by the lagged variables). The SWE tested the robustness of these per participant impacts with a few other regression model specifications and found the results to be robust.

Table 289: Regression Output and Participant Counts

Date	Participants	Hour	Per Participant Impact (kW)	Aggregate Impact (MW)
7/20/2020	30,208	15	0.029	0.88
		16	0.058	1.77
		17	0.051	1.54
		18	0.042	1.28
		Event Average	**0.045**	**1.37**
7/27/2020	30,156	15	0.047	1.41
		16	0.061	1.85
		17	0.040	1.20
		18	0.041	1.25
		Event Average	**0.047**	**1.43**
7/29/2020	30,140	16	0.053	1.59
		17	0.047	1.42
		18	0.042	1.26
		19	0.026	0.79
		Event Average	**0.042**	**1.26**
8/25/2020	29,923	15	0.033	1.00
		16	0.034	1.02
		17	0.040	1.21
		18	0.037	1.12
		Event Average	**0.036**	**1.09**
8/27/2020	29,907	16	0.039	1.17
		17	0.049	1.46
		18	0.044	1.33
		19	0.030	0.89
		Event Average	**0.041**	**1.21**

The average aggregate impact across the 20 event hours was -1.27 MW. Multiplying this value by Penn Power's line loss multiplier for residential customers (1.0949) yields an average savings estimate of 1.4 MW per event hour. This is slightly less than the PYVTD gross MW value calculated by ADM (1.5 MW), but the difference could be attributable to rounding (and the value calculated by ADM is certainly within the confidence bands of the value calculated by the SWE).

G.6.3 C&I

G.6.3.1 Reference Load Selection

ADM's CBL selection method was thoughtful and relied on non-event day testing. At a minimum, the following CBLs were considered for each participant:

- PJM high 4-of-5 with weather sensitive adjustment (WSA) and weekday specific options;
- High 6-of-7 with WSA and weekday specific options; and
- 10-of-10 with WSA and weekday specific options.

From the list above, the top three CBLs for each participant were selected. The basis for "top three" was the lowest relative root mean square error (RRMSE) on non-event, non-holiday, non-shutdown weekdays. On event days, a weighted average of these three CBL types was used in creating the actual CBL. The weights, in this case, were equivalent to the inverse squares of the RRMSEs. For a hypothetical event hour, Table 290 provides an illustration.

Table 290: CBL-of-CBLs Illustration

CBL Type	CBL (kW)	Non-Event Day RRMSE	Inverse Square of RRMSE	Weight
10-of-10	1,100.0	7.1%	198.37	35.7%
10-of-10 with WSA	1,200.0	7.2%	192.90	34.7%
20-of-20	1,300.0	7.8%	164.37	29.6%

Thus, the CBL-of-CBLs value would be: 1,100*0.357 + 1,200*0.347 + 1,300*0.296 = 1,193.90.

G.6.3.2 Weather Sensitive Adjustments (WSAs)

Several of the baseline types ADM considered involved a weather sensitive adjustment (which can be positive or negative). The WSA is a function of three terms: the temperature during the event hour, the average temperature during the same hour across days in the CBL lookback window, and the participant-specific WSA coefficient. Respectively, think of these components as X, Y, and Z. The WSA was then calculated as follows:

$$WSA = Z * (X - Y)$$

Regarding the participant-specific WSA coefficient, this value was derived as follows:

- Map each participant to a weather station. Merge weather data with load data;
- Keep days between 6/1/2020 and the last day of the DR season for PY12 (which occurred on 9/30/2020);
- Drop any holidays, event days, shutdown days, or weekends;
- Keep only the hours when events were called on event days;
- Calculate the average load and average temperature during the event window for each day in the data set. Drop any days where the average temperature during the event window is less than 75 degrees (F);

- Using the averages calculated in the previous step, run a simple linear regression model with load as the response variable and temperature as the explanatory variable; and
- The regression coefficient for the temperature variable is the WSA coefficient. The coefficient represents the expected change in kW per a one-degree increase in temperature (F).

This WSA calculation differed slightly from last year, as previously days were kept between the first day of the DR season and the last event day of the season, instead of the last day of the DR season. Using the whole DR season to construct these WSAs gives a better picture of weather sensitivity and is not a cause for concern.

The WSA is only applied if the outdoor air temperature exceeds 75 degrees. Additionally, two distinct WSA coefficients were calculated for each participant. In PY12, two events started and ended an hour later than the others. ADM calculated separate WSA coefficients for the event that started an hour later, with the logic being that the relationship between load and temperature varies by time of day.

G.6.3.3 Findings

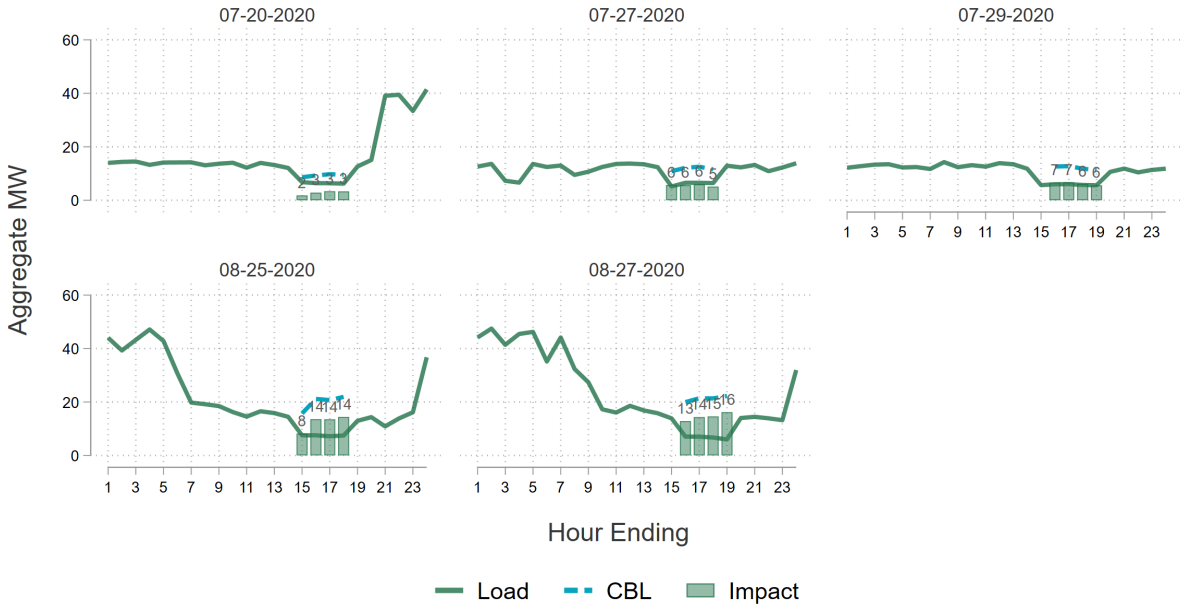
For the five sites in our sample, the SWE was able to reproduce all inputs for four of them. The other customer presented a slight deviance from the savings calculations produced by ADM, due to an issue with the reporting of their shutdown days. This only affects the savings produced for the SWE sample by 0.05 MW, which is likely due to differences in the RRMSEs provided and the RRMSEs used by ADM for this customer. But overall, it leaves the savings for the full Penn Power program at 10.1 MW. Table 291 provides a summary of these results.

Table 291: Penn Power C&I DR Audit Summary

Group	Count	Gross MW Impact - ADM	Gross MW Impact - SWE	% of Total Savings
In SWE Sample	5	8.7	8.8	86.6%
Not in SWE Sample	4	1.4	-	13.4%
Total	**9**	**10.1**	**-**	**100%**

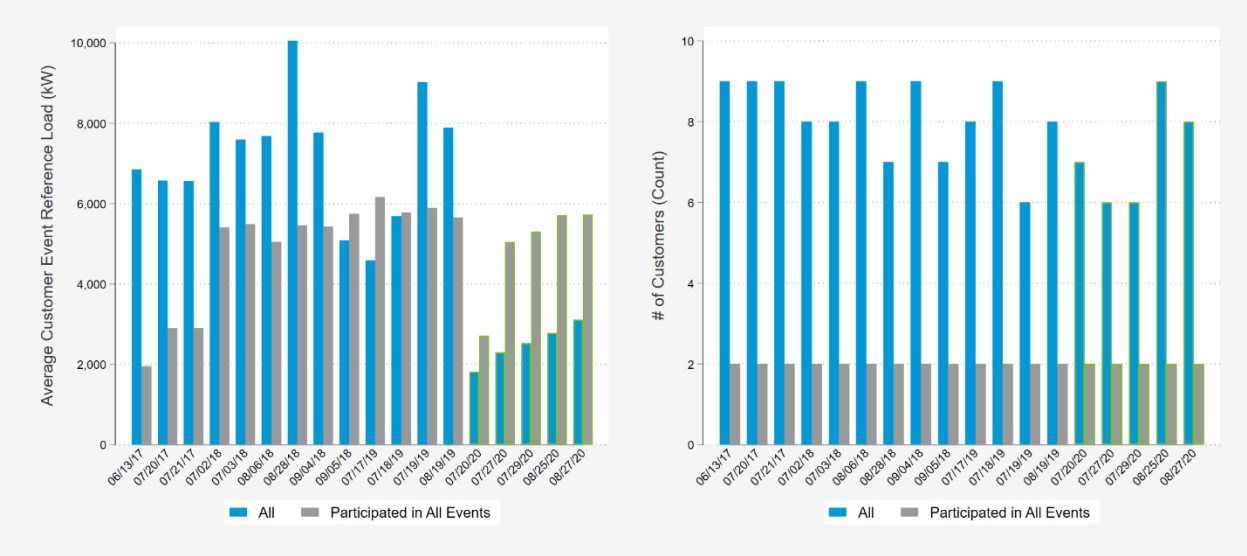
By event day, Figure 116 shows the aggregate load, CBL, and DR impacts (expressed as positive values) for the five sites in the SWE sample. Note these loads and impacts are not adjusted for line losses. Recall that these are large commercial customers. As such, the loads are volatile. Still, the load shed is obvious on all event days, and the CBL-of-CBLs is reasonable.

Figure 116: Aggregate Load, CBL, and Impacts for Sampled Sites



Looking at the average customer reference load on event days in Figure 117, Penn Power appears to have a substantial change in PY12, which is highlighted by the blue bars outlined in green on the left panel. In fact, the average event day reference load for participants in PY12 decreased about 63 percent from PY11. A similar trend appears for the subset of customers that participated in all events across the four program years. This is highlighted by the gray bars outlined in green on the left panel. On the right panel, the number of participants for each event across the four program years is seen as being fairly consistent since the program is made up of a small number of large C&I customers. This leads to the change in average event day reference load to likely be from impacts of the COVID-19 pandemic.

Figure 117: The Impact of COVID on Reference Loads



G.6.4 Conclusion

The SWE agrees with the baseline selection procedures and found no errors in the calculations for four of the five C&I sites examined. For the other site, an issue with shutdown days marginally impacted the savings calculations. The savings calculations for the full program remained unchanged, even with the error. For the residential BDR component, the ADM team leveraged a lagged seasonal model, which the SWE views as a reasonable approach. Our audit uncovered no issues in ADM's residential BDR analysis. The SWE recommends that the Commission adopt the Penn Power/ADM verified savings.

G.7 NTG

G.7.1 Residential Programs

ADM and Tetra Tech did not conduct any new NTG research for residential programs during PY12.

Tetra Tech assigned the HERs component of the program an NTG of 1, in accordance with the Evaluation Framework, and was not informed by participant surveys, but assumes that the RCT design eliminates free-ridership and produces negligible SO.

The PY11 NTG was assigned to the HVAC and Residential Appliances Program and the PY10 NTG was assigned to the Appliance Turn-in Program, the Direct Install Program, the New Homes Program, and the Upstream Programs, as was stated in the Evaluation Plan.

The SWE determined that Tetra Tech utilized data collection, question bevies, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 292: Summary of NTG Estimates for Penn Power Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Appliance Turn-In	0.49	0.0	0.51	-
Program not active in PY12	Energy-Efficiency Kits	-	-	-	-
RCT	HERs	-	-	1	-
PY10	Direct Install	0.19	0.20	1	-
PY10	New Homes	-	-	0.73	-
PY10	Upstream Lighting	0.74	0.0	0.26	-
PY10	Upstream Electronics	-	-	0.58	-
PY11	HVAC	0.53	0.08	0.55	-
PY11	Residential Appliances	0.56	0.12	0.56	-

G.7.2 LI Residential Programs

Tetra Tech assigned LIEEP including LI Residential Appliances and Initiatives, LI Residential Appliance Turn-in, LI Direct Install, and LI Energy-Efficiency Kits a NTG of 1, in keeping with the PY12 Evaluation Plan and SWE Phase III Evaluation Framework.

G.7.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY12. C&I NTG values were evaluated in PY10 and PY11 and those values were applied to the C&I Programs for PY12 (Table 293). It has been previously concluded that all PY10 and PY11 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 293: Summary of NTG Estimates for Penn Power C&I Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Small Energy Solutions for Business Lighting	0.20	0.01	0.81	-
PY10	Small Energy Solutions for Business Custom	0.39	0.0	0.61	-
PY10	Small Energy Solutions for Business Prescriptive	0.54	0.0	0.46	-
PY10	Small Energy Solutions for Business Appliance Turn-In	-	-	0.51	-
PY10	Small Energy Solutions for Business Direct Install	-	-	0.81	-
PY10	Small Energy Solutions for Business Total	-	-	0.73	-
PY10	Large Energy Solutions for Business Lighting	0.20	0.01	0.81	-
PY8	Large Energy Solutions for Business Custom	0.39	0.0	0.61	-
PY10	Large Energy Solutions for Business Prescriptive	0.54	0.0	0.46	-
PY10	Large Energy Solutions for Business Total	-	-	0.76	-

G.8 TRC

Table 294 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for Penn Power's PY12 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 PY12 annual report and the model itself was well-organized and documented. Both gross and net TRC Ratios decreased across nearly all programs from PY11.

Table 294: Summary of Penn Power's PY12 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
Appliance Turn-In	$0	($3)	0.00	$0	($3)	0.00
Energy-Efficient Homes	$1,670	$1,124	1.49	$1,313	$988	1.33
Energy-Efficient Products	$1,679	$1,676	1.00	$718	$926	0.78
Low-Income Energy Efficiency	$73	$300	0.24	$73	$300	0.24
C&I Energy Solutions for Business – Small	$4,961	$4,495	1.10	$3,651	$3,431	1.06
C&I Energy Solutions for Business – Large	$810	$814	1.00	$609	$664	0.92
Governmental & Institutional Tariff	$0	$18	0.00	$0	$18	0.00
C&I Demand Response Program – Small	$0	$6	0.00	$0	$6	0.00
C&I Demand Response Program – Large	$431	$248	1.74	$431	$248	1.74
Portfolio Total	**$9,625**	**$8,677**	**1.11**	**$6,796**	**$6,577**	**1.03**

Of Penn Power's nine EE&C programs offered, five were found to be cost-effective and four were not cost-effective using gross verified savings. Using net verified savings, three of the nine programs were found to be cost-effective and six were not cost-effective. The Energy-Efficient Products and C&I Energy Solutions for Business – Large programs was cost-effective using gross verified savings, but not cost-effective using net verified savings, while the Appliance Turn-in, LI Energy Efficiency, C&I Demand Response – Small, and Governmental & Institutional Tariff programs were not cost-effective using a gross or net basis. Three of the programs that were not cost-effective, the Governmental & Institutional Tariff, C&I Demand Response – Small programs, and Appliance Turn-in, had no gross or net benefits.

G.8.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- To calculate the avoided cost of natural gas, Penn Power used the Annual Energy Outlook (AEO) average natural gas price for all users *in the Middle Atlantic* region, as the SWE recommends. The AEO natural gas prices were converted to nominal dollars before the NPV was calculated.
- Penn Power's annual electric energy savings are calculated and allocated by month and time of day (on-peak and off-peak). FirstEnergy applies an on-peak definition from the PJM market that is broader than the on-peak hours defined in the 2016 TRM (Monday – Friday 8AM-8PM). In the 2021 Pennsylvania TRM, on-peak and off-peak energy periods were adjusted to align with the PJM market definition. The adjusted 2021 TRM peak

window (Monday – Friday, 7AM-11PM) will now also match the definition used in FirstEnergy's Phase III TRC model. The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions.

- Penn Power used a discount rate of 6.89% to calculate the net present value of future program benefits. This discount rate is based on Penn Power's WACC and 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).
- 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 TRC Test Order directive for Phase III.
- 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 that the demand response program TRC Ratio meets the 75% participant cost assumption where 75% of customer incentive payment is used as a proxy for participant cost.
- According to the Phase III Evaluation Framework, LI measures are required to be provided at no cost to the participants. At first glance, it appears that Penn Power's LI programs are requiring participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the LI Energy-Efficiency Program (Table 108 in FirstEnergy's PY12 Annual Report). However, in their Phase III EE&C Plan, Penn Power explains that these costs are only being allocated to landlords and owners of LI properties, rather than the LI customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model followed the protocol specified in the 2016 TRC Test Order pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Non-Electric Benefits. The SWE verified that the savings were accounted for in accordance with the Guidance on Inclusion of Fossil Fuel and Water Benefits in TRC Test memo issued in March 2018. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative Total NPV Lifetime Non-Electric Benefit. As in past years, the SWE agrees that the cost should be accounted for as a negative non-electric benefit rather than a fossil fuel switching program cost. The TRC model claimed nearly 500,000 gallons per year of water saving, which translates to approximately $45,000 in NPV lifetime avoided costs.
- In PY12, the Penn Power TRC Model incorporated the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting

measures. Table 295 shows that without the dual baseline included in the TRC model, the gross and net TRCs are higher than when the dual baselines are included.

Table 295: Penn Power Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.11	1.03
Without Dual Baseline	1.50	1.17

G.9 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penn Power, so the annual evaluation reports of the four FirstEnergy EDCs report identical information about the process evaluation. Therefore, the SWE's audit summary, previously described for Met-Ed, applies to all four FirstEnergy utilities, including Penn Power.

Appendix H FirstEnergy: West Penn Power PY12 Audit Detail

H.1 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of West Penn Power's PY12 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor.

- Despite the voluntary nature of dispatchable demand response targets due to the COVID-19 pandemic, West Penn Power exceeded its Phase III target of 64 MW in each of the five DR events called during summer 2020. Verified gross demand reductions were largest during the three July events and declined during the two August events. The average reference load amongst returning C&I participants was down in PY12 – likely due to the pandemic's effects on operations – but West Penn Power more than tripled the number of participants from the Small C&I sector.
- PY12 had the lowest verified gross MWh savings from HERs of any year in Phase III for West Penn Power. However, Home Energy Reports as a percentage of portfolio savings, was the highest value since PY8 at 18.2%.
    - West Penn Power did not offer energy-efficiency kits in PY12, and upstream lighting was limited to specialty lamps by a baseline change for A-lamps in the TRM. As a result of these changes, HERs was the largest residential measure in PY12.
    - Behavioral Home Energy Reports to LI households accounted for 52.3% of all residential LI savings in PY12.
    - The cohort of West Penn Power HER recipients launched in June 2012 is separated into LI and market rate groups for reporting. In PY12, separate regression analysis showed an increase in consumption among the LI households and a decrease in consumption among the market rate households. Since the cohort was randomized and launched as a single group and split by income status after the fact, the SWE agrees with ADM's decision to run a single pooled regression analysis of the cohort and distribute the verified savings across market rate and LI using pre-treatment aggregate consumption.
- PY12 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE's review of verified savings for non-HER residential programs found that, overall, the verified savings followed proper TRM protocols and that 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 only noted a few minor discrepancies.
- The SWE's review of ADM's verified savings analysis for the non-residential programs found that the recommended procedures outlined in the Phase III evaluation framework were generally followed. TRM protocols were applied correctly, including adherence to the COVID-19 EM&V Guidance Memo, and verified savings calculations were generally appropriate.
- ADM did not conduct primary NTG research for any residential or non-residential programs during PY12 and applied prior program year NTG values.
- The PY12 process evaluation of the Behavioral Demand Response (BDR) program appears was consistent with the Phase III evaluation plan and the reporting followed the SWE guidelines.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in FirstEnergy's Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE has no major concerns. For all West Penn Power's programs, the SWE was able to replicate reported MWh savings and reported MW savings exactly via the tracking data. We also calculated directionally similar (if not identical) participation counts and incentive amounts for all programs.
- West Penn Power's TRC model was well-organized and consistent with the directives of the 2016 TRC Test Order and the key financial assumptions approved in West Penn Power's Phase III EE&C Plan. ADM uses a sampling approach for non-residential incremental measure costs that is unique to the FirstEnergy companies in Pennsylvania. Rather than apply assumed measure costs to each measure in the tracking data, ADM conducts project-specific cost research on each project in the evaluation sample along with the energy and demand savings analysis. The results from the sample are expanded to the population on a $/kWh basis by sampling initiative and EDC. The SWE appreciates this attention to measure costs in the impact evaluation and believes it returns an unbiased estimate of TRC Costs. West Penn Power's PY12 non-residential incentives as a percentage of estimated incremental cost were among the lowest statewide at 14.1% for Small C&I and 11.9% for Large C&I.

