

SWE Annual Report

Act 129 Program Year 11

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DATA DRIVEN RESEARCH AND INSIGHTS



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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 11 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

ACC	Avoided Costs Calculator
AEO	Annual Energy Outlook
BDR	Behavioral Demand Response
C&I	Commercial and Industrial
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
DR	Demand Response
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
EUL	Effective Useful Life
GNI	Government, Non-Profit, Institutional
HER	Home Energy Report
HIM	High Impact Measure
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IDI	In-Depth Interview
IPMVP	International Performance Measurement and Verification Protocol
ISR	In-Service Rate
kW	Kilowatt
kWh	Kilowatt-Hour
LED	Light-Emitting Diode
LI	Low-Income
LIURP	Low-Income Usage Reduction Program
LLF	Line Loss Factor
MSRP	Manufacturer Suggested Retail Price
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-Hour
NPV	Net Present Value
NTG	Net-to-Gross
NTGR	Net-to-Gross Ratio
P3TD	Phase III to Date
PA PUC	Pennsylvania Public Utility Commission
PSA	Phase III to Date Preliminary Savings Achieved; equal to VTD + PYRTD
PSA+CO	PSA savings, plus Carryover from Phase II
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
RCT	Randomized Control Trial
ROB	Replace on Burnout
RTD	Phase III to Date Reported Gross Savings
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

TYPES OF SAVINGS

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

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

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

Unverified Reported Gross: The Phase 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 M&V efforts have been completed.

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

Annual Savings: Energy and demand savings expressed on an annual basis, or the amount of energy and/or peak demand an EE&C measure or program can be expected to save over the course of a typical year. Annualized savings are noted as MWh/year or MW/year. The

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

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

Program Year Reported to Date (PYRTD): The reported gross energy and peak demand savings achieved by an EE&C program or portfolio within the current program year. 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 Preliminary Savings Achieved (PSA): The sum of the verified gross savings (VTD) from previous program years in Phase III where the impact evaluation is complete, plus the reported gross savings from the current program year (PYTD). For PY8, the PSA savings will always equal the PYTD savings because PY8 is the first program year of the phase (no savings will be verified until the PY8 final annual report).

Phase III to Date Preliminary Savings Achieved + Carryover (PSA+CO): The sum of the verified gross savings from previous program years in Phase III, plus the reported gross savings from the current program year and any verified gross carryover savings from Phase II of Act 129. This is the best estimate of an EDC's progress toward the Phase III compliance targets.

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 11 (PY11), June 1, 2019 to May 31, 2020, is the fourth 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).

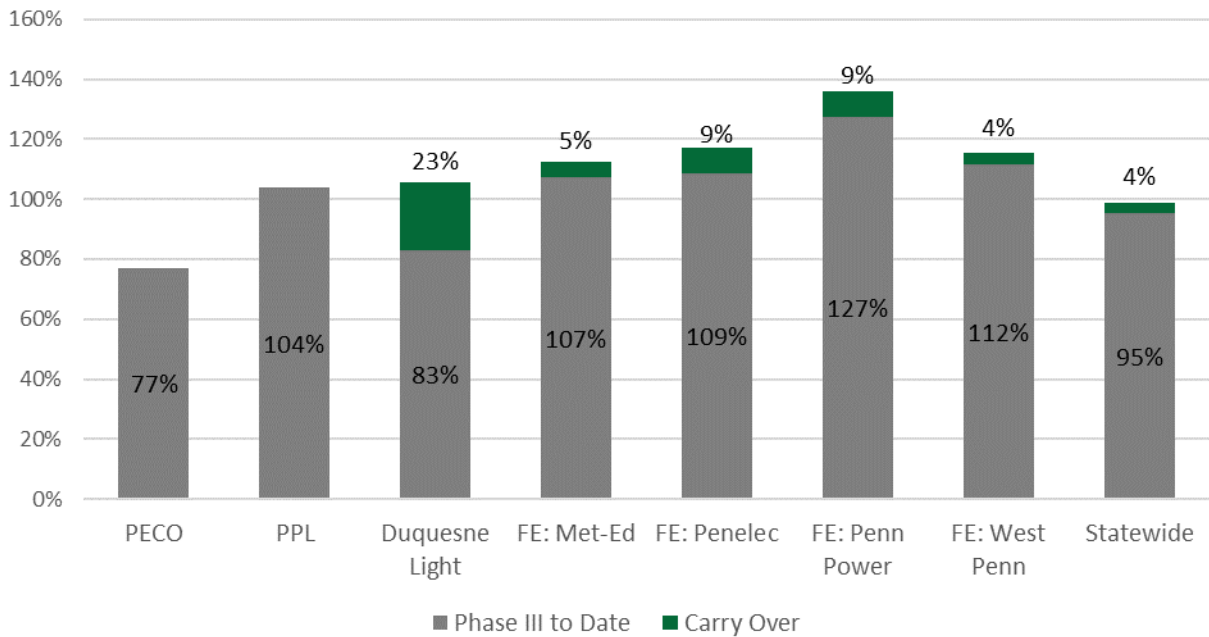
In their PY11 annual reports to the Public Utility Commission (PUC), the seven EDCs claimed a total of 1,406,597 MWh/year of verified gross energy savings for PY11 (approximately 25% of the statewide Phase III target) and a total of 5,436,567 MWh/year of verified gross energy savings for Phase III to date (P3TD) (approximately 95% of the statewide Phase III target). PY11 savings declined 6% compared to PY10. The decline is likely due to the impacts of the start of the COVID-19 pandemic and other contributing factors, such as the winding down of upstream lighting programs by PPL and Duquesne Light and six of seven EDCs reaching their Phase III compliance target by the end of PY11. The Statewide Evaluator (SWE) performed a detailed review of the research methods, assumptions, and calculations utilized by EDC evaluation contractors to determine verified gross savings for PY11. The SWE audit validated all of the savings calculations, resulting in a PY11 gross verified statewide total of 1,406,597 MWh/year (approximately 25% of the statewide Phase III target) and phase-to-date verified gross savings of 5,436,567 MWh/year (95% of the statewide Phase III target). Minor audit findings were noted for other programs but did not result in changes to the verified savings.

PROGRESS TOWARDS PORTFOLIO TARGETS

Progress toward the individual EDC Phase III compliance targets to date in verified gross energy savings ranged from 77% (PECO) to 127% (Penn Power) (see [Figure 1](#)). Including carryover savings from Phase II, total progress toward Phase III targets ranged from 77% (PECO) to 136% (Penn Power). More detailed summary tables of progress toward Phase III targets can be found in [Appendix A](#) and the EDC's program-level impacts can be found in [Section 3](#).

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>

Figure 1: P3TD Verified Savings Progress Toward Phase III Compliance Target, by EDC and Statewide*

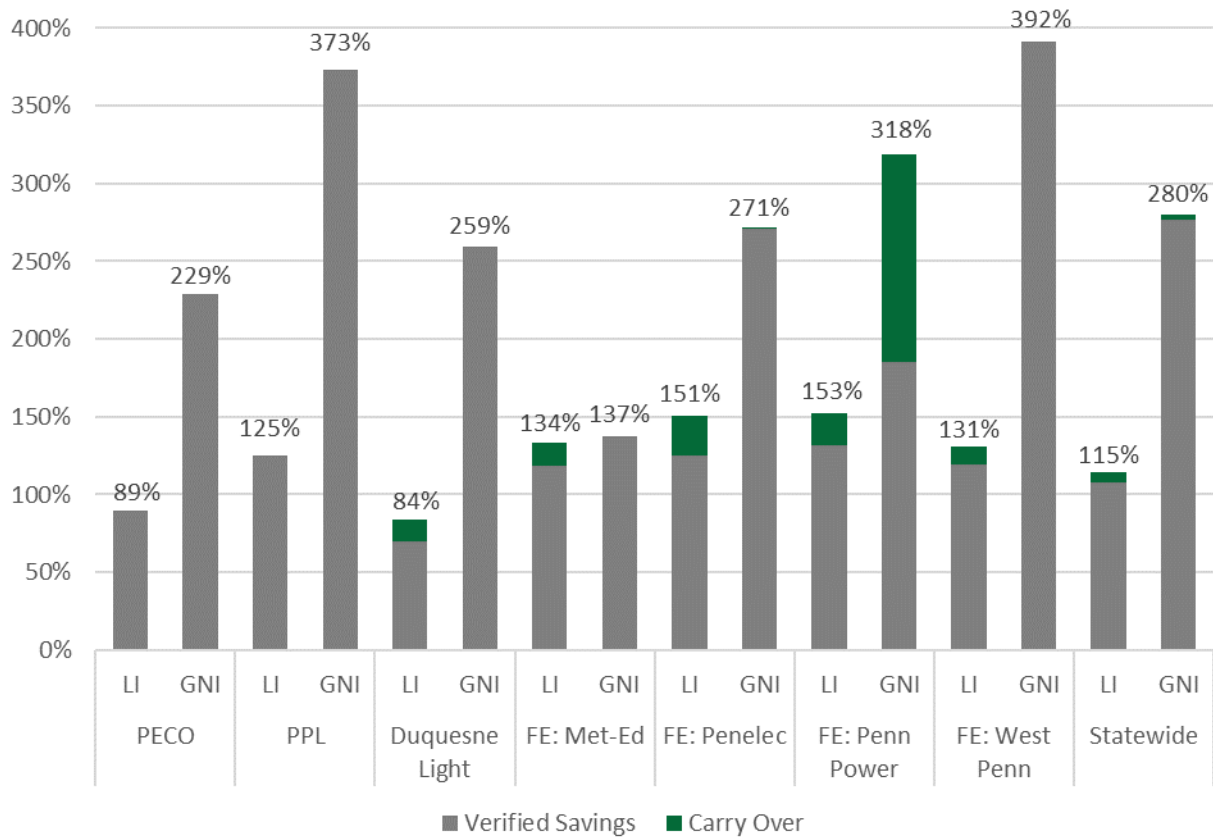


* The overall progress to target may not be equal to the sum of verified and carryover savings due to rounding.

Progress Towards Low-Income (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 2 reports EDC P3TD progress toward their targets. Progress toward the LI target ranged from 70% (Duquesne Light) to 132% (Penn Power) in P3TD verified gross savings and 84% (Duquesne Light) to 153% (Penn Power) when Phase II carryover savings are included. Progress toward the GNI target ranged from 137% (Met-Ed) to 392% (West Penn) in P3TD verified gross savings and 137% (Met-Ed) to 392% (West Penn) when Phase II carryover savings are included.

Figure 2: P3TD Progress Toward Phase III LI and GNI Targets



The Phase III Implementation Order also directed EDCs to offer conservation measures to the LI customer segment based on the proportion of electric sales attributable to LI households.² This “Low-Income Measure Proportionality” requirement directs each EDC to include in their programs a number of energy-efficiency measures for households at or below 150% of the federal poverty income guidelines that is proportionate to each EDC’s total LI consumption relative to the total energy usage in the service territory. An LI measure is defined as a measure that is targeted to LI customers and is available at no cost to LI customers. The SWE found that each EDC complied with the LI proportionality requirement in PY11. Table 1 reports the required minimum proportions and results of the SWE’s verification analysis. The SWE’s verification analysis can be found in Appendix A.

² Phase III Implementation Order at <https://www.puc.pa.gov/pcdocs/1367313.doc>, page 63.

Table 1: LI Measure Proportionality Targets and SWE Verification Results, PY11

EDC	Proportionate Number of Measures, Target	PY11 Proportionate Number of Measures, Reported	PY11 Proportionate Number of Measures, SWE Verified
PECO	8.80%	43.5%	29.1%
PPL	9.95%	21.7%	22.7%
Duquesne Light	8.40%	19.8%	28.1%
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	8.79%	37.3%	34.4%

Phase III Performance by Customer Segment

Figure 3 presents the PY11 verified gross savings by customer segment and Figure 4 presents P3TD 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).³ Residential customers (including LI customers) accounted for just under half of verified gross savings in PY11 and more than half in P3TD verified gross savings (49% and 56%, respectively). The share of savings attributed to residential customers declined approximately 6% from PY10 to PY11.

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

Figure 3: PY11 Verified Gross Savings by Customer Segment, Statewide

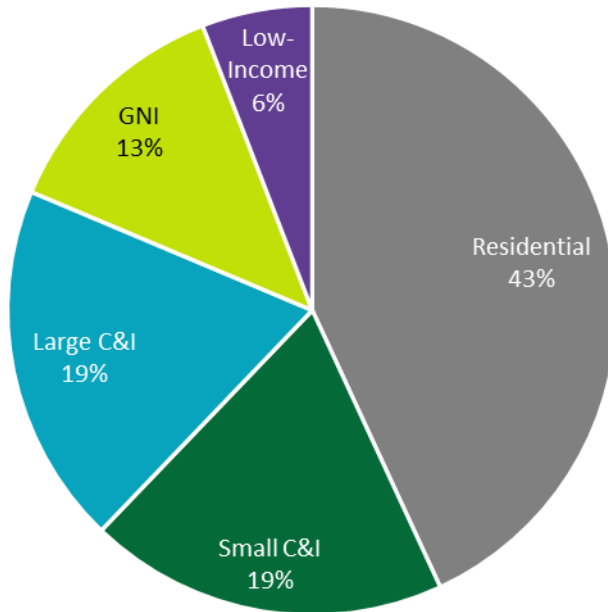
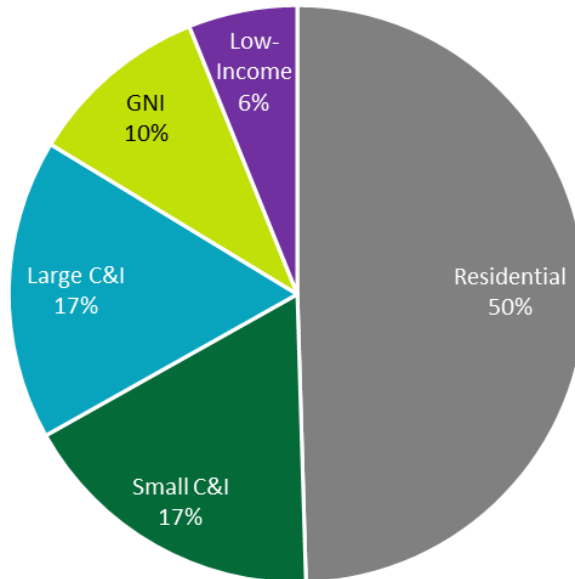


Figure 4: P3TD Verified Gross Savings by Customer Segment, Statewide

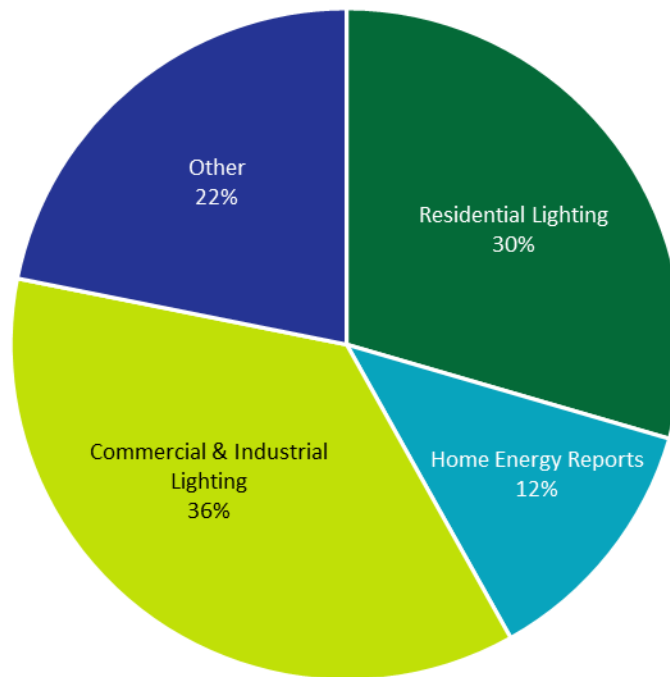


TOP SAVING PROGRAMS

The Pennsylvania EDCs support a wide range of energy-efficient equipment and technologies in their Phase III EE&C plans. Despite the diverse set of offerings, PY11 gross verified energy savings primarily came from three offerings: residential lighting, Home Energy Reports (HERs), and non-residential lighting. These three initiatives are offered by each of the seven EDCs in Phase III. In PY11, the three offerings contributed 78% of the verified gross energy savings in the Commonwealth. The SWE notes that this total value for the top three offerings matches the findings for PY8, PY9, and PY10, when lighting and HERs accounted for approximately 80% of verified gross savings.

Figure 5 shows the contribution to PY11 verified gross portfolio MWh savings from lighting, HERs, and all other offerings combined.

Figure 5: Top Saving Program Types in PY11



Eighty-one percent of the PY11 residential lighting energy savings came from upstream retail lighting programs, while the other 19% were achieved via lighting distributed through kits and direct install offerings. In PY11, the portfolio contribution from C&I Lighting exceeded the contribution from residential lighting for the first time in the Phase. Overall, lighting accounts for 66% of statewide PY11 verified gross savings. Lighting measures accounted for 62% of all MWh savings in PY8, 66% of MWh savings in PY9, and 65% of MWh savings in PY10. The SWE expects this share will decrease in PY12 when the Technical Reference Manual (TRM) baseline for A-lamps changes from a halogen incandescent efficacy to a more stringent baseline.

Section 2 of this report explores each of these core programs in detail. Based on a statewide review, the SWE compares the different ways EDCs delivered these programs in PY11. We also examine the rapidly changing lighting market that EDC programs are working to transform and the implications these market changes have on program delivery.

DEMAND RESPONSE (DR) SUMMARY

The final Phase III Implementation Order⁴ established DR targets for each EDC covered by Act 129 (with no DR target for Penelec). Table 2 presents the peak demand reduction targets, in MW, along with the average performance across the four PY11 DR events and the average performance for the thirteen P3TD DR events. 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.⁵ Each event is four hours in length. 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). The Verified to Date (VTD) performance estimates reported in Table 2 are for the average performance across events in PY9 through PY11.

Table 2: Performance Against Phase III DR Compliance Targets

EDC	Phase III DR Target (MW)	PY11 Average Event Performance (MW)	VTD Average Event Performance
PECO	161	149.5	167.1
PPL	92	104.3	112.8
Duquesne Light	42	56.0	55.2
FE: Met-Ed	49	56.9	53.0
FE: Penelec	0	0	0
FE: Penn Power	17	35.2	39.9
FE: West Penn	64	96.1	112.4
Statewide	425	498.0	540.4

⁴ <http://www.puc.state.pa.us/pcdocs/1367313.doc>. From the Public Meeting of June 11, 2015. Docket No. M-2014-2424864.

⁵ PJM 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>

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,⁶ so the VTD values in [Table 2](#) 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. 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 3](#) compare DR performance on individual event days to this 85% threshold.

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 Order⁷ to document the methodology and assumptions EDCs should use when calculating the costs and benefits of Phase III EE&C portfolios. [Figure 6](#) shows the breakdown of total TRC benefits and costs across all EDCs in PY11. The comparison of Total Gross Net Present Value (NPV) TRC Benefits to Total Gross NPV TRC Costs is the statewide TRC ratio, which was 1.34 in PY11.

⁶ 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>

⁷ 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 Order*). Entered June 22, 2015.

<http://www.puc.pa.gov/pcdocs/1367195.docx>

Figure 6: PY11 Statewide TRC Breakdown

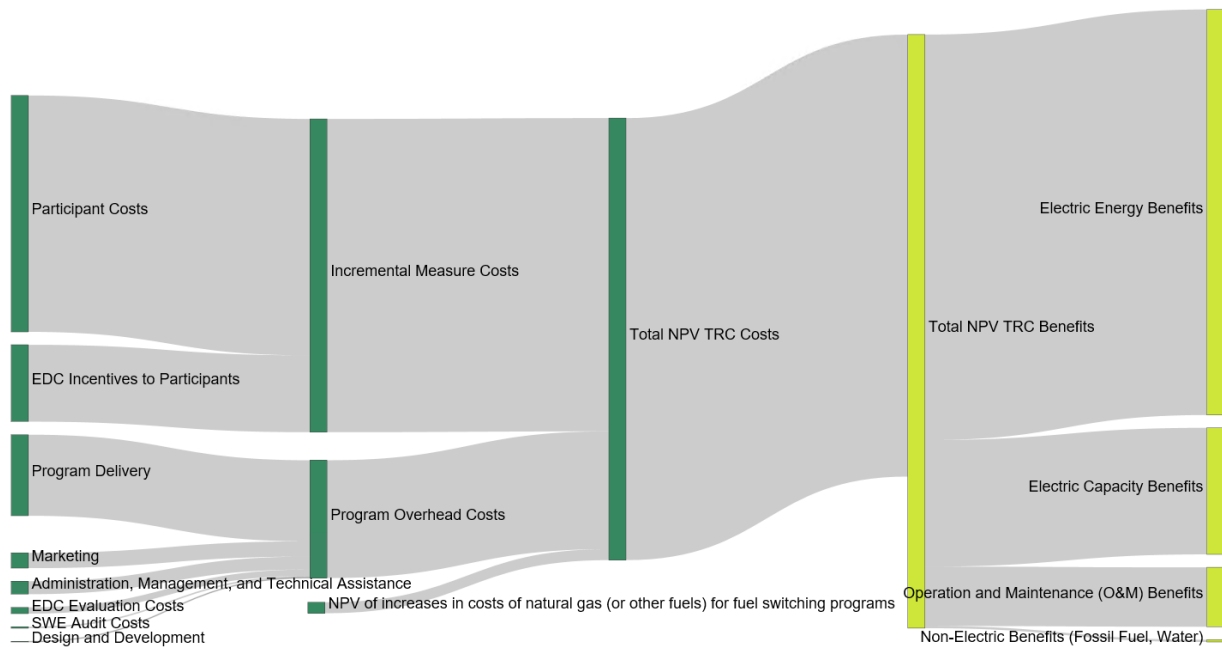


Table 3 shows the NPV costs and benefits for each EDC portfolio in PY11, as well as the TRC ratio (benefits divided by costs). TRC results are presented on both a gross and net savings basis. Per the 2016 TRC Order, incremental participant costs and benefits from free riders are excluded from the calculation 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 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.”⁸ On a gross basis, PY11 programs saved the Commonwealth an estimated \$160.1 million dollars (benefits minus costs). On a net basis, statewide savings from PY11 programs are estimated at \$83.2 million dollars.

⁸ 2016 TRC Order. Page 66.

Table 3: PY11 TRC Test Results by EDC

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO	\$177,663	\$160,431	1.11	\$120,447	\$120,819	1.00
PPL	\$223,782	\$139,766	1.60	\$167,748	\$107,595	1.56
Duquesne	\$49,815	\$24,759	2.01	\$33,324	\$19,724	1.69
FE: Met-Ed	\$54,929	\$43,322	1.27	\$33,746	\$30,220	1.12
FE: Penelec	\$49,617	\$40,784	1.22	\$34,502	\$31,503	1.10
FE: Penn Power	\$18,618	\$13,605	1.37	\$12,046	\$9,953	1.21
FE: West Penn	\$52,411	\$44,063	1.19	\$31,833	\$30,605	1.04
Statewide*	\$626,835	\$466,729	1.34	\$433,646	\$350,419	1.24

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

One of the key findings from the review of PY8 TRC calculations was that the EDCs were not monetizing the water and fossil impacts of measures. For PY11, each of the EDCs included fossil fuel and water impacts in their TRC calculations.

Table 4 shows TRC results for energy-efficiency programs and Table 5 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.

Table 4: PY11 TRC Results by EDC: Energy-Efficiency Programs Only

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO*	\$169,364	\$151,394	1.12	\$112,148	\$111,782	1.00
PPL*	\$218,979	\$137,889	1.59	\$162,945	\$105,718	1.54
Duquesne	\$43,933	\$23,073	1.90	\$27,442	\$18,038	1.52
FE: Met-Ed	\$52,214	\$41,122	1.27	\$31,032	\$28,021	1.11
FE: Penelec	\$49,617	\$40,784	1.22	\$34,502	\$31,503	1.10
FE: Penn Power	\$16,942	\$13,024	1.30	\$10,370	\$9,372	1.11
FE: West Penn	\$48,000	\$42,164	1.14	\$27,422	\$28,705	0.96
Statewide	\$599,050	\$449,450	1.33	\$405,860	\$333,140	1.22

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

Table 5: PY11 TRC Results by EDC: DR Programs Only

EDC	Gross Benefits (\$1000)	Gross Costs (\$1000)	Gross TRC	Net Benefits (\$1000)	Net Costs (\$1000)	Net TRC
PECO*	\$8,299	\$9,037	0.92	\$8,299	\$9,037	0.92
PPL*	\$4,803	\$1,877	2.56	\$4,803	\$1,877	2.56
Duquesne	\$5,882	\$1,686	3.49	\$5,882	\$1,686	3.49
FE: Met-Ed	\$2,715	\$2,200	1.23	\$2,715	\$2,200	1.23
FE: Penelec	\$0	\$0	N/A	\$0	\$0	N/A
FE: Penn Power	\$1,676	\$581	2.88	\$1,676	\$581	2.88
FE: West Penn	\$4,411	\$1,900	2.32	\$4,411	\$1,900	2.32
Statewide	\$27,785	\$17,279	1.61	\$27,785	\$17,279	1.61

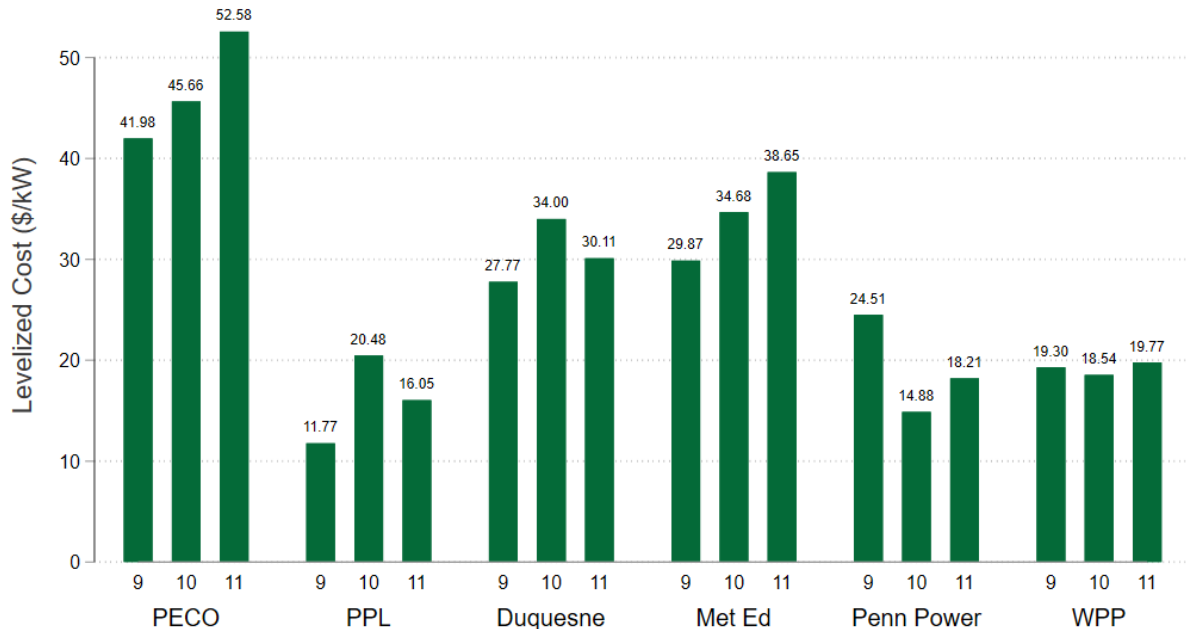
* Costs include cross-cutting or common costs allocated proportionately to energy-efficiency and DR programs

In PY11, statewide cost-effectiveness decreased across both energy-efficiency and DR programs from PY10. Although a comparison of the values in [Table 4](#) and [Table 5](#) suggests that DR programs were more cost-effective than energy-efficiency programs in PY11, the TRC ratios for both portfolios are more aligned in PY11 than they were in previous program years. There is also significantly more variation in cost-effectiveness amongst EDCs in DR portfolios than there is in the energy-efficiency portfolios. The SWE audit of EDC cost-effectiveness and comparison with previous program years revealed several insights about energy-efficiency and DR programs:

- In PY11, energy-efficiency portfolio cost-effectiveness decreased for all EDCs except for Duquesne Light, and DR portfolio cost-effectiveness decreased for all EDCs except for PPL and Duquesne Light. The cost-effectiveness of DR programs has fluctuated more than the cost-effectiveness of energy-efficiency programs during Phase III.
- The slight declines in the cost-effectiveness of energy-efficiency portfolios over the phase are largely due to residential lighting, which makes up a significant portion of the overall energy-efficiency portfolio. Cost-effectiveness of residential light-emitting diode (LED) measures has been reduced throughout Phase III due to the dual baseline assumptions used in the calculation of lifetime energy savings, resulting in lower TRC benefits each year, although the costs remain the same.
- [Figure 7](#) shows the levelized cost of DR for each EDC over the three 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. Overall, the DR levelized cost tracks closely with cost-effectiveness performance between EDCs. PECO's TRC ratio was below 1.0 in PY11 and their levelized cost for one kW of DR savings was significantly higher than the other EDCs. In general, levelized costs have grown since the beginning of the Phase. Changes in DR levelized costs over the years could also reflect the number of DR events called each season; three events were called in PY9, six were called in PY10, and four were called in PY11. Because C&I DR programs include a mix of "reservation" payments for enrollment and volumetric payments for load shed during an event,

volumetric costs are likely higher in years with more events. There is also variation in the types of DR programs offered. PPL and Duquesne Light only operate a C&I program. PECO and Penn Power have both residential and non-residential programs. Met-Ed and West Penn Power only had a non-residential DR program in PY9 but added a residential behavioral DR program in PY10.

Figure 7: Levelized Cost of DR by EDC and Program Year



- The 2016 TRC 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.⁹ 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 Order, the TRC benefits from the avoided cost of generation capacity likely overstate the true benefit to the Commonwealth.
 - In the 2021 TRC Order,¹⁰ 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.
 - The SWE's Phase IV EEPDR Potential Study relied on the methodology and assumptions called for in the 2021 TRC Order and included a section evaluating Phase

⁹ <https://www.pjm.com/committees-and-groups/closed-groups/sodrstrf>

¹⁰ 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. <http://www.puc.state.pa.us/pdocs/1648126.docx>. Page 94-97.

IV metrics with and without funding for dispatchable DR programming.¹¹ Although the DR Potential Study found that the benefits of a Phase IV 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 PY11 DR impacts, the TRC ratios for DR portfolios would be lower and would be comparable to the energy-efficiency TRC ratios.
- In general, the SWE found that the EDCs' cost-effectiveness reporting was well-documented and aligned with the 2016 TRC Order. EDCs resolved issues that were revealed in previous program years and largely followed the SWE's guidance issued in 2020 regarding the 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."¹² The statewide share of spending on incentives as a percentage of total EDC expenditures was 39.5%. Incentive shares ranged from 33.4% at Duquesne Light to 45.2% at Penelec. However, the SWE TRC audit revealed PPL categorizing the cost of kits and direct install measures as program delivery costs rather than incentives. If PPL followed the reporting template with respect to cost categorization, the statewide PY11 ratio would be over 40%.
- As shown in [Figure 6](#), TRC benefits primarily come from the avoided costs of energy and capacity, which account for nearly 90% 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 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.
- Participant costs, which are not paid by the utility, make up the largest TRC cost category. Participant costs and incentives paid by the EDCs account for over 70% of total TRC costs, followed by program overhead costs (27%) and fuel switching costs (3%).

¹¹ 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](#).

¹² Phase IV Implementation Order at page 121. Entered June 18, 2020. Docket No. M-2020-3015228. <https://www.puc.pa.gov/pcdocs/1666981.docx>

COMPARISON OF SAVINGS AND EXPENDITURES TO PLAN

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 8. PPL, Duquesne Light, and the four FirstEnergy companies are ahead of projected energy savings totals despite spending less than projected. PECO is behind their plan on both spending and savings, but has improved from PY10.

Figure 8: P3TD Energy-Efficiency Spending and Savings Compared to EE&C Plan

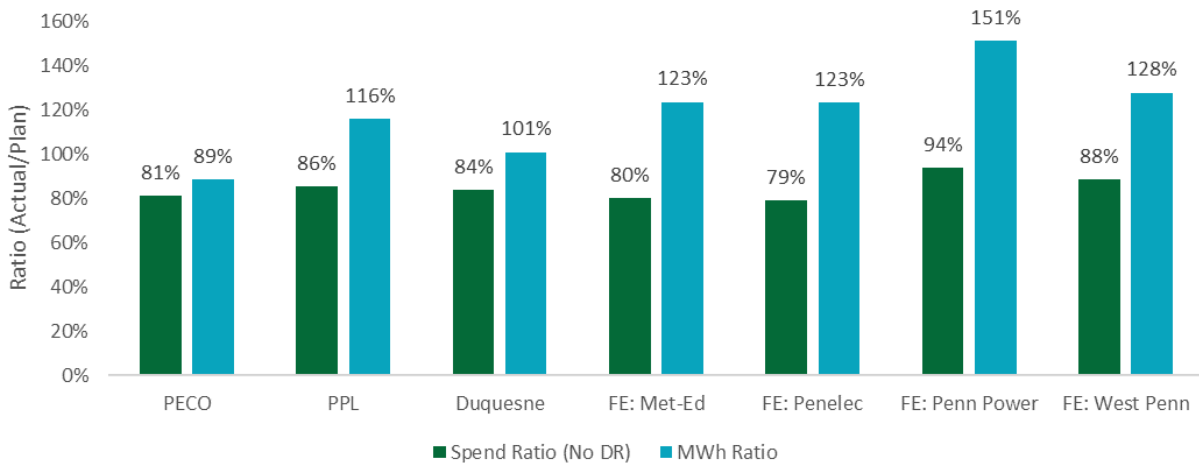


Table 6 provides an overview of the EDC’s planned and actual expenditures for energy-efficiency programs in PY11. In PY11, all EDCs spent less than their approved budget. This could be due in part to EDC programs that were shut down in response to the COVID-19 pandemic. PECO’s PY11 expenditures were closest to the approved budget and their annual energy savings were above target by approximately 8%.

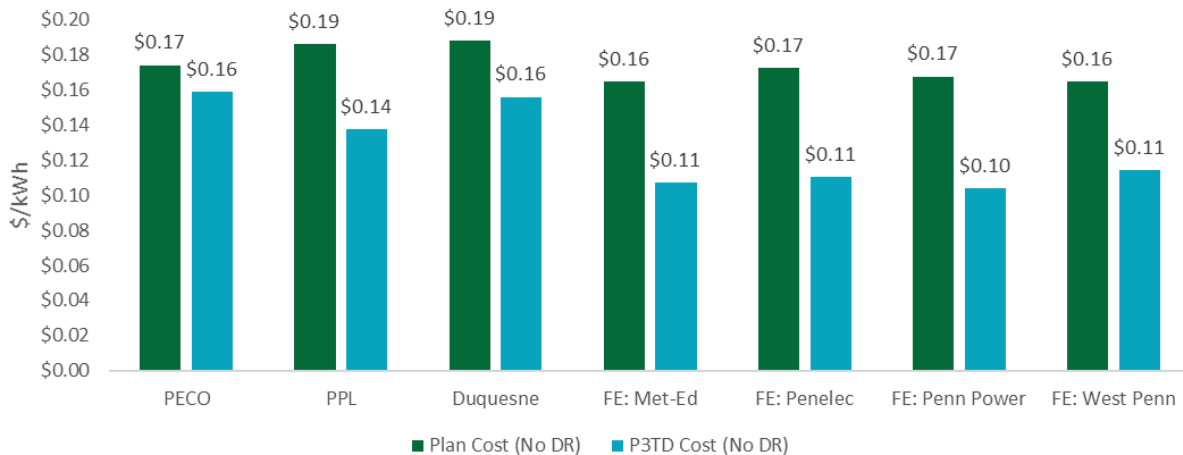
Table 6: Comparison of PY11 Statewide Energy-Efficiency Budgets and Expenditures¹

EDC	Actual PY11 Expenditures (\$1000)	Approved Budget for PY11 (\$1000)	Difference Between Actual and EE&C Plan	Percent Difference from EE&C Plan
PECO	\$68,895	\$72,632	-\$3,737	-5%
PPL	\$50,324	\$63,625	-\$13,301	-21%
Duquesne Light	\$16,075	\$18,793	-\$2,718	-14%
FE: Met-Ed	\$14,760	\$25,054	-\$10,294	-41%
FE: Penelec	\$14,402	\$24,878	-\$10,476	-42%
FE: Penn Power	\$4,245	\$5,976	-\$1,732	-29%
FE: West Penn	\$16,307	\$22,645	-\$6,338	-28%
Statewide	\$185,008	\$233,604	-\$48,596	-21%

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

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 9 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 are delivering energy savings at a lower cost than projected through PY11, with the FirstEnergy companies delivering energy-efficiency savings at approximately 65% of the projected cost in their Phase III EE&C plans.

Figure 9: Planned vs. Actual P3TD Energy-Efficiency Acquisition Cost



While PECO's PY11 savings exceeded planned savings by 8%, phase-to-date performance is below planned performance (89% of planned savings through PY11). PECO's PY11 annual report provided limited information on the causes of low performance values relative to the plan. Most of the shortfall comes from the C&I sectors. PECO's Combined Heat and Power (CHP) program has significantly underperformed relative to plan, with actual MWh savings at just 6% of EE&C plan projection through PY11 and spending at just 1% of plan through four years. PECO has a large CHP project planned for PY12 that will contribute to these goals; however, they will still need to increase the pace of program spending, while being mindful of acquisition cost, to meet its Phase III portfolio reduction target.

Table 7 provides an overview of the EDC's planned and actual energy-efficiency acquisition costs in PY11.

Table 7: Planned Versus Actual Energy-Efficiency Acquisition costs in PY11

EDC	PY11 Verified Savings (MWh/yr)	Forecasted PY11 Acquisition Cost per First-Year kWh Saved	Actual PY11 Acquisition Cost per First-Year kWh Saved	Percent Change from Forecasted Acquisition Cost
PECO	479,702	\$0.16	\$0.14	-12%
PPL	369,322	\$0.20	\$0.14	-31%
Duquesne Light	97,349	\$0.21	\$0.17	-22%
FE: Met-Ed	143,078	\$0.18	\$0.10	-44%
FE: Penelec	136,889	\$0.19	\$0.11	-45%
FE: Penn Power	48,148	\$0.19	\$0.09	-53%
FE: West Penn	132,110	\$0.19	\$0.12	-34%
Statewide	1,406,597	\$0.18	\$0.13	-28%

REDUCTION IN EMISSIONS

Electric power generation is a major source of carbon emissions, so the energy conservation programs implemented by the Pennsylvania EDCs have a direct impact on the amount of carbon dioxide produced. Although the Pennsylvania TRC test does not place a monetary value on emission reductions, it is an important benefit to some stakeholders because of links between CO₂ emissions and climate change. [Table 8](#) was compiled using the gross verified first year and lifetime MWh savings in PY11, EDC-specific line loss factors (LLFs), and an average of the 2020 marginal on-peak and off-peak CO₂ emissions rate in PJM’s spring 2020 Emissions Report.¹³

Table 8: PY11 Carbon Dioxide Emission Impacts

Performance Metric	Value
PY11 Verified Gross MWh/yr	1,406,597
PY11 Verified Gross Lifetime MWh	12,387,116
Weighted Average Measure Life (years)	8.81
Average CO ₂ Emissions Rate (lbs/MWh)	1,113
First-Year Avoided Tons of CO ₂	842,180
Lifetime Avoided Tons of CO ₂	7,411,719

The lifetime emission impacts in [Table 8](#) are calculated using the 2020 CO₂ emission rates and do not include the emissions associated with secondary fossil fuel impacts caused by EE&C measures. If the generation fuel mix in the region becomes cleaner over the life of the measures installed in PY11, the emissions rate would decrease, and the lifetime CO₂ impacts would be lower. If the Act 129 TRC Test valued CO₂ emissions at the Biden administration’s interim social cost of carbon – \$46 per short ton – the statewide PY11 gross TRC ratio would increase from the 1.34 value shown in [Table 3](#) to approximately 1.9.

¹³ <https://www.pjm.com/-/media/library/reports-notice/special-reports/2020/2020-emissions-report.ashx>

PROCESS EVALUATION

Table 9 provides an overview of the PY11 process evaluations conducted by each EDC.

Table 9: PY11 Process Evaluations by EDC

EDC	# of PY11 Programs	# Evaluated	# of Process Findings	# of Process Recommendations	% of Satisfied Residential Customers*	% of Satisfied C&I Customers*
PECO**	8	3	4	4	91%	92%
PPL	9	8	4	7	92%	95%
Duquesne Light	14	10	16	16	79%	97%
FirstEnergy EDCs***	9	6	21	17	92%	N/A

* Average across all programs for which participant surveys were conducted. Average is weighted by number of PY11 participants in each program.

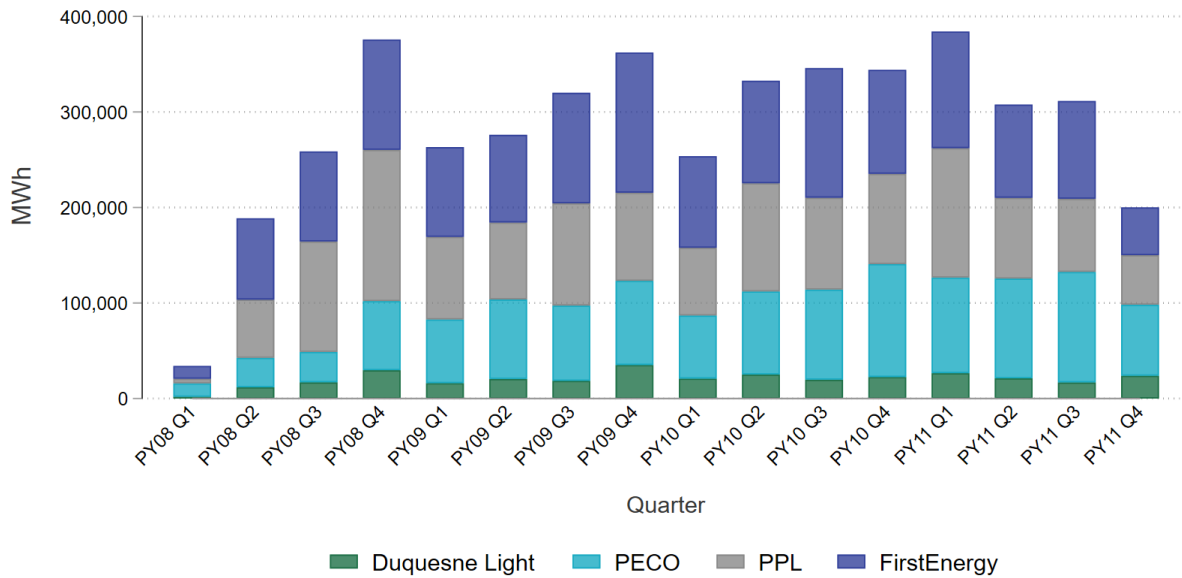
** The eight programs include 21 program solutions and targeted market segments within eight PECO energy-efficiency target areas: residential, LI, small C&I, large C&I, CHP, residential DR, small C&I DR, and large C&I DR. For PY11, nine of these 21 program solutions and targeted market segments were evaluated, including the Appliances & Heating, Ventilating, and Air Conditioning (HVAC) and Marketplace components of the Lighting, Appliances & HVAC Solution within the Residential Energy Efficiency Program; the Appliance Recycling Solution Residential Energy Efficiency Program; the Whole Home Solution Residential Energy Efficiency Program; the New Construction Solution Residential Energy Efficiency Program; the Equipment and Systems solutions of the Small and Large C&I Energy Efficiency programs, the New Construction solutions of the Small and Large C&I Energy Efficiency programs; and the Whole Building Solution of the Small C&I Energy Efficiency Program.

*** The four FirstEnergy EDCs (Met-Ed, Penelec, Penn Power, and West Penn) 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.

SUMMARY OF SWE FINDINGS AND RECOMMENDATIONS

- Finding:** The COVID-19 pandemic affected many aspects of life in 2020 and Act 129 programs were no exception. During Q4 of PY11 (March 1, 2020 to May 31, 2020) some EDC programs, such as Appliance Recycling, were suspended entirely. Other programs saw disruptions in program delivery and reduced participation from commercial businesses in affected industries. [Section 4.8.1](#) discusses the impacts of the pandemic on Evaluation, Measurement, and Verification (EM&V) processes. [Figure 10](#) shows the reported gross energy savings by quarter with the four FirstEnergy EDCs consolidated. The fourth quarter of PY11 had the lowest reported gross MWh savings since the first half of PY8, when Phase III programs were still ramping up. Other contributing factors to PY11Q4 energy savings totals could include 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.

Figure 10: Phase III Reported Gross Energy Savings by Quarter



Energy savings attributable to HER programs are not included.

- **Finding:** PPL, Duquesne Light, and the four FirstEnergy companies reached their Phase III portfolio energy savings totals during PY11 despite spending less than projected. All seven EDCs have delivered energy savings at a lower cost than projected. The statewide Phase-to-Date energy-efficiency acquisition cost is \$134 per MWh.

 - **Recommendation:** Given the efficacy of program delivery to date in Phase III, we project that PPL, Duquesne Light, and the four FirstEnergy companies will exceed their Phase III portfolio targets with Phase III savings alone. In its Phase IV Implementation Order, the Commission stated that EDCs will be allowed to “carryover” these excess Phase III MWh savings and count them towards Phase IV compliance targets.¹⁴ Allowing EDCs to carry over savings from one phase to the next encourages EDCs with excess budget to continue aggressive program delivery after compliance targets for the current phase have been met.
- **Finding:** Through PY11, PECO’s actual energy-efficiency expenditures are 81% of its EE&C plan projections for PY8-PY11 and its verified MWh savings are 89% of EE&C plan projections for the first four years of Phase III. If PECO’s PY12 verified MWh total equals PY11 performance, PECO will meet its Phase III goal.

 - **Recommendation:** With the reduced savings opportunity from residential lighting in PY12, PECO will need to deliver energy savings from other solutions in PY12 to match PY11 performance and meet its Phase III target. The SWE team understands that PECO has at least one large CHP project planned for PY12 that should help significantly.

¹⁴ Phase IV Final Implementation Order. Pages 43-46. Entered June 18, 2020. Docket No. M-2020-3015228. <https://www.puc.pa.gov/pcdocs/1666981.docx>

- **Finding:** Program Year 11 was the third summer in Phase III that DR programs were active. A total of four DR events were called in PY11. The EDC programs were generally successful, with most EDCs achieving at least 85% of their compliance target on each event day. The only exception was PECO, which did not achieve its target on July 18 due to thunderstorms the afternoon of the event, which caused average temperatures to drop abruptly and led to underperformance of the Residential DR program. The six EDCs with Phase III DR goals all have VTD average MW performance above their Phase III target.
 - **Recommendation:** DR compliance is based on average performance over all Phase III DR events. With the Commission’s decision to make PY12 DR events optional, all six EDC’s have met their primary Phase III DR target. For the PECO event that fell short of the 85% compliance target, the SWE team recommends the PUC take into consideration the weather conditions and margin of error for this event day when assessing compliance with Phase III targets.
- **Finding:** Behavioral HER programs accounted for 12% of all PY11 gross verified savings. This contribution of HERs to the statewide portfolio in PY11 was lower than PY8, PY9, and PY10 on both a verified MWh and percentage share of compliance savings. PECO was the only EDC to introduce a new HER cohort during PY11. All EDCs had lower verified gross savings from HERs in PY11 than in PY10. All seven EDCs had lower participation (due to attrition) and six of the seven EDCs had lower savings per HER recipient. The loss of customers to attrition also resulted in some cohorts with statistically significant differences in pre-treatment energy consumption between the treatment and control groups, although the impact estimation method accounts for any differences in pre-treatment consumption.
 - **Recommendation:** EDC evaluation contractors should continue to show the same high level of attention to detail in PY12 that was observed in PY10 and PY11. EDCs should investigate the causes of diminishing HER impacts.
- **Finding:** Non-residential lighting offerings accounted for the highest share of savings in PY11 (36%). This is the first time in Phase III that residential lighting did not account for the largest share of verified savings during a program year (30% in PY11). PPL and Duquesne Light began winding down their lighting programs during PY11 as residential lighting only accounted for 17% and 24% of PY11 verified savings, respectively.
 - **Recommendation:** Beginning in PY12, the baseline for residential general service lamps will be updated from a halogen incandescent efficacy to a more stringent baseline. Because of the more efficient baseline, the SWE anticipates gross savings from residential lighting will decline substantially in PY12. EDCs will need to rely more heavily on measures other than residential lighting in order to meet their savings targets in PY12 and subsequent program years.
- **Finding:** The 2016 TRM calls on EDCs to use a “dual baseline” approach when calculating lifetime savings and TRC benefits for general service residential lighting measures. The dual baseline accounts for the planned EISA 2020 backstop provision. In the first three years of Phase III, all EDCs utilized a dual baseline, but the mechanics of the calculations for each EDC were quite different. In PY11, the SWE worked with EDCs and evaluation

contractors to develop a guidance memo on the topic to standardize dual baseline calculations for PY11 and PY12. In the memo, the SWE recommended one year of pre-shift savings for standard lamps and two years of pre-shift savings for specialty lamps. In PY11, all EDCs implemented the SWE's EUL assumptions consistently in their lighting savings calculations.

- **Recommendation:** EDCs should continue to follow the standardized dual baseline approach in PY12 for specialty lamps and reflect the lower first-year baseline for A-lamps when estimating savings for any A-lamps claimed in PY12.

Section 1 Background and Legislative History

1.1 REQUIREMENTS FROM THE PHASE III IMPLEMENTATION ORDER

Act 129 requires the Public Utility Commission (PUC) to establish an energy-efficiency and conservation program that includes the following characteristics:

- Adopt an “energy-efficiency and conservation program to require electric distribution companies [EDCs] ¹⁵ 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.”¹⁶
- Adopt additional incremental reductions in consumption if the benefits of the Energy Efficiency and Conservation (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 includes “an evaluation process, including a process to monitor and verify data collection, quality assurance, and results of each plan and the program.”¹⁷

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 submittal, review, and approval of all aspects of EDC EE&C plans.”¹⁸ 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.¹⁹

¹⁵ This Act 129 requirement does not apply to an EDC with fewer than 100,000 customers.

¹⁶ 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.

¹⁷ 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.

¹⁸ See Energy Efficiency and Conservation Program Implementation Order, at Docket No. M2008-2069887 (entered Jan. 16, 2009) (hereinafter Phase I Implementation Order).

https://www.puc.pa.gov/electric/pdf/Act129/EEC_Implementation_Order.pdf

¹⁹ 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>

1.1.1 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 10 contains these targets as percentages and five-year cumulative totals in MWh/year for each of the seven EDCs.

Table 10: Act 129 Phase III Five-Year Energy-Efficiency Reduction Compliance Targets¹

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	\$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. <http://www.puc.state.pa.us/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 11. 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). The targets reported in Table 11 are for the other four program years in Phase III.

Table 11: Act 129 Phase III Five-Year Energy DR Reduction Compliance Targets¹

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	\$11.78	\$46,203	64	1.8%
Statewide	\$92.90	\$54,714	424	1.6%

¹ Note that the statewide values reported in this table are from the 2nd Addendum to the 2015 SWE Market Potential Studies. <http://www.puc.state.pa.us/pcdocs/1367057.docx>

1.1.2 Standards Each EDC's Phase III EE&C Plan Must Meet

The PUC requires that each EDC's plan for Phase III meet several standards, including the following:

1. EDCs must include in their filing an EE&C Plan that obtains 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 non-profit entities (Government, Non-Profit, Institutional [GNIs]).
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.²⁰ Savings from non-LI programs, such as general residential programs, will not be counted for compliance. More details about the LI targets and requirements are provided in [Section 1.1.6](#). Act 129 also includes legislative requirements to include several energy-efficiency measures for households at or below 150% of the federal poverty income guidelines that is proportionate to each EDC's total LI consumption relative to the total energy usage in the service territory. The Statewide Evaluator (SWE) has advised that EDCs consider the definition of a LI measure to include a measure that is targeted to LI customers and is available at no cost to LI customers.

²⁰ Qualifying LI savings from multifamily housing may be counted toward the LI-specific savings, and savings from any program that was directly targeting LI customers. This includes all weatherization programs, energy-efficiency kits and home energy report (HER) programs, and specifically targeted compact fluorescent lighting (CFL) and light-emitting diode (LED) lighting giveaway programs

3. EDCs will be awarded credit for all new, first-year, incremental savings delivered in each year of the Phase (rather than focusing on a cumulative approach, as was done in Phase II).
4. EDCs are to develop EE&C Plans that are designed to achieve at least 15% of the target amount in each program year.
5. EDCs are to include at least one comprehensive program for residential customers and at least one comprehensive program for non-residential customers.
6. EDCs should determine the initial mix and proportion of energy-efficiency programs, subject to PUC approval. The PUC expects the EDCs to provide a reasonable mix of energy-efficiency programs for all customers. However, each EDC's Phase III EE&C Plan must ensure that the utility offers each customer class at least one energy-efficiency program.
7. DR programs will meet the following criteria:
 - a. The EDCs will obtain no less than 85% of the target in any one event.
 - b. Curtailment events shall be limited to the months of June through September.
 - c. Curtailment events shall be called for the first six days that a 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 for each year of the program.
 - d. Each curtailment event shall last four consecutive hours.
 - e. Each curtailment event shall be called such that it will occur during the day's forecasted highest peak hour above 96% of PJM's RTO summer peak demand forecast.
 - f. Once six curtailment events have been called in a program year, the peak demand reduction program shall be suspended for that program year.
 - g. 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.
 - h. Compliance will be determined based on the average MW reductions achieved from events called in the last four years of the program.
 - i. The EDCs, in their plans, must demonstrate that the cost to acquire MWs from customers who participate in PJM's Emergency Load Response Program (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. In addition, EDCs' DR programs are to allow for dual participation in Act 129 and PJM's ELRP; dual enrolled participants will have a 50% discount on Act 129 DR incentives imposed.

1.1.3 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 actually attained in Phase II. The Phase II Final Compliance Order further clarified that in order to carry over savings for the LI and GNI carveouts, an EDC must attain savings in Phase II that are in excess of their Phase II targets for application towards Phase III targets.²¹

1.1.4 Incremental Annual Accounting

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

1.1.5 Net-to-Gross Ratio (NTGR) for Phase III of Act 129

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.

1.1.6 LI and GNI Customer Savings

As noted earlier in [Section 1.1.2](#), 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 Guideline. As noted earlier in [Section 1.1.3](#), LI & GNI carryover 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.²²

²¹ 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>)

²² Act 129 Phase II Final Compliance Order.

A summary of the LI and GNI carve-out information is provided in [Table 12](#).

Table 12: 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	8.79%	540,986	29,754	18,935
Statewide		5,710,488	314,075	199,868

Section 2 Top Offerings

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, PY11 gross verified energy savings came largely from three offerings: residential lighting (including upstream and non-upstream lighting), Home Energy Reports (HERs), and non-residential lighting. All seven EDCs offer residential lighting, HERs, and non-residential lighting in Phase III. In PY11, the three offerings contributed 78.5% of the verified gross energy savings in the Commonwealth. [Table 13](#) shows the contribution to PY11 portfolio savings from each of the three primary offerings by EDC.

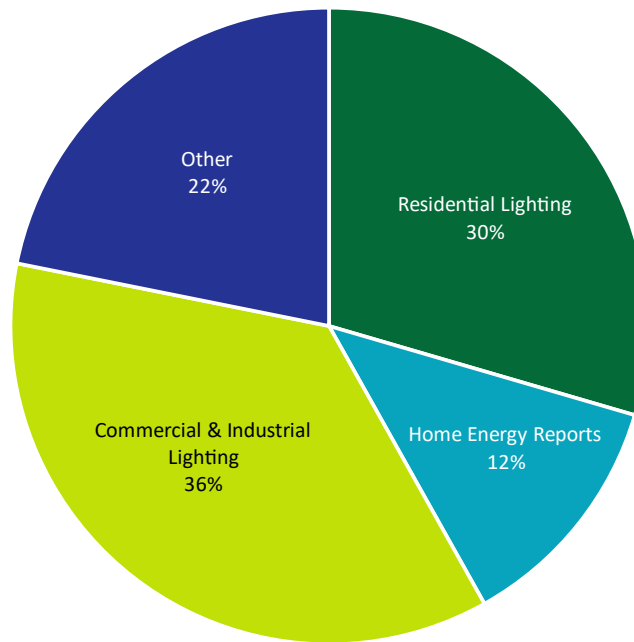
Table 13: PY11 Energy Savings from the Top Three Offerings

EDC	PY11 Verified Gross (MWh)	Residential Lighting (MWh)*	HERs (MWh)	Non-Residential Lighting (MWh)	Percent of PY11 MWh from Big 3
PECO	479,702	177,663	67,056	152,375	82.8%
PPL	369,322	60,868	33,356	150,332	66.2%
Duquesne Light	97,349	28,292	7,415	53,796	91.9%
FE: Met-Ed	143,078	44,357	26,222	42,152	78.8%
FE: Penelec	136,889	47,177	14,272	45,975	78.5%
FE: Penn Power	48,148	17,334	6,185	18,951	88.2%
FE: West Penn	132,110	43,427	19,421	47,698	83.7%
Statewide	1,406,597	419,118	173,927	511,279	78.5%

*Upstream residential lighting (including savings from cross-sector sales), plus non-upstream residential lighting.

[Figure 11](#) displays the distribution of energy savings from residential lighting, non-residential lighting, HERs, and all other offerings. Only 22% of statewide savings occurred outside of the three largest offerings.

Figure 11: PY11 Distribution of Energy Savings from the Top Three and All Other Offerings



The following sections explore the key issues for each of the primary offerings. Differences in delivery strategy across the EDCs are highlighted and discussed.

2.1 RESIDENTIAL LIGHTING

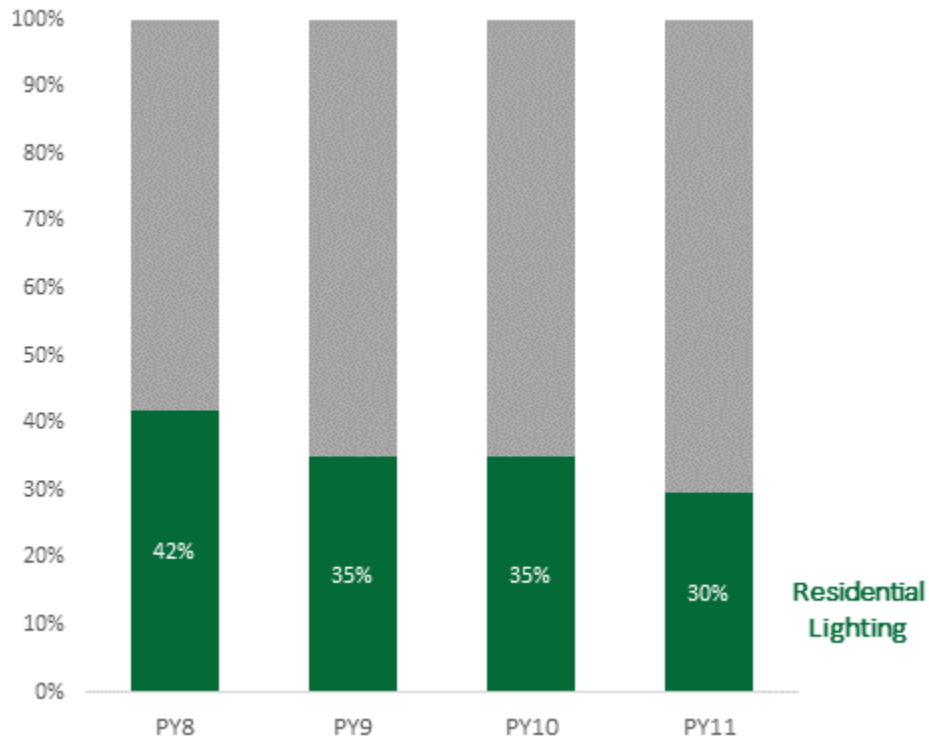
Upstream residential lighting was the second largest program offering among the EDCs, accounting for 24% of statewide PY11 verified gross energy savings. But residential lighting accounts for an even larger share of statewide savings when non-upstream lighting, such as kits and direct install measures, is considered. Non-upstream residential lighting accounted for another 6% of statewide PY11 verified gross savings, and residential lighting programs overall equaled 30% of statewide PY11 verified gross savings (see [Table 14](#)).

Table 14: PY11 Energy Savings, Upstream Residential Lighting, Non-Upstream Residential Lighting, and All Residential Lighting

EDC	PY11 Verified Gross (MWh/yr)	Upstream Res Lighting (MWh/yr)*	Non-Upstream Res Lighting (MWh/yr)	All Res Lighting (MWh/yr)	Percent of PY11 MWh from Res Lighting
PECO	479,702	138,810	38,853	177,663	37%
PPL	369,322	48,339	12,529	60,868	16%
Duquesne Light	97,349	22,290	6,002	28,292	29%
FE: Met-Ed	143,078	35,308	9,049	44,357	31%
FE: Penelec	136,889	36,963	10,214	47,177	34%
FE: Penn Power	48,148	16,800	534	17,334	36%
FE: West Penn	132,110	41,676	1,751	43,427	33%
Statewide	1,406,597	340,186	78,932	419,118	30%

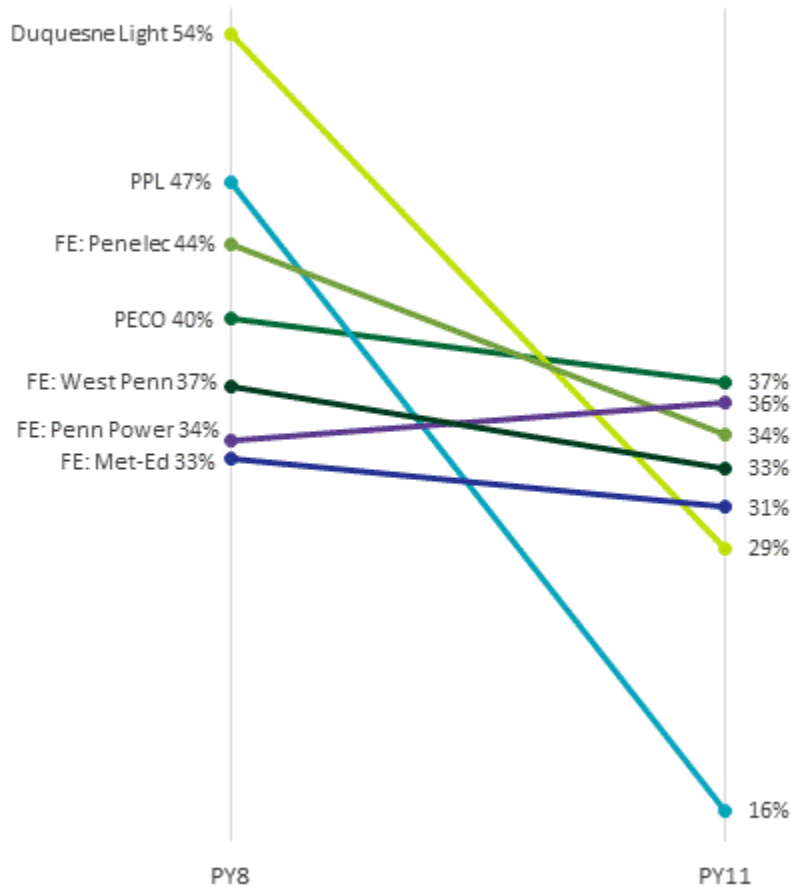
*The SWE notes that upstream lighting includes savings from cross-sector sales (i.e., upstream lighting customers install in commercial settings).

Figure 12 displays the percent of statewide gross energy savings from all residential lighting from PY8 through PY11. The proportion of gross savings from residential lighting declined from 42% in PY8 to 30% in PY11. Starting in PY12, the baseline for residential general service lamps will be reduced to 45 lumens per watt to comply with the EISA 2020 “backstop” provision. Because of the reduced baseline, the SWE anticipates gross savings from residential lighting to decline substantially in PY12.

Figure 12: PY8-PY11 Percent of Verified MWh from Residential Lighting

The reduced residential lighting baseline associated with the EISA 2020 “backstop” provision will require the EDCs to rely more heavily on measures other than residential lighting in order to meet their savings targets in PY12 and subsequent program years. [Figure 13](#) displays percent of gross energy savings from all residential lighting for PY8 and PY11 by EDC. Several EDCs, including Duquesne Light, PPL, and Penelec, had a relatively high proportion of gross savings from residential lighting at the beginning of Phase III, and a substantially lower proportion towards the end of the phase. EDCs that are primed to generate savings from non-residential lighting measures will likely find it easier to meet their savings targets going forward.

Figure 13: PY8 and PY11 Percent of MWh from Residential Lighting by EDC



2.1.1. Upstream Lighting: Lighting Technologies and Sales Channels

Figure 14 displays the distribution of statewide upstream lighting products by technology from PY5 through PY11. One hundred percent of upstream lighting products sold since PY8 were LEDs.

Figure 14: PY5-PY11 Upstream Lighting Technologies

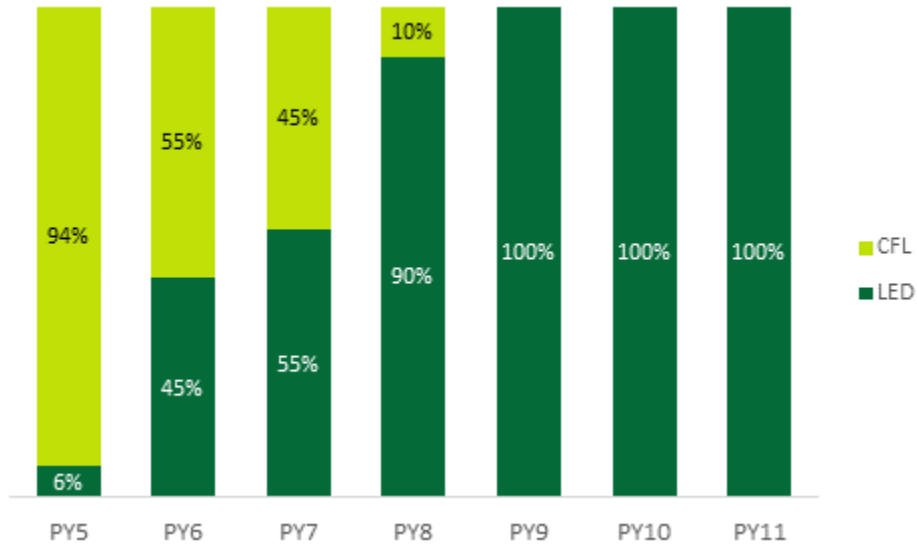
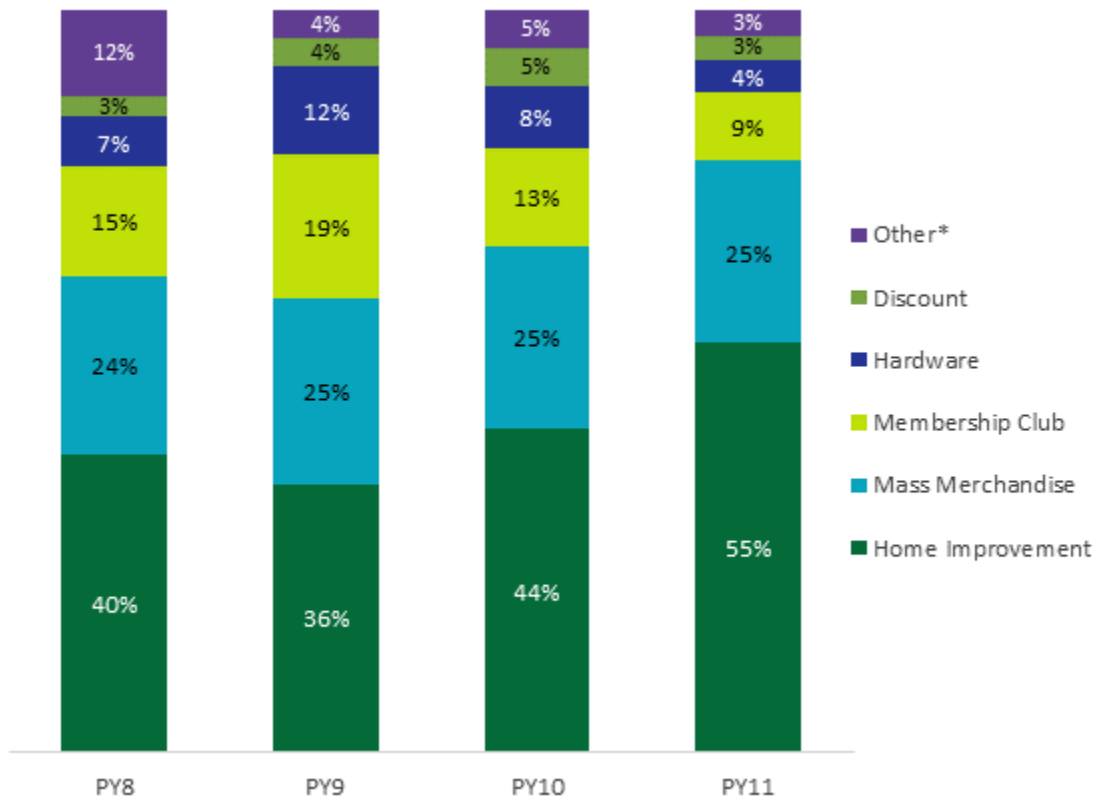


Figure 15 displays the distribution of statewide upstream lighting products sold by retail channel from PY8 through PY11. Over one-half (55%) of PY11 upstream lighting products were sold through home improvement stores, which is up from 40% in PY8. The proportion of products sold through mass merchandise stores has remained stable over time, at around 25%, while the proportion of sales through most other channels has declined. Primary sales channels varied by EDC. See the Upstream Lighting & Cross-Sector Sales sections of the appendices for EDC-specific distributions of sales by retail channel.

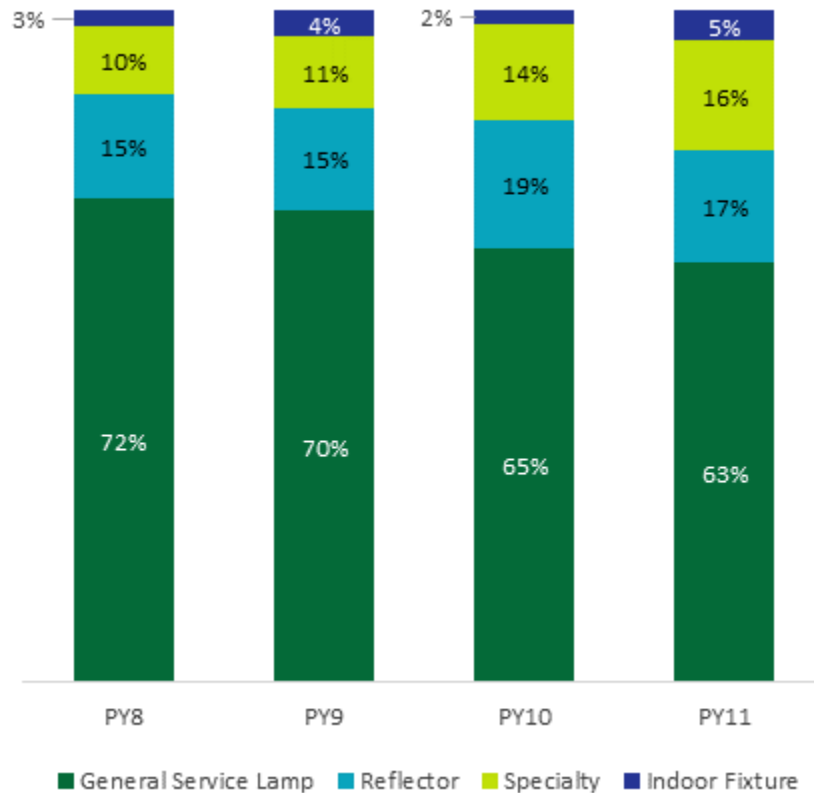
Figure 15: PY8-PY11 Upstream Lighting Sales by Retail Channel



*Other includes grocery, lighting and electronics, and independent stores.

Figure 16 displays the distribution of statewide upstream lighting products by product type from PY8 through PY11. Just over three-fifths (63%) of statewide PY11 upstream lighting products sold were general service lamps, which is down from 72% in PY8. Meanwhile, the proportion of reflectors, specialty lamps, and indoor fixtures has increased. Product types varied by EDC; see the Upstream Lighting & Cross-Sector Sales sections of the appendices for EDC-specific distributions of lighting types.

Figure 16: PY8-PY11 Upstream Lighting Sales by Product Type



2.1.2. 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 PY11. [Table 15](#) displays the cross-sector sales rates EDCs applied in PY11, the study period they were estimated, and the method used to estimate them.

Table 15: PY11 Upstream Lighting Cross-Sector Sales Rates

EDC	Cross-Sector Sales Rate	Study Period	Method
PECO	1.5%*	PY8	In-store intercept survey
PPL	6%	PY10	General population surveys of residential and small business customers
Duquesne Light	3.8%**	PY9	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.

** Respondent bulb weighted average was 3.5 % for standard LEDs and 4.2% for specialty LEDs.

2.1.3. LED Price Trends, PY11

Figure 17 shows quarterly sales-weighted average manufacturer suggested retail prices (MSRPs) for A-lines for PY9 through PY11. Sales-weighted average MSRPs for A-Lines are about \$0.20 less in PY11 than they were in PY10. This drop is less drastic than the drop in prior years, but MSRPs continue to fall. Non-sales-weighted average MSRPs also continued to decline. Figure 18 shows quarterly sales-weighted average MSRPs for light-emitting diode (LED) candelabras, globes, and reflectors. For candelabras, average MSRPs were \$0.61 less in PY11 than they were in PY10. Average sales-weighted MSRPs for globes were essentially the same in PY9 and PY10 and dropped by nearly \$0.50 in PY11. For reflectors, sales-weighted MSRPs actually increased in PY11. This increase was largely driven by PECO, as they had a number of higher-priced reflectors go through the program in PY11. Their sales-weighted reflector MSRP increased by roughly \$1.75 in PY11 compared to PY10.