H.2 EM&V Plan Reviews

FirstEnergy's evaluation contractor, ADM Associates, submitted an updated comprehensive evaluation plan for the four FirstEnergy EDCs that addressed evaluation activities for PY11 and PY12. In addition, the ADM team submitted a memo updating their sampling and evaluation approach for the process evaluation of the Behavioral DR program. The SWE reviewed and approved the plan and memo.

H.3 SAMPLE DESIGN REVIEW

Verified savings estimates for most programs 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 ±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 III Evaluation Framework established a maximum allowable level of sampling uncertainty of ± 15% at 85% confidence level for each "initiative." For 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 program delivery channel or supported technology.

Grouping projects by equipment type and program delivery method leads to more meaningful evaluation results than tariff-based program definitions, each of which would include the same mix of measures. This evaluation strategy also makes sample design more efficient because the same projects are more likely to share similar characteristics across rates classes (i.e., Small C&I, Large C&I, and Government) than a heterogeneous mixture of measures within a single class. For example, projects from West Penn Power's three non-residential energy programs (C&I Energy Solutions for Business – Small, C&I Energy Solutions for Business – Large, and Government & Institutional Tariff) were assigned to one of four solutions:

- C&I Lighting
- C&I Custom
- C&I Prescriptive
- C&I Appliance Turn-In

ADM established a series of initiatives and designed the impact evaluation samples for each to meet the 85/15 precision requirement. Table 296 lists each initiative evaluated in PY12 and the corresponding relative precision of the PY12 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 296: Relative Precision of West Penn Power PY12 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (±)
Residential Appliance Turn-In (ATI)	5.4%
LI ATI	7.8%
LI Direct Install	7.6%
Res Upstream Lighting	8.0%
Res Upstream Electronics	0.0%
Res HVAC	5.8%
Residential Appliances	2.1%
LI Appliances	13.3%
C&I Lighting	8.3%
C&I Custom	6.7%
C&I Prescriptive	7.3%

The C&I Appliance Turn-In, Residential Direct Install, and Residential New Construction initiatives were not evaluated in PY12. ADM estimated verified gross savings for these initiatives using historic realization rates. The Energy-Efficiency Kits initiative was not active in PY12.

Each of the sampling initiatives shown in Table 296 exceeds the requirement of ±15% precision at the 85% confidence level. PY12 verification processes were impacted by the COVID-19 pandemic. Where appropriate, ADM replaced on-site visits with phone interviews and video conferences. Sampling uncertainty does not consider the level of rigor of the verification activities. Results from a sampled project that receives a quick desk review from the evaluation contractor is handled the same way as a sampled project that gets a site inspection with metering of equipment operating characteristics. The level of rigor of ADM's PY12 verification activities is discussed in detail in Appendix H.5.

The Behavioral Modification subprogram provides HERs to residential customers in the West Penn Power service territory. The subprogram is divided between standard 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 the used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase III Evaluation Framework requiring the solution-level verification achieve an *absolute* precision of ±0.5% at the 95% confidence level (two-tailed). Table 297 shows the absolute precision of the behavioral program components.

Table 297: Absolute Precision of West Penn Power PY12 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (±)
Residential	0.28%
LI	1.07%

DR programs offered by West Penn Power in PY12 include BDR targeted at residential customers and the DR Program for both small and large C&I customers. Gross impact evaluations for the DR Programs do not rely on sampling but instead consist of establishing a counterfactual estimates of participant loads. The estimation error present in these DR baselines yields a relative precision of ±22.2% at the 90% confidence level for the DR portfolio.

H.4 Reported Gross Savings Audits

H.4.1 Tracking Data Review

This section summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in West Penn Power's PY12 Annual Report. Specifically, we examined the following values for each program:

- Reported gross energy savings (MWh)
- Reported gross peak demand savings (MW)
- Participation
- 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 PY12 quarterly data request. Also note that DR or 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 West Penn Power's DR programs can be found in Appendix H.6, and our findings regarding the HER components of the Energy-Efficient Homes and LIEEPs can be found in Appendix H.5.1.3.

Table 298 summarizes the SWE's ex-ante findings regarding energy savings. The "Match" column contains "Yes" if the tracking data supports the values in West Penn Power's PY12 Annual Report and "No" otherwise. For each program, the SWE was able to replicate the values reported by West Penn Power.

Table 298: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-In	2,883	2,883	Yes
Energy-Efficient Homes	24,797	24,797	Yes*
Energy-Efficient Products	16,823	16,823	Yes
LI Energy Efficiency	3,164	3,164	Yes*
C&I Energy Solutions for Business – Small	23,063	23,063	Yes
C&I Energy Solutions for Business – Large	35,600	35,600	Yes
Governmental & Institutional Tariff	1	1	Yes
Portfolio Total	**106,331**	**106,331**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 299 summarizes the SWE's review of reported gross peak demand savings by program. The SWE's records matched West Penn Power's reported peak demand savings for each program.

Table 299: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-In	0.38	0.38	Yes
Energy-Efficient Homes	5.01	5.01	Yes*
Energy-Efficient Products	2.58	2.58	Yes
LI Energy Efficiency	0.48	0.48	Yes*
C&I Energy Solutions for Business – Small	3.50	3.50	Yes
C&I Energy Solutions for Business – Large	5.00	5.00	Yes
Governmental & Institutional Tariff	0.00	0.00	Yes
Portfolio Total	**16.95**	**16.95**	**Yes***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 300 summarizes the SWE's ex-ante findings regarding program participation. For all programs, the SWE calculated directionally similar (if not equal) participation counts. Portfolio totals differed by six participants.

Table 300: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-In	2,697	2,697	Yes
Energy-Efficient Homes	1,238	1,238	Yes*
Energy-Efficient Products	144,522	144,522	Yes
LI Energy Efficiency	1,694	1,694	Yes*
C&I Energy Solutions for Business – Small	379	383	No
C&I Energy Solutions for Business – Large	97	99	No
Governmental & Institutional Tariff	1	1	Yes
Portfolio Total	**150,628**	**150,634**	**No***

*The Energy-Efficient Homes and LIEEPs have HER components that are not represented in this table. Behavioral DR participants are not included either.

Finally, Table 301 summarizes the SWE's comparison of incentive dollars in the program tracking data to the program totals in West Penn Power's Annual Report. The SWE replicated incentive dollars or calculated directionally similar values for all seven programs. The portfolio totals are also approximately equal: $4,366,000 in the Annual Report and $4,348,000 in the tracking data.

Table 301: Incentives by Program ($1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-In	$152	$152	Yes
Energy-Efficient Homes	$750	$732	No
Energy-Efficient Products	$1,112	$1,446	No
LI Energy Efficiency	$46	$46	Yes
C&I Energy Solutions for Business – Small	$1,028	$694	No
C&I Energy Solutions for Business – Large	$1,278	$1,278	Yes
Governmental & Institutional Tariff	$0	$0	Yes
Portfolio Total	**$4,366**	**$4,348**	**No**

H.4.2 Project File Reviews

H.4.2.1 Residential

As part of the reported savings (i.e., ex-ante) review, the SWE conducted a project file review of a sample of West Penn Power's residential project files for PY12 using the project file documentation provided by West 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.

Table 302 presents a summary of SWE's residential project file reviews.

Table 302: West Penn Power PY12 Residential Project File Review Summary

Program	Sub Program	Number of Files Reviewed[1]	Did EDC provide project files?	Are most of the requested files included?	Are projects easily located in the tracking data?	Does the data in the files match the tracking data?[2]
Appliance Turn-In	NA	23	✓	✓	✓	✓
Energy-Efficient Homes	Audits	30	✓	✓	✓	✓
Energy-Efficient Homes	New Homes	16	✓	✓	✓	✓
Energy-Efficient Products	HVAC	32	✓	✓	✓	✓
Energy-Efficient Products	Appliances and Electronics	14	✓	✓	✓	✓
Energy-Efficient Products	Lighting	16	✓	✓	✓	✓
LI Energy-Efficiency	Multifamily/LILU Single-Family	7	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Rebate	8	✓	✓	✓	✓
LI Energy-Efficiency	Appliance Turn-In	11	✓	✓	✓	✓
LI Energy-Efficiency	Weatherization	12	✓	✓	✓	✓

[1] The number of files reviewed reflects the total number for all FirstEnergy EDCs.
[2] 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 programs. Below, is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

Appliance Turn-In

For the Appliance Turn-In Program, the quarterly upload included a list of projects with information such as age, cubic feet, configuration, etc. The projects were found in the residential downstream database and were applied a default savings value in the reported savings. However, the SWE observed that there were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance evaluator (e.g., using captured model and serial numbers).

School Education

The School Education Program was not run in PY12.

Energy-Efficiency Kits

The Energy-Efficiency Kits Program was not run in PY12.

Audits

Project files mostly aligned with tracking data, but the SWE observed minor discrepancies regarding rebate amounts, kWh, audit dates, and appliance quantities. Project files did not provide enough information to always verify rebate amount or kWh.

New Homes

REM/Rate reports' kWh savings tended to match tracking but overestimated peak kW by 28% for all FE utilities. Project files mostly aligned with tracking data, but the SWE observed minor discrepancies between the kW listed in the REM report as compared to the quarterly tracking data.

HVAC

The SWE observed the same discrepancy as during previous reviews, regarding the heating and cooling capacity of heat pump projects. The TRM requires separate inputs for heating and cooling capacity to calculate savings. In the tracking data, capacity was displayed as a singular *tons* variable.[81]

Starting in PY9, the evaluator, ADM, worked with the SWE to clarify this discrepancy. Their approach is to use single point estimates for these values for the reported ex-ante savings, and to then pull the heating and cooling capacities directly from the AHRI database and other independent sources during the verified savings calculations.

The SWE also found one case of equipment specifications – COP for a geothermal heat pump – which were missing in tracking data but present in the reviewed invoice.

[81] For example, for a mini split project, the heating capacity might be 12 kBtu, and the cooling capacity 9 kBtu, but this would appear in a single *tons* variable as 12 kBtu in the tracking data. As noted, ADM reported that this is corrected in the verified savings calculations.

Midstream Appliances

The Midstream Appliance Project files that the SWE reviewed matched the tracking data.

Appliances and Electronics

The Appliance files typically matched the tracking data. The SWE also encountered issues in tracking projects by account number, likely due to automatic truncation in spreadsheet software (e.g., scientific notation reverted to number formatting). One project's data request was in the incorrect program dataset.

There was no available tracking data for Q3 And Q4 requests. Furthermore, the information provided with the requests had little relevant information and would not have corroborated tracking data metrics.

Upstream Lighting

The Upstream Lighting files mostly matched the tracking data; however, not all suppliers provided enough information on invoices to corroborate both incentive amounts and lighting quantities. All incentive amounts matched, and where available, so did lighting quantities.

LI Multifamily / LILU Single-Family

The Multifamily files matched the tracking data. Additionally, many of the projects had multiple entries in the tracking data that the provided receipts did not include. In Q2 and Q3, a few projects had multiple entries, but the provided receipt could not corroborate each entry in the tracking data. The project files contained receipts, WARM program applications, audit forms, etc. There was an overall low amount of data requests for this program and none for Q1 or Q4.

LI Appliance Rebate

LI Appliance Rebate files mostly matched tracking data: however, many project requests contained receipts missing relevant information like rebate amounts, energy savings, and serial/model numbers. Many project requests were saved as GIF files, which made them difficult to verify. This limited SWE ability to review projects for Q1 completely. There was no available tracking data for the Q3 or Q3 data requests.

LI Appliance Turn-In

The LI Appliance Turn-In files mostly matched the tracking data, and the quarterly upload included a list of projects with information such as: participant signatures, cubic feet, configuration, etc. However, the SWE observed that there were no supplemental documents available to corroborate the age, size, and configuration of the recycled appliance evaluator (e.g., using captured model and serial numbers). West Penn Power did not provide any LI Appliance Turn-In program data requests for Q1, Q3, or Q4.

LI Weatherization

LI Weatherization files matched the quarterly tracking data. The SWE observed some project files that included certain measures in the tracking data and left out additional measures listed in the project files. ADM clarified in previous program years that the additional measures listed in these project files are provided by the LIURP program during the same visit, but they are not part of Act

129 and so do not carry any associated savings in the tracking system. There were no data requests for Q4.

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 PY12. 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 303 presents an overview of the results of the SWE's C&I project file reviews.

Table 303: West Penn Power PY12 C&I Project File Review Summary

Program	Sub-Program	Number of Files Reviewed	Are all files included?	Do values match program tracking data?	Does scope of work match between invoices and calculations?	Is there sufficient information for SWE to follow?	For TRM measures, are correct algorithms and inputs used?	For custom measures, is the approach clear, auditable, and appropriate?
C&I Energy Solutions for Business Program – Large	Custom – LCI	2	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Custom – SCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Food Service	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Large	HVAC – LCI	1	✓	✓	✓	✓	✓	-
Governmental & Institutional Tariff Program	HVAC – SCI	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Large	Lighting – LCI	3	✓	✓	2/3	✓	✓	-
C&I Energy Solutions for Business Program – Small	Lighting – 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 that savings calculators were locked for three projects. Finally, baseline project data was limited or unavailable for one Custom – LCI project. While baseline data is often not available, documentation on which baseline assumptions based should be provided. In addition to these general observations, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- **Food Service**
  - Workbook calculator locked in project reviewed; SWE cannot verify calculations.
- **HVAC – SCI**
  - Workbook calculator locked in project reviewed; SWE cannot verify calculations.
- **HVAC – LCI**
  - Workbook calculator locked in project reviewed; SWE cannot verify calculations.
- **Custom – LCI**
  - Baseline information not included for one custom refrigeration project.
- **Lighting – LCI**
  - Invoice lamp quantity does not align with workbook calculator for one project.

Despite minor issues with some project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

H.5 VERIFIED GROSS SAVINGS AUDITS

H.5.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the verified gross savings of the West Penn Power portfolio of residential programs. West Penn Power's portfolio of residential programs includes the following: the Appliance Turn-In Initiative, the Energy-Efficient Homes Initiative, the Energy-Efficient Products Initiative, and the LI Energy-Efficiency Initiative. Each program contains various subprograms, which are addressed separately below in tables and text as needed (if evaluation details differ or where the SWE audits determined that certain subprograms showed discrepancies not shared by others in a program). Note that the SWE reports residential savings in the three following sections: upstream lighting, residential non-lighting, and behavior.

Overall, the verified savings followed proper TRM protocols, and the verified savings are accurate. The SWE identified the evaluation activities used to verify savings for the residential programs. Table 304 provides a summary of the evaluation and M&V approaches used by West Penn Power in their PY11 verified savings calculations.

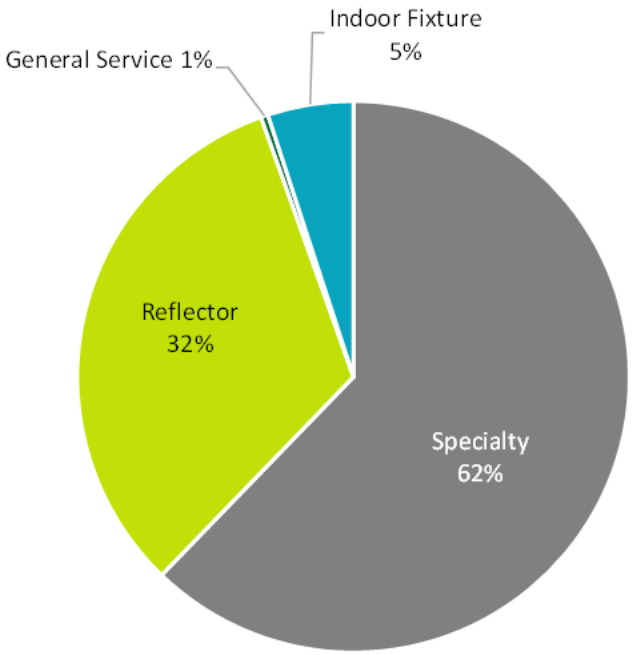
Table 304: Residential Program Evaluation Activities – West Penn Power

Program/ Subprogram	Surveys	Site Visits	Desk Review[a]	Billing Analysis
Appliance Turn-In				
Appliance Turn-In (LI & Non-LI)	✓	-	✓	-
EE Homes				
Energy-Efficiency Kits	-	-	-	-
Energy-Efficiency Kits – LI	-	-	-	-
HERs	-	-	✓	✓
Residential Direct Install	-	-	-	-
Residential New Construction	-	-	-	-
Upstream Lighting				
Upstream Lighting	-	-	✓	-
EE Products				
Upstream Electronics	-	-	✓	-
HVAC	✓	-	✓	-
Appliances	✓	-	✓	-
Appliances – LI	✓	-	✓	-
LI WARM				
LI WARM – Extra Measures	-	✓	✓	✓
LI WARM – Multifamily	-	✓	✓	✓
LI WARM – Plus	-	✓	✓	✓

H.5.1.1 Upstream Lighting & Cross-Sector Sales

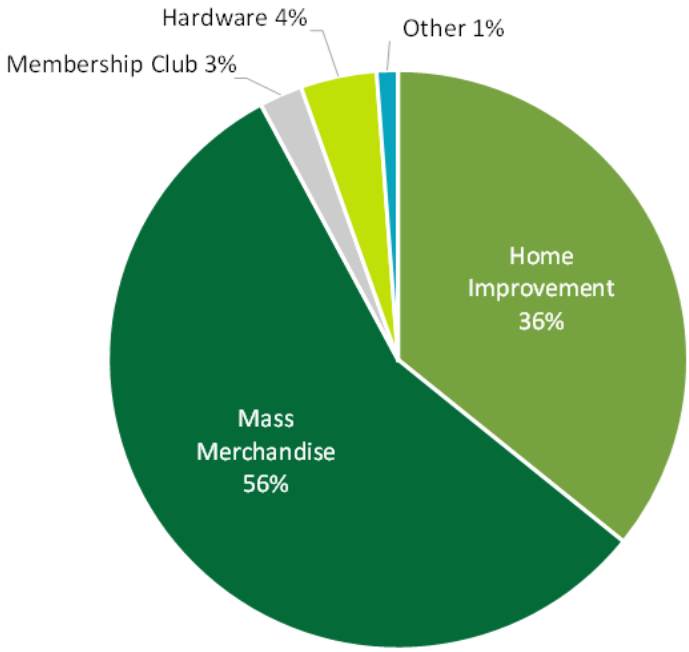
Customers purchased nearly 351,000 efficient light bulbs and fixtures through West Penn Power's PY12 upstream lighting program. Figure 118 displays the distribution of sales by product type. Just over three-fifths (65%) of the products were specialty bulbs.

Figure 118: West Penn Power PY12 Upstream Lighting Sales by Product Type



West Penn Power's PY12 upstream light bulbs and fixtures were sold primarily through mass merchandise (56%) and home improvement stores (36%, Figure 119).

Figure 119: West Penn Power PY12 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY12 impact analysis for West Penn Power's Upstream Lighting Initiative before the PY12 West Penn Power Annual Report was submitted to the PUC on November 15, 2021. This allowed time for the SWE to conduct its audit, provide ADM with feedback, and for ADM to adjust the analysis based on this feedback. The SWE agrees with ADM's verified gross savings for upstream lighting.

Cross-Sector Sales

ADM did not conduct cross-sector sales research in PY12 but applied the PY10 cross-sector sales rate 7.1%.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY12 upstream lighting analysis.

H.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.

Energy-Efficient Homes Program

In PY12, the Energy-Efficient Homes program included only the New Homes Initiative. The FirstEnergy Companies did not run the direct install or kit portions of the program in PY12. The SWE noted that the FirstEnergy Companies used an average of PY10 and PY11 results when calculating savings. The realization rates used for calculation were consistent with PY10 and PY11.

Energy-Efficient Products Program

Each component of the EEP Program was audited by the SWE, including appliances, HVAC equipment, and consumer electronics. Note that the SWE's audit of the upstream lighting portion of the EEP is reported in Section H.5.1.1 of this appendix.

Analysis files and data sets included in the gross impact data were reviewed for all HVAC, appliance, and consumer electronics measures included in the program. The SWE found that in all cases the correct TRM values and algorithms were used, the verified savings were correct, and the savings and sample sizes included in the annual request data matched those reported in the PY12 annual report.

The Midstream Appliances subprogram includes two measures: ENERGY STAR dehumidifiers and heat pump water heaters. Verification occurred via a review of distributor invoices and the gross impact calculations followed TRM algorithms with specific equipment capacity and efficiency parameters drawn from the ENERGY STAR Qualified Product Lists. Changes to federal standards and ENERGY STAR qualifying criteria in late 2019 complicated the analysis for dehumidifiers. ADM's PY12 verified savings calculations for dehumidifiers aligned with a March 2021 SWE Guidance Memo on the topic. Realization rates for both measures were well over 100% due to the conservative efficiency assumptions used by West Penn Power to claim reported gross energy and demand savings. The SWE audit found the verified savings were well-organized, free of errors, and consistent with Act 129 guidance documents.