Figure 17: PY9 – PY11 Quarterly LED Prices – A-lines

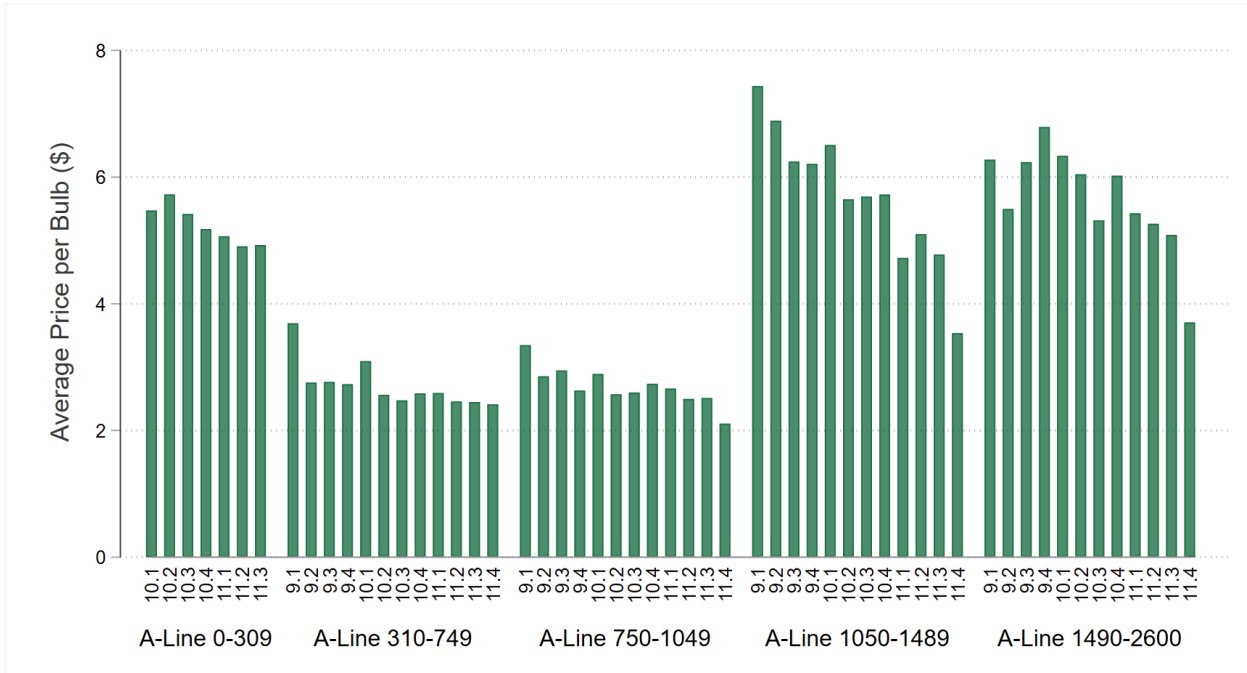
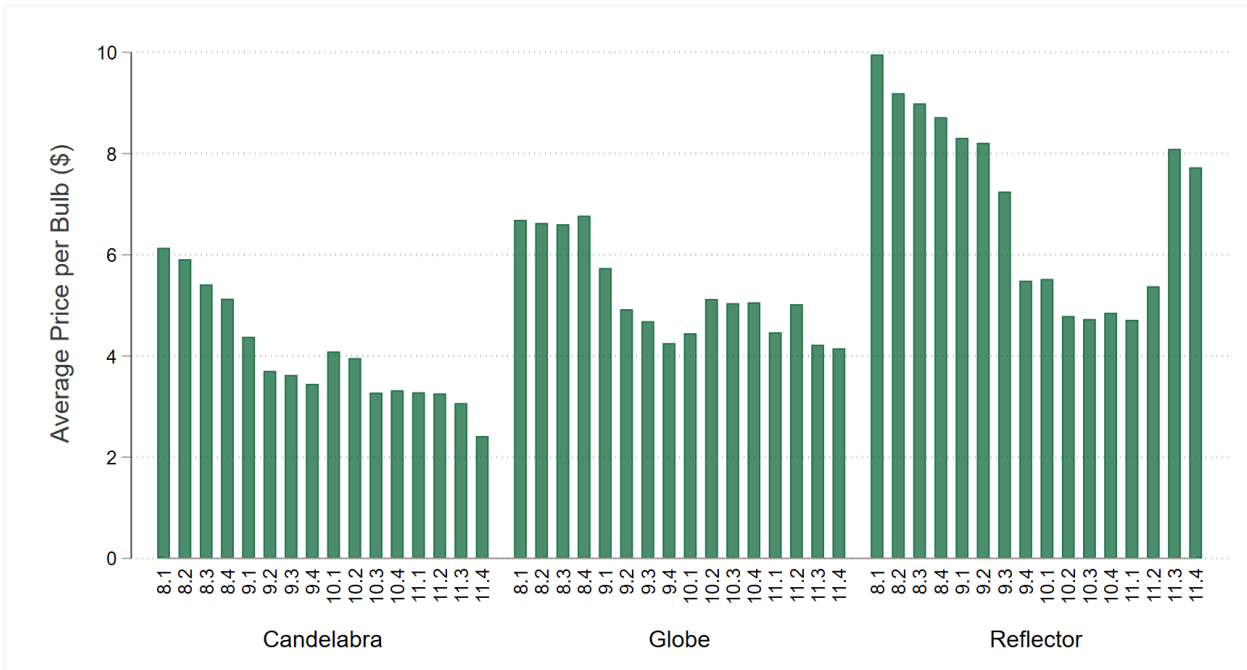


Figure 18: PY9 – PY11 Quarterly LED Prices – Candelabras, Globes, and Reflectors



2.1.4. 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 PY11 upstream lighting programs. For each EDC, summary statistics are shown in [Table 16](#). Note that 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. Also note that the average prices and incentive levels are per bulb (not pack). Duquesne Light offered the largest percent discount per bulb (41%), followed by PECO (29%) and PPL (25%). FirstEnergy companies did not provide MSRPs, so percent discounts could not be calculated for FirstEnergy companies. That said, their sales-weighted average incentive level is in line with the other EDCs. The relatively high MSRP for PPL could be related to the Marketplace Pilot component of their Energy Efficient Home Program, which incented a number of smart Wi-Fi enabled LED bulbs. As an aside, PECO reported identical MSRPs and rebated prices for all PY11 lighting records. The SWE recalculated retail prices for PECO by adding per-bulb incentives to per-bulb discounted prices.

Table 16: Variation in LED Incentives Across EDCs

EDC	MSRP	Discounted Price	Incentive	% Discount	PY11 LED Bulbs	Bulbs / Household
PECO	\$3.86	\$2.74	\$1.12	29%	3,666,207	2.5
PPL	\$4.71	\$3.51	\$1.19	25%	1,202,606	1.0
Duquesne Light	\$3.60	\$2.13	\$1.47	41%	403,971	0.7
FirstEnergy Companies	NA	NA	\$0.89	NA	3,032,788	1.7

2.2 HERs

Over one million Pennsylvania homes received HERs in PY11. This represents approximately 21% of the residential electric accounts served by the EDCs subject to Act 129. [Table 17](#) summarizes the average number of residential accounts according to FERC Form 861 filings²³ and PY11 HER recipients by EDC. Recipient counts are PY11 averages rounded to the nearest thousand.

²³ <https://www.eia.gov/electricity/data/eia861/>

Table 17: PY11 Statewide HER Summary Statistics

EDC	Residential Premises	PY11 HER Recipients	Percent of Homes Receiving HERs
PECO	1,480,000	370,000	25%
PPL	1,265,000	172,000	14%
Duquesne Light	544,000	64,000	12%
FE: Met-Ed	505,000	133,000	26%
FE: Penelec	498,000	141,000	28%
FE: Penn Power	146,000	25,000	17%
FE: West Penn	624,000	141,000	23%
Total	5,062,000	1,046,000	21%

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 18 presents the average evaluated PY11 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 1.8% per household.

Table 18: HER Average Impacts by EDC

EDC	PY11 kWh Usage (HER Recipients)	Average PY11 kWh Savings per Recipient	Average Percent Reduction
PECO	13,571	205	1.5%
PPL	16,457	232	1.4%
Duquesne Light	9,552	155	1.6%
FE: Met-Ed	13,494	197	1.5%
FE: Penelec	10,272	101	1.0%
FE: Penn Power	13,499	248	1.8%
FE: West Penn	14,912	122	0.8%
Statewide Total	13,524	181	1.3%

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.

2.2.1 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 PY11, 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 the 150% Federal Poverty Line. The customers that were no longer classified as LI were split into a separate cohort. The savings for this cohort were treated as residential savings in PY11. The remaining cohort of customers that were below the Federal Poverty Line included just under 17,000 households and produced approximately 1,500 MWh of gross verified savings in PY11. In PY11, PPL did claim the energy savings achieved by this cohort towards the LI target. Table 19 shows the PY11 verified gross LI savings for each EDC and how much of the energy savings came from HER programs.

Table 19: Contribution Towards LI Targets from HERs

EDC	PYVTD LI MWh	PYVTD LI MWh from HERs	Percent of PY11 LI Savings from HERs
PECO	35,888	0	0.0%
PPL	29,945	1,564	5.2%
Duquesne Light	5,681	1,890	33.3%
FE: Met-Ed	4,159	2,554	61.4%
FE: Penelec	3,942	1,745	44.3%
FE: Penn Power	1,114	560	50.3%
FE: West Penn	3,800	1,647	43.3%
Statewide Total	84,529	9,960	11.8%

2.2.2 HER Contributions to Portfolio Totals

Figure 19 shows the gross verified MWh savings attributable to HER programs, by EDC, for the first four years of Phase III. The statewide total was approximately 20,000 MWh lower in PY11 compared to PY10. PECO, PPL, Penelec, and West Penn Power accounted for most of the decline. PECO was the only EDC to introduce new HER cohorts in PY11 and a decline in aggregate savings is typical for existing HER cohorts because of attrition. 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 19: Verified MWh Savings from HERs, by EDC and Program Year

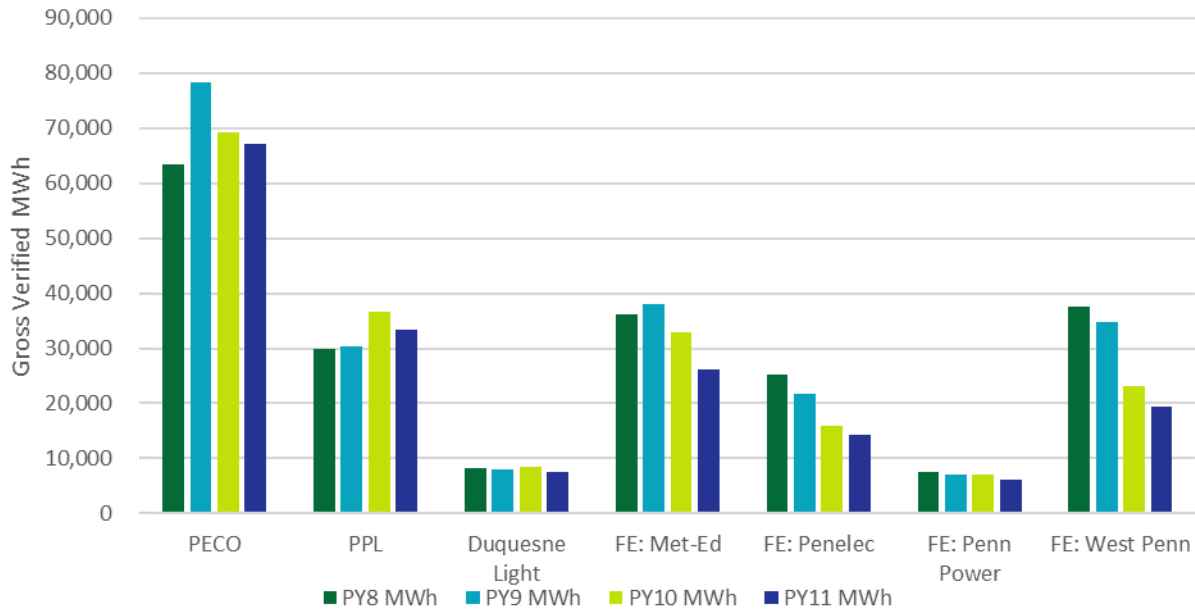
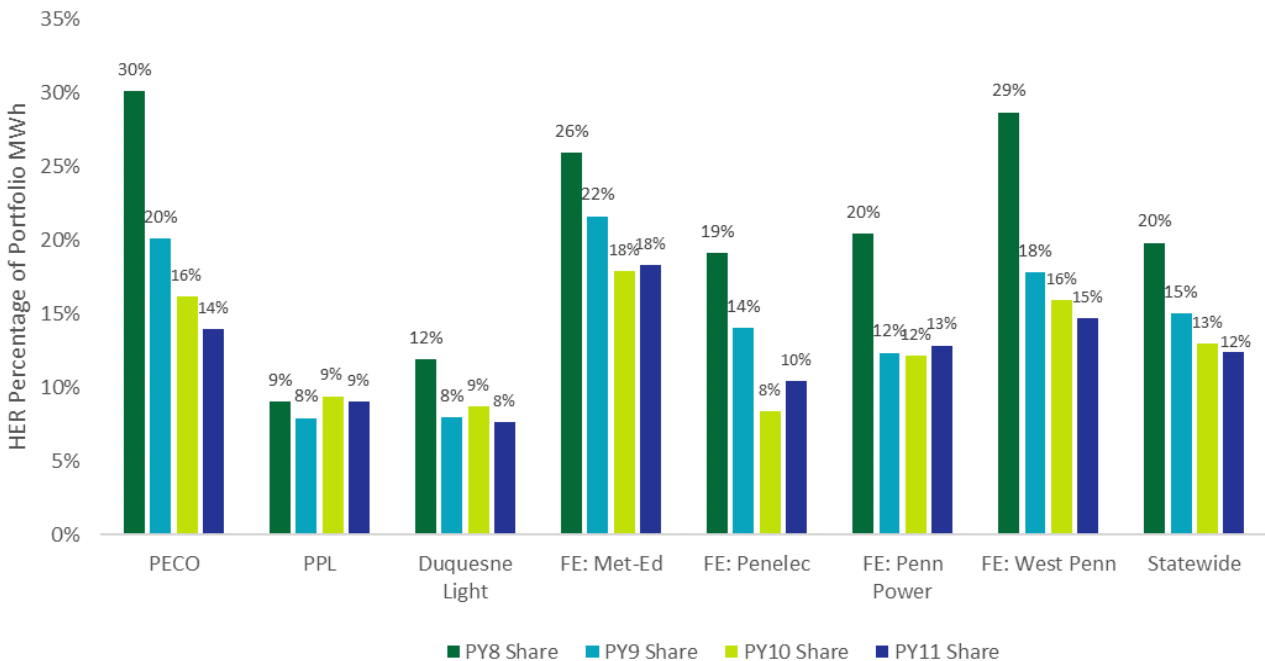


Figure 20 looks at HER verified savings as a percentage of all compliance savings recorded in a program year. HER contribution has decreased each year of Phase III. In PY8, HER offerings accounted for 20% of all gross verified savings. The share dropped to 15% in PY9, 13% in PY10, and down to 12% in PY11.

Figure 20: HER Savings as a Percentage of the Portfolio, by EDC and Program Year



2.3 NON-RESIDENTIAL LIGHTING

Non-residential lighting improvements accounted for 36% of statewide PY11 energy savings. These projects largely utilized Technical Reference Manual (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 PY11 non-residential lighting improvements in both downstream and midstream programs. Fluorescent lighting technologies did not contribute a significant share of energy savings in PY11 (less than 0.25% of verified energy savings for non-residential lighting improvements).

2.3.1. Downstream Lighting Programs

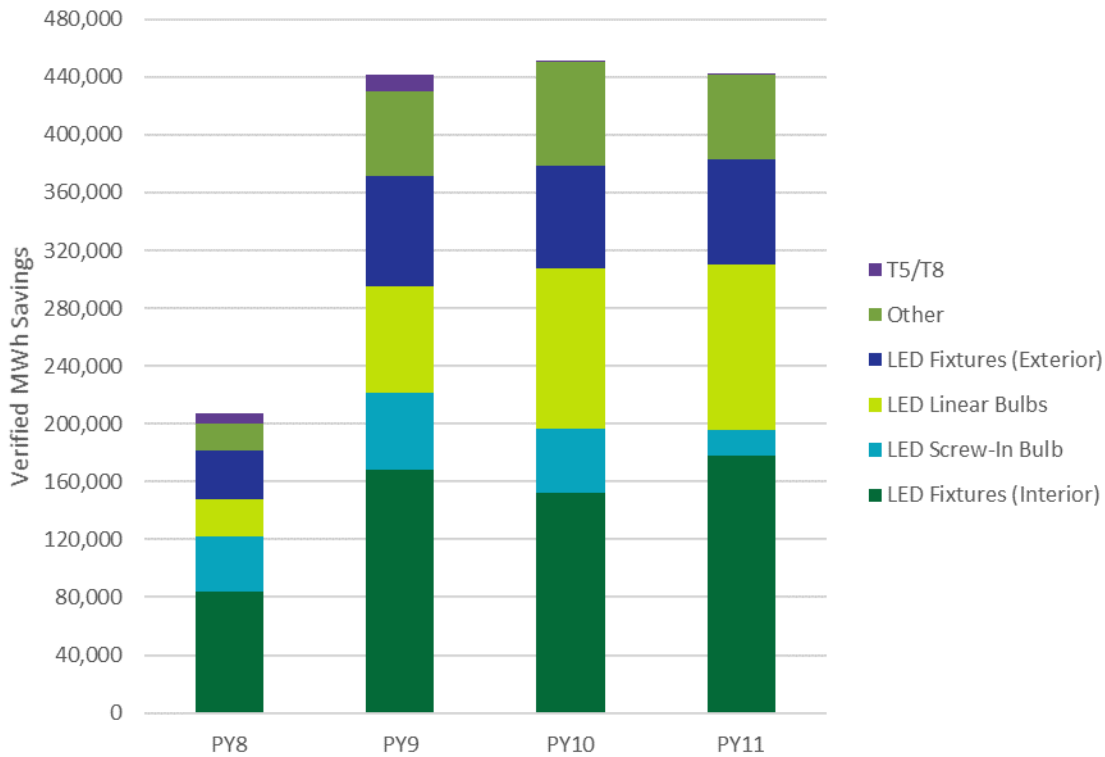
Downstream offerings continue to dominate the lighting programs across the EDCs and represent the single largest program offering, accounting for 31% of statewide PY11 verified gross energy savings. Downstream programs provide direct incentives for business customers who upgrade their facilities with 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 submits an application 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 21 shows verified energy savings for Program Years 8 through 11 for downstream lighting offerings. The level of achieved energy savings in PY11 increased relative to the savings achieved in PY10. The savings achieved through linear LED bulb measures has shown significant increases each year. Savings from both interior and exterior LED fixtures increased relative to PY10, whereas fluorescent fixture savings remained about the same. Overall, LED technologies accounted for at least 87%²⁴ of PY11 verified non-residential downstream lighting energy savings.

²⁴ The "Other" category largely includes measures tracked as "Custom," "Lighting-Other," etc. that do not designate a specific lighting technology.

Figure 21: PY8 – PY11 Downstream Lighting Technologies



2.3.2. Midstream Lighting Programs

Three EDCs – Duquesne Light, PPL, and PECO – offered a midstream lighting program in PY11.²⁵ Energy savings contribution results from the three EDCs offering midstream lighting programs in PY11 are presented in Table 20. The combined savings from these programs are about 13% of all verified non-residential lighting savings in PY11 but totals 19% of non-residential lighting savings for the three EDCs with midstream programs.

Table 20: Midstream Lighting Verified Energy Savings by EDC

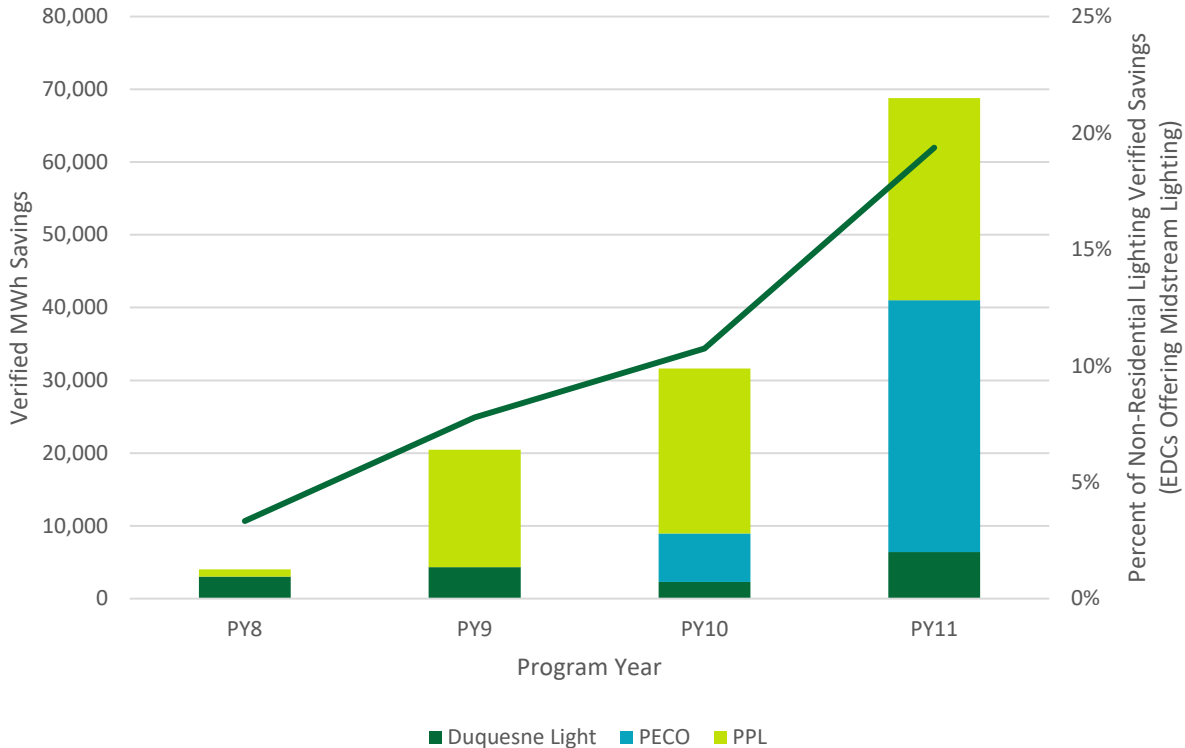
EDC	Total Non-Residential Lighting (MWh)	Midstream Lighting (MWh)
Duquesne Light	53,796	6,388
PECO	152,375	34,636
PPL	150,332	27,794

Figure 22 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 increased participation in PY11. PPL’s midstream program slightly increased in total verified energy savings from PY10.

²⁵ Both PPL and Duquesne Light’s midstream lighting programs began in PY8. PECO’s program began in PY10.

Duquesne Light’s PY11 midstream lighting savings also included unverified savings from the last eight months of PY10, which were verified in PY11.

Figure 22: PY8 – PY11 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 PY11. For Phase IV, the 2021 TRM includes a midstream lighting section.

2.4 COMBINED HEAT AND POWER (CHP)

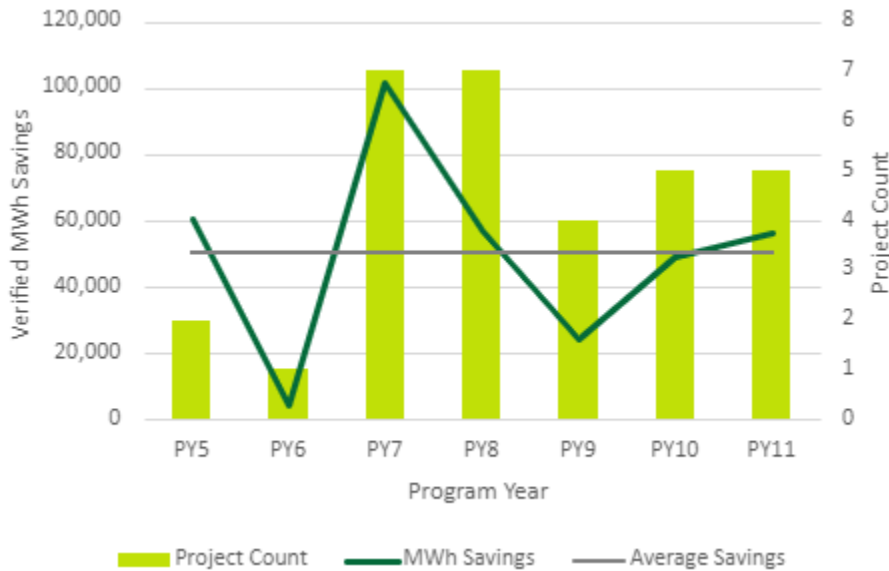
The PUC has made a commitment to advance the prevalence of CHP and released a Final Policy Statement on CHP in April of 2018, which is designed to advance the deployment of CHP technology throughout Pennsylvania. While not a top offering, the five CHP projects completed in PY11 accounted for just over 4% of the statewide gross verified savings.

Figure 23 shows the energy savings contributions from Act 129 CHP projects over the past seven years.²⁶ The average CHP contribution is 50,395 MWh per program year, with notable variation

²⁶ Energy savings contributions for CHP projects from PY5-PY7 are derived from annual reports issued in Phase II of Act 129.

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 PY11 slightly increased in verified energy savings, but PY11 participation remained the same from PY10. PY11 verified savings for CHP projects were 56,659 MWh, which is an increase of 7.6 MWh from PY10.

Figure 23: Historical CHP Savings



In PY11, CHP projects were completed by three EDCs – PECO, PPL, and Met-Ed – as shown in [Table 21](#). Realization rates observed to be greater than 100% were generally due to overstated assumptions around uncertainty in early operational periods and a low-capacity factor incorporated into ex-ante savings calculations.

Table 21: PY11 CHP Verified Energy Savings and Realization Rate by EDC

EDC	Qty	Verified Savings (MWh)	Realization Rate
PECO	1	816	109%
PPL	3	45,810	100%
FE: Met-Ed	1	10,033	100%

Section 3 Portfolio and Program-Level Savings by EDC

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

Table 22 presents a statewide overview of PY11 and phase-to-date savings, while Table 23 presents an overview of statewide EDC spending on incentives and program overhead costs and overall benefits in PY11.

Table 22: Summary of Statewide PY11 and Phase III Impacts: Gross and Net Annual and Lifetime Savings

Savings Category	Statewide Total
Phase III Reported Gross Savings (MWh/yr)	5,410,198
Phase III Verified Gross Savings (MWh/yr)	5,436,567
Phase III Net Savings (MWh/yr)	3,898,639
Phase III Gross Lifetime Savings (MWh)	47,156,269
Phase III Net Lifetime Savings (MWh)	32,637,443
PY11 Reported Gross Savings (MWh/yr)	1,404,056
PY11 Verified Gross Savings (MWh/yr)	1,406,597
PY11 Net Savings (MWh/yr)	964,437
PY11 Gross Lifetime Savings (MWh)	12,387,116
PY11 Net Lifetime Savings (MWh)	8,383,361

Table 23: Summary of Statewide Portfolio Finances**

Row #	Element	PY11 (\$1000)
1	EDC Incentives to Participants ^[1]	\$81,147
2	EDC Incentives to Trade Allies	\$0
3	Participant Costs (net of incentives/rebates paid by utilities)	\$249,843
4	Incremental Measure Costs (Sum of rows 1 through 3)	\$330,991
5	Design and Development ^[2]	\$687
6	Administration, Management, and Technical Assistance ^[3]	\$13,629
7	Marketing ^[4]	\$16,108
8	Program Delivery ^[5]	\$85,638
9	EDC Evaluation Costs	\$6,678
10	SWE Audit Costs	\$1,600
11*	Program Overhead Costs (Sum of rows 5 through 10)	\$124,341
12	Net Present Value (NPV) of increases in costs of natural gas (or other fuels) for fuel switching programs	\$11,604
13	Total NPV TRC Costs ^[6] (NPV of sum of rows 4, 11, and 12)	\$466,935
14	Total NPV Lifetime Electric Energy Benefits	\$428,200
15	Total NPV Lifetime Electric Capacity Benefits	\$133,640
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$62,651
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	\$2,335
18	Total NPV TRC Benefits ^[7] (Sum of rows 14 through 17)	\$626,828
19	Statewide TRC Ratio ^[8]	1.34

[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, 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.

* 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.

3.1 PECO

3.1.1 Impact Evaluation

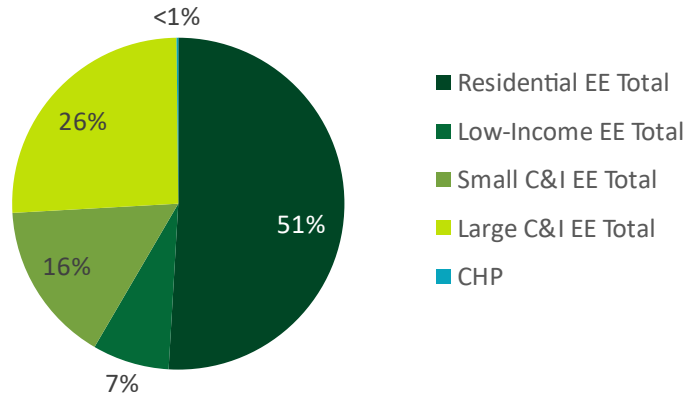
A summary of energy impacts by program for PY11 is presented in [Table 24](#). Over half of the savings (51%) are attributable to the Residential Energy Efficiency Program (Residential Energy Efficiency Program), which is an umbrella program containing solutions for lighting, appliances, and Heating, Ventilation, and Air Conditioning (HVAC); appliance recycling; whole home; new construction; multifamily; and behavioral adjustment (see [Figure 20](#)). The program is designed to give customers the option to save electricity across all residential end-uses. Given this comprehensive approach, the program has a much wider reach and higher participation than other programs in the portfolio.

Table 24: PY11 Incremental Annual Energy Savings by Program (MWh/Year)* – PECO

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Res. Energy Efficiency Program	248,114	98%	244,306	0.67	163,140
LI Energy Efficiency Program	37,265	96%	35,888	1.00	35,888
Small C&I Energy Efficiency Program	66,669	113%	75,329	0.76	57,439
Large C&I Energy Efficiency Program	113,652	109%	123,363	0.60	73,769
CHP	747	109%	816	0.87	713
Portfolio Total	466,447	103%	479,702	0.69	330,948

* Rows may not sum to totals due to rounding.

Figure 24: Percent of Portfolio PY11VTD Gross Savings, by Program – PECO

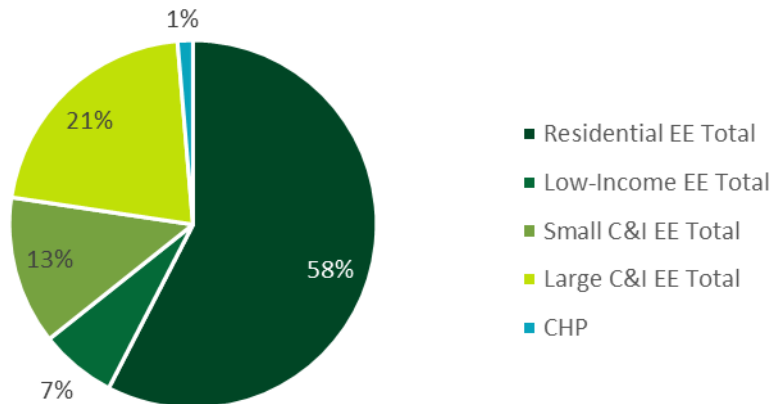


A summary of phase-to-date energy impacts by program is presented in Table 25. Consistent with PY11, the bulk of savings (58%) in the phase is attributable to the Residential Energy Efficiency Program (Figure 25).

Table 25: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year)* – PECO

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Res. Energy Efficiency Program	878,299	99%	867,979	0.67	582,472
LI Energy Efficiency Program	110,572	93%	102,950	1.00	102,950
Small C&I Energy Efficiency Program	189,762	104%	196,543	0.76	149,198
Large C&I Energy Efficiency Program	315,365	102%	321,025	0.68	219,847
CHP	26,450	77%	20,440	0.88	17,912
Portfolio Total	1,520,448	99%	1,508,937	0.71	1,072,379

* Rows may not sum to totals due to rounding.

Figure 25: Percent of Portfolio VTD Gross Savings, by Program – PECO

A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 26](#) and phase-to-date in [Table 27](#).

Table 26: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year)* – PECO

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Res. Energy Efficiency Program	23.21	1.34%	31.07	0.67	20.94
LI Energy Efficiency Program	4.35	0.96%	4.18	1.00	4.18
Small C&I Energy Efficiency Program	10.65	1.26%	13.46	0.76	10.28
Large C&I Energy Efficiency Program	16.55	1.23%	20.36	0.60	12.09
CHP	0.13	0.62%	0.08	0.88	0.07
Portfolio Total	54.88	1.26%	69.17	0.69	47.57

* Rows may not sum to totals due to rounding.

Table 27: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year)* – PECO

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Res. Energy Efficiency Program	77.76	1.43%	111.54	0.66	73.45
LI Energy Efficiency Program	13.00	0.93%	12.06	1.00	12.06
Small C&I Energy Efficiency Program	28.59	1.07%	30.66	0.76	23.20
Large C&I Energy Efficiency Program	44.50	1.10%	49.04	0.68	33.11
CHP	2.80	0.88%	2.45	0.88	2.15
Portfolio Total	166.65	1.23%	205.75	0.70	143.96

* Rows may not sum to totals due to rounding.

3.1.2 DR

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 28](#) provides the definitions used and the counts of PY11 and Phase III participation for each included DR program.

Table 28: PECO Participation by Program

Program	Definition of Participant	PYTD Participation	P3TD 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.	53,924	*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	1,312	*1,586

Program	Definition of Participant	PYTD Participation	P3TD Participation
	disconnected, who have opted out of the program, or for whom the DLC device was removed are not counted as participants.		
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.	340	*348

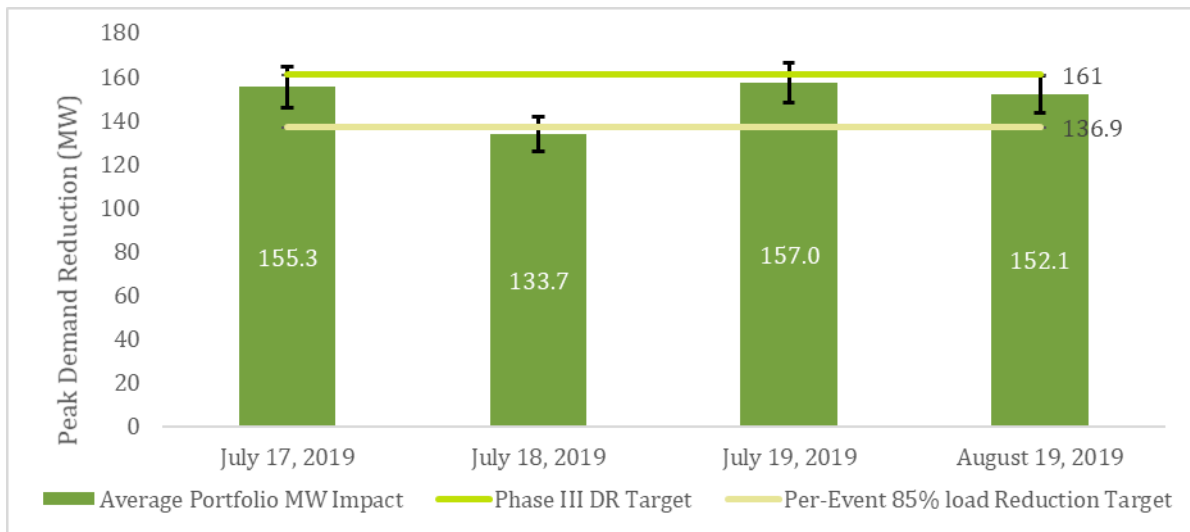
*DR participation is not additive like other programs because the same participants tend to remain in the program with only small attrition. Therefore, total participation in the DR programs for Phase III is equal to the highest program year participation count for each of the three programs.

PECO’s three DR programs – Residential DR, Small C&I DR, and Large C&I DR – had four event days in PY11. The Phase III DR performance target for PECO is 161.0 MW. Table 29 shows the DR savings for each program, as well as the portfolio average for each event day. Average performance for PY11 events and Phase III events are included at the bottom of the table.

Table 29: PECO DR 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 17, 2019	15	18	34.4	0.9	120.0	155.3±9.5
July 18, 2019	16	19	11.1	1.0	121.6	133.7±7.9
July 19, 2019	15	18	34.9	1.2	120.9	157.0±9.1
August 19, 2019	15	18	24.9	1.0	126.2	152.1±8.5
PYVTD - Average PY11 DR Event Performance						149.5±8.8
VTD - Average Phase III DR Event Performance						167.1±16.7

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 26 compares the performance of each of the DR events in PY11 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For three of four events, PECO exceeded the 85% threshold. Average temperatures dropped abruptly on July 18, 2019, leading to underperformance of the Residential DR program.

Figure 26: PECO Event Performance Compared to Per-Event Target

3.1.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. [Table 30](#) shows the TRC ratios by program and for the portfolio. The benefits in [Table 30](#) were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 30: PY11 Gross TRC Ratios by Program (\$1,000) – PECO

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Residential EE	\$63,159	\$43,000	1.47	\$20,159
LI EE	\$19,213	\$8,393	2.29	\$10,820
Residential DR	\$2,435	\$3,188	0.76	(\$753)
Residential Total	\$84,807	\$54,581	1.55	30,226
Small C&I EE	\$32,164	\$32,168	1.00	(\$5)
Large C&I EE	\$54,403	\$58,795	0.93	(\$4,391)
CHP	\$424	\$670	0.63	(\$245)
Small C&I DR	\$93	\$115	0.82	(\$21)
Large C&I DR	\$5,771	\$4,557	1.27	\$1,213
Non-Residential Subtotal	\$92,855	\$96,305	0.96	(\$3,449)
Cross-Cutting		\$9,545		(\$9,545)
Portfolio Total	\$177,663	\$160,431	1.11	\$17,231

3.1.4 Process Evaluation

Guidehouse reported on PY11 process evaluations for the following PECO programs and target market segments.

Table 31: PECO PY11 Process Evaluations Conducted for Program Solutions

Programs and Program Solutions	
Residential Energy Efficiency Program^{27,28}	Small C&I Energy Efficiency Program²⁹
Lighting, Appliances, & HVAC Solution	Equipment and Systems Solution
Appliance Recycling Solution	New Construction Solution
Whole Home Solution	Whole Building Solution
New Construction Solution	
	Large C&I Energy Efficiency Program³⁰
	Equipment and Systems Solution
	New Construction Solution

For PY11, Guidehouse conducted and reported on full process evaluations for a total of nine solutions within the PECO residential, small C&I, and large C&I energy-efficiency programs. From these evaluations, it produced a total of four process evaluation findings that resulted in four recommendations, all of which were accepted, with two already implemented and two to be implemented. A key cross-program finding was program satisfaction from participants and builders. Participant satisfaction information was collected for three residential program solutions (the Appliances & HVAC and Marketplace components of the Lighting, Appliances, & HVAC Solution; the Appliance Recycling Solution; and the Whole Home Solution), three small C&I program solutions (the Equipment and Systems Solution, the New Construction Solution, and the Whole Building Solution) and two large C&I solutions (the Equipment and Systems Solution and the New Construction Solution). On average, across these participant surveys, 91% of residential participants and 92% of C&I participants were satisfied with the programs overall. Satisfaction information was also collected from builders in one residential program solution, with an average of 88% satisfaction for builders active with the New Construction Solution.

For the *PECO Residential Energy Efficiency Program*, the PY11 process evaluation produced two findings that resulted in two recommendations that were associated with the Appliances and HVAC component of the Lighting, Appliances, & HVAC Solution. The two recommendations will be implemented by the program. A key cross-program finding was an increase in builder and

²⁷ As described in the Phase III Evaluation Plan updated for PY11 and approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Multifamily Targeted Market Segment or the Behavioral Solution in PY11 for the REEP.

²⁸ Note that as of PY10, the Lighting, Appliances, & HVAC Solution also includes the online PECO Marketplace.

²⁹ As described in the Phase III Evaluation Plan updated for PY11 and approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Multifamily Targeted Market Segment, the Behavioral Solution, or the Data Centers Targeted Market Segment in PY11 for the Small C&I Energy Efficiency Program.

³⁰ As described in the Phase III Evaluation Plan updated for PY11 and approved by the SWE, Guidehouse did not complete any in-depth process evaluation activities for the Data Centers Targeted Market Segment or the Multifamily Targeted Market Segment in PY11 for the Large C&I Energy Efficiency Program.

participant satisfaction. The evaluation conducted a participant survey for the Appliances & HVAC components of the Lighting, Appliances, & HVAC Solution; a participant survey of the Marketplace channel of the Lighting, Appliances, & HVAC Solution; a participant survey for the Appliance Recycling Solution; a participant survey for the Whole Home Solution; and a builder survey for the New Construction Solution. On average, 91% of the participants and 88% of builders were satisfied with the programs overall. Solution-specific findings for these program solutions addressed a broad range of topics beyond satisfaction, including the following:³¹

- Primary sources of program information
- Strengths and areas of improvement in program marketing and outreach
- Informational sources on ways to save energy
- Challenges of building ENERGY STAR and Code Plus homes (builders survey only)
- Anticipated future program activity (builders survey only)
- Drivers and barriers of program participation
- Barriers to program delivery
- Suggestions for program improvement
- Likelihood to recommend the program

For the PECO *Small and Large C&I Energy-Efficiency programs*, the PY11 process evaluation of the Equipment and Systems Solution, the New Construction Solution, and the Whole Buildings Solution provided a total of two findings and two recommendations. By program, one of the recommendations was for the Equipment and Systems Solution and one was for the New Construction Solution. Across both Small and Large C&I Energy Efficiency program solutions, both recommendations have been implemented. A key cross-program program finding was on program satisfaction from participating customer surveys, which were conducted for the Small and Large Equipment and Systems Solution, the Small and Large New Construction Solution, and the Small Whole Building Solution. On average, 95% of the participants were satisfied with the Small C&I program overall and 85% of the participants were satisfied with the Large C&I program overall.

Solution-specific findings for these Small and Large C&I program solutions addressed a broad range of topics beyond satisfaction, including the following:³²

- Primary sources of program information
- Strengths and areas of improvement in program outreach and marketing
- The level of effort required to receive their incentive
- Communication with PECO staff, and the program overall
- Drivers and barriers of program participation
- Barriers to program delivery
- Likelihood to recommend the program

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

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

3.1.5 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the PECO PY11 Annual Report and the supporting detail provided by PECO's evaluation contractor. The detailed audit findings can be found in [Appendix B](#).

- The PY11 DR impact analysis was transparent, replicable, and consistent with the guidelines of the Evaluation Framework. Following the filing of PECO's semi-annual report for PY11, the SWE audit uncovered that holidays were not excluded from the baseline calculations for Large C&I DR participants. This issue was corrected in the preliminary annual report and PECO's final annual report for PY11, which increased the verified MW performance by 9 MW.
- PECO's average event performance was down approximately 20% from PY10 (149.5 MW versus 185.0 MW). Additionally, the verified MW performance for the July 18, 2019, DR fell short of the Commission's requirement that each DR event achieve at least 85% of the Phase III compliance target. As shown in [Figure 26](#), the margin of error around the verified MW estimate includes the event-specific goal of 137 MW on July 18. The SWE also recommends the Commission factor weather conditions into its assessment of performance for this day. On July 18, the weather forecast called for hot and humid conditions, but a thunderstorm occurred mid-day and lowered the outdoor air temperature significantly. This reduced the cooling demand for the day and diminished the impacts of the DR event, particularly in the residential sector. Excluding July 18, 2019, PECO's Residential DR program has averaged approximately 32 MW per event in Phase III. On July 18, however, the Residential program only produced 11 MW. If the Residential DR program had contributed 15 MW (less than half of its Phase III average), the July 18 event day would have reached the 85% threshold. The purpose of DR events is to reduce electric demand. For this day, residential demand was reduced in the afternoon hours. However, the reduction was driven by weather and this limited the DR capability of the program.
- In the Tracking Data Review audit activity, the SWE was able to replicate reported gross energy savings and reported gross demand savings for all programs in PECO's portfolio. Regarding participation, the SWE calculated directionally similar counts for each program. Portfolio totals differed by less than 0.3%. For incentives, the SWE also calculated directionally similar values using the tracking data.
- The PY11 analysis of PECO's Behavioral Solution (HERs) was well-documented and free of errors. PECO's AC Saver cohort is the only Act 129 HER cohort that is not an RCT. Instead of the usual evaluation approach where the control is established via randomization, AC Saver requires the use of a matched control group. The addition of Wave 6 at the beginning of PY11 further complicated matters because some of the households assigned to the Wave 6 treatment group were in the matched control group for the AC Saver wave. PECO's Evaluation, Measurement, and Verification (EM&V) contractor, Guidehouse, made the appropriate adjustments to ensure that the PY11 verified gross savings estimates for both Wave 6 and the AC Saver cohort were unbiased.
- 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 PY11 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 recommendations to Guidehouse regarding specific aspects of some impact analyses. The difference in SWE's savings and the evaluator's savings was approximately 2%. The SWE's feedback was provided to the evaluator with sufficient time so that PECO could include all suggested changes in their annual report.
- 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 PY11. The residential solutions audit is detailed in [Appendix B.4.1](#).
- Adequate numbers of project files were submitted for the residential solutions in PY11, and the sampled project file packages included the requested number of project files and supporting details.
- Overall, Guidehouse estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- The extended reporting timeline for PY11 allowed the SWE to review PECO's TRC model prior to the filing of the PY11 final annual report. The modeling issues from PY10 were largely resolved and the PECO team was able to resolve a few minor items before filing its PY11 final annual report.
- In general, for all the process evaluations, the SWE determined that the reporting followed the SWE guidelines. PECO's PY11 Annual Report included descriptions of the methods, summary of findings, and a table of recommendations with a description of whether PECO was implementing or considering those recommendations. The report included sufficient detail 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 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.

3.2 PPL

3.2.1 Impact Evaluation

A summary of energy impacts by program for PY11 is presented in [Table 32](#). The largest portion of savings (62%) 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 27](#)).

Table 32: PY11 Incremental Annual Energy Savings by Program (MWh/Year) – PPL

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTGR	PYVTD Net (MWh/yr)
Appliance Recycling	10,119	98%	9,945	0.66	6,564
Efficient Lighting	49,834	97%	48,339	0.83	40,121
Energy Efficiency Kits and Education	14,011	78%	10,888	1.00	10,888
Energy Efficient Home**	20,261	84%	16,929	0.66	11,192
Home Energy Education*	36,145	92%	33,356	1.00	33,356
Non-Residential Energy Efficiency	232,732	99%	229,943	0.71	163,647
Student Energy Efficient Education (SEEE)	6,260	98%	6,158	1.00	6,158
WRAP	15,197	91%	13,764	1.00	13,764
Total	384,558	97%	369,322	0.78	285,690

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

** Verified savings and realization rate for the Energy Efficient Home Program does not include unverified savings.

Figure 27: Percent of Portfolio PY11VTD Gross Savings, by Program – PPL

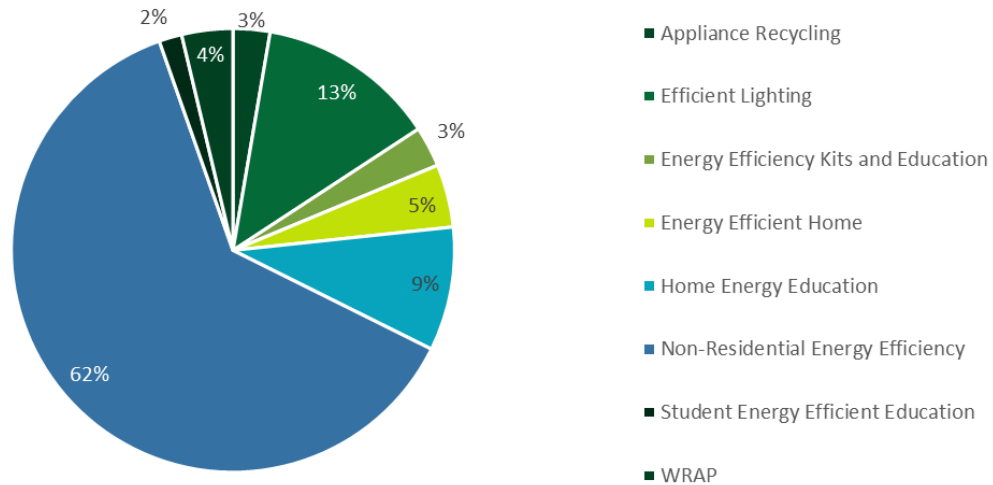


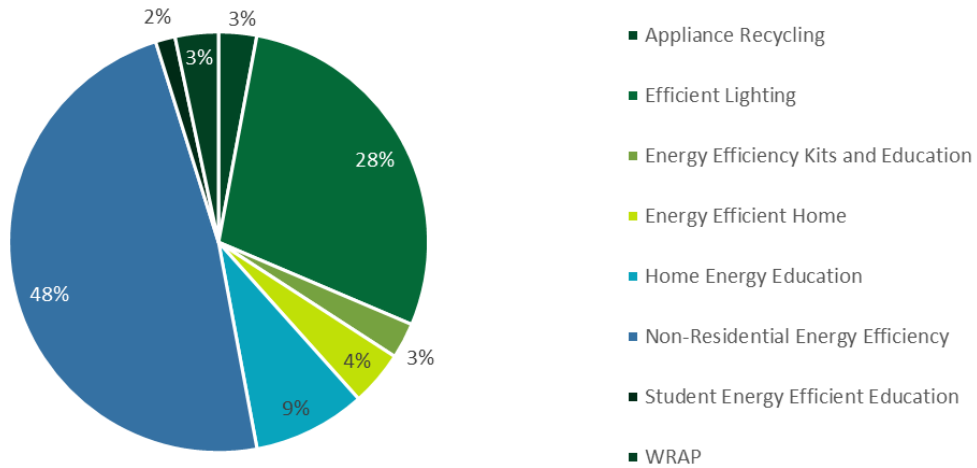
Table 33: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – PPL

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTGR	VTD Net (MWh/yr)
Appliance Recycling	49,903	88%	43,883	0.66	28,963
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**	73,021	87%	63,336	0.69	43,669
*Home Energy Education	152,567	85%	130,210	1.00	130,210
Non-Res Energy Efficiency	738,497	98%	720,882	0.73	527,776
SEEE	23,050	99%	22,731	1.00	22,731
WRAP	57,369	87%	49,937	1.00	49,937
Portfolio Total	1,581,626	96%	1,498,971	0.80	1,198,730

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

** Verified savings and realization rate for the Energy Efficient Home Program does not include unverified savings.

Figure 28: Percent of Portfolio VTD Gross Savings, by Program – PPL



A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 34](#).

Table 34: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – PPL

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Recycling	1.84	99%	1.82	0.66	1.20
Efficient Lighting	6.60	94%	6.21	0.83	5.16
Energy Efficiency Kits and Education	0.97	124%	1.20	1.00	1.20
Energy Efficiency Home**	3.95	65%	2.57	0.66	1.68
Home Energy Education*	6.23	105%	5.78	1.00	5.78
Non-Res Energy Efficiency	33.30	89%	29.63	0.71	21.14
SEEE	0.61	104%	0.64	1.00	0.64
WRAP	1.49	94%	1.40	1.00	1.40
Portfolio Total	54.98	90%	49.26	0.78	38.20

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

** Verified savings and realization rate for the Energy Efficient Home Program does not include unverified savings.

Table 35: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year) – PPL

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Appliance Recycling	7.55	91%	6.87	0.66	4.54
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	13.17	84%	11.05	0.66	7.27
Home Energy Education*	74.45	32%	24.19	1.00	24.19
Non-Res Energy Efficiency	100.71	98%	98.73	0.74	72.65
SEEE	2.23	106%	2.37	1.00	2.37
WRAP	5.62	93%	5.22	1.00	5.22
Portfolio Total	268.84	79%	209.39	0.80	167.54

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

3.2.2 DR

PPL has one DR Program with participants from three sectors: Small C&I, Large C&I, and GNI. [Table 36](#) provides the definition used and the counts of PY11 and Phase III participation for the DR program.

Table 36: PPL Participation by Program

Program	Definition of Participant	PYTD Participation	P3TD Participation
DR	Unique account number; corresponds to a customer that enrolled in the program, not the number who participated in at least one event	*70	227

*70 customers participated in at least one event in PY11.

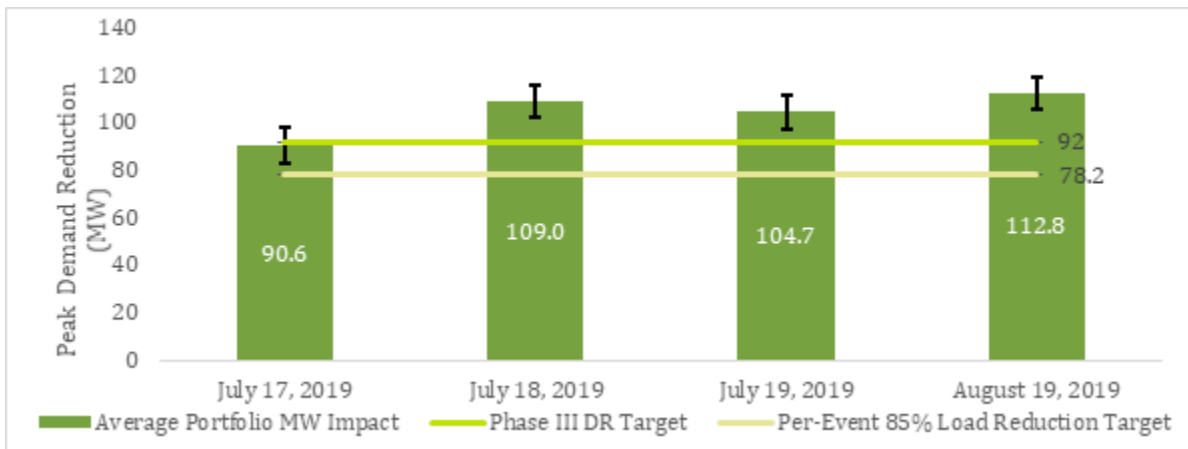
PPL's DR program had four event days in PY11. The Phase III DR performance target for PPL is 92.0 MW. [Table 37](#) shows the DR savings for the program and the portfolio average for each event day. Average performance for PY11 events and Phase III events are included at the bottom of the table.

Table 37: PPL DR 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 17, 2019	15	18	1.7	82.4	6.5	90.6±7.0
July 18, 2019	16	19	2.0	100.0	7.0	109.0±7.4
July 19, 2019	15	18	1.4	97.3	5.9	104.7±7.4
August 19, 2019	15	18	1.4	107.2	4.3	112.8±7.6
PYVTD - Average PY11 DR Event Performance						104.3±3.7
VTD - Average Phase III DR Event Performance						112.8±2.4

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 29 compares the performance of each of the DR events in PY11 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For each event, PPL exceeded the 85% threshold and three of the events exceeded the target of 92 MW.

Figure 29: PPL Event Performance Compared to Per-Event Target



3.2.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. Table 38 shows the TRC ratios by program and for the portfolio. The benefits in Table 38 were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 38: PY11 Gross TRC Ratios by Program (\$1,000) – PPL

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
Appliance Recycling	\$3,843	\$2,156	1.78	\$1,687
Efficient Lighting	\$12,863	\$4,281	3.01	\$8,582
Energy Efficiency Kits and Education	\$7,493	\$1,373	5.46	\$6,120
Energy Efficient Home	\$18,203	\$13,684	1.33	\$4,519
Home Energy Education	\$2,358	\$1,845	1.28	\$513
SEEE	\$7,522	\$1,654	4.55	\$5,868
WRAP	\$6,115	\$8,161	0.75	(\$2,046)
Residential (Including LI) Subtotal	\$58,397	\$33,154	1.76	\$25,245
Non-Residential Subtotal	\$160,902	\$99,554	1.62	\$61,348
DR	\$4,803	\$1,674	2.87	\$3,129
Common Portfolio Costs	(\$319)	\$5,385	-	(\$5,704)
Portfolio Total	\$223,782	\$139,766	1.60	\$84,016

3.2.4 Process Evaluation

Cadmus reported on PY11 process evaluations for the following PPL programs:

Table 39: PPL PY11 Process Evaluations

Residential and C&I Programs	
Residential Programs ^{33,34}	C&I Programs
Appliance Recycling	Non-Residential Energy Efficiency ¹
Energy Efficient Home	DR
Student Energy Efficient Education	
Home Energy Education	
Residential LI Programs	
Winter Relief Assistance Program (WRAP)	
Energy Efficiency Kits and Education	

¹ PPL's Non-Residential Energy Efficiency Program includes four distinct components: Efficient Equipment, Midstream Lighting, Custom, and Continuous Energy Improvement (CEI).

For PY11, Cadmus evaluated and reported on a total of eight programs within the PPL residential, LI, and C&I sectors. One of the programs in the C&I sector has four distinct program components (Efficient Equipment, Midstream Lighting, Custom, and CEI) with separate evaluations.³⁵ These evaluations generated a total of four process evaluation findings, which resulted in seven recommendations, two of which were accepted and five of which are under consideration.³⁶ A key cross-program finding was on program satisfaction from participants, builders, contractors, distributors, and market actors (e.g., property managers). Participant satisfaction information was collected for three residential programs (Appliance Recycling, Energy Efficient Home Program, and Student Energy Efficient Education Program), two residential LI programs (WRAP and Energy Efficiency Kits and Education Program), and four C&I programs and program components (Efficient Equipment Program, Midstream Lighting Program, Custom Program, and DR Program). On average, across all participant surveys, 92% of residential and LI participants and 95% of C&I participants were satisfied with the programs or program measures overall.³⁷ Satisfaction information was also collected from builders in one residential program, with an average of 100% satisfaction for builders active with the Energy Efficient Home Program. Satisfaction information was also collected for property managers in one LI program, with an average of 100% satisfaction for property managers active with the WRAP. Satisfaction information was also collected for

³³ For residential programs, the Efficient Lighting Program is not included because a process evaluation was not completed for the program in PY11.

³⁴ For residential programs, the Home Energy Education Program is included though it was a very limited program evaluation in PY11. PPL ceased sending the HERs to residential customers for the remainder of Phase III as of October 2019. Therefore, PPL and Cadmus canceled the customer satisfaction survey in PY11.

³⁵ For the C&I programs, the CEI component was not evaluated in PY11 because the program is no longer being offered.

³⁶ There are additional findings and recommendations in the PY11 report; however, this section reports only findings and recommendations that were specifically related to the process evaluation.

³⁷ Weighted by the number of PY11 participants in each program.

distributors and contractors in one C&I program component, with an average of 100% satisfaction for distributors and 100% satisfaction for contractors active with the Midstream Lighting Program.

For the *PPL Residential programs*, the PY11 process evaluation provided a total of two findings and five recommendations. All five of the recommendations are under consideration. A key cross-program finding was on program satisfaction from participant and builder surveys. The evaluation conducted a participant survey for the Appliance Recycling Program, a participant survey and a builder survey for the Energy Efficient Home Program, and a participant survey for the Student Energy Efficient Education Program. On average, 89% of participants and 100% of the builders were satisfied with the programs or program measures overall.³⁸ Program-specific findings for these residential program solutions addressed a broad range of topics, including the following:

- Strengths and weaknesses in program outreach
- Decision factors associated with online marketplace
- Drivers and barriers of program success
- Program improvement suggestions

For the *PPL Residential LI programs*, the PY11 process evaluation provided a total of one finding and one recommendation. The recommendation has been implemented. A key cross-program finding was program satisfaction from participant and property manager surveys. The evaluation conducted a participant survey and a property manager survey for the WRAP and a participant survey for the Energy Efficiency Kits and Education Program. On average, 98% of the participants and 100% of property managers were satisfied with the program overall. Program-specific findings for the LI programs addressed program delivery, strengths and weaknesses in program outreach, drivers and barriers to program success, and program improvement suggestions.

For the *PPL C&I programs*, the PY11 process evaluation provided a total of one finding and one recommendation. The recommendation has been implemented. A key cross-program finding was on program satisfaction from participant, distributor, and contractor surveys. The evaluation conducted a participant survey for the Efficient Equipment Program; a participant survey for the Custom Program; a participant survey for the DR Program; and a participant survey, a distributor survey, and a contractor survey for the Midstream Lighting Program. On average, 95% of the participants, 100% of distributors, and 100% of contractors were satisfied with the program overall.³⁹ Program-specific findings for the C&I programs primarily addressed program awareness, reporting system improvements, event experience, drivers and barriers of program success, and program improvement suggestions.

³⁸ The PPL annual report provides further detail regarding these topics.

³⁹ The PPL annual report provides further detail regarding these topics.

3.2.5 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the PPL PY11 Annual Report and the supporting detail provided by PPL's evaluation contractor. The detailed audit findings can be found in [Appendix C](#).

- The SWE found the Cadmus DR verified savings analysis to be thorough and well-documented for PY11. PPL's gross verified performance was comfortably above the 85% Phase III minimum performance target for each event. The PPL/Cadmus team resolved the issue from PY10 where sites that participated in fewer than four event hours on a given event day were included in the regression analysis when estimating reference loads. The PY11 audit uncovered one minor issue, where certain regression models were incorrectly specified without an intercept. The issue only affected six customers, which together accounted for 1.2% of overall MW performance. The SWE believes the omission did not have a meaningful impact on program performance and recommends that the Commission adopt the PPL/Cadmus verified savings estimates when assessing compliance at the end of Phase III.
- 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.
- The SWE audit of PPL's Home Energy Education (HEE) program uncovered no issues in PY11. PY11 is the first year where savings from the Home Energy Education program were counted towards PPL's LI compliance target for Phase III. PPL revaluated the October 2014 LI wave to identify which customers are still at or below the 150% Federal Poverty Line. The customers that were no longer classified as LI were split into a separate cohort and received their last treatment in February 2019 (PY10). For these customers, PY11 savings were estimated through eight months of PY11 until January 2020, when their PY10 treatment expired. Savings from this cohort were treated as residential savings. PPL also stopped issuing HERs and tracking savings for the second LI cohort after PY10. The SWE has several minor recommendations for the PY12 analysis, largely regarding billing data outliers and the reconciliation of participation counts between the billing data and the tracking data.
- 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. The residential programs audit is detailed in [Appendix C.4.1](#).
- 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 PY11 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. The SWE made recommendations to Cadmus regarding specific aspects of some impact analyses, and Cadmus adopted those recommendations.

- PY11 residential project files responses were adequate, and the supporting details were provided. All the program measures used default or EDC collected data as outlined in the EM&V plan.
- The SWE TRC audit uncovered some minor issues with PPL's cost-effectiveness calculations, although the SWE does not believe they impacted the material results of the TRC model and only made recommendations for adjustments to future annual reporting. The SWE found that in the O&M benefit calculations, some of the categories did not use a discount rate, which overestimates the NPV of the O&M benefits. The SWE also found that the incremental costs of some efficient products were unusually high and recommends a careful review of the inputs used to develop the weighted retail prices for residential LED bulbs with prices exceeding \$10. In their TRC calculations, PPL also incorporated the cost of kits as a program delivery cost, rather than an incentive to participants. This approach is inconsistent with the EDC Annual Report template and overstates the share of EE&C spending on overhead costs. The SWE recommends PPL file its PY12 annual report consistently with the statewide reporting template and the Commission's accounting preference on this issue.
- Overall, Cadmus estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- In general, for all process evaluations, the SWE determined that the reporting followed the SWE guidelines. PPL's PY11 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 mostly 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.

3.3 DUQUESNE LIGHT

3.3.1 Impact Evaluation

A summary of energy impacts by program for PY11 is presented in [Table 40](#). The largest share of savings (18%) is attributable to the upstream lighting portion of the REEP Program, where incentives are provided to retailers to discount the prices of LED bulbs sold at local retail stores (see also [Figure 30](#)).

Table 40: PY11 Incremental Annual Energy Savings by Program (MWh/Year) – Duquesne Light

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
REEP	5,384	95%	5,137	0.76	3,913
REEP (Upstream Lighting)	17,882	97%	17,316	0.43	7,425
Res. Appliance Recycling	2,206	94%	2,066	0.47	966
Res. Behavioral Savings	8,135	68%	5,525	1.00	5,525
Res. Whole House Retrofit	0	--	0	--	0
LI Energy Efficiency	3,870	99%	3,831	1.00	3,831
Express Efficiency	9,620	138%	13,308	0.72	9,621
Small/Medium Midstream Lighting	3,691	122%	4,509	0.72	3,226
Small Commercial Direct Install	0	--	0	--	0
Multifamily Housing Retrofit	1,807	102%	1,851	0.45	842
Commercial Efficiency	13,633	98%	13,315	0.79	10,486
Large Midstream Lighting	1,897	99%	1,879	0.72	1,344
Industrial Efficiency	15,841	85%	13,441	0.61	8,170
Public Agency Partnership	11,857	109%	12,897	0.45	5,867
Community Education	2,317	98%	2,275	0.45	1,035
Portfolio Total	98,139	99%	97,349	0.64	62,251

Figure 30: Percent of Portfolio PY11VTD Gross Savings, by Program – Duquesne Light

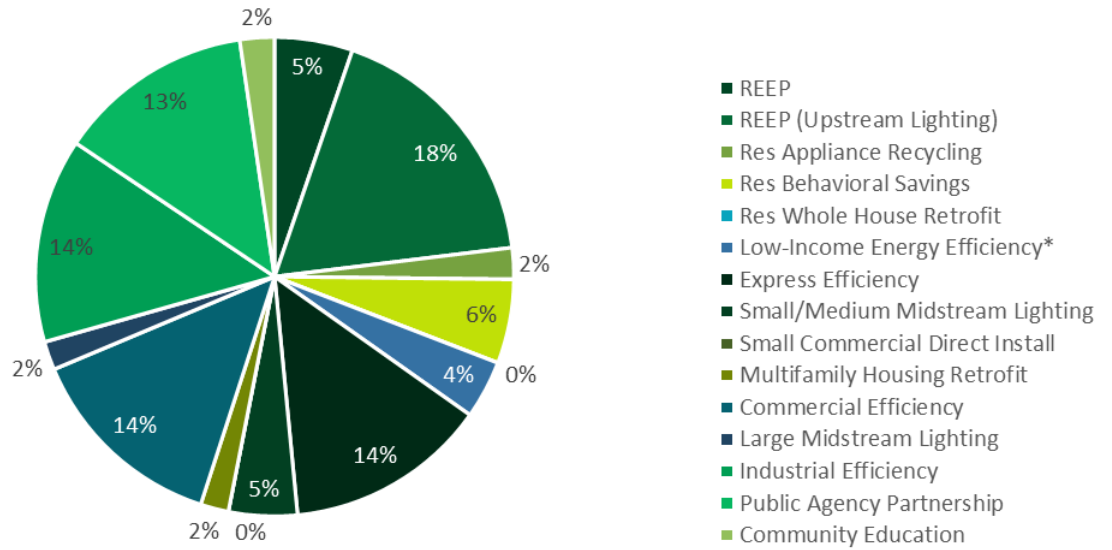
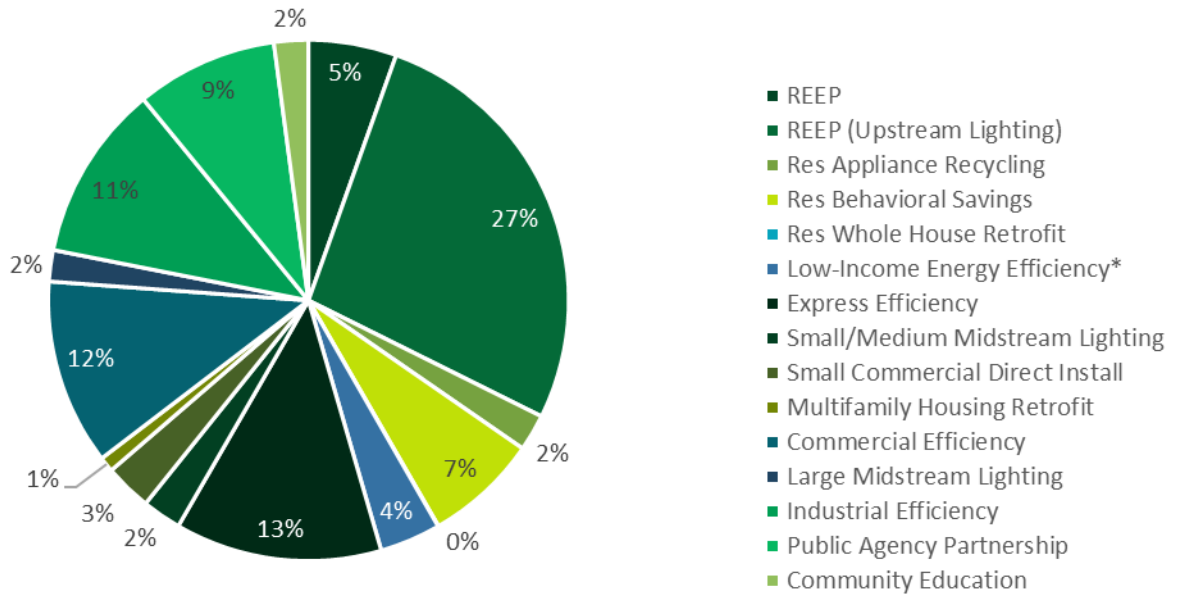


Table 41: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – Duquesne Light

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
REEP	24,808	81%	20,019	0.72	14,411
REEP (Upstream Lighting)	97,895	100%	98,210	0.52	51,488
Res. Appliance Recycling	8,793	95%	8,322	0.47	3,876
Res. Behavioral Savings	30,503	85%	25,789	1.00	25,789
Res. Whole House Retrofit	134	85%	114	1.00	114
LI Energy Efficiency	15,018	92%	13,808	0.99	13,714
Express Efficiency	32,787	143%	47,007	0.61	28,662
Small/Medium Midstream Lighting	7,709	115%	8,890	0.78	6,947
Small Commercial Direct Install	10,934	98%	10,688	0.99	10,613
Multifamily Housing Retrofit	3,448	99%	3,411	0.47	1,591
Commercial Efficiency	43,278	97%	42,177	0.65	27,600
Large Midstream Lighting	6,263	113%	7,100	0.81	5,732
Industrial Efficiency	42,223	95%	40,013	0.45	18,052
Public Agency Partnership	31,457	102%	32,230	0.50	16,006
Community Education	7,655	102%	7,789	0.50	3,933
Portfolio Total	362,906	101%	365,567	0.63	228,529

Figure 31: Percent of Portfolio VTD Gross Savings, by Program – Duquesne Light



A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 42](#).

Table 42: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Duquesne Light

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
REEP	0.70	100%	0.70	0.76	0.50
REEP (Upstream Lighting)	1.81	97%	1.75	0.43	0.75
Res. Appliance Recycling	0.25	94%	0.23	0.47	0.11
Res. Behavioral Savings	0.93	68%	0.63	1.00	0.63
Res. Whole House Retrofit	0.00	--	0	--	0.00
LI Energy Efficiency	0.38	101%	0.38	1.00	0.38
Express Efficiency	1.30	146%	1.90	0.72	1.38
Small/Medium Midstream Lighting	0.68	129%	0.88	0.72	0.63
Small Commercial Direct Install	0	--	0	--	0.00
Multifamily Housing Retrofit	0.15	108%	0.16	0.45	0.07
Commercial Efficiency	2.28	101%	2.30	0.79	1.81
Large Midstream Lighting	0.35	85%	0.30	0.72	0.21
Industrial Efficiency	2.15	99%	2.13	0.61	1.29
Public Agency Partnership	1.79	80%	1.44	0.45	0.65
Community Education	0.37	102%	0.38	0.45	0.17
Portfolio Total	13.14	100%	13.17	0.65	8.59

Table 43: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Duquesne Light

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
REEP	3.33	87%	2.91	0.64	1.87
REEP (Upstream Lighting)	9.92	100%	9.94	0.52	5.21
Res. Appliance Recycling	0.98	95%	0.93	0.46	0.43
Res. Behavioral Savings	3.48	84%	2.94	1.00	2.94
Res. Whole House Retrofit	0.01	100%	0.01	1.00	0.01
LI Energy Efficiency	1.49	95%	1.41	0.99	1.40
Express Efficiency	4.88	147%	7.16	0.61	4.36
Small/Medium Midstream Lighting	1.34	114%	1.53	0.78	1.19
Small Commercial Direct Install	1.36	102%	1.39	0.99	1.38
Multifamily Housing Retrofit	0.31	100%	0.31	0.48	0.15
Commercial Efficiency	5.76	101%	5.80	0.67	3.89
Large Midstream Lighting	1.13	113%	1.28	0.81	1.04
Industrial Efficiency	4.75	100%	4.77	0.49	2.32
Public Agency Partnership	4.40	74%	3.24	0.49	1.59
Community Education	1.31	102%	1.34	0.51	0.69
Portfolio Total	44.45	101%	44.97	0.63	28.46

3.3.2 DR

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 44](#) provides the definition used and the counts of PY11 and Phase III participation for the DR program.

Table 44: Duquesne Light Participation by Program

Program	Definition of Participant	PYTD Participation	P3TD 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.	192	*192

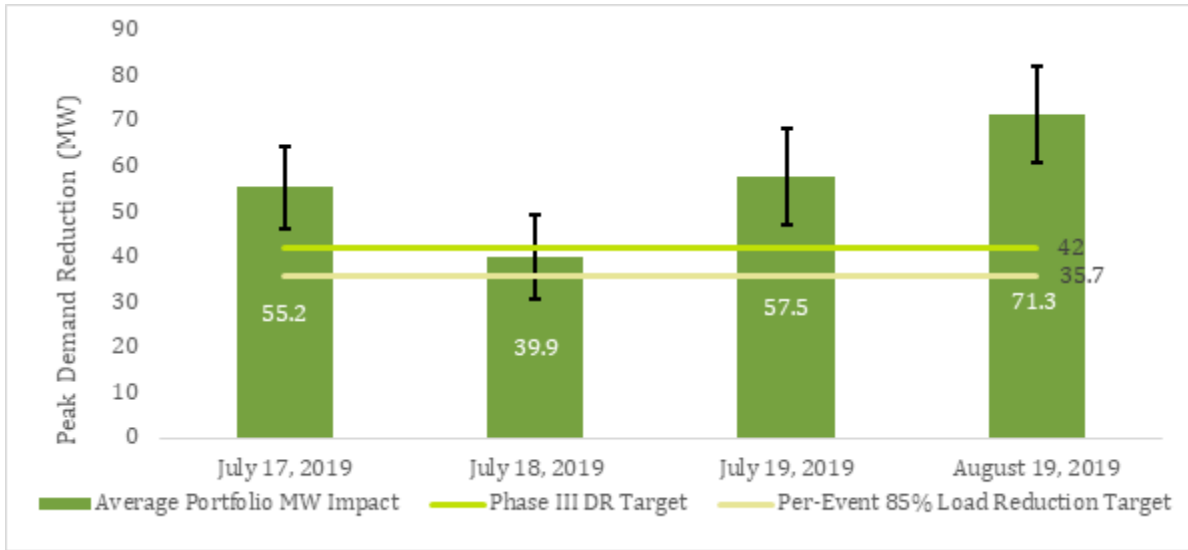
Duquesne's Large Curtailable Load program had four event days in PY11. The Phase III DR performance target for Duquesne Light is 42.0 MW. [Table 45](#) shows the DR savings for the program, as well as the portfolio average for each event day. Average performance for PY11 events and all Phase III events to date are included at the bottom of the table.

Table 45: Duquesne Light DR 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 17, 2019	15	18	1.6	53.6	55.2±8.9
July 18, 2019	16	19	1.6	38.3	39.9±9.5
July 19, 2019	15	18	1.3	56.3	57.5±10.5
August 19, 2019	15	18	1.2	70.2	71.3±10.7
PYVTD - Average PY11 DR Event Performance					56.0±5.0
VTD - Average Phase III DR Event Performance					55.2±3.2

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 32](#) compares the performance of each of the DR events in PY11 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For each event, Duquesne Light exceeded the 85% threshold and three of the events exceeded the target of 42 MW.

Figure 32: Duquesne Light Event Performance Compared to Per-Event Target



3.3.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. [Table 46](#) shows the TRC ratios by program and for the portfolio. The benefits in [Table 46](#) were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 46: PY11 Gross TRC Ratios by Program (\$1,000) – Duquesne Light

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits – Costs)
REEP	\$3,609	\$4,456	0.81	-\$847
Res. Appliance Recycling	\$673	\$377	1.79	\$296
Res. Behavioral Savings	\$273	\$926	0.29	-\$653
Res. Whole House Retrofit	\$0	\$79	0	-\$79
LI Energy Efficiency	\$492	\$1,209	0.41	-\$717
Residential Subtotal	\$5,047	\$7,047	0.72	-\$2,000
Express Efficiency	\$7,236	\$2,710	2.67	\$4,526
Small/Medium Midstream Lighting	\$949	\$479	1.98	\$470
Small Commercial Direct Install	\$0	\$77	0	-\$77
Multifamily Housing Retrofit	\$1,064	\$2,579	0.41	-\$1,515
Commercial Efficiency	\$9,528	\$2,954	3.23	\$6,574
Large Midstream Lighting	\$356	\$350	1.02	\$6
Industrial Efficiency	\$9,139	\$2,825	3.23	\$6,314
Public Agency Partnership	\$8,875	\$3,045	2.92	\$5,830
Community Education	\$1,738	\$1,007	1.73	\$731
Large C&I DR Curtailable	\$5,882	\$1,686	3.49	\$4,196
Non-Residential Subtotal	\$44,767	\$17,712	2.53	\$27,055
Portfolio Total	\$49,815	\$24,759	2.01	\$25,056

3.3.4 Process Evaluation

Guidehouse reported on PY11 process evaluations for the following Duquesne Light programs.

Table 47: Duquesne Light PY11 Process Evaluations

Residential and C&I Programs	
Residential Programs ⁴⁰	C&I Programs ⁴¹
Residential Energy Efficiency Program	Express Efficiency
Residential Appliance Recycling	Multifamily Housing Retrofit
Residential Behavioral Savings	Commercial Efficiency
LI Energy Efficiency	Industrial Efficiency
	Public Agency Partnership (PARP)
	Community Education

For PY11, Guidehouse evaluated and reported on a total of ten programs within the Duquesne Light residential and C&I sectors. These evaluations generated a total of 16 process evaluation findings, which resulted in 15 recommendations, seven of which were accepted and eight of which are under consideration (none were rejected).

For the *Duquesne Light Residential programs*, the PY11 process evaluation provided a total of five recommendations between the programs. Four were accepted by Duquesne Light and three are under consideration. A key cross-program finding was on program satisfaction from a survey of participants in the Residential Energy Efficiency, Residential Appliance Recycling, and Residential Behavioral Savings programs. Across the participants in the programs, 80% of market rate customers and 76% of LI customers were satisfied with the programs overall (79% of all residential customers overall).

Program-specific findings addressed topics that include the following:

- Program satisfaction
- Program awareness
- Program engagement
- Program influence
- On-site data collection procedures

For the *Duquesne Light C&I programs*, the PY11 process evaluation provided a total of nine recommendations between the programs. Three were accepted by Duquesne Light and six are under consideration. A key cross-program finding is satisfaction was on program satisfaction from a survey of participants in the Industrial Efficiency, Express Efficiency, and Commercial Efficiency programs. Across the participants in the program, 97% were satisfied with the programs overall.

⁴⁰ Guidehouse did not conduct a PY11 process evaluation for the Upstream Lighting and Residential WHRP.

⁴¹ Guidehouse did not conduct a PY11 process evaluation for Midstream Lighting, Small Commercial Direct Install Program (SCDI), or the Large Curtailable Load. SCDI reached its savings goals in PY9 and there were no new projects after Q1 of PY10.

Program-specific findings addressed topics that include the following:

- Program satisfaction
- Program awareness
- Barriers and challenges to participation
- Implementation

3.3.5 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of the Duquesne Light PY11 Annual Report and the supporting detail provided by Duquesne Light's evaluation contractor. The detailed audit findings can be found in [Appendix D](#).

- The SWE found the Guidehouse DR verified savings analysis to be systematic and well-documented for PY11. In the PY9 analysis, the SWE's audit revealed an issue with data completeness for the last day of each month, which was resolved in the PY10 analysis. This issue reappeared in the PY11 analysis and the SWE recommends that the Duquesne Light/Guidehouse team investigate and mitigate this meter data collection issue in PY12. Duquesne Light's verified MW performance exceeded its Phase III target in three of four PY11 DR events, while all four events exceeded the 85% per-event minimum performance requirement. The SWE recommends the PUC adopt the DR performance totals in Duquesne Light's PY11 Final Annual Report when assessing compliance with Phase III targets.
- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in Duquesne Light's Annual Report to the tracking data provided to the SWE on a quarterly basis. The SWE was able to use the tracking data to perfectly replicate reported gross energy savings and reported gross demand savings for all of Duquesne Light's programs. We were also able to mostly replicate participation counts and incentives for most of Duquesne Light's programs. In the cases where we were unable to replicate exact participation counts, we know why the discrepancy exists and are not concerned. For cases where we were unable to replicate incentives, the two sources provided directionally similar answers.
- The PY11 Behavioral evaluation was well-organized and consistent with industry best practices. The SWE was able to independently replicate the energy and demand impacts provided by Guidehouse in the PY11 annual report. In PY10, the newest cohort of LI HER customers had negative savings, although the estimates were not statistically significant. In PY11, this cohort delivered significant, positive savings that contributed to Duquesne Light's LI compliance target. While Duquesne Light was among the least HER-reliant EDCs for portfolio energy savings in PY11, approximately one-third of Duquesne Light's progress toward its LI target in PY11 came from HERs.
- The SWE's audit of Duquesne Light's TRC model revealed two minor issues in their benefit-cost calculations. While Duquesne Light correctly implemented the SWE's guidance on EUL calculations for replace on burnout (ROB) bulbs, the SWE found that for early replacement A-lamps, the bulbs' first- and second-year wattages (post-EISA 2007 Watts) should be used as the baseline and adjusted to Post-2020 Watts for 13 years. The

SWE team also found that the DR program TRC calculations did not follow the 75% participant cost assumption, where 75% of the customer incentive payment is used as a proxy for participant cost. The baseline wattage adjustment increased LI energy-efficiency benefits, while the DR participant cost adjustment lowered DR TRC costs. The TRC values shown in this report reflect both corrections and Duquesne Light should incorporate the adjustments to future P3TD benefit-cost reporting.

- 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. The residential upstream lighting audit is detailed in [Appendix D.4.1.1](#).
- 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 PY11 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 made recommendations to Guidehouse regarding specific aspects of some impact analyses, and Guidehouse adopted those recommendations.
- PY11 residential project files responses were adequate and the supporting details were provided.
- The SWE notes that for the appliance recycling program, nameplate photos were not collected by the CSP, for the Phase III contract period. Due to the lack of nameplate photos and on-site data collection forms, the SWE recommends during the next contracting Phase, that CSP on-site data is collected through forms and photos, specifically for information that informs the TRM regression inputs, in order to ensure that accurate inputs for verified savings are being collected.
- 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 response to SWE comments in the PY10 Annual Report, Guidehouse improved upon reporting in PY11, notably by adding explicit language regarding recommendation status, showing the distribution of satisfaction ratings, and adding a survey disposition table (found in [Appendix D](#)).

3.4 MET-Ed

3.4.1 Impact Evaluation

A summary of energy impacts by program for PY11 is presented in [Table 48](#). The bulk of savings is attributable to the Energy Efficient Products Program (EEP), Energy Efficient Homes Program, and the Large C&I Energy Solutions for Business Program (see also [Figure 33](#)).

Table 48: PY11 Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Appliance Turn-in	3,350	100%	3,347	0.45	1,506
Energy Efficient Homes	40,059	95%	37,908	0.93	35,193
Energy Efficient Products	33,766	117%	39,431	0.31	12,337
LI Energy Efficiency	3,638	113%	4,121	1.00	4,121
C&I Energy Solutions for Business (Small)	21,973	94%	20,557	0.63	12,925
C&I Energy Solutions for Business (Large)	39,482	95%	37,526	0.60	22,656
Governmental & Institutional Tariff	202	93%	188	0.63	119
Portfolio Total	142,469	100%	143,078	0.62	88,857

Figure 33: Percent of Portfolio PY11VTD Gross Savings, by Program – Met-Ed

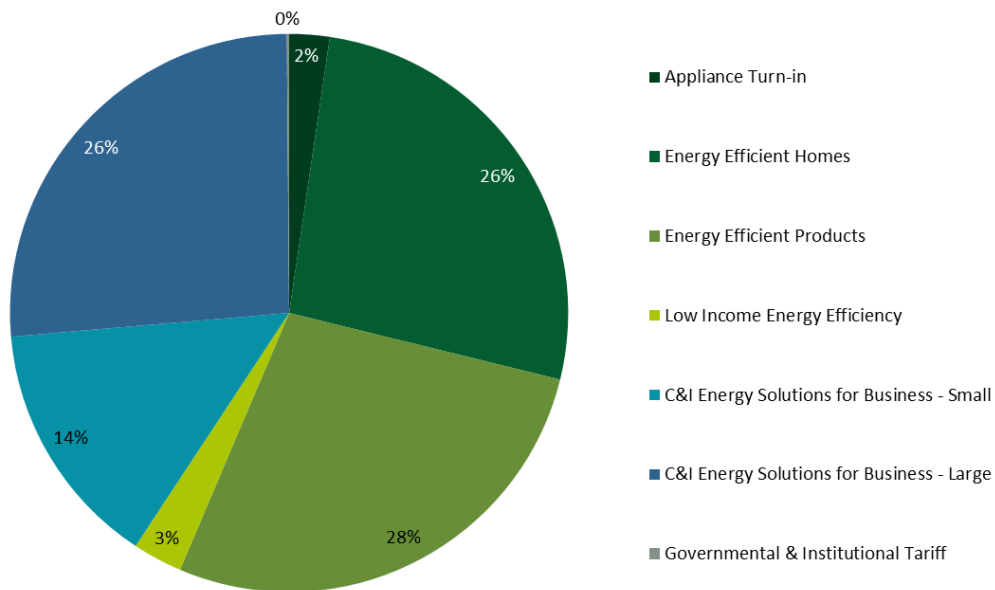
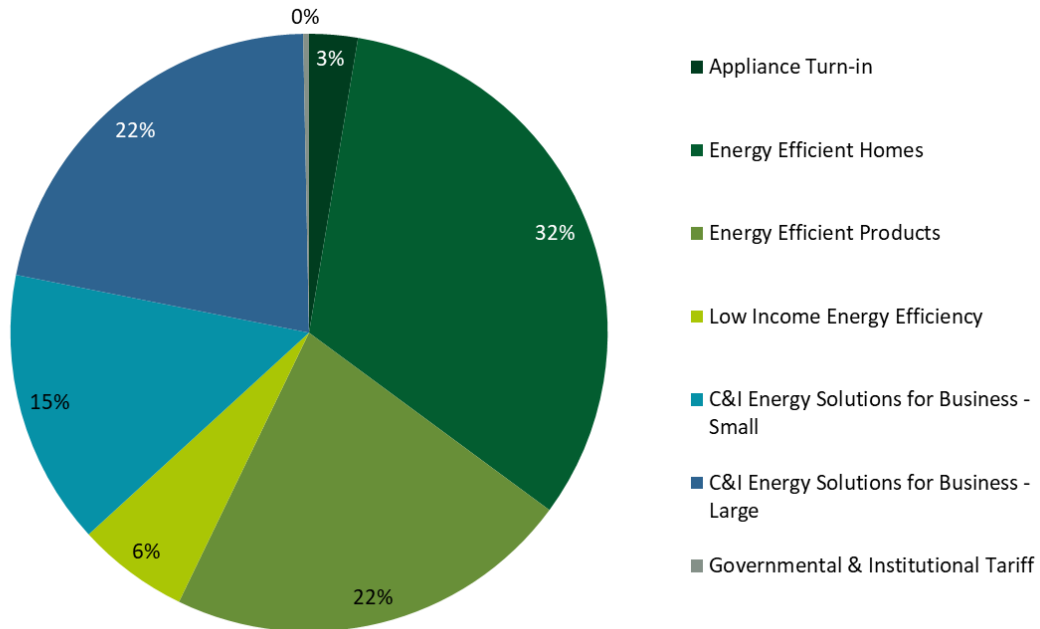


Table 49: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – Met-Ed

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Appliance Turn-in	17,208	98%	16,909	0.47	7,994
Energy Efficient Homes	195,412	107%	209,079	0.92	192,163
Energy Efficient Products	112,368	126%	142,030	0.34	48,679
LI Energy Efficiency	34,119	114%	38,875	1.00	38,875
C&I Energy Solutions for Business (Small)	98,131	98%	95,836	0.63	60,109
C&I Energy Solutions for Business (Large)	142,226	98%	138,949	0.59	81,698
Governmental & Institutional Tariff	2,061	98%	2,020	0.64	1,292
Portfolio Total	601,527	107%	643,697	0.67	430,809

Figure 34: Percent of Portfolio VTD Gross Savings, by Program – Met-Ed



A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 50: PY11 Peak Demand Savings by Energy-Efficiency Program \(MW/Year\) – Met-Ed](#)

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Turn-in	0.49	97%	0.47	0.45	0.21
Energy Efficient Homes	6.16	81%	4.97	0.90	4.48
Energy Efficient Products	4.24	122%	5.17	0.32	1.65
LI Energy Efficiency	0.51	94%	0.48	1.00	0.48
C&I Energy Solutions for Business (Small)	3.35	88%	2.95	0.63	1.86
C&I Energy Solutions for Business (large)	5.60	92%	5.17	0.60	3.12
Governmental & Institutional Tariff	0.02	87%	0.01	0.63	0.01
Portfolio Total	20.37	94%	19.22	0.61	11.80

Table 50: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Met-Ed

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Turn-in	0.49	97%	0.47	0.45	0.21
Energy Efficient Homes	6.16	81%	4.97	0.90	4.48
Energy Efficient Products	4.24	122%	5.17	0.32	1.65
LI Energy Efficiency	0.51	94%	0.48	1.00	0.48
C&I Energy Solutions for Business (Small)	3.35	88%	2.95	0.63	1.86
C&I Energy Solutions for Business (large)	5.60	92%	5.17	0.60	3.12
Governmental & Institutional Tariff	0.02	87%	0.01	0.63	0.01
Portfolio Total	20.37	94%	19.22	0.61	11.80

Table 51: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Met-Ed

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Appliance Turn-in	2.44	0.96	2.33	0.47	1.10
Energy Efficient Homes	26.96	0.94	25.39	0.90	22.86
Energy Efficient Products	14.27	1.34	19.16	0.35	6.69
LI Energy Efficiency	4.25	1.06	4.50	1.00	4.50
C&I Energy Solutions for Business (Small)	14.74	0.98	14.39	0.63	9.08
C&I Energy Solutions for Business (large)	19.44	0.97	18.93	0.58	11.05
Governmental & Institutional Tariff	0.04	0.95	0.03	0.64	0.02
Portfolio Total	82.12	1.03	84.73	0.65	55.30

3.4.2 DR

In PY11, 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 52](#) provides the definitions used and the counts of PY11 and Phase III participation to date for each included DR program.

Table 52: Met-Ed Participation by Program

Program	Definition of Participant	PYTD Participation	P3TD 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.	189,678	189,678
C&I DR Program – Small	The number of participants who participated in one or more DR events.	45	139
C&I DR Program – Large	The number of participants who participated in one or more DR events.	104	247

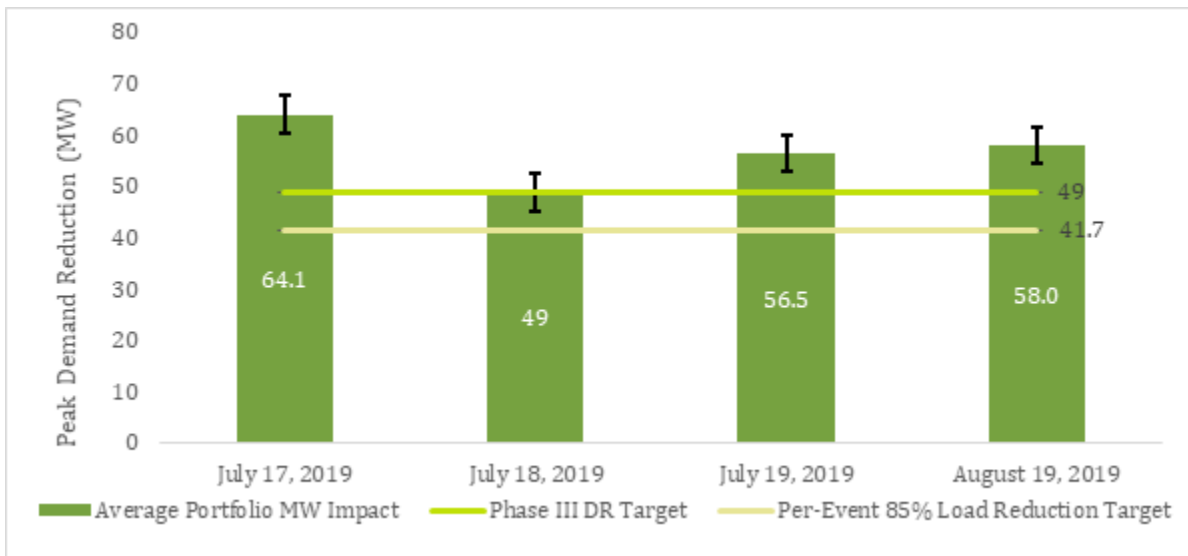
Met-Ed's three DR programs had four event days in PY11. The Phase III DR performance target for Met-Ed is 49.0 MW. [Table 53](#) shows the DR savings for each program, as well as the portfolio average for each event day. Average performance for PY11 events and Phase III events are included at the bottom of the table.

Table 53: Met-Ed DR 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 17, 2019	15	18	1.5	50.0	12.6	64.1±3.6
July 18, 2019	16	19	1.7	40.1	7.2	49.0±3.6
July 19, 2019	15	18	1.4	44.2	11.0	56.5±3.6
August 19, 2019	15	18	1.4	48.8	7.7	58.0±3.5
PYVTD - Average PY11 DR Event Performance						56.9±1.8
VTD - Average Phase III DR Event Performance						53.0±1.8

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 Met-Ed, this translates to a 41.7 MW minimum for each DR event. Figure 35 compares the performance of each of the DR events in PY11 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For each event, Met-Ed exceeded the 85% threshold. Met-Ed met or exceeded the target of 49 MW for all four events.

Figure 35: Met-Ed Event Performance Compared to Per-Event Target



3.4.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. Table 54 shows the TRC ratios by program and for the portfolio. The benefits in Table 54 were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 54: PY11 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	\$1,117	\$628	1.78	\$489
Energy Efficient Homes	\$9,827	\$6,149	1.60	\$3,678
Energy Efficient Products	\$12,756	\$10,079	1.27	\$2,677
LI Energy Efficiency	\$741	\$1,641	0.45	-\$901
Residential Subtotal	\$24,440	\$18,497	1.32	\$5,944
C&I Energy Solutions for Business (Small)	\$9,586	\$6,591	1.45	\$2,995
C&I Energy Solutions for Business (Large)	\$18,703	\$16,635	1.12	\$2,068
Governmental & Institutional Tariff	\$80	\$101	0.78	-\$22
C&I DR Program (Small)	\$105	\$77	1.36	\$28
C&I DR Program (Large)	\$2,016	\$1,420	1.42	\$596
Non-Residential Subtotal	\$30,488	\$24,825	1.23	\$5,663
Portfolio Total	\$54,929	\$43,322	1.27	\$11,607

3.4.4 Process Evaluation

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.

ADM/Tetra Tech reported on PY11 process evaluations for the following FirstEnergy Utilities programs.

Table 55: Met-Ed PY11 Process Evaluations

Residential and C&I Programs	
Energy Efficient Homes ⁴²	Energy Efficient Homes ⁴³
Energy Efficient Products ⁴⁴	Energy Efficient Products ⁴⁵
LI Energy Efficiency	DR Program – Large

For PY11, ADM/Tetra Tech evaluated and reported on a total of six programs within the Met-Ed residential and C&I sectors. These evaluations generated a total of 21 process evaluation findings, which resulted in 17 recommendations, six of which were accepted, four of which were rejected, and six of which are under consideration.⁴⁶ A key cross-program finding was on program satisfaction from participant surveys, which were conducted for two sub-programs of the EEP program and the Low-Income Energy Efficiency (LIEEP) program. On average, among participants in programs evaluated for PY11 in all FirstEnergy Companies, 92% of residential participants⁴⁷ were satisfied with the programs overall.

For the *Met-Ed Residential programs*, the PY11 process evaluation provided a total of 17 findings and 13 recommendations, two of which were accepted, four of which were rejected, and six of

⁴² In PY11, ADM/Tetra Tech only conducted process evaluations for one program component: BDR. Online Audit Kits, HERs, Audit/Direct Install, and BDR underwent a process evaluation in PY10. The New Homes component was evaluated in PY9.

⁴³ In PY11, ADM/Tetra Tech only conducted process evaluations for one program component: BDR. Online Audit Kits, HERs, Audit/Direct Install, and BDR underwent a process evaluation in PY10. The New Homes component was evaluated in PY9.

⁴⁴ In PY11, ADM/Tetra Tech conducted process evaluations for two of four program components: Appliances and HVAC. The program components for which process evaluations were not conducted in PY10 were Upstream Lighting and Upstream Electronics.

⁴⁵ In PY11, ADM/Tetra Tech conducted process evaluations for two of four program components: Appliances and HVAC. The program components for which process evaluations were not conducted in PY10 were Upstream Lighting and Upstream Electronics.

⁴⁶ It was unclear from the Annual Report whether one of the LI Energy Efficiency recommendations had been rejected or was under consideration.

⁴⁷ Weighted by the population of participants from each FirstEnergy EDC in the following residential programs: Energy Efficient Products and LI Energy Efficiency. The SWE considered participants satisfied if they rated their satisfaction a 7 or higher on a scale from 1 to 10, where 1 is “very dissatisfied” and 10 is “very satisfied,” and a 4 or higher on a scale from 1 to 5, where 1 is “very dissatisfied” and 5 is “very satisfied.”

which were under consideration.⁴⁸ A key cross-program finding was on program satisfaction from surveys of participants in the Energy Efficient Products and LI Energy Efficiency programs. Across the participants in the programs, 92% of Met-Ed participants, 93% of Penelec participants, 93% of Penn Power participants, and 92% of West Penn Power participants were satisfied with the program overall.⁴⁹

Program-specific findings addressed topics that included the following:

- Primary sources of program information
- Satisfaction levels
- Assessment of program processes and performance
- What is working well with program administration and delivery
- Barriers to program administration or delivery
- Program-induced energy saving actions taken
- Suggested improvements in program administration
- The effect of the COVID-19 pandemic on participants and program activity

For the Met-Ed *Small and Large C&I DR Programs*, the PY11 process evaluation provided four findings and four recommendations, all of which were accepted. Program-specific findings addressed topics that included the following:

- Primary sources of program information
- What is working well with program administration and delivery
- Impact of program on participants' business activities

3.4.5 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of Met-Ed's PY11 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor. The detailed audit findings can be found in [Appendix E](#).

- The SWE found that ADM's DR analysis was thorough and free of errors. The SWE found the approaches implemented by ADM to be well-aligned with the Evaluation Framework and consistent with industry best-practice for all three DR programs: BDR for residential customers, small C&I, and large C&I. The SWE team agrees with the PY11 gross verified savings estimates and recommends that the Commission adopt them when assessing compliance with Phase III targets.
- 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 via the tracking data. We also calculated directionally similar (if not equal) participation counts for

⁴⁸ It was unclear from the Annual Report whether one of the LI Energy Efficiency recommendations had been rejected or was under consideration.

⁴⁹ Weighted by participation in the two of the Energy Efficient Products program components (HVAC and Water Heating and Appliances) and LI Energy Efficiency. The SWE considered participants satisfied if they rated their satisfaction a 7 or higher on a scale from 1 to 10, where 1 is "very dissatisfied" and 10 is "very satisfied," and a 4 or higher on a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied."

all programs. For six of the seven programs, the SWE was able to calculate directionally similar (though not the same) incentive dollars via the tracking data. The SWE's only difference of note is the incentive dollars for the Energy Efficient Homes program, which is due to the costs of the Energy Efficiency kits being correctly treated as incentives in the Annual Report, but not recorded in the program tracking data.

- Met-Ed's TRC model was well-organized and consistent with the directives of the 2016 TRC Order and the key financial assumptions approved in Met-Ed's Phase III EE&C Plan. In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. Met-Ed resolved both issues in the PY11 TRC calculations. Met-Ed correctly implemented the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures. The SWE 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. However, the SWE recommends that the incremental costs be split out by replacement type whenever possible since the measure cost can be very dependent on the equipment replacement type.
- 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 PY11 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 made recommendations to ADM regarding specific aspects of some impact analyses, and ADM adopted those recommendations.
- PY11 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE notes that for the appliance turn-in program, 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). The SWE recommends that the CSP collect on-site data through forms and photos, specifically for information that informs the TRM regression inputs, in order to ensure that accurate inputs for verified savings are being collected.
- The SWE's audit of Met-Ed's HER residential savings uncovered no issues. In the group equivalence checks, one cohort was found to have statistically significant pre-treatment differences between the treatment and control groups. In prior years, differences for this cohort were not statistically significant, but as customers move over time, the make-up of the experimental cells change. The impact estimation method accounts for the differences in pre-treatment consumption.
- 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. The residential verified savings audit is detailed in [Appendix E.4.1.1](#).

- Overall, the ADM/Tetra Tech team estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- The process evaluations of these programs appear to have been mostly consistent with the Phase III evaluation plan. In the PY11 Annual Report, the evaluation team listed evaluation activities, key findings, recommendations, and the EDC's response to the recommendations. Although the description of the process evaluation in the PY11 final annual report included limited information, the evaluation contractor submitted separate memos providing more detailed results of specific process evaluation tasks. These memos included descriptions of the methods, summary of findings, recommendations, and a description of whether Met-Ed was implementing or considering those recommendations. The memos included mostly sufficient detail to assess the methods, findings, and recommendations (more details are available in [Appendix E.8](#)).

3.5 PENELEC

3.5.1 Impact Evaluation

A summary of energy impacts by program for PY11 is presented in [Table 56](#). The bulk of savings is attributable to the EEP Program and the Large C&I Energy Solutions for Business Program (see also [Figure 36](#)).

Table 56: PY11 Incremental Annual Energy Savings by Program (MWh/Year) – Penelec

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Appliance Turn-in	3,183	98%	3,113	0.47	1,463
Energy Efficient Homes	30,967	88%	27,179	0.91	24,718
Energy Efficient Products	35,263	114%	40,245	0.33	13,263
LI Energy Efficiency	3,540	110%	3,892	1.00	3,892
C&I Energy Solutions for Business (Small)	26,348	101%	26,663	0.78	20,804
C&I Energy Solutions for Business (Large)	34,757	101%	35,166	0.80	28,029
Governmental & Institutional Tariff	623	101%	630	0.77	484
Portfolio Total	134,682	102%	136,889	0.68	92,653

Figure 36: Percent of Portfolio PY11VTD Gross Savings, by Program – Penelec

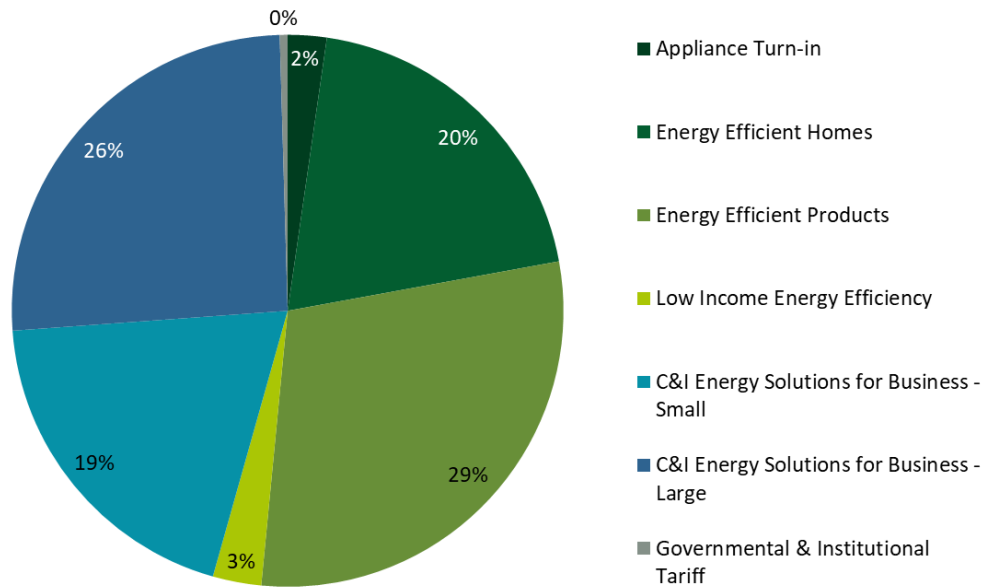
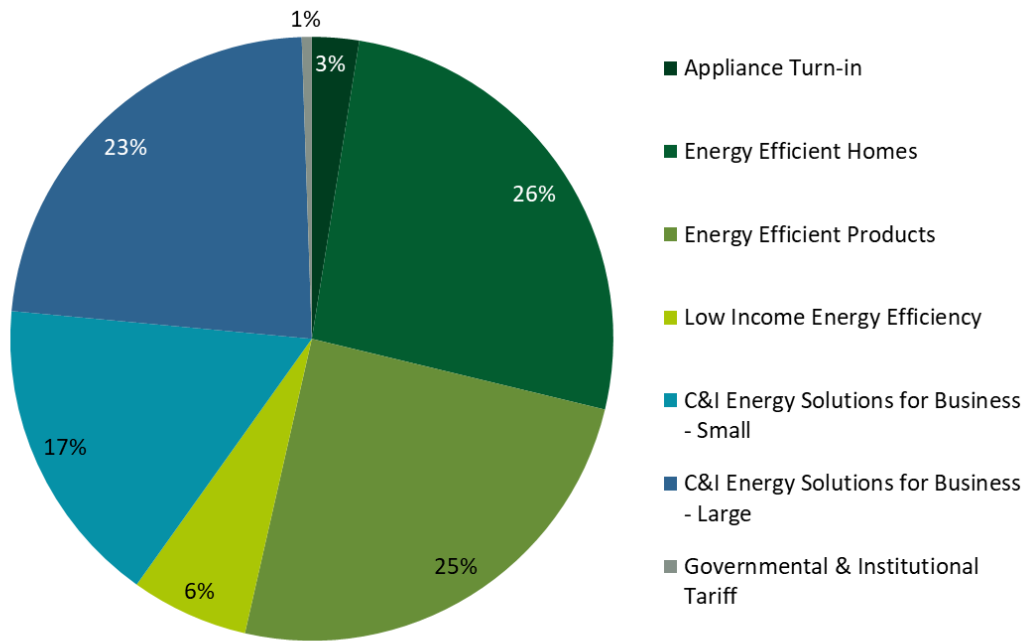


Table 57: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – Penelec

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Appliance Turn-in	16,514	94%	15,498	0.46	7,062
Energy Efficient Homes	150,120	107%	161,292	0.90	145,249
Energy Efficient Products	125,077	122%	152,388	0.34	51,458
LI Energy Efficiency	35,144	110%	38,730	1.00	38,730
C&I Energy Solutions for Business (Small)	104,101	98%	102,029	0.78	79,688
C&I Energy Solutions for Business (Large)	146,493	96%	141,341	0.79	111,824
Governmental & Institutional Tariff	3,427	96%	3,291	0.80	2,648
Portfolio Total	580,876	106%	614,570	0.71	436,660

Figure 37: Percent of Portfolio VTD Gross Savings, by Program – Penelec



A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 58](#).

Table 58: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penelec

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Turn-in	0.44	98%	0.43	0.47	0.20
Energy Efficient Homes	3.81	79%	3.02	0.91	2.74
Energy Efficient Products	3.97	121%	4.81	0.34	1.61
LI Energy Efficiency	0.43	99%	0.43	1.00	0.43
C&I Energy Solutions for Business (Small)	3.75	95%	3.57	0.78	2.78
C&I Energy Solutions for Business (Large)	4.25	96%	4.08	0.80	3.25
Governmental & Institutional Tariff	0.01	94%	0.01	0.73	0.01
Portfolio Total	16.66	98%	16.36	0.67	11.02

Table 59: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penelec

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Appliance Turn-in	2.22	93%	2.07	0.46	0.94
Energy Efficient Homes	18.85	93%	17.56	0.90	15.79
Energy Efficient Products	14.12	131%	18.47	0.34	6.34
LI Energy Efficiency	4.10	101%	4.15	1.00	4.15
C&I Energy Solutions for Business (Small)	15.60	94%	14.74	0.79	11.66
C&I Energy Solutions for Business (Large)	17.92	92%	16.45	0.80	13.13
Governmental & Institutional Tariff	0.07	96%	0.06	0.79	0.05
Portfolio Total	72.88	101%	73.49	0.71	52.06

3.5.2 DR

Penelec does not have a Phase III DR target.

3.5.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. [Table 60](#) shows the TRC ratios by program and for the portfolio. The benefits in [Table 60](#) were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 60: PY11 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	\$983	\$586	1.68	\$397
Energy Efficient Homes	\$7,239	\$4,064	1.78	\$3,175
Energy Efficient Products	\$11,974	\$8,724	1.37	\$3,250
LI Energy Efficiency	\$1,030	\$1,845	0.56	-\$815
Residential Subtotal	\$21,226	\$15,219	1.39	\$6,007
C&I Energy Solutions for Business (Small)	\$12,193	\$11,678	1.04	\$515
C&I Energy Solutions for Business (Large)	\$15,970	\$13,539	1.18	\$2,432
Governmental & Institutional Tariff	\$228	\$347	0.66	-\$119
Non-Residential Subtotal	\$28,391	\$25,564	1.11	\$2,827
Portfolio Total	\$49,617	\$40,784	1.22	\$8,834

3.5.4 Process Evaluation

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 summary, described previously for Met-Ed, applies to all four FirstEnergy utilities, including Penelec.

3.5.5 Key Audit Findings

In this section, the SWE provides a summary of key audit findings of the SWE's audit of Penelec's PY11 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor. The detailed audit findings can be found in [Appendix F](#).

- The SWE performed a detailed comparison of the energy, demand, participation, and incentive amounts in 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 via the tracking data. We also calculated directionally similar (if not equal) participation counts for all programs. For six of the seven programs, the SWE was able to calculate directionally similar (though not the same) incentive dollars via the tracking data. The SWE's only difference of note is the incentive dollars for the Energy Efficient Homes program, which is due to the costs of the energy-efficiency kits being correctly treated as incentives in the Annual Report, but not recorded in the program tracking data.

- Penelec’s TRC model was well-organized and consistent with the directives of the 2016 TRC Order and the key financial assumptions approved in Penelec’s Phase III EE&C Plan. In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. Penelec resolved both issues in the PY11 TRC calculations. Penelec correctly implemented the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures. The SWE spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with Penelec’s EE&C plan. However, the SWE recommends that the incremental costs be split out by replacement type whenever possible since the measure cost can be very dependent on the equipment replacement type.
- 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 PY11 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.
- PY11 residential project file responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE’s audit of Penelec’s HER residential savings uncovered no issues. In the group equivalence checks, one cohort was found to have statistically significant pre-treatment differences between the treatment and control groups. In prior years, differences for this cohort were not statistically significant, but as customers move over time the make-up of the experimental cells change. The impact estimation method accounts for any differences in pre-treatment consumption.
- 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. The residential verified savings audit is detailed in [Appendix F.4.1.1](#).
- Overall, the ADM/Tetra Tech team estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- FirstEnergy’s evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penelec. The SWE’s audit summary, previously described for Met-Ed, applies to all four FirstEnergy utilities, including Penelec (more details are available in [Appendix E.8](#)).

3.6 PENN POWER

3.6.1 Impact Evaluation

A summary of energy impacts by program for PY11 is presented in [Table 61](#). The bulk of savings is attributable to the Energy Efficient Products and the Small C&I Energy Solutions for Business Program (see also [Figure 38](#)).

Table 61: PY11 Incremental Annual Energy Savings, by Program (MWh/Year) – Penn Power

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Appliance Turn-in	815	97%	789	0.51	402
Energy Efficient Homes	6,289	104%	6,540	0.96	6,310
Energy Efficient Products	15,828	114%	18,003	0.28	5,037
LI Energy Efficiency	1,087	100%	1,089	1.00	1,089
C&I Energy Solutions for Business (Small)	16,149	101%	16,267	0.77	12,556
C&I Energy Solutions for Business (Large)	5,376	102%	5,459	0.72	3,926
Governmental & Institutional Tariff	2	100%	2	0.79	2
Portfolio Total	45,546	106 %	48,148	0.61	29,321

Figure 38: Percent of Portfolio PY11VTD Gross Savings, by Program – Penn Power

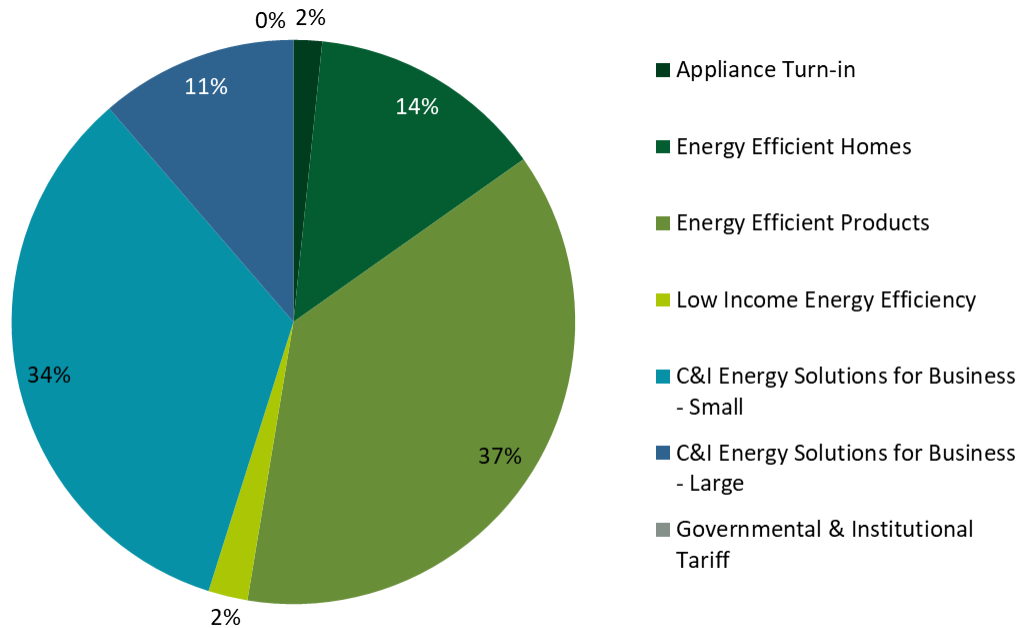
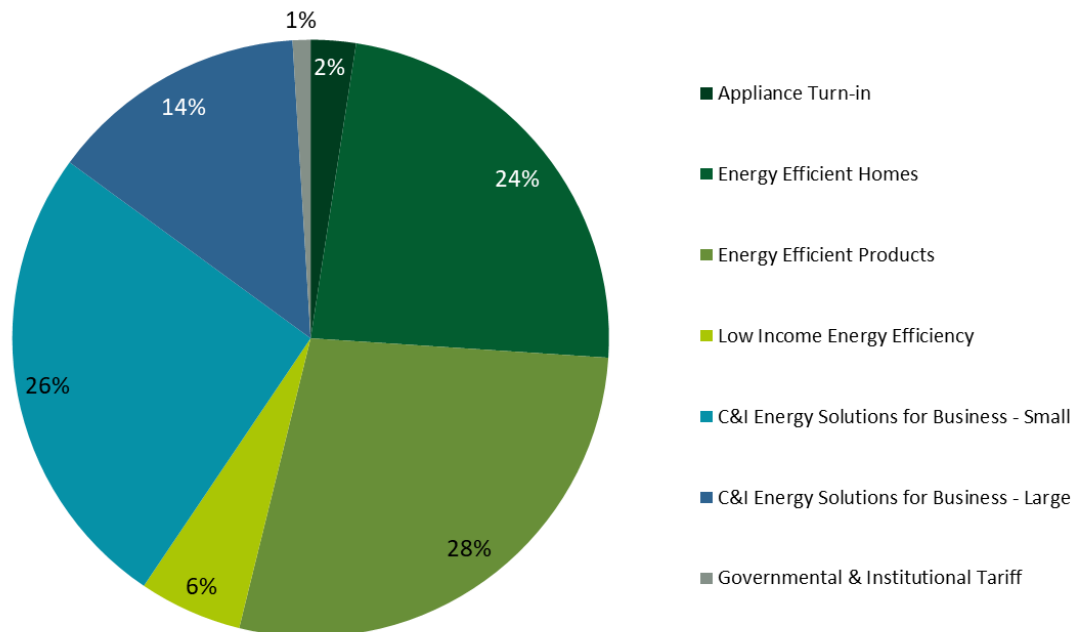


Table 62: Phase-to-date Incremental Annual Energy Savings, by Program (MWh/Year) – Penn Power

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Appliance Turn-in	5,635	87%	4,890	0.53	2,583
Energy Efficient Homes	42,351	112%	47,279	0.91	42,790
Energy Efficient Products	44,302	126%	55,727	0.32	18,095
LI Energy Efficiency	11,000	102%	11,199	1.00	11,199
C&I Energy Solutions for Business (Small)	52,452	98%	51,260	0.75	38,303
C&I Energy Solutions for Business (Large)	28,576	98%	28,046	0.69	19,352
Governmental & Institutional Tariff	2,034	96%	1,948	0.75	1,464
Portfolio Total	186,351	108%	200,349	0.67	133,785

Figure 39: Percent of Portfolio VTD Gross Savings, by Program – Penn Power



A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 63](#).

Table 63: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penn Power

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Turn-in	0.10	96%	0.10	0.51	0.05
Energy Efficient Homes	1.28	85%	1.08	0.89	0.96
Energy Efficient Products	1.99	124%	2.47	0.30	0.75
LI Energy Efficiency	0.15	84%	0.12	1.00	0.12
C&I Energy Solutions for Business (Small)	2.14	99%	2.12	0.77	1.64
C&I Energy Solutions for Business (Large)	0.61	101%	0.62	0.71	0.44
Governmental & Institutional Tariff	0.00	99%	0.00	0.79	0.00
Portfolio Total	6.28	104%	6.51	0.61	3.97

Table 64: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year) – Penn Power

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Turn-in	0.72	87%	0.63	0.53	0.33
Energy Efficient Homes	6.84	99%	6.75	0.85	5.73
Energy Efficient Products	5.49	136%	7.45	0.34	2.52
LI Energy Efficiency	1.38	94%	1.31	1.00	1.31
C&I Energy Solutions for Business (Small)	7.51	97%	7.32	0.75	5.47
C&I Energy Solutions for Business (Large)	3.31	95%	3.13	0.69	2.16
Governmental & Institutional Tariff	0.07	104%	0.07	0.75	0.05
Portfolio Total	25.31	105%	26.65	0.66	17.57

3.6.2 DR

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 65](#) provides the definitions used and the counts of PY11 and Phase III participation for each included DR program.

Table 65: Penn Power Participation by Program

Program	Definition of Participant	PYTD Participation	P3TD 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.	29,557	30,186
C&I DR Program – Small	The number of participants who participated in one or more DR events.	0	3
C&I DR Program – Large	The number of participants who participated in one or more DR events.	9	24

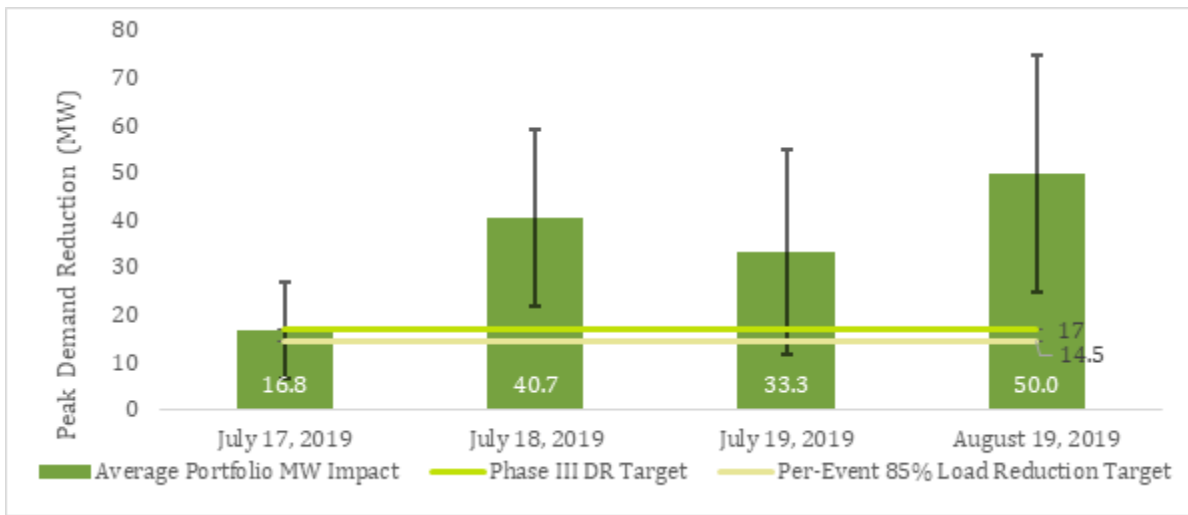
Penn Power’s three DR programs had four event days in PY11. The Phase III DR performance target for Penn Power is 17.0 MW. [Table 66](#) shows the DR savings for each program, as well as the portfolio average for each event day. Average performance for PY11 events and Phase III events are included at the bottom of the table.

Table 66: Penn Power DR 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 17, 2019	15	18	0.0	15.4	1.4	16.8±10.1
July 18, 2019	16	19	0.0	38.6	2.0	40.7±18.7
July 19, 2019	15	18	0.0	31.0	2.3	33.3±21.6
August 19, 2019	15	18	0.0	48.6	1.4	50.0±25.0
PYVTD - Average PY11 DR Event Performance						35.2±9.8
VTD - Average Phase III DR Event Performance						39.9±8.8

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 Penn Power, this translates to a 14.5 MW minimum for each DR event. [Figure 40](#) compares the performance of each of the DR events in PY11 to the event-specific minimum and average targets. For each event day, 90% Confidence Intervals are indicated with a black bar. For each event, Penn Power exceeded the 85% threshold. For three of four events Penn Power exceeded the Phase III target of 17 MW.

Figure 40: Penn Power Event Performance Compared to Per-Event Target



3.6.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. [Table 67](#) shows the TRC ratios by program and for the portfolio. The benefits in [Table 67](#) were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 67: PY11 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	\$250	\$151	1.65	\$99
Energy Efficient Homes	\$2,228	\$1,581	1.41	\$647
Energy Efficient Products	\$5,324	\$3,124	1.70	\$2,200
LI Energy Efficiency	\$199	\$530	0.37	-\$332
Residential Subtotal	\$8,001	\$5,386	1.49	\$2,615
C&I Energy Solutions for Business (Small)	\$6,852	\$5,643	1.21	\$1,209
C&I Energy Solutions for Business (Large)	\$2,292	\$2,113	1.08	\$179
Governmental & Institutional Tariff	\$1	\$24	0.05	-\$22
C&I DR Program (Small)	\$0	\$8	-	-\$8
C&I DR Program (Large)	\$1,471	\$431	3.41	\$1,040
Non-Residential Subtotal	\$10,617	\$8,218	1.29	\$2,398
Portfolio Total	\$18,618	\$13,605	1.37	\$5,013

3.6.4 Process Evaluation

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.

3.6.5 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of Penn Power's PY11 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor. The detailed audit findings can be found in [Appendix G](#).

- The SWE found that ADM's DR analysis was thorough and free of errors. The SWE found the approaches implemented by ADM to be well-aligned with the Evaluation Framework and consistent with industry best-practice for both BDR and C&I programs. Penn Power exceeded the minimum performance level in all four events and achieved its DR compliance target in three of four events. Penn Power's VTD DR performance is almost 250% of its Phase III compliance target. The SWE recommends the Commission adopt the Penn Power/ADM verified savings estimates when assessing compliance at the end of Phase III.

- 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, reported MW savings, and participation counts via the tracking data. The SWE also calculated directionally similar (if not equal) incentive dollars for all programs.
- Penn Power's TRC model was well-organized and consistent with the directives of the 2016 TRC Order and the key financial assumptions approved in Penn Power's Phase III EE&C Plan. In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. Penn Power resolved both issues in the PY11 TRC calculations. Penn Power correctly implemented the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures. The SWE spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with Penn Power's EE&C plan. However, the SWE recommends that the incremental costs be split out by replacement type whenever possible since the measure cost can be very dependent on the equipment replacement type.
- 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.
- PY11 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE's audit of Penn Power's HER residential savings uncovered no issues. In the group equivalence checks, one cohort was found to have statistically significant pre-treatment differences between the treatment and control groups. In prior years, differences for this cohort were not statistically significant, but as customers move over time, the make-up of the experimental cells change. The impact estimation method accounts for the differences in pre-treatment consumption.
- 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. The residential verified savings audit is detailed in [Appendix G.4.1](#)
- Overall, the ADM/Tetra Tech team estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.
- FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including Penn Power. The SWE's audit summary, previously described for Met-Ed, applies to all four FirstEnergy utilities, including Penn Power (more details are available in [Appendix E.8](#)).

3.7 WEST PENN POWER

3.7.1 Impact Evaluation

A summary of energy impacts by program for PY11 is presented in [Table 68](#). The bulk of savings is attributable to the Energy Efficient Products and the Small C&I Energy Solutions for Business Program (see also [Figure 41](#)).

Table 68: PY11 Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power

Program	PYRTD (MWh/yr)	Realization Rate	PYVTD Gross (MWh/yr)	NTG	PYVTD Net (MWh/yr)
Appliance Turn-in	3,787	99%	3,765	0.48	1,807
Energy Efficient Homes	25,842	79%	20,312	0.98	19,880
Energy Efficient Products	40,255	115%	46,239	0.26	12,175
LI Energy Efficiency	3,829	96%	3,660	1.00	3,660
C&I Energy Solutions for Business (Small)	31,387	100%	31,342	0.63	19,859
C&I Energy Solutions for Business (large)	26,250	99%	25,948	0.65	16,778
Governmental & Institutional Tariff	865	98%	844	0.66	558
Portfolio Total	132,215	100%	132,110	0.57	74,717

Figure 41: Percent of Portfolio PY11VTD Gross Savings, by Program – West Penn Power

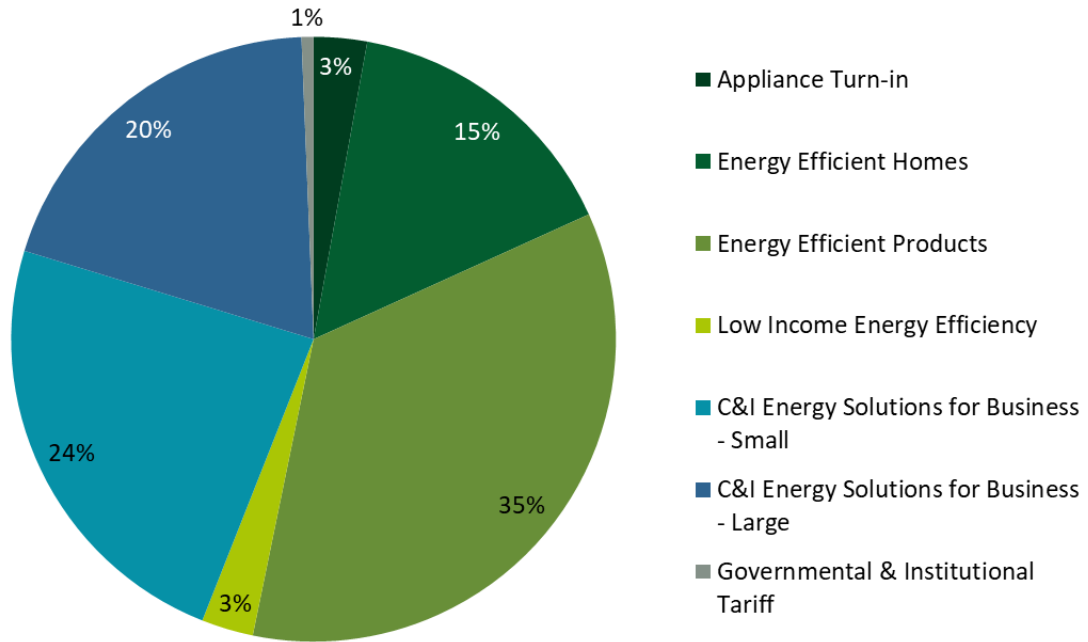
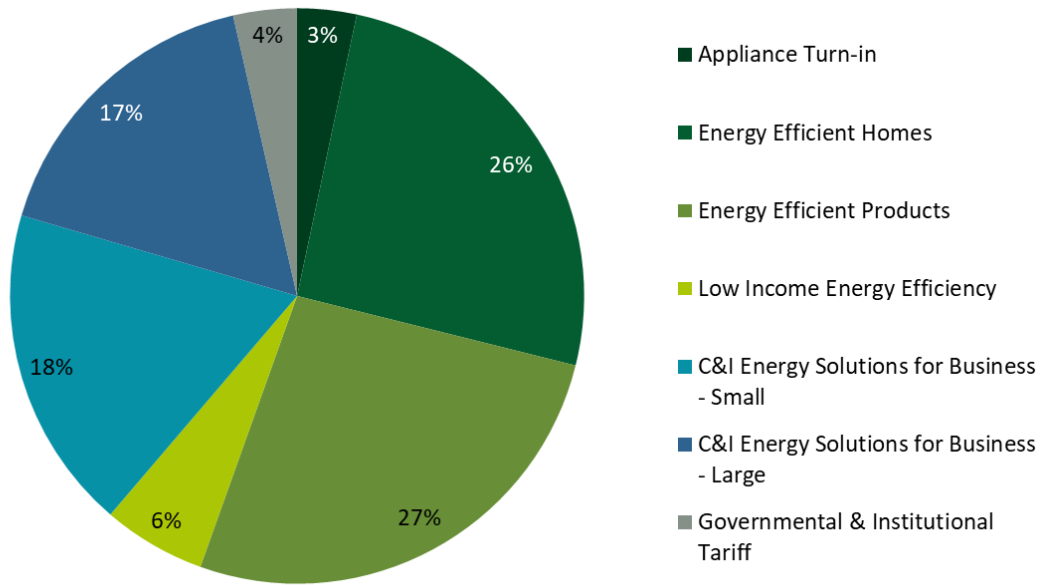


Table 69: Phase-to-date Incremental Annual Energy Savings by Program (MWh/Year) – West Penn Power

Program	RTD (MWh/yr)	Realization Rate	VTD Gross (MWh/yr)	NTG	VTD Net (MWh/yr)
Appliance Turn-in	20,737	97%	20,188	0.48	9,728
Energy Efficient Homes	159,022	97%	154,402	0.94	144,973
Energy Efficient Products	130,150	123%	160,723	0.28	44,219
LI Energy Efficiency	33,719	104%	35,042	1.00	35,042
C&I Energy Solutions for Business (Small)	108,748	101%	110,299	0.72	79,808
C&I Energy Solutions for Business (large)	103,622	99%	102,199	0.65	66,847
Governmental & Institutional Tariff	20,467	106%	21,623	0.79	17,130
Portfolio Total	576,465	105%	604,476	0.66	397,747

Figure 42: Percent of Portfolio VTD Gross Savings, by Program – West Penn Power



A summary of the peak demand impacts by energy-efficiency program for PY11 are presented in [Table 70](#).

Table 70: PY11 Peak Demand Savings by Energy-Efficiency Program (MW/Year) – West Penn Power

Program	PYRTD (MW/yr)	Realization Rate	PYVTD Gross (MW/yr)	NTG	PYVTD Net (MW/yr)
Appliance Turn-in	0.51	99%	0.50	0.48	0.24
Energy Efficient Homes	5.11	56%	2.84	0.92	2.63
Energy Efficient Products	5.46	118%	6.42	0.27	1.75
LI Energy Efficiency	0.57	74%	0.42	1.00	0.42
C&I Energy Solutions for Business (Small)	4.38	102%	4.45	0.65	2.88
C&I Energy Solutions for Business (large)	3.53	104%	3.69	0.65	2.40
Governmental & Institutional Tariff	0.02	113%	0.02	0.66	0.01
Portfolio Total	19.58	94%	18.34	0.56	10.33

Table 71: Phase-to-date Peak Demand Savings by Energy-Efficiency Program (MW/Year) – West Penn Power

Program	RTD (MW/yr)	Realization Rate	VTD Gross (MW/yr)	NTG	VTD Net (MW/yr)
Appliance Turn-in	2.69	98%	2.62	0.48	1.26
Energy Efficient Homes	26.17	76%	19.96	0.90	18.00
Energy Efficient Products	17.77	127%	22.61	0.28	6.42
LI Energy Efficiency	4.53	91%	4.12	1.00	4.12
C&I Energy Solutions for Business (Small)	15.65	99%	15.46	0.73	11.27
C&I Energy Solutions for Business (large)	12.74	95%	12.13	0.68	8.26
Governmental & Institutional Tariff	0.20	104%	0.21	0.81	0.17
Portfolio Total	79.75	97%	77.10	0.64	49.50

3.7.2 DR

In PY11, West Penn Power (West Penn) had three active DR Programs: C&I DR Program – Small, C&I DR Program – Large, and the BDR Program. West Penn’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’s service territory. Each of these programs define participation slightly differently due to variations in delivery and/or data tracking methodologies. [Table 72](#) provides the definitions used and the counts of PY11 and Phase III participation for each included DR program.

Table 72: West Penn Power Participation by Program

Program	Definition of Participant	PYTD Participation	P3TD 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.	56,565	56,565
C&I DR Program – Small	The number of participants who participated in one or more DR events.	15	48
C&I DR Program – Large	The number of participants who participated in one or more DR events.	32	79

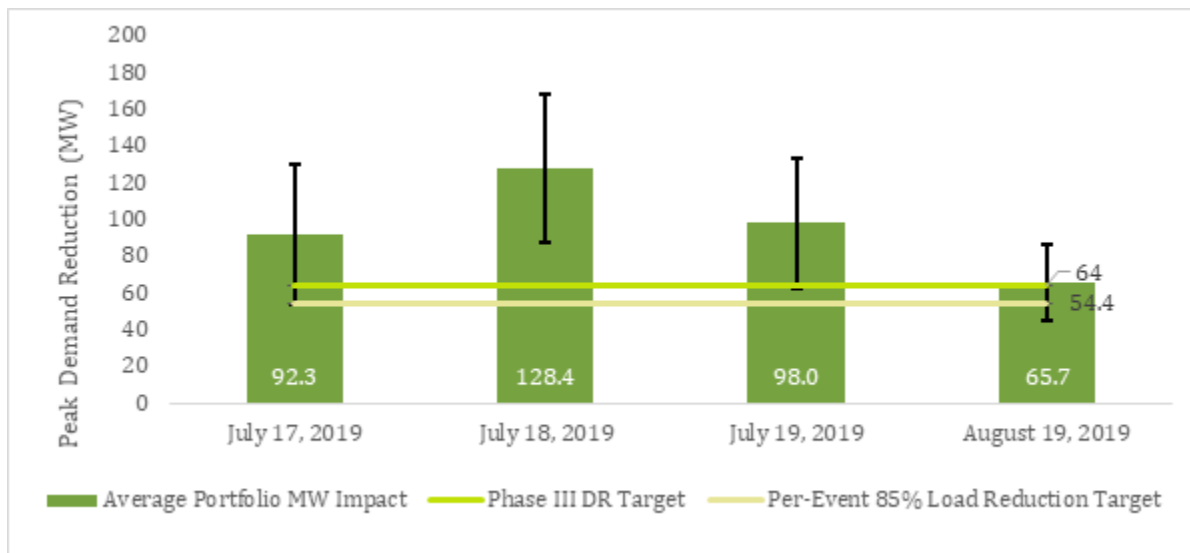
West Penn Power’s three DR programs had four event days in PY11. The Phase III DR performance target for West Penn Power is 64.0 MW. Table 73 shows the DR savings for each program, as well as the portfolio average for each event day. Average performance for PY11 events and Phase III events are included at the bottom of the table.

Table 73: West Penn Power DR 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 17, 2019	15	18	0.7	88.2	3.4	92.3±38.1
July 18, 2019	16	19	1.0	124.4	3.0	128.4±40.3
July 19, 2019	15	18	1.0	93.5	3.6	98.0±35.3
August 19, 2019	15	18	0.8	62.2	2.7	65.7±20.5
PYVTD - Average PY11 DR Event Performance						96.1±17.2
VTD - Average Phase III DR Event Performance						112.4±15.0

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 West Penn Power, this translates to a 54.4 MW minimum for each DR event. Figure 43 compares the performance of each of the DR events in PY11 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 exceeded the 85% threshold and the target of 64 MW.

Figure 43: West Penn Power Event Performance Compared to Per-Event Target



3.7.3 Cost-Effectiveness

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented elsewhere in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. [Table 74](#) shows the TRC ratios by program and for the portfolio. The benefits in [Table 74](#) were calculated using gross verified impacts. Costs and benefits are expressed in 2019 dollars.

Table 74: PY11 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	\$1,188	\$647	1.84	\$541
Energy Efficient Homes	\$6,528	\$4,444	1.47	\$2,085
Energy Efficient Products	\$14,049	\$11,050	1.27	\$2,999
LI Energy Efficiency	\$779	\$3,584	0.22	-\$2,804
Residential Subtotal	\$22,545	\$19,724	1.14	\$2,821
C&I Energy Solutions for Business (Small)	\$14,021	\$13,063	1.07	\$958
C&I Energy Solutions for Business (Large)	\$11,436	\$9,343	1.22	\$2,093
Governmental & Institutional Tariff	\$293	\$309	0.95	-\$16
C&I DR Program (Small)	\$63	\$41	1.55	\$22
C&I DR Program (Large)	\$4,054	\$1,584	2.56	\$2,470
Non-Residential Subtotal	\$29,866	\$24,340	1.23	\$5,527
Portfolio Total	\$52,411	\$44,063	1.19	\$8,348

3.7.4 Process Evaluation

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.

3.7.5 Key Audit Findings

In this section, the SWE provides a summary of key findings of the SWE's audit of West Penn Power's PY11 Annual Report and the supporting detail provided by FirstEnergy's evaluation contractor. The detailed audit findings can be found in [Appendix H](#).

- West Penn Power showed strong DR performance in PY11, with West Penn Power achieving their DR compliance target of 64 MW in all four events. The SWE found that ADM's DR analysis was thorough and free of errors. The SWE found the approaches implemented by ADM to be well-aligned with the Evaluation Framework and consistent with industry best-practice for all three DR programs: BDR for residential customers, small C&I, and large C&I. The SWE recommends the Commission adopt the West Penn

Power/ADM verified savings estimates when assessing compliance at the end of Phase III.

- 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 via the tracking data. The SWE also calculated directionally similar (if not equal) participation counts and incentive dollars for all programs.
- West Penn Power's TRC model was well-organized and consistent with the directives of the 2016 TRC Order and the key financial assumptions approved in West Penn Power's Phase III EE&C Plan. In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. West Penn Power resolved both issues in the PY11 TRC calculations. West Penn Power correctly implemented the guidance provided by the SWE after PY10 regarding the calculation of dual baselines for residential LED lighting measures. The SWE spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with West Penn Power's EE&C plan. However, the SWE recommends that the incremental costs be split out by replacement type whenever possible, since the measure cost can be very dependent on the equipment replacement type.
- 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.
- PY11 residential project files responses were adequate and, overall, the supporting details were provided and accurate.
- The SWE's audit of West Penn Power's HER residential savings was well-documented and free of errors. In PY11, the number of participants and average kWh savings per customer decreased across all five cohorts from PY10.
- 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. The residential verified savings audit is detailed in [Appendix H.4.1.1](#).
- Overall, the ADM/Tetra Tech team estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including West Penn Power. The SWE's audit summary, previously described for Met-Ed, applies to all four FirstEnergy utilities, including West Penn Power (more details are available in [Appendix E.8](#)).

Section 4 Cross-Cutting SWE Activities

This section presents a summary of the audit and cross-cutting activities conducted by the SWE during PY11, 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 44](#) shows the C&I sector specific SWE audit activities and their correspondence to the evaluation steps.

Figure 44: The SWE Audit Activities



4.1 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.

4.1.1 2021 TRM Errata and Amendment

After the PUC adopted the 2021 TRM on August 8, 2019, the SWE conducted a review of the 2021 TRM for Errata with input from the EDCs and their evaluators.

A Secretarial Letter for the TRM Errata was released by the PUC on September 24, 2020.⁵⁰ Approximately fifty separate errata were identified and addressed. The errata typically fit into one of the following broad categories:

- Typographical errors
- Inconsistencies between assumptions or inputs
- Algorithm/equation/unit errors (missing parentheses, or inappropriate conversion factors)
- Broken hyperlinks in source references
- Appendix C - Lighting Audit & Design Tool for C&I Projects functionality

Most errata are minor and will have little or no impact on savings estimates or program administration.

Following the Commission's release of the Errata to the 2021 TRM in September 2020, the SWE, in collaboration with the program evaluation group (PEG) and staff from the Commission's Bureau of Technical Utility Services (TUS), reviewed the 2021 TRM with a focus on measures that were not assigned peak demand savings. The focus was due to the establishment of peak demand savings goals in the Phase IV Implementation Order, which was adopted after the adoption of the 2021 TRM. The Commission proposed several changes for inclusion in the 2021 TRM. The major goals of the proposed modifications were as follows:

- To incorporate peak demand savings for all applicable measures in the 2021 TRM
- To improve existing calculation methods
- To incorporate an updated ENERGY STAR specification into an existing measure
- To remove a redundant measure

The Commission's Tentative Order regarding the proposed 2021 amendment to the TRM was made public at the October 29, 2020 Public Meeting as part of [Docket No. M-2019-3006867](#).⁵¹

The Commission received comments from one stakeholder group. The Final Implementation Order incorporated the amendment to the 2021 TRM and was made public at the February 4, 2021, Public Meeting.⁵²

⁵⁰ <https://www.puc.pa.gov/pcdocs/1678498.docx>

⁵¹ <https://www.puc.pa.gov/pcdocs/1682671.docx>

⁵² <https://www.puc.pa.gov/pcdocs/1692540.docx>

4.1.2 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, in order 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 were no IMPs reviewed and approved to be effective during PY11 (note that the PY11 Midstream Lighting IMP was approved during PY10).

4.2 EM&V PLAN REVIEW AND APPROVAL

EDC evaluation contractors are required to prepare and submit a detailed evaluation plan to the SWE each program year. The intent of the evaluation plan is to document the research objectives and data collection activities for each program within the EDC portfolio. Evaluation plans are expected to generally align with the guidance provided by the SWE in the Pennsylvania Evaluation Framework to ensure consistency in evaluation practices across EDCs. Evaluation contractors were directed to discuss 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 PY11, EDC evaluation contractors submitted redline versions for proposed adjustments and modifications for evaluation activities in PY11.

The SWE reviewed the revised PY11 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 PY11.

In addition, each EDC evaluation contractor submitted memos that outlined their proposed EM&V methods in response to the COVID-19 outbreak. The SWE then developed a memo, released on June 3, 2020, to provide guidance to the EDCs and their evaluators (see [Section 4.8.1](#)).

4.3 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.

4.4 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.⁵³ The SWE cross-checks actual program files, receipts, invoices, and work orders against their corresponding database entries to verify that the EDCs have reported program data correctly and consistently. This “project file review” is designed to audit the accuracy of the savings values stored in the EDC tracking system and to confirm that the EDCs’ calculations were performed in accordance with the current TRM. The uploaded project files include project savings calculation workbooks, specification sheets for equipment installed, invoices, customer incentive agreements, and post-inspection forms. Through these reviews, the SWE verifies that the equipment quantities, efficiency levels, and savings values recorded in project files and the program tracking database are consistent.

4.5 VERIFIED SAVINGS AUDIT

The SWE conducts a detailed review of data collection, estimation methods, and calculations used by the EDC evaluation contractors to calculate verified gross and verified net savings. Following the submission of their annual reports, EDC evaluation contractors are required to submit the supporting work products for audit. These datasets and calculation workbooks – along with the EDC annual reports – are the basis for the SWE verified savings audit. Based on the results of the verified savings audit, the SWE makes one of the three recommendations to the PUC for a given initiative:

1. The SWE agrees with the verified savings calculations and results and suggests the PUC count the reported total 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.

⁵³ 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.

3. The SWE discovered an error or disagrees with an assumption with negligible impact at the portfolio level. This report provides guidance on correcting the issue on a going-forward basis.

4.6 POTENTIAL STUDIES

The final Energy-Efficiency and DR market potential studies were released via Secretarial Letter on March 2, 2020. Due to the COVID-19 pandemic, the Commission cancelled the stakeholder meeting for the studies with a Secretarial Letter released on March 20, 2020 ([Docket No. M-2020-3015229](#)).⁵⁴ The Commission solicited formal comments on the studies through its Phase IV Tentative Implementation Order ([Docket No. M-2020-3015228](#)).

4.7 PHASE IV IMPLEMENTATION ORDER

In 2020, the SWE team worked closely with TUS Staff and Law Bureau to develop the Phase IV Tentative Implementation Order, which was made public at the March 12, 2020, Public Meeting as part of [Docket No. M-2020-3015228](#).⁵⁵ The Tentative Order proposed reductions in consumption, including reduction targets for the LI sector and proposed that each EDC EE&C Plan include specific energy-efficiency measures for households at or below 150% of the Federal Poverty Income Guidelines (FPIG). The Tentative Order did not propose similar reduction targets for GNI entities. The Tentative Order also proposed reductions in peak demand savings, with peak demand reduction targets equal to the expected reduction in coincident peak demand estimated in the EEPDR Potential Study rather than the dispatchable DR targets that were adopted in Phase III. The Tentative Implementation Order addressed a number of other aspects of the proposed Phase IV EE&C Programs, including the plan approval process, plan effectiveness evaluation process, benefit-cost analysis approval process, process to ensure compliance, and EDC cost recovery.

The Commission received comments from 30 stakeholder groups and reply comments from 14 stakeholder groups. The Final Implementation Order established Phase IV of the EE&C Program and addressed each of the comments raised by stakeholders. The Phase IV Final Implementation Order was made public at the June 18, 2020 Public Meeting.⁵⁶ The Tentative Order, Final Order, comments, and reply comments can be found on the [EE&C Program](#) page of the PUC website.