LI WARM Program

The LI WARM Program is a LI direct install initiative offering similar measures across three sub-programs: WARM-Plus, WARM-Extra Measure, and WARM-Multifamily. The WARM program includes LED lighting, smart power strips, domestic hot water measures, HVAC measures, refrigerator and freezer replacement and recycling, insulation, air sealing, and duct sealing. The SWE audited all measures included in the program using the full downstream dataset and the survey sample subset provided by FirstEnergy. The SWE found that the correct TRM-approved methods were followed, survey sample sizes were correct and survey data correctly incorporated into the verified savings calculations, and the verified savings were correct.

Appliance Turn-In Program (LI and Non-LI)

The SWE performed audits on all measures included in the Appliance Turn-In Program, including dehumidifiers, refrigerators and freezers, and room air conditioners. Overall, the SWE concluded that the proper TRM algorithms and protocols were used, and that verified savings were correct.

H.5.1.3 Behavior

Approximately 18% of West Penn Power's verified gross energy savings for PY12 came from Home Energy Reports issued to more than 150,000 residential and residential-LI households. The SWE reviewed ADM's methodology and accepts their verified MWh and MW savings values for West Penn Power's HER offering in PY12. By cohort, Table 305 shows average kWh savings and average percent savings per participant in PY12. Note that the 'Number of Participants' column shows the average number of participants during PY12.

Table 305: Average PY12 kWh Savings per Participant

Sector	Cohort Start Date	Number of Participants	Average PY12 kWh Savings	Average PY12 % Savings
Low-Income	June 2012	9,079	113	0.74%
Residential	June 2012	102,714	98	0.66%
Low-Income	January 2014	3,044	77	0.57%
Residential	January 2014	15,629	283	1.57%
Residential	December 2014	23,297	145	1.05%

The following sections highlight some of the more important audit steps and findings: the calendarization of billing data, group equivalence, duplicating participant counts, the calculation of lag terms, missing eligibility filters, and energy and demand savings.

Calendarization

The first step the SWE team took was to review ADM's calendarized data. "Calendarization" is a process that prorates billing data into a common calendar month basis shared by all accounts. Our review of the calendarized data had three primary components:

- Check the coding of the "pre" and "post" indicator variables;
- Confirm that the calendarized average daily usage values are correct; and
- Confirm that the lag terms (average usage in the pre period, average summer usage in the pre period, average winter usage in the pre period) are correct.

Our team found no issues in the coding of the pre and post indicator variables. Table 306 shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.[82] The distribution of average daily kWh is basically identical in the two data sets.

[82] The table only summarizes PY12 records.

Table 306: Comparison of Calendarized Data

Variable	Mean	5th Percentile	25th Percentile	75th Percentile	95th Percentile
Average Daily kWh – ADM	40.81	13.94	24.28	50.76	88.29
Average Daily kWh – SWE	40.81	13.94	24.28	50.76	88.29

Regarding the lag terms, the SWE found that ADM's calculations were sound. ADM did not calculate summer or winter lag terms in cases where pre period summer or winter data did not exist. Because we found no issues with ADM's calendarized data, the figures, tables, and summary statistics presented herein were created or calculated using ADM's calendarized data rather than our own.

Group Equivalence

After reviewing the calendarization, the SWE compared average daily consumption (kWh) between the treatment and control groups during the pre-treatment period. Table 307 shows the results for each cohort. Note that calendarized data was used to calculate the averages and any customer without at least 12 month of pre-treatment data was dropped. To avoid comparing averages calculated over different time spans (e.g., 14 months and 12 months), averages within each month were calculated before calculating overall averages for each customer. The 'P-value' column indicates the likelihood that the observed differences could happen by chance if the two experimental cells use the same amount of energy, on average. A p-value less than 0.05 indicates that the difference in average consumption between the two groups is statistically significant. No cohorts were found to have statistically significant pre-treatment differences between the treatment and control groups.

Table 307: Group Equivalence in the Pre-Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
Low-Income	June 2012	44.2	43.9	0.68
Residential	June 2012	42.4	42.5	0.81
Low-Income	January 2014	39.8	39.5	0.53
Residential	January 2014	53.6	53.5	0.73
Residential	December 2014	38.3	38.5	0.46

Participation Counts

The SWE team leveraged the raw billing data to audit participant counts. Because billing cycles can exceed 31 days in length (meaning bill dates can occasionally skip over a month), the SWE team calculated the number of unique IDs beyond a certain bill date. As an illustrative example, suppose we wanted to compute the number of participants in West Penn Power's 2012 LI cohort for March of 2021. We removed any households with a billing end date prior to 3/1/2021, then

counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Table 308: Participant Counts by Month and Cohort

Month	June 2012 LI	June 2012 Residential	January 2014 LI	January 2014 Residential	November 2014 Residential
Jun-20	9,311	104,717	3,146	15,946	23,921
Jul-20	9,277	104,265	3,126	15,870	23,762
Aug-20	9,233	103,851	3,109	15,812	23,645
Sep-20	9,183	103,428	3,084	15,754	23,526
Oct-20	9,143	103,084	3,068	15,688	23,414
Nov-20	9,099	102,734	3,050	15,636	23,308
Dec-20	9,057	102,414	3,028	15,587	23,218
Jan-21	9,011	102,155	3,015	15,548	23,133
Feb-21	8,976	101,917	2,999	15,502	23,042
Mar-21	8,940	101,662	2,987	15,460	22,976
Apr-21	8,885	101,323	2,967	15,395	22,865
May-21	8,833	101,019	2,946	15,351	22,753

Eligibility Filters

The LS regression model is a post-only model – only records from the post period are used in the regression. That said, some of the explanatory variables in the model are calculated based on pre period data: (1) average daily consumption in the pre period, (2) average daily consumption during the summer in the pre period, and (3) average daily consumption during the winter in the pre period. For a number of homes, there was not enough pre period data to calculate these lag terms. In PY12, ADM dropped any homes without 12 months of pre period data from the LS model. The monthly impact estimates derived from the model were then applied to the homes with insufficient pre period data. There is no evidence to suggest that homes without sufficient pre period data are systematically different from homes with sufficient pre period data. The SWE believes this is the correct approach.

Impact Coefficients and Energy Savings

Figure 120 through Figure 124 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY12. Only homes active in PY12 are included in the “pre period” portion of the figure. As has been noted, the regression model used to estimate the impact of the HER program has daily usage controls for potential pre period differences.

Figure 120: June 2012 LI Cohort Usage Comparison

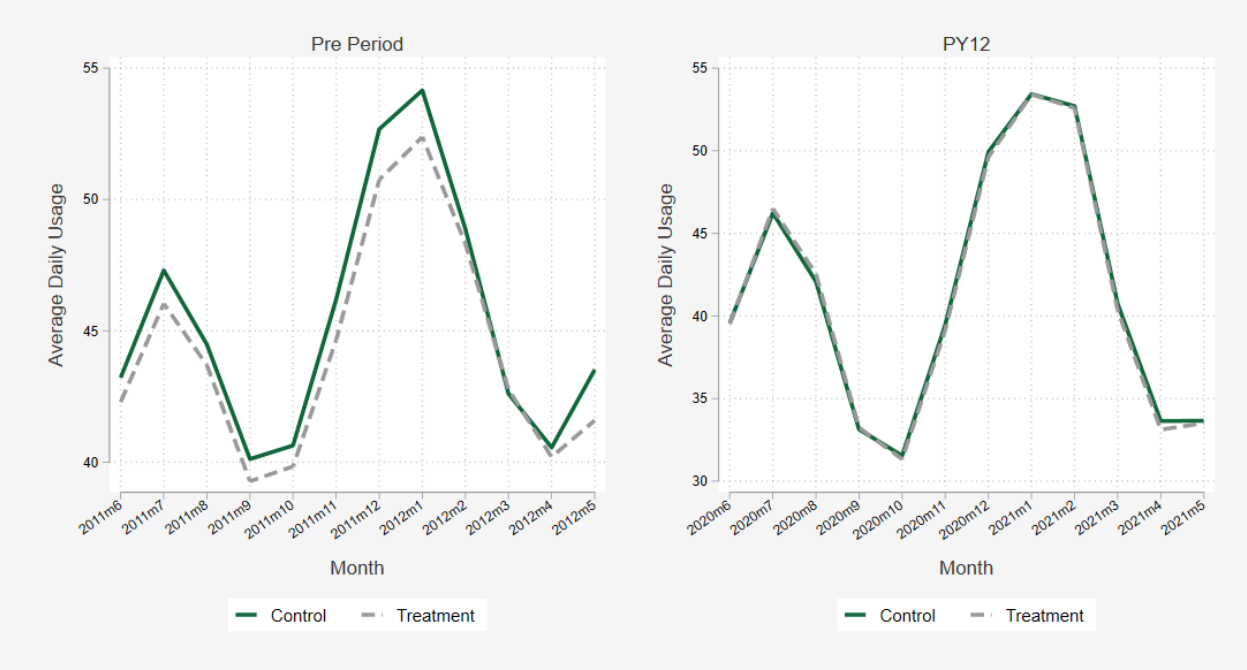


Figure 121: June 2012 Residential Cohort Usage Comparison

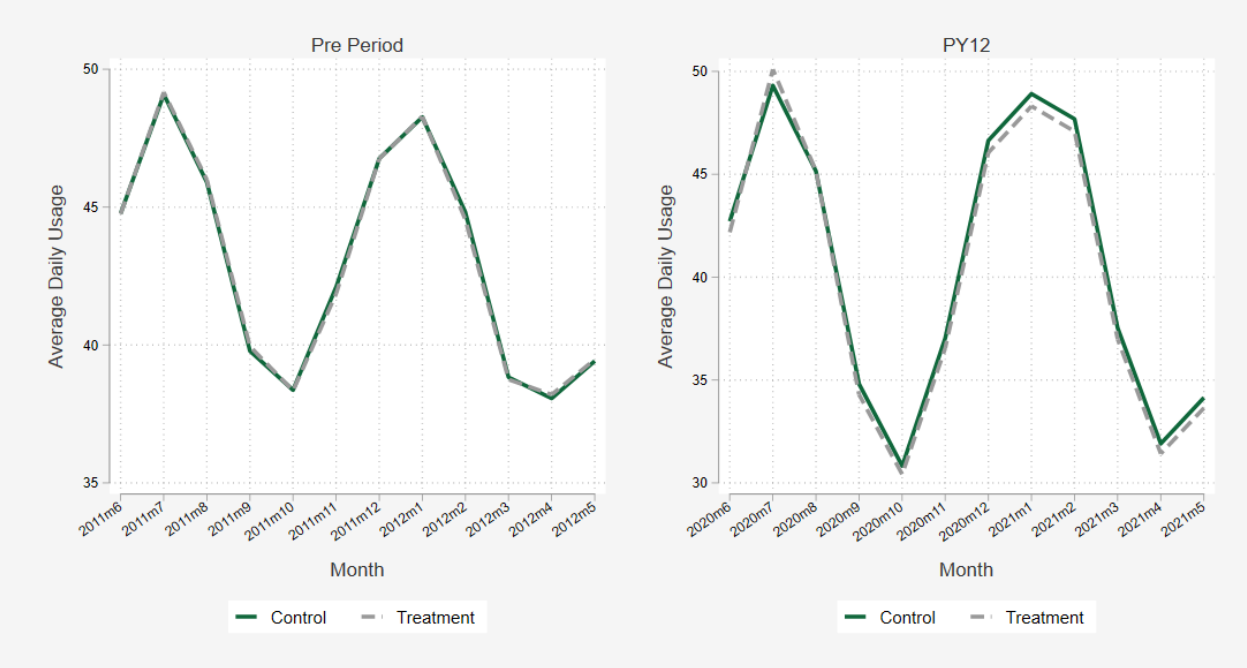


Figure 122: January 2014 LI Cohort Usage Comparison

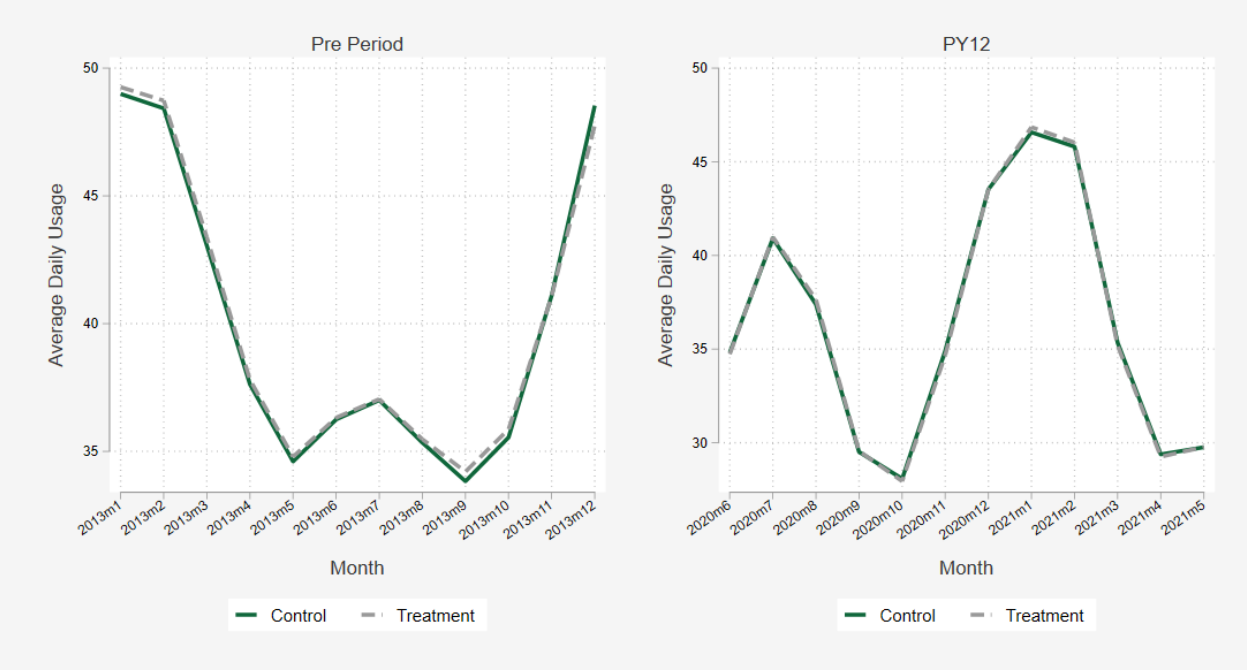


Figure 123: January 2014 Residential Cohort Usage Comparison

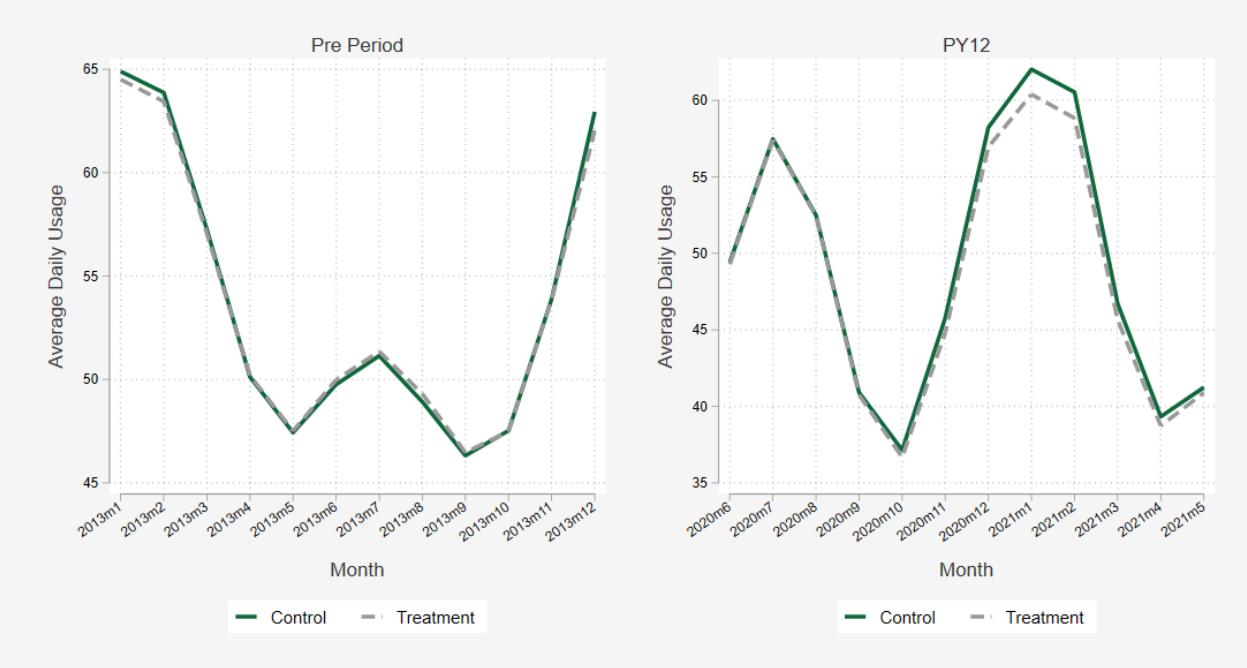


Figure 124: December 2014 Residential Cohort Usage Comparison

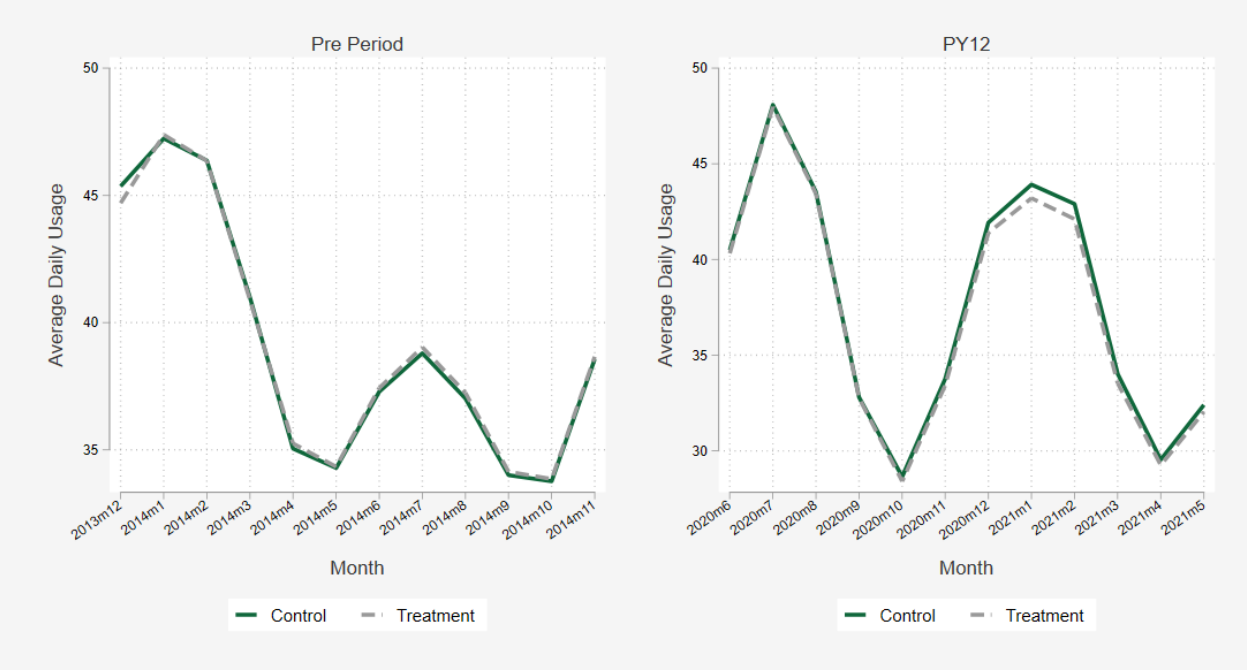


Table 309 shows PY12 impact estimates for each cohort. Note that a different impact estimate was calculated for each month in PY12 – the estimates shown in the table reflect the averages of the PY12 monthly estimates (weighted by month duration). Using the second impact estimate as an example, the practical interpretation is as follows: treatment group homes in the residential June 2012 cohort saved 0.38 kWh per day, on average, during PY12. The average impact estimate for the LI June 2012 cohort is positive, indicative of an increase in consumption.

Table 309: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
Low-Income	June 2012	0.64	0.64
Residential	June 2012	(0.38)	(0.38)
Low-Income	January 2014	(0.25)	(0.25)
Residential	January 2014	(0.85)	(0.85)
Residential	December 2014	(0.42)	(0.42)

To account for dual participation, savings are reported after adjusting for downstream measures and upstream measures. HER programs promote other energy-efficiency & conservation programs, creating a situation where treatment group homes participate in other energy-efficiency & conservation programs at a higher rate than control group homes. Therefore, there is incremental kWh savings in the regression analysis that must be subtracted from the HER impacts to avoid double-counting. ADM identified energy-efficiency program participation that occurred from each cohort's treatment start date onwards to calculate the downstream adjustment factor.

The upstream reduction factor for each cohort varies depending on the number of years passed since the cohort's respective start date. Because all the cohorts had a start date at least four years before PY12, the upstream reduction factor for all cohorts is 3%.

Using the impact estimates shown above, Table 310 shows ADM's and the SWE's aggregate energy savings (MWh), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 310: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE – ADM)
Low-Income	June 2012	1,025	1,023	(2)
Residential	June 2012	10,038	10,045	7
Low-Income	January 2014	233	231	(3)
Residential	January 2014	4,421	4,418	(3)
Residential	December 2014	3,376	3,382	6
Total		**19,093**	**19,098**	**5**

Readers will note that the 2012 Low-Income cohort produced positive energy savings although the impact estimate for this cohort indicated an increase in consumption during PY12. This is due to an adjustment made for the 2012 cohorts that ADM discussed with the SWE in 2017. Essentially, savings for the 2012 Low-Income and Residential cohorts are summed and then redistributed based on the relative share of pre-treatment aggregate consumption for these cohorts.

Demand Savings

Table 311 shows ADM's and the SWE's aggregate peak demand savings (MW), after accounting for dual participation, for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

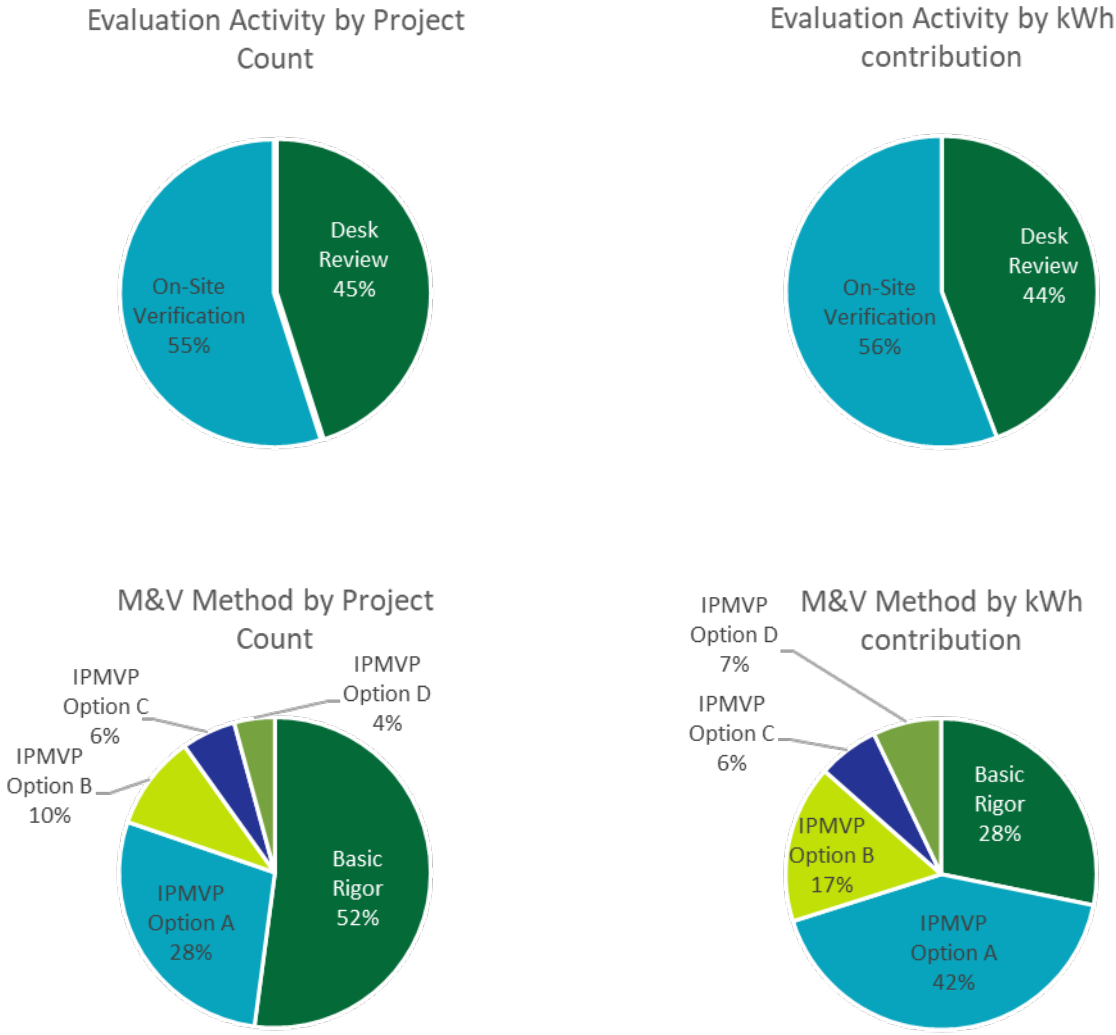
Table 311: Demand Savings Comparison

Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE – ADM)
Low-Income	June 2012	0.11	0.11	0.00
Residential	June 2012	1.07	1.07	0.00
Low-Income	January 2014	0.02	0.02	0.00
Residential	January 2014	0.51	0.51	0.00
Residential	December 2014	0.38	0.38	0.00
Total		**2.09**	**2.09**	**0.00**

H.5.2 Non-Residential Audit Activities

Figure 125 provides a summary of the evaluation activities and M&V approaches utilized by West Penn Power's evaluation contractor, ADM, in their PY12 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY12, West Penn Power's evaluation contractor completed site visits to 55% of projects, and these projects represented 56% of total evaluated energy savings. A total of 39 site visits were conducted, a greater number than PY11. IPMVP Options A, B, C, and D were employed for the majority (72%) of total evaluated energy savings. Basic Rigor (verification only) was employed for all prescriptive projects and select lighting projects.

Figure 125: Summary of West Penn Power's C&I Evaluation Activities



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 five evaluation initiatives, as West Penn Power's programs target specific sectors of C&I customers, but offerings are often identical across the programs. Table 312 provides a summary of the evaluation activities West Penn Power's evaluation contractor used across strata for all projects by initiative.

Table 312: Summary of West Penn Power's PY12 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	On-Site Verification Only
Appliance Turn-In	**0**	**96%**	**0**	**0**
Custom	**23**	**111%**	**17**	**6**
Custom – 1	11	133%	5	6
Custom – 2	-	-	-	-
Custom – Certainty	12	103%	12	-
Direct Install	**0**	**86%**	**0**	**0**
Lighting	**33**	**96%**	**0**	**33**
Lighting – 1	2	100%	-	2
Lighting – 2	10	81%	-	10
Lighting – 3	7	107%	-	7
Lighting – Certainty	14	100%	-	14
Prescriptive	**15**	**98%**	**15**	**0**
Prescriptive – 1	15	98%	15	-
Prescriptive – 2	-	-	-	-
TOTAL	**71**	**101%**	**32**	**39**

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

H.5.2.1 Appliance Turn-In Initiative

In PY12, West Penn Power's Appliance Turn-In Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the average of respective PY10 and PY11 realization rates.

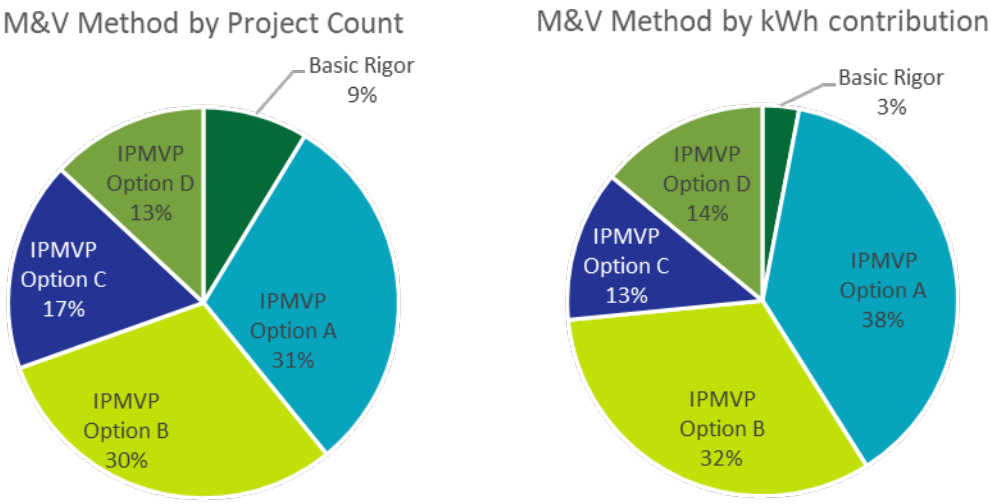
H.5.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews, site visits, and/or IPMVP evaluation methods for all sampled projects. Site visits are always conducted unless the evaluation can be satisfactorily conducted remotely using data provided by the customer (EMS data, billing data, etc.). 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 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 3-2 of the Phase III Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. IPMVP Options were employed to evaluate 97% of the evaluated energy savings for the projects in the sample, as shown in Figure 126.

Figure 126: Summary of West Penn Power's C&I Custom Program M&V Methods



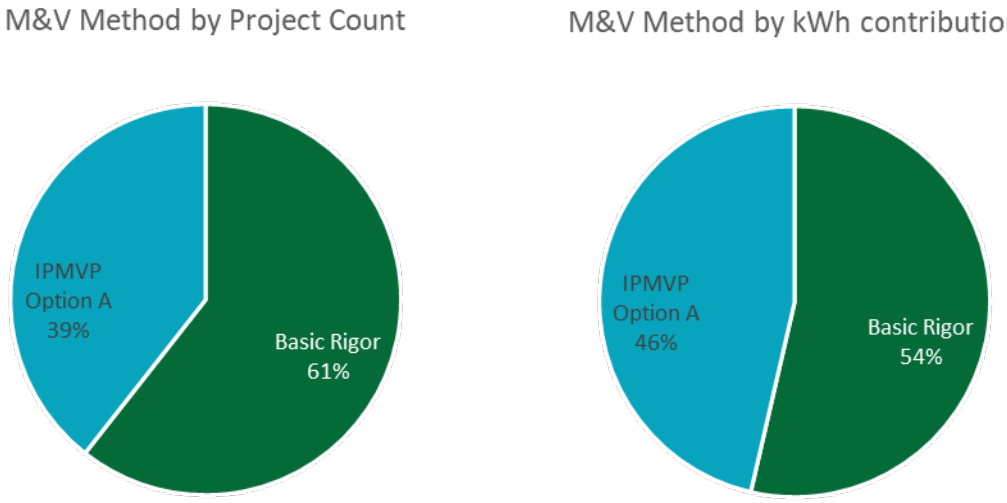
H.5.2.3 Lighting Initiative

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 a basic rigor method 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 four strata for projects in the Lighting initiative. The largest projects, with ex-ante savings estimates of 750 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.

IPMVP Option A using standalone data loggers to measure lighting hours of use was employed for nearly half (46%) of the evaluated savings in this initiative, as illustrated in Figure 127.

Figure 127: Summary of West Penn Power's C&I Lighting Program M&V Methods



H.5.2.4 Prescriptive Initiative

Evaluation activities for this initiative include desk reviews and basic rigor application of TRM-based savings calculation methodologies. None of the West Penn Power prescriptive projects received a site-visit this program year.

West Penn Power's evaluation contractor employed two strata for projects in the Prescriptive Initiative, with the threshold set at 20 MWh of annual energy savings. All the PY12 sampled projects were in the Prescriptive-1 stratum, meaning no sampled project reached the savings threshold.

IPMVP-based methods were not employed for this initiative. All projects were evaluated using basic rigor desk reviews.

H.5.2.5 Direct Install Initiative

In PY12, West Penn Power's Direct Install Initiative was not evaluated. The gross energy and demand realization rates for each evaluation stratum were taken to be the PY11 realization rates, as the program had no participation in PY10.

H.5.2.6 Ride-Along Site Visits

The SWE audited the activities above through a combination of Ride-Along Site Visits (conducted both in person and virtually) and Desk Reviews. The details of the SWE's findings are presented in the following subsections.

Table 313 provides an overview of the SWE milestones for the audit of West Penn Power's site inspection efforts.

Table 313: West Penn Power Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Attainment Percentage
5	2,597,563	1	2	100%

Overall, the SWE agreed with the methods of calculation employed by West Penn Power's evaluation contractor. The calculations and accompanying reports were easy to follow and showed evidence that the TRM and custom methodologies were being followed appropriately. Of the five projects reviewed, the SWE did not make any recommendations to the evaluator's energy savings. Thus, an attainment percentage of 100% was achieved for the total site inspections audited.

H.5.2.7 Verified Savings Desk Reviews

Table 314 provides an overview of the SWE milestones for the verified savings review of evaluated West Penn Power projects.

Table 314: West Penn Power Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
7	11,758,626	1,747	100%	100%

Overall, the SWE found that West Penn Power's evaluation contractor demonstrated general adherence to the TRM and employed sound engineering methods to evaluate custom projects. The SWE asserts that ADM conducted appropriate M&V efforts, and that sufficient documentation supporting savings analyses was provided. Among the seven projects reviewed, the SWE found no basis for recommending adjustments to energy or demand savings and determined a 100% attainment percentage.

H.6 DR

According to the Phase III Implementation Order, West Penn Power's Phase III demand response (DR) compliance target is 64 MW. Note that compliance is determined based on the average MW performance across events during the second, third and fourth program years consistent with the Commission's Order entered on June 3, 2020, amending the original implementation order. This amendment permitted EDCs to operate the approved DR programs on a voluntary basis for the fifth and final year of the program with results not counted toward compliance goals. The PY12 results of the DR program provided below are based on voluntary customer participation. Additionally, DR goals are assessed at the system level, meaning that line loss adjustments are applied to the load impacts measured at the customer meter.

Decisions about which day DR events are called are guided by a set of prescriptive directions issued by the PUC in the Phase III Implementation Order[83] and Clarification Order[84]. West Penn Power called DR events on the five days those guidelines required during summer 2020.

In PY12, West Penn Power had active DR programs in both the residential and C&I customer classes. On the C&I side, there were 79 participants – 29 categorized as large C&I sites and 50 categorized as small C&I sites. The residential behavioral demand response (BDR) component had over 57,000 homes in the treatment group, though this number declined throughout the summer.

Table 315 shows West Penn Power's performance across the five events during the 2020 DR season, as well as the average performance during the season, the Phase III-to-date performance, and the value with which compliance will be evaluated (the average MW performance across events from PY9 to PY11). The evaluation team identified a slight error in the Phase III-to-date calculation, that we recommend be adjusted in the July semi-annual report and November final annual report.

Table 315: West Penn Power Performance by Event

Event Date	Start Hour (Hour Ending)	End Hour (Hour Ending)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Residential Energy-Efficient Homes (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 20, 2020	15	18	1.6	105.5	2.8	109.9 ± 49.5
July 27, 2020	15	18	0.9	116.2	3.2	120.2 ± 52.8
July 29, 2020	16	19	1.1	85.4	2.8	89.4 ± 40.2
August 25, 2020	15	18	1.3	66.6	2.9	70.8 ± 48.9
August 27, 2020	16	19	0.9	62.9	2.6	66.3 ± 32.5
PYVTD – Average PY12 DR Event Performance						**91.3 ± 20.3**
VTD – Average Phase III DR Event Performance						**106.6 ± 14.3**
Compliance Value – Average DR Event Performance from PY9 to PY11						**112.4 ± 15.0**

The West Penn Power/ADM team also submitted a response to the SWE DR data request. The elements of this response included:

- A data set that provided the top three CBLs for each C&I participant and the relative root mean square error (RRMSE) for each CBL/participant combination;

[83] Pennsylvania Public Utility Commission, Energy Efficiency and Conservation Program Implementation Order, at Docket No. M-2014-2424864 (Phase III Implementation Order), entered June 11, 2015 https://www.puc.pa.gov/pcdocs/1367313.doc

[84] Pennsylvania Public Utility Commission, Phase III Clarification Order, at Docket No. M-2014-2424864, entered August 20, 2015. https://www.puc.pa.gov/pcdocs/1378016.doc

- For each event hour, a record of which C&I facilities participated, their reference load, metered load, and verified DR impact;
- For seven C&I sites selected by the SWE, the hourly load data needed to replicate the ADM impact estimates. Note that these seven sites accounted for approximately 75% of West Penn Power's C&I gross verified PY12 DR impacts. This workbook also mapped each facility to a weather station and flagged shutdown days and days in which the facilities were active in PJM;
- Historical weather data that was used in creating weather sensitive adjustments;
- Hourly load and weather data for approximately ~79,000 residential accounts (~57,500 treatment group accounts and ~21,500 control group accounts); and
- A map that indicated which residential accounts belonged to which experimental cell.

The data request response and a few follow-up emails formed the basis of the SWE audit activities – which are described in this section. The SWE found the approaches implemented by ADM to be well-aligned with the Evaluation Framework and consistent with industry best-practice. The execution of the analysis was thorough and free of errors. The SWE team agrees with the PY12 gross verified savings estimates.

H.6.1 Replicate Program Totals

West Penn Power's PY12 C&I DR program had 79 participants. ADM's verified gross peak demand savings generated by these sites are shown in Table 316. Note that these values are adjusted for line losses (by a multiplier of 1.079). For each DR event hour during the 2020 DR season, the SWE was provided with the metered load and CBL for each participant. Using this data, the SWE was able to replicate the PYVTD gross MW for both components of the C&I DR program. Table 316 also shows verified gross peak demand savings attributable to the residential BDR program (also adjusted for line losses).

Table 316: West Penn Power DR Savings

Program	PYVTD Gross MW
C&I – Small	1.2
C&I – Large	87.3
Energy-Efficient Homes	2.8
Total	**91.3**

H.6.2 Residential BDR

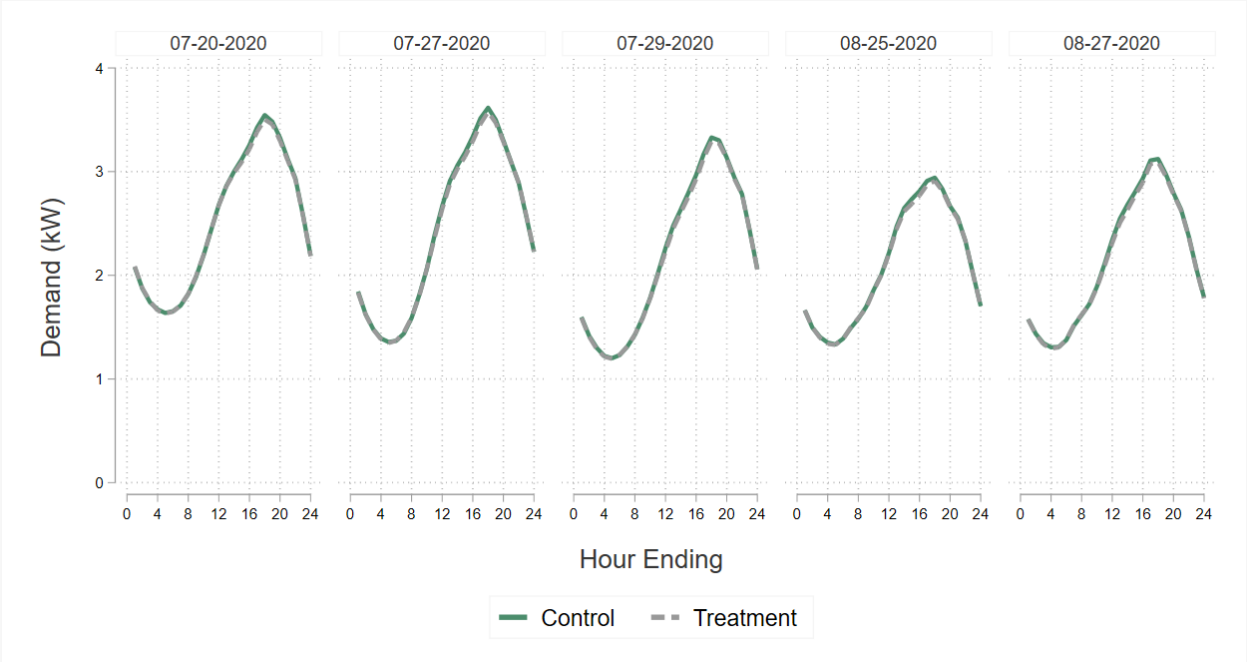
West Penn Power's behavioral DR program operates as a randomized control trial – customers were randomly selected and placed into control and treatment groups. As of the beginning of the 2020 summer DR season, there were 57,467 premises in the treatment group and 21,340 premises in the control group. Some of these homes were added in 2018, some in 2019, and the rest were added in 2020. Table 317 shows counts by start date as of the beginning of the 2020 DR season. At the end of the DR season, these numbers were 55,902 and 20,733 respectively.