⁵⁴ <https://www.puc.pa.gov/pcdocs/1658893.docx>

⁵⁵ <https://www.puc.pa.gov/pcdocs/1658127.docx>

⁵⁶ <https://www.puc.pa.gov/pcdocs/1666981.docx>

4.8 AD HOC TASKS

4.8.1 Guidance Memo on COVID Protocols

The SWE developed a memo, released on June 3, 2020, to provide guidance to 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 as a means to allow EM&V activities to continue during the COVID-19 pandemic where in person activities were widely restricted. 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. Virtual verification activities are continuing in PY12 for all EDCs.

The memo also provides guidance on appropriate use of normalization to adjust Option C, billing data, and AMI data analyses to adjust for temporary effects of the pandemic.

4.8.2 Incremental Cost Database Update

During Phase III, the SWE built upon the incremental cost research conducted as part of the energy-efficiency market potential study to fully update the Pennsylvania Incremental Cost Database. The potential study data was a primary input to this update. This data was augmented where appropriate through automated web-scraping of price data, and other research to ensure any significant cost changes between the completion of the potential study's measure characterization work and the update to the incremental cost database were captured. The updated database was completed in the summer of 2020 and was made available for use during Phase IV program planning and implementation.

4.8.3 Phase IV EE&C Plan Template

The SWE worked closely with TUS Staff to develop an EE&C Plan template for the EDCs Phase IV plans. The template was drafted in order to provide guidelines to the EDCs for implementing the fourth phase of the Act 129 EE&C Program. The draft template was released for comment on July 27, 2020, when the Commission issued a Secretarial Letter.⁵⁷ The Commission received comments from three stakeholder groups and the final template addressed each of the comments raised by stakeholders. The Commission issued a Secretarial Letter releasing its final template for the EDCs' Act 129 Phase IV EE&C Plans on September 9, 2020.⁵⁸

⁵⁷ <https://www.puc.pa.gov/pcdocs/1671474.docx>

⁵⁸ <https://www.puc.pa.gov/pcdocs/1676672.docx>

Section 5 Findings & Recommendations

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

5.1 PROGRAM DELIVERY

- The COVID-19 pandemic affected many aspects of life in 2020 and Act 129 programs were no exception. During Q4 of PY11 (March 1, 2020 to May 31, 2020) some EDC programs, such as Appliance Recycling, were suspended entirely. Other programs saw disruptions in program delivery and reduced participation from commercial businesses in affected industries. The fourth quarter of PY11 had the lowest reported gross MWh savings since the first half of PY8, when Phase III programs were still ramping up. Other contributing factors to PY11Q4 energy savings totals could include 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.
- PPL, Duquesne Light, and the four FirstEnergy companies have reached their Phase III portfolio MWh compliance targets at the end of PY11, despite spending less than EE&C Plan budgets for PY8-PY11.
- We project that PPL, Duquesne Light, and the four FirstEnergy companies will exceed their Phase III portfolio targets with Phase III savings alone. In its Phase IV Implementation Order, the Commission stated that EDCs will be allowed to “carryover” these excess Phase III MWh savings and count them towards Phase IV compliance targets.⁵⁹ Allowing EDCs to carry over savings from one phase to the next encourages EDCs with excess budget to continue aggressive program delivery after compliance targets for the current phase have been met.
- PECO has reached 77% of their Phase III compliance target through PY11. If PECO’s PY12 verified MWh total equals PY11 performance, PECO will meet its Phase III goal
- All seven EDCs continue to remain heavily reliant on the lighting measures, with 66% of PY11 verified gross energy savings coming from the lighting end-use. Changing baselines in the residential sector are going to necessitate a significant shift in program focus in PY12 and Phase IV.
- The gradual shift in upstream lighting from A-lamp GSLs to non-A-lamp GSLs continued in PY11. Sixty three percent of PY11 upstream lighting products were general service

⁵⁹ Phase IV Final Implementation Order. Page 43-46. Entered June 18, 2020. Docket No. M-2020-3015228. <https://www.puc.pa.gov/pcdocs/1666981.docx>

lamps, down from 72% in PY8. Seventeen percent were reflectors, 16% were specialty bulbs (i.e., globes and candelabras), and 5% were indoor fixtures.

- Overall, PY11 residential and non-residential project files responses were adequate and the supporting details were provided. In a limited number of cases, project files and project file details could not be matched to the tracking data.
- Downstream offerings continue to dominate the non-residential lighting programs across the EDCs, accounting for 31% of statewide PY11 verified gross energy savings.
- Three EDCs – Duquesne Light, PPL, and PECO – offered a midstream lighting program in PY11. The combined savings from these programs is about 13% of all verified non-residential lighting savings in PY11 but totals 19% of non-residential lighting savings for the three EDCs with midstream programs. All three midstream programs expanded relative to PY10.
- CHP projects in PY11 were similar to PY10 both in quantity of projects and verified energy saving. Three EDCs reported CHP projects, totaling 56,656 MWh.
- HER programs accounted for 12% of all PY11 gross verified savings. HER contribution has decreased each year of Phase III, from a high of 20% in PY8. A decline in aggregate savings is typical for HER cohorts because of attrition and no new cohorts were introduced in PY11.

5.2 EVALUATION

The Pennsylvania EDCs and their evaluation contractors conducted a significant volume of verification and program design research in PY11. Some of the key findings and recommendations from their research – and the SWE audit activities – included the following:

- The SWE's review of verified savings for residential and non-residential programs for all EDC's found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and were generally accurate.
- With the help of the EDCs and their evaluators, the SWE completed the audit of verified savings for PY11 before the EDC annual reports were finalized and submitted to the PUC. The SWE provided feedback that the EDCs and their evaluators were able to address before the EDCs submitted their final PY11 reports to the PUC.
- The SWE's audit found that several of the EDC annual reports did not accurately follow the EDC annual report template provided by the SWE. For example, in some cases, kits and direct install measures were categorized as program delivery costs rather than incentives. In other cases, O&M Benefits and Fossil Fuel/Water Benefits were combined into a single category rather than being reported separately or the reporting of savings by customer segment did not follow the template. The SWE recommends following the EDC annual report template.
- The SWE notes that there was again an increase in the number of lighting fixtures in the EDC upstream lighting programs. Through the preliminary reviews with the EDC

evaluators, the SWE provided guidance to the EDCs in assigning baseline wattages to downlight fixtures and retrofit kits in PY11 due to the ambiguity in the TRM.

- The EDC evaluations of HER programs showed good attention to detail in PY11. The accounting method for HER programs changes in PY13 with the introduction of the HER protocol in the 2021 TRM. With the transition to a multi-year measure life perspective, the PY11 and PY12 verified gross savings are inputs to the PY13 incremental annual impact calculation for cohorts that continue into Phase IV. The organized analysis and reporting infrastructure of the EDC EM&V contractors from Phase III positions them well for the Phase IV accounting change.
- The SWE cost-effectiveness audit uncovered calculation issues for Duquesne Light, which is detailed in [Appendix Error! Reference source not found.](#) The PY11 TRC results presented in this report reflect corrections for the errors and Guidehouse will incorporate the revisions into P3TD cost-effectiveness calculations in the PY12 annual report. The Duquesne Light errors were relatively minor, overstating gross TRC costs by \$206,000 and understating benefits by \$6,000. The corrected gross TRC ratio for Duquesne Light's PY11 portfolio is 2.01 compared to the 2.00 value presented in the Duquesne Light PY11 Annual Report.
- 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.
- Overall, the EDC evaluators estimated NTG following the recommended procedures outlined in the Phase III Evaluation Framework.

Appendix A Summary of EDC Progress Towards Portfolio Targets & Cross-Cutting Findings

A.1 EDC PROGRESS TOWARDS PORTFOLIO TARGETS

The following tables provide a summary of progress toward the individual EDC Phase III compliance targets and PY11 verified gross savings by customer segment.

Table 75: Summary of PY11 Verified Savings and Phase III Portfolio Targets*

EDC	Phase III Compliance Targets (MWh)			PY11 Verified Gross Savings (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	479,702	35,888	62,969
PPL	1,443,035	79,367	50,507	369,322	29,945	71,681
Duquesne Light	440,916	24,250	15,432	97,349	5,681	15,172
FE: Met-Ed	599,352	32,964	20,977	143,078	4,159	6,732
FE: Penelec	566,168	31,139	19,816	136,889	3,942	9,679
FE: Penn Power	157,371	8,655	5,508	48,148	1,114	1,932
FE: West Penn	540,986	29,754	18,935	132,110	3,800	11,669
Statewide	5,710,488	314,075	199,868	1,406,597	84,529	179,834

* Rows may not sum to statewide totals due to rounding

Table 76: Summary of Phase-to-date Verified Savings and Phase III Portfolio Targets*

EDC	Phase III Compliance Targets (MWh)			Phase-to-date Verified Gross Savings (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	1,508,937	96,558	157,229
PPL	1,443,035	79,367	50,507	1,498,971	99,604	188,429
Duquesne Light	440,916	24,250	15,432	365,567	17,052	40,019
FE: Met-Ed	599,352	32,964	20,977	643,697	39,058	28,814
FE: Penelec	566,168	31,139	19,816	614,570	39,085	53,624
FE: Penn Power	157,371	8,655	5,508	200,349	11,405	10,220
FE: West Penn	540,986	29,754	18,935	604,476	35,619	74,134
Statewide	5,710,488	314,075	199,868	5,436,567	338,381	552,469

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

Table 77: 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	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 78: Summary of Phase-to-date Verified Savings and Phase II Carryover*

EDC	Phase III Compliance Targets (MWh)			Phase-to-date Verified Gross Savings + CO (MWh)		
	Overall	LI	GNI	Overall	LI	GNI
PECO	1,962,659	107,946	68,693	1,508,937	96,558	157,229
PPL	1,443,035	79,367	50,507	1,498,971	99,604	188,429
Duquesne Light	440,916	24,250	15,432	466,034	20,318	40,019
FE: Met-Ed	599,352	32,964	20,977	674,179	44,083	28,814
FE: Penelec	566,168	31,139	19,816	664,265	46,957	53,706
FE: Penn Power	157,371	8,655	5,508	214,215	13,210	17,536
FE: West Penn	540,986	29,754	18,935	625,016	38,973	74,134
Statewide	5,710,488	314,075	199,868	5,651,617	359,703	559,867

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

Table 79: Summary of PY11 Verified Savings by Customer Segment¹

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI* (MWh)
PECO	243,548	48,942	88,355	62,969	35,888
PPL	103,406	104,846	59,485	71,893	29,692
Duquesne Light	30,044	19,667	28,635	15,172	3,831
FE: Met-Ed	75,755	22,515	33,917	6,732	4,159
FE: Penelec	65,715	25,284	32,267	9,679	3,942
FE: Penn Power	23,121	16,751	5,230	1,932	1,114
FE: West Penn	64,669	30,227	21,745	11,669	3,800
Statewide	606,258	268,232	269,635	180,046	82,426

¹ Does not include carryover savings.

*The verified savings for the FirstEnergy company LI customer segment differs slightly from the LI compliance target because ADM confirms the income status of customers from a LI school kit program for the compliance target (but considers all participants part of the LI customer segment).

Table 80: Summary of Phase-to-date Verified Savings by Customer Segment¹

EDC	Residential (MWh)	Small C&I (MWh)	Large C&I (MWh)	GNI (MWh)	LI* (MWh)
PECO	864,457	149,715	240,980	157,229	96,556
PPL	598,196	364,340	248,885	190,856	96,694
Duquesne Light	152,453	69,997	89,290	40,019	13,808
FE: Met-Ed	350,041	102,940	122,844	28,814	39,058
FE: Penelec	310,542	97,757	113,561	53,624	39,085
FE: Penn Power	100,952	50,763	27,009	10,220	11,405
FE: West Penn	315,744	107,148	71,830	74,134	35,619
Statewide	2,692,385	942,661	914,400	554,896	332,224

¹ Does not include carryover savings.

*The verified savings for the FirstEnergy company LI customer segment differs slightly from the LI compliance target because ADM confirms the income status of customers from a LI school kit program for the compliance target (but considers all participants part of the LI customer segment).

Table 81: PY11 Costs, kWh Savings, and Cost per First-Year kWh Saved

Category	Sector	Program Year 11 Performance
Total Utility Costs (\$1000)	Residential Non-LI	\$75,434
	Residential LI	\$28,916
	Residential Total	\$104,349
	Non-Residential Total	\$80,658
	Total	\$185,008
First-Year kWh Saved	Residential Non-LI	606,258
	Residential LI	85,817
	Residential Total	692,075
	Non-Residential Total	714,522
	Total	1,406,597
Utility \$/kWh Saved	Residential Non-LI	\$0.12
	Residential LI	\$0.34
	Residential Total	\$0.15
	Non-Residential Total	\$0.11
	Total	\$0.13

A.2 LOW- INCOME MEASURE PROPORTIONALITY ANALYSIS

As noted in the [Executive Summary](#), 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 that is proportionate to each EDC’s total LI consumption relative to the total energy usage in the service territory. An LI measure is defined as a measure that is targeted to LI customers and is available at no cost to LI customers. The SWE found that each EDC complied with the LI proportionality requirement.

Table 82 reports the required minimum proportions and results of the SWE's verification analysis.

Table 82: LI Measure Proportionality Targets and SWE Verification Results

EDC	Proportionate Number of Measures Target	PY11 Proportionate Number of Measures, Reported	PY11 Proportionate Number of Measures, SWE Verified
PECO	8.80%	43.5%	29.1%
PPL	9.95%	21.7%	22.7%
Duquesne Light	8.40%	19.8%	28.1%
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	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 PY11 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 that are not addressed in the PA TRM."⁶⁰

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, 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

⁶⁰ Evaluation Framework.

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 lists⁶¹ 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 that was 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 to be LI if it included any EDC-reported, LI qualified measures.

A.2.2 Consistency with PY11

PECO, Duquesne Light, 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, Duquesne Light, and the FirstEnergy companies offered the same measures to customers in PY11 as they did in PY10. Therefore, the LI proportionality analysis from PY11 is identical to that in PY10.

PPL did change their measure offerings in PY11. Full proportionality analysis was done for PPL to verify compliance with the LI requirement.

⁶¹ 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.2.3 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 unit and the new unit. One EDC considered these as separate measures, which would technically match the SWE recommendation. However, the other EDCs did not separate these measures given that 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:** The TRM has one section, 2.4.3, that 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 21.7% of its 115 conservation measures qualified as LI measures, which surpasses its 9.95% requirement. By the SWE's analysis, when the EDC-reported measures are matched to TRM algorithm sections, 22.7% of 119 measures qualified as LI measures. All measure were matched to the TRM algorithms. 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 19.6% of its 102 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, 28.1% qualify as LI measures with measures unmatched to the TRM included. When unmatched measures are excluded, 27.6% 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 83 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) 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 83: Summary of LI Measures Provided by EDCs

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs ¹
<i>N</i>	85	60	27	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	✓	✓		✓
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	✓			

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs ¹
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	✓			
Electric Chillers	3.2.2	✓			

Measure	TRM Algorithm Section	PECO	PPL	Duquesne Light	FirstEnergy EDCs ¹
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) 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 an RCT design and the only difference between the treatment and control group are the reports themselves (and thus the analysis directly calculates net savings). The residential lighting NTG was consistently among the lowest NTG values and has been decreasing over the past few years. There was less consistency across C&I NTG values across EDCs, although C&I lighting continues to be among the higher NTG C&I values.

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 continue to keep sample sizes large enough to produce robust NTG estimates while being aware of possible customer fatigue made possible by recruiting from the same small pool of C&I participants.

Appendix B PECO Audit Detail

B.1 EM&V PLAN REVIEWS

PECO's evaluation contractor, Guidehouse (formerly Navigant), submitted a redline version of their PY11 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 PY11 EM&V plan.

In addition, Guidehouse submitted several memos updating their sampling approach for several solutions and programs, including their targeted multifamily solution; the appliance recycling solution; the residential whole home solution; the LI energy efficiency whole home solution; the lighting, appliances, and HVAC solution; the residential new construction 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 a number of survey instruments for the appliance recycling solution; the residential whole home solution; the Small and Large C&I Energy Efficiency programs; the lighting, appliances, and HVAC solution; the residential new construction solution; and the LI energy efficiency whole home solution.

Guidehouse also submitted two memos to the SWE that outlined Guidehouse's proposed EM&V methods in response to the COVID-19 outbreak.

B.2 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 $\pm 10\%$ 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 $\pm 15\%$ 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 that are a more logical grouping 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 PY11 Annual Report by solution. Samples were devised to meet the 85/15 sampling requirement for each solution. [Table 84](#) shows the relative precision of the energy savings for each solution. The SWE was able to reproduce the precision values in [Table 84](#) with the project-level sample dispositions furnished in response to the SWE annual data request.

Table 84: Relative Precision of PY11 Gross Verified Energy Savings by Program

Program	Solution/Initiative	Relative Precision at 85% Confidence Level (\pm)
Residential Energy Efficiency Program	Lighting, Appliances, and HVAC	0.0%
Residential Energy Efficiency Program	Appliance Recycling	2.3%
Residential Energy Efficiency Program	Whole Home	5.6%
Residential Energy Efficiency Program	New Construction	6.3%
Residential Energy Efficiency Program	Multifamily Targeted	44.6%
LI Energy Efficiency Program	Whole Home	25.5%
Small C&I Energy Efficiency Program	Equipment and Systems	10.2%
Small C&I Energy Efficiency Program	New Construction	14.0%
Small C&I Energy Efficiency Program	Multifamily Targeted	4.8%
Small C&I Energy Efficiency Program	Whole Building	4.5%
Large C&I Energy Efficiency Program	Equipment and Systems	12.0%
Large C&I Energy Efficiency Program	New Construction	14.0%
Large C&I Energy Efficiency Program	Multifamily Targeted	5.5%

In PY11, Guidehouse adjusted 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 other situations where the memo's guidance was not applicable. In some cases, phone survey verification was used when the pandemic prevented certain evaluation activities, such as onsite verification and metering. For the Multifamily Targeted solutions, Guidehouse applied realization rates from onsite verification conducted in PY10, adjusted by the findings from PY11 engineering file reviews.

There are two values in [Table 84](#) above the 15% threshold: the Multifamily Targeted solution within the Residential Energy Efficiency Program and the Whole Home solution within the LI Energy Efficiency program. The Multifamily Targeted solution includes samples from the Residential, Small C&I, and Large C&I Energy Efficiency programs. Since Guidehouse used the PY10 realization rates for the Multifamily Targeted solutions, this uncertainty was carried forward from PY10 onsite verification. The largest source of uncertainty was the Large Residential stratum. In PY10, Guidehouse reported scheduling difficulties that lead to a reduction in the number of site visits for the Large Residential Stratum by one sample point. The primary driver of high uncertainty was variance between the quantities of expected and verified lighting measures. To resolve the issue, Guidehouse calculated savings using a weighted average HOU and CF value based on the space types in which lamps were installed as opposed to a default regardless of space type. In the LI Energy Efficiency Whole Home Solution, the uncertainty is driven by the Very Small Single-Family Stratum and the Giveaways stratum. Since no sample sites were collected for the Very Small stratum, the relative precision for the realization rate is 100%. It is unclear why Guidehouse assumes $\pm 50\%$ relative precision for Giveaways when no verification activities were conducted.

After a preliminary mid-year review of verified savings, Guidehouse adjusted the sample design for the Large C&I Equipment and Systems Solution that was originally outlined in their PY11 sample design memo. During the mid-year review, Guidehouse found large differences between reported and verified savings within the Very Large Projects stratum. These differences stemmed from several retrocommissioning (RCx) and variable frequency drive (VFD) projects. Guidehouse found that savings had been misapplied for kitchen exhaust fans in the VFD projects and that there was significant variability in the RCx projects. Through discussions with the SWE, Guidehouse decided to re-stratify these projects into their own strata for PY11. For PY12, the SWE recommended using a higher coefficient of variation (Cv) for the Very Large stratum so that the sample can withstand higher variation between reported and verified savings. This recommendation is reflected in the PY12 sampling plan for the program.

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 Guidehouse's PY11 verification activities is discussed in detail in [Appendix B.4](#).

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 $\pm 0.5\%$ at the 95% confidence level (two-tailed). This requirement for program design is less stringent than the

sampling requirement (described above) that programs annually achieve $\pm 15\%$ *relative* precision at the 85% confidence level. Standard precision requirements are not reasonable expectations for behavioral programs because the size of the average effect is typically much smaller, and all estimation error is captured as opposed to sampling error only. The 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 85](#).

Table 85: Gross DR Savings Impact Evaluation Relative Precision by Program

DR Program	Relative Precision at 90% Confidence Interval (\pm)
Residential	3%
Small C&I	27%
Large C&I	8%

B.3 REPORTED GROSS SAVINGS AUDITS

B.3.1 Tracking Data Review

This report section summarizes the SWE’s assessment of the savings, participation counts, and incentives reported in PECO’s PY11 Annual Report. Specifically, the values we examined are as follows:

- Reported gross energy savings (MWh) for each program;
- Reported gross peak demand savings (MW) for each program;
- Participation counts for each program; and
- Incentive dollars for each program.

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 PY11 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 Error! Reference source not found.](#), and our findings regarding the behavioral component of PECO’s Residential Energy Efficiency Program can be found in [Appendix B.4.1.3](#).

[Table 86](#) summarizes our findings regarding reported gross energy savings. The “Match” column contains “Yes” if the tracking data supports the values in PECO’s PY11 Annual Report and “No” otherwise. The tracking data supports the Annual Report for all programs.

Table 86: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Residential Energy Efficiency Program	176,386	176,386	Yes*
LI Energy Efficiency Program	37,265	37,265	Yes
Small C&I Program	66,669	66,669	Yes
Large C&I Program	113,652	113,652	Yes
CHP	747	747	Yes
Portfolio Total	394,719	394,719	Yes

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

Table 87 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 for all programs.

Table 87: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Residential Energy Efficiency Program	23.21	23.21	Yes*
LI Energy Efficiency Program	4.35	4.35	Yes
Small C&I Program	10.65	10.65	Yes
Large C&I Program	16.55	16.55	Yes
CHP	0.13	0.13	Yes
Portfolio Total	54.88	54.88	Yes

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

Table 88 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: 1,250,483 in the Annual Report and 1,253,572 in the tracking data.

Table 88: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Residential Energy Efficiency Program	1,230,297	1,233,630	No*
LI Energy Efficiency Program	14,536	14,310	No
Small C&I Program	3,444	3,436	No
Large C&I Program	2,205	2,195	No
CHP	1	1	Yes
Portfolio Total	1,250,483	1,253,572	No

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

Finally, [Table 89](#) summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE was able to replicate incentives shown in PECO's Annual Report for just the CHP program. Note that our totals do align with PECO's PY11 Preliminary Annual Report.

Table 89: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Residential Energy Efficiency Program	\$9,825	\$8,795	No
LI Energy Efficiency Program	\$6,337	\$170	No
Small C&I Program	\$5,719	\$4,077	No
Large C&I Program	\$7,093	\$7,066	No
CHP	\$54	\$54	Yes
Portfolio Total	\$29,028	\$20,162	No

B.3.2 Project File Reviews

B.3.2.1 Residential

The SWE conducted a project file review for a sample of PECO's residential and LI solutions in PY11 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 90](#) 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 PY11. Improvements were made to quarterly data submissions, such as providing a project file key, which allowed the SWE auditors to conduct thorough reviews of project file packages, TRM equations and values, and the tracking data.

Table 90: PECO PY11 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 Program	Upstream Lighting	9	✓	✓	✓	✓
Residential Energy Efficiency Program	Appliance and HVAC	15	✓	✓	✓	✓
Residential Energy Efficiency Program	Appliance Recycling	20	✓	✓	✓	✓
Residential Energy Efficiency Program	Whole Home Solutions	15	✓	✓	✓	✓
Residential Energy Efficiency Program	New Construction	24	✓	✓	✓	✓
Residential Energy Efficiency Program	Multifamily Targeted Segment	15	✓	✓	✓	✓
LI Energy Efficiency Program	LI-WHS	10	✓	✓	✓	✓

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

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

Lighting, Appliance, and HVAC (LAH) Solution

The upstream lighting project file review included manufacturer invoices. Typically, rebate amounts matched with the tracking data, but invoices tended not to specify whether they listed bulb or pack (unit of sale) quantity. As a result, the SWE checked whether invoiced quantities were reasonable given average pack sizes calculated from tracking data. As in PY10, 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 that they be included in the tracking data moving forward in PY12.

Appliance and HVAC project files generally matched the quarterly tracking data. There was one case where the tracking data noted a furnace fan measure was installed but was not indicated in the project file.

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 installed bulb counts and hot water and appliance information for individual projects.

The reported savings in the tracking data corresponded to the REM/Rate building files in all instances except for one, where a minor discrepancy between the reported savings in the tracking data and the REM/Rate savings was observed.

Reported savings in the tracking data matched software-based (REM/Rate) results and included savings from lighting and appliance end-uses. 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.⁶²

Appliance Recycling Solution

The SWE reviewed the requested records for recycled units in Quarters 1 through 4 for PY11 and found no discrepancies within the tracking data. There were three observations where the appliance age characteristics did not align between the data collection form and the electronic project file data.

⁶² 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.

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 that most reviewed project files matched the tracking database for the Whole Home Solution. Dates matched between sets of documents. Brand/model, capacity, and other specifications tended to match as well. The SWE observed two cases where weatherization measures occurred; however, 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.

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.3.2.2 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 PY11. 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 91 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 91: PECO PY11 C&I Project File Review Summary Checklist

Project Number	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?
PECLPS1540476770	C&I New Construction Solutions	Lighting (NC)	✓	✓	✓	✓	✓	-
PECLPS1539572874	C&I New Construction Solutions	Lighting (NC)	✓	✓	✓	✓	✓	-
PECLPS1540904009	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1540719366	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1539502660	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1541131663	C&I New Construction Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1541692788	C&I New Construction Solutions	HVAC & Lighting	✗	✓	✓	✗	✓	-
PECLPS1542294016	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1539552222	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1540895399	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	-	✗
PECLPS1540718955	C&I New Construction Solutions	Lighting	✗	✗	✓	✗	✓	-
PECLPS1541884521	C&I New Construction Solutions	HVAC	✗	✓	✗	✗	✓	-
PECLPS1540871486	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1543571220	Equipment & Systems Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1540246922	C&I New Construction Solutions	HVAC & Lighting	✗	✓	✓	✗	✓	-
PECLPS1544626121	C&I New Construction Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1543383966	C&I New Construction Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1544775307	C&I New Construction Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1543497826	C&I New Construction Solutions	Lighting	✓	✓	✓	✓	✓	-
PECLPS1544582355	C&I New Construction Solutions	Lighting	✓	✓	✓	✓	✓	-

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 PY11. The SWE completed reviews on a sample of eight projects across both the Large C&I and Small C&I programs for the E&S solution. These eight 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 the 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.

New Construction Solution

The SWE reviewed 12 projects from various non-residential segments covering multiple measure types within the New Construction solution. For three projects in the sample, the HVAC savings calculators were not included in the submitted project files. The SWE reviewed one lighting project where the lighting savings analysis also was not included. Additionally, the savings listed in the program tracker for that same lighting project did not match the savings claimed by the evaluator.

B.4 VERIFIED GROSS SAVINGS AUDITS

B.4.1 Residential Audit Activities

This section presents a summary of the SWE's audit of the 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, that are 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 that were used to verify savings for the residential programs. [Table 92](#) provides a summary of the evaluation and M&V approaches used by PECO in their PY11 verified savings calculations.

Table 92: Residential Program Evaluation Activities (by Solution) – PECO

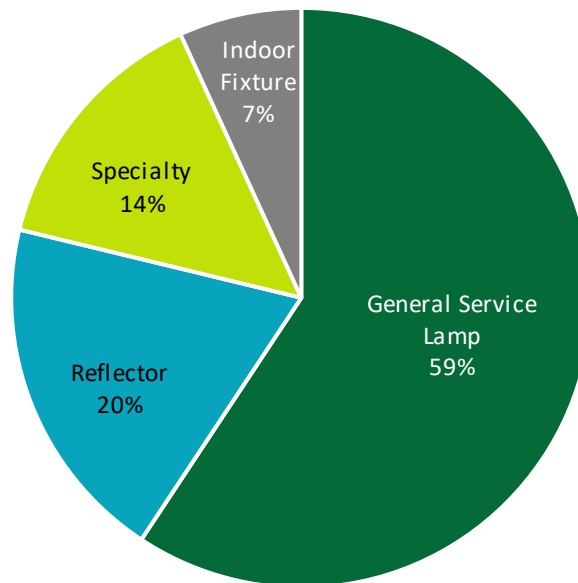
Solution	Surveys	Site Visits	Desk Review ^a	Billing Analysis	Applied PY10 RR
Lighting, Appliances, and HVAC Solution	✓	--	✓	--	--
Appliance Recycling Solution	✓	--	✓	--	--
Whole Home Solution	✓	--	✓	--	--
New Construction Solution	--	--	✓	--	--
Multifamily Targeted Market Segment	--	--	--	--	✓
Behavioral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

^a The Desk Review Column includes database reviews, application reviews, and engineering desk reviews, or a combination of these activities.

B.4.1.1 Upstream Lighting & Cross-Sector Sales

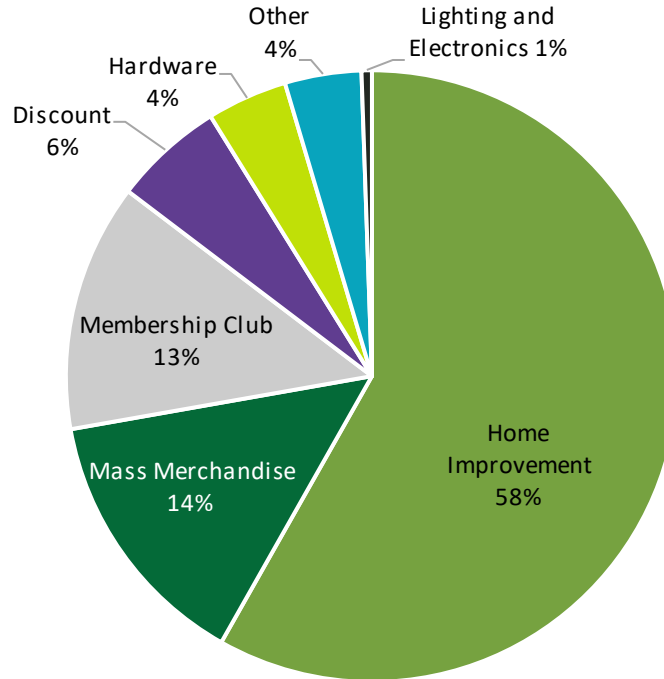
Customers purchased over 3 million efficient light bulbs and fixtures through PECO’s PY11 upstream lighting program. Figure 45 displays the distribution of sales by product type. Over one-half (59%) of the products were general service lamps.

Figure 45: PECO PY11 Upstream Lighting Sales by Product Type



Over one-half (58%) of PECO's PY11 upstream light bulbs and fixtures were sold through home improvement stores, followed by mass merchandise (14%) and membership clubs (13%, [Figure 46](#)).

Figure 46: PECO PY11 Upstream Lighting Sales by Retail Channel



Audit Findings

Guidehouse provided the PY11 impact analysis for PECO's upstream lighting before the PY11 PECO Annual Report was submitted to the PUC on February 15, 2021. This allowed time for the SWE to conduct its audit, provide Guidehouse with feedback, and for Guidehouse to adjust the analysis based on this feedback. The SWE agrees with Guidehouse's verified gross savings for upstream lighting.

Cross-Sector Sales

Guidehouse did not conduct cross-sector sales research in PY11, but applied the PY8 cross-sector sales rates of 0.73% for standard LEDs and 2.0% for specialty LEDs.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY11 upstream lighting analysis.

B.4.1.2 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, were 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.4.1.1](#) 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 SWE audited verified gross savings for all measures covered under the Appliance Recycling Solution, including refrigerators, freezers, and room air conditioners. 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 SWE audited the verified savings for all measures sampled in the Whole Home Solution evaluation. The evaluators conducted a comprehensive TRM review of the reported savings tracking data and applied adjusted savings to the verified savings. The evaluation also included a sample of sites that received phone verification, which was also used to calculate the programs realization rate. The SWE observed a minor discrepancy in the sample size reported in the analysis files compared to the main report; however, the correct sample sizes were reported in the detailed appendix for the solution. The population and realization rates were verified to be correct and that verified savings calculations applied correct algorithms and followed the proper TRM protocols. The SWE confirmed that verified savings calculations incorporated early SWE

feedback and confirmed the proper TRM algorithms were used to calculate savings. The SWE observed no discrepancies in the savings values reported in the EDC annual report.

Additionally, Guidehouse reported errors and potential solutions in the PECO annual report for six measures, which the SWE agrees should be addressed by PECO, the CSP, and evaluator in PY12.

New Construction Solution

In accordance with the program's evaluation plan, the New Construction Solution was evaluated in PY11. The PY11 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 that were 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.

Additionally, Guidehouse reported discrepancies and potential solutions in the PECO annual report for the New Construction Solutions, which the SWE agrees should be addressed by PECO, the CSP, and evaluator in PY12.

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. 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 Energy Efficiency – 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-WHS and resolved any questions that were outstanding prior to the EDC annual report. The SWE confirmed that sample sizes and population sizes were accurate and TRM specified algorithms were properly administered to calculate gross verified savings.

B.4.1.3 Behavior

Approximately 14% of the PY11 verified gross energy savings listed in PECO's PY11 Annual Report came from HERs issued to over 380,000 households. PECO was among the most HER-reliant EDC for portfolio savings in PY11 but did not claim HER energy savings towards its LI compliance target. PECO's Behavioral Solution consists of nine different waves, or cohorts, of homes summarized in [Table 93](#). Two new cohorts were added in July 2019. Home counts are rounded to the nearest thousand and represent the average number of active households across PY11.

Table 93: PECO HER Cohort Summary

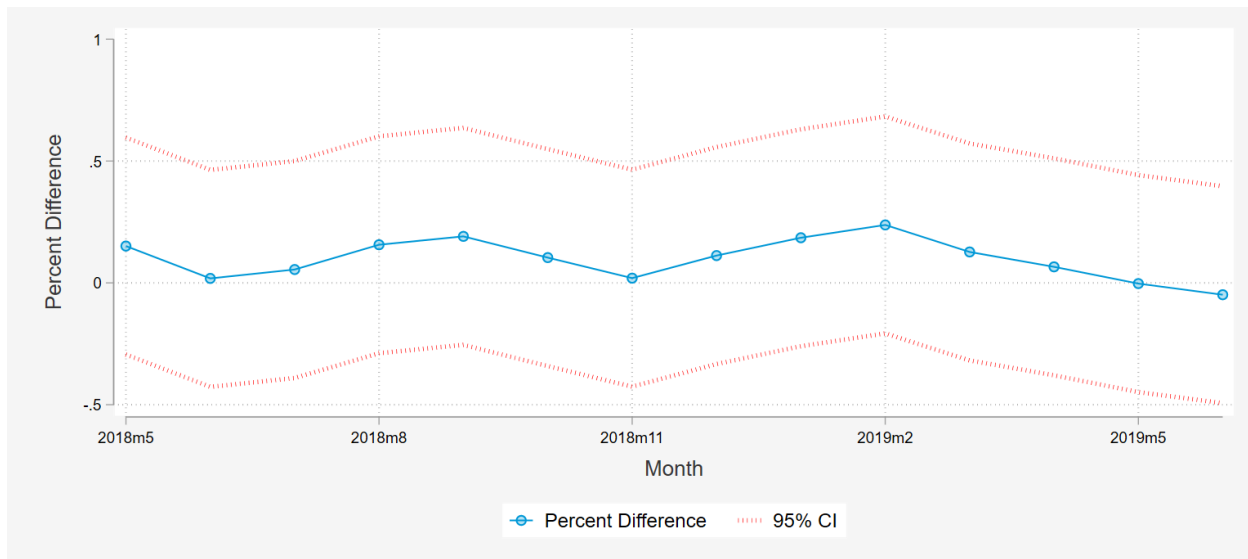
Wave	Wave Start Date	Treatment Group Homes	Control Group Homes
Wave 1	August 2013	24,000	15,000
Wave 2	March 2014	31,000	13,000
Wave 3	June 2015	53,000	16,000
Wave 4	June 2016	170,000	15,000
Wave 5 Electric	June 2017	23,000	9,000
Wave 5 Dual Fuel	June 2017	14,000	6,000
Wave 6 Electric	July 2019	18,000	14,000
Wave 6 Dual Fuel	July 2019	5,000	4,000
AC Saver*	June 2016	31,000	27,000

*The AC Saver cohort uses a matched control group rather than the RCT. The number of control group homes represents the number of households in the matched control group, which were selected without replacement.

The program ICSP Oracle implemented Waves 1-6 as 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. 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. Wave 6 is new starting in PY11. Figure 47 shows the percent difference of average usage between treatment and control customers for the pre-treatment period. The difference varies slightly, but the 95% confidence interval falls around zero, demonstrating that the pre-treatment energy usage patterns were similar across the two groups.

Figure 47: Wave 6 Pre-Treatment
Percent Difference (Control-Treatment)



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 Guidehouse data and regression model to confirm the savings estimates provided by Guidehouse, shown in Table 94. 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 PY11 homes.

Table 94: PY11 HER Energy Savings Before Dual Participation Adjustment

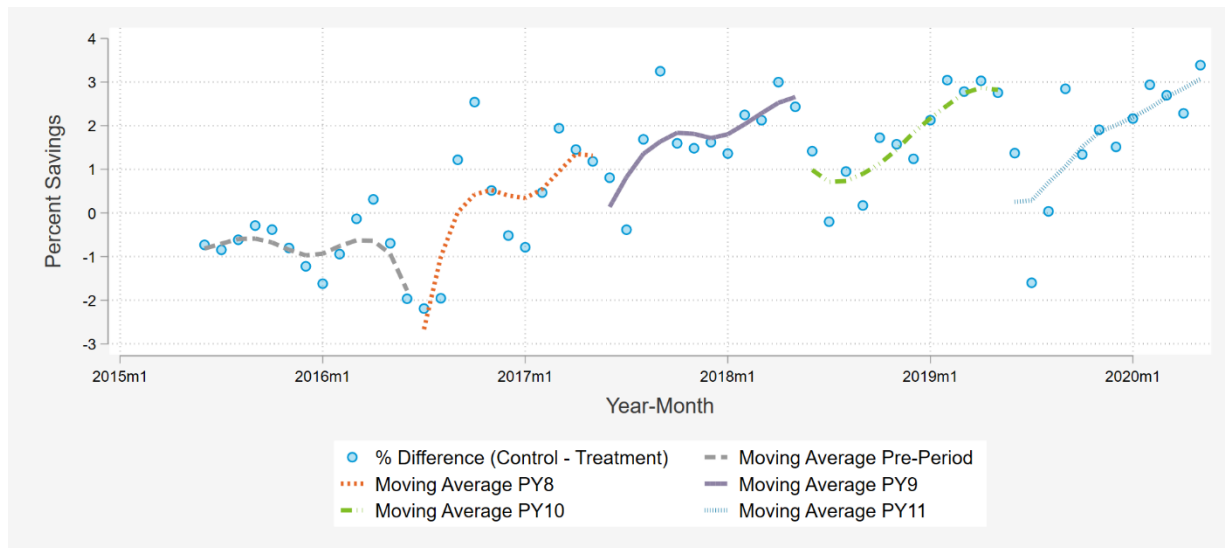
Wave	PY11 Gross Savings MWh	Average kWh per Home	Average Percent Savings
1	5,881	245	1.5%
2	13,036	422	1.8%
3	18,359	345	2.2%
4	25,144	147	1.3%
5 – Electric	4,075	176	1.4%
5 – Dual Fuel	1,524	105	0.9%
6 – Electric	2,818	160	1.0%
6 – Dual Fuel	908	171	1.3%
AC Saver	4,154	126	1.7%
Total	75,901	205	1.5%

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 controls that are a 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.

Figure 48 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 PY11 was significant and similar in magnitude to PY9 and PY10.

Figure 48: AC Saver Percent Impacts over Time



Dual Participation

In [Table 94](#), calculated savings were 75,901 MWh. It is important to note that HERs 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 67,056 MWh (reported in [Table 95](#)).

The PY11 dual participation adjustment levels were typical for all cohorts other than the AC Saver wave, which had its saving reduced by almost 60%. 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 Energy Efficiency participation than its matched control group and the result is a significant dual participation adjustment.

Table 95: PY11 HER Energy Savings - Dual Participation Adjustment

Wave	PY11 Gross Savings MWh	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Net Savings (MWh)
1	5,881	673	156	5,052
2	13,036	1,331	351	11,354
3	18,359	927	523	16,909
4	25,144	1,120	721	23,303
5 – Electric	4,075	147	88	3,840
5 – Dual Fuel	1,524	162	31	1,332
6 – Electric	2,818	68	21	2,730
6 – Dual Fuel	908	31	7	871
AC Saver	4,154	2,437	52	1,666
Total	75,901	6,896	1,949	67,056

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 7.65 MW for the Behavioral Solution.

$$\text{Verified MW Savings} = \frac{67,056 \text{ MWh}}{8,760 \text{ hours}} = 7.65 \text{ MW}$$

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's 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 PY11 verified savings results for PECO's Behavioral Solution and recommends that the PUC adopt these savings when assessing compliance with Phase III goals.

B.4.2 Non-Residential Audit Activities

As noted in [Section 3.1](#), 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 (no PY11 participation)
- 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 96](#) presents the list of evaluation activities by project count.

Table 96: PECO Evaluation Activities by Project Count

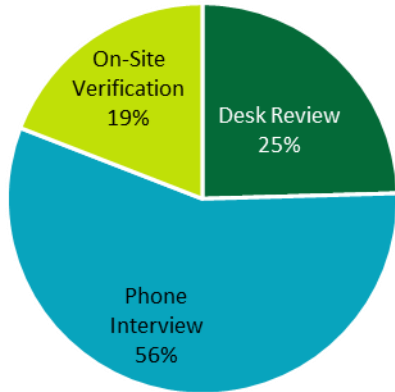
Program / Solution	Sample Quantity	RR–Energy	Desk Review	Phone Interview	On-Site Verification
Small C&I	57	113%	10	40	7
E&S	30	118%	7	22	1
New Construction	13	105%	3	9	1
Multifamily	0	98%	-	-	-
Whole Building	14	93%	-	9	5
Data Centers	0	N/A	-	-	-
Large C&I	52	109%	16	22	14
E&S	38	109%	10	18	10
New Construction	14	111%	6	4	4
Multifamily	0	99%	-	-	-
Data Centers	0	N/A	-	-	-
Combined Heat & Power	1	109%	1	-	-
Total	110		27	62	21

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

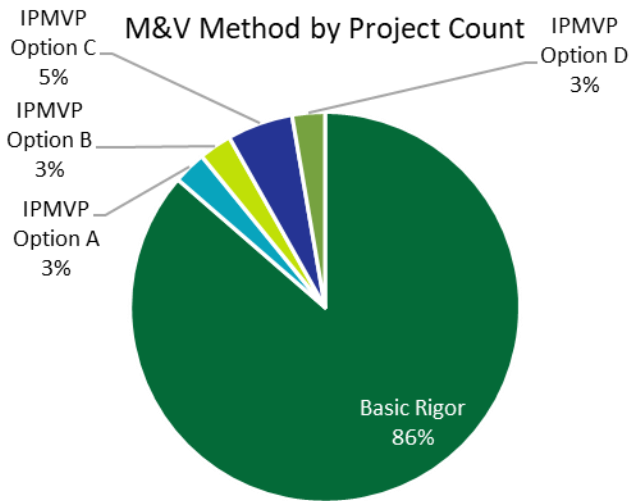
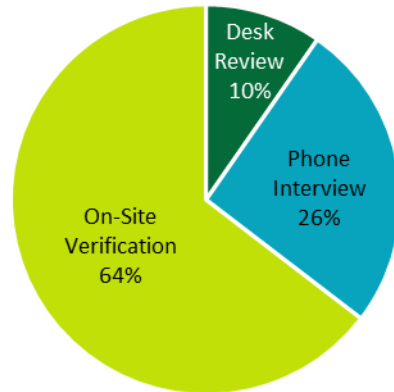
[Figure 49](#) provides a summary of the evaluation activities and M&V approaches utilized by Guidehouse for the PY11 verified savings calculations across the non-residential portfolio. Each figure reflects evaluation activities for all programs and solutions combined. Twenty-one site visits were completed within the evaluation sample. 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. Similar to their approach used in PY10, Guidehouse reserved IPMVP Options A and B for primarily projects in the Large C&I E&S Solution Program.

Figure 49: Summary of PECO’s PY11 C&I Evaluation Activities

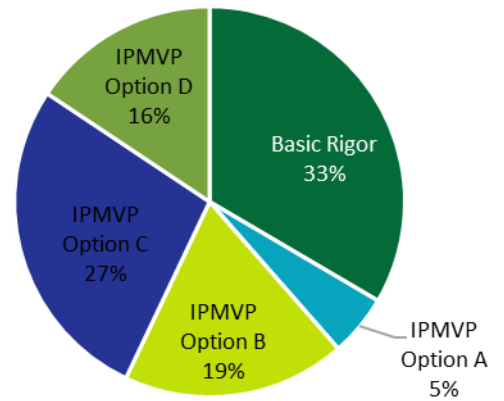
Evaluation Activity by Project Count



Evaluation Activity by kWh contribution



M&V Method by kWh contribution



B.4.2.1 E&S

The E&S solution comprised the majority of the energy savings within the PECO non-residential portfolio. Guidehouse derived a sample of 68 projects from the Large and Small C&I programs and allocated them to multiple strata based on project type and size.

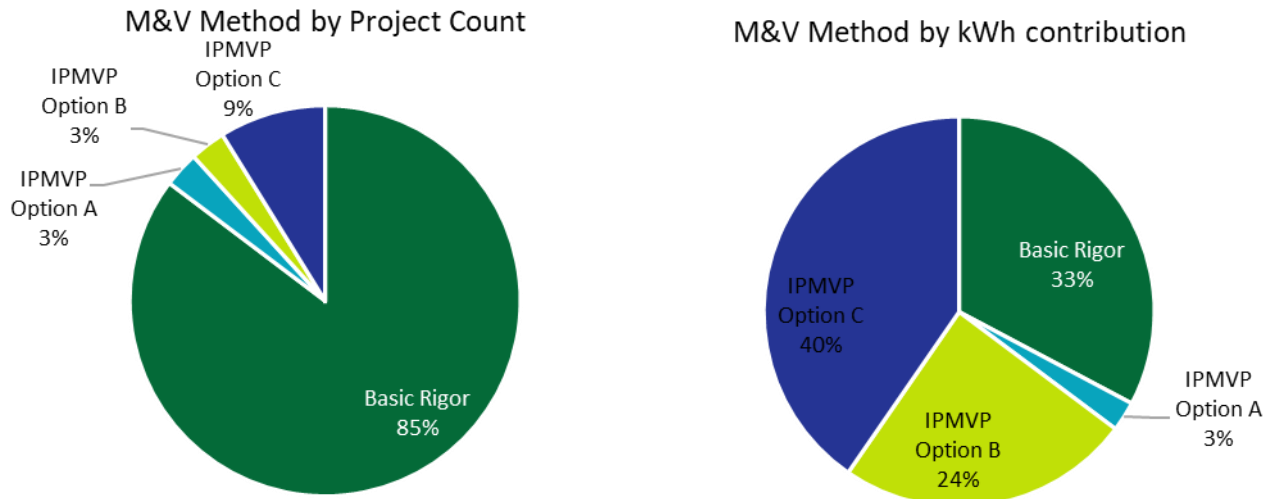
For Small C&I E&S, of the 30 projects evaluated, 28 included lighting or lighting control retrofits, one was classified as custom HVAC, and one was classified as custom motors. For Large C&I Equipment and Systems, of the 38 projects evaluated, 24 included lighting or lighting control retrofits, four were classified as custom, three were classified as kitchen ventilation, two were classified as HVAC, one was classified as custom motors, and four were classified as Retro-commissioning.

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

Guidehouse conducted desk reviews for all projects in the evaluation sample. The desk reviews used project applications, project-specific analysis files and associated calculation sheets, 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. The majority of the sampled projects from the Equipment and Systems Solution achieved realization rates for both demand and energy within 20% of the expected values. Eleven projects had verified energy savings values fall below 80% of the reported values, while twenty-two projects had verified energy savings values above 120% 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 HOU's were 10% different from the deemed HOU's
- Discrepancy in fixture wattages for one project and control types for two projects
- Miscategorized VFDs for three sampled projects
- Changes made to regression models to better fit data collected

Figure 50 displays the share of M&V methods performed under the Equipment and Systems. IPMVP methods accounted for two-thirds of the evaluated savings, but only represented 15% 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 50: Summary of PECO's E&S Solution M&V Methods

B.4.2.2 Data Centers

PECO's Data Center solution saw no participation for PY11.

B.4.2.3 Non-Residential New Construction

The New Construction solution contributed approximately 9% of reported savings to PECO's non-residential portfolio. Guidehouse derived its sample from the New Construction solution under both the Small and Large C&I programs and included 27 samples for PY11: 14 from the Large C&I program and 13 from the Small C&I program. These 27 projects were stratified into Very High Impact, High Impact, Medium/Low Impact, and Very Low Impact strata.

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. The evaluation team supplemented the desk reviews with phone verifications, which Guidehouse assigned to projects in accordance with the sampling memo. Guidehouse only conducted five site verifications for the sampled projects due to COVID-19 on-site restrictions and therefore, achieved most verification through phone interviews with the customers. There were no metered projects in PY11.

For Large C&I New Construction, Guidehouse verified fourteen projects in PY11. These projects included the following:

- Seven projects including lighting and/or lighting controls
- Two projects including HVAC measures
- Two projects including refrigeration measures
- Three whole building projects

For Small C&I New Construction, Guidehouse verified thirteen projects in PY11. These projects included the following:

- Four projects including HVAC measures
- Nine projects including lighting or lighting controls⁵³

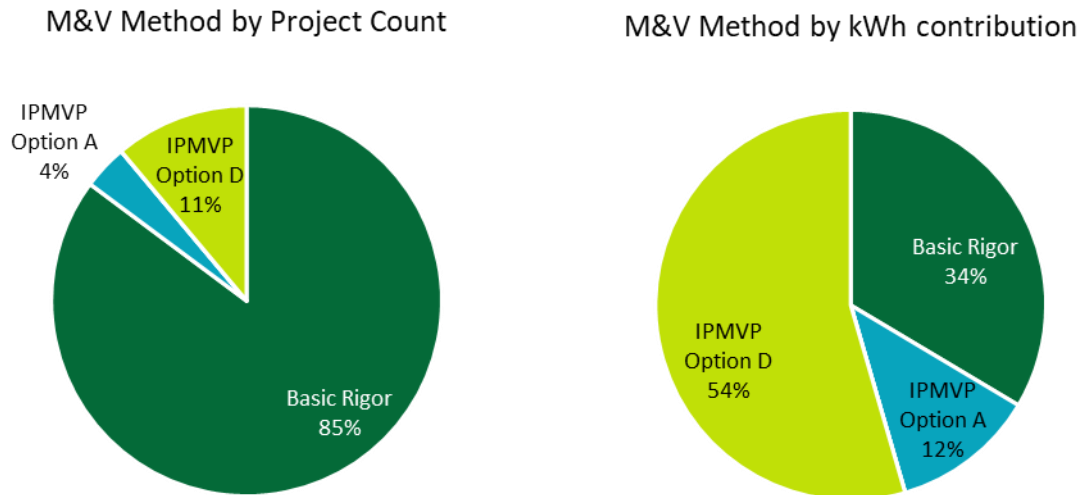
The common reasons for discrepancy between ex post and ex-ante savings as noted by Guidehouse for the New Construction Solution were as follows:

- Annual HOU's for lighting measures in three projects were higher than the ex-ante HOU's.
- Verified peak demand savings of one project were more than double the reported savings due to miscalculation of peak demand savings.
- Incorrect wattage was used for one refrigeration project – the ex-ante calculation used the overall unit wattage in the place of the single motor wattage.

The SWE attended two site visits and conducted one desk review for the New Construction solution in the Large C&I program. Guidehouse met the relative precision targets for the New Construction solution in both programs.

Figure 51 illustrates Guidehouse's PY11 M&V approaches. In the New Construction Solution, IPMVP methods accounted for two-thirds of the evaluated savings, but only represented 15% of projects.

Figure 51: Summary of PECO's New Construction Solution M&V Methods

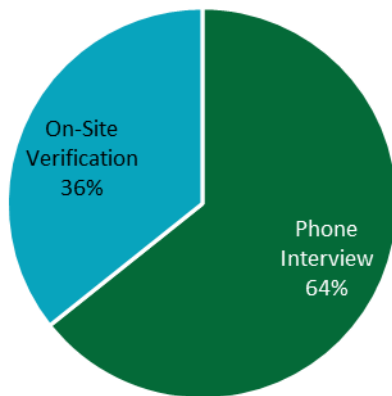


B.4.2.4 Non-Residential Whole Building

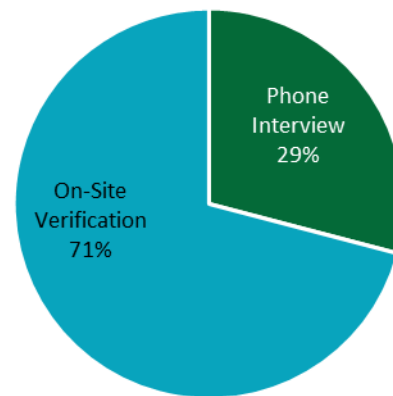
Guidehouse sampled fourteen whole building projects in the Small C&I program in PY11. Of the fourteen, five were verified through on-site verification and the remaining sampled projects were verified through phone verification calls made by Guidehouse. Figure 52 below shows the share of the evaluation activities for the Whole Building solution. The energy and demand relative precisions were met for the Whole Building solution at 4.5% and 3.7%, respectively.

Figure 52: Summary of PECO's Whole Building Solution Evaluation Activities

Evaluation Activity by Project Count



Evaluation Activity by kWh contribution



B.4.2.5 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 4% of PECO's non-residential portfolio. Guidehouse did not sample any projects from this solution in PY11 and applied the realization rates from PY10 for energy and demand to the PY11 gross savings.

B.4.2.6 CHP

The CHP program completed one project for PY11 and only contributed 0.5% of the non-residential portfolio reported savings at 816 MWh. The CHP Program gross impact evaluation involved a thorough desk review of the project using interval data and telephone interviews. An energy realization rate of 109% was achieved, while the demand realization rate fell short at 65%. This low demand realization rate was attributed to a low capacity factor, with the system output curtailed to 75% of its nameplate rating.

B.4.2.7 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 97 provides an overview of the SWE milestones for the audit of PECO's site inspection efforts.

Table 97: PECO Ride-Along Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	kWh Attainment Percentage
9	22,608,081	5	6	97.7%

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.

The SWE provided recommendations for some of the ride-alongs conducted. In an initial review of the new construction lighting project PECLPS1533978788, some lighting fixtures were considered unqualified. The SWE recommended for the savings attributed from unqualified fixtures to not be averaged or included in the overall savings, per Appendix E of the TRM. Guidehouse updated their analysis to reflect the SWE's initial recommendations to be in accordance with Appendix E, which led to an increase in LPD and a decrease in total project savings.

In the project PECLPS1536050544, a mixed-use facility retrofitted two of their 1,040-ton chillers with four 500-ton chillers. The evaluator utilized chiller consumption data for occupied and unoccupied periods to create a baseline model. The SWE agreed with this approach but proposed an adjustment to the regression model used for the baseline. To create a better model, the SWE suggested separating cooling from non-cooling consumption in the regression model, which led to a slightly lower savings than what the evaluator originally claimed.

B.4.2.8 Verified Savings Desk Reviews

Table 98 provides an overview of the SWE milestones for the verified savings review of evaluated PECO projects.

Table 98: PECO Verified Savings Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
4	4,103,264	663.03	100.0%	103.2%

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 order reached a 100% attainment percentage for energy savings for all four projects reviewed. For one project, PECLPS1538278599, which was a HVAC retro commissioning project, the SWE determined that the evaluator defined the peak period differently

than how it is defined in the Phase III Evaluation Framework. The SWE adjusted the peak period to align with the PA TRM definition (non-holiday weekdays from 2:00 pm to 6:00 pm between June 1 and August 31), resulting in a 109% attainment percentage for demand savings.

B.5 DR

According to the Phase III Implementation Order, PECO's Phase III 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 four days those guidelines required during summer 2019. PECO fell short of the 161 MW performance target for all four of the PY11 DR event days. For three of these events, PECO exceeded the 85% threshold of 137 MW.

PECO had three DR programs active in PY11: Residential, Small C&I, and Large C&I. Discussion of the analysis and participation is separately provided for each of these programs, and impact estimates are jointly discussed.

B.5.1 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.5.1.1 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.5.1.2 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 99](#). The largest impact of the PY11 season occurred during the August 19, 2019 event for the Large C&I program, but the portfolio experienced the aggregate greatest savings on July 19, 2019. Combined, the DR programs produced 149.5 MW of savings in PY11.

Table 99: Average Event Impacts, 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 17, 2019	15	18	34.4	0.9	120.0	155.3±9.5
July 18, 2019	16	19	11.1	1.0	121.6	133.7±7.9
July 19, 2019	15	18	34.9	1.2	120.9	157.0±9.1
August 19, 2019	15	18	24.9	1.0	126.2	152.1±8.5
PYVTD - Average PY11 DR Event Performance						149.5±8.8
VTD - Average Phase III DR Event Performance						167.1±16.7

B.5.2 Residential DR Program

PECO's Residential DR program consists of DLC switches installed on central air conditioners across 54,000 residential households. Guidehouse utilized a matched control group with a lagged dependent variable (LDV) 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 rounding error for each of the PY11 event hours.

B.5.2.1 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 LLF 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 53,924 for the Residential DR program. However, not all participating accounts had interval load data; therefore, these accounts were not included in the regression analysis. [Table 100](#) shows the number of participating accounts with load data by event date and the replicated counts from the participation data. The implicit assumption in the analysis is that DR impacts among the 2,500 homes without interval data are the same as the homes with interval data.

Table 100: Participating Households

Event Date	Accounts with Interval Load Data	Count of Accounts in Participation Data
7/17/2019	51,286	53,924
7/18/2019	51,134	53,912
7/19/2019	51,863	53,912
8/19/2019	51,627	53,628

B.5.3 Small C&I DR Program

PECO's 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 1 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 16 PY11 event hours. The remaining event hours were estimated within 0.01 MW of Guidehouse's estimates.

B.5.3.1 Participation

The regression model returns the average kW savings per participating business. This gets multiplied by the number of participating businesses and escalated by the assumed LLF to calculate aggregate system-level performance in MW. The SWE was able to replicate the Guidehouse participant count of 1,312 participants for the Small C&I DR program. [Table 101](#) shows the number of accounts with load data by event date.

Table 101: Small C&I Participants

Event Date	Count of Accounts with Interval Load Data
7/17/2019	1,312
7/18/2019	1,312
7/19/2019	1,312
8/19/2019	1,302

B.5.4 Large C&I DR Program

For PECO's PY11 Large C&I program, 340 unique customers participated in the DR program. The participant count by event date is provided in [Table 102](#).

Table 102: Large C&I Participants

Event Date	Participants
7/17/2019	330
7/18/2019	331
7/19/2019	327
8/19/2019	335

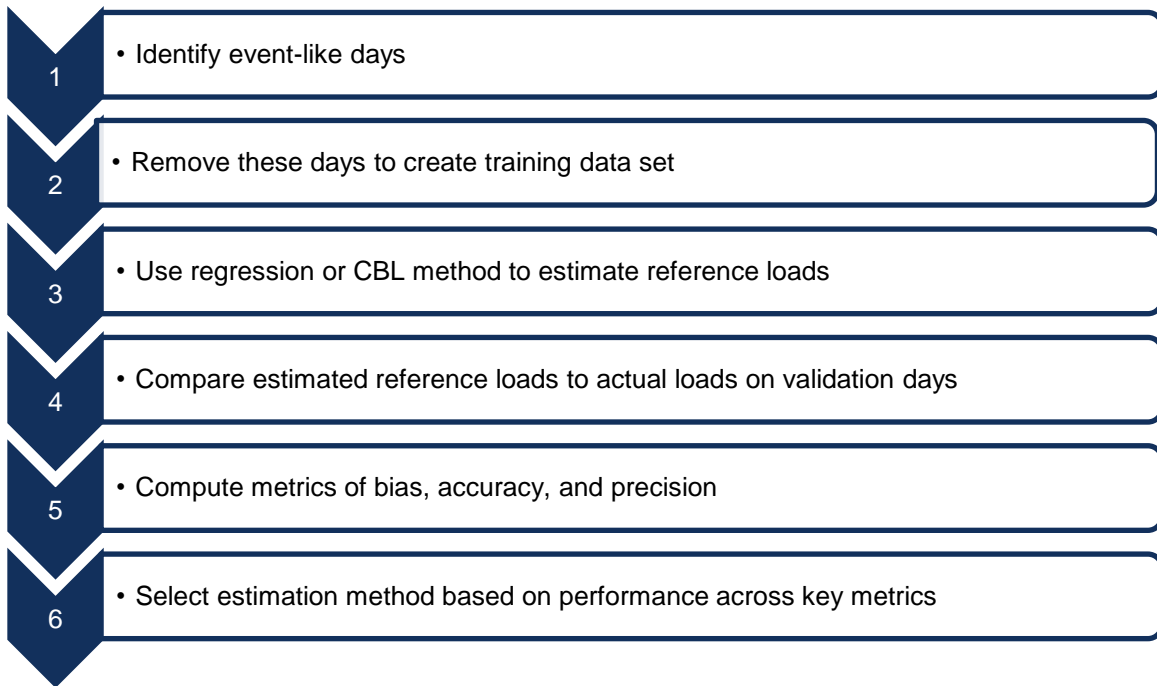
The SWE team requested data to implement the audit analysis. The PECO/Guidehouse team submitted the following in response to this SWE DR data request:

- 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 66% of the gross verified PY11 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.5.4.1 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 53](#), 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 PY11 impacts.

Figure 53: 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. The majority of sites were analyzed using individual regression analysis, and these sites made up 70% of the DR impacts.

Table 103: PY11 Reference Load Frequency Table

Baseline Method	Number of Sites Used	Share of DR Impacts (at Meter)
Missing	1	1.7%
CBL	74	28.1%
Individual Customer Regression	265	70.2%

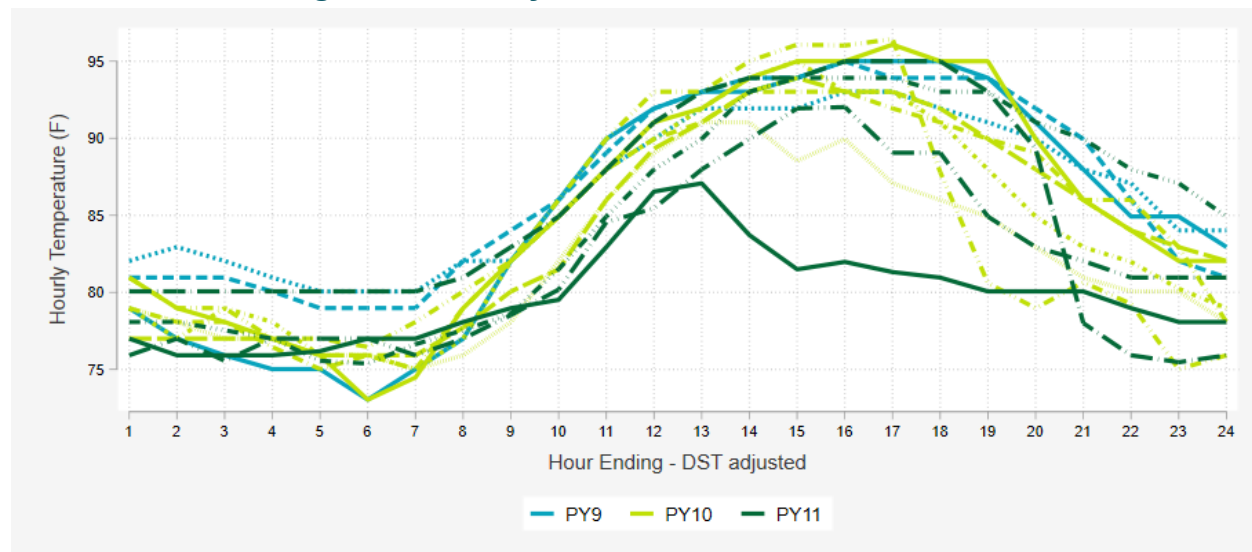
Guidehouse has effectively implemented the testing of multiple models on each customer and selected the specific model that excels in terms of accuracy, bias, and precision.

The SWE team was able to closely reproduce Guidehouse’s aggregated findings, excluding the impacts from the “Missing” baseline customer method. During the audit process, the SWE identified an issue in the 20 individual customer analyses, where holidays were not excluded from the reference load estimation in Guidehouse’s initial regression and CBL analysis. Guidehouse addressed this issue in the final analysis by removing the holidays to align with the Evaluation Framework and PY11 EM&V Plan.

B.5.5 Discussion

PECO fell short of the 85% threshold for the July 18, 2019, event. The SWE team recommends the PUC take into consideration the weather for this event day when assessing compliance with Phase III targets. Figure 54 shows the weather pattern for each Phase III event day. Blue curves indicate the three PY9 events, light green indicates the six PY10 events, and dark green indicates the four PY11 events. July 18, 2019, is indicated by the solid dark green curve that dips around hour ending 11. On this day, the weather was expected to continue along a similar path as the other event days, but a thunderstorm occurred mid-day and lowered the outdoor air temperature significantly. This reduced the cooling demand for the day and diminished the impacts of the DR event. On the event days bracketing this event, July 17 and July 19, the Residential DR Program averaged a 34 MW impact. On July 18, however, the Residential program only produced 11 MW. If the Residential DR program had contributed 15 MW, the July 18 event day would have met the 85% threshold. Excluding July 18, 2019, PECO's Residential DR program has averaged approximately 32 MW per event in Phase III. The purpose of DR events is to reduce electric demand. For this particular day, residential demand was reduced in the afternoon hours. However, the reduction was driven by weather and this limited the DR capability of the program.

Figure 54: Hourly Weather for Phase III Events



B.5.6 Conclusion

PECO met their 85% threshold for three of the four events in PY11, and the SWE team believes the fourth event, July 18, 2019, deserves special attention due to the weather abnormality experienced on that day. In the initial DR analysis conducted by Guidehouse, holidays were not excluded from the reference load estimates for the Large C&I evaluation during the data cleaning process. When the SWE noticed this issue during the audit process, the Guidehouse team quickly updated the analysis to address the issue.

B.6 NTG

B.6.1 Residential Programs

Guidehouse conducted primary NTG research for the Appliance Recycling Solution; New Construction; Whole Home; and the downstream channel and PECO Marketplace strata of the Lighting, Appliances, and HVAC Solution using online participant surveys. The NTG estimation method was consistent with SWE recommended practices and formulas and included free-ridership and SO variables. Guidehouse applied the PY10 NTG ratios to the Multifamily Targeted Market Segment.

Guidehouse assigned an NTG of one to the Behavioral Solution, in accordance with the Evaluation Framework recommendations for RCT program designs.

Table 104: Summary of NTG Estimates for PECO Residential Program¹

Approach	Solution or Program	Free-Ridership	SO	NTG	Sample Size
Evaluated	Lighting, Appliances & HVAC	0.54	0.06	0.51	404
Evaluated	Appliance Recycling	0.47	0.0	0.53	241
Evaluated	Whole Home	0.21	0.18	0.97	112
Evaluated	New Construction	0.08	0.00	0.92	8
PY10	Multifamily Targeted Market Segment	0.08	0.00	0.92	60
RCT	Behavioral	--	--	1.0	--
Combination of Program component NTGs	Residential Program Total	0.37	0.04	0.67	765 ²

¹ Table values may not sum to one due to rounding.

² Combination of Program Component sample size does not include the 60 responses from PY10 Multifamily Targeted Market Segment Program.

B.6.2 Residential LI Energy Efficiency Programs

In compliance with the Phase III Evaluation Framework, Guidehouse did not conduct NTG evaluations for the LI-WHS for PY11.

B.6.3 C&I Energy Efficiency Programs

The Small and Large C&I Equipment and Systems, Small and Large C&I New Construction, Small C&I Whole programs were evaluated using data from participant phone and online surveys that was used for NTG estimation. Guidehouse stratified the C&I participant samples by project size, which has the benefit of not overburdening the small number of high impact participants with continued survey participation requests (many of whom are both large and small C&I participants). The Multifamily Targeted Market Segments were not evaluated this program year, and the PY10 NTG values were applied to these solutions.

The SWE determined that Guidehouse utilized data collection, question beives, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 105: Summary of NTG Estimates for PECO C&I Energy Efficiency Programs¹

Approach	Solution or Program	Free-Ridership	SO	NTG	Sample Size
Evaluated	Small C&I Equipment and Systems	0.34	0.12	0.77	34
Evaluated	Small C&I New Construction	0.67	0.0	0.33	10
Evaluated	Small C&I Whole Building	0.13	0.03	0.90	39
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	0.10	0.76	83
Evaluated	Large C&I Equipment and Systems	0.43	0.03	0.60	38
Evaluated	Large C&I New Construction	0.58	0.06	0.48	14
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	52

¹ Table values may not sum to one due to rounding.

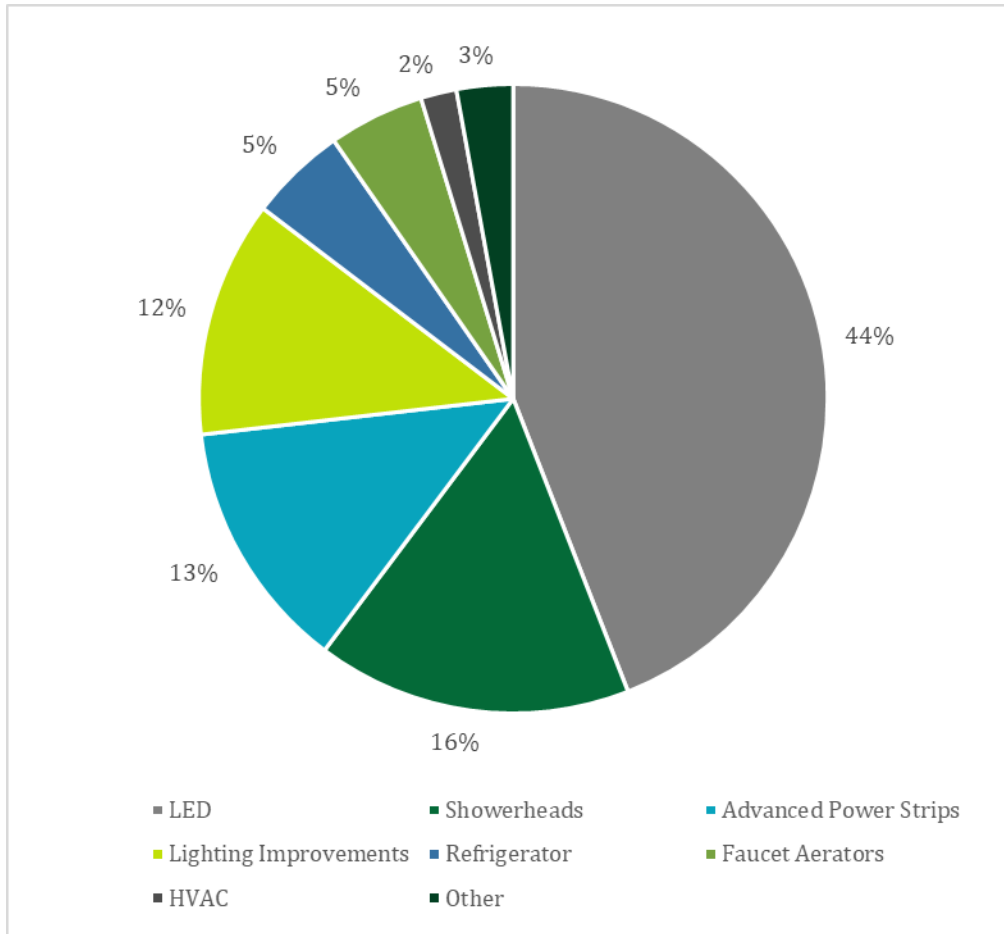
B.7 TRC

Table 106 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for PECO's PY11 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 PY11 annual report. Both gross and net TRC ratios improved for the LI Energy Efficiency and Small C&I DR programs from PY10. In fact, the LI Energy Efficiency Program was PECO's most cost-effective program in PY11. The Residential Energy Efficiency, Small C&I Energy Efficiency, Large C&I Energy Efficiency, CHP, Residential DR, and Large C&I DR programs' TRC ratios all decreased from PY10.

Table 106: Summary of PECO PY11 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
LI Energy Efficiency	\$19,213	\$8,393	2.29	\$19,213	\$8,393	2.29
Residential Energy Efficiency	\$63,159	\$43,000	1.47	\$36,036	\$32,059	1.12
Small C&I Energy Efficiency	\$32,164	\$32,168	1.00	\$24,313	\$25,185	0.97
Large C&I Energy Efficiency	\$54,403	\$58,795	0.93	\$32,244	\$37,190	0.87
CHP	\$424	\$670	0.63	\$371	\$586	0.63
Residential DR	\$2,435	\$3,188	0.76	\$2,435	\$3,188	0.76
Small C&I DR	\$93	\$115	0.82	\$93	\$115	0.82
Large C&I DR	\$5,771	\$4,557	1.27	\$5,771	\$4,557	1.27
Common Portfolio Costs	\$0	\$9,545	0.00	\$0	\$9,545	0.00
Portfolio	\$177,663	\$160,431	1.11	\$120,477	\$120,819	1.00

Three of PECO's eight EE&C programs were found to be cost-effective when estimating the TRC using gross verified savings. Using net verified savings, the same three programs (LI Energy Efficiency, Residential Energy Efficiency, and Large C&I DR) were found to be cost-effective. PECO's LI Energy Efficiency Program was the only LI program with a TRC ratio greater than 1.0 statewide. The strong cost-effectiveness is driven by a heavy focus on low-cost measures like LED lighting, advanced power strips, low-flow showerheads, and faucet aerators. [Figure 55](#) shows the distribution of MWh impacts for the LI Energy Efficiency Program.