Table 317: Residential BDR Customer Counts

Date Added	Active Treatment Accounts	Active Control Accounts
5/19/2018	43,732	16,263
5/22/2019	7,997	2,963
5/18/2020	5,738	2,114
Total	**57,467**	**21,340**

Prior to the DR events, homes in the treatment group are notified of a pending DR event by the program's ICSP with the expectation that customers will curtail load during the event itself. The means by which load curtailment is achieved isn't obvious, though ADM notes that the ICSP is involved in participant education and coaching. On average, load reductions are not very big – approximately 0.05 kW per home, which is about 2% of household demand during peak hours on peak days. For an illustration of the load shed, see Figure 128. In this figure, control group and treatment group loads for each PY12 DR event day are compared. The impact is small but separation between the experimental cells can be seen in the late afternoon. With over 57,000 homes in the treatment group, small impacts add up.

Figure 128: West Penn Power Residential BDR



H.6.2.1 Group Equivalence

The first step the SWE team took was to assess the equivalence between the treatment and control groups in the baseline period (the 30 days prior to notifying treatment group homes of their selection). Note the customers added in 2020 have a different baseline period than the customers added in 2018 and 2019, but all periods straddle April and May. Figure 129 shows the average hourly load profiles for the two experimental cells in each cohort during the baseline periods. As

can be seen, the two groups used energy in the baseline period in an approximately identical fashion.

Figure 129: West Penn Power Baseline Equivalence

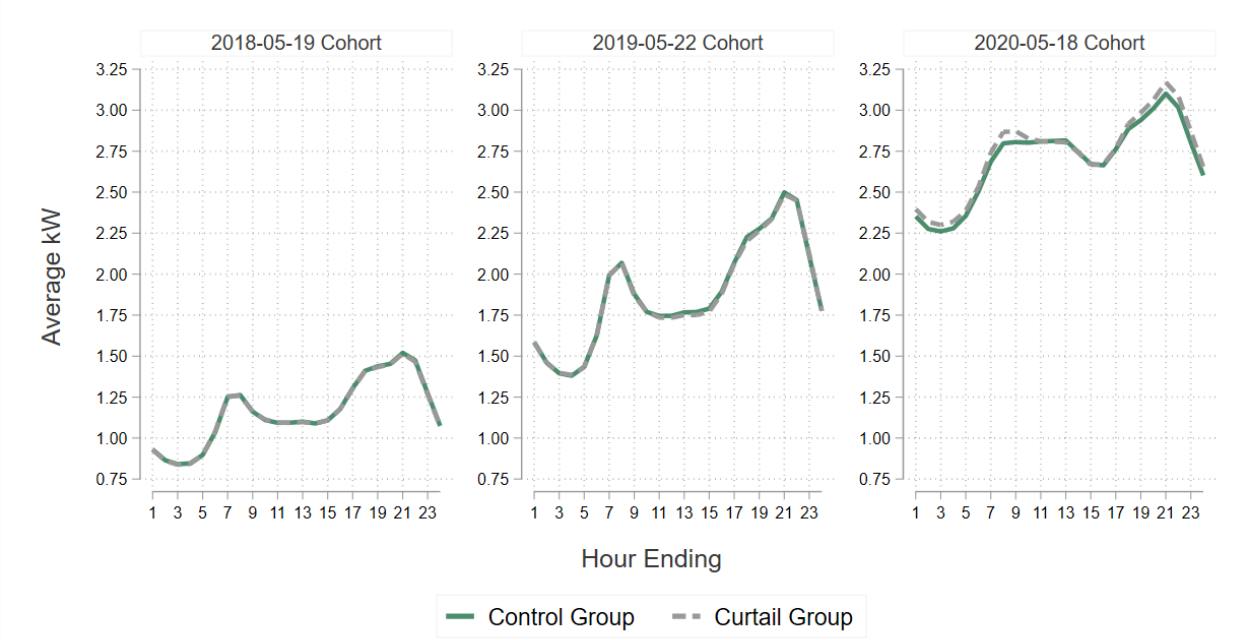


Table 318 shows average daily kWh for the control and treatment groups during the baseline period. A significance test suggests the difference between mean daily consumption values is not statistically significant (p-value = 0.84). The table also shows the average demand for the two groups during common event hours. Like the average daily kWh values, the difference between the average demand values is not statistically significant (p-value = 0.85).

Table 318: Equivalence Check

Group	Average Daily kWh	Average kW During Event Hours
Control	32.18	1.47
Treatment	32.22	1.47
Combined	**32.21**	**1.47**

H.6.2.2 Impact Estimation

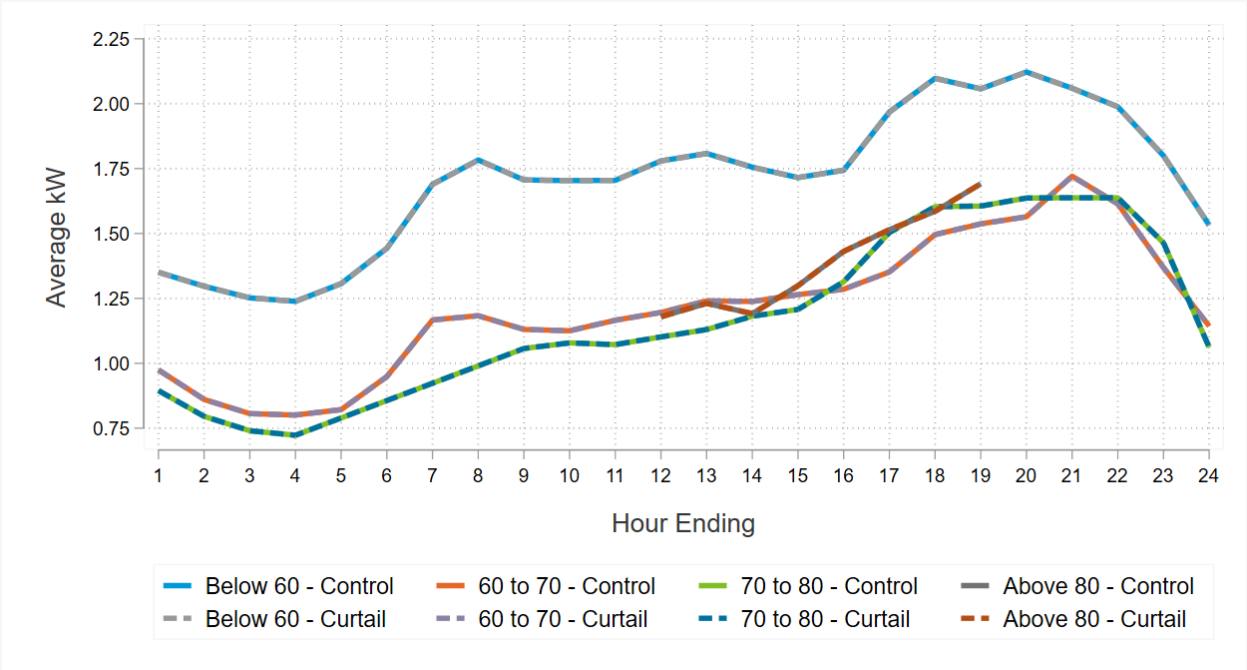
Savings calculations for the residential BDR component relied on a control group comparison and regression modeling. The regression model only used data from event hours on event days. Explanatory variables included date and hour fixed effects, an interaction between the treatment indicator variable and the date/time fixed effects, and three lag variables. The lag variables are customer-specific constants calculated based on consumption over a 30-day period that spanned April and May of 2018 and April and May of 2019 for the first two cohorts. For the 2020 cohort, the baseline period was extended longer than 30 days, from 4/1/2020-5/17/2020, because there

were no days in which the 2:00 PM – 6:00 PM window fell into the 70 to 80-degree range. Steps taken in producing these lag variables are as follows:

- Limit the load data to 2:00 PM – 6:00 PM on non-holiday weekdays;
- Create three temperature bins: 60 to 70 (no cooling), 70 to 80 (medium cooling), and above 80 (high cooling); and
- In each temperature bin, calculate average load for each customer.

Figure 130 compares baseline usage in the treatment and control groups for the three bins (plus a fourth bin – temperature below 60) discussed above. The figure shows all hours rather than just common event hours. The main takeaway from this figure is that the treatment and control groups were, on average, hardly distinguishable in terms of hourly load profiles. (Gaps in the plot can be explained by the fact that the temperature never exceeded 80 during some hours of the baseline period.) Additionally, and perhaps as one would expect, overall usage increases in the higher temperature bins. Because the control group homes and treatment group homes were exposed to the same weather conditions, temperature itself was not included as an explanatory variable in the model.

Figure 130: Usage by Temperature Bin



H.6.2.3 Findings

Table 319 shows the relevant per participant impacts (treatment effect by hour and date), participant counts, and aggregate impacts. Note that neither the per participant impacts nor the aggregate impacts are adjusted for line losses in this table. The practical interpretation of the first per participant impact in the table (0.035) is that average demand in the treatment group was about 0.04 kW lower than the average control group load (after controlling for date, time, and the

customer-specific usage patterns captured by the lagged variables). The SWE tested the robustness of these per participant impacts with a few other regression model specifications and found the results to be robust.

Table 319: Regression Output and Participant Counts

Date	Participants	Hour	Per Participant Impact (kW)	Aggregate Impact (MW)
7/20/2020	56,934	15	0.035	1.96
		16	0.044	2.49
		17	0.046	2.63
		18	0.050	2.82
		Event Average	**0.044**	**2.48**
7/27/2020	56,857	15	0.044	2.49
		16	0.050	2.84
		17	0.057	3.27
		18	0.047	2.68
		Event Average	**0.050**	**2.82**
7/29/2020	56,820	16	0.046	2.62
		17	0.046	2.62
		18	0.047	2.70
		19	0.036	2.04
		Event Average	**0.044**	**2.49**
8/25/2020	56,386	15	0.053	3.00
		16	0.050	2.82
		17	0.043	2.41
		18	0.040	2.25
		Event Average	**0.046**	**2.62**
8/27/2020	56,353	16	0.048	2.70
		17	0.041	2.33
		18	0.040	2.27
		19	0.032	1.81
		Event Average	**0.040**	**2.28**

The average impact across the 20 event hours was -2.54 MW. Multiplying this value by West Penn Power's line loss multiplier for residential customers (1.0943) yields an average savings estimate of 2.8 MW per event hour. This matches the PYVTD gross MW value calculated by ADM (2.8).

H.6.3 C&I

H.6.3.1 Reference Load Selection

ADM's CBL selection method was thoughtful and relied on non-event day testing. At a minimum, the following CBLs were considered for each participant:

- PJM high 4-of-5 with weather sensitive adjustment (WSA) and weekday specific options;
- High 6-of-7 with WSA and weekday specific options; and
- 10-of-10 with WSA and weekday specific options.

From the list above, the top three CBLs for each participant were selected. The basis for "top three" was the lowest relative root mean square error (RRMSE) on non-event, non-holiday, non-shutdown weekdays. On event days, a weighted average of these three CBL types was used in creating the actual CBL. The weights, in this case, were equivalent to the inverse squares of the RRMSEs. For a hypothetical event hour, Table 320 provides an illustration.

Table 320: CBL-of-CBLs Illustration

CBL Type	CBL (kW)	Non-Event Day RRMSE	Inverse Square of RRMSE	Weight
10-of-10	1,100.0	7.1%	198.37	35.7%
10-of-10 with WSA	1,200.0	7.2%	192.90	34.7%
20-of-20	1,300.0	7.8%	164.37	29.6%

Thus, the CBL-of-CBLs value would be: 1,100*0.357 + 1,200*0.347 + 1,300*0.296 = 1,193.90.

H.6.3.2 Weather Sensitive Adjustments (WSAs)

Several of the baseline types ADM considered involved a weather sensitive adjustment (which can be positive or negative). The WSA is a function of three terms: the temperature during the event hour, the average temperature during the same hour across days in the CBL lookback window, and the participant-specific WSA coefficient. Respectively, think of these components as X, Y, and Z. The WSA was then calculated as follows:

$$WSA = Z * (X - Y)$$

Regarding the participant-specific WSA coefficient, this value was derived as follows:

- Map each participant to a weather station. Merge weather data with load data;
- Keep days between 6/1/2020 and the last day of the DR season for PY12 (which occurred on 9/30/2020);
- Drop any holidays, event days, shutdown days, or weekends;
- Keep only the hours when events were called on event days;
- Calculate the average load and average temperature during the event window for each day in the data set. Drop any days where the average temperature during the event window is less than 75 degrees (F);

- Using the averages calculated in the previous step, run a simple linear regression model with load as the response variable and temperature as the explanatory variable; and
- The regression coefficient for the temperature variable is the WSA coefficient. The coefficient represents the expected change in kW per a one-degree increase in temperature (F).

This WSA calculation differed slightly from last year, as previously days were kept between the first day of the DR season and the last event day of the season, instead of the last day of the DR season. Using the whole DR season to construct these WSAs gives a better picture of weather sensitivity and is not a cause for concern.

The WSA is only applied if the outdoor air temperature exceeds 75 degrees. Additionally, two distinct WSA coefficients were calculated for each participant. In PY12, two event started and ended an hour later than the others. ADM calculated separate WSA coefficients for the event that started an hour later, with the logic being that the relationship between load and temperature varies by time of day

H.6.3.3 Findings

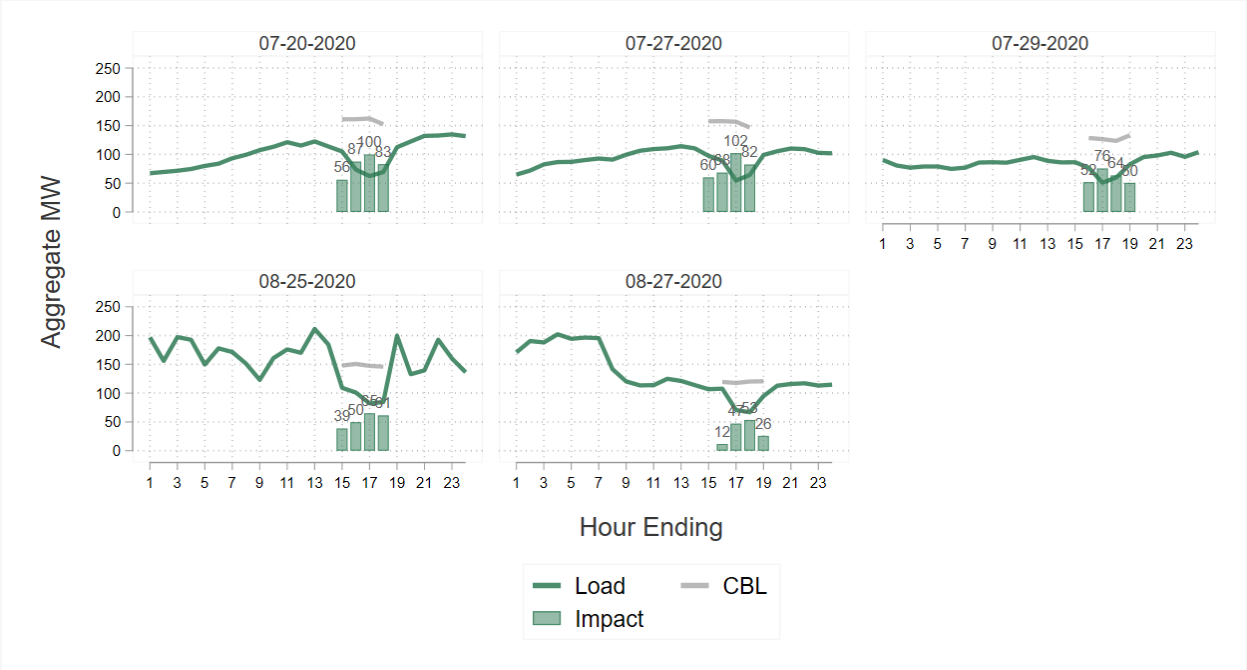
For the seven sites in our sample, the SWE was able to reproduce all inputs that feed into the savings. Table 321 provides a summary of the results.

Table 321: West Penn Power C&I DR Audit Summary

Group	Count	Gross MW Impact - ADM	Gross MW Impact - SWE	% of Total Savings
In SWE Sample	7	66.6	66.6	75.2%
Not in SWE Sample	72	21.9	-	24.8%
Total	**79**	**88.5**	**-**	**100%**

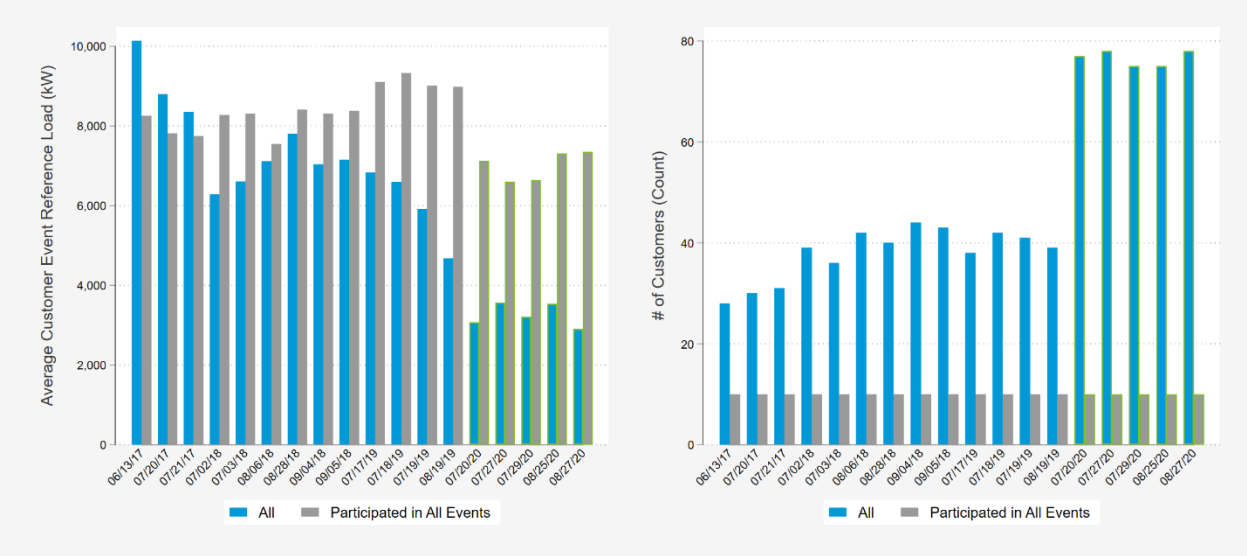
By event day, Figure 131 shows the aggregate load, CBL, and DR impacts (expressed as positive values) for the seven sites in the SWE sample. Note these loads and impacts are not adjusted for line losses. The loads show considerable volatility on 8/25 but are relatively stable across the other four event days. On each day, the load shed is obvious and the CBL-of-CBLs is reasonable.

Figure 131: Aggregate Load, CBL, and Impacts for Sampled Sites



Looking at the average customer reference load on event days in Figure 132, West Penn Power does appear to have a substantial change in PY12, which is highlighted by the blue bars outlined in green on the left panel. In fact, the average event day reference load for participants in PY12 decreased about 45 percent from PY11. The trend for the subset of customers that participated in all events across the four program years decreases, but at a smaller interval. This is highlighted by the gray bars outlined in green on the left panel. On the right panel, the number of participants for each event across the four program years is displayed, and it increases dramatically during the 2020 demand response season. The large increase in participants coupled with the drastic decrease in average event day reference load is likely related to West Penn Power incorporating significantly more small C&I customers into their program. The decreasing trend in the subset of customers who participated across all events likely better portrays the impacts of the COVID-19 pandemic on the West Penn Power demand response program.

Figure 132: The Impact of COVID on Reference Loads



H.6.4 Conclusion

The SWE agrees with the baseline selection procedures and found no errors for the seven C&I sites examined. For the residential BDR component, the ADM team leveraged a lagged seasonal model, which the SWE views as a reasonable approach. Our audit uncovered no issues in ADM's residential BDR analysis. The SWE recommends that the Commission adopt the West Penn Power/ADM verified savings estimates.

H.7 NTG

H.7.1 Residential Programs

ADM and Tetra Tech did not conduct any new NTG research for residential programs during PY12.

Tetra Tech assigned the HERs component of the program an NTG of 1, in accordance with the Evaluation Framework, and was not informed by participant surveys, but assumes that the RCT design eliminates free-ridership and produces negligible SO.

The PY11 NTG was assigned to the HVAC and Residential Appliances Program and the PY10 NTG was assigned to the Appliance Turn-in Program, the Direct Install Program, the New Homes Program, and the Upstream Programs, as was stated in the Evaluation Plan.