Figure 55: LI Energy-Efficiency Energy Impacts by Measure Category

B.7.1 Notes from the TRC Model Review

The PY11 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 that were verified by the SWE.

- The PY11 TRC model used a nominal discount rate of 7.6%, which matches PECO's Phase III EE&C plan.
- An 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 some of the measure lives 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 PY11 TRC model was based on verified savings, so program impacts were adjusted by an applicable realization rate prior to being imported into the model. The SWE

confirmed that energy and demand realization rates applied in the TRC model are consistent with the impact evaluation results reported in PECO's PY11 Annual Report.

- The application of the NTG results in the calculation of net TRC benefits and costs were handled consistently with the 2016 TRC Order directive for Phase III. All NTG ratios appear to be consistent with PECO's PY11 Annual Report.
- The PY11 TRC Model uses the avoided costs of energy and capacity approved in PECO's Phase III EE&C Plan and the SWE was able to independently replicate the calculation of all TRC benefits.
- Like with 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 only provided at the program level. As a result, there is little transparency into cost-effectiveness at the solution level.
- PECO followed the SWE guidance with respect to LED dual baseline calculations for PY11. PECO used one year of pre-EISA savings and fourteen years of post-EISA savings for standard lamps and two years of pre-shift and thirteen years of post-shift savings for specialty lamps.
- 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 the TRC Test memo issued in March 2018. The TRC model also 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. In the PY12 annual report, we recommend that 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 two.

B.8 PROCESS

B.8.1 Residential Energy-Efficiency Programs

The Residential Energy Efficiency Program is made up of six solutions and two targeted market segments, shown with the solution or segment below:

- Lighting, Appliances, and HVAC Solution⁶³
- Appliance Recycling Solution
- Whole Home Solution
- New Construction Solution
- Multifamily Targeted Market Segment (no process evaluation in PY11)
- Behavioral Solution (no process evaluation in PY11)

⁶³ Note that, as of PY10, the Lighting, Appliances, & HVAC Solution also includes the online PECO Marketplace.

For PY11, Guidehouse reported on process evaluations for four residential solutions: The Lighting, Appliances, and HVAC Solution; the Appliance Recycling Solution; the Whole Home Solution; and the New Construction Solution.⁶⁴

For the process evaluations of these solutions, Guidehouse reviewed program documents and data, interviewed utility and implementation staff, and surveyed participants and builders. The research issues addressed by the primary data-collection activities (in-depth interviews [IDIs] and surveys) included the effectiveness of program administration, implementation, and delivery; customer program awareness, informational sources on ways to save energy, satisfaction, and likelihood to recommend the program; builder awareness, satisfaction, and challenges in building to higher standards; and recommendations.

B.8.1.1 Lighting, Appliances, and HVAC Solution

Summary of the Process Evaluation Findings

Guidehouse employed several data-collection methods to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, conducted an online survey with 242 participating customers associated with the Appliances and HVAC Solution, and an online survey with 167 participating customers associated with the Marketplace. Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, two key process findings emerged:

- Respondents most frequently learned about the PECO Marketplace through a PECO bill insert or letter (32%), the PECO website (30%), or a PECO email (19%).
- Customers reported internet searches (56%) and the PECO website (51%) as the top sources of information on ways to save energy.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. Guidehouse segmented the Appliances and HVAC survey sample by the two non-Lighting measure categories (Appliances and HVAC). Guidehouse segmented the Marketplace survey sample by the three measures (smart/learning thermostats, LED lighting, and smart strip plug outlets).

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

⁶⁴For REEP, Guidehouse did not conduct a full process evaluation for the Multifamily Targeted Market Segment or the Behavioral Solution in PY11, other than process interviews with program staff.

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

B.8.1.2 Appliance Recycling Solution

Summary of the Process Evaluation Findings

Guidehouse employed several data-collection methods to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted an online survey with 270 participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. These data and analyses did not result in any process findings that resulted in recommendations.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. Guidehouse segmented the survey sample according to participation type (e.g., refrigerator, freezer, AC).

The SWE also determined that the reporting followed the SWE guidelines. The annual report included descriptions of the methods and summary of findings. The report included sufficient detail for the SWE (and other readers) to assess the methods and findings.

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

B.8.1.3 Whole Home Solution

Summary of the Process Evaluation Findings

Guidehouse employed several data-collection methods to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted an online survey with 117 participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. These data and analyses did not result in any process findings that resulted in recommendations.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. Guidehouse segmented the survey sample based on four project sizes, creating four strata: Large Projects, Medium Projects, Small Projects and Very Small Projects.

The SWE also determined that the reporting followed the SWE guidelines. The annual report included descriptions of the methods and summary of findings. The report included sufficient detail for the SWE (and other readers) to assess the methods and findings.

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

B.8.1.4 New Construction Solution

Summary of the Process Evaluation Findings

Guidehouse employed several data-collection methods to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted an online survey with eight participating builders. Guidehouse also reviewed the participation tracking databases and other program materials. These data and analyses did not result in any process findings that resulted in recommendations.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan.

For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. Guidehouse conducted a census of participating builders and did not segment the sample in any way.

The SWE also determined that the reporting followed the SWE guidelines. The annual report included descriptions of the methods and summary of findings. The report included sufficient detail for the SWE (and other readers) to assess the methods and findings.

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

B.8.1.5 Behavioral Solution

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.1.6 Multifamily Targeted Market Segment

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.2 LIEEP

The LIEEP is made up of two solutions, shown below.

- Whole Home Solution (no process evaluation in PY11)
- Lighting Solution (suspended in PY9)

B.8.2.1 Whole Home Solution

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.2.2 Lighting Solution

No process evaluation was conducted in PY11 because the solution was suspended in PY9.

B.8.3 Small C&I Energy Efficiency Program

The Small C&I Energy Efficiency Program is made up of four solutions and two targeted market segments, shown with the solution or segment below.

- Equipment and Systems Solution
- New Construction Solution
- Whole Building Solution
- Behavioral Solution (no process evaluation in PY11)
- Multifamily Targeted Market Segment (process evaluation performed in PY11)
- Data Centers Targeted Market Segment (no process evaluation in PY11)

For PY11, Guidehouse reported on process evaluations for three small C&I solutions: The Equipment and Systems Solution, the New Construction Solution, and the Whole Building Solution.⁶⁵

For the process evaluations of these solutions, Guidehouse reviewed program documents and data, interviewed utility and implementation staff, and surveyed participating customers. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; customer program awareness, satisfaction with the application, the level of effort required to receive the incentive, communication with PECO staff, perspectives on the program overall; and recommendations.

B.8.3.1 Equipment and Systems Solution

Summary of the Process Evaluation Findings

Guidehouse relied on several data sources to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted a telephone and online survey with 34 participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, one key process finding emerged:

- Participants rated their satisfaction with the application process lower than other aspects of the program. PECO staff noted that the application process has been a barrier to participation for customers during Phase III due to the required amount of documentation. Customers noted they would like more information on the application requirements prior to starting the application process.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing

⁶⁵ For the Small C&I Energy Efficiency Programs, Guidehouse did not conduct a full process evaluation for the Behavioral Solution, the Data Centers Targeted Market Segment, or the Multifamily Targeted Market Segment in PY11, other than process interviews with program staff.

the sampling strategy. The survey sample was stratified by project size (high impact, medium impact, and low and very low impact).

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

Overall, the process evaluation discussion was generally 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.

B.8.3.2 New Construction Solution

Summary of the Process Evaluation Findings

Guidehouse relied on several data sources to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted a telephone survey with ten participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, one key process finding emerged:

- Participants rated their satisfaction with the application process lower than other aspects of the program. PECO staff noted that the application process has been a barrier to participation for customers during Phase III due to the required amount of documentation. Customers noted they would like more information on the application requirements prior to starting the application process.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. Guidehouse conducted a census of participating New Construction customers and did not segment the sample in any way.

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

Overall, the process evaluation discussion was generally 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.

B.8.3.3 Whole Building Solution

Summary of the Process Evaluation Findings

Guidehouse relied on several data sources to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted an online survey with 39 participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. These data and analyses did not result in any process findings that resulted in recommendations.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. The survey sample was stratified by project size (medium impact, low impact, and very low impact).

The SWE also determined that the reporting followed the SWE guidelines. The annual report included descriptions of the methods and a summary of findings. The report included sufficient detail for the SWE (and other readers) to assess the methods and findings.

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

B.8.3.4 Behavioral Solution

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.3.5 Data Centers Targeted Market Segment

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.3.6 Multifamily Targeted Market Segment

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.4 Large C&I Energy Efficiency Program

The Large C&I Energy Efficiency Program is made up of two solutions and two targeted market segments, shown with the solution or segment below.

- Equipment and Systems Solution
- New Construction Solution
- Data Centers Targeted Market Segment (no process evaluation in PY11)
- Multifamily Targeted Market Segment (no process evaluation in PY11)

For PY11, Guidehouse reported on process evaluations for two solutions: The Equipment and Systems Solution and the New Construction Solution.⁶⁶

For the process evaluation of these solutions, Guidehouse reviewed program documents and data, interviewed utility and implementation staff, and surveyed participating customers. The research issues addressed by the primary data-collection activities (IDIs and surveys) included the effectiveness of program administration, implementation, and delivery; customer program awareness, satisfaction with the application, the level of effort required to receive the incentive, communication with PECO staff, and perspectives on the program overall; and recommendations.

B.8.4.1 Equipment and Systems Solution

Summary of the Process Evaluation Findings

Guidehouse relied on several data sources to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted a telephone and online survey with 27 participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, one key process finding emerged:

- Participants rated their satisfaction with the application process lower than other aspects of the program. PECO staff noted that the application process has been a barrier to participation for customers during Phase III due to the required amount of documentation. Customers noted that they would like more information on the application requirements prior to starting the application process.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. The survey sample was stratified by project size (very high and high impact, medium impact, and low and very low impact).

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

Overall, the process evaluation discussion was generally 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.

⁶⁶ For the Large C&I Energy Efficiency Programs, Guidehouse did not conduct a full process evaluation for the Data Centers Targeted Market Segment or the Multifamily Targeted Market Segment in PY11, other than process interviews with program staff.

B.8.4.2 New Construction Solution

Summary of the Process Evaluation Findings

Guidehouse relied on several data sources to gather information for the process evaluation. It reviewed program materials, interviewed program manager and implementation staff, and conducted a telephone survey with nine participating customers. Guidehouse also reviewed the participation tracking databases and other program materials. Based on these data, one key process finding emerged:

- Participants rated their satisfaction with the application process lower than other aspects of the program. PECO staff noted that the application process has been a barrier to participation for customers during Phase III due to the required amount of documentation. Customers noted that they would like more information on the application requirements prior to starting the application process.

Summary of the Process Evaluation Audit

Guidehouse completed all the PY11 activities listed in the evaluation plan. For the data-collection tasks requiring sampling, the SWE determined that the sampling approach for those tasks followed the approved sampling plans, and the report incorporated the required tables showing the sampling strategy. Guidehouse conducted a census of participating New Construction customers and did not segment.

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

Overall, the process evaluation discussion was generally 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.

B.8.4.3 Data Centers Targeted Market Segment

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.4.4 Multifamily Targeted Market Segment

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.5 CHP Program

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff. Guidehouse will conduct a process evaluation in PY12.

B.8.6 DR Programs

The DR Programs made up of three programs, shown below.

- Residential DR Program
- Small C&I DR Program
- Large C&I DR Program

B.8.6.1 Residential DR Program

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.6.2 Small C&I DR Program

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

B.8.6.3 Large C&I DR Program

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff.

Appendix C PPL Audit Detail

C.1 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, generally with minor revisions.

In addition to reviewing PPL's revised evaluation plans, the SWE reviewed and approved several surveys and interview guides for the Student Energy Efficient Education Program, Energy Efficient Home Program (New Homes Component), and the Energy Efficient Home Online Marketplace.

Cadmus also submitted a memo to the SWE outlining Cadmus' proposed EM&V methods in response to the COVID-19 outbreak, as well as two more detailed memos for PPL's WRAP and residential new construction programs.

C.2 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 $\pm 10\%$ 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 $\pm 15\%$ 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 107](#) shows the relative precision of the verified energy savings by program. The SWE reviewed the realization rate function Cadmus uses to 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 107: Relative Precision of PY11 Gross Verified Energy Savings Estimates for Programs with Sampling Error

Program/Initiative	Relative Precision at 85% Confidence Level (\pm)
Efficient Equipment (Lighting)	5.2%
Efficient Equipment (Equipment)	4.2%
Midstream Lighting	10.3%
Custom	2.9%
Efficient Lighting	1.9%
Energy Efficient Home	0.5%
Winter Relief Assistance Program	1.5%
Energy Efficiency Kits and Education	1.8%
Appliance Recycling	7.6%
Student Energy Efficient Education	1.1%

The relative precision values present in [Table 107](#) represent sampling uncertainty for just PY11 verified savings because Cadmus verifies each program annually. All programs comfortably met the $\pm 15\%$ precision requirement in PY11. For the Winter Relief Assistance Program, Cadmus used a 0% relative precision for the LED stratum, although these savings were calculated using PA TRM entries and were not verified using sampling or other methodologies. For programs that do not conduct verification activities, 100% relative precision should be used as the default.

PPL adjusted some of its evaluation procedures in response to the COVID-19 pandemic. Since on-site visits 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 did not verify PY11 savings since on-site visits would be necessary and were not possible due to the pandemic. Cadmus will verify PY11 savings in PY12.

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' PY11 verification activities is discussed in detail in [Appendix C.4](#).

The Home Energy Education, DR, and CEI 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. PPL did not offer the CEI Program in PY11.

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 $\pm 0.5\%$ at the 95% confidence level (two-tailed). That said, Cadmus reports the relative precision and given this is a higher bar to meet, the program achieves the Framework requirements. The relative precision for programs with estimation-based uncertainty are shown in [Table 108](#). The DR relative precision is based on demand savings as opposed to energy savings, which were displayed for all other programs.

Table 108: Relative Precision of PY11 Gross Verified Savings Estimates for Programs with Estimation Error

Program/Initiative	Confidence Level	Relative Precision at Confidence Level (\pm)
Home Energy Education Program	85%	15.0%
DR	90%	3.5%

C.3 REPORTED GROSS SAVINGS AUDITS

C.3.1 Tracking Data Review

This section summarizes the SWE’s assessment of the reported gross savings, participation counts, and incentives reported in PPL’s PY11 Annual Report. Specifically, the values we examined are as follows:

- Reported gross energy savings (MWh) for each program,
- Reported gross peak demand savings (MW) for each program,
- Participation counts for each program, and
- Incentive dollars for each program.

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 PY11 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 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 PPL’s DR program can be found in [Appendix Error! Reference source not found.](#), and our findings regarding PPL’s Home Energy Education program can be found in [Appendix C.4.1.3](#).

[Table 109](#) 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 109: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Recycling	10,119	10,119	Yes
Efficient Lighting	49,834	49,834	Yes
Energy Efficiency Kits and Education	14,011	14,011	Yes
Energy Efficient Home	20,261	20,261	Yes
LI WRAP	15,197	15,197	Yes
Non-Residential Energy Efficiency	232,732	232,732	Yes
Student Energy Efficient Education	6,260	6,260	Yes
Portfolio Total	348,414	348,414	Yes

Table 110 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 110: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Recycling	1.84	1.84	Yes
Efficient Lighting	6.60	6.60	Yes
Energy Efficiency Kits and Education	0.97	0.97	Yes
Energy Efficient Home	3.95	3.95	Yes
LI WRAP	1.49	1.49	Yes
Non-Residential Energy Efficiency	33.30	33.30	Yes
Student Energy Efficient Education	0.61	0.61	Yes
Portfolio Total	48.76	48.76	Yes

Table 111 summarizes the SWE's findings regarding program participation. The SWE was able to replicate participation counts for all programs.

Table 111: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Recycling	13,117	13,117	Yes
Efficient Lighting	119,867	119,867	Yes
Energy Efficiency Kits and Education	15,682	15,682	Yes
Energy Efficient Home	19,634	19,634	Yes
LI WRAP	11,656	11,656	Yes
Non-Residential Energy Efficiency	9,031	9,031	Yes
Student Energy Efficient Education	24,357	24,357	Yes
Portfolio Total	213,344	213,344	Yes

Finally, Table 112 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 112: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Recycling	\$408	\$366	No
Efficient Lighting	\$2,008	\$1,628	No
Energy Efficiency Kits and Education	---	---	---
Energy Efficient Home	\$3,096	\$3,161	No
LI WRAP	---	---	---
Non-Residential Energy Efficiency	\$13,957	\$13,989	No
Student Energy Efficient Education	---	---	---
Portfolio Total	\$19,469	\$19,144	No

C.3.2 Project File Reviews

C.3.2.1 Residential

The SWE conducted a project file review for a sample of PPL's residential and LI solutions in PY11 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 a majority of the documentation requested. For the sample files that were provided, a sample key and sample memo was included that allowed for consistent matching between files and the tracking data.

Table 113 presents a summary of SWE's residential project file reviews.

Table 113: PPL PY11 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	19	✓	✓	✓	✓
Energy Efficient Homes	New Homes	16	✓	✓	✓	✓ ¹
Energy Efficient Homes	Audits and Energy-Savings Kits	19	✓	✗	✓	✓
Energy Efficient Homes	Weatherization	17	✓	✓	✓	✓
Energy Efficient Homes	Efficient Equipment	17	✓	✓	✓	✓
Energy Efficient Kits	n/a	12	✓	✓	✓	✓
Energy Efficient Lighting	n/a	15	✓	✓	✓	✓
Winter Relief Assistance	n/a	16	✓	✓	✓	✓ ¹

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

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

Appliance Recycling Program

The SWE located the Appliance Recycling project files within the tracking database. However, 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. In two of these cases there were observed discrepancies between the project file documentation and the tracking data. In one case, the project file indicated three refrigerators were recycled, while the tracking data only listed two. In the second case, the project file documentation indicated four refrigerators and four freezers, while the tracking data suggested seven refrigerators and one freezer. While there were no additional discrepancies between the tracking database and the project files reviewed, the photographs provided by the CSP do not capture the nameplates of the recycled equipment. Consequently, the SWE could not independently confirm the values in the tracking data.

Energy Efficient Homes: New Homes Solution

In PY9 and PY10, the SWE learned from Cadmus that the ICSP calculates reported savings using the version of software the original REM/Rate file was developed with. As a result, due to the use of older versions of REM/Rate (including an instance of version v15.7.3), it was often not possible to verify the exact savings of several homes using more recent versions (such as v15.8) found in the majority of sampled program files. In the one reviewed home that applied version v15.7.3, the same program home had a 906 kWh decrease in savings when the file was ran in v15.8. Two cases were observed where the reports were run in v15.7.4, and in both cases the home did not meet the minimum qualifications for the New Homes Solution if they were run in v15.8. The SWE observed that most of the sample files were conducted in v15.8 of the REM/Rate software, though a few were applying older versions and a few applied a newer version (v16.0); the software has undergone many enhancements in recent years, including better accounting for DHW efficiencies and wind-driven infiltration. The SWE observed only minor differences between V15.8 and v16.0 in reported savings estimates compared to the 15.7 versions.

While the 2016 TRM does not specify whether to use the most current version of REM/Rate or to use a consistent version for all homes in a PY to calculate savings, doing so would result in more consistent and accurate estimates of reported and verified savings. The SWE also 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 and the audit forms were missing. The SWE observed that, generally, only five projects per quarter were sampled for this sub-program compared to the requested ten.

Energy Efficiency Kits and Education Program

In the SWE's review of the Energy Efficiency Kits and Education program, it was noted that the Q4 entries did not include documentation or indicators of the water heating fuel of the participant.

Therefore, the SWE was unable to determine if the correct kit-type was distributed. The SWE also noted that the kit provides participants that have electric water heaters with two showerhead measures and claims savings for both showerheads. The sample key included participant data regarding the number of showers on the sampled premise, while most of the additional data did not align with the column header. The SWE was able to review one quarter of data for the number of showers and found that nine of the ten sampled participants only had one shower on the premise, indicating a large potential for overestimating reported savings from these measures in the kit.

Energy Efficient Homes: Weatherization

The SWE verified the validity of the sampled rebates, although the quality of the documentation varied greatly, which is similar to the In-Home Audits sub-program. The SWE found that the rebates and documentation generally matched the tracking database. However, the SWE noted that the reported savings seemed extremely high in some cases – for example, 4,799 kWh of savings reported for only 1000 feet of ceiling insulation installed, while the project documentation indicated a purchase of insulation rated at R-13.

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 one instance the project files only included a receipt of purchase for a 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.

Energy Efficient Lighting

The SWE reviewed incentive records for upstream and mid-stream lighting, and while there were no discrepancies, no records were provided for Q4 upstream. The evaluator noted in their quarterly data submission memo that the remaining lighting invoices were to be provided in the annual data request.

Winter Relief Assistance Program

The SWE located the Winter Relief Assistance project files within the tracking database. There were a few discrepancies observed between the tracking database and the project files reviewed:

- For one reviewed project, project files indicated three smart strips were installed in entertainment centers; however, the tracking data did not include any.
- One project only listed two thermostatic restrictor valve measures in the tracking data, while the project file documentation suggested 27 LED bulbs, two-bathroom aerators, and potentially a showerhead were also installed.

One project indicated only three LED bulbs in the project file documentation but eight were listed in the tracking data.

C.3.2.2 Non-Residential

The SWE reviewed PPL's C&I projects for PY11 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 114](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 114: PPL PY11 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	14	✓	13/14	12/14	✓	✓	-
Efficient Equipment	Compressed Air	1	✗	✓	✗	✗	✗	-
Efficient Equipment	Heating/Cooling	4	✓	1/4	1/4	✓	✓	-
Efficient Equipment	Refrigeration	1	✓	✓	✓	✓	✓	-

The SWE conducted project file reviews for 20 PPL C&I projects for PY11. 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 a compressed air project did not include the savings analysis files. The SWE was unable to verify the savings or calculation methodology used for this project. It should be noted that the annual savings and rebate amount in the program data tracker matched the final savings document.

The SWE found discrepancies between some of the values listed in the program data tracker and the analysis files. Specifically, the SWE found discrepancies in the peak savings values, equipment types, and equipment efficiencies during the review of four projects. The SWE also found some discrepancies between the bulb wattages listed in specification sheets/DLC certificates and the wattages used in the energy savings calculator for three projects.

C.4 VERIFIED GROSS SAVINGS AUDITS

C.4.1 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.

Table 115 provides a summary of the EM&V approaches used by Cadmus in their PY11 verified savings calculations. The SWE discovered no discrepancies for non-lighting residential programs.

Table 115: Residential and LI Program Impact Evaluation Activities – PPL

Program	Surveys	Site Visits	Desk Review ^a	Billing Analysis	PY10 Realization Rate
Efficient Lighting Program	--	--	✓	--	--
Energy Efficient Home Program	✓	-- ^b	✓	--	--
WRAP	✓	--	✓	--	--
Energy Efficiency Kits and Education Program	✓	--	✓	--	--
Appliance Recycling Program	--	--	✓	--	--
Student Energy Efficient Education Program	✓	--	✓	--	--

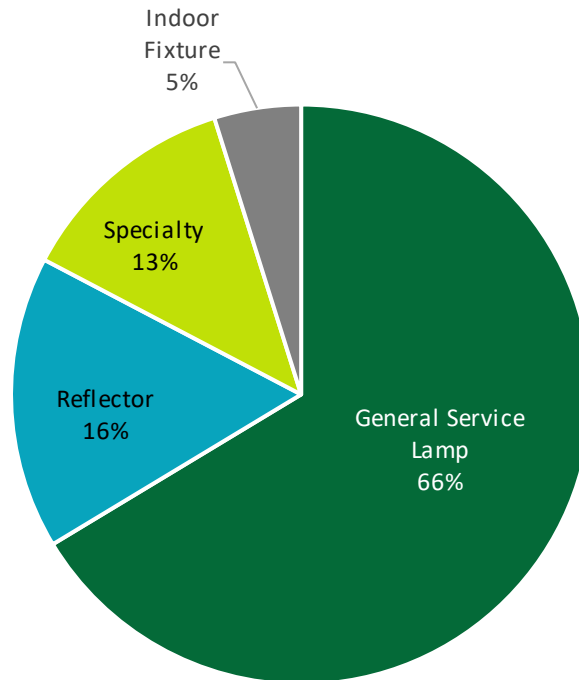
^a The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.

^b Planned PY11 site visits for the New Homes offering were cancelled due to COVID-19. Virtual site visits will be used in PY12 for verification of PY11 and PY12 savings for the New Homes offering.

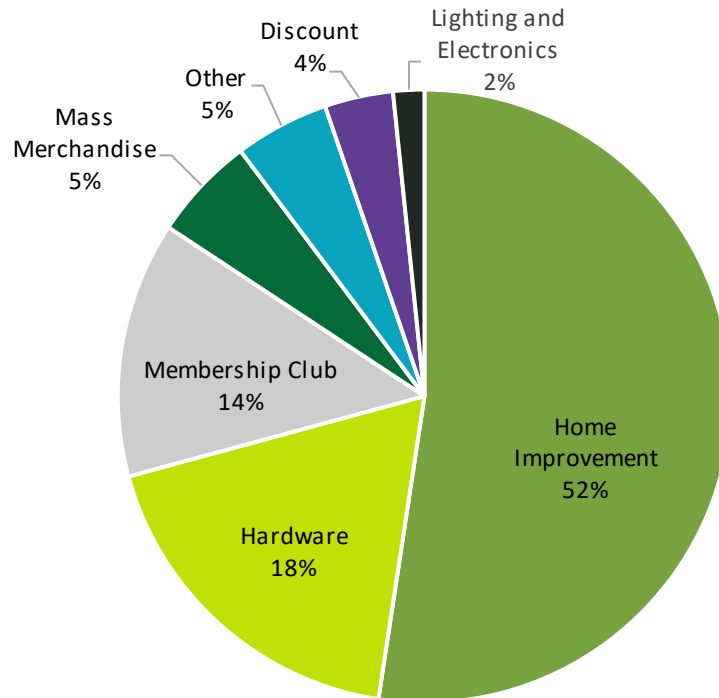
C.4.1.1 Upstream Lighting & Cross-Sector Sales

Customers purchased nearly two million efficient light bulbs and fixtures through PPL's PY11 upstream lighting program. [Figure 56](#) displays the distribution of sales by product type. Around two-thirds (66%) of the bulbs were general service lamps.

Figure 56: PPL PY11 Upstream Lighting Sales by Product Type



Over one-half (52%) of PPL's PY11 upstream light bulbs were sold through home improvement stores. Membership clubs and hardware stores were the next most common retail channels for lighting equipment, accounting for 18% and 14% of sales, respectively ([Figure 57](#)).

Figure 57: PPL PY11 Upstream Lighting Sales by Retail Channel**Audit Findings**

Cadmus provided the PY11 impact analysis for PPL's upstream lighting before the PY11 PPL Annual Report was submitted to the PUC on February 15, 2021. This allowed time for the SWE to conduct its audit, provide Cadmus with feedback, and for Cadmus to adjust the analysis based on this feedback. The SWE agrees with Cadmus's verified gross savings for upstream lighting.

Cross-Sector Sales

Cadmus did not conduct cross-sector sales research in PY11 but applied the PY10 cross-sector sales rate of 6%.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY11 upstream lighting analysis.

C.4.1.2 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 did not find any issues in the verified savings calculations for residential non-lighting programs.

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 program in PY11, including in-home audits and online assessments, weatherization, efficient equipment, and the online marketplace. The SWE did not audit the new homes component because planned verification site visits were cancelled due to the impacts of COVID-19. The SWE, PPL, and Cadmus agreed on a revised approach to conduct virtual site visits with New Homes participants in PY12 and use those to verify savings for PY11 and PY12.

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 PY11 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.

The SWE audited each component of the LI WRAP Program for all stratum reported – baseline jobs, low-cost jobs, and full-cost jobs in single and multifamily homes. 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 PY11 annual report.

Energy Efficiency Kits and Education

PPL delivers energy education and kits with energy saving products to income-eligible customers through the Energy Efficiency Kits and Education program. In PY11, kits included six LED bulbs, two LED night lights, a furnace whistle, tips on energy-efficiency behavior, and a paper survey. Kits for homes with electric domestic hot water also included two low-flow showerheads and a kitchen aerator. The SWE audited the paper surveys, phone surveys, and the records review conducted by the evaluator to verify realization rates and savings. The SWE verified savings calculations for all measures included in the kits, reviewed both paper and telephone survey results, and determined realization rates were applied correctly. All measures applied the correct TRM-approved methods, sample sizes were correct, and the survey data was correctly incorporated.

Appliance Recycling

The Appliance Recycling program covers refrigerator, freezer, dehumidifier, and room air conditioner retirement. 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 clarification from Cadmus regarding updates to some of the regression coefficients used in the savings algorithm that were based on PY10 participant surveys and the use of custom weather data. As in PY9, the evaluator's calculations included custom TMY3-based heating and cooling degree days that do not match TRM values.⁶⁷ The combined effect of this change in weather data, along with more up to date primary use and unconditioned space values from a PY10 survey, increase savings for refrigerators by approximately 2.4% relative to savings calculated using the TRM default values.

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.4.1.3 Behavior

Roughly 9% of PPL's verified gross energy savings for PY11 came from the Home Energy Education Program, which had around 172,000 residential and LI household participants during PY11. The SWE reviewed Cadmus' methodology and accepts their verified MWh and MW savings values for PPL's HER offering in PY11. [Table 116](#) shows the average kWh savings and average percent savings per participant in PY11 by cohort. The "Reference Load" column represents average PY11 usage for treatment group homes throughout the period that were active in the program year (indicated by PY11 Months) with the HER effect added back. PY11 is the first year where savings from the Home Energy Education program were counted towards PPL's LI compliance target for Phase III. PPL reevaluated the October 2014 LI wave to identify which customers are still at or below the 150% Federal Poverty Line. The customers that were no longer classified as LI were split into a separate cohort and received their last treatment in February 2019 (PY10). For these customers, PY11 savings were estimated through January of 2020, when their PY10 treatment expired. The savings for this cohort were treated as residential savings across eight months in PY11, as indicated in [Table 116](#). [Table 116](#) does not include the second LI wave, which began in June 2015. PPL stopped issuing HERs and tracking savings for this wave after PY10.

⁶⁷ The 2021 TRM uses TMY3 weather data, although the SWE was not able to confirm that Cadmus' ZIP Code weather station assignments followed the 2021 TRM approach.

Table 116: Average PY11 kWh Savings per Participant

Wave	Wave Start Date	PY11 Months	Reference Load (kWh)	Average PY11	Average PY11
				Savings (kWh)	% Savings
Legacy Wave 1	April 2010	12	16,268	317	1.95%
Legacy Wave 2	June 2011	12	23,016	339	1.47%
Expansion Wave 1	October 2014	12	19,852	231	1.16%
LI Wave 1 (Low-Income)	October 2014	12	12,335	97	0.79%
LI Wave 1 (Residential)	October 2014	8	6,216	102	1.65%
Expansion Wave 2	June 2016	12	15,338	190	1.24%

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 an 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 homes that were active in PY11 (i.e., had not changed ownership prior to PY11), 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 117](#) 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.

Table 117: Group Equivalence in the Pre Period

Wave	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
Legacy Wave 1	50.7	50.9	0.24
Legacy Wave 2	75.5	75.3	0.40
Expansion Wave 1	63.3	63.2	0.74
LI Wave 1 (Low-Income)	36.7	36.2	0.15
LI Wave 1 (Residential)	27.7	27.7	0.95
Expansion Wave 2	41.5	41.6	0.31

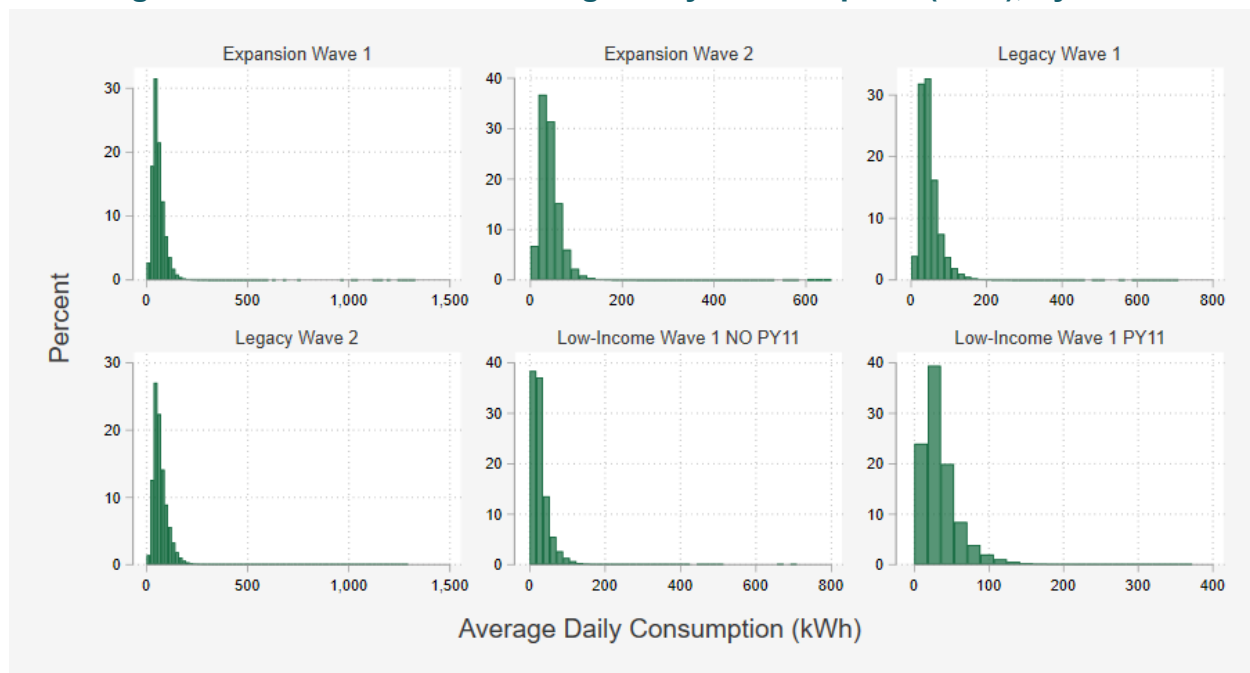
Data Checks

Before estimating HER impacts, the SWE team ran a number 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 (LS) terms were calculated correctly.

Regarding the first two points, the SWE found that all homes had at least eleven months of pre-treatment data. Additionally, we 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 58](#) 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. We recommend that such records be removed from the regression analysis in future program years unless there is a reason to believe residential customers are actually using this much energy. One approach would be to calculate standardized usage values for each customer and drop any record that is more than three or four standard deviations above or below the mean. Another approach would be to just pick a sensible cutoff – 300 kWh per day, for example – and drop any record that exceeds the threshold.

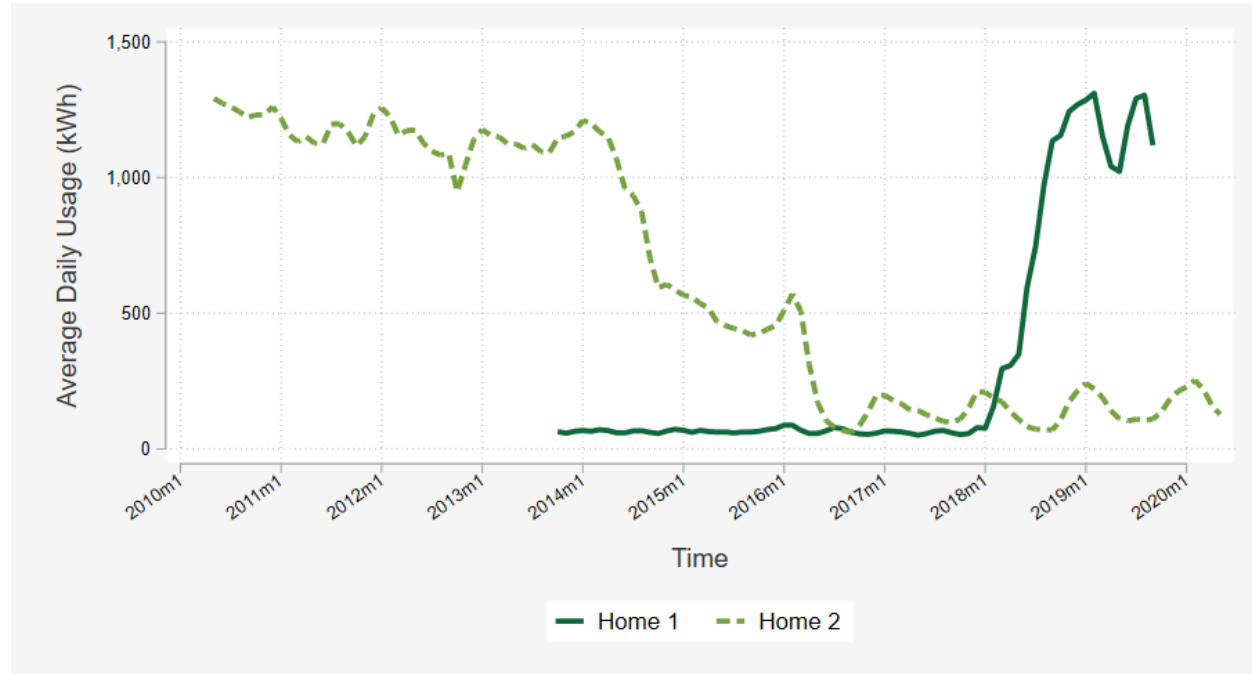
Figure 58: Distribution of Average Daily Consumption (kWh), by Wave



One other anomalous finding is worth noting. There were instances where a customer's typical consumption shows a large change in magnitude. [Figure 59](#) shows a few examples. In the figure, Home 1 uses less than 100 kWh per day over a four-year span, then their consumption reaches 1,250 kWh per day in PY11. Home 2 uses over 1,000 kWh per day over a four-year span and

less than 250 kWh per day in recent years. Finding each instance of large magnitude changes may be difficult, but the steps noted in the previous paragraph could help remove any undue effect such homes have on the analysis.

Figure 59: Large Shifts in Consumption Patterns



The issue of some homes being in multiple study cells (e.g., the treatment group in one wave and the control group in another) was discussed in previous SWE reports. In the tracking data Cadmus provided, such homes were flagged. When aggregating savings, we found that Cadmus correctly counted treatment group homes (e.g., did not double count). Though there are not many of these homes in the data, the regression analysis would be a little cleaner if these homes were removed (either entirely or just from one study cell) from the regression portion of the ex post verified savings analysis.

As a final data check, the SWE reviewed the three LS variables employed by the 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 of the LS 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 PY11 (i.e., no actual reads) in order to not show up in the calendarized billing data. It is also possible that Cadmus dropped incomplete months while calendarizing. For example, if the last billing read date for a customer was June 5, 2018, then the calendarized June data for this customer may have been

dropped since there were only five days of June represented. This customer would then not be counted as active when using the calendarized billing data to count active PY11 treatment accounts. [Table 118](#) shows the number of active PY11 treatment group homes per the tracking data and calendarized billing data (where “active” implies no change in homeownership). 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 118: PY11 Active Treatment Accounts

Wave	Tracking Data	Calendarized Billing Data
Legacy Wave 1	31,701	30,916
Legacy Wave 2	36,691	34,400
Expansion Wave 1	36,194	35,759
LI Wave 1 (Low-Income)	16,970	16,736
LI Wave 1 (Residential)	25,371	24,856
Expansion Wave 2	24,859	23,737

The tracking data also had a “legacy_inactive” field that flagged customers who were inactive when PPL changed implementers for Phase III. Any such customers were not included in the treatment group counts. In PY10, some legacy inactive customers were included in the billing data and the SWE recommended that these accounts either be removed from the billing data or added to the treatment group counts. In PY11, PPL addressed this recommendation and removed the legacy inactive customers from the billing data.

Impact Coefficients

The SWE was able to replicate the impact coefficients from both the LS model and the difference-in-difference fixed effects regression model. The results are displayed in [Table 119](#). An impact of -0.867 for Legacy Wave 1 means that average daily consumption in treatment group homes was 0.867 kWh less in PY11 than average daily consumption in control group homes, on average, after controlling for the effects of weather, time, and pre period consumption patterns.

Table 119: PY11 Impact Coefficients

Wave	LS Coefficient	LFER Coefficient
Legacy Wave 1	-0.867	-0.912
Legacy Wave 2	-0.925	-0.796
Expansion Wave 1	-0.630	-0.713
LI Wave 1 (LI)	-0.265	-0.047
LI Wave 1 (Residential)	-0.417	-0.466
Expansion Wave 2	-0.518	-0.548

Figure 60 through Figure 65 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY11. Only homes that were active in PY11 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 60: Legacy Wave 1 Usage Comparison

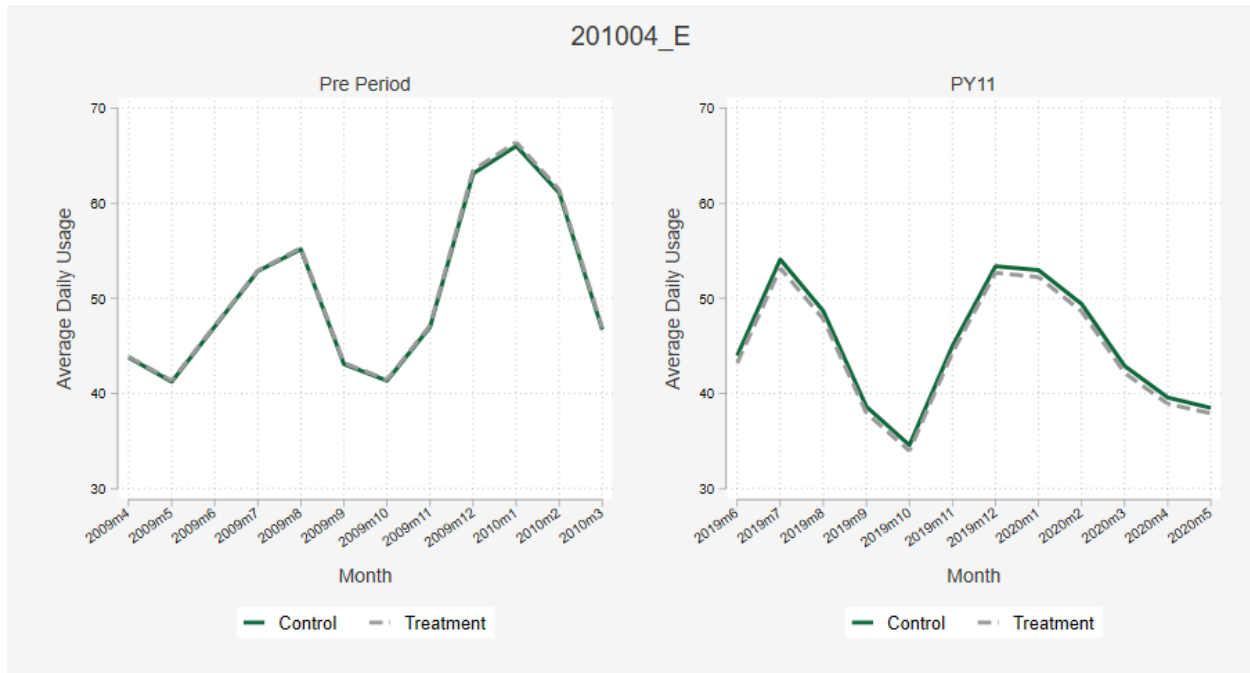


Figure 61: Legacy Wave 2 Usage Comparison

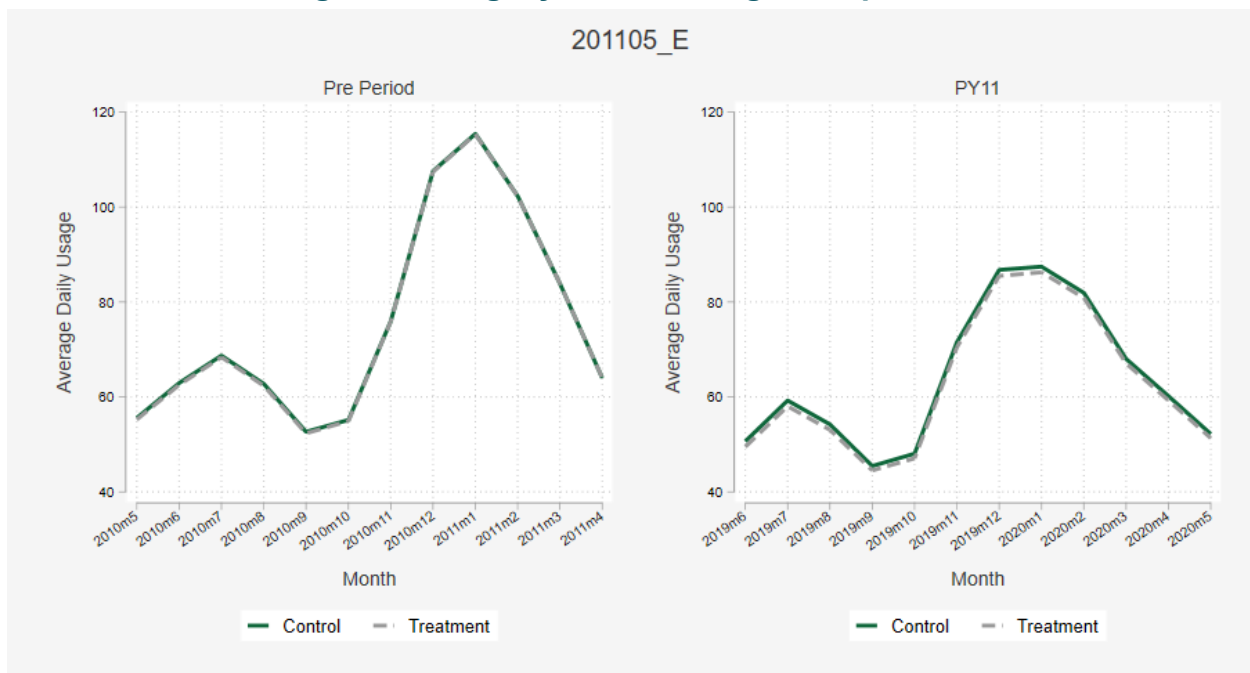


Figure 62: Expansion Wave 1 Usage Comparison

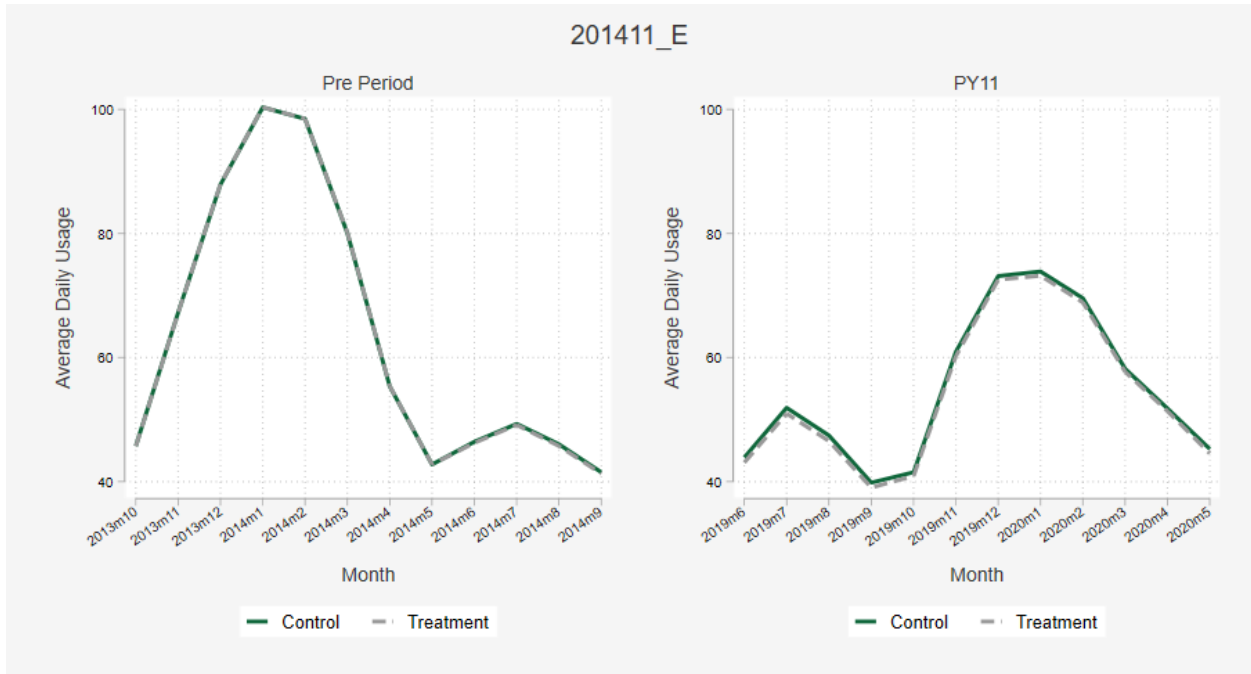


Figure 63: LI Wave 1 (LI) Usage Comparison

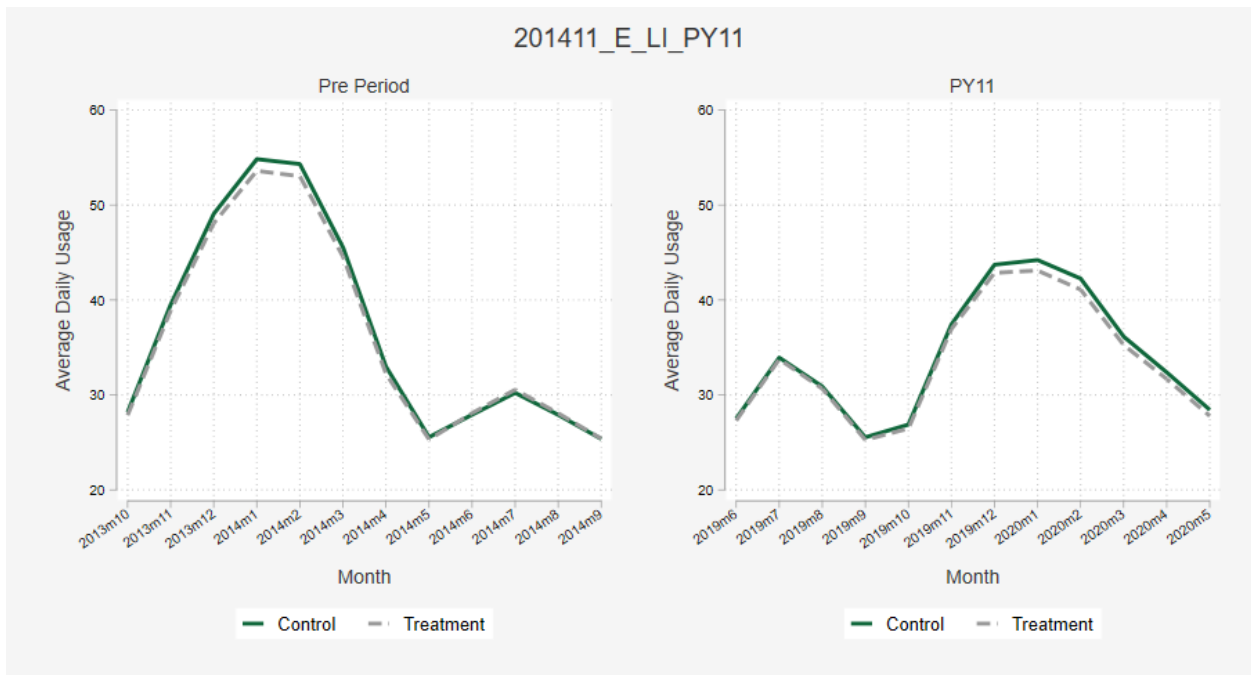


Figure 64: LI Wave 1 (Residential) Usage Comparison

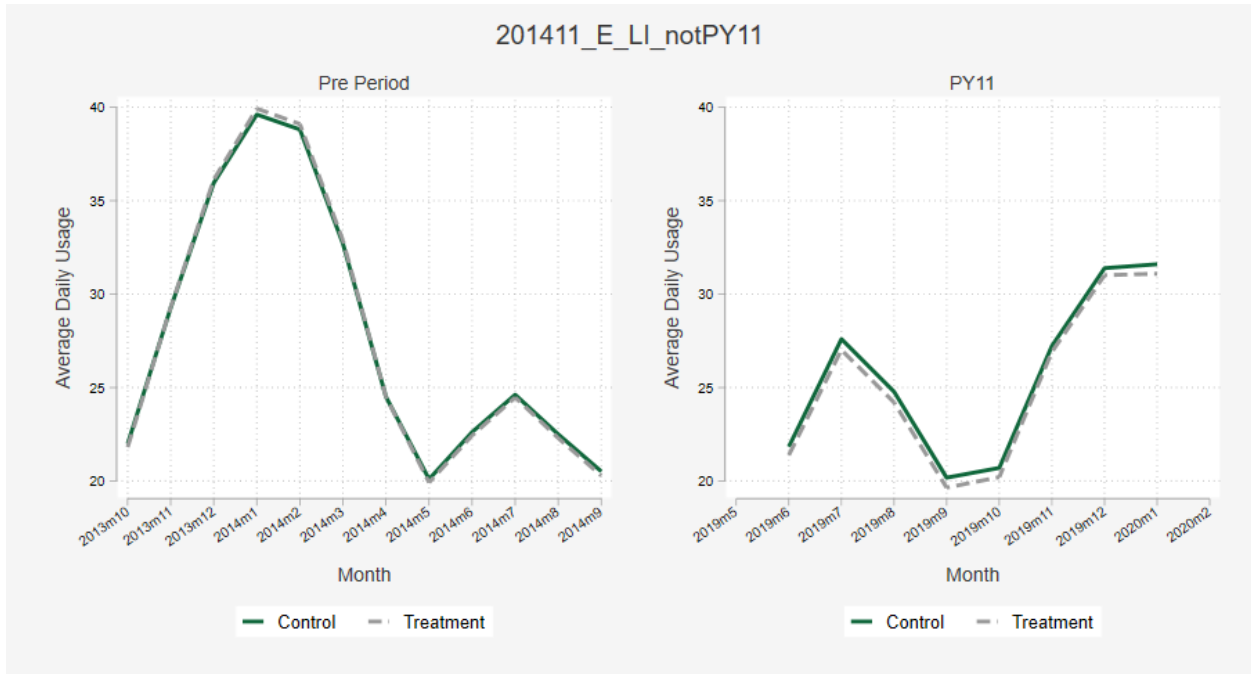
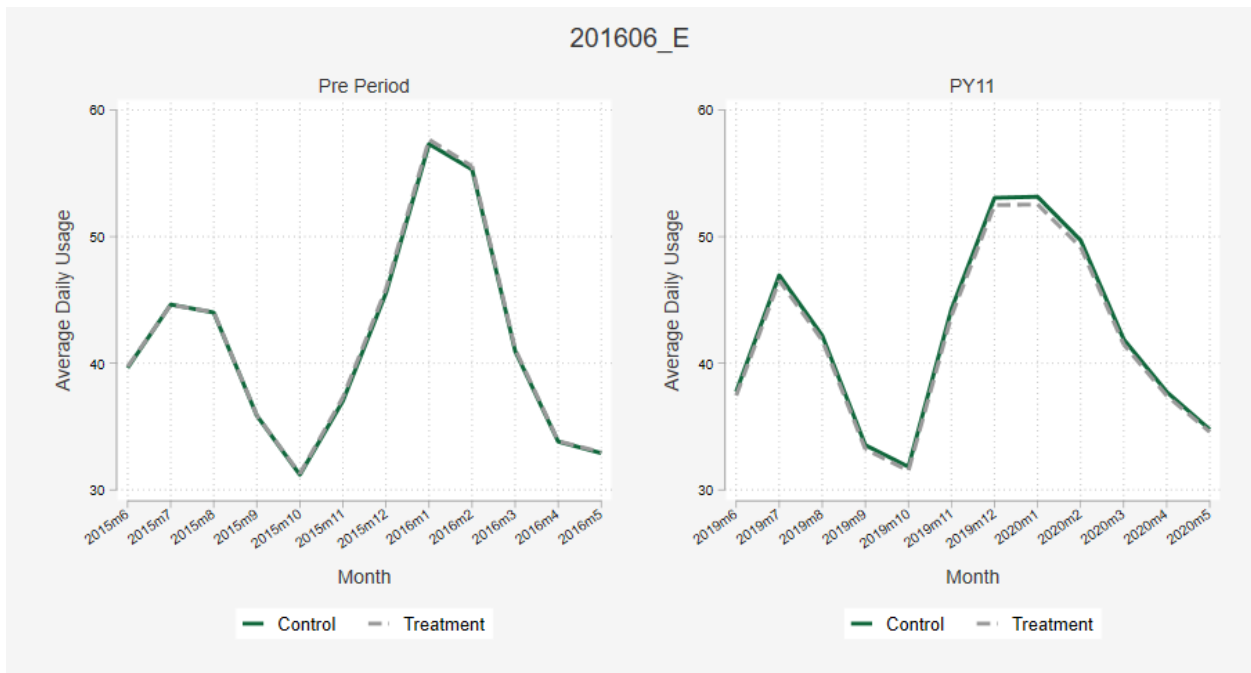


Figure 65: Expansion Wave 2 Usage Comparison



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. As noted, Cadmus did not double-count savings for homes that were randomized into multiple treatment group cells. Such homes were counted only once in the aggregation of savings. Table 120 shows the results. The “Equivalent Accounts” column is simply the number of treatment days divided by 366 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 below, in the “Downstream and Upstream Uplift” section. The Total Savings for Legacy Wave 2 and Expansion Wave 1 differ from the savings reported in Table 10-4 of PPL’s Annual Report, but the differences are small and are likely due to rounding. The SWE agrees with Cadmus’ MWh savings estimates.

Table 120: Annual MWh Savings by Cohort

Wave	PY11 Total Savings (MWh/year)	Total Treatment Days	Equivalent Accounts	Avg. Account Savings (kWh/year)
Legacy Wave 1	9,844	11,358,278	31,034	317
Legacy Wave 2	12,155	13,136,637	35,892	339
Expansion Wave 1	8,127	12,899,345	35,244	231
LI Wave 1 (LI)	1,564	5,891,074	16,096	97
LI Wave 1 (Residential)	2,519	6,033,732	24,627	102
Expansion Wave 2	4,584	8,847,469	24,173	190
Total	38,793⁶⁸	58,166,535	167,066	232

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 PY11 program energy savings into demand reductions. Using this method, the SWE was able to replicate Cadmus’s verified peak demand savings estimates. These values are shown in Table 121 (without accounting for uplift).

⁶⁸ Cadmus’ estimate of PY11 total savings is 38,787 MWh/year (Table 10-4 in PPL’s PY11 Annual Report).

Table 121: Peak Demand Savings

Wave	Total Peak Demand Savings (MW)	Equivalent Accounts	Peak Demand Savings per Account (kW)
Legacy Wave 1	1.66	31,034	0.054
Legacy Wave 2	2.05	35,892	0.057
Expansion Wave 1	1.37	35,244	0.039
LI Wave 1 (LI)	0.26	16,096	0.016
LI Wave 1 (Residential)	0.43	16,486	0.026
Expansion Wave 2	0.77	24,173	0.032
Total	6.55	158,925	0.037

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 their methods are sound. For each wave, [Table 122](#) shows the downstream and upstream uplift energy savings and [Table 123](#) shows the same for peak demand. In total, Cadmus calculated 3,054 MWh and 1,072 MWh in downstream and upstream uplift energy savings, respectively, and 0.44 MW and 0.18 MW in downstream and upstream uplift peak demand savings. Additionally, Cadmus included a 1,305 MWh adjustment and a 0.14 MW adjustment for LEDs that were installed in PY7. Combined, these adjustments total up to 5,431 MWh and 0.76 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 122: Downstream and Upstream Uplift – Energy

Wave	PY11 Annual Savings (MWh/yr)	Downstream Uplift (MWh/yr)	Adjusted Annual Savings (MWh/yr)	Upstream Adjustment Factor	Upstream Uplift (MWh/yr)
Legacy Wave 1	9,844	452	9,393	3.00%	282
Legacy Wave 2	12,155	1,386	10,770	3.00%	323
Expansion Wave 1	8,127	250	7,877	3.00%	236
LI Wave 1 (LI)	1,564	361	1,203	3.00%	36
LI Wave 1 (Residential)	2,519	175	2,343	3.00%	70
Expansion Wave 2	4,584	431	4,153	3.00%	125
Total	38,793	3,054	35,739	---	1,072

Table 123: Downstream and Upstream Uplift – Peak Demand

Wave	PY11 Peak Demand Savings (MW/yr)	Downstream Uplift (MW/yr)	Adjusted Peak Demand Savings (MW/yr)	Upstream Adjustment Factor	Upstream Uplift (MW/yr)
Legacy Wave 1	1.66	0.05	1.61	3.00%	0.05
Legacy Wave 2	2.05	0.15	1.91	3.00%	0.06
Expansion Wave 1	1.37	0.11	1.27	3.00%	0.04
LI Wave 1 (LI)	0.26	0.06	0.21	3.00%	0.01
LI Wave 1 (Residential)	0.43	0.05	0.37	3.00%	0.01
Expansion Wave 2	0.77	0.03	0.74	3.00%	0.02
Total	6.55	0.44	6.11	---	0.18

Recommendations

The SWE accepts Cadmus’s verified MWh and MW savings values for PPL’s HER offering in PY11. For future program years, we make the following recommendations:

- Review the calendarized billing data for potential outliers and remove these values before estimating HER impacts. One approach would be to use a sensible cutoff, such as 300 kWh/day. Another approach would be to calculate standardized consumption values (“z-scores”) for each record and remove any record that is more than three or four standard deviations away from the mean.
- Attempt to replicate participation counts with the raw billing data. If counts do not tie out with the counts from the tracking data, figure out if (1) some billing data is missing or (2) some account inactive dates in the tracking data are missing.

C.4.2 Non-Residential Audit Activities

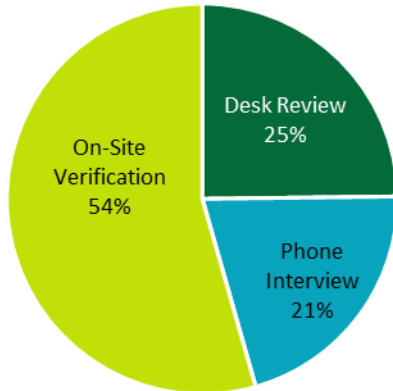
The SWE conducted various review and audit activities for PPL’s energy-efficiency programs. These activities included a review of the evaluation efforts and an audit of the savings verification completed by PPL’s evaluation contractor, Cadmus. The remainder of this section presents the SWE’s findings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

Figure 66 provides a summary of the evaluation activities and M&V approaches utilized by PPL’s evaluation contractor in their PY11 verified savings calculations summarized by total project counts and evaluated savings. For PY11, PPL’s evaluation contractor completed site visits to 54% of projects corresponding to a total of 68 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, IPMVP A and B were employed for the majority (58%) of total projects reviewed. Basic evaluation rigor (desk reviews, phone interviews, and on-site verification) was employed for non-residential Efficient Equipment (Lighting and Non-Lighting) projects and Midstream Lighting projects. Figure 66 provides a summary of the share of projects, which underwent Cadmus’

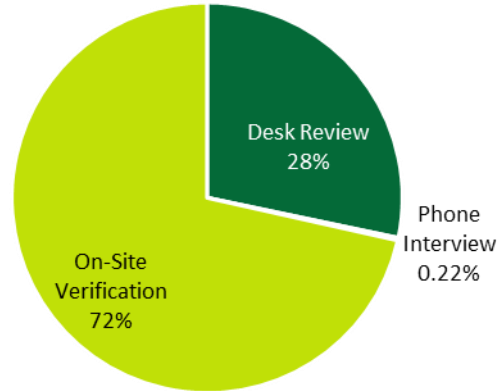
evaluation activities by quantity of projects and evaluated savings. Figure 66 also displays the share of projects which were reviewed using basic rigor methods and IPMVP methods.

Figure 66: Summary of PPL’s C&I Evaluation Activities

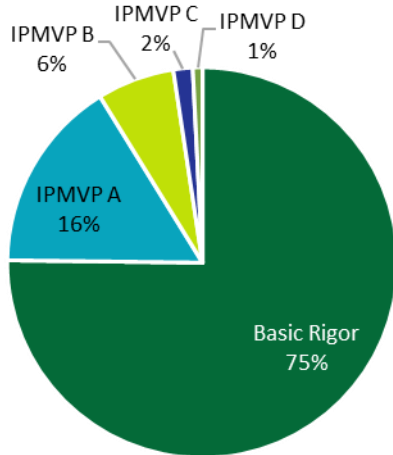
Evaluation Activity by Project Count



Evaluation Activity by kWh contribution



M&V Method by Project Count



M&V Method by kWh contribution

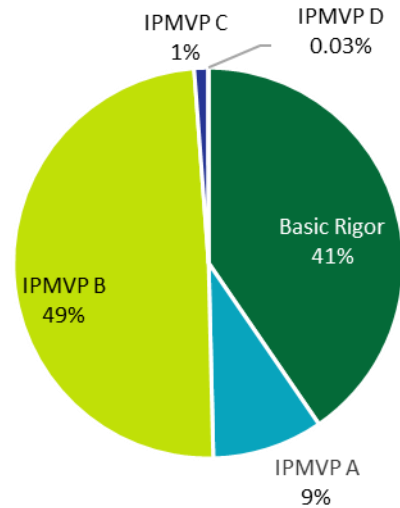


Table 124 provides a summary of the evaluation activities and M&V approaches PPL’s evaluation contractor used across strata for all projects stratified by program.

Table 124: Summary of PPL's PY11 C&I Evaluation Activities by Program

Program / Strata	Sample Quantity	Realization Rate %	Desk Review	Phone Interview	On-Site Verification
Non-Res Efficient Equipment Program	60	102%	31	0	29
Prescriptive and Direct Discount Lighting	43	102%	24	-	19
Prescriptive and Direct Discount Equipment	17	86%	7	-	10
Midstream Lighting Program	34	94%	0	26	8
Small	3	294%	-	3	0
Medium	6	92%	-	6	0
Medium-Large	4	106%	-	4	0
Large	18	86%	-	12	6
Convenience	2	78%	-	0	2
PY9 Return	1	0%	-	1	0
Custom Program	31	96%	0	0	31
Large	18	100%	-	-	18
Small	10	67%	-	-	10
CHP	3	100%	-	-	3
Total	125	99%	31	26	68

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.4.2.1 Non-Residential Energy Efficiency Program

In PY11, Cadmus grouped the direct discount and the prescriptive lighting projects into one stratum and the equipment component in a separate stratum. The PY11 evaluation sampling plan was designed to meet 90% confidence and $\pm 10\%$ precision (90/10) for the lighting stratum and of 85% confidence and 15% precision (85/15) for the equipment stratum. The program met both relative precision targets for energy and demand for 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.

Cadmus divided lighting projects further into four substrata: small, medium, large, and threshold. 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.⁶⁹ In

⁶⁹ TecMarket Works. *The California Evaluation Framework*. 2004. Pages 368-371.

PY11, Cadmus conducted site visits to verify ten non-lighting projects: six HVAC projects, two Motor projects, and two Refrigeration projects. Some of those site-visits were conducted virtually due to COVID-19.

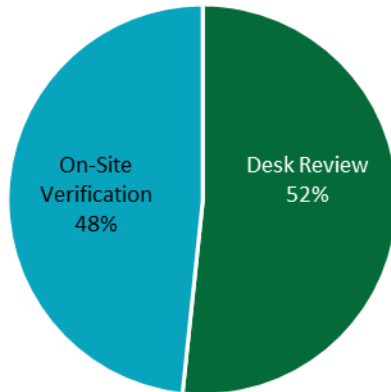
In summary, the strata and substrata for the Non-Residential Efficient Equipment program were as follows:

- Prescriptive and Discount Lighting
 - Threshold (projects larger than 750 MWh)
 - Large
 - Medium
 - Small
- Non-Lighting Equipment
 - Agriculture
 - HVAC
 - Motors
 - Refrigeration

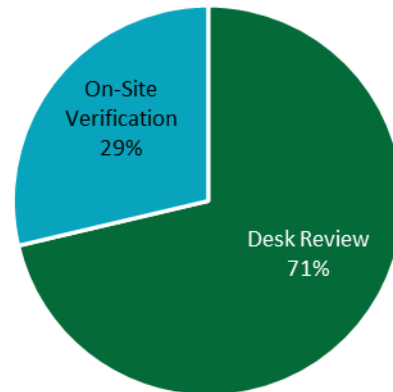
As shown in [Figure 67](#), PPL's evaluation contractor verified approximately half of projects via desk reviews and half of projects via on-site verification. In PY11, only 29% of evaluated savings were verified through an on-site visit.

Figure 67: Summary of PPL's PY11 Efficient Equipment Program Evaluation Activities

Evaluation Activity by Project Count



Evaluation Activity by kWh Contribution



C.4.2.2 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 PY11 projects. Cadmus conducted five site visits and 20 desk audits to evaluate 25 total projects: 23 that Cadmus randomly sampled and two that Cadmus conveniently sampled. These projects corresponded to 34 jobs, of which eight were evaluated with on-site or virtual visits and 26 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 energy with a relative precision of 10.3% but fell short for demand, with a relative precision of 34.9%. 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
- PY9 Return
- Large
- Medium
- Medium-Large
- Small

One project in the PY11 sample was a PY9 project return that was stratified individually and netted to zero savings to not impact the other strata and overall program relative precision.

C.4.2.3 Custom Program

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

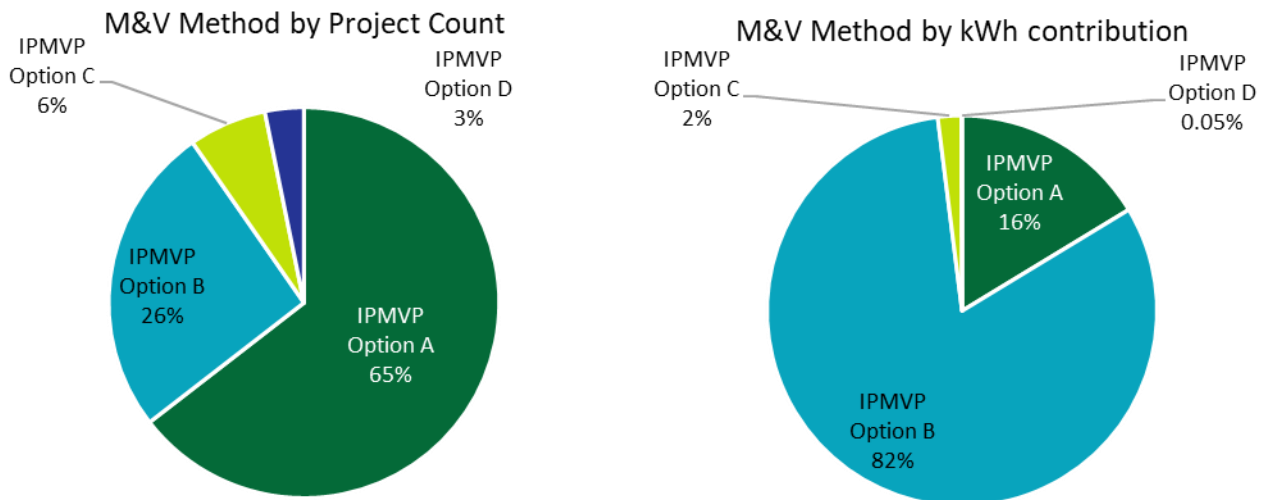
- Large (expected energy savings greater than 2,000,000 kWh/yr. or high level of uncertainty)
- Small (expected energy savings below 2,000,000 kWh/yr.)
- CHP

In PY11, the savings threshold increased from 500,000 kWh/yr. to 2,000,000 kWh/yr.

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%. At the end of Q2 and Q4 in PY11, 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 three CHP projects. Figure 68 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 98% of the evaluated energy savings in PY11.

Figure 68: Summary of PPL’s PY11 Custom Program M&V Methods



C.4.2.4 Continuous Energy Improvement Program

No projects were evaluated for the CEI Program as it was discontinued in PY11.

C.4.2.5 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 125 provides an overview of the SWE milestones for the audit of PPL's site inspection efforts.

Table 125: PPL Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Energy Attainment Percentage
4	51,908,707	3	4	100%

The SWE attended ride-along site visits for four projects, which included a chiller retrofit, a CHP project, VFD controls, and a lighting project. 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 TRM was utilized by the contractor for appropriate measures. The SWE agreed with the engineering decisions made by the evaluators for custom calculations.

C.4.2.6 Verified Savings Desk Reviews

Table 126 provides an overview of the SWE milestones for the verified savings review of evaluated PPL projects conducted via desk review.

Table 126: PPL Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
8	11,531,950	1,466.76	99.1%	99.0%

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 were able to accurately provide an overview of the project and approach taken by the evaluator to verify energy savings. The SWE made recommendations for two projects. The SWE recommended for the evaluator to use a consistent criterion to identify gas cooling mode events in the baseline and post-install periods, as seen in the custom compressor project RBT-1665247. In project RBT-1893814, a CHP engine system was reviewed. For this project, the SWE suggested a revision to the peak demand period definition to align with the PA TRM in the calculation of demand savings.

C.5 DR

PPL's Phase III DR 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. 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 four days those guidelines required.

Table 127 summarizes verified gross impacts of the four PY11 DR events. PPL's gross verified performance was comfortably above the 85% Phase III minimum performance target for each event.

Table 127: PY11 DR Impacts 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)	GNE Load Curtailment (Verified MW)	Average Portfolio (Verified MW) w/ 90% CI
July 17, 2019	15	18	1.7	82.4	6.5	90.6±7.0
July 18, 2019	16	19	2.0	100.0	7.0	109.0±7.4
July 19, 2019	15	18	1.4	97.3	5.9	104.7±7.4
August 19, 2019	15	18	1.4	107.2	4.3	112.8±7.6
PYVTD - Average PY11 DR Event Performance						104.3±3.7
VTD - Average Phase III DR Event Performance						112.8±2.4

The PPL/Cadmus team also submitted a response to the SWE DR data request. The data elements of this request included the following information:

- 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, LLF, and verified DR impact
- For 18 sites selected by the SWE, the hourly load data and PJM participation records needed to replicate the Cadmus impact estimates
 - These 18 sites represented approximately 28% of the gross verified PY11 DR impacts

The data request response and DR evaluation report formed the basis of the SWE audit activities, which are described in this section. 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 regression baselines for certain model specifications. This issue effected two 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 only six customers used the incorrectly specified regression model for baseline estimates, the SWE team does not believe there would be a significant impact on the DR program total savings.

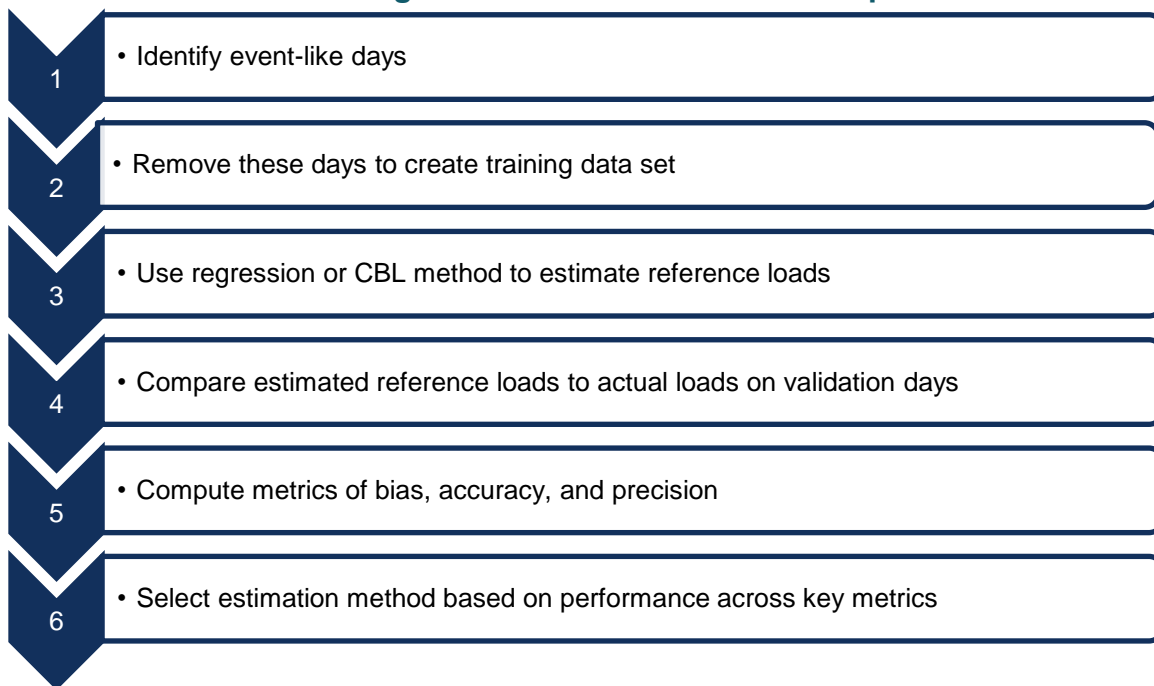
C.5.1 Replicate Program Totals

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 PY11 data request included sector information – which determines the LLF 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 PY11 semi-annual report exactly.

C.5.2 Reference Load Selection

Cadmus submitted a DR Program EM&V Plan for PY11 to the SWE documenting the approach that was used to select site-specific baselines. The approach was consistent with the process shown in [Figure 69](#), which is taken from the Evaluation Framework.

Figure 69: Baseline Selection Steps



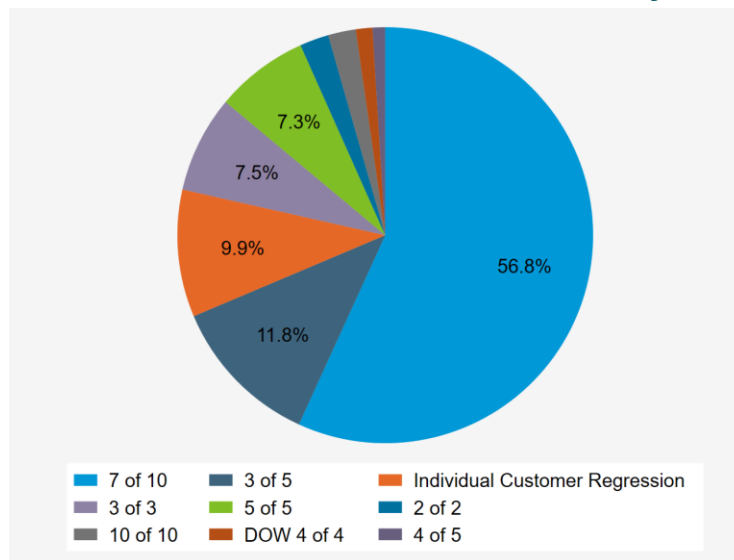
Cadmus tested, and ultimately used a variety of baseline methods in PY11. [Table 128](#) shows the distribution of baseline approaches across the PY11 program population. Individual customer regression analysis was by far the most common approach (73% of sites), but the model specification differed across customers.

Table 128: PY11 Baseline Frequency Table

Baseline	Number of Sites Used
10 of 10	2
2 of 2	4
3 of 3	1
3 of 5	1
4 of 5	1
5 of 5	1
7 of 10	6
DOW 4 of 4	1
Individual Customer Regression	47

Figure 70 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 10% 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 70: 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 PY11, 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 and PY10 impacts, with one exception. In PY10, Keystone Cement had two participating facilities, one of which used a 2 of 2 day-matching method and one with an individual customer regression, but in PY11, both of these facilities used the 2 of 2 day-matching method. For regression sites, Cadmus reassigned individual customer model specification between PY10 and PY11.

For new PY11 participating facilities, Cadmus tested the accuracy of each day-matching and regression-based CBL method on summer, non-holiday weekdays between 2:00 p.m. and 6:00 p.m. using 2018 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). In PY11, all six new participants used individual customer regressions for their baseline calculations.

The SWE compared the baselines ultimately used to calculate gross verified PY11 impacts with the selections identified via performance testing of 2017 data and found they were aligned.

C.5.3 Day-Matching Baselines

Of the 18 sites for which the SWE team received hourly load data, eight had their baselines estimated through a day-matching technique. [Table 129](#) shows the methodology and average size of the DR impact for those eight sites.

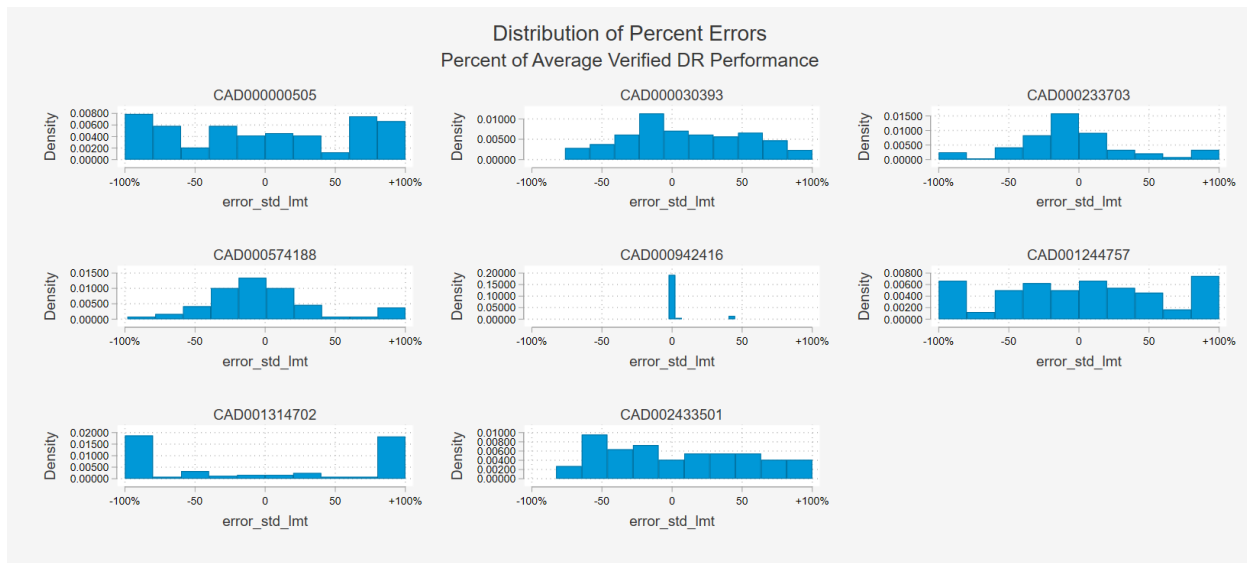
Table 129: Day-Matching Audit Sites

Customer	Baseline	Average DR Impact (kW)
1	7 of 10	17,971
2	3 of 3	7,859
3	2 of 2	3,550
4	2 of 2	1,540
5	DOW 4 of 4	1,347
6	4 of 5	1,020
7	2 of 2	-37
8	2 of 2	-115

The PA SWE team was able to exactly replicate Cadmus' DR impact estimates for each site-event-hour in the sample which utilized a day-matching technique.

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 eight sample customers on 2019 summer data to assess if the chosen CBL methods were still appropriate. The SWE team used the 30 non-holiday, summer weekdays in 2019 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 2:00 p.m. to 6:00 p.m. 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 71](#) shows the distribution of errors for each sample customer, with errors expressed as a percentage of average verified PY11 DR 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 71: Distribution of Errors as Percentage of Avg. DR Performance

The SWE team determined that the PY9 day-matching methods were still appropriate for the eight 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. Cadmus may choose to revisit the baseline selections using non-event days during summer 2019 or continue using the same baseline for PY12.

C.5.4 Regression Analysis

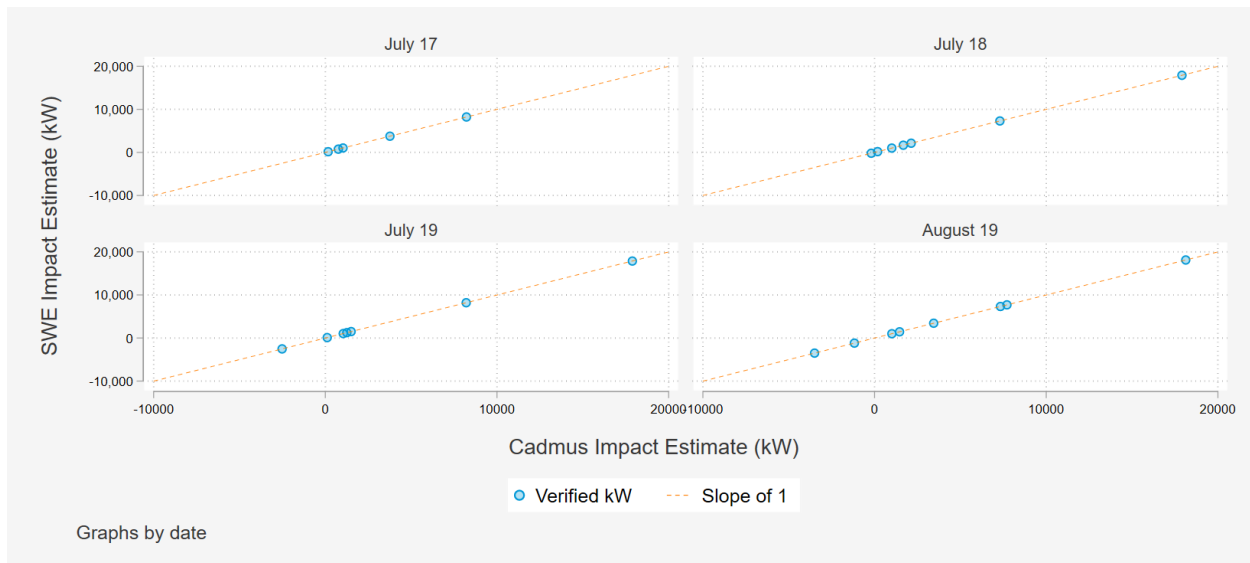
Cadmus used regression analysis for all Small CI and GNE participants as well a few of the Large CI sites where regression methods out-performed day-matching in out-of-sample testing. The SWE agrees with this approach as the Small CI and GNE sites are typically more weather-dependent, which makes regression approaches more suitable. Cadmus tested a set of 81 regression models, which included various combinations of date, time, and weather regressors 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 PY11, Cadmus excluded all event hours from the references loads in the regression models, even if a customer was not participating in certain event hours. This adjustment follows the SWE team’s recommendations from PY10.

C.5.5 Independent Verification of Calculations

The SWE team was able to perfectly replicate the DR impact estimates for all nine sites whose baselines were calculated using day-matching techniques. [Figure 72](#) contains scatter plots of the SWE and Cadmus impact estimates for day-matching sites in the sample. The trends are perfect diagonal lines with slope = 1.

Figure 72: Impact Estimate Comparison for Day Matching Sites



The SWE team independently calculated reference loads and load impacts for each event hour for ten sites where regression was the baseline calculation methodology. The SWE identified two sites that used models that did not include intercept terms. Both sites used the same model, which included an interaction between hour and solar radiation and suppressed the constant term but did not include a full set of fixed effects for hour. The intercept term should only be suppressed if a full set of fixed effects is included in the model. The models without intercepts were tested against and outperformed 70 models that included intercept terms.

Figure 73 contains scatter plots of the SWE and Cadmus impact estimates for all regression sites in the sample. The blue markers indicated the verified estimates, using the Cadmus specified models, and the gray markers show the impact estimate for the two affected sites using the intended model specification. The effect of the correction varied for the two sites. One of the affected sites only participated in three hours on July 17, and the point showing the SWE estimate for that site is visibly lower than the Cadmus estimate. The differences for the other site, which participated in two hours on all four event days, are nearly imperceptible.

Figure 73: Reference Load Comparison for Regression Sites

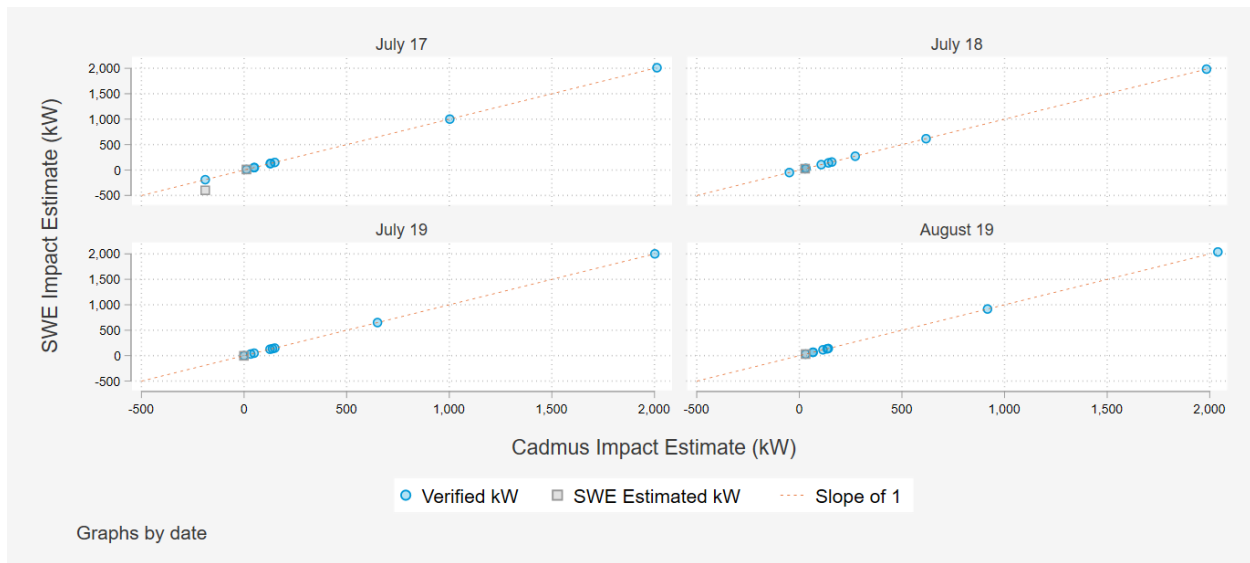


Table 130 compares the SWE load impact estimates with the Cadmus calculations for the 18 sites in the SWE sample. The differences are solely attributable to the two sites that used no intercept models. The results in the table match the visual impacts in Figure 73. The larger differences that appear on three hours on July 17 can be attributed to the site that only participated on those hours. The differences for the other site, which participated in two hours on all four event days, are insignificant. In all cases, the Cadmus estimate was greater than or equal to the SWE estimate.

Table 130: Impact Comparison – All Sites in SWE Sample

Date	Hour	SWE kW Estimate	Cadmus Verified kW	Difference (kW)	Sites Participating
7/17/2019	15	12,766	13,023	-257	10
7/17/2019	16	17,990	18,201	-212	12
7/17/2019	17	15,875	16,035	-160	14
7/17/2019	18	12,395	12,395	0	11
7/18/2019	16	32,441	32,436	5	13
7/18/2019	17	32,575	32,575	0	14
7/18/2019	18	36,191	36,197	-6	16
7/18/2019	19	30,567	30,568	0	15
7/19/2019	15	28,338	28,338	0	12
7/19/2019	16	31,147	31,147	0	13
7/19/2019	17	30,355	30,357	-2	15
7/19/2019	18	31,284	31,286	-2	14
8/19/2019	15	33,902	33,902	0	13
8/19/2019	16	38,101	38,101	0	14
8/19/2019	17	39,198	39,199	-1	16
8/19/2019	18	39,597	39,597	0	14

On Cadmus' provided regression list, 11 of the 81 models listed are specified with no intercept and no fixed effects variable. Including the two sites in the sample, there are six sites total that use one of these models and all six customers use the same model. For these six sites, the specified regression model without intercepts outperformed all other candidate models in predictive accuracy and bias during the model testing procedure. The SWE team only has load data for the sample of sites, and thus cannot produce adjusted estimates for the remaining four sites. However, since these six sites only account for 1.2% of overall MW performance, it is unlikely that this issue will have a meaningful impact at the program level. Cadmus is now aware of the issue and will adjust the model specifications in future program evaluations.

C.5.6 Conclusion

The SWE team found the Cadmus verified savings analysis to be thorough and well-documented for PY11. 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 day matching customers. Certain model specifications omitted intercept terms, but the magnitude of the discrepancy is minute in comparison with program totals. Corrected program totals could not be calculated since only 18 sites were examined by the SWE team. The SWE recommends the Commission adopt the PPL/Cadmus verified savings estimates when assessing compliance at the end of Phase III. We suggest Cadmus memorialize some of the procedural steps and decisions made in PY11 in the PY12 evaluation plan in advance of the summer 2020 DR season and so the SWE can approve.

C.6 NTG

C.6.1 Residential Programs

In PY11, Cadmus assigned a PY8 NTG value for the Efficient Lighting Program and a PY10 NTG value for Appliance Recycling. New research was conducted on the online marketplace component of the Energy Efficient Home Program to develop a component NTG that was combined with the PY9 refrigerator and dehumidifier program component NTG and the PY8 evaluated NTG for the remaining program components to generate a weighted NTG for the entire Energy Efficient Home Program. These NTG values were generated using the common method as outlined in the Phase III Evaluation Framework.

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 131: Summary of NTG Estimates for PPL Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY8 based on Demand Elasticity Model	Efficient Lighting	0.17	--	0.83	-
PY10	Appliance Recycling	--	--	0.66	--
Evaluated, PY9, PY8	Energy Efficient Home	0.41	0.07	0.66	37
RCT	Home Energy Education	0.0	0.0	1	--
Assigned Value	Student Energy Efficient Education	0.0	0.0	1	--

C.6.2 LI Residential Programs

Cadmus did not conduct NTG research for any LI program during PY11.

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 is in keeping with Cadmus' approved EMV plan.

C.6.3 C&I Programs

Cadmus utilized the methodology outlined in the Phase III Evaluation Framework to calculate PY11 NTG values for all C&I programs. Data for Efficient Equipment (lighting and equipment) and Custom NTG calculations were gathered from participants using online and phone surveys. IDIs by telephone were conducted for the Midstream Lighting Program to collect data from businesses that installed the measures (identified as end users) for the PY11 NTG.

The SWE determined that Cadmus utilized data collection, question beives, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 132: Summary of NTG Estimates for PPL C&I Program¹

Approach	Program	Free-Ridership	SO	NTG	Sample Size
Estimated	Total Custom	0.34	0.0	0.66	16
Estimated	Midstream Lighting	0.38	0.0	0.62	24
Estimated	Efficient Equipment (lighting)	0.23	0.0	0.77	62
Estimated	Efficient Equipment (equipment)	0.44	0.0	0.56	14

¹ SO was not included in NTG C&I calculations.

C.7 TRC

Table 133 shows the high-level results of the PPL TRC test calculation 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 133 differ slightly from the TRC statistics presented in PPL's PY11 Final Annual Report because the SWE consolidates the impact of HER uplift in the TRC metrics of the Home Energy Education program instead of listing it as a negative TRC benefit in at the Common Portfolio Cost level.

Table 133: Summary of PPL's PY11 TRC Results

Program Name	TRC NPV Gross Benefits (\$1000)	TRC NPV Gross Costs (\$1000)	Gross TRC	TRC NPV Net Benefits (\$1000)	TRC NPV Net Costs (\$1000)	Net TRC
Energy Efficiency Kits and Education	\$7,493	\$1,373	5.46	\$7,493	\$1,373	5.46
Home Energy Education	\$2,039	\$1,845	1.11	\$2,039	\$1,845	1.11
LI WRAP	\$6,115	\$8,161	0.75	\$6,115	\$8,161	0.75
Student Energy Efficient Education	\$7,522	\$1,654	4.55	\$7,522	\$1,654	4.55
Efficient Lighting	\$12,863	\$4,280	3.01	\$10,676	\$3,792	2.82
Appliance Recycling	\$3,843	\$2,156	1.78	\$2,537	\$2,156	1.18
Energy Efficient Home	\$18,203	\$13,684	1.33	\$11,988	\$9,751	1.23
Non-Residential Energy Efficiency	\$160,902	\$99,554	1.62	\$114,576	\$71,804	1.60
DR	\$4,803	\$1,674	2.87	\$4,803	\$1,674	2.87
Common Portfolio Costs	-	\$5,385	-		\$5,385	-
Portfolio	\$223,782	\$139,766	1.60	\$167,748	\$107,595	1.56

All but one of PPL's EE&C programs were cost-effective on both a gross and net basis. The LI WRAP program fell short with a Gross and Net TRC ratio of 0.75. The Non-Residential Energy Efficiency program includes several subcomponents: Custom, Efficient Equipment, and Midstream Lighting.

C.7.1 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 SO, 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 PY11 electric energy and capacity benefits. This exercise replicated the electric benefits perfectly with one exception. For a few measures, the load shape listed in the “Measure Calculations” tab of the replicate model was not listed in the inventory of load shapes included in the TRC Model Appendix supporting file. Some of these measures were easy to identify the correct load shape, but for one measure, this was not the case. The unmatched measure was Solar PV from the Custom initiative within the Non-Residential Energy Efficiency program. The SWE confirmed that energy and capacity were calculated for this measure and the values were reasonable, we just could not replicate them. In other words, Cadmus used a load shape to compute TRC benefits, it just was not included in the data request response to the SWE.
- 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 PY11 fossil fuel benefits through a similar process as described for the electric benefits. The derivation of these non-electric impacts was well-documented in PY11 with supporting workbooks for each program.
- The PY11 gross TRC model includes \$12.8 million of O&M benefit, which is approximately 6% of all gross TRC benefits. The O&M benefits have been reduced substantially since PY10, where there were \$20.37 million of O&M benefit. PPL provided detailed workbooks showing the calculation of O&M benefits in PY11. Analysis of these O&M workbooks suggests that there may be a missing discount rate assumption in the C&I LED lighting calculations. There are a variety of formulas used for the O&M Benefits and the O&M Benefits 2020 columns, but at least some of the categories reference a discount rate cell that is not populated. Not including the discount rate, or effectively applying a discount rate of 0%, returns an O&M estimate that is higher than intended because the cost of avoided future replacements is assigned a NPV equal to the future value. Overall, the PY11 O&M estimates claimed by PPL are reasonable and well-documented.
- The incremental cost values were provided to the SWE team for review. Generally, the baseline costs and costs for the efficient products are reasonable, but there are a few residential lighting efficient product prices that appear unusually high. The SWE recommends a careful review of the inputs used to develop weighted retail prices for efficient products, specifically, any residential bulbs with retail prices exceeding \$10.
- The calculation of DR benefits was handled consistently with the directives of the 2016 TRC Order. Separate capacity benefit values were 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. Standard A-lamps were assigned one year of savings at the “pre-shift” savings level and 14 years of lower post-shift savings. Specialty LEDs get two years of pre-shift savings due to the baseline change in the TRM occurring one year later. The PPL model handles the dual baseline calculations expertly by including two distinct measures that overlap during the pre-shift period.
- The cost of kits was incorporated into the TRC test as program delivery costs rather than incentives to participants. Under the PPL reporting convention, the Energy Efficiency Kits and Education program is 100% administrative cost with no incentives to participants. This approach is inconsistent with the EDC Annual Report template and overstates the share of EE&C spending on overhead costs. Cost categorization is clearly an area of emphasis for the Commission as its Phase IV Implementation Order required that “*EDCs be required to 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.*”⁷⁰ In the 2021 TRC Order, the Commission made it clear that the cost of kits should be treated as both an incremental measure cost and an incentive.⁷¹ The SWE recommends PPL file its PY12 annual report consistently with the statewide reporting template and the Commission’s accounting preference on this issue.

C.8 PROCESS

C.8.1 Residential Programs

Cadmus reported on PY11 process evaluations for three residential programs: The Appliance Recycling Program, the Energy Efficient Home Program, and the Student Energy Efficiency Education Program. In addition, Cadmus conducted a limited process evaluation for the Home Energy Education Program in PY11 that involved staff interviews with the ICSP and the HERs vendor to assess changes to program design and delivery from PY10 to PY11.⁷²

For the full process evaluations of the above programs, Cadmus reviewed program materials, interviewed PPL and implementation staff, and surveyed program participants and builders. The document and program data review helped to clarify program goals; activities; updates; and, in some instances, development of program theory and logic models. 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; customer and builder 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, mainly centered around sample size issues for various

⁷⁰ Phase IV Implementation Order at page 121. Entered June 18, 2020. Docket No. M-2020-3015228.

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

⁷¹ 2021 TRC Order at page 75. Entered December 19, 2019, at Docket No. M-2019-3006868.

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

⁷² Cadmus did not conduct a full process evaluation in PY11 for the Efficient Lighting Program or the Home Energy Education Program as full process evaluations had been completed in prior years.

research activities or a response to evolving evaluation needs. These will be covered in each program's respective process evaluation audit summary below. 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.8.1.1 Appliance Recycling Program

Summary of Process Evaluation Findings

In PY11, Cadmus conducted a process evaluation that included one interview with PPL program managers, and online participant surveys.⁷³ The process evaluation findings for PY11 are summarized below:

- Like findings from PY9 and PY10, participants are satisfied with the program, with 88% reporting that they are “very satisfied” with the program and 9% reporting that they are “somewhat satisfied.”
 - Looking specifically at particular program components, 84% of respondents were “very satisfied” with the clarity of application requirements, 74% of respondents were “very satisfied” with PPL rebates for qualifying equipment and services, and 66% were “very satisfied” with information they learned online from PPL Utilities about how to save energy.
- The most frequent program improvement suggestions included improving program communication (15%), such as clarifying what services pick-up contractors can provide, easing the application process, and providing information about eligible appliances.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan. All planned research activities for the process evaluation were performed. Cadmus interviewed one PPL program staff member to review program design and implementation. For participant surveys, Cadmus contacted the entire sample with the goal of targeting as many completes as possible, achieving a final sample size of 552.

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. Though Cadmus found that the Appliance Recycling Program has continued to run smoothly over the course of PY11, there was one

⁷³ Cadmus conducted a limited process evaluation of the Appliance Recycling Program in PY11. Cadmus conducted a full process evaluation earlier in Phase III. The PY11 limited process evaluation of the Appliance Recycling Program assessed participant satisfaction with the program.

recommendation to improve program communication regarding cancellations and the removal process.

C.8.1.2 Energy Efficient Home Program

Summary of Process Evaluation Findings

In PY11, Cadmus conducted a process evaluation that included surveys with program participants and builders and interviews with program staff and implementers.⁷⁴ The findings from the process evaluation are detailed below.

- More than nine in ten (91%) participants expressed satisfaction with the Energy Efficient Home Program. Compared to PY10, there was a statistically significant increase in respondents reporting satisfaction with the program (87%). Respondents in the equipment component reported the highest overall satisfaction (95%), while respondents in the online assessment component reported 80% overall satisfaction. Online assessment respondents were not as satisfied with the report they received and requested that it be more customized to their needs. This finding contrasts with PY10, when the kit was the program aspect that most online assessment respondents asked to be improved.
- Builders were highly satisfied with the New Homes program. Of 11 builders, nine were very satisfied and two were somewhat satisfied (n=11). Builders' requested changes to the program included marketing support (more print literature and digital support) (n=2), increasing the incentive amount (n=1), and speeding up the administrative process (n=1).

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan. The planned sample size for program and ICSP staff of two interviews was exceeded, with three interviews completed. For participant surveys, Cadmus targeted the entire population of 24,725 participants and achieved 700 completes across five strata. The sample of in-home audit participants (n=7) was too small to evaluate program satisfaction individually. 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. For the builder survey, Cadmus exceeded the target of ten phone surveys, with 11 phone surveys completed. 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 were two recommendations that followed from the process evaluation, both of which are under consideration.

⁷⁴ Cadmus conducted a full process evaluation of the Energy Efficient Home Program earlier in Phase III. The PY11 limited process evaluation of the program was to assess participant satisfaction using data collected through online participant surveys and interviews with home builders. Cadmus removed the interviews with HVAC (initially planned for ten interviews), heat pump water heater (initially planned for five interviews), and in-home audit (initially planned for five interviews) trade allies. Cadmus conducted interviews with these trade ally groups in PY8.

C.8.1.3 Home Energy Education Program

Summary of Process Evaluation Findings

No process evaluation was conducted in PY11 beyond interviews with program and implementation staff and the HERs vendor.⁷⁵

C.8.1.4 Student Energy Efficient Education Program

Summary of Process Evaluation Findings

Process evaluation activities undertaken by Cadmus included analysis of the home energy worksheets (HEWs) returned from kit recipients and interviews with program staff and implementers.⁷⁶ The program has three cohorts: Bright Kids (2nd-3rd grades), Take Action (5th-7th grades), and Innovation (9th-12th grades). In PY11, 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. The findings of the process evaluation are summarized below.

- Sixty-nine percent of participants completed HEWs, a decrease from 73% in PY10.
- Eighty-three percent of students reported satisfaction with the program overall. Similar to prior program year findings, the Bright Kids cohort was most frequently *very satisfied* (75%). Innovation and Innovation Pilot cohorts were least frequently *very satisfied* (53% and 51%, respectively).

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 two were completed because there were no major program changes.

There were no planned sample sizes for the number of HEWs returned. A total of 16,720 HEWs were returned. 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 while they drew from a mix of process and impact evaluation activities, the link to process evaluation activities was clear. As the SEEE Program performed well in PY11, no process recommendations were made for program improvement in PY11.

⁷⁵ Cadmus conducted a full process evaluation of the Home Energy Education Program earlier in Phase III. Cadmus did not conduct the customer satisfaction survey and logic model review that were indicated in the evaluation plan for PY11. PPL ceased sending the HERs to residential customers in 2019. Cadmus reviewed the logic model in prior years and decided not to review it in PY11 because the program theory and logic had not changed.

⁷⁶ Cadmus conducted a full process evaluation of the Student Energy Efficient Education Program earlier in Phase III. For PY11, a limited process evaluation assessed student participant satisfaction with the program.

C.8.1.5 Efficient Lighting

No process evaluation was conducted in PY11. Cadmus conducted process evaluations in prior program years and because the program did not change between PY10 and PY11, Cadmus did not interview program staff.

C.8.2 LI Programs

Cadmus reported on PY11 process evaluations for two LI programs: The WRAP Program and the Energy Efficient Kits and Education Program. For the process evaluations of these programs, Cadmus interviewed utility and implementation staff, conducted market actor interviews with multifamily property managers, and surveyed program participants. The document and program data review informed identification of program goals, activities, and updates. The research issues addressed by the primary data-collection activities (IDIs and surveys) varied among programs, but generally included effectiveness of program administration, implementation, and delivery; 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 one omitted activity was observed and is discussed in the program's process evaluation audit summary below.

The findings were clearly presented, and the conclusions were well supported by the findings overall. The conclusions were concise and informative, the recommendations followed from the conclusions, and the recommendations were clear and actionable.

C.8.2.1 WRAP Program

Summary of Process Evaluation Findings

In PY11, Cadmus conducted a process evaluation to generate findings on program delivery and participation, including the satisfaction levels amongst one market actor group (multifamily property managers) and participants.⁷⁷ The planned sample size for program and ICSP staff of three interviews was met. Participant satisfaction was gauged through phone surveys, and satisfaction levels among market actors (multifamily property managers) was assessed through phone interviews. The findings of the process evaluation are summarized below.

- Both interviewed multifamily said they were very satisfied with the program. Unlike in PY10, no property managers mentioned installation or performance issues with any measure.
- Both interviewed multifamily property managers recommended that the program provide measures for multifamily common areas and expressed disappointment that common areas are excluded. They seemed unaware that these measures are available through PPL's nonresidential programs.
- Cadmus found that 97% of PY11 survey respondents were satisfied (82% were very satisfied and 15% were somewhat satisfied with their overall program experience).

⁷⁷ Cadmus conducted a full process evaluation earlier in Phase III. In PY11, the limited process evaluation of WRAP assessed participants' and multifamily building property managers' satisfaction with the program.

- When asked how the program could be improved, 45% of participants recommended expanding program measures. Participants recommended windows, refrigerators, and showerheads (only customers with electric water heaters receive low-flow showerheads).
- Participants were generally satisfied with the program components, with participants most satisfied with the quality of work by the WRAP auditor (79% reported “very satisfied”).
- The ICSP’s subcontractor recommended that PPL Electric Utilities coordinate with a third-party agency who funds windows, insulation, and health and safety upgrades to mobile homes because there is an unmet need for these measures in the mobile home community. Mobile homes receive baseload measures through WRAP, which does not include those measures. This coordination would allow mobile homes to receive PPL and third party services in the same timeframe.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were mostly consistent with the Phase III Evaluation Plan, with one exception. Cadmus did not review the logic model because there were no substantial program changes in PY11.

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 one recommendation that followed from the process evaluation. The recommendation has been implemented.

C.8.2.2 Energy Efficiency Kits and Education Program

Summary of Process Evaluation Findings

The process evaluation performed by Cadmus in PY11 included interviews with PPL and ICSP program managers, as well as surveys with participants.⁷⁸ The process evaluation findings are summarized below.

- Customers continue to be satisfied with the energy-efficiency kit they received as part of the program in PY11. Overall, 98% of customers said they were satisfied (78% were very satisfied and 19% were somewhat satisfied; n=1,897).
- Most participants (96%) agreed the program helped them understand how much energy the kit items could save, and 86% agreed that the kits had what they needed to install the products.
- The ICSP reported achieving the highest marketing success with the direct mail customers who received multiple marketing touchpoints about the program. Though the ICSP’s direct

⁷⁸ Cadmus conducted a full process evaluation of the Energy Efficiency Kits and Education Program earlier in Phase III. The PY11 limited process evaluation of the programs assessed participant satisfaction with the program.

mail campaigns typically yield a 2% response rate, conducting its direct mail campaign shortly after PPL Electric Utilities marketed the program via bill inserts yielded a 25% response rate.

- The ICSP recommended the following for Phase IV if PPL Electric Utilities continues to offer a program similar to the Energy Efficiency Kits and Education Program:
 - Add Tier 1 powerstrips to the kits. The 2021 TRM shows higher savings for Tier 1 powerstrips (89kWh to 101 kWh) than the 2016 TRM (49 kWh to 75 kWh). However, the 2021 TRM assigns lower savings to Tier 2 powerstrips (141 kWh) than does the 2016 TRM (204 kWh to 307 kWh). The smaller gap in deemed savings between Tier 1 and Tier 2 powerstrips in the 2021 TRM, combined with the lower price point of Tier 1 powerstrips compared to Tier 2 powerstrips, could make Tier 1 powerstrips a viable option for future kits programs.
 - Add specialty bulbs to the energy-efficient kits to expand energy-savings opportunities.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan. Cadmus met planned sample sizes for all research activities and were able to analyze 1,793 paper kit surveys from direct mail responders and 134 from agency responders.

Cadmus 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, in general, 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 functioned well in PY11 and will not be delivered in PY12, Cadmus did not provide any recommendations for the program.

C.8.3 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 this evaluation, Cadmus treated each component of this program as individual program offerings and evaluated them separately in PY11. Cadmus reported on PY11 process evaluations for two non-residential programs: DR Program and the Non-Residential Energy Efficiency Program, which has four distinct components: Efficient Equipment, Midstream Lighting, Custom, and CEI.⁷⁹

For the process evaluations of the above programs, 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;

⁷⁹ In PY11, the CEI component of the Non-Residential Energy Efficiency Program was not evaluated because it is no longer being offered.

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.8.3.1 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.⁸⁰ The results of the overall process evaluation are summarized below:

- Ninety-five percent of PY11 respondents were satisfied with the overall program (73% were very satisfied and 22% were somewhat satisfied; n=79). Though this was an increase from PY10, where overall satisfaction was 91% (n=67), it was not a significant change.
- All direct discount lighting participants (100%, n=33), 94% of prescriptive lighting participants (n=32) and 86% of equipment participants, were very or somewhat satisfied (n=14).
- Two prescriptive lighting respondents were not too satisfied with the program overall. One respondent said better communication in regard to the application is needed. The other respondent said the program could be more user-friendly.
- Participants were most satisfied with information about the application process (95%; n=54), which was a significant increase from 79% (n=54) in PY10.
- Two equipment (n=7) and one direct discount lighting (n=19) respondents were not too satisfied or not at all satisfied with information provided about the application process. Satisfaction with all other program components increased from PY10.
- The survey asked respondents if anything could change about the program to improve it. More than half (67%; n=70) said no changes were needed and 33% (n=23) left a suggestion for improvement, including the following:
 - Provide clearer information/communication about the program (41%)
 - Simplify or extend application process (36%)
 - Increase rebate amount or types of rebates (14%)

⁸⁰ Cadmus conducted a full process evaluation of the Efficient Equipment Program earlier in Phase III. The PY11 limited process evaluation of the program assessed participant satisfaction with the program.

- Reduce rebate processing time (9%)

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. All process evaluation research activities included in the evaluation plan for PY11 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. There were no process recommendations made for program improvement in PY11.

C.8.3.2 Midstream Lighting Program

Summary of Process Evaluation Results

The process evaluation for the Midstream Lighting Program 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.

- In PY11, 100% of the distributors were satisfied with the Midstream Lighting component (57% were very satisfied and 43% were somewhat satisfied; n=14). These results are not significantly different from PY10.
- Cadmus interviewed eight contractor purchasers and 24 end users (17 purchasers and seven non-purchasers). All but one interview respondent (distributors, end users, and contractors) said they were either very satisfied or somewhat satisfied with the Midstream Lighting component (98%; n=46).
- For end users (n=24), 88% were very satisfied, 8% were somewhat satisfied, and 4% were neither satisfied nor dissatisfied.
- For contractors (n=8), 100% were very satisfied.
- Distributors are the core drivers of awareness for the program, with 14 of 24 end users and six of seven contractors stating their distributor was how they learned about the program. Additionally, 19 of 24 end users and all seven contractors said the distributor specifically mentioned Midstream Lighting when they purchased lighting.
- Distributors are happy with and successfully using the portal-based system, activated by the ICSP in PY10, to validate qualifying products and report sales. Distributors who used a similar portal for other midstream programs were pleased that PPL Electric Utilities made this change; two said the Midstream Lighting portal had a huge advantage over similar programs that did not have a portal.

- The most common suggestion for improvement provided by the distributors was to add more products to the program (n=8); however, Cadmus confirmed that the products usually requested are offered by the program. Other suggestions were to improve the upload process (n=4), increase the incentives for LEDs (n=2), pay incentives for strong sales performance or compensate for time spent on program administration (n=2), increase general advertising (n=2), and not require the account number (n=1).
- Six of 12 distributors in PY11 reported expanding the number of program-qualifying products they stock to keep up with higher customer demand, which they attributed in part to utility program incentives, including those offered by Midstream Lighting. Two said they now tend to stock a greater variety of program-qualifying products as well. Four distributors with stores outside of PPL Electric Utilities' territory said that Midstream Lighting had some impact on the products these stores stock because their companies try to purchase in larger quantities to get better rates.
- As in PY10, LEDs were the majority of distributors' lighting sales, specifically LEDs eligible for PPL Electric Utilities' program. Additionally, distributors reported that program-qualifying LEDs were a larger share of sales in PY11 than in PY10.
- As in PY10, several distributors said they served more smaller customers and noticed some increase in customers doing small jobs over the past year. They attributed this change to Midstream Lighting. Five of 13 distributors said they were more likely to promote program-qualifying products now that they were participating in Midstream Lighting. Specifically, they were more often recommending installing new fixtures over replacing like-for-like bulbs in an older fixture.
- Likewise, all contractors interviewed tended to recommend efficient lighting to their clients, with five saying they always do and two saying they often do. Contractors also credited Midstream Lighting discounts and distributors' recommendations in their clients' decisions to upgrade their lighting. These findings are consistent with PY10.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan but the sample composition was altered. The target for 30 purchaser interviews was achieved through eight contractor purchaser interviews and 24 end user interviews (Cadmus collected two completed interviews beyond the target, one additional contractor and one additional end user).

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. Target sample sizes were achieved for program staff interviews, end-user purchasers, and contractor purchaser interviews. Cadmus attempted to reach and interview all 21 participating distributors, with the goal of completing at least 15 interviews, though only 14 interviews were achieved, despite multiple outreach attempts.

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.8.3.3 Continuous Energy Improvement

No process evaluation was conducted in PY11 because the program is no longer being offered.

C.8.3.4 Custom Program

Summary of Process Evaluation Results

The process evaluation for the Custom Program included interviews with PPL and ICSP program managers and a mix of phone and online participant surveys.⁸¹ The findings of the process evaluation are summarized below.

- Overall, 88% of PY11 respondents were satisfied with the program (63% were very satisfied and 25% were somewhat satisfied; n=16). Overall satisfaction was lower when compared to PY10 (96%). Participants were most satisfied with the professionalism of program representatives (93% were satisfied; n=15), and least satisfied with the time it took to process their application (27% very satisfied).
- Seven of 16 respondents provided recommendations to improve the program. The most common suggestion was to improve communication or the timing of communication.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were consistent with the Phase III Evaluation Plan, including meeting specified sample size target for program staff interviews and participant 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 PY11 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. There were no process recommendations made for program improvement in PY11.

C.8.3.5 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 PY11, PPL initiated four 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.

⁸¹ Cadmus conducted a full process evaluation of the Custom Program earlier in Phase III. The PY11 limited process evaluation of the program assessed participant satisfaction with the program.

- In PY11, eight of ten respondents were satisfied with the DR Program: six were very satisfied and two were somewhat satisfied. No respondent said they were dissatisfied. Respondents were most satisfied with the timing of event notifications (5 “very satisfied” and 3 “somewhat satisfied”) and were least satisfied with the incentive amount (2 “very satisfied” and 4 “somewhat satisfied”).
- In PY11, PPL Electric Utilities and the ICSP operated the program the same as in previous years. They implemented four events, three of which occurred on consecutive days (July 17, 18, and 19). This was the first time in Phase III that the program implemented three consecutive events. Nine of the ten companies that completed the survey participated in the three consecutive events; one company did not participate in any events during PY11.
 - Eight said they were aware of the forecast for the three consecutive events. Of these, six were concerned about adverse impacts on business operations, particularly the managers of manufacturing facilities who were concerned about the loss of production for their business. Two respondents said they were not concerned.
 - The survey asked the nine respondents who participated in at least two of three consecutive events how easy or difficult it was for their facilities to participate. Two said somewhat easy, and one said very easy. Six respondents said it was difficult: one said very difficult, and five said somewhat difficult. These respondents explained that the consecutive events required additional staff, operational planning, and communication to employees. Notably, the respondent who said it was very easy manages a higher education facility and explained that events in general were easy to implement because there were fewer occupants in the building during the summer semester.

Summary of Process Evaluation Audit

The research activities performed under the process evaluation were mostly consistent with the Phase III Evaluation Plan, with the exception of fewer completed participant surveys than targeted. Despite multiple attempts, Cadmus gathered data for ten 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 PY11 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. There were no process recommendations made for program improvement in PY11.

Appendix D Duquesne Light Audit Detail

D.1 EM&V PLAN REVIEWS

Duquesne Light's evaluation contractor, Guidehouse (formerly Navigant), submitted a redline version of their PY11 EM&V plan with relatively minor adjustments to the evaluation approach. In addition, Guidehouse submitted several memos providing more details on their sampling plans for non-residential and residential impact and process evaluations. The SWE reviewed and approved the plans and memos, generally with minor revisions.

In addition to reviewing Duquesne Light's revised evaluation and sampling plans, the SWE reviewed and approved survey instruments and interview guides for CEEP, the Residential Behavioral program, Duquesne Light's non-residential programs (process and NTG), the rebates and kits components of REEP, RARP, and the Whole House Retrofit Program (WHRP).

Guidehouse also submitted a memo to the SWE that outlined Guidehouse's proposed EM&V methods in response to the COVID-19 outbreak.

D.2 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 $\pm 15\%$ 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 134](#) shows the relative precision at the 85% confidence level of the PY11 energy savings for each program. [Table 134](#) also includes notes about how data collection activities from multiple program years are synthesized to develop the PY11 realization rates and associated uncertainty.

Table 134: Relative Precision of PY11 Gross Verified Energy Savings Estimates by Initiative

Program / Initiative	RP at 85% Confidence Level (\pm)	Notes
Residential Energy Efficiency Program	3.7%	Leverages PY11 online participant surveys, PY11 file review, and PY9 in-store lighting interviews and cross-sector sales research
Residential Appliance Recycling	1.1%	PY11 surveys + PY11 tracking data review
LI Energy Efficiency Program	1.4%	PY11 surveys for resident-initiated WHRP audits and kits, PY9 and PY10 survey results for WHRP for refrigerator and freezer recycling, PY10 survey and onsite-verification results for property-owner audits and multifamily building retrofits
Commercial/Express Efficiency	15.1% ¹	PY10-PY11 rolling sample
Midstream Lighting	16.7%	Verified PY10 savings from the latter eight months of PY10 due to program changes from Oct 2018. Leveraged phone interviews and on-site visits for verification.
Multifamily Housing Retrofit	2.3%	PY11 phone interviews
Industrial	12.3% ¹	PY10-PY11 rolling sample
Public Agency Partnership	13.7%	PY10-PY11 rolling sample
Community Education	10.3%	Applied PY10 results to PY11

¹SWE 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 show less than $\pm 15\%$ relative precision requirement in [Table 134](#) is the Midstream Lighting. Guidehouse evaluated this program over a 20-month period (eight months of PY10 and 12 months of PY11) following program implementation changes that occurred in PY10. Consistent with other programs, Guidehouse targeted 85/15 confidence/precision over the period. Guidehouse found significant variation between reported and verified savings, attributed to discrepancies between estimated and observed in-service rates and hours of use. The frequency and magnitude of these discrepancies resulted in the 16.7% relative precision for the program. In order to comply with Evaluation Framework requirements, Guidehouse adjusted the evaluation plan to include additional samples from the Midstream program in PY12.

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 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 D.4](#).

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 $\pm 0.5\%$ at the 95% confidence level (two-tailed). This requirement for program design is less stringent than the sampling requirement, described above, that programs annually achieve $\pm 15\%$ *relative* precision at the 85% confidence level. Standard precision requirements are not reasonable expectations for behavioral programs because the size of the average effect is typically much smaller, and all estimation error is captured as opposed to sampling error only. The SWE reviewed the design of Duquesne Light's behavioral 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 PY11 verified DR MW savings from the Large Curtailable Load program was $\pm 8.9\%$ at the 90% confidence level.

D.3 REPORTED GROSS SAVINGS AUDITS

D.3.1 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 PY11 Annual Report. Specifically, the values we examined are as follows:

- Reported gross energy savings (MWh) for each program;
- Reported gross peak demand savings (MW) for each program;
- Participation for each program; and
- Incentive dollars for each program.

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 PY11 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 Error! Reference source not found.](#), and our findings regarding Duquesne Light's Residential Behavioral Savings program (and the HER component of the LIEEP) can be found in [Appendix D.4.1.3](#).

Table 135 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 135: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Commercial Efficiency	13,633	13,633	Yes
Community Education	2,317	2,317	Yes
Express Efficiency	9,620	9,620	Yes
Industrial Efficiency	15,841	15,841	Yes
Large Midstream Lighting	1,897	1,897	Yes
LI Energy Efficiency (LIEEP)	2,174	2,174	Yes*
Multifamily Housing Retrofit	1,807	1,807	Yes
Public Agency Partnership	11,857	11,857	Yes
REEP: Residential Energy Efficiency	5,384	5,384	Yes
Residential Appliance Recycling	2,206	2,206	Yes
Residential Whole House Retrofit	0	0	Yes
Small Commercial Direct Install	0	0	Yes
Small/Medium Midstream Lighting	3,691	3,691	Yes
Upstream Lighting	17,882	17,882	Yes
Portfolio Total	88,309	88,309	Yes*

*The LIEE program has an HER component that is excluded from this table.

Table 136 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 136: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Commercial Efficiency	2.28	2.28	Yes
Community Education	0.37	0.37	Yes
Express Efficiency	1.30	1.30	Yes
Industrial Efficiency	2.15	2.15	Yes
Large Midstream Lighting	0.35	0.35	Yes
LI Energy Efficiency	0.19	0.19	Yes*
Multifamily Housing Retrofit	0.15	0.15	Yes
Public Agency Partnership	1.79	1.79	Yes
REEP: Residential Energy Efficiency	0.70	0.70	Yes
Residential Appliance Recycling	0.25	0.25	Yes
Residential Whole House Retrofit	0	0	Yes
Small Commercial Direct Install	0	0	Yes
Small/Medium Midstream Lighting	0.68	0.68	Yes
Upstream Lighting	1.81	1.81	Yes
Portfolio Total	12.02	12.02	Yes*

*The LIEE program has an HER component that is excluded from this table.

Table 137 summarizes the SWE's ex-ante findings regarding program participation. For all programs except for LI Energy Efficiency, 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 Whole House Retrofit component of the LI Energy Efficiency program. In prior annual reports, Duquesne Light noted that their tracking data system aggregates activities for this program component and does not track individual audits. Duquesne Light reported 2,449 participants for the Kits component of this program – this lines up with the SWE's participant count. Thus, we do not view the discrepancy as a concern.

Table 137: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Commercial Efficiency	63	63	Yes
Community Education	24	24	Yes
Express Efficiency	265	265	Yes
Industrial Efficiency	43	43	Yes
Large Midstream Lighting	99	99	Yes
LI Energy Efficiency	3,931	2,449	No
Multifamily Housing Retrofit	15	15	Yes
Public Agency Partnership	134	134	Yes
REEP: Residential Energy Efficiency	11,345	11,346	Yes
Residential Appliance Recycling	2,068	2,068	Yes
Residential Whole House Retrofit	0	0	Yes
Small Commercial Direct Install	0	0	Yes
Small/Medium Midstream Lighting	238	238	Yes
Portfolio Total	18,225	16,747	No

*The LIEE program has an HER component that is excluded from this table.

Finally, [Table 138](#) 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 138: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Commercial Efficiency	\$724	\$838	No
Community Education	\$0	\$157	No
Express Efficiency	\$633	\$602	No
Industrial Efficiency	\$704	\$728	No
Large Midstream Lighting	\$104	\$104	Yes
LI Energy Efficiency	\$254	\$1	No
Multifamily Housing Retrofit	\$502	\$622	No
Public Agency Partnership	\$1,115	\$955	No
REEP: Residential Energy Efficiency	\$964	\$989	No
Residential Appliance Recycling	\$77	\$77	Yes
Residential Whole House Retrofit	\$0	\$0	Yes
Small Commercial Direct Install	\$0	\$0	Yes
Small/Medium Midstream Lighting	\$212	\$212	Yes
Portfolio Total	\$5,289	\$5,287	No

D.3.2 Project File Reviews

D.3.2.1 Residential

The SWE conducted a project file review for a sample of Duquesne Light's residential programs in PY11 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 a majority of the documentation requested.

[Table 139](#) 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 139: Duquesne Light PY11 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 Program	Appliance Rebates	16	✓	✓	✓	✓
Residential Energy Efficiency Program	Efficiency Kits	4	✓	✓	✓	✓
Residential Energy Efficiency Program	Upstream Lighting	15	✓	✓	✓	✓
Residential Appliance Recycling	N/A ²	N/A	✓ ²	✓ ²	✓	✓ ²
Residential WHRP	Direct Install	10	✓	✓	✓	✓ ³

¹ It should be noted that while typically the data matches, there were minor discrepancies 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 of the reviewed project files matched the tracking data. There was one observed instance where the tracking data only indicated one lighting occupancy sensor when the project files indicated two units. 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. 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. 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 project files included manufacturer invoices for the number of light bulbs purchased and subsequently rebated. The SWE received quarterly invoices compiled into PDF files, each containing multiple manufacturer invoices compiled by billing date.

For the reviewed files, the SWE was able to verify counts, rebate amounts, model numbers, and wattage values. Although the SWE did not observe any discrepancies in wattage values between program tracking data and invoices, the SWE has confirmed with Guidehouse in previous years that they conduct a similar calculation review for the verified savings analysis and adjust TRM values when incorrect values are identified, including discrepancies observed in previous years.

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.

The SWE reviewed the lack of supplemental documents for the Appliance Recycling program with Guidehouse in previous program years. Guidehouse confirmed that nameplate photos were not collected by the CSP, ARCA, for the Phase III contract period. It should be noted that Guidehouse informed the SWE that photos were not collected for this program in PY8, PY9, and PY10. Guidehouse also confirmed that the actual date of manufacture is used to inform the TRM regression. Due to the lack of nameplate photos and on-site data collection forms, the SWE recommends that CSP on-site data is collected through forms and photos during the next contracting Phase, specifically for information that informs the TRM regression inputs, in order to ensure that accurate inputs for verified savings are being collected.

Whole Home Retrofit Program

The Whole Home Retrofit (WHRP) program project file packages included documentation for measures that were directly installed during the audit. The evaluator, Guidehouse, provided substantial data covering both audit-based and building-level WHRP projects, though the SWE was not able to verify all project file documentation with the tracking database.

Individual project files were provided for projects associated with individual customers, while the tracking database included aggregated measure-level quantities and savings. The tracking database was limited to prescriptive and custom lighting measures.

Though project-specific savings were unavailable for individual customer projects, the SWE compared their audit reports against project tracking documents to verify quantities and specifications for the installed equipment. The SWE observed instances of audit reports that indicated 69 LED bulbs were installed but the project tracking documents for the sampled projects did not include these lighting measures. Due to the tracking data reporting at the aggregate level, the SWE was not able to identify whether these installed measures were accounted for in the tracking data or not.

The provided project files contained WHRP projects where landlords and/or building managers were engaged rather than individual customers. In these instances, the tracking database encompassed directly installed measures from multiple audits (presumably) from the same building. The SWE did not observe discrepancies for measures that could be identified separately in the tracking data (such as refrigerator recycling and custom lighting measures).

The SWE observed in PY9 and PY10 the tracking database rounds 0.5 values for SEER and system capacity for central air conditioners up to the nearest whole number. The SWE file review found similar inconsistencies in the tracking data for PY11. In addition, the SWE observed in the tracking data that capacity and SEER values were all whole numbers for central air-conditioners and air-source heat pumps. This appears to be happening at a system level and causes reported savings to be consistently overreported.

Recommendation: Update tracking database to include two decimal points to avoid rounding.

Appliance Recycling program includes tracking data on age, cubic feet, manufacturer, and configuration in the tracking database. Recycled appliance savings are based on a deemed savings regression equation that incorporates TRM defaults and EDC gathered data for variables such as date of manufacture.

Recommendation: Ensure that on-site data is collected in Phase IV contract period for appliance recycling.

D.3.2.2 Non-Residential

The SWE reviewed a sample of Duquesne Light’s Small C&I, Large C&I, and GNI projects for PY11 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 twenty-four projects sampled.

Table 140 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.

Table 140: Duquesne Light PY11 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 information for the SWE to follow?	For TRM measures, are correct algorithms and inputs used?	Does the data in the files match the tracking data?
Community Education	2	✓	✓	✓	✓	✓	✓
Express Efficiency	4	✓	2/4*	✓	✓	✓	✓
Multifamily Housing Retrofit	5	✓	3/5*	✓	✓	✓	✓
Industrial Efficiency	6	✓	4/6*	✓	✓	✓	✓
Commercial Efficiency	2	✓	✓	✓	✓	✓	✓
Public Agency Partnership Program	5	✓	3/5*	✓	✓	✓	✓

*Number of satisfactory files out of total reviewed. See program specific notes below.

Community Education

As mentioned above, the SWE found most project files reviewed to be accurate and complete. Of the two projects reviewed, there were no notable discrepancies between the workbook calculator and tracking data, and all requested supporting files were included for both projects.

Express Efficiency

The SWE reviewed four projects for the Express Efficiency program and found most projects to be accurate. The SWE noted two projects in which the rebate incentives listed in the tracking data did not match the provided calculation workbooks and/or rebate applications.

Multifamily Housing Retrofit

In total, five project files were reviewed by the SWE for this program. Of these five projects, two projects had date discrepancies between the tracking data and calculation workbooks or rebate applications. One project had an installation date discrepancy of two months and a second project had an installation date discrepancy of two weeks. Both projects also had different rebates in the provided project files than what appeared in the tracker.

Industrial Efficiency

The SWE reviewed six project files from the Industrial Efficiency program. From this review, the SWE found all project files to be complete and mostly accurate with the exception of two projects, one of which had an installation date discrepancy of one year with the date provided in the tracking data. The other which claimed an incentive \$1,040 lower in the rebate application than in the tracker.

Commercial Efficiency

The SWE reviewed two project files and found both to be accurate and complete.

Public Agency Partnership Program (PAPP)

Of the five project files reviewed, two projects had varying rebate incentives between the rebate application and the calculation workbook/tracker.

D.4 VERIFIED GROSS SAVINGS AUDITS**D.4.1 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 141](#) provides a summary of the evaluation and M&V approaches used by Duquesne Light in their PY11 verified savings calculations.

Table 141: Residential Program Evaluation Activities – Duquesne Light Company

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis	Applied PY9 RR
REEP: Residential Energy Efficiency Rebate Program	--	--	✓	--	✓
REEP: Energy Efficiency Kits	--	--	✓	--	✓
REEP: Upstream Lighting	--	--	✓	--	✓
Residential Appliance Recycling ^b	--	--	✓	--	✓
Residential Behavioral Savings			--	✓	
Residential Whole House Retrofit	✓	✓	✓	--	--
LI Energy Efficiency Program (LIEEP)	✓	✓	✓	--	--

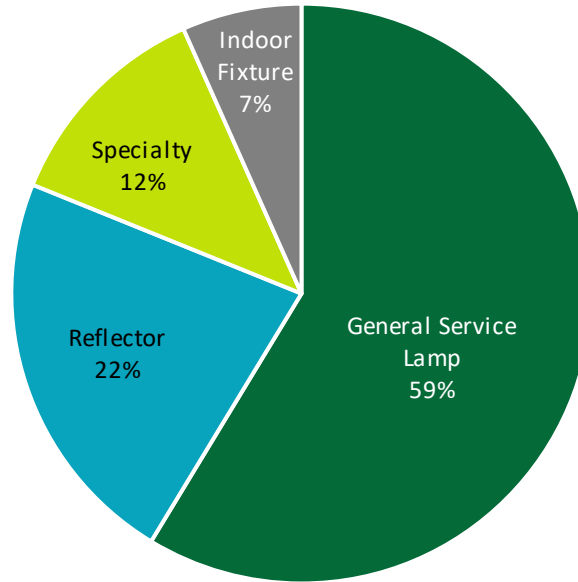
^a The Desk Review column includes database reviews, application reviews, and/or engineering desk reviews.

^b The Residential Appliance Recycling Program used survey results from PY8.

D.4.1.1 Upstream Lighting & Cross-Sector Sales

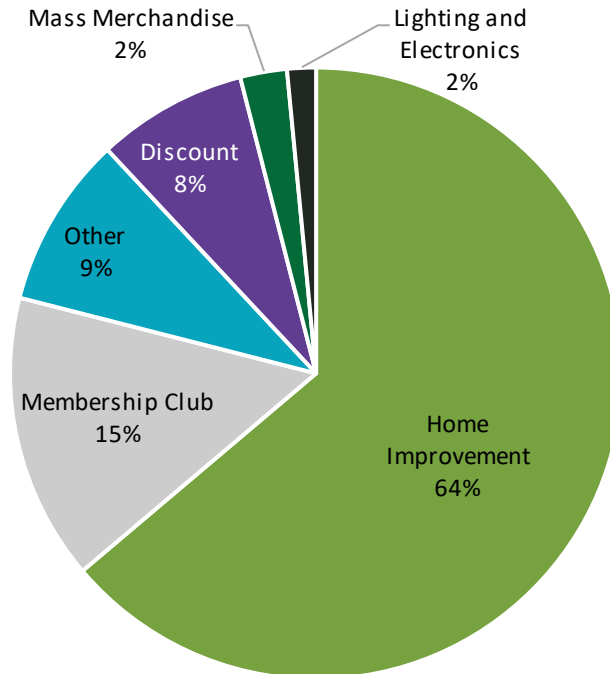
Customers purchased over 400,000 efficient light bulbs and fixtures through Duquesne Light's PY11 upstream lighting program. Figure 74 displays the distribution of sales by product type. Nearly three-fifths (59%) of the bulbs were general service lamps.

Figure 74: Duquesne Light PY11 Upstream Lighting Sales by Product Type



Over three-fifths (64%) of Duquesne Light's PY11 upstream light bulbs and fixtures were sold through home improvement stores (Figure 75).

Figure 75: Duquesne Light PY11 Upstream Lighting Sales by Retail Channel



Audit Findings

Guidehouse provided the PY11 impact analysis for Duquesne Light's upstream lighting before the PY11 Duquesne Light Annual Report was submitted to the PUC on February 15, 2021. This allowed time for the SWE to conduct its audit, provide Guidehouse with feedback, and for Guidehouse to adjust the analysis based on this feedback. The SWE agrees with Guidehouse's verified gross savings for upstream lighting.

Cross-Sector Sales

Guidehouse did not conduct cross-sector sales research in PY11 but applied the PY9 cross-sector sales rates of 3.5% for standard LEDs and 4.2% for specialty LEDs.

Recommendations

The SWE does not have any recommendations beyond the early feedback provided on the PY11 upstream lighting analysis.

D.4.1.2 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 evaluation activities that were reviewed. No discrepancies were observed.

Residential Energy Efficiency Program (REEP)

Guidehouse provided the PY11 impact analysis for REEP earlier than in previous years, before the PY11 Duquesne Light Annual Report was submitted to the PUC on February 15, 2021. This allowed time for the SWE to conduct its audit, provide Guidehouse with feedback, and for Guidehouse to adjust the analysis based on this feedback.

The SWE audited both components – rebates and energy-efficiency kits – of the REEP. Note that the SWE's audit of the upstream lighting portion of REEP is reported in [Section D.4.1.1](#) of this appendix.

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 SWE reviewed the rebate portion of the REEP program and found that the sample sizes and participation counts matched what is reported in the PY11 annual report. The SWE determined that TRM algorithms were followed correctly during the evaluator's review of the reported savings tracking data and confirmed that EDC gathered data was applied to open variables during the verified savings evaluation. The SWE determined the verified savings and realization rates for rebated measures were correct.

The kit portion of the REEP program was comprised of 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, and
 - 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 11-watt LED
 - One 9-watt LED
 - One LED night light

The SWE was able to verify the sampled savings calculations, realization rates, and participation counts for the kit giveaways that were tracked at an individual level. The SWE was able to verify the savings based on the total reported quantity of measures given away during the events.

Residential Appliance Recycling Program

Guidehouse provided the PY11 impact analysis for the Residential Appliance Recycling program earlier than in previous years. This allowed time for the SWE to conduct its audit, provide Guidehouse with feedback, and for Guidehouse to adjust the analysis based on this feedback.

The Residential Appliance Recycling program covers the recycling of older model refrigerators and freezers. Following the approved PY11 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.

Residential Whole House Retrofit

The WHRP serves market rate and 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 are accurate. Many TRM default or deemed values were used for directly installed measures – the SWE recommends considering collecting data by the ICSP while on-site and using values from the equipment being installed to more accurately reflect savings, but the SWE also acknowledges that on-site data collection adds time and costs to each site-visit and should be balanced against the gains of more accurate savings estimates.

LI Energy Efficiency Program

Duquesne Light also offers kits to LI customers and attributes savings to the LIEEP Program. The LIEEP program offered identical kits through the same channels as the REEP program. The SWE verified the sampled savings calculations, realization rates, and participation counts for the kit giveaways that were tracked at an individual level. There were certain give-away events that consisted of one-off lamp giveaways, which were tracked by the number of measures rather than the participant who received the measure. The SWE was able to verify the savings based on the reported total quantity of measures given away during the events.

The SWE audit of the LI component of the WHRP determined the sample sizes were correct, and savings were calculated in accordance with TRM protocols. Many TRM defaults were used for direct install measures – the SWE recommends the EDC consider working with its implementer to gather these values from the installed measures. However, the SWE also acknowledges that on-site data collection adds time and costs to each site-visit and should be balanced against the gains of more accurate savings estimates.

D.4.1.3 Behavior

Approximately 8% of Duquesne Light's verified gross energy savings for PY11 came from HERs issued to around 66,000 residential and residential-LI households. While Duquesne Light was among the least HER-reliant EDCs for portfolio energy savings in PY11, close to 50% of Duquesne Light's progress toward its LI target in PY11 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 PY11 are summarized in [Table 142](#), by cohort. Duquesne Light has two market rate cohorts that 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.

Table 142: Duquesne Light HER Cohort Summary

Wave	First HER Mailing	Treatment Group Homes	Control Group Homes
2012 Market Rate	July 2012 ⁸²	13,544	35,515
2015 Market Rate	March 2015	37,526	13,688
2015 LI	March 2015	9,980	5,026
2018 LI	July 2018	2,734	2,712

The program ICSP Oracle implemented each of the four waves as 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 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 PY11 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. 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 LDV regression model for the PY11 impact analysis as called for in the PY11 EM&V plan and the model specification implemented matches the specification called for in the EM&V plan exactly.

Participant Count

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

⁸² The 2012 Market Rate cohort did not receive HERs from June 2013 to February 2015.

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 the SWE team was able to reproduce Guidehouse's customer counts exactly.

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 143](#). 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 143](#) shows the aggregate PY11 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 smallest savings in the LI cohorts. The 2015 Market Rate cohort had the largest per-home kWh savings in PY11. 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 LI cohort has the largest percent savings. Average kWh savings per home and percent savings are calculated before dual participation adjustment.

Table 143: PY11 HER Energy Savings

Wave	Pre-Adjustment Savings (MWh)	Downstream Dual Participation (MWh)	Upstream Dual Participation (MWh)	Net Savings (MWh)	Average kWh Savings per Home	Average % Savings
2012 Market Rate	2,984	501	75	2,409	220	1.9%
2015 Market Rate	4,852	1,408	103	3,341	129	1.4%
2015 LI	1,781	286	45	1,450	178	2.2%
2018 LI	274	55	3	216	100	1.2%
Total	9,892	2,250	226	7,415	155	1.6%

Dual Participation

In [Table 143](#), calculated pre-adjustment savings were 9,892 MWh. It is important to note that HERs 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 rate for the energy-efficiency kits was 75%. In order to mitigate for the large impact these energy efficiency kits had on the HER impacts, Guidehouse analyzed the realization rate and 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 optional, *“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.”*⁸³
- If downstream savings exceed 5% of gross verified HER savings, Guidehouse will examine savings by program, initiative, or measure to identify the primary contributors.
- 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.

For PY11, the kit realization rate was 94% for market rate and 92% for LI so the reported savings were used in the PY11 uplift calculations. The dual participation calculations consider all incremental energy-efficiency impacts since a cohort began receiving HERs so kit savings from PY10 were still adjusted by the PY10 realization rate as it was outside of the 90%-110% range described above. 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 PY11 HER program is 7,415 MWh. These values are all reported in [Table 143](#).

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 PY11 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

⁸³ https://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework050818.pdf Page 129

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 144](#).

Table 144: PY11 HER Gross and Net Verified MWh Savings

Wave	PY11 MWh
Market Rate	5,525
LI	1,890
Total	7,415

Peak Demand Impacts

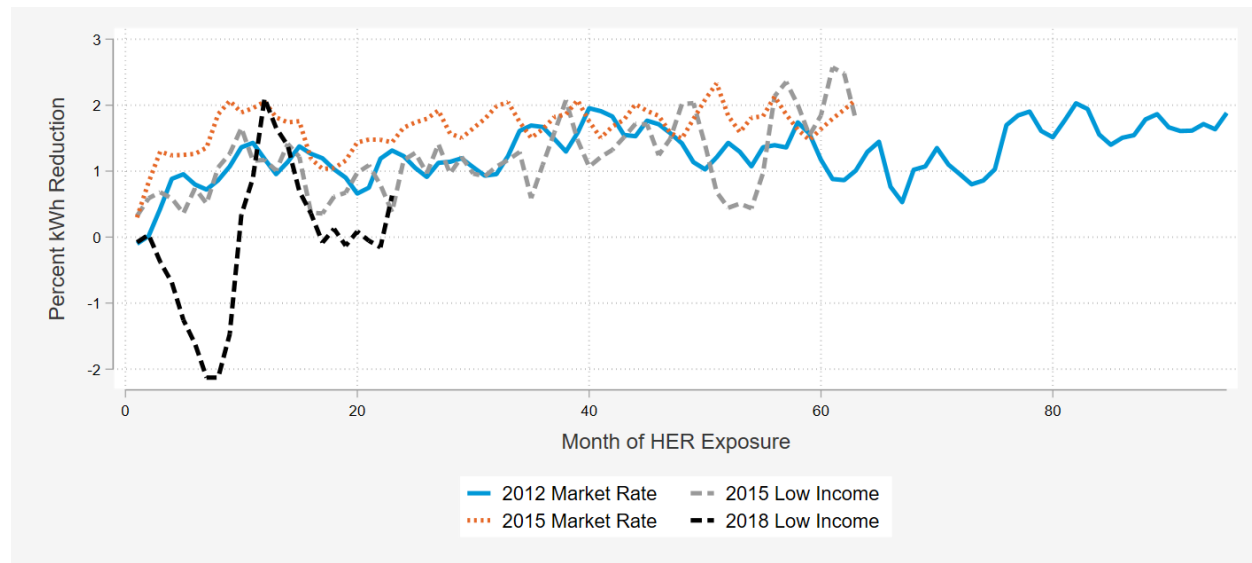
The behavioral protocol of the Evaluation Framework provided evaluation contractors with several options for estimating peak demand savings for HER programs. Guidehouse utilized the flat load assumption, which assumes HER savings occur equally in each hour of the year. Gross verified demand savings are calculated as follows for the Residential Behavioral Savings program:

$$\text{Verified MW Savings} = \frac{7,415 \text{ MWh}}{8,760 \text{ hours}} = 0.847 \text{ MW}$$

Conclusion

[Figure 76](#) 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 fairly consistent level of savings around 1.0% to 2.0%, with seasonal fluctuations. The 2018 LI cohort is unique in that initial impacts were actually negative for PY10, but in PY11 have seen net positive savings. HER cohorts typically show increasing savings over the first two years of exposure.

Figure 76: Percent Impacts Over Time



When reviewing [Figure 76](#), 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. PY11 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 PY11 annual report.

The SWE has one minor prospective recommendation for the PY12 HER analysis. In the PY11 data files, 88 accounts were listed in control group of both the 2015 Market Rate and 2015 LI cohorts. For each account, the billed consumption is identical in every month. These households are in the control group, so there is no issue with double-counting of savings, but it would be good housekeeping to only include them in one regression analysis.

D.4.2 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.