The SWE determined that Tetra Tech utilized data collection, question bevies, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 322: Summary of NTG Estimates for West Penn Power Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Appliance Turn-In	0.52	0.0	0.48	-
Program not active in PY12	EE Kits	-	-	-	-
RCT	HERs	-	-	1	-
PY10	Direct Install	0.20	0.24	1.04	-
PY10	New Homes	-	-	0.73	-
PY10	Upstream Lighting	0.77	0.0	0.23	-
PY10	Upstream Electronics	-	-	0.58	-
PY11	HVAC	0.48	<0.01	0.52	-
PY11	Residential Appliances	0.49	0.14	0.65	-

H.7.2 LI Residential Programs

Tetra Tech assigned LIEEP including LI Residential Appliances and Initiatives, LI Residential Appliance Turn-in, LI Direct Install, and LI Energy-Efficiency Kits a NTG of 1, in keeping with the PY12 Evaluation Plan and SWE Phase III Evaluation Framework.

H.7.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY12. C&I NTG values were evaluated in PY10 and PY11 and those values were applied to the C&I Programs for PY12. It has been previously concluded that all PY10 and PY11 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 323: Summary of NTG Estimates for West Penn Power C&I Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Small Energy Solutions for Business Lighting	0.34	<0.01	0.66	-
PY10	Small Energy Solutions for Business Custom	0.47	0.0	0.53	-
PY10	Small Energy Solutions for Business Prescriptive	0.59	0.0	0.41	-
PY10	Small Energy Solutions for Business Appliance Turn-In	-	-	0.48	-
PY10	Small Energy Solutions for Business Direct Install	-	-	0.66	-
PY10	Small Energy Solutions for Business Total	-	-	0.61	-
PY10	Large Energy Solutions for Business Lighting	0.34	<0.01	0.66	-
PY10	Large Energy Solutions for Business Custom	0.47	0.0	0.53	-
PY10	Large Energy Solutions for Business Prescriptive	0.59	0.0	0.41	-
PY10	Large Energy Solutions for Business Total	-	-	0.60	-

H.8 TRC

Table 324 presents TRC NPV benefits, TRC NPV costs, and the TRC Ratios for West Penn Power's PY12 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 PY12 annual report and the model itself was well-organized and documented.

West Penn Power's gross and net portfolio TRC Ratios increased slightly compared to PY11. The Governmental & Institutional Tariff program claimed no energy or demand savings in PY12 so there are no TRC Benefits.

Table 324: Summary of West Penn Power's PY12 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
Appliance Turn-In	$830	$506	1.64	$398	$506	0.79
Energy-Efficient Homes	$5,500	$3,130	1.76	$4,663	$2,773	1.68
Energy-Efficient Products	$7,101	$8,154	0.87	$2,718	$4,299	0.63
Low-Income Energy Efficiency	$435	$1,535	0.28	$435	$1,535	0.28
C&I Energy Solutions for Business – Small	$11,526	$9,863	1.17	$7,116	$7,094	1.00
C&I Energy Solutions for Business – Large	$17,984	$13,287	1.35	$10,738	$8,278	1.30
Governmental & Institutional Tariff	$0	$48	0.00	$0	$48	0.00
C&I Demand Response Program – Small	$80	$54	1.46	$80	$54	1.46
C&I Demand Response Program – Large	$3,733	$1,700	2.20	$3,733	$1,700	2.20
Portfolio Total	**$47,188**	**$38,277**	**1.23**	**$29,879**	**$26,287**	**1.14**

Six of West Penn Power's nine EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. Using net verified savings, five programs were found to be cost-effective and four were not cost-effective. The Appliance Turn-In program were cost-effective under gross verified savings, but not cost-effective under net verified savings, while the Energy-Efficient Products, LI Energy-Efficiency and Governmental & Institutional Tariff programs were not cost-effective using a gross or net basis.

H.8.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- To calculate the avoided cost of natural gas, West Penn Power used the Annual Energy Outlook (AEO) average natural gas price for all users *in the Middle Atlantic* region, as the SWE recommends. The AEO natural gas prices were converted to nominal dollars before the NPV was calculated. West Penn Power's annual electric energy savings are calculated and allocated by month and time of day (on-peak and off-peak). FirstEnergy applies an

on-peak definition from the PJM market that is broader than the on-peak hours defined in the 2016 TRM (Monday – Friday 8AM-8PM). In the 2021 Pennsylvania TRM, on-peak and off-peak energy periods were adjusted to align with the PJM market definition. The adjusted 2021 TRM peak window (Monday – Friday, 7AM-11PM) will now also match the definition used in FirstEnergy's Phase III TRC model. The SWE verified that the avoided costs and load profiles share common on-peak and off-peak definitions.

- West Penn Power used a discount rate of 6.68% to calculate the net present value of future program benefits. This discount rate is based on West Penn Power's WACC and is consistent with their EE&C plan. Line loss adjustment factors varied by sector Residential (1.0943), Small C&I (1.079) and Large C&I (1.079).
- 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 TRC Test Order directive for Phase III.
- 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 that the demand response program TRC Ratio meets the 75% participant cost assumption where 75% of customer incentive payment is used as a proxy for participant cost.
- According to the Phase III Evaluation Framework, LI measures are required to be provided at no cost to the participants. At first glance, it appears that West Penn Power's LI program requires participants to bear a portion of the incremental cost, based on the cost-effectiveness reporting for the LI Energy-Efficiency Program (Table 110 in FirstEnergy's PY12 Annual Report). However, in its Phase III EE&C Plan, West Penn Power explains that these costs are only being allocated to landlords and owners of LI properties, rather than the LI customers, so these programs are consistent with the Act 129 policy directives and the SWE's Evaluation Framework.
- The TRC model followed the protocol specified in the 2016 TRC Test Order pertaining to the treatment of free rider participant costs; free-ridership participant costs are not included in net program costs.
- The TRC model accounted for fossil fuel and water savings benefits under Total NPV Lifetime Non-Electric Benefits. The SWE verified that the savings were accounted for in accordance with the Guidance on Inclusion of Fossil Fuel and Water Benefits in TRC Test memo issued in March 2018. The TRC model reports the cost from increased fossil fuel heating usage due to lighting interactive effects from more efficient lighting as a negative Total NPV Lifetime Non-Electric Benefit. As in past years, the SWE agrees that the cost should be accounted for as a negative non-electric benefit rather than a fossil fuel switching program cost. The TRC model claimed over 24 million gallons per year of water saving, which translates to approximately $1,345,000 in NPV lifetime avoided costs.

- In PY12, the West Penn Power TRC Model incorporated the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures. Table 325 shows that without the dual baseline included in the TRC model, the gross and net TRCs are higher than when the dual baselines are included.

Table 325: West Penn Power Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.23	1.14
Without Dual Baseline	1.45	1.21

H.9 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including West Penn Power, so the annual evaluation reports of the four FirstEnergy EDCs report identical information about the process evaluation. Therefore, the SWE's audit summary, previously described for Met-Ed, applies to all four FirstEnergy utilities, including West Penn Power.

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 326: PA Statewide Energy-Efficiency Budgets and Expenditures

EDC	Actual PY12 Expenditures	Approved Budget for PY12
PECO	$67,044	$72,632
PPL	$44,123	$52,657
Duquesne Light	$16,757	$17,510
FE: Met-Ed	$10,323	$19,375
FE: Penelec	$8,245	$19,088
FE: Penn Power	$2,639	$5,140
FE: West Penn Power	$11,602	$19,013
Statewide	**$160,733**	**$205,415**

Table 327: PA Statewide Gross Verified Annual and Lifetime MWh Savings

EDC	Gross Verified Annual Savings (PY12)	Gross Verified Lifetime Savings (PY12)
PECO	559,940	5,384,832
PPL	246,183	3,320,667
Duquesne Light	103,486	1,371,121
FE: Met-Ed	102,958	993,725
FE: Penelec	81,623	774,706
FE: Penn Power	23,599	219,145
FE: West Penn Power	104,990	1,061,114
Statewide	**1,222,779**	**13,125,310**

Table 328: PA Statewide Net Verified Annual and Lifetime MWh Savings

EDC	Net Verified Annual Savings (PY12)	Net Verified Lifetime Savings (PY12)
PECO	424,486	4,091,786
PPL	166,077	2,154,778
Duquesne Light	76,839	986,510.00
FE: Met-Ed	66,919	592,745.86
FE: Penelec	60,584	592,421.48
FE: Penn Power	17,151	156,519.68
FE: West Penn Power	65,577	635,884.67
Statewide	**877,632**	**9,210,645**

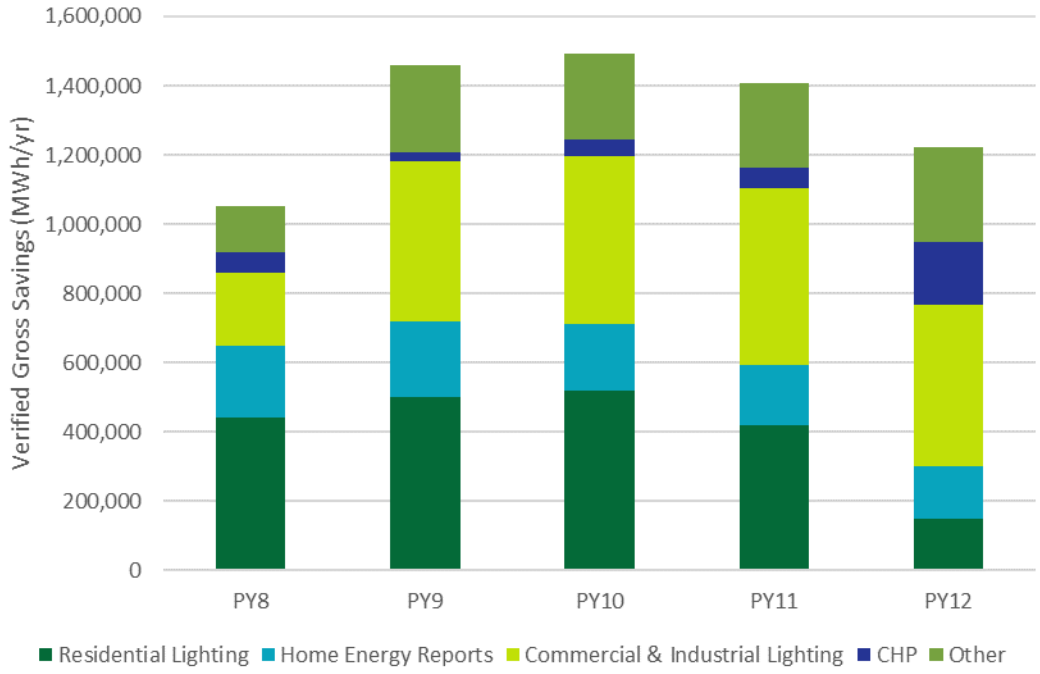
Appendix J Top Offerings

J.1 Top Saving Programs for Phase III

Three initiatives – Residential Lighting, Home Energy Reports, and Commercial & Industrial Lighting – contributed the majority of verified gross energy savings in the Commonwealth during each year of Phase III. These three initiatives totaled approximately 80% of the portfolio verified gross savings each year through PY11 but declined to 63% of statewide savings in PY12 largely because of the decline of residential lighting to 12% of statewide savings (after averaging 35% of annual statewide savings in PY8 through PY11). In PY12, savings from CHP projects increased to 15% of statewide savings, partially offsetting the notable reduction in savings attributable to Residential Lighting.

Figure 133 shows the contribution to each program year in Phase III from these initiatives, with "Other" representing all other initiatives offered in each program year.

Figure 133: Top Saving Program Performance Through Phase III



J.2 Top Saving Programs for PY12

The Pennsylvania EDCs support a wide range of energy-efficient equipment and technology in their Phase III EE&C plans. Despite the diverse set of offerings, PY12 gross verified energy savings came largely from four offerings: residential lighting (including upstream and non-upstream lighting), Home Energy Reports (HERs), non-residential lighting, and CHP. All seven

EDCs participated in these offerings in Phase III. In PY12, the four offerings contributed 78% of the verified gross energy savings in the Commonwealth. Table 329 shows the contribution to PY12 portfolio savings from each of the three primary offerings by EDC.

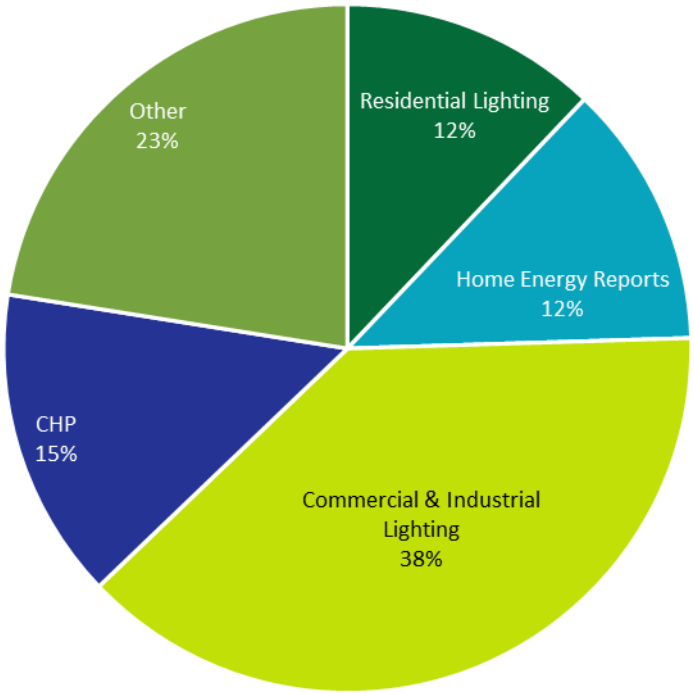
Table 329: PY12 Energy Savings from the Top Four Offerings

EDC	PY12 Verified Gross (MWh/yr)	Residential Lighting (MWh/yr)	HER (MWh/yr)	Commercial Lighting (MWh/yr)	CHP (MWh/yr)	Percent of PY12 MWh from Top 4
PECO	559,940	95,843	68,367	157,724	165,298	87.02%
PPL	246,183	3,055	13,097	127,337	10,486	62.54%
Duquesne Light	103,486	1,669	7,308	65,395	-	71.87%
FE: Met-Ed	102,958	13,353	22,692	40,465	-	74.31%
FE: Penelec	81,623	14,294	15,397	32,350	-	76.01%
FE: Penn Power	23,599	3,173	5,535	8,017	-	70.87%
FE: West Penn Power	104,990	16,554	19,093	37,127	3,298	72.46%
Statewide	**1,222,779**	**147,941**	**151,489**	**468,414**	**179,082**	**77.44%**

*Upstream residential lighting (including savings from cross-sector sales), plus non-upstream residential lighting.

Figure 134 displays the distribution of energy savings from residential lighting, non-residential lighting, HERs, and all other offerings. Only 23% of statewide savings occurred outside of the four largest offerings.

Figure 134: PY12 Distribution of Energy Savings from the Top Four and All Other Offerings



Eighty-four percent of the PY12 residential lighting energy savings came from upstream retail lighting programs, while the other 16% were achieved via lighting distributed through kits and direct install offerings. In PY12, the contribution from Residential Lighting moved into fourth place, below both CHP and Home Energy Reports for the first time in the phase. Overall, residential and C&I lighting combined accounts for 50% of statewide PY12 verified gross savings and 63% of verified gross savings for Phase III. Lighting measures accounted for 62% of all MWh savings in PY8, 66% of MWh savings in PY9, and 65% of MWh savings in PY10, 66% of MWh savings in PY11.

J.2.1 Residential Lighting

Residential lighting, and upstream lighting in particular, has historically been one of the primary sources of energy savings for EDCs. Starting in PY12, the baseline for residential general service lamps was reduced to 45 lumens per watt to comply with the EISA 2020 "backstop" provision. PPL and Duquesne Light did not offer upstream lighting programs in PY12. Figure 135 displays the percent of statewide gross energy savings from residential lighting between PY8 and PY12. The proportion of gross savings from residential lighting declined significantly between PY11 and PY12, from 30% to 12%.

Figure 135: PY8-PY12 Percent of Verified MWh from Residential Lighting

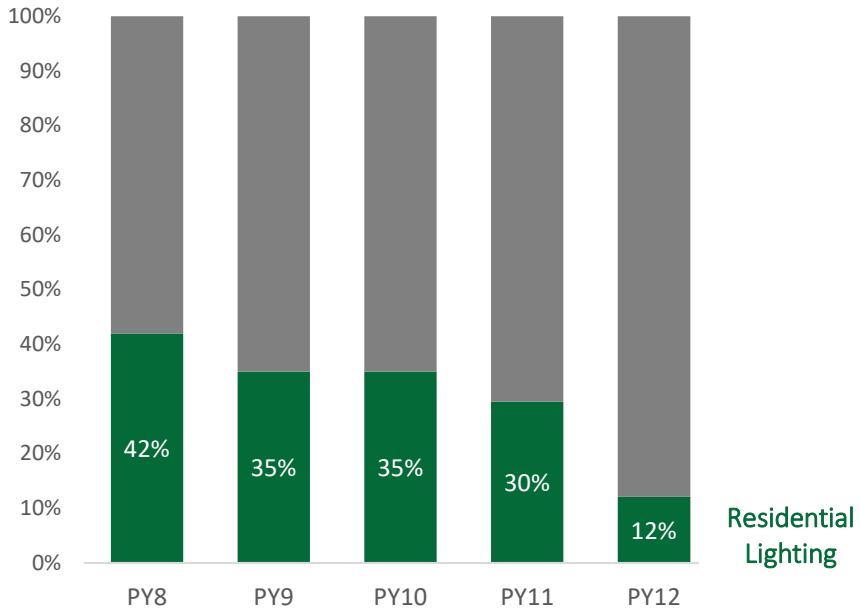


Table 330 displays PY12 energy savings from residential lighting by EDC. Having cancelled their upstream lighting programs, PPL and Duquesne Light had the lowest proportion of savings from residential lighting (1% and 2%, respectively) while PECO and Penelec had the highest (17% and 18%, respectively).

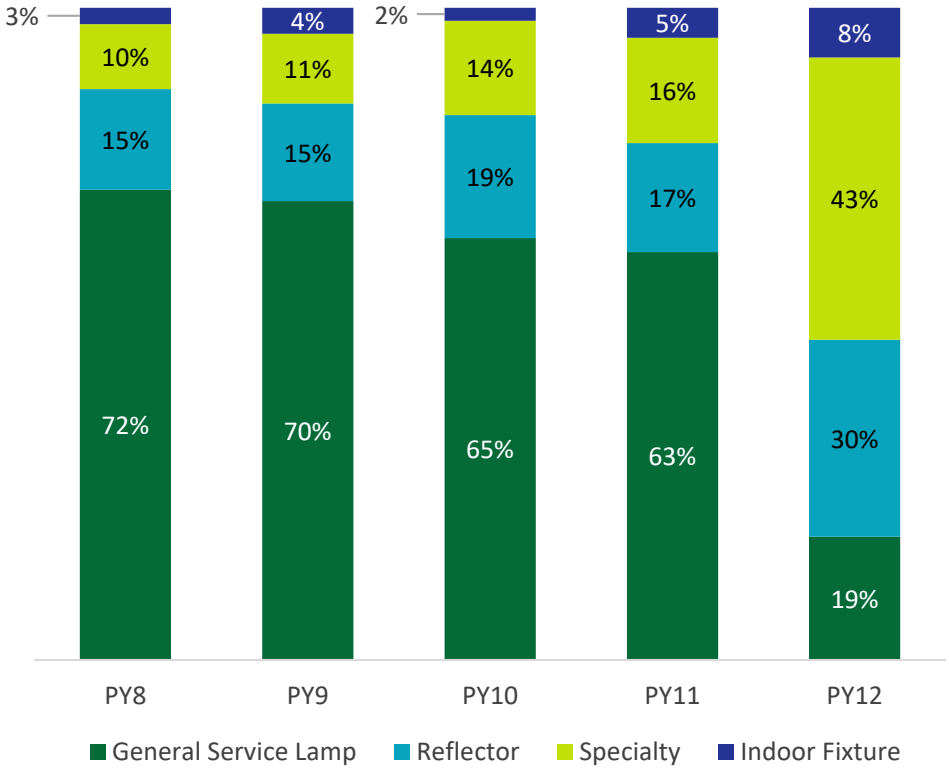
Table 330: PY12 Energy Savings, Upstream Residential Lighting, Non-Upstream Residential Lighting, and All Residential Lighting

EDC	PY12 Verified Gross (MWh/yr)	Upstream Res Lighting (MWh/yr)*	Non-Upstream Res Lighting (MWh/yr)	All Res Lighting (MWh/yr)	Percent of PY12 MWh from Res Lighting
PECO	559,940	79,020	16,823	95,843	17%
PPL	246,183	0	3,055	3,055	1%
Duquesne Light	103,486	0	1,669	1,669	2%
FE: Met-Ed	102,958	12,565	788	13,353	13%
FE: Penelec	81,623	13,845	449	14,294	18%
FE: Penn Power	23,599	2,886	287	3,173	13%
FE: West Penn Power	104,990	15,645	909	16,554	16%
Statewide	**1,222,779**	**123,961**	**23,980**	**147,941**	**12%**

*The SWE notes that upstream lighting includes savings from cross-sector sales (i.e., upstream lighting customers install in commercial settings).