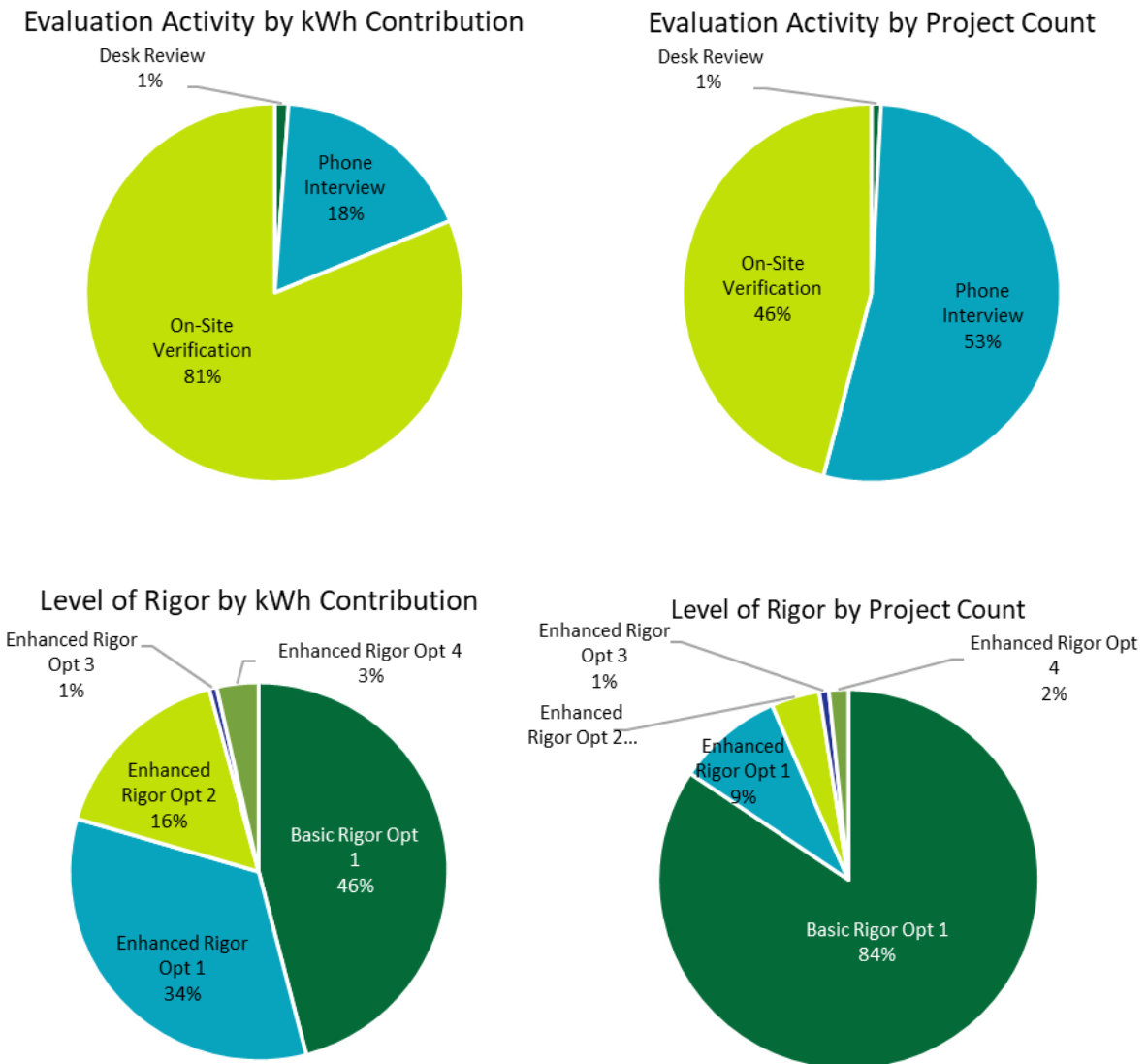
Table 145 outlines the evaluation activities by project count for each of Duquesne Light's non-residential programs, along with the evaluation realization rates. It should be noted that no evaluation activities were conducted for the Small Commercial Direct Install (SCDI) and the Community Education programs.

Table 145: Duquesne Light Evaluation Activities by Project Count

Program / Strata	Sample Quantity (PY10/PY11)	RR	Desk Review	Phone Interview	On-Site Verification
Commercial Efficiency / Express Efficiency	36	114%	0	15	21
Commercial - Large	6	79	-	-	6
Express - Large	0		-	-	-
Commercial - Medium	7	103%	-	1	6
Express - Medium	8		-	0	8
Commercial - Small	3	127%	-	2	1
Express - Small	12		-	12	-
Small/Medium and Large Midstream Lighting	31	114%	0	17	14
SNUP-Certainty	2	133%	-	-	2
SNUP-Large	7	121%	-	3	4
SNUP-Small	5	116%	-	2	3
LNUP-Certainty	2	70%	-	-	2
LNUP-Large	9	66%	-	6	3
LNUP-Small	6	168%	-	6	-
SCDI	0	N/A	0	0	0
Multifamily House Retrofit	8	102%	0	8	0
MFHR-Large	5	99%	-	5	-
MFHR-Small	3	113%	-	3	-
Industrial	19	85%	1	8	10
Small	10	100%	-	7	3
Medium	8	72%	1	1	6
Large	1	100%	-	-	1
Public Agency Partnership	28	109%	0	17	11
PAPP - Large	8	96%	-	2	6
PAPP - Small	20	139%	-	15	5
Community Education	0	98%	0	0	0
Community Ed - Large	-	94%	-	-	-
Community Ed - Small	-	114%	-	-	-
Total	122	114%	1	65	56

Figure 77 provides a summary of the evaluation activities and M&V approaches utilized by Duquesne Light’s evaluation contractor in their PY11 verified savings calculations. Guidehouse conducted site verification for approximately half of the PY11 evaluation sample, and this is most pronounced from the perspective of verified savings. However, most of these site visits encompassed verification only.

Figure 77: Summary of Duquesne Light’s C&I Evaluation Activities



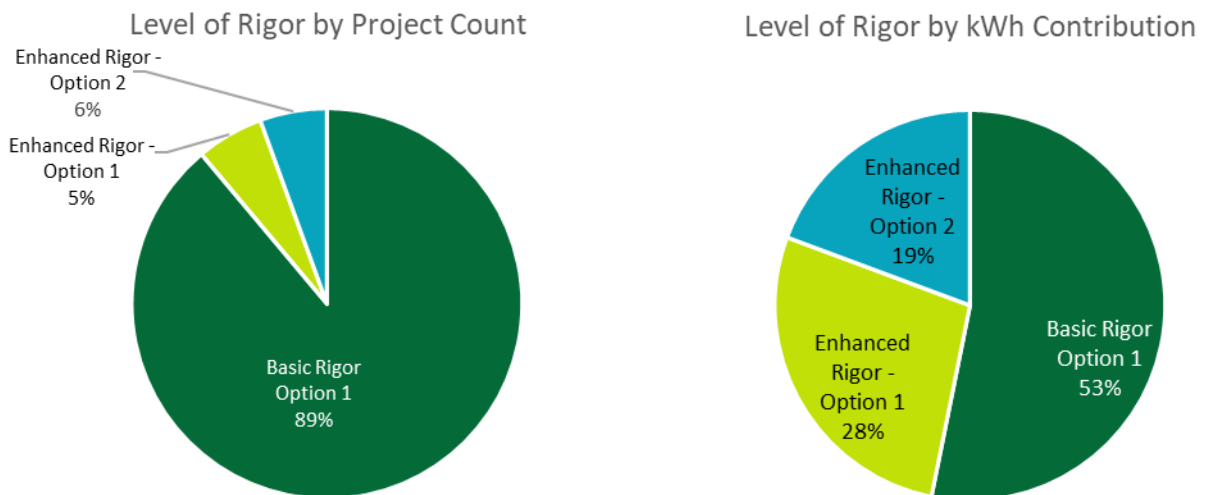
The SWE’s review of verified savings for non-residential programs found that, overall, the verified savings estimations were aligned with the Evaluation Framework, followed proper custom site-specific M&V activities, applied TRM protocols correctly, and that the verified savings are generally accurate. The following subsections outline the evaluation activities for each of Duquesne Light’s non-residential programs in PY11.

D.4.2.1 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 PY10 and PY11 projects. The combined Commercial Efficiency and Express Efficiency programs comprised approximately 42% of the PY11 verified energy savings for the non-residential portfolio. Guidehouse sampled 36 projects across both programs from its PY10-PY11 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 78. Guidehouse only evaluated 11% of the program sample using Enhanced Rigor methods; this accounted for approximately 47% of verified program savings.

For PY11, Guidehouse targeted a relative precision of 15% at the 90% confidence interval. The achieved precision slightly exceeded this target at 17.3%. Sample sizes in PY12 can be adjusted to bring achieved precisions within target.

Figure 78: Summary of Duquesne Light's PY11 Commercial and Express Efficiency Program by Level of Rigor



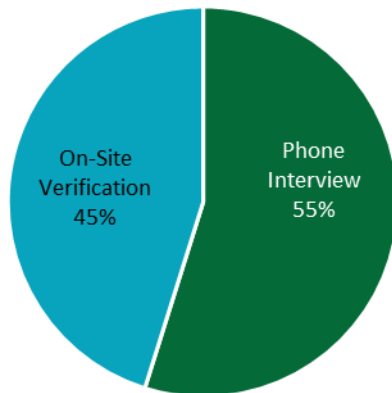
D.4.2.2 Small/Medium and Large Midstream Non-Residential Lighting

The Midstream Lighting program consists of two strata: Small/Medium and Large. Both strata are further divided into Certainty, Large, and Small sub-strata. Certainty projects are those projects that claim demand savings of 20 kW or greater. Since this program was not evaluated in PY10, PY11 savings are the combined verified savings from PY11 and the unverified savings from the last eight months of PY10.

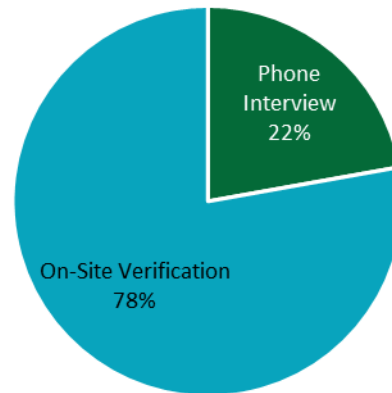
Thirty-one Midstream projects are included in the PY11 sample: 14 Small/Medium projects and 17 Large projects. Of the sampled projects, 45% were evaluated through an on-site verification which accounted for 78% of verified savings, as presented in Figure 79. All sampled projects used a Basic Rigor – Option 1 method to calculate savings.

Figure 79: Summary of Duquesne Light's PY11 Midstream Lighting Program Evaluation Activities

Evaluation Activity by Project Count



Evaluation Activity by kWh Contribution



Guidehouse achieved realization rates for the Midstream program of 114% for both energy and 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. Both energy and demand relative precisions fell just short of this target at 16.7% and 15.3%, respectively.

D.4.2.3 SCDI

No program savings for the SCDI program have been achieved since Q1 of PY10; therefore, Guidehouse did not evaluate SCDI in PY11. Since no further savings were achieved in PY11, Guidehouse only reported program total savings from previous years as Phase III savings for this program.

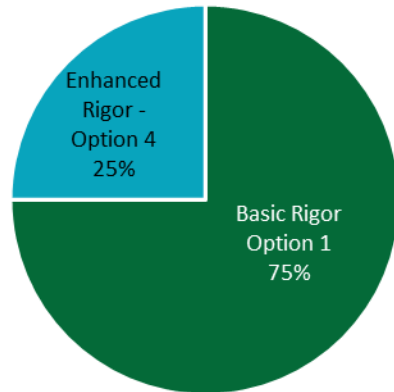
D.4.2.4 Multifamily House Retrofit

For PY11, Guidehouse evaluated the gross savings of eight MFHR projects. The MFHR program is stratified into Large and Small projects. No evaluation activities were conducted for this program in PY10, so the sample consists solely of projects completed in PY11. Guidehouse estimated a program realization rate of 102% for energy and 108% for demand. Due to COVID-19 impacts and the inability to safely access multifamily areas, only phone interviews were conducted as the

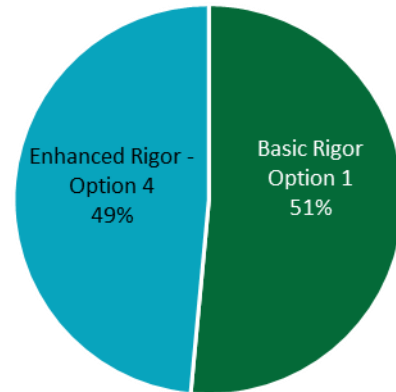
primary evaluation activity. Three-quarter of the sampled projects were evaluated using a Basic Rigor Option 1 method, while two projects were evaluated using Enhanced Rigor Option 4, as depicted in [Figure 80](#).

Figure 80: Summary of Duquesne Light's PY11 Multifamily House Retrofit Program by Level of Rigor

Level of Rigor by Project Count



Level of Rigor by kWh Contribution

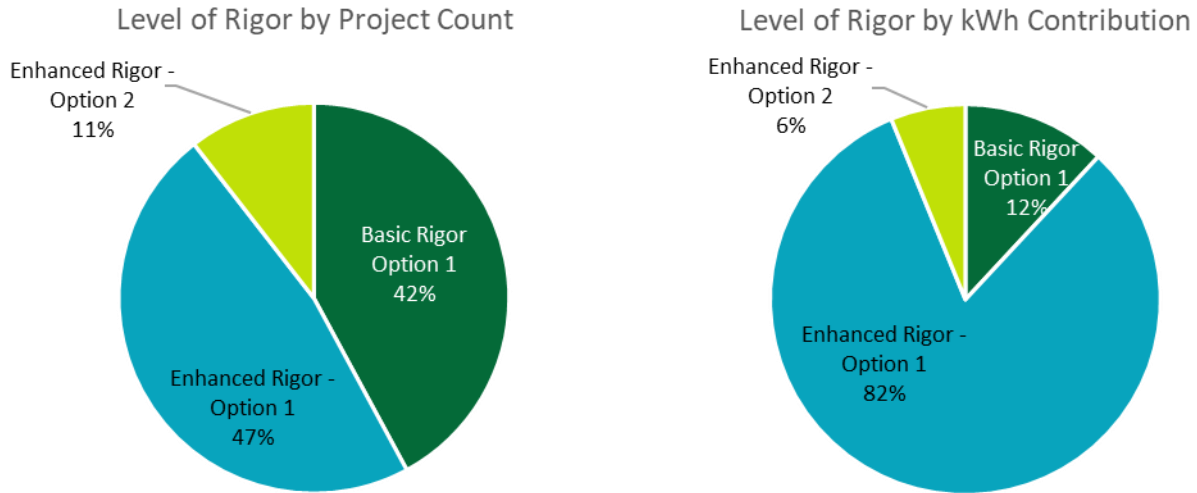


Of the eight MFHR projects sampled, five were Large projects and three were Small projects. In a non-pandemic year, a site-visit with metering would have been required for one of the Large projects as the total savings for this Custom – Ventilation project surpassed the 250,000 kWh TRM threshold for metering. For PY11, 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.4.2.5 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 PY10 and PY11. Guidehouse reviewed a total of 19 measures across both program years, of which nine were sampled from PY11. Relying on the previously analyzed PY10 measures combined with the PY11 sampled measures, Guidehouse estimated a program realization rate of 85% 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 81](#). Guidehouse evaluated approximately 58% of the program sample using Enhanced Rigor methods; this accounted for approximately 88% of verified program savings.

Figure 81: Summary of Duquesne Light's PY11 Industrial Efficiency Program by Level of Rigor



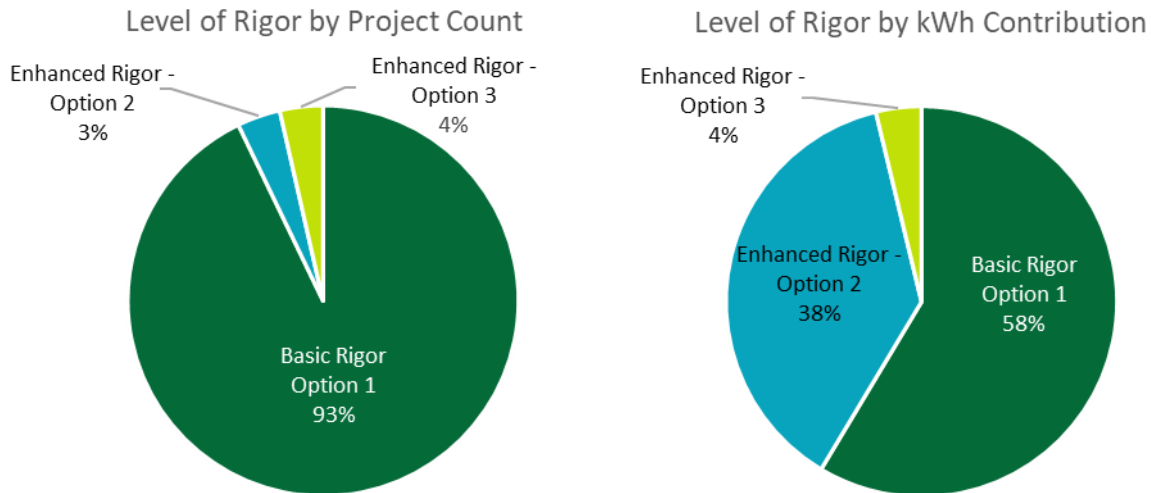
One Large strata measure was evaluated in PY11. This Large measure was a Custom – Interior Lighting measure with over 3 million kWh in savings. It accounted for two-thirds of the total savings in the sample. Guidehouse conducted a site-verification with metering visit for this measure and performed Enhanced Rigor – Option 1 (IPMVP Option A) on this measure to verify savings.

For PY11, Guidehouse targeted a relative precision of 15% at the 90% confidence interval. Guidehouse met this goal for both energy and demand verified savings.

D.4.2.6 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 PY11, as well as projects in PY10. Across both program years, Guidehouse completed analysis on 28 sites, of which twenty were from PY11. All twenty PY11 samples were lighting retrofits except for one project, which was a pumping retrofit with VFD controls. Guidehouse segmented its sample into two strata: Large and Small. Relying on the previously analyzed PY10 measures combined with the PY11 sampled measures, Guidehouse estimated a program realization rate of 109% for energy savings and an 80% realization rate for demand savings.

Guidehouse used the Basic Rigor Option 1 (TRM deemed savings) evaluation method for all PY10 and PY11 sampled projects except for two projects, which were evaluated using Enhanced Rigor Option 2 (equivalent to IPMVP Option B) and Enhanced Rigor Option 3, as illustrated in [Figure 82](#). Only one Custom – Cooling project in the sample claimed savings over the 250,000 kWh criteria, for which a site-visit with metering was conducted for this project. All other remaining projects did not surpass the TRM threshold for enhanced rigor M&V methods.

Figure 82: Summary of Duquesne Light's PY11 PAPP Program by Level of Rigor

For PY11, Guidehouse targeted a relative precision of 15% at the 85% confidence interval. Guidehouse met this goal for energy verified savings. While a precision target is not required for demand savings, Guidehouse only achieved $\pm 51\%$ relative precision for the demand savings realization rate. Per the Phase III Evaluation Framework, if precision of demand savings is significantly less than precision of energy estimates, evaluators should investigate the source of variation further to determine if revisions to ex-ante savings assumptions or ex post analysis techniques are warranted. Guidehouse noted that a potential reason for the low demand precision is that for a large pumping system project completed in PY11, the billing data for that project revealed lower demand savings than what was originally claimed.

D.4.2.7 Community Education Program

Guidehouse did not evaluate the Community Education Program for PY11. Instead, the program's realization rates were used from PY10 and applied to PY11 savings. In PY11, 31 projects participated in the CEP program. The energy and demand realization rates used for this program are 98% and 102%, respectively.

D.4.2.8 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 146 provides an overview of the SWE milestones for the audit of Duquesne Light’s site inspection efforts.

Table 146: Duquesne Light Ride-Along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)*	Field Engineers Observed	Measure Types Observed	Attainment Percentage
4	1,611,319	1	2	100.8%

*Savings reported by evaluation contractor.

The SWE conducted a total of four ride-alongs and project reviews that included LED lighting and Custom – Ventilation measure types. The SWE generally agreed with the methodology and calculations submitted by Duquesne Light’s evaluation contractors. For one lighting project, the SWE observed that the evaluator inadvertently left out controls savings for a portion of the project. Correcting these issues resulted in an attainment percentage of 103% for that project.

For the remaining three projects, 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. The SWE made recommendations to Guidehouse regarding correction of the identified issue for the one project mentioned above, and Guidehouse incorporated those recommendations into final verified savings estimates for that project.

D.4.2.9 Verified Savings Desk Reviews

Table 147 provides an overview of the SWE milestones for the verified savings review of evaluated Duquesne Light projects.

Table 147: Duquesne Light Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Measure Types Observed	kWh Attainment Percentage
5	4,545,787	4	100%

*Savings reported by evaluation contractor.

The SWE conducted a total of five project reviews: two LED lighting projects, a New Construction lighting project, a New Construction Process project, and a VFD 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.5 DR

Duquesne Light's Phase III DR 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 four days those guidelines required in PY11.

Table 148 summarizes gross verified impacts for the four PY11 DR events the average event. During the initial review by the SWE Team, it was noted that there was an error with the handling of holidays in the data cleaning process. The Duquesne Light/Guidehouse team updated the analysis in March 2020 and produced the final PY11 DR Impacts that are presented in Table 148.

Table 148: PY11 DR Impacts 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)	Average Portfolio (Verified MW) w/ 90% CI
July 17, 2019	15	18	1.6	53.6	55.2±8.9
July 18, 2019	16	19	1.6	38.3	39.9±9.5
July 19, 2019	15	18	1.3	56.3	57.5±10.5
August 19, 2019	15	18	1.2	70.2	71.3±10.7
PYVTD - Average PY11 DR Event Performance					56.0±5.0
VTD - Average Phase III DR Event Performance					55.2±3.2

The Duquesne Light/Guidehouse 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, and verified DR impact
- For 14 sites selected by the SWE, the hourly load and weather data needed to replicate the Guidehouse impact estimates
 - These 14 sites represented approximately 67% of the gross verified PY11 DR impacts
- The Weather Sensitive Adjustment (WSA) slopes for sites that used a “high 4 of 5 with WSA” baseline method

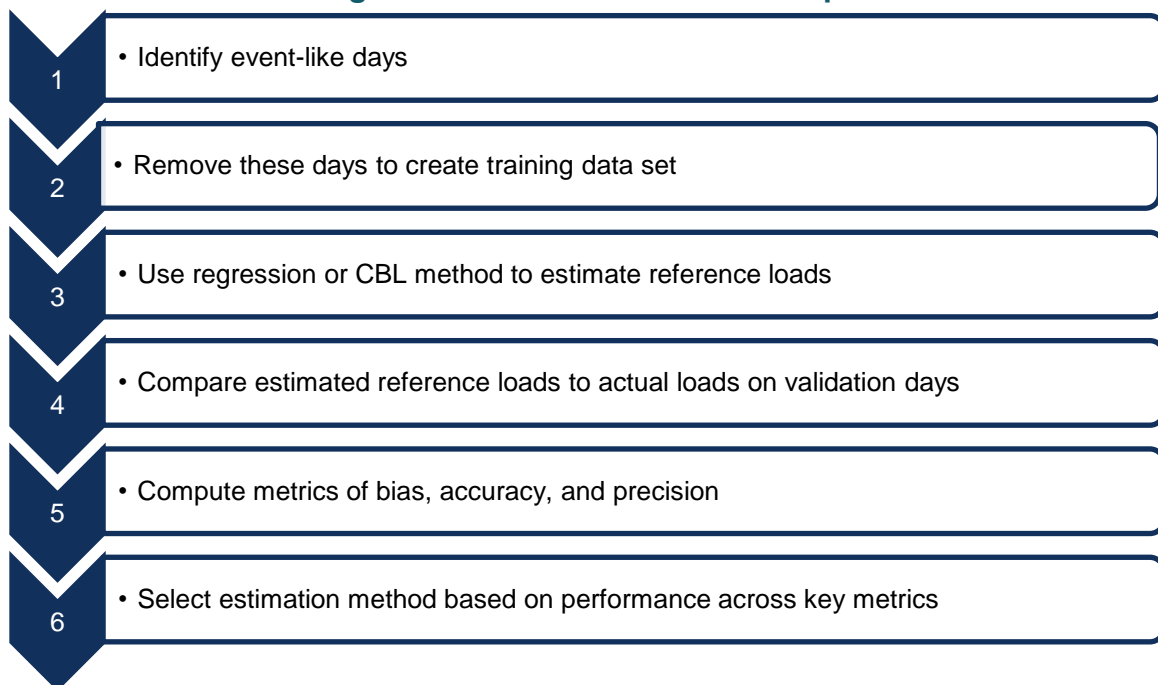
D.5.1 Application of LLFs

Guidehouse used a commercial 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 C&I values of Table 1-4 of the 2016 PA TRM.

D.5.2 Reference Load Selection

The approach Guidehouse used to determine reference loads for C&I DR participants was consistent with the process shown in [Figure 83](#), 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 PY11 impacts.

Figure 83: Baseline Selection Steps



Guidehouse tested High 4 of 5 CBL with and without WSA and 170 regression baselines in order to select the best model for each customer. The PY11 uses a new simplified baseline regression model that performed well in PY11. [Table 149](#) shows the distribution of baseline approaches across the PY11 program population. Individual customer regression analysis was used for 153 sites and 86% of the DR impacts.

Table 149: PY11 Reference Load Frequency Table

Baseline Method	Number of Sites Used	Share of DR Impacts (at Meter)
High 4 of 5	11	3.2%
High 4 of 5 with WSA	28	10.8%
Individual Customer Regression	153	86.0%

Guidehouse has effectively implemented the testing of multiple models on each customer and selected the specific model that best models facility peak loads on metrics of accuracy, bias, and precision.

D.5.3 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 final results (after the March 2020 update). After the totals were confirmed, the SWE team independently calculated reference loads and load impacts for each event hour for each of the 14 sites where hourly load data was requested. For all event hours for the 14 sites, excluding a single customer and event hour, the SWE estimates matched the Guidehouse values exactly. For the single event hour that was not a perfect match, this customer's impacts were matched for all other seven participating hours. The SWE team is not concerned with this edge case. For the PY11 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.5.4 Data Management

The PY9 analysis noted issues with data completeness for the last day of each month. Guidehouse's provided load data 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.

D.5.5 Conclusion

Duquesne Light exceeds the 85% event-specific target for all PY11 events and maintains consistent progression towards Phase III compliance target with only one event falling below the target of 42 MW across all DR events in this program year.

The SWE team found the Guidehouse verified savings analysis to be systematic and well-documented for PY11. Duquesne Light/Guidehouse should attempt to uncover the meter data collection issue that affects the last day of each month and mitigate this problem in PY12. If an Act 129 event day were to fall on the final day of a month, the missing data issue would go from a quirk to a major EM&V barrier. The SWE recommends that PUC adopt the verified savings totals when assessing compliance with Phase III targets.

D.6 NTG

D.6.1 Residential Programs

Guidehouse conducted primary research to estimate PY11 Appliance Recycling, REEP Rebates, and REEP Kits Program NTG values. Guidehouse utilized the common method of NTG calculation as identified in the Phase III Evaluation Framework. Residential Appliance Recycling, REEP Rebates and Kits NTG values were measured using data collected from participant surveys. Guidehouse also applied PY9 NTG to the REEP Standard and Specialty LED Programs. Guidehouse did not report a market rate NTG for the WHRP during PY11.

The Residential HER Program claimed an NTG of one, 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 SWE determined that Guidehouse utilized data collection, question beviies, and the common NTG formula recommended in the current Evaluation Framework.

Table 150: Summary of NTG Estimates for Duquesne Light Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
Evaluated	Residential Appliance Recycling	0.61	0.08	0.47	217
RCT	HER	0.0	0.0	1.0	--
Evaluated	REEP Rebates	0.46	0.07	0.61	112
Evaluated	REEP Kits	0.32	0.11	0.79	609
PY9	REEP Standard LED	0.66	0.09	0.43	--
PY9	REEP Specialty LED	0.65	0.09	0.43	--
Combination of program NTG values	REEP Total	0.58	0.09	0.50	721

D.6.2 LI Residential Programs

Guidehouse did not gather data during PY11 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 151: 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.6.3 C&I Programs

Guidehouse conducted NTG research in PY11 for the Commercial Efficiency/Express Efficiency and Industrial Efficiency Programs using participant phone and email surveys. Guidehouse applied the PY10 NTG to the Midstream Lighting Program and applied PY9 Multifamily Housing Retrofit, Public Agency Partnership, and Community Education Programs.

The SWE determined that Guidehouse utilized data collection, question beviies, decision trees, and the common NTG formula recommended in the current Evaluation Framework.

Table 152: Summary of NTG Estimates for Duquesne Light C&I Programs

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Total Midstream Lighting	0.28	0	0.72	--
Evaluated	Commercial Efficiency/ Express Efficiency	0.21	0.00	0.79	32
Program Not Active in PY11	SCDI	--	--	--	--
PY9	Multifamily Housing Retrofit	0.55	0.0	0.45	--
Evaluated	Industrial Efficiency	0.39	0.0	0.61	10
PY9	Public Agency Partnership	0.55	0.0	0.45	--
PY9	Community Education	0.55	0.0	0.45	--

D.7 TRC

Table 153 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Duquesne Light's PY11 individual programs and overall portfolio. The SWE team found no major inconsistencies between the TRC model outputs and the TRC results shown in the PY11 annual report.

Table 153: Summary of Duquesne Light's PY11 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	3,609	4,456	0.81	1,826	3,294	0.55
Residential Appliance Recycling	673	377	1.79	315	377	0.83
Residential Behavioral Savings	273	926	0.29	273	926	0.29
Residential Whole House Retrofit	0	79	0.00	0	79	0.00
LI Energy Efficiency	492	1,209	0.41	492	1,209	0.41
Express Efficiency	7,236	2,710	2.67	5,232	2,303	2.27
Small/Medium Midstream Lighting	949	479	1.98	679	419	1.62
SCDI	0	77	0.00	0	77	0.00
Multifamily Housing Retrofit	1,064	2,579	0.41	484	1,507	0.32
Commercial Efficiency	9,528	2,954	3.23	7,504	2,529	2.97
Large Midstream Lighting	356	350	1.02	255	321	0.80
Industrial Efficiency	9,139	2,825	3.23	5,555	2,324	2.39
Public Agency Partnership	8,875	3,045	2.92	4,037	1,978	2.04
Community Education	1,738	1,007	1.73	791	696	1.14
Large C&I DR Curtailable	5,882	1,686	3.49	5,882	1,686	3.49
Portfolio Total	49,815	24,759	2.01	33,324	19,724	1.69

Of Duquesne's 15 energy efficiency programs offered, nine were found to be cost-effective and six were non-cost-effective when estimating the TRC using gross verified savings. Using net verified savings, seven programs were found to be cost-effective and eight were non-cost-effective. The Residential Appliance Recycling and Large Midstream Lighting programs were cost-effective under gross-verified savings but non-cost-effective under net verified savings. PY11 residential programs saw a general decrease in TRC ratios compared to PY10 TRC ratios whereas non-residential programs saw a general increase. The PY11 Portfolio TRC ratio increased slightly from the previous PY10 TRC ratio.

D.7.1 Notes from the Review of the TRC Model

- Duquesne Light used a discount rate of 6.9%, which is used to calculate the NPV 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), 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. DR realization rate excluded line losses.
- The calculation of NTG using free-ridership and SO, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the TRC 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.
- 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 693 thousand gallons of water saved over the lifetime (at \$0.01 per gallon avoided) or approximately \$4,678 in lifetime avoided costs.
- Duquesne Light accounts for the dual baselines for residential and nonresidential lighting by reducing the EULs to adjust lifetime savings. The team found that the EULs for ROB were consistent with the *Dual Baseline Assumptions for Screw-In LED Lighting in PY11 and PY12 TRC Test*. For ROB A-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. For ROB specialty lamps, the bulbs' first- and second-years' wattages (post-EISA 2007 Watts) are used as the baseline and are adjusted to Post-2020 Watts for 13 years. The team found for early replacement A-lamps, 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. This adjustment is reflected in [Table 153](#) under the LI Energy Efficiency Program.

The Duquesne Light TRC model is performing most of the benefit-cost calculations in accordance with the 2016 TRC Order, although one inconsistency was noted with regard to the DR

calculations. The SWE Team recommends adjustments to the DR calculations be made for PY11 and update PY11 values in future P3TD reporting.

- The DR program TRC ratio did not meet the 75% participant cost assumption where 75% of customer incentive payment is used as a proxy for participant cost. The following changes shown for the Large C&I DR Curtailable program (LCL) in [Table 154](#) are also reflected in [Table 153](#).

Table 154: Summary of LCL Finances – Gross and Net Verified¹

Row #	Cost Category	PYTD (\$1000)	P3TD (\$1000)
1	EDC Incentives to Participants	\$824	\$2,124
2	EDC Incentives to Trade Allies	\$0	\$0
3	Participant Cost (net of incentives/rebates paid by utilities)	-\$206	-\$531
4	Incremental Measure Costs (sum to rows 1 through 3)	\$618	\$1,593

¹ Tables 3.14-5 and 3.14-6 in DLC PY11 Final Annual Report

D.8 PROCESS

The Duquesne Light PY11 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 PY11.

D.8.1 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 PY11, Guidehouse conducted process evaluation activities for four Duquesne Light residential programs: REEP, RARP, the HER program, and the LIEEP.

For the PY11 process evaluation of the above programs, Guidehouse conducted interviews with program managers and conservation service providers (CSPs), reviewed program documentation and tracking databases, and conducted surveys with program participants.

For each program, the SWE provides a summary of the process evaluation findings and the SWE’s audit of those findings.

D.8.1.1 Residential Energy Efficiency Program (REEP)

Summary of Process Evaluation Findings

The Duquesne Light REEP program is designed to encourage customers to make an energy-efficient choice when purchasing and installing household appliance and equipment measures by offering customers educational materials and financial incentives. The REEP program has three main components:

1. Rebates for energy-efficient equipment
2. Upstream incentives for efficient lighting
3. Distribution of energy-efficiency kits

Guidehouse's PY11 process evaluation activities for REEP addressed two components of the program: the rebates and kits components. When reporting, Guidehouse combined results from LI kit and market rate kit survey efforts to offer a comparison.

The process evaluation for the REEP program in PY11 included a participant survey and interviews with program managers and the CSP.

Key findings for the rebates program component included the following:

- *Program Awareness.* The most common sources of program awareness are Duquesne Light's website, the installation contractor or trade ally, energy equipment vendor or salesperson, and the HERs program.

Key findings for the energy efficiency kits program component included the following:

- *Program Awareness.* About 17% of kit survey respondents heard about other Duquesne Light energy efficiency programs.
- *Satisfaction.* Participants reported very high satisfaction with the kits, with 91% providing a rating of 7 or higher on a scale from 0 to 10. Participants were interested in receiving more or different products and requested more information about the products contained in the kit.

Summary of Process Evaluation Audit

The process evaluation of REEP appears to have been generally consistent with the Phase III evaluation plan. The PY11 residential sampling plan targeted 150 participant surveys (75 for REEP Rebates, 50 for REEP Kits, and 25 for REEP Kits – LI) and exceeded those targets.⁸⁴ The SWE notes that Appendix E includes a number of detailed tables on respondent demographics; however, additional clarity could have been achieved by reporting survey disposition separately for REEP market rate and LI participants.

Three recommendations follow from the process evaluation; two were accepted and one is under consideration.

⁸⁴ Table 3; Sample Design for Program Year 11 Duquesne Light: Residential Sector Impact and Process Evaluation. Memo sent by Guidehouse on March 24, 2020 to the SWE.

D.8.1.2 Residential Appliance Recycling Program (RARP)

Summary of Process Evaluation Findings

The Duquesne Light RARP program is designed to produce cost-effective, long-term, coincident peak demand reduction and annual energy savings by removing operable, inefficient, primary and secondary refrigerators and freezers from the power grid in an environmentally safe manner.

The process evaluation for the RARP program in PY11 included a participant survey and interviews with the program managers and the CSP.

Key findings included the following:

- *Satisfaction.* Participants reported a high satisfaction with the program, with 95% rating it a 7 or higher on a scale from 0 to 10. The most common suggestion for program improvement was for the CSP to be more specific about the pick-up time for the appliance.

Summary of Process Evaluation Audit

The process evaluation of RARP appears to have been consistent with the Phase III evaluation plan with the exception of program staff interviews, which were conducted but not planned for PY11.⁸⁵

In the residential sampling plan, Guidehouse targeted 140 participant surveys (25 for freezers and 115 for refrigerators).⁸⁶ Guidehouse completed surveys with 201 participants (Table E-1).⁸⁷ In addition, the SWE notes that it would be useful to report on the survey disposition by appliance type to match the detail from the sampling plan.

One recommendation follows from the process evaluation; it was accepted by Duquesne Light.

D.8.1.3 Low-Income Energy Efficiency Program (LIEEP)

Summary of Process Evaluation Findings

The Duquesne Lighting LIEEP serves qualified LI customers in the following program components:

1. LI Kits Program (LI Kits)
2. Residential Behavioral Savings Program (LI HER)
3. WHRP (LI HER)
4. Multifamily Housing Retrofits Program (MFHR)

Key findings included:

- *WHRP Data Management.* Guidehouse heard from onsite auditors that physical paperwork can be cumbersome and make efficient data collection difficult. Additionally,

⁸⁵ Table 6-10 in the PY11 Update of DLC Act 129 Phase III EMV Plan.

⁸⁶ Table 5; Sample Design for Program Year 11 Duquesne Light: Residential Sector Impact and Process Evaluation. Memo sent by Matt O'Hare on March 24, 2020 to the SWE.

⁸⁷ In an email to the SWE on March 19, 2021, Guidehouse confirmed that the total number of participants surveyed for the RARP evaluation was 201.

onsite auditors said that the pandemic made exchanges of physical report and application papers with participants difficult given the desire for social distancing.

- *Direct Install Measure Offerings.* Guidehouse heard from on-site auditors that participants tend to have a mix of bulb types installed within their homes (e.g., candelabras, PAR, globe), so only offering A-line type LEDs is leaving potential program savings on the table.

Summary of Process Evaluation Audit

In the PY11 update of the evaluation plan, Guidehouse indicates that the LI specific program component participants will consist of separate strata in the WHRP, REEP, and HER evaluations. Guidehouse notes that this is consistent with guidance in the SWE's Evaluation Framework.

Program manager, implementer, and audit contractor interviews were planned as part of the PY11 process evaluation. Guidehouse conducted interviews with four onsite auditors from the CSP for the LI WHRP, which produced findings for the report.⁸⁸ The program manager and implementer interviews were not mentioned in the Annual Report.

In PY9, the SWE observed that it would improve clarity to summarize results pertaining to LI segments of other programs in the LIEEP section of the report, even if they are also mentioned in context alongside process findings for market rate survey respondents. In the PY10 audit, the SWE noted that Guidehouse followed through with this recommendation in the PY10 annual report. The process evaluation of the PY11 LIEEP program (Section 3.6.5) directs readers to the report sections for the market rate REEP kits and HER program without summarizing findings from the relevant LI programs. The SWE recognizes the value of presenting the LI results alongside market-rate results as it provides important context; however, the SWE would like to see a summary of process evaluation activities conducted for LI programs in the LIEEP section.

Guidehouse reported that they targeted 40 LI HER participant surveys and achieved 71 total responses (33 online surveys and 38 phone surveys). This conforms with the sample plan.⁸⁹ Guidehouse reported on the HER component of LIEEP alongside the process evaluation findings for the market-rate HER program. In the PY11 Residential Sampling Plan, Guidehouse planned to target 25 participant surveys for LI kit recipients. Process evaluation results for the LI kit program component are reported on alongside the market-rate REEP kits and achieved at least 114 total LI responses.⁹⁰ The SWE notes that the Survey Disposition Summary table in Appendix E does not disaggregate REEP Kit participant survey completion rates by market rate and LI participants.

Two recommendations followed from the process evaluation of LIEEP; they are under consideration by Duquesne Light.

⁸⁸ Guidehouse noted that the program manager and implementer interviewers were intended to inform evaluation activities and did not produce any notable findings.

⁸⁹ Duquesne Light: PY11 Residential Process Evaluation Sample Design. Sent to the SWE by Guidehouse on May 6, 2020.

⁹⁰ Figure 3.2-1 on the Annual Report indicates there were at least 114 LI survey respondents. However, the SWE notes this is not a substitute for a table summarizing sample targets, survey methodology, and completed surveys.

D.8.1.4 HER Program

Summary of Process Evaluation Findings

The Duquesne Light Residential Behavioral Savings Program, also known as the HER program, influences behavior changes in customers by providing information via energy reports to participants.

Key findings included the following:

- *Program Engagement.* Only 4% of customers access the report via website portal.
- *Program Influence.* The HER program has a very strong influence on participants' behavior. Sixty percent of customers who received HERs changed their behavior related to energy conservation and 75% reported making energy-efficient appliance purchases or home upgrades in the past year.

Summary of Process Evaluation Audit

The process evaluation for the HER program in PY11 included a participant survey and interviews with the program manager and program implementer.

In the PY11 Update of the DLC Act 129 Phase III EMV Plan, Guidehouse mentioned developing a program theory and logic model as part of the process evaluation, but that activity was not reported on in the Annual Report. With the exception of that activity, evaluation activities conformed with the evaluation plan and the methodology was well-documented. In particular, the SWE notes the inclusion of a table summarizing survey sample design (Table 3.4-6), which was not included in the report sections for some of the other residential program process evaluations.

One recommendation follows from the process evaluation; it was accepted by Duquesne Light.

D.8.1.5 WHRP

Duquesne Light focused its direct install and audit efforts on the LI market segment during PY11. Savings were not achieved in the market rate program in PY11. As a result, Guidehouse did not evaluate the non-LI portion of WHRP in PY11.

D.8.2 C&I Programs

Duquesne Light operated nine C&I energy-efficiency programs in PY11:

- 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 PY11, Guidehouse conducted process evaluations for six of the programs: the Express Efficiency Program (EXP), Commercial Efficiency Program (CEP), Multifamily Housing Retrofit Program (MFHR), Industrial Efficiency Program (IEP), Public Agency Partnership Program (PAPP), and Community Education Energy Efficiency Program (CEEEP). Process evaluation activities and summaries for EXP, CEP, and IEP were combined. Process evaluation activities for PY11 included participant surveys and interviews with program managers, CSP, and trade allies.

The SWE notes that a number of summaries and clarifying details recommended in the SWE PY10 Annual Report, such as value ranges of survey responses and summaries of process evaluation activities, were included in the PY11 Duquesne Light Annual Report.

For each program, the SWE provides a summary of the process evaluation findings and the SWE's audit of those findings. Eight recommendations followed from process evaluation activities. Two recommendations were accepted and six recommendations were under consideration by Duquesne Light. In PY10, the SWE requested that Duquesne Light's responses to recommendations to be prefaced by a clearly defined status (e.g., "accepted," "rejected," "under consideration"). The SWE notes that Guidehouse implemented this suggestion throughout the PY11 report.

D.8.2.1 Express Efficiency Program

Summary of Process Evaluation Findings

The EXP provides rebates to offset the higher cost of high-efficiency equipment. EXP targets all Duquesne Light C&I customers with maximum demand less than 300 kW that are not already participating in other Act 129 programs.

The EXP and CEP were grouped together for evaluation purposes. Process evaluation activities also included the IEP. Key findings included the following:

- *Program Awareness.* Participants first heard about the program from contractors (28%), word of mouth (15%), and program staff (10%). Trade allies most frequently learned about the programs from the program website.
- *Program Influence.* More than 90% of participants reported that rebates were at least somewhat influential in their decision to install energy-efficient equipment, and more than 70% of participants reported that recommendations from installation contractors and trade allies were at least somewhat influential in their decisions to install energy-efficient equipment.
- *Barriers and Challenges to Participation.* Some trade allies found it challenging to identify the correct point of contact for the three programs. Trade allies noted that program materials could be improved. Participants also reported burdensome paperwork as one of the main barriers for participating in the program.
- Trade allies recommended adding measures related to HVAC, refrigeration, food service equipment, and lighting and controls to Duquesne Light's prescriptive catalog.

Summary of Process Evaluation Audit

Evaluation activities conformed with the evaluation plan and the methodology was generally well-documented, with some exceptions, as noted. For the process evaluation of CEP, EXP, and IEP, Guidehouse conducted interviews with program managers and the CSPs, trade ally interviews, and participant surveys.

A total of 330 unique sites participated in the CEP or EXP programs. The Guidehouse team sampled 229 unique contacts for the participant survey (150 for EXP, 36 for CEP, and 43 for IEP) and completed 42 surveys (38 full and four partial completes).⁹¹

Due to the similarity of the three programs, findings from the process evaluation were presented across all programs.

Guidehouse targeted 26 trade ally interviews and was able to complete 13. The SWE notes that the methodology would have benefited from clarification of how many trade allies participated in more than one program, given the aforementioned similarities between the CEP, EXP, and IEP.

Five recommendations followed from the process evaluation activities. One was accepted and the other four are under consideration from Duquesne Light.

D.8.2.2 Midstream Lighting Program

Guidehouse did not conduct process evaluation research for the Midstream Lighting Program during PY11. However, according to Table 6-17 in the PY11 Update of the Phase III EM&V plan, Guidehouse planned to conduct program manager and implementer interviews in PY11.

D.8.2.3 Small Commercial

There was no process evaluation for the Small Commercial Program in PY11.

D.8.2.4 Multifamily Housing Retrofit Program

Summary of Process Evaluation Findings

The MFHR Program targets multifamily housing for income-qualified occupants. The program assists customers in improving the efficiency of common area spaces and any dwelling units served by a building-level meter.

Key findings included the following:

- *Program Awareness, Barriers, and Challenges.* One of the two trade allies interviewed mentioned that uncertainty in the incentive amount makes it challenging to communicate costs and finalize a potential sale of energy-efficient equipment with multifamily customers.

⁹¹ Guidehouse confirmed in an email on March 19, 2021, that the number of unique contacts was less than total participation because some contacts owned multiple sites. Guidehouse confirmed that Table 3.7-1 contains the primary definition for number of participants. The SWE notes that the report would have benefited from additional clarity by providing this context in the report.

Summary of Process Evaluation Audit

Evaluation activities conformed with the evaluation plan. Guidehouse conducted program manager, CSP, and trade ally interviews. Attempts to contact all three trade allies who participated in the MFHR program were well-documented in the report. Guidehouse was able to complete interviews with two of the three participating trade allies.

One recommendation followed from the process evaluation activities; it is under consideration from Duquesne Light.

D.8.2.5 Commercial Efficiency Program

Guidehouse reported on the process evaluation research activities and findings alongside the EXP and the IEP. See [Appendix D.8.2.1](#) for details on the CEP process evaluation for PY11.

D.8.2.6 Industrial Efficiency Program

Guidehouse reported on the process evaluation research activities and findings alongside the EXP and the IEP. See [Appendix D.8.2.1](#) for details on the CEP process evaluation for PY11.

D.8.2.7 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 PY11, Duquesne Light leveraged the opportunity presented by pandemic-related school closures to implement an additional delivery channel that targeted schools with direct shipments of linear replacement LEDs. Guidehouse sampled three of these projects 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:

- *Implementation.* Duquesne Light launched the self-install schools delivery channel within weeks of Covid-19 pandemic restrictions. Guidehouse heard anecdotally through discussions with verification site contacts that there is high satisfaction among the participating schools.
- *Program Awareness, Barriers, and Challenges.* Trade allies interviewed for PAPP said they found it challenging to identify the correct point of contact for the program.

Summary of Process Evaluation Audit

In the PY11 update of the Phase III EM&V plan, Guidehouse indicated that they planned to pivot from planned participant surveys to focus primarily on interviews with trade allies. Evaluation activities conformed with the evaluation plan. Guidehouse completed program manager, CSP, and trade ally interviews for the process evaluation of PAPP in PY11. Contact information was available for 37 representatives from 24 companies. Guidehouse attempted to contact each of these representatives up to six times via email or phone, and ultimately conducted three interviews. The COVID-19 pandemic is the likely reason for the low response rate for trade ally interviews.

Two recommendation followed from the process evaluation; they were both accepted by Duquesne Light.

D.8.2.8 Community Education Program

Summary of Process Evaluation Findings

The CEEP is designed to prepare middle school and high school students to become energy-efficiency auditors and provide hands-on training while they perform energy audits at their schools. The program objective is to build the community capacity and early workforce development to support energy audits throughout the community.

Key findings include the following:

- *Program Barriers and Challenges.* The teachers interviewed reported that time constraints and alignment of the program content with existing school curriculum are the two main barriers to program participation.

Summary of Process Evaluation Audit

Evaluation activities confirmed with the evaluation plan. In the PY11 update to the Phase III EM&V plan, Guidehouse described its intention to replace process & NTG participant surveys with student or teacher interviews, given the historically small sample sizes in the program. Guidehouse interviewed the program manager, the CSP, and representatives of participating schools. The Guidehouse team met its targeted sample by interviewing all three program participants.

The reporting on program satisfaction states that the three teachers gave all program components scores of 9 or 10 on a scale of 0 to 10, where 0 means “not at all satisfied” and 10 means “very satisfied.”

One recommendation followed from the process evaluation; it is under consideration from Duquesne Light.

D.8.2.9 Large Curtailable Load Program

There was no process evaluation scheduled for the Large Curtailable Load Program in PY11.

Appendix E Met-Ed Audit Detail

E.1 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 several memos updating their sampling and evaluation approach for several programs, including for EEP appliance retailers, HVAC and appliance participants and HVAC contractors, as well as the LI direct install program and the PY12 process evaluation for the BDR program. The SWE reviewed and approved these plans with minor comments and suggestions.

In addition to reviewing FirstEnergy's evaluation memos, the SWE reviewed and approved several surveys and interview guides for the EEP appliances and HVAC programs, the residential BDR program, the LI direct install program, and the C&I DR program.

The ADM team also submitted a memo to the SWE outlining ADM's proposed EM&V methods in response to the COVID-19 outbreak.

E.2 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 $\pm 5\%$ at the 85% confidence level, then there is an 85% chance that the true value of savings for the population is between 950 MWh/year and 1,050 MWh/year. All programs that rely on sampling to calculate verified savings must include the relative precision to quantify the sampling uncertainty.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of $\pm 15\%$ 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 155](#) lists each initiative and the corresponding relative precision of the PY11 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 155: Relative Precision of Met-Ed PY11 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (\pm)
Residential Appliance Turn-In (ATI)	3.3%
LI ATI	8.1%
C&I ATI	12.3%
Res Energy Efficiency Kits	4.6%
LI Energy Efficiency Kits	71.0%
Res Direct Install	10.1%
LI Direct Install	11.6%
Res Upstream Lighting	7.9%
Res Upstream Electronics	0.0%
Res HVAC	6.5%
Residential Appliances	21.2%
LI Appliances	124.6%
Residential New Construction	13.0%
C&I Lighting	11.8%
C&I Custom	4.0%
C&I Prescriptive	9.9%

Three of the sampling initiatives shown in [Table 155](#) failed to produce verified gross savings estimates with better than $\pm 15\%$ precision at the 85% confidence level. Met Ed's LI Energy Efficiency Kits initiative only had a sample size of one in PY11, resulting in a high relative precision estimate. The high relative precisions in the Residential and LI Appliances initiatives were caused by conservative ex-ante savings values for clothes washers (93 kWh/unit) and heat pump water heaters (1,289 kWh per unit). The Residential Upstream Electronics programs have no sampling uncertainty because all files reviewed showed perfect alignment between reported and verified savings. Met-Ed adjusted some of its verification processes in response to the COVID-19

pandemic. After March 2020, ADM replaced on-site visits with phone interviews, video conferences, and data loggers.

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 E.4](#).

The Behavioral Modification subprogram provides HERs to residential customers in the Met-Ed service territory. The subprogram is divided between market rate residential customers and LI customers and each is administered as an RCT. Participants are enrolled in experimental cohorts and a monthly billing analysis regression is used to calculate savings. All program participants are included in the regression model so there is no sampling error. There is estimation error that results because a regression model is not able to fully capture the variation present in the data. Precision requirements for behavioral program are unique, with the Phase III Evaluation Framework requiring the solution-level verification achieve an *absolute* precision of $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 156](#) shows the absolute precisions of the behavioral program components.

Table 156: Absolute Precisions of Met-Ed PY11 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (\pm)
Residential	0.14%
LI	0.53%

DR programs offered by Met-Ed in PY11 include 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 PY11 DR impacts is $\pm 3.2\%$ at the 90% confidence level.

E.3 REPORTED GROSS SAVINGS AUDITS

E.3.1 Tracking Data Review

This section of the memo summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Met-Ed's PY11 Annual Report. Specifically, the values we examined are as follows:

- Reported gross energy savings (MWh) for each program;
- Reported gross peak demand savings (MW) for each program;
- Participation for each program; and
- Incentive dollars for each program.

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 PY11 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.5.3](#), and our findings regarding the HER components of the Energy Efficient Homes and LIEEP can be found in [Appendix E.4.1.3](#).

[Table 157](#) 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 PY11 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by Met-Ed.

Table 157: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-in	3,350	3,350	Yes
Energy Efficient Homes	15,272	15,272	Yes*
Energy Efficient Products	33,766	33,766	Yes
LI Energy Efficiency	1,514	1,514	Yes*
C&I Energy Solutions for Business – Small	21,973	21,973	Yes
C&I Energy Solutions for Business – Large	39,482	39,482	Yes
Governmental & Institutional Tariff	202	202	Yes
Portfolio Total	115,588	115,588	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

[Table 158](#) 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 158: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-in	0.49	0.49	Yes
Energy Efficient Homes	2.35	2.35	Yes*
Energy Efficient Products	4.24	4.24	Yes
LI Energy Efficiency	0.19	0.19	Yes*
C&I Energy Solutions for Business – Small	3.35	3.35	Yes
C&I Energy Solutions for Business – Large	5.60	5.60	Yes
Governmental & Institutional Tariff	0.02	0.02	Yes
Portfolio Total	16.24	16.24	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 159 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 participants are removed, as they have no representation in the tracking data.

Table 159: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-in	3,319	3,319	Yes
Energy Efficient Homes	33,198	33,208	No*
Energy Efficient Products	342,988	342,988	Yes
LI Energy Efficiency	1,965	1,965	Yes*
C&I Energy Solutions for Business – Small	432	432	Yes
C&I Energy Solutions for Business – Large	174	174	Yes
Governmental & Institutional Tariff	13	13	Yes
Portfolio Total	382,089	382,099	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 160 summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE was able to exactly replicate incentive dollars for LI Energy Efficiency and Large C&I Energy Solutions. For four other programs, the SWE calculated directionally similar values using the tracking data. For these six programs, the totals are also directionally similar: \$4,542,000 in the Annual Report and \$4,537,000 in the tracking data.

For the remaining program – Energy Efficient Homes – incentives from the tracking data are vastly different from the incentives shown in the Annual Report. The SWE understands the discrepancy between incentives in the quarterly tracking data and incentives in the Annual Report for these two programs is largely attributable to Energy Efficiency kits.

Table 160: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-in	\$193	\$194	Yes
Energy Efficient Homes	\$2,291	\$677	No
Energy Efficient Products	\$1,648	\$1,705	No
LI Energy Efficiency	\$75	\$75	Yes
C&I Energy Solutions for Business – Small	\$982	\$918	No
C&I Energy Solutions for Business – Large	\$1,636	\$1,636	Yes
Governmental & Institutional Tariff	\$8	\$10	Yes
Portfolio Total	\$6,833	\$5,215	No

E.3.2 Project File Reviews

E.3.2.1 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 PY11 using the project file documentation provided by Met Ed, the program implementors, and the evaluation contractor, ADM. This is in response to the SWE’s standing quarterly data request. The project file packages included rebate applications, equipment invoices, equipment specification sheets, and post-inspection forms. Most of the project file packages that were uploaded included a majority of the documentation requested.

Table 161 presents a summary of SWE’s residential project file reviews.

Table 161: Met-Ed PY11 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 Program	Appliance Turn In Program	22	✓	✓	✓	✓
Energy Efficient Homes Program	School Education	11	✓	✓	✓	✓
Energy Efficient Homes Program	EE Kits	8	✓	✓	✓	✓
Energy Efficient Homes Program	Audits	8	✓	✓	✓	✓
Energy Efficient Homes Program	New Homes	24	✓	✓	✓	✓
Energy Efficient Products Program	HVAC	24	✓	✓	✓	✓
Energy Efficient Products Program	Appliances and Electronics	26	✓	✓	✓	✓
Energy Efficient Products Program	Midstream Appliances	8	✓	✓	✓	✓
Energy Efficient Products Program	Lighting	24	✓	✓	✓	✓
LI Energy Efficiency Program	Weatherization	28	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all First Energy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

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

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q4 because none were reported for that period.

Energy Efficiency Kits

The Energy Efficiency Kits project files reviewed mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q3 or Q4 because none were reported for that period.

Audits

Project files reviewed were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q3 or Q4 because none were reported for that period.

New Homes

REM/Rate reports' kWh savings tended to match tracking but overestimated peak kW by 28% for all FE utilities. It should be noted that reported savings includes lighting and appliance savings; however, the evaluator addresses this during the verified savings review.

HVAC

The HVAC project files mostly matched the quarterly tracking data. However, the SWE reviewed one project file listing both a CAC and furnace, whereas in tracking data showed only the furnace. Otherwise, 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.⁹²

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.

Appliances

The Appliance files typically matched the tracking data, but the SWE will confirm during the verified savings review, as in PY9 and PY10, that default TRM savings are used only for reported ex-ante savings, while model-specific TRM values are used in verified savings calculations. Reviewed ex-ante savings were based on TRM defaults.

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).

Midstream Appliances

The Midstream Appliance project files that the SWE reviewed matched the tracking data.

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.

As during PY9 and PY10 SWE review, ADM worked with the SWE to clarify the base wattage variable for specialty bulbs, which depends on bulb shape and lumen range when using TRM tables and equations. However, the tracking data did not break out bulb shape enough to make this determination.⁹³

ADM has confirmed in previous program years that this issue is corrected during the verified savings calculations, which are entirely independent from these ex-ante calculations. The model numbers are used to pull in all bulb information, including specific shape, from a compiled database, primarily using ENERGY STAR data.

Low-Income WARM

The SWE observed some project files that only included certain measures in the tracking data and left out additional measures that were 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.

⁹² 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.

⁹³ For example, a specialty bulb at 500 lumens could have a base wattage of 40, 45, 60, or 65 depending on the shape, but there is no way to tell which value should be used without more specific shape categories being used. ADM confirmed that this is addressed in the verified savings calculations.

E.3.2.2 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 PY11. 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.

Despite the issues with some project files, the SWE found that most of the projects contained sufficient data to review the savings calculations and understand the project scope. With these findings, the SWE has confidence that the reported savings were being calculated accurately

[Table 162](#) presents an overview of the results of the SWE's C&I project file reviews. The SWE found most project files contained sufficient documentation to understand the scope of the project and how savings were calculated. However, the SWE found two lighting projects that lacked specification sheets for the installed fixtures. The SWE found that the savings analysis for a custom process improvement project did not include the hours of use or coincidence factors. The SWE also found that the calculated savings values for two projects did not match the reported savings values listed in the tracker provided by Met-Ed.

Despite the issues with some project files, the SWE found that most of the projects contained sufficient data to review the savings calculations and understand the project scope. With these findings, the SWE has confidence that the reported savings were being calculated accurately.

Table 162: Met-Ed PY11 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	3	✓	✓	2/3	1/3	-	✓
C&I Energy Solutions for Business Program - Small	Custom - SCI	1	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Large	Lighting - LCI	6	✓	5/6	4/6	4/6	✓	-
C&I Energy Solutions for Business Program - Small	Lighting - SCI	10	✓	9/10	✓	✓	✓	-

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 many project files lacked documentation indicating project approvals and rebate forms indicating final approved program savings. Additionally, several 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. Finally, baseline project data was absent for all reviewed projects with the exception of two projects. While baseline data is often not available, documentation on which baseline assumptions based should be provided. In addition to these general issues, the SWE also noted specific project files with deficiencies as addressed below by sub-program.

- Lighting - SCI
 - Project file missing documentation on application and approvals, project scope, budget, and baseline data.
- Lighting - LCI
 - Invoice quantity does not align with workbook calculator.
- Food Service
 - Workbook calculator locked; SWE cannot verify calculations.
- Custom - LCI
 - Workbook calculator locked; SWE cannot verify calculations.
- Custom - SCI
 - Workbook calculator links to other workbooks that were not provided; 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.4 VERIFIED GROSS SAVINGS AUDITS

E.4.1 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 that were used to verify savings for the residential programs. [Table 163](#) provides a summary of the evaluation and M&V approaches used by Met-Ed in their PY11 verified savings calculations.

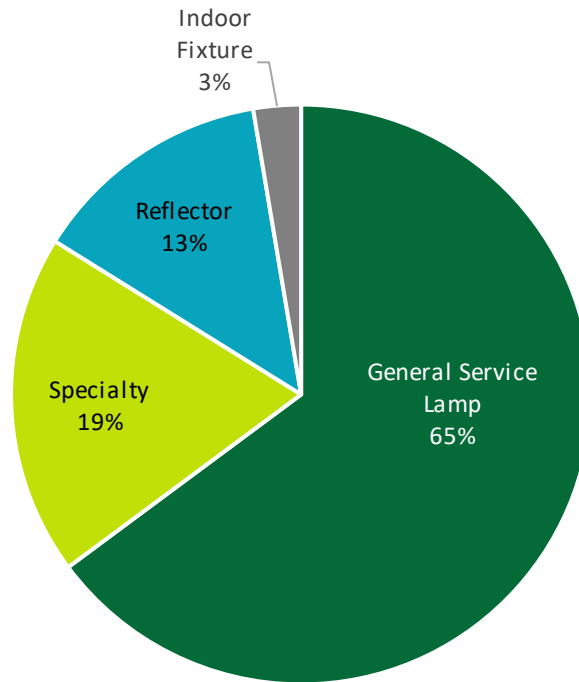
Table 163: Residential Program Evaluation Activities – Met-Ed

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.4.1.1 Upstream Lighting & Cross-Sector Sales

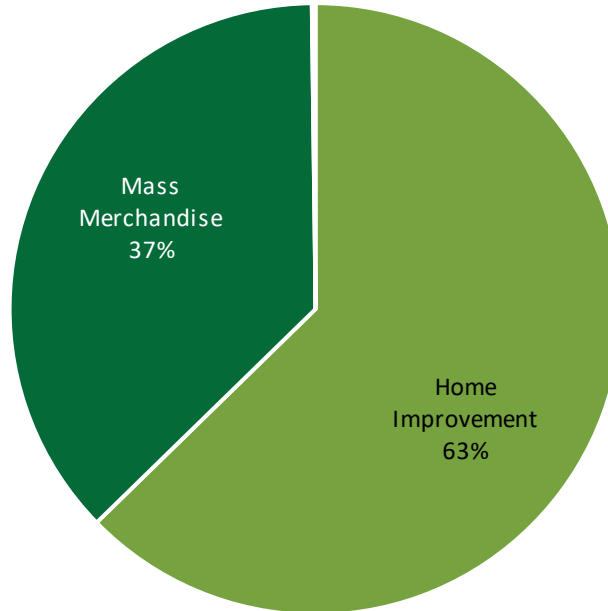
Customers purchased over 920,000 efficient light bulbs and fixtures through Met-Ed's PY11 upstream lighting program. Figure 84 displays the distribution of sales by product type. Over three-fifths (65%) of the products were general service lamps.

Figure 84: Met-Ed PY11 Upstream Lighting Sales by Product Type



Met-Ed's PY11 upstream light bulbs and fixtures were sold through home improvement (63%) and mass merchandise stores (37%, [Figure 85](#)).

Figure 85: Met-Ed PY11 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY11 impact analysis for Met-Ed's Upstream Lighting Initiative before the PY11 Met-Ed Annual Report was submitted to the PUC on February 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 PY11 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 PY11 upstream lighting analysis.

E.4.1.2 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

The SWE audited each of the four components of the Energy Efficient Homes Program: Energy Efficiency Kits, HERs (reported in [Section E.4.1.3](#) of this appendix), Residential Direct Install, and New Homes by using the gross impact data submitted by FirstEnergy. Overall, the SWE audits

concluded that the correct TRM algorithms were applied and verified savings were correct for all program kits and direct install measures.

The SWE had previously identified a small error in the New Homes subprogram in which ENERGY Star dishwasher savings were incorporating an incorrect TRM default value for homes with gas water heaters, but this error has been corrected in 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.4.1.1](#) 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 PY11 annual report.

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. However, population and sample sizes in the annual request data did not match those included in the annual report.

E.4.1.3 Behavior

Approximately 18% of Met-Ed's verified gross energy savings for PY11 came from HERs issued to over 130,000 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 PY11. By cohort, [Table 164](#) shows average kWh savings and average percent savings per participant in PY11. Note that the "Average Number of Participants" column shows the average number of participants per month during PY11.

Table 164: Average PY11 kWh Savings per Participant

Sector	Cohort Start Date	Average Number of Participants	Average PY11 kWh Savings	Average PY11 % Savings
LI	July 2012	8,881	251	1.81%
Residential	July 2012	68,440	197	1.46%
LI	January 2014	1,799	180	1.11%
Residential	January 2014	44,222	178	1.34%
Residential	January 2015	9,644	240	1.77%

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, and energy and demand savings.

Calendarization

The first step the SWE 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 165](#) shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.⁹⁴ The distribution of average daily kWh is basically identical in the two data sets.

Table 165: Comparison of Calendarized Data

Variable	Mean	5 th Percentile	25 th Percentile	75 th Percentile	95 th Percentile
Average Daily kWh – ADM	36.55	12.71	21.81	45.79	77.42
Average Daily kWh – SWE	36.55	12.71	21.81	45.79	77.42

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

⁹⁴ The table only summarizes PY11 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 166](#) 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. One cohort was found to have statistically significant pre-treatment differences between the treatment and control groups. In 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 166: Group Equivalence in the Pre Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
LI	July 2012	40.3	40.3	0.94
Residential	July 2012	39.2	39.2	0.83
LI	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, uncalendarized 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 2020. The SWE removed any records with a billing end date prior to March 1, 2020, then counted the number of unique IDs in the remaining records. Using this method, the SWE calculated participant counts that matched the reported counts.

Participant counts, by cohort and month, are shown in [Table 167](#).

Table 167: Met-Ed PY11 HER Participant Counts by Cohort and Month

Month	July 2012 LI	July 2012 Residential	January 2014 LI	January 2014 Residential	November 2014 Residential
Jun-19	9,185	69,920	1,880	45,398	10,029
Jul-19	9,112	69,574	1,858	45,132	9,946
Aug-19	9,047	69,289	1,845	44,883	9,866
Sep-19	8,993	68,993	1,830	44,658	9,790
Oct-19	8,938	68,701	1,812	44,419	9,715
Nov-19	8,884	68,444	1,798	44,199	9,652
Dec-19	8,846	68,216	1,788	44,033	9,578
Jan-20	8,788	68,013	1,776	43,876	9,511
Feb-20	8,757	67,829	1,764	43,740	9,474
Mar-20	8,718	67,633	1,756	43,588	9,428
Apr-20	8,667	67,417	1,743	43,424	9,382
May-20	8,640	67,252	1,732	43,317	9,351

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 PY11, 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 be applied to the homes with insufficient pre period data. The SWE believes this is the correct approach. (Note that the underlying assumption here is that homes without sufficient pre period data do not systematically differ from homes with sufficient pre period data.) 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 PY10, 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 be applied to the homes with insufficient pre period data. The SWE believes this is the correct approach. (Note that the underlying assumption here is that homes without sufficient pre period data do not systematically differ from homes with sufficient pre period data.)

Impact Coefficients and Energy Savings

Figure 86 through Figure 90 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY11. For the treatment group homes, only homes that were active in PY11 are included in the “pre period” portion of the figure. As has been noted, the regression model used to estimate the impact the HER program has on daily usage controls for potential pre period differences.