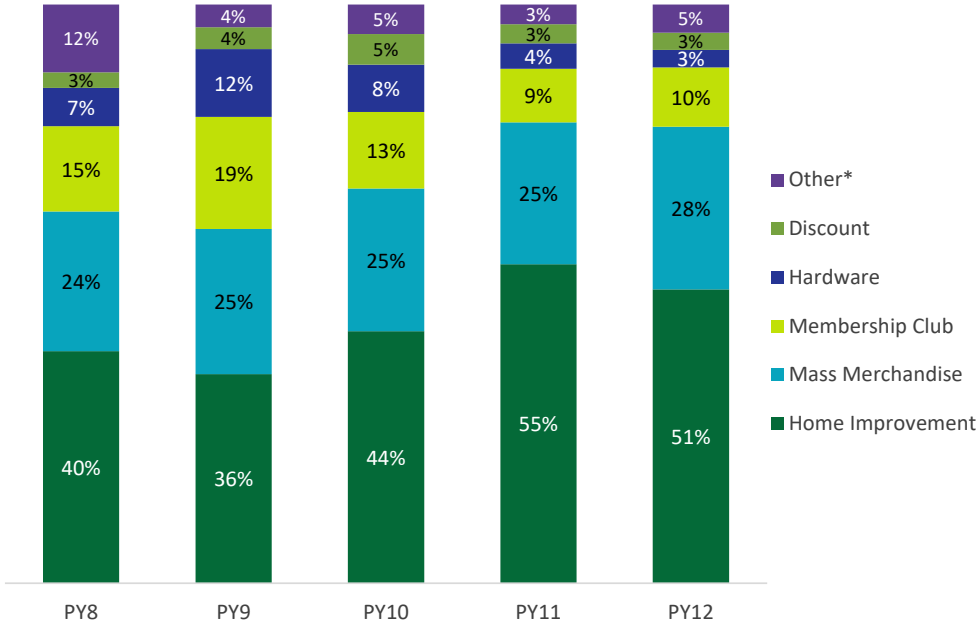
The distribution of upstream lighting products by product type changed significantly between PY11 and PY12. Savings from general service lamps were reduced by the EISA 2020 “backstop” provision, but savings from other lighting products were not affected. Therefore, EDCs could maximize residential lighting savings by promoting these other lighting products. Figure 136 shows that specialty lamps (43%) and reflectors (30%) accounted for the majority of PY12 upstream lighting sales, while general service lamps accounted for only 19% of sales.

Figure 136: PY8-PY12 Upstream Lighting Sales by Product Type



The distribution of statewide upstream lighting products sold by retail channel changed very little in PY12. As shown Figure 137, home improvement stores (51%) and mass merchandise stores (28%) moved the majority of PY12 upstream lighting products.

Figure 137: PY8-PY12 Upstream Lighting Sales by Retail Channel



*Other includes grocery, lighting and electronics, and independent stores.

J.2.1.1 Cross-Sector Sales

Cross-sector sales rates represent the proportion of residential upstream program bulbs customers install in small commercial settings. Bulbs installed in commercial settings are subject to higher HOU, resulting in higher kWh and kW savings. Cross-sector sales rates determine the share of program savings and costs attributable to the small commercial class. None of the EDCs conducted cross-sector sales research in PY12. Table 331 displays the cross-sector sales rates EDCs applied in PY12, the study period they were estimated, and the method used to estimate them.

Table 331: PY12 Upstream Lighting Cross-Sector Sales Rates

EDC	Cross-Sector Sales Rate	Study Period	Method
PECO	1.5%*	PY8	In-store intercept survey
FE Companies	7.1%	PY8	General population survey of residential customers

* Respondent bulb weighted average was 0.73% for standard LEDs and 2.0% for specialty LEDs.

J.2.1.2 LED Price Trends, PY12

Figure 138 shows sales-weighted average manufacturer suggested retail prices (MSRPs) for A-lines by program year. Comparisons between PY12 and other program years should be made with caution, as PECO was essentially the only EDC to support A-lines in PY12 (PPL's online marketplace provided incentives on 28 A-lines in the first quarter). That said, prices were up a tick compared to PY11 but down relative to the beginning of the phase. Figure 139 shows sales-weighted average MSRPs for LED candelabras, globes, and reflectors by program year. Like with A-lines, readers should exercise caution when comparing PY12 with other program years, as the majority of these bulbs went through PECO's upstream lighting program. Thus, the sales-weighted averages in PY12 tilt towards PECO more than they did in prior program years. For candelabras and globes, PY12 prices were comparable to PY11 prices. For reflectors, sales-weighted MSRPs increased in PY11 and PY12. The increase in PY11 was largely driven by PECO, as they had a number of higher-priced reflectors go through the program in PY11. The increase in PY12 can be similarly explained – the weighted average tilts towards PECO because other EDCs incented fewer bulbs relative to prior program years, and PECO began supporting higher-priced reflectors in PY11.

Figure 138: PY8 – PY12 LED Prices – A-lines

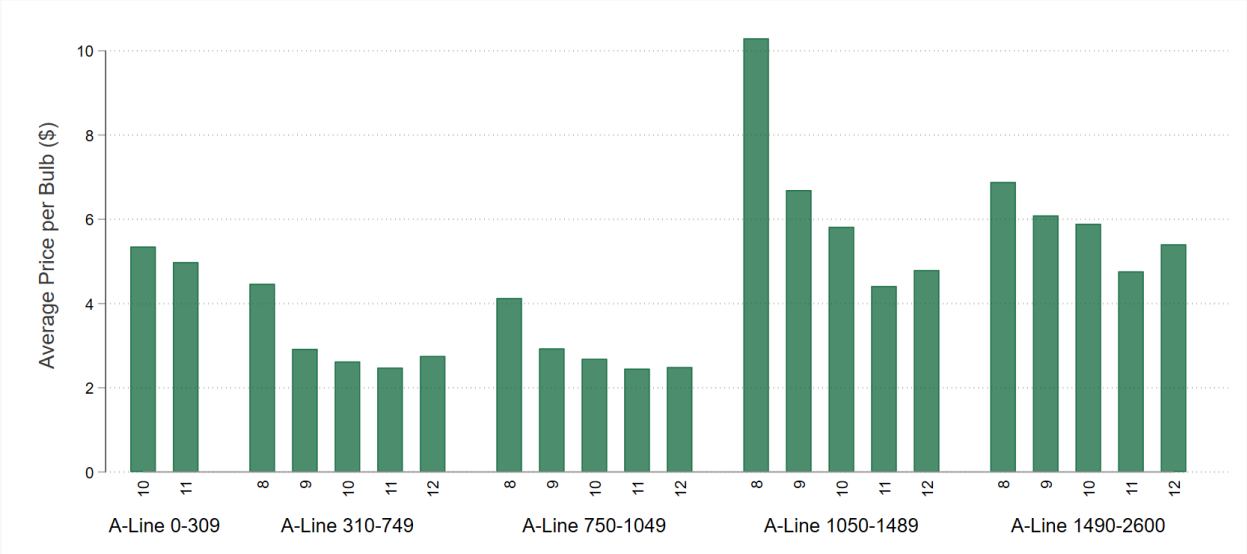
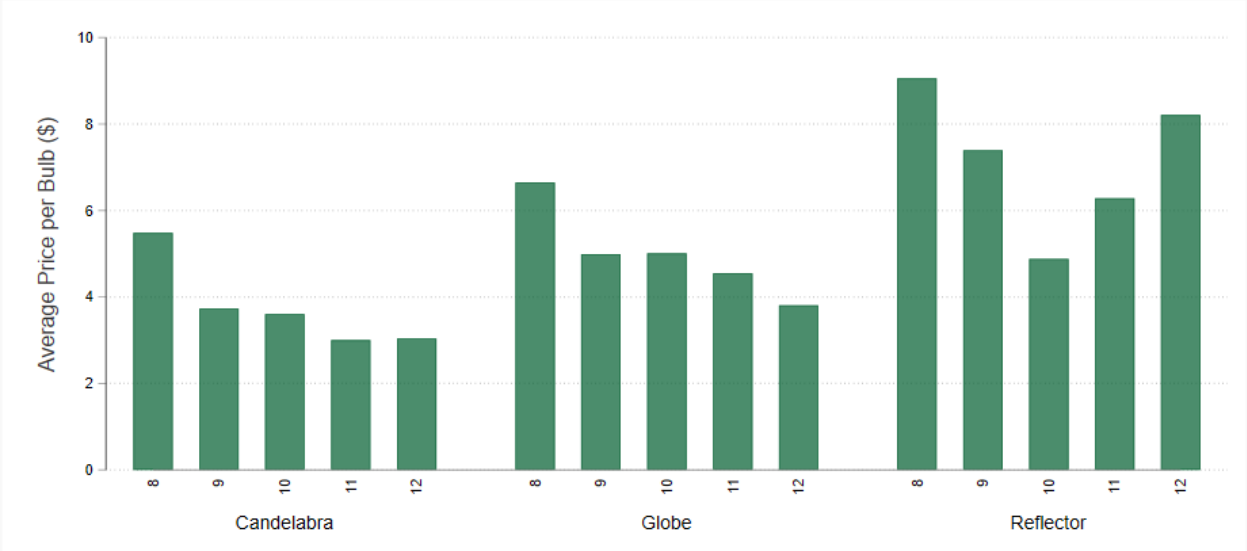


Figure 139: PY8 – PY12 LED Prices – Candelabras, Globes, and Reflectors



J.2.1.3 EDC Upstream Lighting Incentive Levels and Sales Volume

The SWE reviewed sales-weighted average MSRPs, rebated prices, and incentive levels for the LED bulbs in the PY12 upstream lighting programs. For each EDC, summary statistics are shown in Table 332. The first four columns in the table (average MSRP, average discounted price, average incentive, and percent discount) exclude LI upstream bulbs, giveaway bulbs, fixtures/kits, and records with manufacturer incentives, and the counts strictly reflect upstream bulbs. The average prices and incentive levels are per bulb (not pack). Note that PPL and Duquesne Light did not have an upstream lighting offering in PY12. FirstEnergy companies did not provide MSRPs, so percent discounts could not be calculated for FirstEnergy companies. PECO reported identical MSRPs and rebated prices for all PY12 lighting records. The SWE recalculated retail prices for PECO by adding per-bulb incentives to per-bulb discounted prices. For PECO and PPL, MSRPs are higher than they have been in the past, but this can be explained by the mix of bulbs moving through the program (more specialty and smart Wi-Fi enabled bulbs, which are more expensive than A-line bulbs, than in prior years). PPL incentives were also higher than they had been in the past, but volume was much lower, and these bulbs were purchased via the online marketplace (which provided higher discounts in PY11 than the discounts given at the register in retail stores).

Table 332: Variation in LED Incentives Across EDCs

EDC	MSRP	Discounted Price	Incentive	% Discount	PY12 LED Bulbs	Bulbs / Household
PECO	$5.34	$4.00	$1.34	25%	2,123,075	1.4
PPL	$5.56	$1.99	$3.57	64%	1,047	0.0
Duquesne Light	NA	NA	NA	NA	0	NA
FirstEnergy Companies	NA	NA	$0.96	NA	1,013,631	0.6

J.2.2 HERs

Almost 900,000 Pennsylvania homes received HERs in PY12. This represents approximately 17% of the residential electric accounts served by the EDCs subject to Act 129. Table 333 summarizes the average number of residential accounts according to 2020 FERC Form 861 filings[85] and PY12 HER recipients by EDC. Recipient counts are PY12 averages rounded to the nearest thousand. PPL largely discontinued its Home Energy Education program in PY12 so the total number of homes receiving HERs was lower in PY12 than prior years of Phase III.

Table 333: PY12 Statewide HER Summary Statistics

EDC	Residential Premises	PY12 HER Recipients	Percent of Homes Receiving HERs
PECO	1,502,000	380,000	25%
PPL	1,271,000	15,000	1%
Duquesne Light	543,000	58,000	11%
FE: Met-Ed	509,000	125,000	25%
FE: Penelec	498,000	130,000	26%
FE: Penn Power	147,000	20,000	14%
FE: West Penn Power	627,000	150,000	24%
Total	**5,097,000**	**878,000**	**17%**

In addition to the homes receiving HERs, many additional Pennsylvania homes are part of HER control groups. HER programs are delivered using an experimental design known as a randomized control trial (RCT). In an RCT, eligible homes are randomly assigned into either a treatment or a control group. Random assignment ensures that the two groups use energy the same way prior to HER exposure. It also means that the only plausible explanation for observed differences in energy consumption following HER exposure is the program intervention.

Table 334 presents the average evaluated PY12 kWh savings per HER recipient, as well as the total electric usage (with HER savings added back) and percent reduction. Average percent savings ranged from 0.8% to 1.7% per household.

[85] Annual Electric Power Industry Report, Form EIA-861 detailed data files. https://www.eia.gov/electricity/data/eia861/

Table 334: HER Average Impacts by EDC

EDC	PY12 kWh Usage (HER Recipients)	Average PY12 kWh Savings per Recipient	Average Percent Reduction
PECO	12,924	221	1.7%
*PPL	7,730	108	1.4%
Duquesne Light	7,771	126	1.6%
FE: Met-Ed	13,893	179	1.3%
FE: Penelec	10,229	115	1.1%
FE: Penn Power	13,906	232	1.7%
FE: West Penn Power	15,272	124	0.8%
Statewide Total	**12,657**	**175**	**1.4%**

* Includes five months of consumption and savings for cohorts last treated in PY11

Because of the RCT design, HER impact evaluations directly estimate verified net savings. No adjustments for free-ridership or spillover (SO) are needed because the control group does everything the treatment *would have done* absent program exposure.

J.2.2.3 HER Contribution to LI Targets

Six of the seven EDCs use HERs mailed to known LI households to achieve energy savings towards their LI compliance target. PECO is the only EDC that did not have one or more dedicated cohorts of LI households in PY12, per PECO's agreement with stakeholders to only use the dedicated Residential LI Program and solutions, that do not include a behavioral solution, to count savings towards the carveout. PECO does have LI customers in the behavioral program but does not count the savings towards the carveout. PPL revaluated the October 2014 LI wave to identify which customers are still at or below 150% of the Federal Poverty Income Guidelines. The remaining cohort of customers at or below 150% of the Federal Poverty Income Guidelines included approximately 15,000 households and produced 822 MWh of gross verified savings in PY12. Table 335 shows the PY12 verified gross LI savings for each EDC and how much of the energy savings came from HER programs. The FirstEnergy EDCs were particularly reliant on HERs for LI savings in PY12 as the COVID-19 pandemic limited in-home program delivery operations and the EDCs discontinued their energy-efficiency kits offering.

Table 335: Contribution Towards LI Targets from HERs

EDC	PYVTD LI MWh	PYVTD LI MWh from HERs	Percent of PY12 LI Savings from HERs
PECO	14,840	0	0.0%
PPL	10,852	822	7.6%
Duquesne Light	6,076	1,714	28.2%
FE: Met-Ed	3,688	2,231	60.5%
FE: Penelec	2,520	1,197	47.5%
FE: Penn Power	755	639	84.6%
FE: West Penn Power	2,405	1,258	52.3%
Statewide Total	**41,136**	**7,861**	**19.1%**

J.2.2.4 HER Contributions to Portfolio Totals

Figure 140 shows the gross verified MWh savings attributable to HER programs, by EDC, for each year of Phase III. The statewide total declined each year from PY9 to PY12. This is expected because each year, somewhere between 4% and 8% of treatment group households will close their account. This churn reduces the total number of households in the cohort that receive HERs.

Figure 140: Verified MWh Savings from HERs, by EDC and Program Year

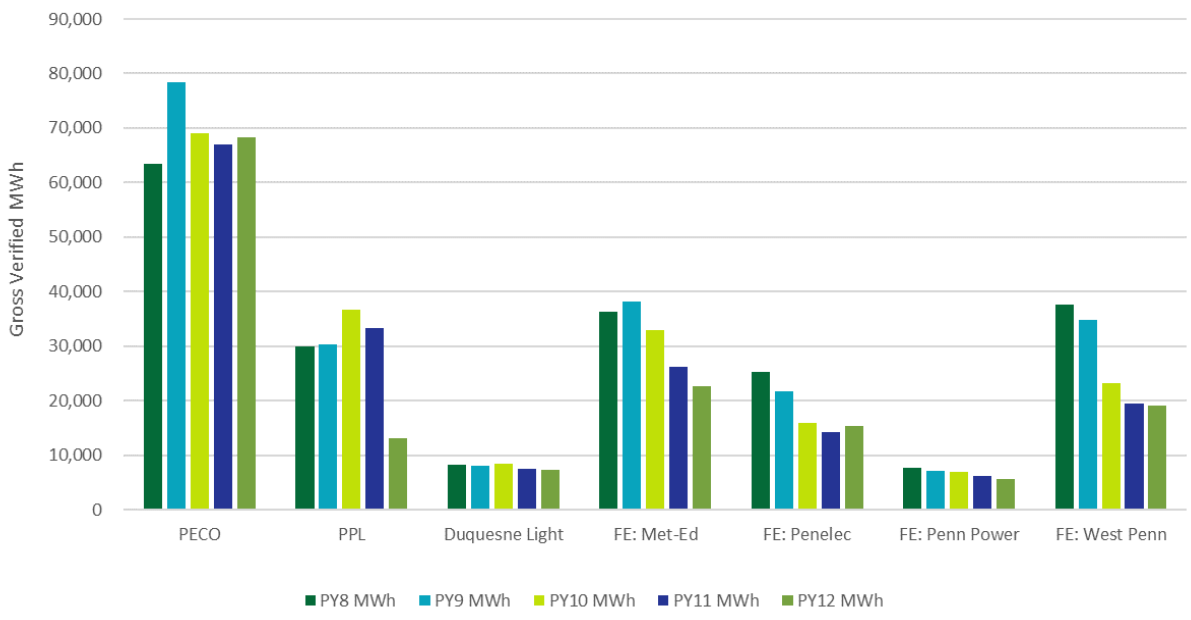


Table 336 looks at HER verified savings as a percentage of all compliance savings recorded in a program year. HER contribution has decreased each year of Phase III. In PY8, HER offerings accounted for 20% of all gross verified savings. The share dropped to 15% in PY9, 13% in PY10, and down to 12% in PY11 and PY12.

Table 336: HER Contribution to Portfolio Savings, by EDC and Program Year

EDC	PY8 Share	PY9 Share	PY10 Share	PY11 Share	PY12 Share
PECO	30%	20%	16%	14%	12%
PPL	9%	8%	9%	9%	5%
Duquesne Light	12%	8%	9%	8%	7%
FE: Met-Ed	26%	22%	18%	18%	22%
FE: Penelec	19%	14%	8%	10%	19%
FE: Penn Power	20%	12%	12%	13%	23%
FE: West Penn Power	29%	18%	16%	15%	18%
Statewide	**20%**	**15%**	**13%**	**12%**	**12%**

J.2.3 Non-Residential Lighting

Non-residential lighting improvements accounted for 38% of statewide PY12 energy savings. These projects largely utilized TRM provided measure methodologies, with smaller shares of savings being achieved through midstream lighting programs and custom measure protocols. Light emitting diode (LED) technologies have rapidly increased market share in the last several years, now accounting for a significant majority of all PY12 non-residential lighting improvements in both downstream and midstream programs. Fluorescent lighting technologies did not contribute a significant share of energy savings in PY12 (less than 0.30% of verified energy savings for non-residential lighting improvements).

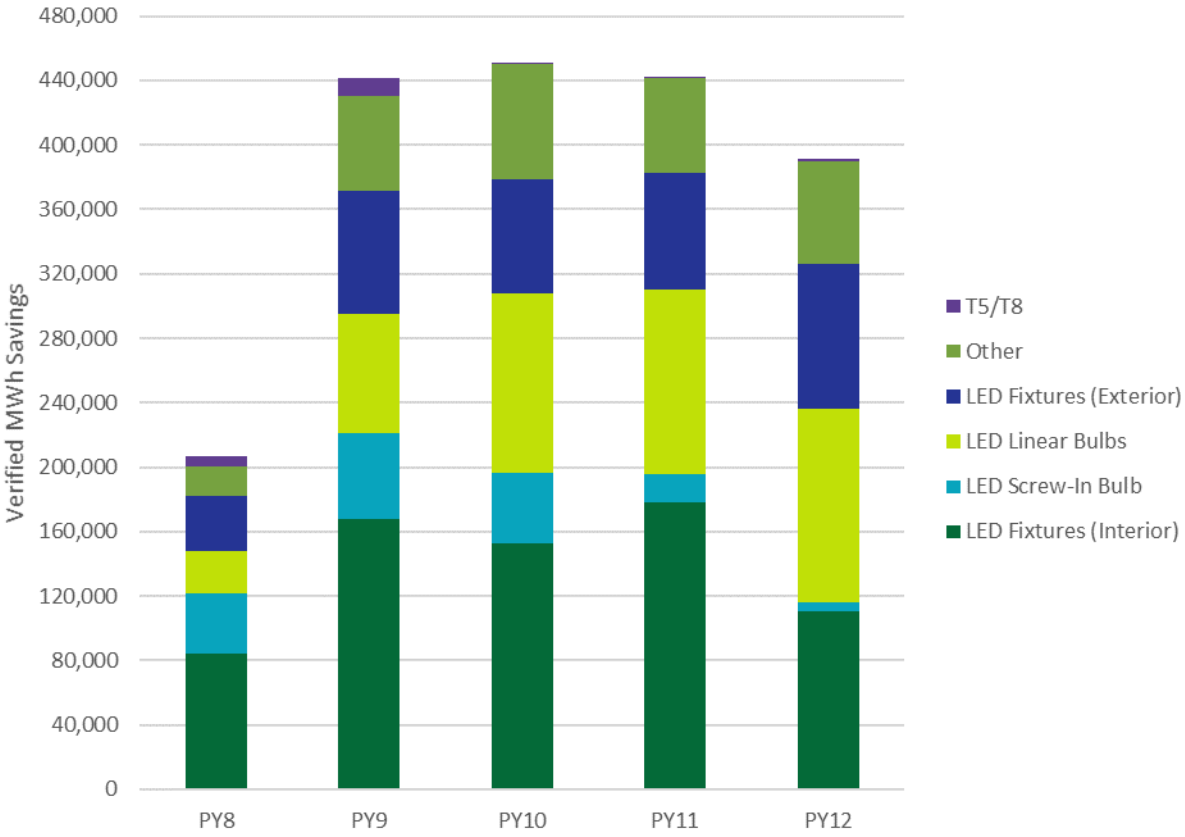
J.2.3.1 Downstream Lighting Programs

Downstream offerings continue to dominate the lighting programs across the EDCs and represent the single largest program offering, accounting for 32% of statewide PY12 verified gross energy savings. Downstream programs provide direct incentives for business customers who upgrade their facilities with energy-efficient equipment. Typically, pre-determined incentives are made available to customers for common energy-efficiency measures to facilitate the implementation of cost-effective energy-efficiency improvements. To participate in a downstream program, a customer typically applies with requested project documentation, such as invoices, project specification sheets, and other applicable information.

LED technology improvements have rapidly matured in the last several years, which have been readily accepted by non-residential customers and lighting contractors. LED technologies include direct lamp replacement options for linear, screw-in, and high-intensity applications, along with integral LED fixture replacements for interior low-bay and high-bay applications, exterior lighting, and street lighting. In addition to LED lighting lamp and fixture technologies, the availability of enhanced control options integrated with LED fixtures is increasing.

Figure 141 shows verified energy savings for Program Years 8 through 12 for downstream lighting offerings. The level of achieved energy savings in PY12 decreased relative to the savings achieved in PY11, with the largest decrease attributable to interior LED fixtures. Savings from exterior LED fixtures increased relative to PY11. Overall, LED technologies accounted for at least 86%[86] of PY12 verified non-residential downstream lighting energy savings.

Figure 141: PY8 – PY12 Downstream Lighting Technologies



J.2.3.2 Midstream Lighting Programs

Three EDCs – Duquesne Light, PPL, and PECO – offered a midstream lighting program in PY12.[87] Energy savings contribution results from the three EDCs offering midstream lighting programs in PY12 are presented in Table 337. The combined savings from these programs are about 16% of all verified non-residential lighting savings in PY12 but totals 22% of non-residential lighting savings for the three EDCs with midstream programs.

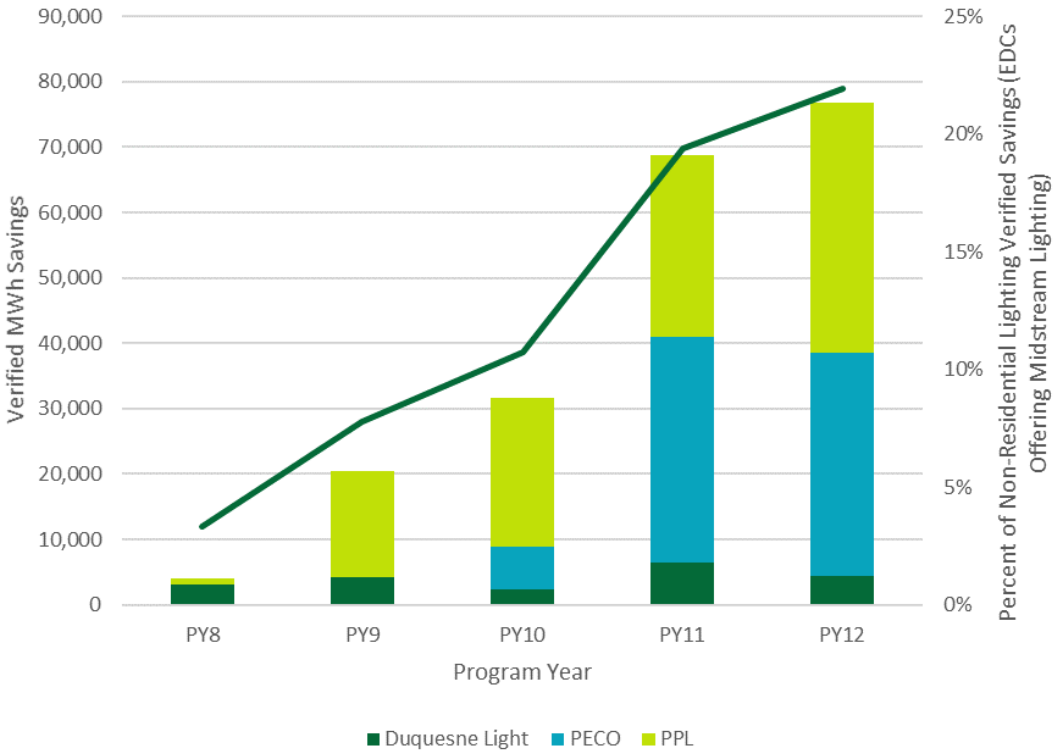
[86] The "Other" category largely includes measures tracked as "Custom," "Lighting-Other," etc. that do not designate a specific lighting technology.
[87] Both PPL and Duquesne Light's midstream lighting programs began in PY8. PECO's program began in PY10.

Table 337: Midstream Lighting Verified Energy Savings by EDC

EDC	Total Non-Residential Lighting (MWh)	Midstream Lighting (MWh)
Duquesne Light	65,395	4,406
PECO	157,724	34,228
PPL	127,337	38,196

Figure 142 illustrates how the midstream components of non-residential lighting have expanded through Phase III. PECO's program was a new offering in PY10 and saw steady participation from PY11 to PY12. PPL's midstream program noticeably increased in total verified energy savings in PY12 by 10 MWh from PY11. Duquesne Light's PY12 midstream lighting savings totaled 4,406 MWh for PY12.

Figure 142: PY8 – PY12 Midstream Non-Residential Lighting Programs



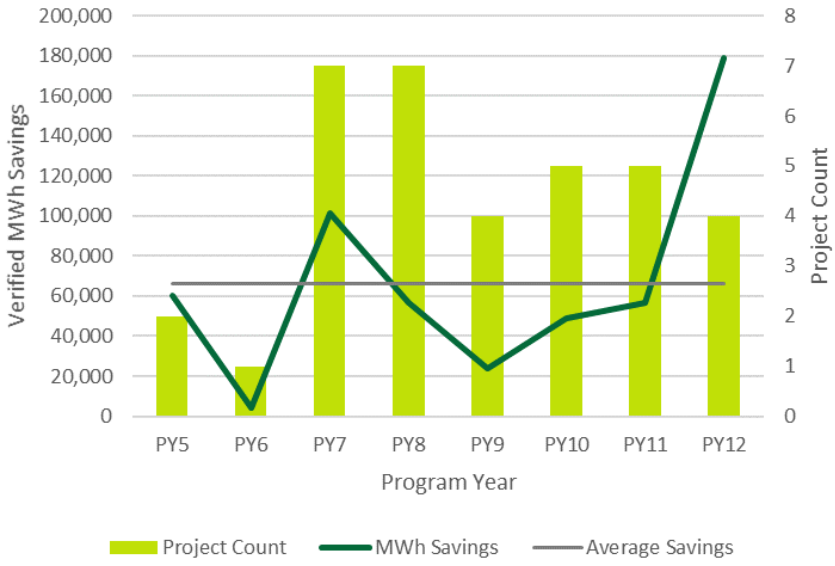
Because of the anticipated expansion of midstream lighting offerings, the SWE developed an Interim Measure Protocol (IMP) for Midstream Lighting Programs that went into effect for PY11. Because midstream lighting was not included in the 2016 TRM, the IMP was developed to ensure consistency between EDCs regarding evaluation data collection, lamp wattage assumptions, treatment of fixtures with integrated controls, etc. This IMP was used by all three EDCs to calculate midstream lighting savings in PY12. For Phase IV, the 2021 TRM includes a midstream lighting section.

J.2.4 Combined Heat and Power (CHP)

The PUC has made a commitment to advance the prevalence of CHP and released a Final Policy Statement on CHP in April of 2018, which is designed to advance the deployment of CHP technology throughout Pennsylvania. The four CHP projects completed in PY12 accounted for nearly 15% of the statewide gross verified savings.

Figure 143 shows the energy savings contributions from Act 129 CHP projects over the past eight years.[88] The average CHP contribution is 66,481 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. Relative to the prior year, CHP projects in PY12 significantly increased in verified energy savings, but PY12 participation saw one less project than PY11. PY12 verified savings for CHP projects were 179,082 MWh, which is a 216% increase (122,423 MWh) from PY11, making PY12 the program year with the largest energy savings resulting from CHP projects.

Figure 143: Historical CHP Savings



[88] Energy savings contributions for CHP projects from PY5-PY7 are derived from annual reports issued in Phase II of Act 129.

In PY12, four CHP projects were completed by three EDCs – PECO, PPL, and West Penn Power – as shown in Table 338.

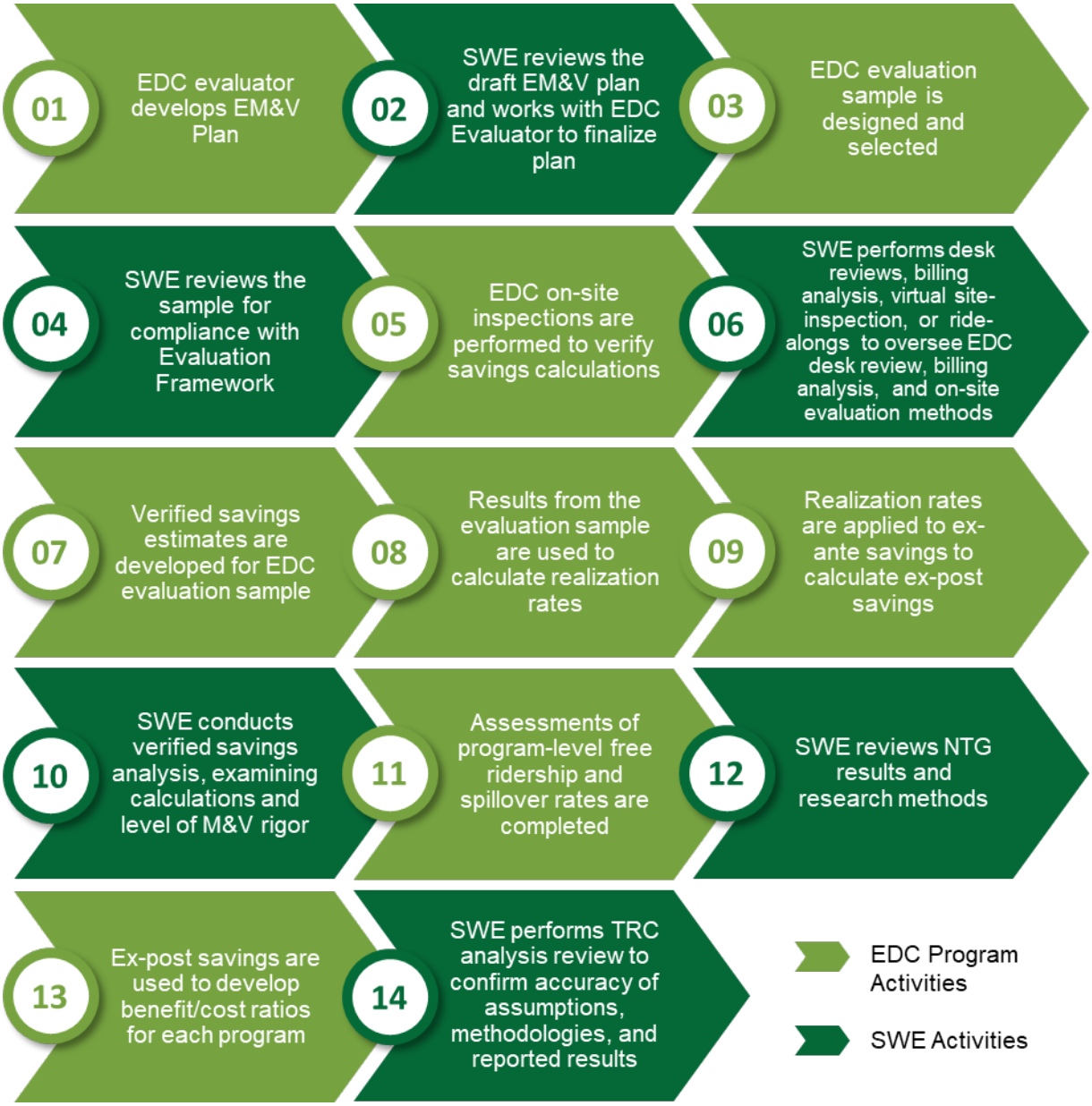
Table 338: PY12 CHP Verified Energy Savings and Realization Rate by EDC

EDC	Qty	Verified Savings (MWh)	Realization Rate
PECO	2	165,298	82%
PPL	1	10,486	100%
FE: West Penn Power	1	3,298	100%

Appendix K Cross-Cutting SWE Activities

This section presents a summary of the audit and cross-cutting activities conducted by the SWE during PY12, 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 144 presents a diagram of the C&I and residential audit process for ex-post or verified savings.

Figure 144: The SWE Audit Activities[89]



[89] The figure shows both gross and net components of the C&I and residential audit process, including the TRC audit approach.

K.1 TRM UPDATE

The Pennsylvania TRM provides algorithms and assumptions for calculation of energy and peak demand savings from prescriptive measures. Implementation Conservation Service Providers (ICSPs) use the TRM to calculate reported gross savings, and EDC evaluation contractors use the TRM to calculate gross verified savings. Having each of the seven EDCs subject to Act 129 utilize common set of formulas and inputs promotes statewide consistency. Following the TRM gives EDCs a degree of certainty when calculating progress towards compliance targets because the TRM is formally issued by the Commission, following a formal comment and reply comment process.

K.1.1 2016 TRM Interim Measure Protocols (IMPs)

As described in the Evaluation Framework, IMPs are used for measures that do not exist in the TRM, and for additions that expand the applicability of an existing 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, to maintain a database for new/revised measure protocols that should be included in subsequent TRM updates. This catalogue is also for EDCs to use to claim reported savings, and for evaluators to follow when determining verified savings.

There was one IMP reviewed and approved during PY12, for cold climate air source heat pumps. Note that the PY12 Midstream Lighting IMP was approved during PY11.

K.1.2 2021 TRM Interim Measure Protocols (IMPs)

During PY12, the SWE received inquiries from several EDC evaluators about developing IMPs for nearly 30 measures that either (1) were not covered by the 2021 TRM or (2) did not have protocols for midstream program delivery. The SWE worked with TUS staff and the EDCs to prioritize IMPs and finalized residential and commercial HVAC midstream delivery IMPs during PY12.

In addition, the SWE drafted IMPs for midstream delivery of commercial hot food holding cabinets and commercial fryers. Both IMPs were finalized early in PY13.

K.1.3 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 the gross impact evaluation, NTG analysis, process evaluation, and cost-effectiveness evaluation activities and outcomes separately.

In PY8, the SWE reviewed and provided feedback on detailed evaluation plans that addressed evaluation activities for all of Phase III. For PY12, EDC evaluation contractors submitted redline versions for proposed adjustments and modifications for evaluation activities in PY12.

The SWE reviewed the revised PY12 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 PY12.

K.1.4 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. For Phase III, 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, which are a foundation of other audit activities, are consistent with the EDC's records.

K.1.5 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.[90] The SWE cross-checks actual program files, receipts, invoices, and work orders against their corresponding database entries to verify that the EDCs have reported program data correctly and consistently. This "project file review" is designed to audit the accuracy of the savings values stored in the EDC tracking system and to confirm that the EDCs' calculations were performed in accordance with the current TRM. The uploaded project files include project savings calculation workbooks, specification sheets for equipment installed, invoices, customer incentive agreements, and post-inspection forms. Through these reviews, the SWE verifies that

[90] 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.

the equipment quantities, efficiency levels, and savings values recorded in project files and the program tracking database are consistent.

K.1.6 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 submission of their annual reports, EDC evaluation contractors are required to submit the supporting work products for audit. These datasets, calculation workbooks, and EDC annual reports, are the basis for the SWE verified savings audit. Based on the results of the verified savings audit, the SWE makes one of the three recommendations to the PUC for a given initiative:

1. The SWE agrees with the verified savings calculations and results and suggests the PUC count the reported total towards 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 1% of savings (MWh) at the portfolio level, EDCs refile their annual report to correct the error. If the magnitude of the error is less than 1% of savings (MWh), 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.

K.1.7 Ad Hoc Tasks

K.1.7.1 Guidance Memo for ENERGY STAR Dehumidifiers, Version 5.0, and the 2016 TRM for PY12

The SWE developed a memo, released on May 1, 2021, to provide guidance to the EDCs and their evaluators, for calculating gross savings for ENERGY STAR Dehumidifiers that are certified under the Version 5.0 and 4.0 specifications

The guidance was needed because the 2016 TRM algorithm for dehumidifiers is based on version 3.0 of the ENERGY STAR specification and a baseline of the 2012 federal minimum standards, both of which use Energy Factor (EF) as the metric of efficiency. Version 5.0 of the ENERGY STAR dehumidifier specifications, which went into effect on October 31, 2019, and introduced a new energy-efficiency metric for dehumidifiers, the ‘Integrated Energy Factor (IEF)’ to replace the old metric, Energy Factor (EF).

For version 5.0 ENERGY STAR dehumidifiers, the SWE recommended using the existing default savings presented in table 2-93 of the 2016 TRM by using the nameplate capacity of the rebated dehumidifier to lookup the appropriate default savings. For those ENERGY STAR Dehumidifiers certified under Version 4.0 or earlier, the EDCs and their evaluators have the option of using the TRM algorithm or the TRM defaults presented in Table 2-93.

K.1.7.2 Guidance Memo for 2021 TRM Volume 2: Table Cross-Reference Errata

The SWE developed a memo, released on March 11, 2021, to alert the EDCs and their evaluators that Volume 2 of the 2021 TRM included a number of incorrect table cross-references. The guidance memo provided a list of the affected tables and cross-references and a recommended method to correct the errata by updating the affected cross-reference fields.

K.1.7.3 Guidance Memo for 2021 TRM Section 2.4.3: Refrigerator / Freezer Recycling with and without Replacement

The SWE developed a memo, released on May 21, 2021, to provide guidance to the EDCs and their evaluators to section 2.4.3 (Refrigerator / Freezer Recycling with and without Replacement) of the 2021 TRM to (1) address an error in the UEC algorithms for refrigerators and freezers and (2) clarify a term in the energy savings algorithm

K.1.7.4 Phase IV Evaluation Costs Meeting with the Energy Association of Pennsylvania (EAP) and EDCs

On April 20, 2021, the EAP hosted a meeting with the SWE, Commission staff and the EDCs to discuss evaluation costs in Phase IV. The meeting covered several topics, including identifying ways streamline and reduce evaluation costs in Act 129 Phase IV for low-impact measures and initiatives, to streamline and reduce reporting costs for EDCs and SWE in Phase IV, and to streamline and reduce costs associated with data collection in Phase IV. The EAP prepared a memo in advance of the meeting, which the SWE reviewed and discussed with Commission staff in preparation for the April 20th meeting.

K.1.7.5 Phase IV EE&C Plan Review

The SWE conducted a review of the EDC's draft EE&C plans, submitted to the Commission on November 30, 2020, and presented a summary to Commission staff. The SWE's review included EDC savings targets and other implementation order requirements, budget and parity analysis, EDC's RPM bidding strategy for demand savings, observations of the EDC's EE&C programs, cost-effectiveness, and analysis comparing the EE&C plans to the EEMPS, including an analysis of savings by end-use. The SWE conducted follow-up analysis comparing the final EE&C plans to the EEMPS (including an updated analysis of savings by end-use).