Figure 86: July 2012 LI Cohort Usage Comparison

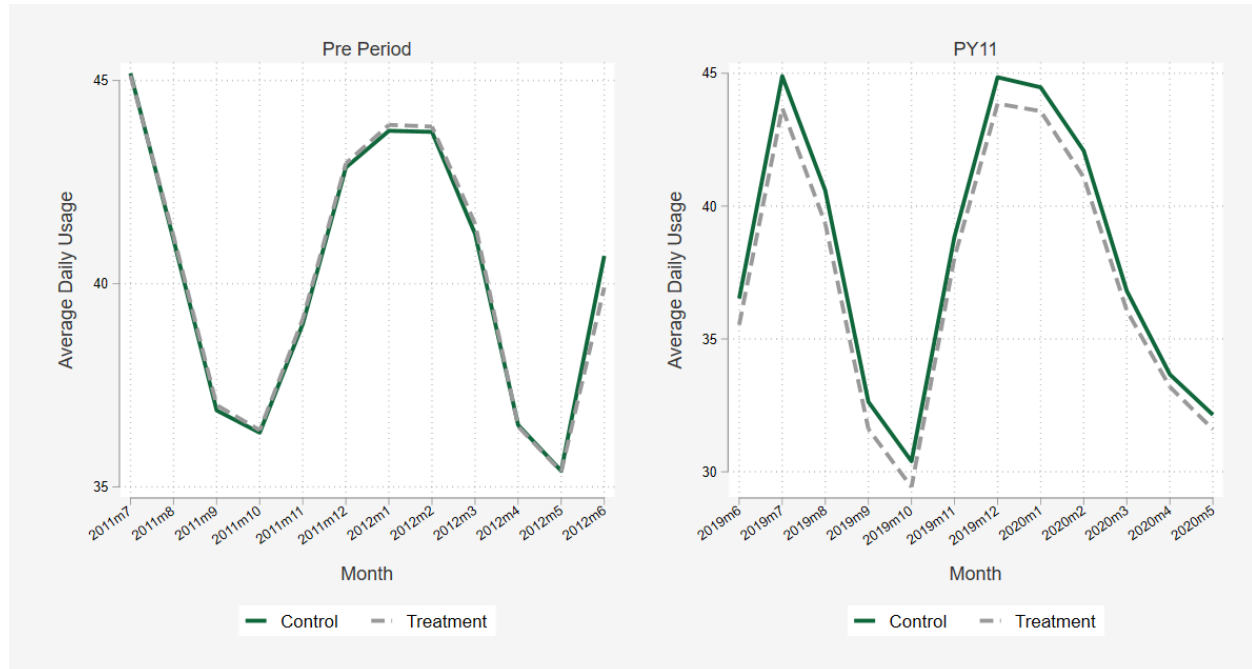


Figure 87: July 2012 Residential Cohort Usage Comparison

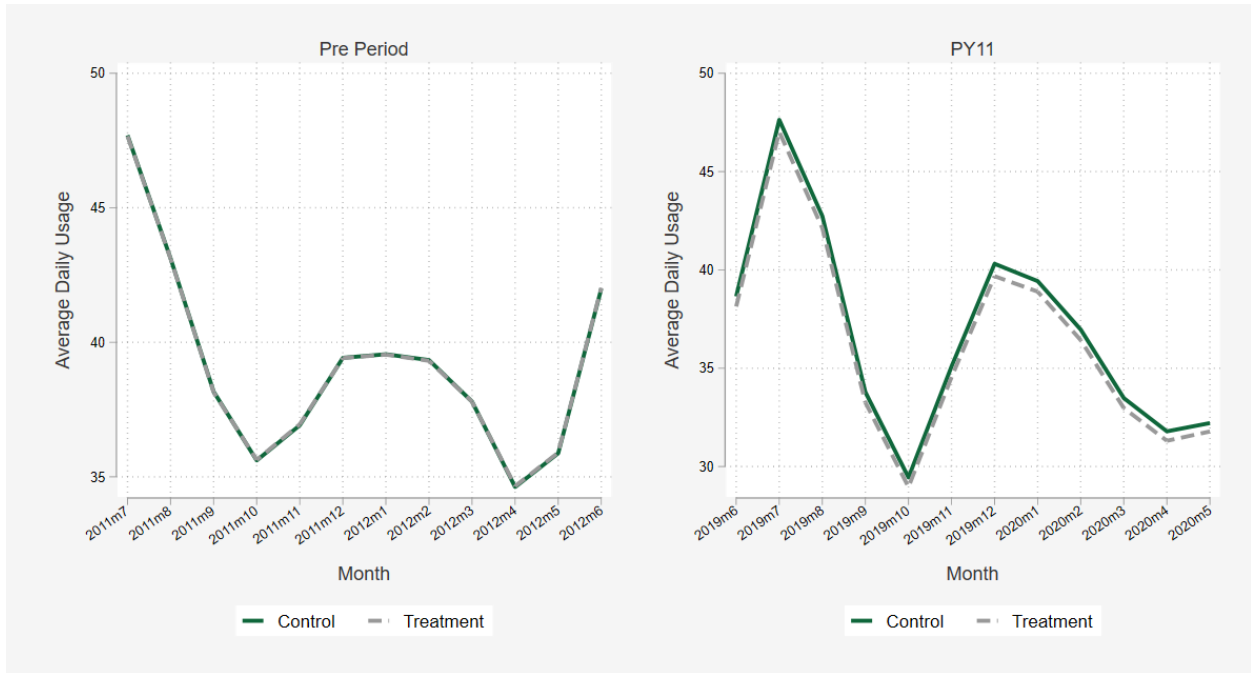


Figure 88: January 2014 LI Cohort Usage Comparison

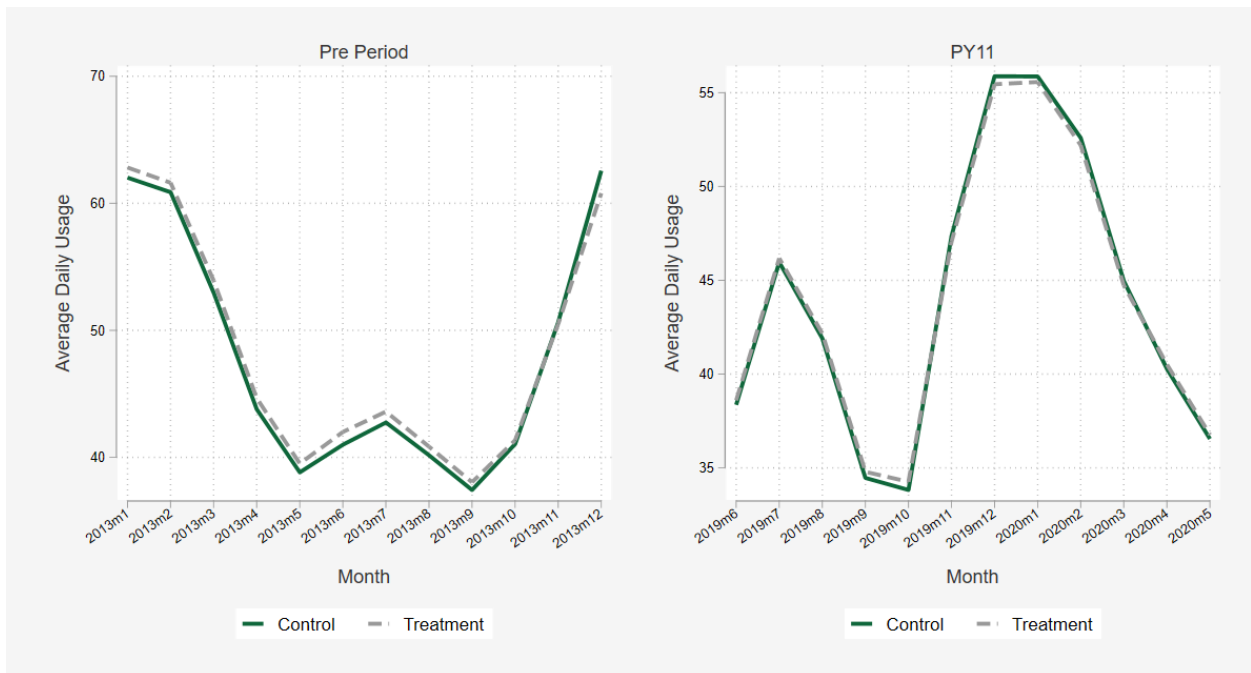


Figure 89: January 2014 Residential Cohort Usage Comparison

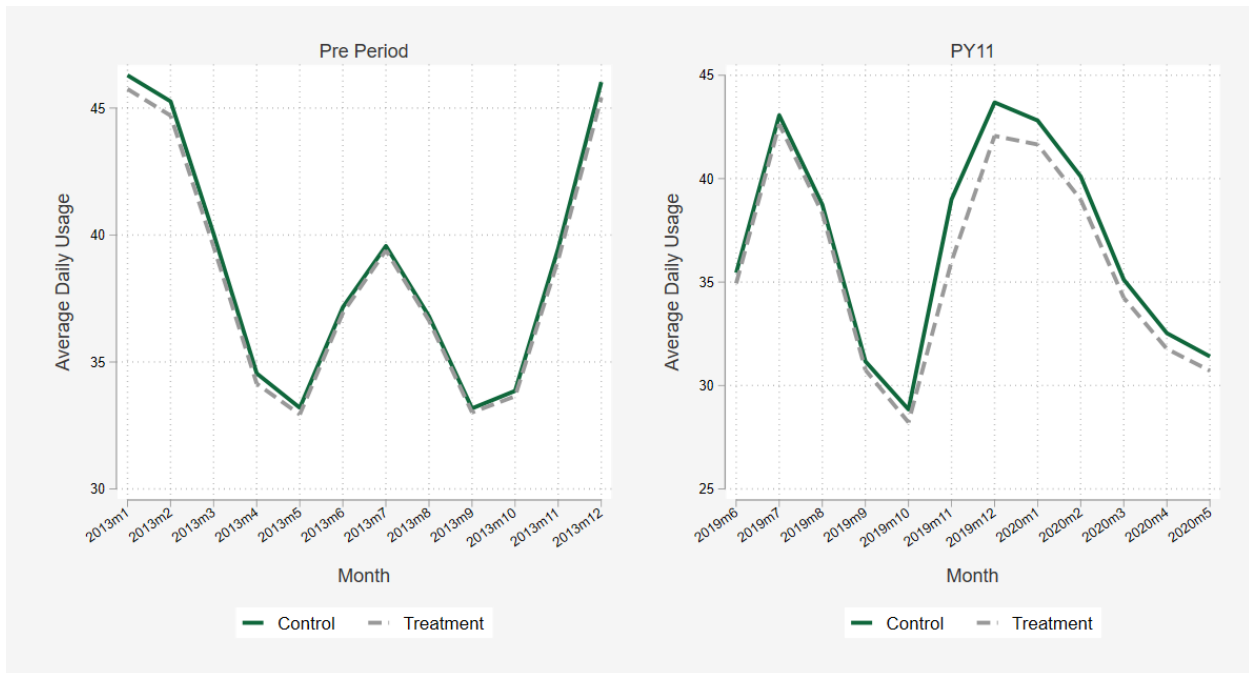


Figure 90: January 2015 Residential Cohort Usage Comparison

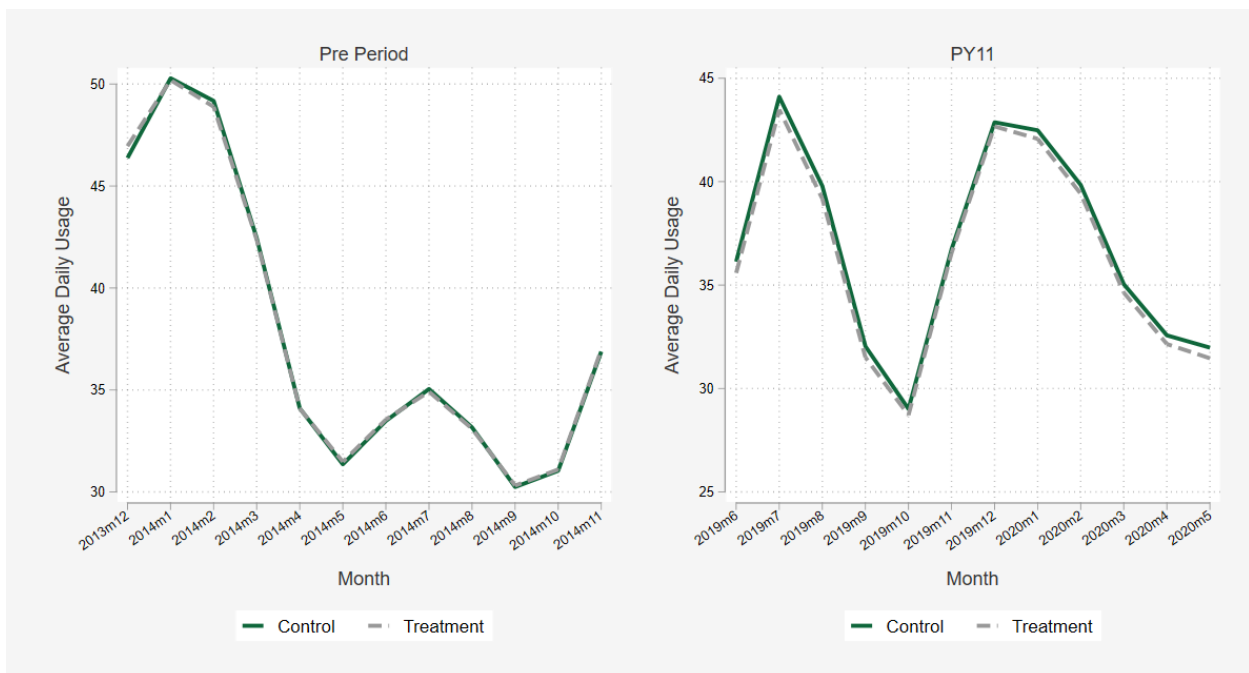


Table 168 shows PY11 impact estimates for each cohort (as calculated by ADM and the SWE). Note that a different impact estimate was calculated for each month in PY11 – the estimates shown in the table reflect the averages of the PY11 monthly estimates. Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the LI July 2012 cohort saved 1.18 kWh per day, on average, during PY11.

Table 168: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
LI	July 2012	-1.18	-1.18
Residential	July 2012	-0.53	-0.53
LI	January 2014	-0.43	-0.43
Residential	January 2014	-0.56	-0.56
Residential	January 2015	-0.74	-0.74

Using the impact estimates shown above, [Table 169](#) shows ADM's and the SWE's aggregate energy savings (MWh) for each cohort after correcting for dual participation in other energy-efficiency programs and applying the upstream adjustment factors. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 169: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE – ADM)
LI	July 2012	2,230	2,225	-5
Residential	July 2012	13,477	13,467	-10
LI	January 2014	324	320	-4
Residential	January 2014	7,877	7,870	-7
Residential	January 2015	2,314	2,309	-6
Total		26,222	26,191	-31

Demand Savings

[Table 170](#) shows ADM's and the SWE's aggregate peak demand savings (MW) for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

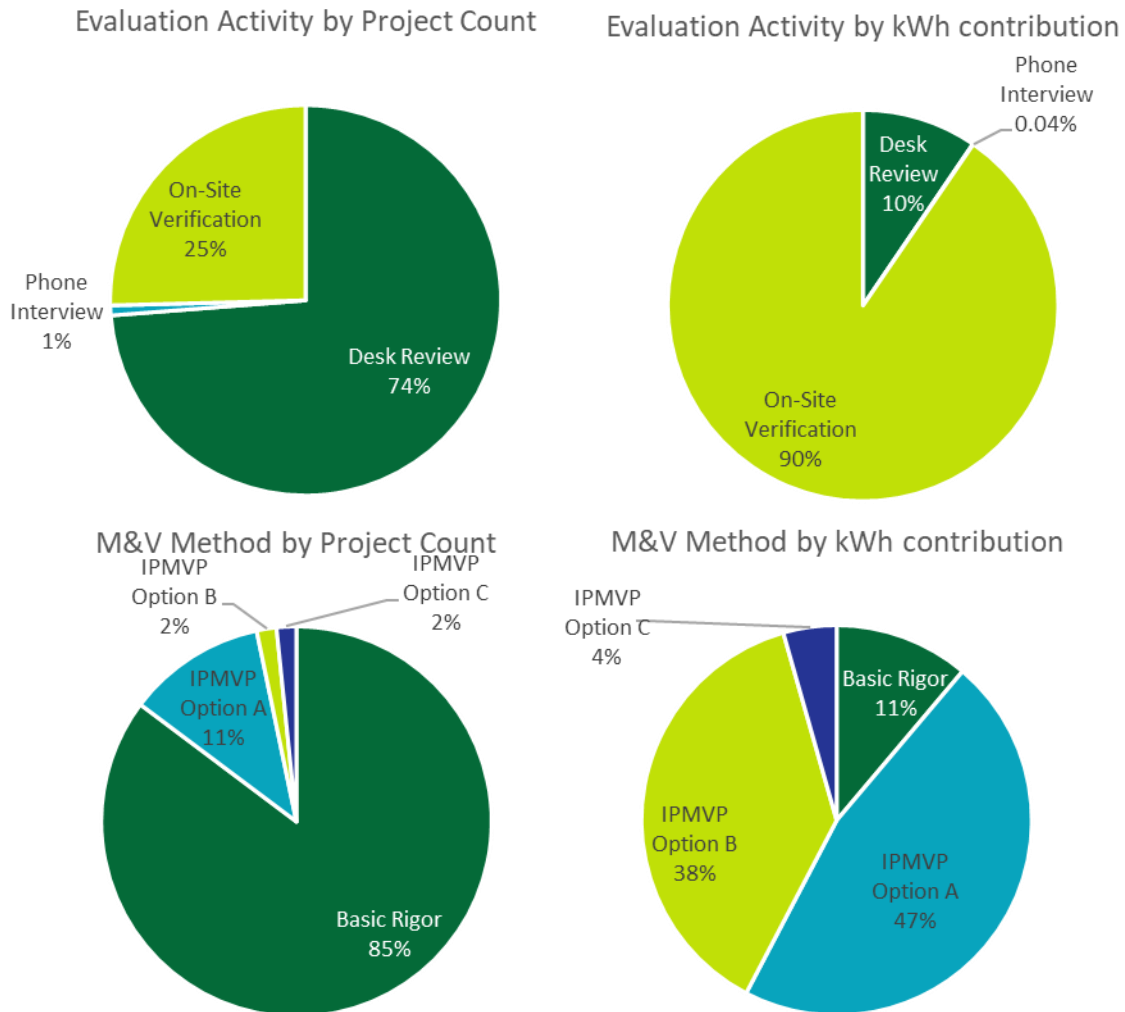
Table 170: Demand Savings Comparison

Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE – ADM)
LI	July 2012	0.25	0.25	0.00
Residential	July 2012	1.50	1.50	0.00
LI	January 2014	0.04	0.04	0.00
Residential	January 2014	0.90	0.90	0.00
Residential	January 2015	0.27	0.26	0.00
Total		2.95	2.95	0.00

E.4.2 Non-Residential Audit Activities

Figure 91 provides a summary of the evaluation activities and M&V approaches utilized by Met-Ed’s evaluation contractor, ADM, in their PY11 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY11, Met-Ed’s evaluation contractor completed site visits to 25% of projects, and these projects represented 90% of total evaluated energy savings. In total, only 31 site visits were completed. IPMVP Options A, B, and C were employed for the majority (89%) of total evaluated energy savings. Basic Rigor (verification only) was employed for 11% of the total evaluated savings, including all appliance recycling projects and direct install projects and a small selection of custom, lighting, and prescriptive projects.

Figure 91: 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 171 provides a summary of the evaluation activities Met-Ed's evaluation contractor used across strata for all projects by initiative.

Table 171: Summary of Met-Ed's PY11 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	Phone Interview	On-Site Verification
Appliance Turn-In	53	109%	53	0	0
ApplianceRecycling-1	53	109%	53	-	-
Custom	20	99%	12	0	8
Custom-1	14	101%	9	-	5
Custom-2	4	88%	3	-	1
Custom-Certainty	2	100%	-	-	2
Direct Install	3	109%	3	0	0
Direct_Install-2	3	109%	3	-	-
Lighting	31	93%	9	1	21
Lighting-1	9	88%	4	1	4
Lighting-2	6	98%	2	-	4
Lighting-3	7	85%	3	-	4
Lighting-Certainty	9	100%	-	-	9
Prescriptive	15	100%	13	0	2
Prescriptive-1	15	100%	13	-	2
Prescriptive-2	-	-	-	-	-
TOTAL	122		90	1	31

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.4.2.1 Appliance Turn-In Initiative

The evaluation contractor conducted phone surveys to verify projects in this initiative. No site visits were conducted for these projects. Impacts were calculated through desk reviews and TRM calculations using project-specific data from the tracking system or verification surveys when available. TRM default values were used in absence of project-specific data.

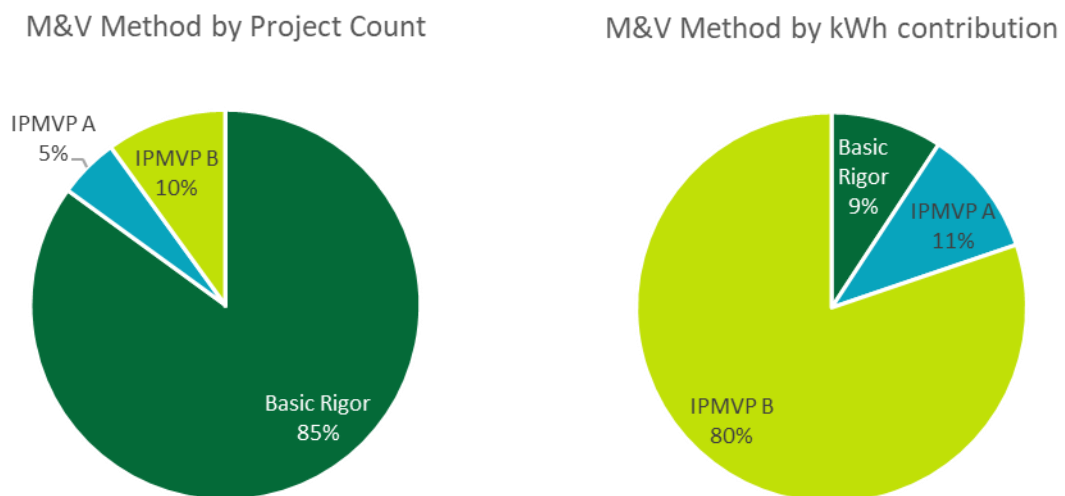
E.4.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews, site visits, and/or IPMVP evaluation methods for all sampled projects. Only eight site visits were conducted for PY11 custom sampled projects. The evaluation was satisfactorily conducted remotely for most 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 a combined 91% of the evaluated savings, as shown in [Figure 92](#).

Figure 92: Summary of Met-Ed's C&I Custom Program M&V Methods



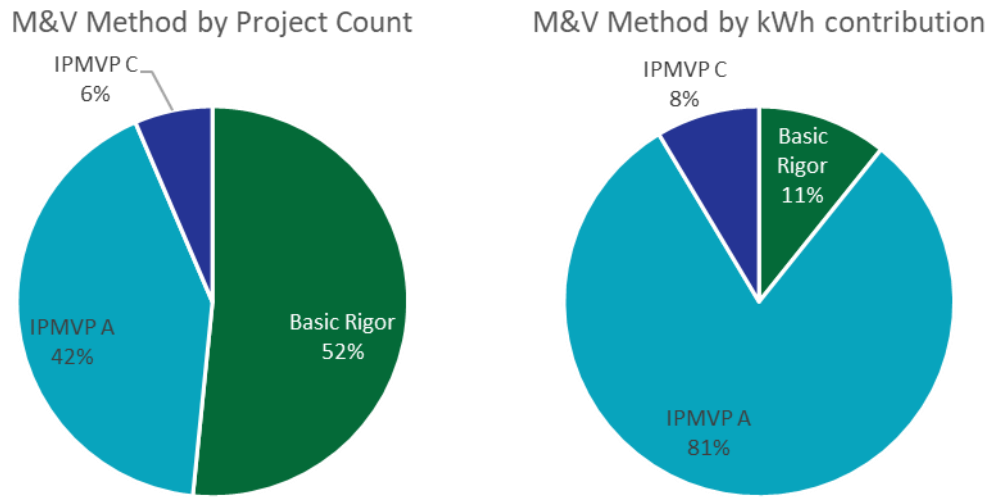
E.4.2.3 Lighting Initiative

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 and C combined were employed for approximately half of projects (48% of projects, 89% of total evaluated savings) evaluated in this initiative, as seen in [Figure 93](#) below.

Figure 93: Summary of Met-Ed's C&I Lighting Program M&V Methods



E.4.2.4 Prescriptive Initiative

Evaluation activities for this initiative include verification site visits and application of TRM-based savings calculation methodologies. Only two of the sampled prescriptive projects received a site-visit this program year. Prior to site visits, all sampled projects undergo a full documentation review. This documentation review included identification of the appropriate TRM protocol and the defined key input parameters.

Met-Ed's evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 50 MWh of annual energy savings. All the PY11 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 and/or on-site verification visits in most cases.

E.4.2.5 Direct Install Initiative

The sole evaluation activity for the Direct Install initiative is a desk review using TRM-based savings algorithms to quantify savings. There are two strata in the Direct Install initiative, with a threshold of 20 MWh set for the Direct Install-2 stratum. In PY11, Met-Ed sampled all three of its total projects, all of which were in the Direct Install-2 stratum. A realization rate of 109% was achieved for this initiative.

E.4.2.6 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 172 provides an overview of the SWE milestones for the audit of Met-Ed's site inspection efforts.

Table 172: Met-Ed Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Energy Attainment Percentage
5	16,566,987	3	4	99.8%

Overall, the SWE agreed with the methods of calculation employed by Met-Ed's evaluation contractor, ADM. The calculations and accompanying reports were easy to follow and showed evidence that the TRM was being followed appropriately. The SWE's energy savings of the five projects with ride-along audits reached an attainment percentage of 99.8% of the evaluator's energy savings.

The SWE made a few recommendations for two projects. For PRJ-9124, a new construction lighting project, the SWE recommended for the evaluator to make methodologies used in estimating parameters clearer in savings calculations. Also, for this project, the SWE suggested for the evaluator to separate distinct space types to arrive at more accurate savings values for each space in the new construction project.

In PRJ-9147, the SWE reviewed savings for a custom-HVAC project with multiple measures. For this project, the evaluator created a regression analysis with a model based on the relationship between CDD and daily electricity consumption. The SWE agreed with the evaluator's decision to use the billing data and regression analysis to calculate savings but recommended for the evaluator to use both HDD and CDD to more accurately reflect a typical year.

E.4.2.7 Verified Savings Desk Reviews

Table 173 provides an overview of the SWE milestones for the verified savings review of evaluated Met-Ed projects via desk review.

Table 173: Met-Ed Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
4	5,170,531	843.6	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 SWE recommended for the evaluator to consult the PA TRM for inputs such as

control SVG factors, as this recommendation was made for two new construction lighting projects of the four total projects. The overall energy and demand savings attainment percentages of Met-Ed’s reviewed projects were 100% for both energy and demand savings.

E.5 DR

According to the Phase III Implementation Order, Met-Ed’s Phase III DR compliance target is 49 MW. Note that 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 Met-Ed, this translates to a 41.65 MW minimum performance level for any given DR event. 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. Met-Ed called DR events on the four days those guidelines required during summer 2019.

In PY11, Met-Ed had active DR programs in both the residential and C&I customer classes. On the C&I side, there were 149 participants: 104 categorized as large C&I sites and 45 categorized as small C&I sites. The residential BDR component had approximately 189,000 homes in the treatment group, though this number declined throughout the summer.

Table 174 shows Met-Ed’s performance across the four events during the 2019 DR season. The average impact for each event exceeded 41.65 MW and the average impact for PY11 exceeded the Phase III compliance target (as does the average for the phase, 53.0 MW).

Table 174: Met-Ed PY11 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 17, 2019	15	18	1.5	50.0	12.6	64.1±3.6
July 18, 2019	16	19	1.7	40.1	7.2	49.0±3.6
July 19, 2019	15	18	1.4	44.2	11.0	56.5±3.6
August 19, 2019	15	18	1.4	48.8	7.7	58.0±3.5
PYVTD - Average PY11 DR Event Performance						56.9±1.8
VTD - Average Phase III DR Event Performance						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 eleven C&I sites selected by the SWE, the hourly load data needed to replicate the ADM impact estimates. Note that these eleven sites accounted for approximately 36% of Met-Ed’s gross verified PY11 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 WSAs;
- Hourly load and weather data for approximately ~226,000 residential accounts (~190,000 treatment group accounts and ~36,000 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 PY11 gross verified savings estimates and recommends that the Commission adopt them when assessing compliance with Phase III targets.

E.5.1 Replicate Program Totals

Met-Ed’s PY11 C&I DR program had 149 participants. ADM’s verified gross peak demand savings generated by these sites are shown in [Table 175](#). Note that these values are adjusted for line losses (by a multiplier of 1.072). For each DR event hour during the 2019 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 175](#) also shows verified gross peak demand savings for the residential BDR program (also adjusted for line losses).

Table 175: Met-Ed PY11 DR Savings

Program	PYVTD Gross MW	VTD Gross MW
C&I – Small	1.5	3.4
C&I – Large	45.8	43.8
Energy Efficient Homes	9.6	5.8
Total	56.9	53.0

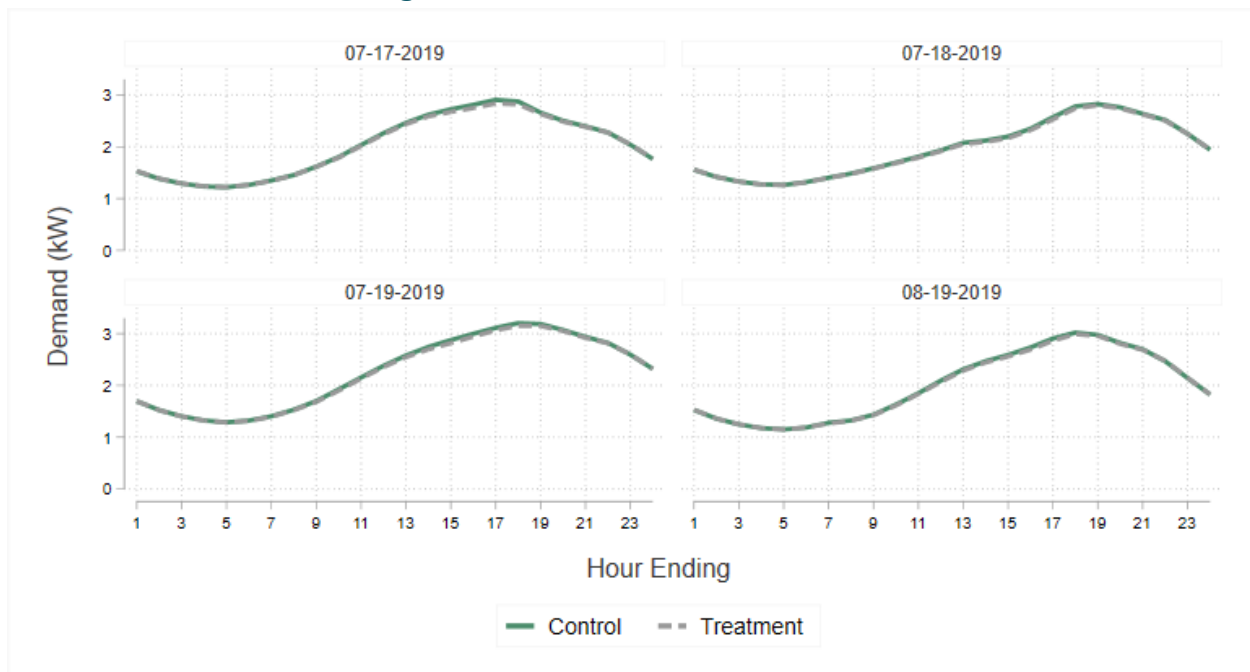
E.5.2 Residential BDR

Met-Ed’s behavioral DR program operates as an RCT – customers were randomly selected and placed into control and treatment groups. As of the beginning of the 2019 summer DR season, there were 189,678 premises in the treatment group and 36,176 premises in the control group. Some of these homes were added in 2018 and some were added in 2019. [Table 176](#) shows counts by start date as of the beginning of the 2019 DR season. At the end of the DR season, these numbers were 182,836 and 34,811 respectively.

Table 176: Residential BDR Customer Counts

Date Added	Active Treatment Accounts	Active Control Accounts
5/22/2018	116,158	22,174
5/22/2019	73,520	14,002
Total	189,678	36,176

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 is not 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 94](#). In this figure, control group and treatment group loads for each PY11 DR event day are compared. The impact is small but separation between the experimental cells can be seen in the late afternoon. With nearly 190,000 homes in the treatment group, small impacts add up.

Figure 94: Met Ed Residential BDR

E.5.2.1 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 95](#) shows the average hourly load profiles for the two experimental cells in each cohort during the baseline periods. Note that the customers added in 2019 have a different baseline period than the customers added in 2018, but both periods straddle April and May. As can be seen, the two groups used energy in the baseline period in an approximately identical fashion.

Figure 95: Met-Ed Baseline Equivalence

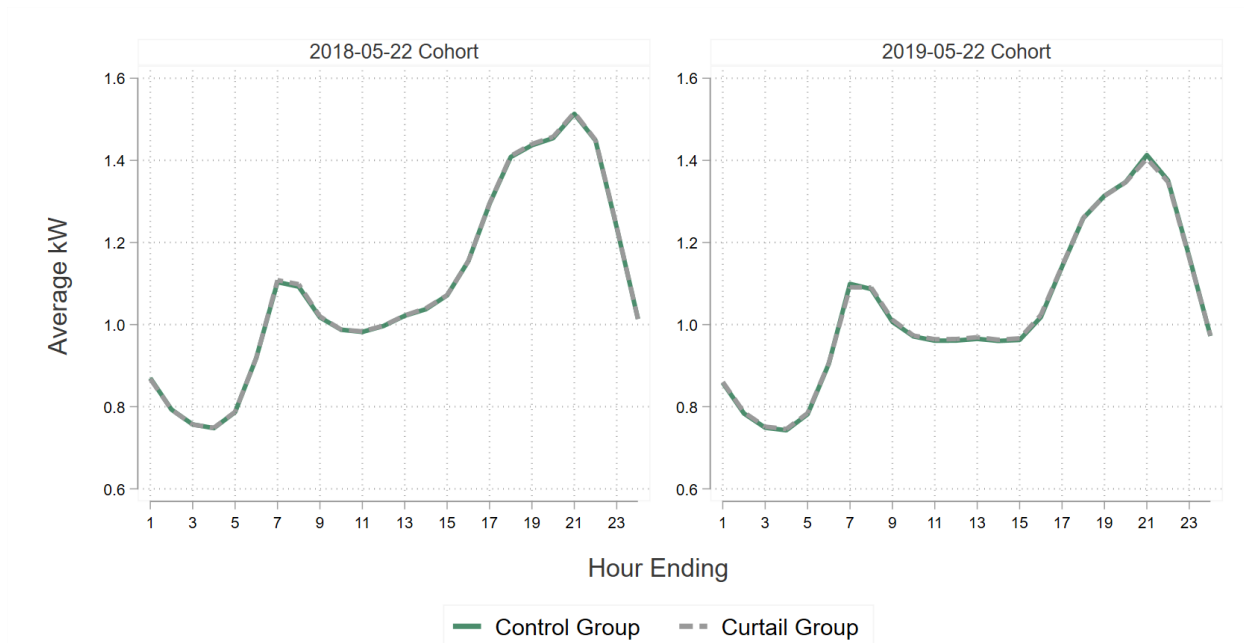


Table 177 shows average daily kWh for the control and treatment groups during the baseline period. A significance test suggests the difference between mean daily consumption values is not statistically significant (p -value = 0.73). The table also shows the average demand for the two groups during common event hours. Like the average daily kWh values, the difference between the average demand values is not statistically significant (p -value = 0.64).

Table 177: Equivalence Check

Group	Average Daily kWh	Average kW During Event Hours
Control	25.54	1.18
Treatment	25.56	1.18
Combined	25.56	1.18

E.5.2.2 Impact Estimation

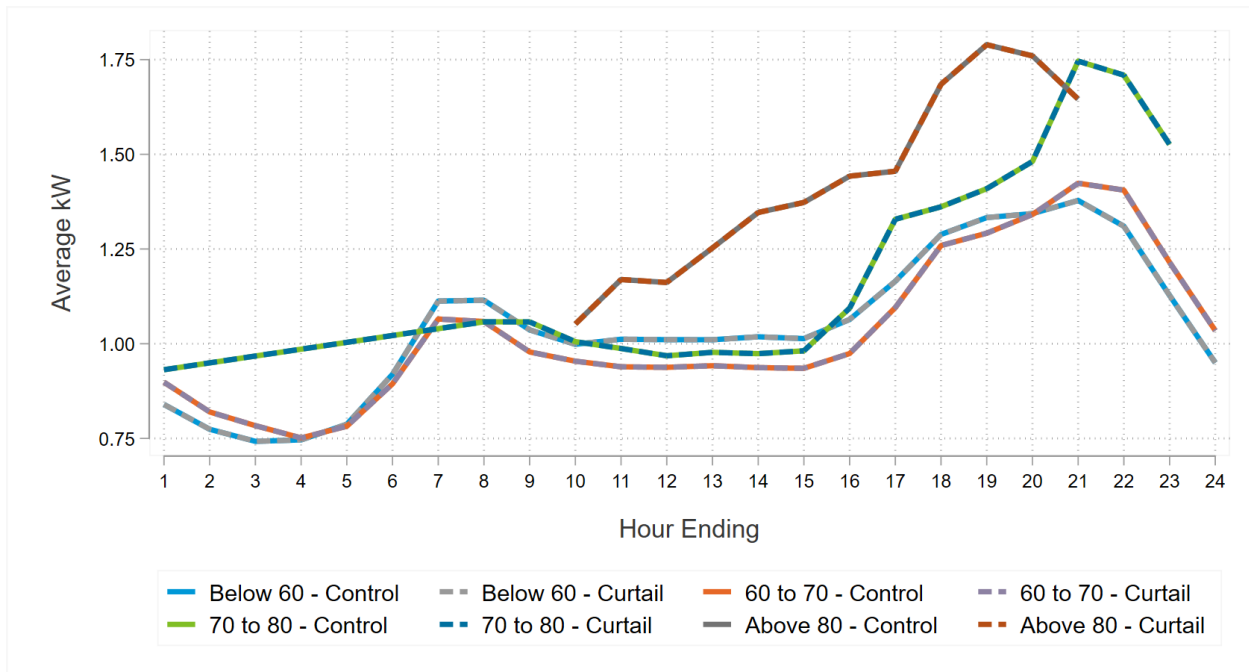
Savings calculations for the residential BDR component relied on a control group comparison and regression modeling. The regression model only used data from event hours on event days. Explanatory variables included date and hour fixed effects, an interaction between the treatment indicator variable and the date/time fixed effects, and three lag variables. The lag variables are customer-specific constants that were calculated based on consumption over a 30-day period that spanned April and May of 2018 for one cohort and April and May of 2019 for the other. Steps taken in producing these lag variables are as follows:

- Limit the load data to 2:00 PM to 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 96 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 96: Usage by Temperature Bin



E.5.2.3 Findings

Table 178 shows the relevant regression coefficients (treatment effect by hour and date), participant counts, and aggregate impacts. Note that neither the regression coefficients nor the aggregate impacts are adjusted for line losses in this table. The practical interpretation of the first regression coefficient in the table (-0.052) is that average demand in the treatment group was 0.052 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 regression coefficients with several other regression model specifications and found the results to be robust.

Table 178: Regression Output and Participant Counts

Date	Hour	Coefficient	Participants	Aggregate Impact (MW)
7/17/2019	15	-0.052	186,677	9.73
	16	-0.064	186,677	11.89
	17	-0.071	186,677	13.28
	18	-0.058	186,677	10.87
7/18/2019	16	-0.030	186,613	5.51
	17	-0.044	186,613	8.24
	18	-0.041	186,613	7.73
	19	-0.026	186,613	4.82
7/19/2019	15	-0.059	186,552	10.98
	16	-0.056	186,552	10.53
	17	-0.048	186,552	9.01
	18	-0.052	186,552	9.70
8/19/2019	15	-0.034	184,562	6.20
	16	-0.042	184,562	7.81
	17	-0.044	184,562	8.15
	18	-0.031	184,562	5.75

The average aggregate impact across the 16 event hours was -8.76 MW. Multiplying this value by Met-Ed's line loss multiplier for residential customers (1.0945) yields an average savings estimate of 9.6 MW per event hour. This is identical to the PYVTD gross MW value calculated by ADM.

E.5.3 C&I

E.5.3.1 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 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 179](#) provides an illustration.

Table 179: CBL-of-CBLs Illustration

CBL Type	CBL	Non-Event Day RRMSE	Inverse Square of RRMSE	Weight
10-of-10	1,100	7.1%	198.37	35.7%
10-of-10 with WSA	1,200	7.2%	192.90	34.7%
20-of-20	1,300	7.8%	164.37	29.6%

Thus, the CBL-of-CBLs value would be: $1,100 \times 0.357 + 1,200 \times 0.347 + 1,300 \times 0.296 = 1,193.90$.

E.5.3.2 Weather Sensitive Adjustments (WSAs)

Several of the baseline types that ADM considered involved a WSA (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 June 1, 2019 and the last DR event of PY11 (which occurred on August 19, 2019);
- 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).

The WSA is only applied if the outdoor air temperature exceeds 75 degrees. Additionally, two distinct WSA coefficients were calculated for each participant. In prior program years, event hours were the same for each event. In PY11, one event (July 18) 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.

E.5.3.3 Findings

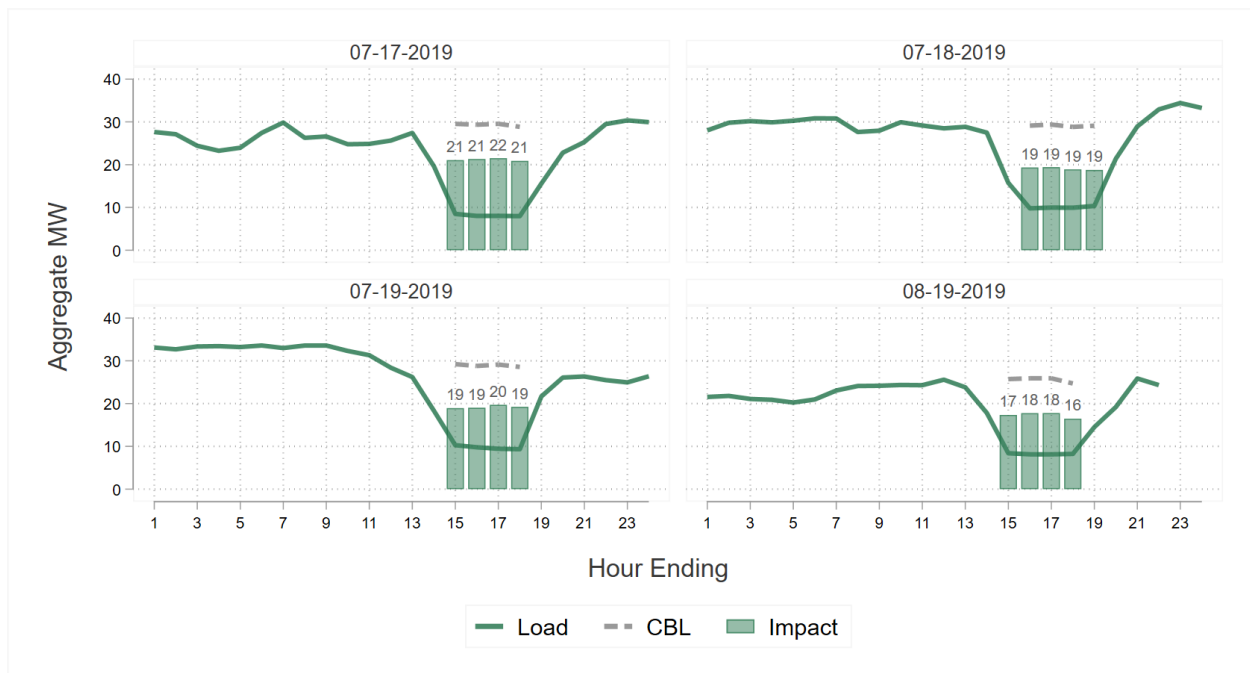
For the eleven sites in our sample, the SWE was able to reproduce all inputs that feed into the savings. [Table 180](#) provides a summary of the results.

Table 180: Met-Ed C&I DR Audit Summary

Group	Count	Gross MW Impact - ADM	Gross MW Impact - SWE	% of Total Savings
In SWE Sample	11	20.6	20.6	43.6%
Not in SWE Sample	138	26.7	---	56.4%
Total	149	47.3	---	100%

By event day, [Figure 97](#) shows the aggregate load, CBL, and DR impacts (expressed as positive values) for the eleven 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 97: Aggregate Load, CBL, and Impacts for Sampled Sites



E.5.4 Conclusion

The SWE agrees with the baseline selection procedures and no errors in the calculations for the eleven C&I sites examined during the audit process. For the residential BDR component, the ADM team leveraged an LS 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 when assessing compliance at the end of Phase III.

E.6 NTG

E.6.1 Residential Programs

ADM and Tetra Tech estimated a PY11 NTG for the HVAC and Residential Appliances Programs using participant surveys. NTG was estimated with the recommended UMP protocol.

The Energy Efficiency Kits Program NTG research consisted of participant surveys from PY8, PY9, and PY10. The PY8 and PY9 Energy Efficiency Kit NTG data was gathered from Opt-In Kit component of the program. The data was weighted by program substrata contribution to the program gross verified impacts and applied to the common NTG formula.

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 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 beivies, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 181: 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	--
PY8	Energy Efficiency Kits	0.21	0.03	0.82	--
RCT	HERs	--	--	1	--
PY10	Direct Install	0.19	0.14	0.95	--
PY10	New Homes	--	0.0	0.73	--
PY10	Upstream Lighting	0.71	0.0	0.29	--
PY10	Upstream Electronics	--	--	0.58	--
Estimated	HVAC	0.50	0.01	0.51	72
Estimated	Residential Appliances	0.53	0.03	0.50	72

E.6.2 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 PY11 Evaluation Plan and SWE Phase III Evaluation Framework.

E.6.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY11. C&I NTG values were evaluated in PY10 and those values were applied to the C&I Programs for PY11. It has been previously concluded that all PY10 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 182: 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	0.37	<0.01	0.64	--
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	0.55	0.0	0.45	--
PY10	Small Energy Solutions for Business Direct Install	.37	<0.01	0.64	--
PY10	Small Energy Solutions for Business Total	--	--	0.63	--
PY10	Large Energy Solutions for Business Lighting	0.37	<0.01	0.64	--
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.7 TRC

Table 183 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Met-Ed's PY11 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 PY11 annual report and the model itself was well-organized and documented.

Both gross and net TRC ratios decreased across all categories from PY10, with the largest changes occurring in the LI Energy Efficiency and Small C&I DR programs.

Table 183: Summary of Met-Ed's PY11 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	\$1,117	\$628	1.78	\$503	\$628	0.80
Energy Efficient Homes	\$9,827	\$6,149	1.60	\$8,039	\$5,825	1.38
Energy Efficient Products	\$12,756	\$10,079	1.27	\$4,208	\$4,822	0.87
LI Energy Efficiency	\$741	\$1,641	0.45	\$741	\$1,641	0.45
C&I Energy Solutions for Business - Small	\$9,586	\$6,591	1.45	\$6,049	\$4,620	1.31
C&I Energy Solutions for Business - Large	\$18,703	\$16,635	1.12	\$12,037	\$11,102	1.08
Governmental & Institutional Tariff	\$80	\$101	0.78	\$50	\$86	0.59
C&I DR Program – Small	\$105	\$77	1.36	\$105	\$77	1.36
C&I DR Program – Large	\$2,016	\$1,420	1.42	\$2,016	\$1,420	1.42
Portfolio Total	\$54,929	\$43,322	1.27	\$33,746	\$30,220	1.12

Seven of Met-Ed'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 and EEP programs were cost-effective under gross verified savings, but not cost-effective under net verified savings, while the LI Energy Efficiency and Governmental & Institutional Tariff programs were not cost-effective under gross or net verified savings.

E.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. First, to calculate natural gas prices, Met-Ed used the Annual Energy Outlook (AEO) average natural gas price for all users in the entire United States region rather than the AEO average natural gas price for all users in the Middle Atlantic region, as the SWE

recommends. Second, the AEO natural gas prices were not converted to nominal dollars before the NPV was calculated. Met-Ed resolved both of these issues in the PY11 TRC model.

- 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 to Friday 8 a.m. to 8 p.m.). 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 to Friday, 7 a.m. to 11 p.m.) 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 NPV 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 DEER, company assumptions, and actual project costs as gathered from the PY11 evaluation. The SWE 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 SO, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the TRC 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 DR 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 would appear that 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 104 in FirstEnergy's PY11 Annual Report). However, in their 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 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 PY9 and PY10, 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 20 million gallons per year of water saving, which translates to approximately \$1,001,000 in NPV lifetime avoided costs.
- Under the Phase III Implementation Order, the PUC allows EDCs to achieve electric savings from converting electric equipment to non-electric equipment. Increased fuel consumption from these measures is regarded as a non-electric cost. In PY11, Met-Ed had one fuel-switching project under the CHP measure. This project resulted in 10,002 MWh/year of energy savings in PY11 and increased fossil fuel consumption of 51,088 MMBTU/year. This translates to an NPV lifetime cost of \$2,827,088 for the increased fuel consumption.
- In PY11, 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 184](#) 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. FirstEnergy used one year of pre-EISA savings and fourteen years of post-EISA savings for standard lamps and two years of pre-shift and thirteen years of post-shift savings for specialty lamps.

Table 184: Met-Ed Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.27	1.12
Without Dual Baseline	1.46	1.20

E.8 PROCESS

Four EDCs – Met-Ed, Penn Power, Penelec, and West Penn – 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 PY11, the evaluation contractor conducted process evaluations for selected programs and program components. In addition to reporting PY11 process evaluation findings, the PY11 final report also incorporated the PY8, PY9, and PY10 process evaluation results. As the SWE noted in the PY10 Annual Report, this redundancy with the prior process evaluation reports was unnecessary and slightly confusing. The SWE notes that the process evaluation

sections in the PY11 final annual report presented high-level, key findings, while more detailed findings were reported in separate, supplemental memos.

E.8.1 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 PY11, the ADM/Tetra Tech team reported on process evaluation activities for three of these four residential programs: Residential Energy Efficient Homes, Residential Energy Efficient Products, and LI Energy Efficiency. More specifically, the PY11 process evaluations of the Residential Energy Efficient Homes program focused on one program component (BDR) and of the Residential EEP program focused on the two program components (HVAC and Appliances).

The process evaluations of these programs appear to have been mostly consistent with the Phase III evaluation plan. The SWE notes that the process evaluation sections in the PY11 final annual report presented high-level, key findings while more detailed findings were reported in separate, supplemental memos.

E.8.1.1 Appliance Turn-In Program

ADM/Tetra Tech did not conduct a process evaluation for this program in PY11.

E.8.1.2 Energy Efficient Homes Program

Summary of Process Evaluation Findings

For PY11, ADM/Tetra Tech conducted process evaluations for one of seven program components of the Energy Efficient Homes Program: BDR.⁹⁵

The PY11 evaluation is limited in focus. The evaluation team reviewed program progress with FirstEnergy program managers and representatives of the CSP and analyzed data on customer notifications during PY11. The evaluators reported the following key findings:

1. *Both First Energy and Oracle report that the program is running well. Communication between the two entities is effective, and the program is generally meeting energy reduction goals. Both FirstEnergy and Oracle acknowledge challenges presented by consecutive day events and Monday events. First Energy initiates day-ahead notifications to treatment group customers through Facebook, and these have been especially useful in reaching customers for Monday events because they can be provided on Sunday, whereas the Oracle-led notifications can only be provided Monday morning.*
2. *Pre-event notifications via telephone are more likely to reach customers than email messages. Almost all customers (94%) receive telephone messages from the interactive*

⁹⁵ The seven program components include Energy Efficiency Kits, Online Audits, School Education, Behavioral HERs, BDR, Residential Energy Audits, and New Homes.

voice recording (IVR) pre-event notifications, while about 30% of the email notifications that are sent are confirmed as *received* (defined as *opened and/or clicked*). *Post-event* notifications sent by email are *received* (defined as *open and/or clicked*) by a larger proportion of customers across all EDCs.

3. *Opt-out rates are very low, but requests to leave the program are concentrated around the events themselves.* About 1% or 2% of treatment customers opted out in PY11. Most opt-out requests occur near the events themselves since customers use the event notifications to initiate the request (i.e., using the *unsubscribe* hyperlink in the email or *select 9* option on the IVR message).
4. *The disposition of email notifications is more difficult to track than the IVR notices, and the delivery status of many email notifications cannot be confirmed (i.e., is “unknown”).* The disposition of nearly all IVR notifications can be accounted for in the data provided by Oracle. Only about 5% of IVR notifications are not *received* (defined as answered by a person or by voicemail in our analysis). Those notifications are tracked as *busy* or *no answer*. In contrast, email notifications are not as straightforward as those for IVR, and it is more complicated to track the status of emails. In the data provided by Oracle, more than one-half of email messages sent for the pre- and post-event notices do not fit in any of the existing disposition categories (*delivered, opened, clicked, bounced, other not delivered*) and have an unknown delivery status.

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. Although the process evaluation sections in the PY11 final annual report is limited to the key findings, the evaluation contractors submitted separate memos providing more detailed process evaluation results from the review of customer notification data and IDIs with program staff and program implementers.

Three recommendations followed from the process evaluation of the BDR Response program. Two were accepted and one was rejected.

E.8.1.3 Energy Efficient Products Program

Summary of Process Evaluation Findings

For PY11, ADM/Tetra Tech conducted process evaluation activities for two of four program components: HVAC and Appliances.⁹⁶ Process evaluation tasks that were conducted jointly for both program components included IDIs with program staff and implementers and interviews with midstream appliance retailers, HVAC, and water heating contractors, and non-participating HVAC and water heating contractors. A participant survey was conducted with 179 Met-Ed customers, 199 Penelec customers, 165 Penn Power customers, and 191 West Penn customers. ADM/Tetra Tech completed surveys with appliance retailers in each service territory: Met-Ed (44 surveys), Penelec (35 surveys), Penn Power (seven surveys), and West Penn (38 surveys). The process

⁹⁶ For PY8, the evaluation included process evaluations of the Appliances, HVAC, and Upstream Lighting program components. For PY9, the evaluation included a process evaluation of the Appliances component. For PY10, the evaluation included a process evaluation of the Upstream Lighting and Upstream Electronics components.

evaluation of the Midstream Appliances program component additionally included interviews with three retailers (all EDCs).

For the HVAC and Water Heating Measures program component, the evaluator reported the following key findings:

1. *The program is challenged by high incremental costs for efficient equipment.* All interviewed contractors felt rebate levels were insufficient to cover the incremental cost of efficient HVAC and water heating equipment.
2. *Contractors are having a difficult time obtaining AHRI numbers for HVAC units.* Five of the six participating HVAC contractors that were interviewed found the AHRI website difficult to navigate and reported having to call manufacturers to obtain AHRI certificates.

For the Appliances program component, the evaluator reported the following key findings:

1. *Twenty-two percent of retailers surveyed said they were not aware that FirstEnergy offers downstream rebates to customers for select energy-efficient appliances.*
2. *Ten percent of retailers surveyed are located outside of FirstEnergy's service territories. It has been a challenge to sign up retail stores for the Electronics subprogram.*
3. *While program satisfaction is high with midstream retailers and the distributor, lack of signage and brochures was the reason for the somewhat satisfied response by one midstream retailer. All interviewed said the signage, stickers, and brochures help promote sales of more energy-efficient appliances.*
4. *A major distributor of heat pump water heaters said the midstream appliance program is a great approach to move volume in sales of equipment.* It also creates more demand among plumbers and other trades.

Summary of Process Evaluation Audit

The process evaluation of the EEP Program appears to have been generally consistent with the Phase III evaluation plan. Participant and retailer surveys exceeded targets in the sampling plans, with the exception of appliance retailer surveys for Penelec (35 were targeted and seven completed). The evaluation plan targeted 12 retailer interviews and the evaluators completed three. The process evaluation sections in the PY11 final annual report is limited to the key findings, while additional details and results from the process evaluation were submitted in a separate memo.

Six recommendations followed from the process evaluation. Three were accepted and three are under consideration.

E.8.1.4 LI Program

Summary of Process Evaluation Findings

ADM/Tetra Tech conducted process evaluations for the LI WARM and Multifamily components in PY11. Process evaluations for the Appliance Rebate, Behavioral, and Kits sub-programs were conducted with the similar Non-LI programs in the Energy Efficient Products and Energy Efficient Homes programs, respectively.

For the PY11 process evaluation of the Direct Install measure of the WARM and Multifamily components, ADM/Tetra Tech conducted customer surveys with 105 Met-Ed customers, 105 Penn Power customers, 94 Penelec customers, and 105 West Penn customers. The evaluation team also conducted nine interviews with energy specialists (across all four EDCs).

Process evaluation activities were briefly described in the annual report. Additional details and findings from the evaluation were submitted in a separate memo.

The process evaluation of the LI program yielded the following key findings:

1. *Overall, most participants learn about the program through word-of-mouth, but results vary by subprogram.* Word-of-mouth was the most effective method for multifamily participants. Single-family participants were more likely to become aware of the program through bill inserts or direct mailing.
2. *The program influences participants' energy-saving behaviors.* Over 80% attributed the energy-saving actions they took after participating in the program to what they learned from the energy assessment.
3. *Most equipment received through the program is still installed.* Less than 10% of participants removed the equipment that was installed through the program. The most common equipment removed was LED bulbs due to the bulbs being broken or burned out.
4. *Energy specialists provide respondents with clear explanations of the actions they are taking in the participant's home.* Almost 90% of participants said that their energy specialist explained what they were doing in their home, and of those, all but three said they were able to understand the explanation they were given.
5. *Participants and energy specialists are very satisfied with the program.* Three-fourths of participants rated their overall satisfaction with the program as a 10 on a scale of 1 to 10, where 1 was "very dissatisfied" and 10 was "very satisfied." The highest-rated aspects of the program were interactions with program staff, the quality of the items received through the program, and the interactions with the energy specialist. All but one energy specialist rated their satisfaction with the program as "very satisfied."
6. *Participants are interested in receiving additional types of equipment through the program.* When asked if there was anything FirstEnergy could do to improve the program, the most common response was to offer additional types of equipment.
7. *Energy specialists are very satisfied with the LEEN tracking data system.* All but one rated the ease of use of the LEEN tracking system as a 5, on a scale of 1 to 5, where 1 was "very difficult" and 5 was "very easy."
8. *Some energy specialists experienced difficulties completing projects with customers who express interest in the program.* The main barriers for energy specialists were scheduling visits with the customer and being able to complete the necessary work in customer homes because multiple visits may be needed.
9. *Some energy specialists reported difficulties with the transition of program goals from participation to savings.* These difficulties centered around being able to track project savings to adhere to quarterly goals. Energy specialists now have to rely on the TRM to

calculate project savings, although certain measures such as insulation cannot be estimated until a project is complete.

Summary of Process Evaluation Audit

The participant survey achieved the target sample sizes for each EDC as identified in the sampling plan. The evaluation team identified 30 active trade allies in the tracking data and reached out to the top 15 auditors and installers (ranked by number of projects completed), achieving nine interviews across all four EDCs and all three subprograms.

Four recommendations followed from the process evaluation; two were accepted and one was rejected. The status of Recommendation #2 was unclear.⁹⁷ As per the SWE evaluation framework, the report should clearly state the actions the EDC is planning to take based on the recommendations (accept, reject, under consideration, etc.).⁹⁸

E.8.2 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

For PY11, the ADM/Tetra Tech team conducted a process evaluation of two C&I programs: C&I DR – Small and C&I DR – Large.

E.8.2.1 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 PY11.

E.8.2.2 C&I DR – Small and C&I DR – Large

The Large C&I and Small C&I DR programs have combined program delivery. As such, ADM/Tetra Tech conducted combined process evaluations for two programs: C&I DR – Small and C&I DR – Large.

Process Evaluation Findings

For the PY11 process evaluation of the two C&I DR programs, the ADM/Tetra Tech team conducted a program documentation and tracking data review, interviews with Company staff, and IDIs with five participating customers and one non-participant. The process evaluation section of the annual report was focused on the key findings, while additional details about the evaluation and the findings were presented separately in a memo.

⁹⁷ Recommendation #2 was to consider expanding the types of equipment offered through the program. ADM clarified to the SWE that the recommendation was rejected since most of the measures listed are already cost-effective and offered by the program. The measures that are not cost-effective, doors and windows, will not be offered.

⁹⁸ Efficiency Framework for Pennsylvania Act 129 Phase III EE&C Programs, October 21, 2016.

The evaluator reported the following key findings:

1. *Participants with detailed event plans reported less impact on their business.* In the previous evaluation, some respondents noted that events affect their business longer than the exact hours of the event since they might need to shut down early or take time to restart equipment. Respondents in this evaluation noted that a detailed plan minimized this impact and allowed greater flexibility in responding to the event.
2. *Communicate to participants on their performance following events in context of the full event to encourage them to participate fully in further events.* If First Energy needs additional demand reduction, consider additional outreach to these participants.
3. *Some Act 129 non-participants do participate in PJM's DR programs and have confusion between the PJM and FirstEnergy DR programs.*
4. *The evaluation had difficulty contacting some participants, even though FirstEnergy or their CSP provided the contact information.* This issue may be unique to 2020 due to the effects of Coronavirus on staff working remotely or staff turnover.

Process Evaluation Audit

The evaluation team aimed to complete ten interviews across three categories of interest: full participants, partial participants, and non-participants. An original list of 69 contacts was pared to 45 after excluding customers hit heavily by Covid response efforts. The evaluation team obtained contact information for 38 of the 45 customers and ultimately completed six interviews (three full participants, two partial participants, and one non-participant).⁹⁹

Four recommendations followed from the process evaluation; all four recommendations were accepted.

⁹⁹ The evaluation team provided additional details on the sampling plan in an email to the SWE on March 19, 2021.

Appendix F Penelec Audit Detail

F.1 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 several memos updating their sampling and evaluation approach for several programs, including for EEP appliance retailers, HVAC and appliance participants and HVAC contractors, as well as the LI direct install program and the PY12 process evaluation for the BDR program. The SWE reviewed and approved these plans with minor comments and suggestions.

In addition to reviewing FirstEnergy's evaluation memos, the SWE reviewed and approved several surveys and interview guides for the EEP appliances and HVAC programs, the residential BDR program, the LI direct install program, and the C&I DR program.

The ADM team also submitted a memo to the SWE outlining ADM's proposed EM&V methods in response to the COVID-19 outbreak.

F.2 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 $\pm 5\%$ at the 85% confidence level, then there is an 85% chance that the true value of savings for the population is between 950 MWh/year and 1,050 MWh/year. All programs that rely on sampling to calculate verified savings must include the relative precision to quantify the sampling uncertainty.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of $\pm 15\%$ 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 185](#) lists each initiative and the corresponding relative precision of the PY11 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 185: Relative Precision of Penelec PY11 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (\pm)
Residential Appliance Turn-In (ATI)	3.3%
LI ATI	6.7%
C&I ATI	9.2%
Res Energy Efficiency Kits	4.3%
LI Energy Efficiency Kits	0.0%
Res Direct Install	12.7%
LI Direct Install	7.9%
Res Upstream Lighting	8.0%
Res Upstream Electronics	0.0%
Res HVAC	7.3%
Residential Appliances	18.8%
LI Appliances	103.1%
Residential New Construction	15.0%
C&I Lighting	12.5%
C&I Custom	6.0%
C&I Prescriptive	5.8%

Two of the sampling initiatives shown in [Table 185](#) failed to meet the requirement of $\pm 15\%$ precision at the 85% confidence level. The high relative precisions in the Residential and LI Appliances initiatives were caused by conservative ex-ante savings values for clothes washers (93 kWh/unit) and heat pump water heaters (1,289 kWh per unit). The Residential New Construction initiative passed, but the relative precision was at the 15% threshold. Penelec adjusted some of its verification processes in response to the COVID-19 pandemic. After March 2020, ADM replaced on-site visits with phone interviews, video conferences, and data loggers.

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 F.4](#).

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 $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 186](#) shows the absolute precisions of the behavioral program components.

Table 186: Absolute Precisions of Penelec PY11 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (\pm)
Residential	0.17%
LI	0.58%

F.3 REPORTED GROSS SAVINGS AUDITS

F.3.1 Tracking Data Review

This section of the memo summarizes the SWE’s assessment of the reported gross savings, participation counts, and incentives reported in Penelec’s PY11 Annual Report. Specifically, the values we examined are as follows:

- Reported gross energy savings (MWh) for each program;
- Reported gross peak demand savings (MW) for each program;
- Participation for each program; and
- Incentive dollars for each program.

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 PY11 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 LIEEPs can be found in [Appendix F.4.1.3](#).

[Table 187](#) 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 PY11 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by Penelec.

Table 187: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-in	3,183	3,183	Yes
Energy Efficient Homes	15,904	15,904	Yes*
Energy Efficient Products	35,263	35,263	Yes
LI Energy Efficiency	2,135	2,135	Yes*
C&I Energy Solutions for Business – Small	26,348	26,348	Yes
C&I Energy Solutions for Business – Large	34,757	34,757	Yes
Governmental & Institutional Tariff	623	623	Yes
Portfolio Total	118,213	118,213	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 188 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 188: 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 189 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 one participant.

Table 189: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-in	2,881	2,881	Yes
Energy Efficient Homes	36,754	36,755	Yes*
Energy Efficient Products	327,150	327,150	Yes
LI Energy Efficiency	2,794	2,794	Yes*
C&I Energy Solutions for Business – Small	707	707	Yes
C&I Energy Solutions for Business – Large	140	140	Yes
Governmental & Institutional Tariff	91	91	Yes
Portfolio Total	370,517	370,518	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Finally, [Table 190](#) summarizes the SWE's ex-ante findings regarding incentive dollars. The SWE replicated incentive dollars or calculated directionally similar values for six of the seven programs. For these six programs, the totals are also approximately equal: \$4,604,000 in the Annual Report and \$4,604,000 in the tracking data.

For the remaining program – Energy Efficient Homes – incentives from the tracking data are vastly different from the incentives shown in the Annual Report. The SWE understands the discrepancy between incentives in the quarterly tracking data and incentives in the Annual Report for these two programs is largely attributable to Energy Efficiency kits.

Table 190: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-in	\$166	\$167	Yes
Energy Efficient Homes	\$2,006	\$192	No
Energy Efficient Products	\$1,299	\$1,354	No
LI Energy Efficiency	\$143	\$143	Yes
C&I Energy Solutions for Business – Small	\$1,283	\$1,218	No
C&I Energy Solutions for Business – Large	\$1,682	\$1,691	No
Governmental & Institutional Tariff	\$31	\$31	Yes
Portfolio Total	\$6,610	\$4,797	No

F.3.2 Project File Reviews

F.3.2.1 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 PY11 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 project file packages that were uploaded included a majority of the documentation requested.

[Table 191](#) presents a summary of SWE's residential project file reviews.

Table 191: Penelec PY11 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 Program	Appliance Turn In Program	22	✓	✓	✓	✓
Energy Efficient Homes Program	School Education	11	✓	✓	✓	✓
Energy Efficient Homes Program	EE Kits	8	✓	✓	✓	✓
Energy Efficient Homes Program	Audits	8	✓	✓	✓	✓
Energy Efficient Homes Program	New Homes	24	✓	✓	✓	✓
Energy Efficient Products Program	HVAC	24	✓	✓	✓	✓
Energy Efficient Products Program	Appliances and Electronics	26	✓	✓	✓	✓
Energy Efficient Products Program	Midstream Appliances	8	✓	✓	✓	✓
Energy Efficient Products Program	Lighting	24	✓	✓	✓	✓
LI Energy Efficiency Program	Weatherization	28	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all First Energy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below, is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

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

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q4 because none were reported for that period.

Energy Efficiency Kits

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The Energy Efficiency Kits project files from Q2 appeared to be “credit” invoices, either returns or carry overs from previous months. The SWE did not review project files for Q3 or Q4 because none were reported during those periods.

Audits

Project files reviewed were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q3 or Q4 because none were reported for that period. Only one invoice was provided for Q2.

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.¹⁰⁰

¹⁰⁰ 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.

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.

New Homes

REM/Rate reports' kWh savings tended to match tracking but overestimated peak kW by 28% for all FE utilities. It should be noted that reported savings includes lighting and appliance savings; however, the evaluator addresses this during the verified savings review.

Midstream Appliances

The Midstream Appliance project files that the SWE reviewed matched the tracking data.

Appliances

The Appliance files typically matched the tracking data, but the SWE will confirm during the verified savings review, as in PY9 and PY10, that default TRM savings are used only for reported ex-ante savings, while model-specific TRM values are used in verified savings calculations. Reviewed ex-ante savings were based on TRM defaults.

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).

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.

As during PY9 and PY10 SWE review, ADM worked with the SWE to clarify the base wattage variable for specialty bulbs, which depends on bulb shape and lumen range when using TRM tables and equations. However, the tracking data did not break out bulb shape enough to make this determination.¹⁰¹

ADM has confirmed in previous program years that this issue is corrected during the verified savings calculations, which are entirely independent from these ex-ante calculations. The model numbers are used to pull in all bulb information, including specific shape, from a compiled database, primarily using ENERGY STAR data.

LI WARM

The SWE observed some project files that only included certain measures in the tracking data and left out additional measures that were 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.

¹⁰¹ For example, a specialty bulb at 500 lumens could have a base wattage of 40, 45, 60, or 65 depending on the shape, but there is no way to tell which value should be used without more specific shape categories being used. ADM confirmed that this is addressed in the verified savings calculations.

F.3.2.2 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 PY11. 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 192](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 192: Penelec PY11 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	3	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Small	Custom - SCI	3	✓	✓	✓	✓	-	2/3
C&I Energy Solutions for Business Program - Small	Food Service	2	✓	✓	✓	✓	✗	-
C&I Energy Solutions for Business Program - Small	HVAC - SCI	2	✓	✓	✓	✓	✗	-
Governmental & Institutional Tariff Program	Lighting - Govt	3	✓	✓	2/3	✓	2/3	-
C&I Energy Solutions for Business Program - Large	Lighting - LCI	3	✓	✓	2/3	✓	✓	-
C&I Energy Solutions for Business Program - Small	Lighting - SCI	4	✓	✓	3/4	✓	✓	-

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 many project files lacked documentation indicating project approvals and rebate forms indicating final approved program savings. Additionally, baseline project data was absent for five projects: two Food Service projects, two HVAC – SCI projects, and one Lighting – Gov’t 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.

- **Custom – SCI**
 - Workbook calculator locked for a Custom – Process project; SWE cannot verify calculations.
- **Food Service**
 - Workbook calculator locked for both projects reviewed; SWE cannot verify calculations.
 - Savings for refrigerator seem low for one project.
- **HVAC – SCI**
 - Workbook calculator locked for both projects reviewed; SWE cannot verify calculations.
- **Lighting – Gov’t**
 - Workbook calculator locked; SWE cannot verify calculations.
 - Invoice quantity for one project does not align with workbook calculator.
- **Lighting – LCI**
 - Invoice quantity for one project does not align with workbook calculator.
- **Lighting – SCI**
 - Invoice quantity for one project does not align with workbook calculator.

Despite minor issues with some locked calculation workbooks and fixture quantities, 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.4 VERIFIED GROSS SAVINGS AUDITS

F.4.1 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 that were used to verify savings for the residential programs. [Table 193](#) provides a summary of the evaluation and M&V approaches used by Penelec in their PY11 verified savings calculations.

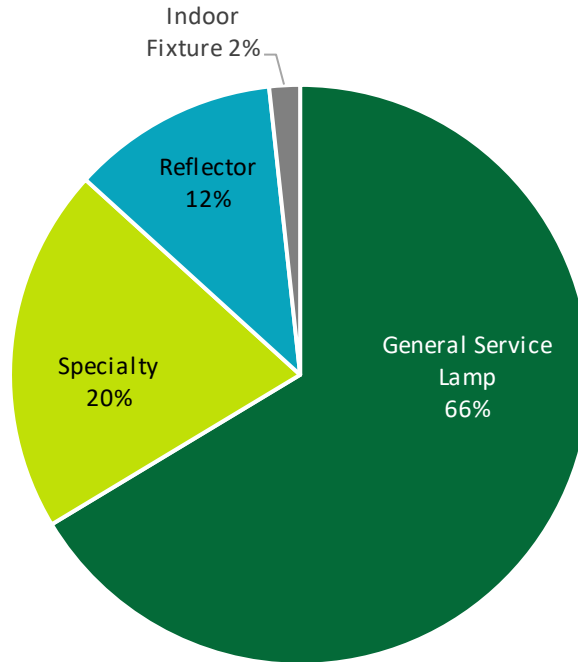
Table 193: Residential Program Evaluation Activities – Penelec

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Appliance Turn-In				
Appliance Turn-in (LI & Non-LI)	✓	--	✓	--
Energy Efficiency Homes				
Energy Efficiency Kits	✓	--	✓	--
Energy Efficiency Kits-LI	✓	--	✓	--
HERs	--	--	✓	✓
Residential Direct Install	✓	--	✓	--
Residential New Construction	--	✓	✓	--
Upstream Lighting				
Upstream Lighting	✓	--	✓	--
Energy Efficiency Products				
Upstream Electronics	--	--	✓	--
HVAC	✓	--	✓	--
Appliances	✓	--	✓	--
Appliances- LI	✓	--	✓	--
LI WARM				
LI WARM- Extra Measures	--	✓	✓	✓
LI WARM- Multifamily	--	✓	✓	✓
LI WARM- Plus	--	✓	✓	✓

F.4.1.1 Upstream Lighting & Cross-Sector Sales

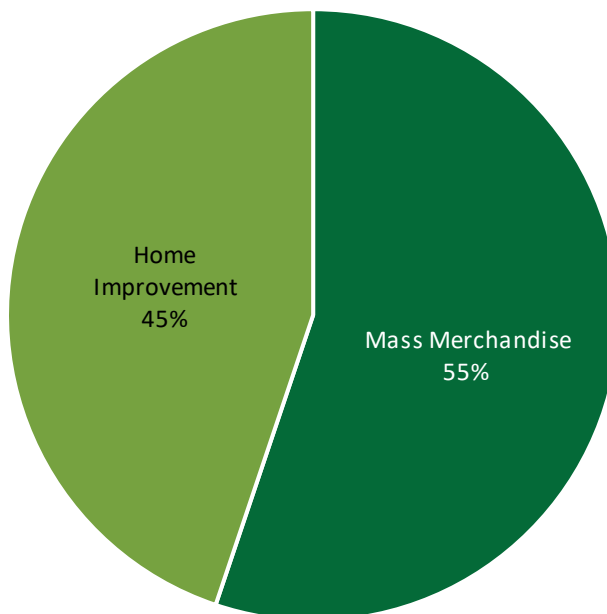
Customers purchased nearly 920,000 efficient light bulbs and fixtures through Penelec's upstream lighting program in PY11. [Figure 98](#) displays the distribution of sales by product type. Almost two-thirds (66%) of the products were general service lamps.

Figure 98: Penelec PY11 Upstream Lighting Sales by Product Type



Penelec's PY11 upstream light bulbs and fixtures were sold through mass merchandise (55%) and home improvement stores (45%, [Figure 99](#)).

Figure 99: Penelec PY11 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY11 impact analysis for Penelec's Upstream Lighting Initiative before the PY11 Penelec's Annual Report was submitted to the PUC on February 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 PY11 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 PY11 upstream lighting analysis.

F.4.1.2 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

The SWE audited each of the four components of the Energy Efficient Homes Program: Energy Efficiency Kits, HERs (reported in [Section F.4.1.3](#) of this appendix), Residential Direct Install, and New Homes by using the gross impact data submitted by FirstEnergy. Overall, the SWE audits concluded that the correct TRM algorithms were applied and verified savings were correct for all program kits and direct install measures.

The SWE had previously identified a small error in the New Homes subprogram in which ENERGY Star dishwasher savings were incorporating an incorrect TRM default value for homes with gas water heaters, but this error has been corrected in 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.4.1.1](#) 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 vales 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 PY11 annual report.

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. However, population and sample sizes in the annual request data did not match those included in the annual report.

F.4.1.3 Behavior

Approximately 10% of Penelec’s verified gross energy savings for PY11 came from HERs issued to around 140,000 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 PY11. By cohort, [Table 194](#) shows average kWh savings and average percent savings per participant in PY11. Note that the ‘Number of Participants’ column shows the average number of participants during PY11.

Table 194: Average PY11 kWh Savings per Participant

Sector	Cohort Start Date	Number of Participants	Average PY11 kWh Savings	Average PY11 % Savings
LI	July 2012	5,683	192.84	1.57%
Residential	July 2012	44,985	139.15	1.16%
LI	January 2014	1,354	359.43	2.77%
Residential	January 2014	57,560	101.57	1.15%
LI	December 2014	7,104	22.89	0.30%
Residential	December 2014	24,035	17.52	0.24%

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 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 195](#) shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.¹⁰² The distribution of average daily kWh is basically identical in the two data sets.

Table 195: Comparison of Calendarized Data

Variable	Mean	5 th Percentile	25 th Percentile	75 th Percentile	95 th Percentile
Average Daily kWh – ADM	26.48	8.13	14.96	33.05	59.40
Average Daily kWh – SWE	26.48	8.13	14.96	33.05	59.40

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 196](#) 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 LI cohort was the only group to have statistically significant pre-treatment differences between the treatment and control groups. In prior years, differences for this cohort were not statistically significant, but customers move over time and the make-up of the experimental cells change. The impact estimation method accounts for the differences in pre-treatment consumption.

¹⁰² The table only summarizes PY11 records.

Table 196: Group Equivalence in the Pre Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
LI	July 2012	37.2	37.8	0.01
Residential	July 2012	37.0	36.9	0.13
LI	January 2014	39.7	40.4	0.22
Residential	January 2014	25.3	25.3	0.79
LI	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, uncalendarized 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 2020. We removed any records with a billing end date prior to March 1, 2020, then counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Participant counts, by cohort and month, are shown in [Table 197](#).

Table 197: Penelec PY11 HER 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-19	5,861	45,772	1,414	58,933	7,484	24,870
Jul-19	5,824	45,605	1,401	58,637	7,396	24,663
Aug-19	5,785	45,443	1,381	58,356	7,317	24,511
Sep-19	5,753	45,281	1,372	58,072	7,238	24,323
Oct-19	5,707	45,103	1,364	57,783	7,158	24,135
Nov-19	5,677	44,957	1,355	57,498	7,086	23,999
Dec-19	5,651	44,867	1,345	57,332	7,040	23,903
Jan-20	5,628	44,762	1,337	57,146	6,991	23,796
Feb-20	5,614	44,657	1,335	56,985	6,954	23,708
Mar-20	5,587	44,571	1,321	56,831	6,908	23,610
Apr-20	5,564	44,452	1,315	56,645	6,855	23,491
May-20	5,548	44,351	1,308	56,507	6,825	23,409

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 PY11, 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 be applied to the homes with insufficient pre period data. The SWE believes this is the correct approach. (Note that the underlying assumption here is that homes without sufficient pre period data do not systematically differ from homes with sufficient pre period data.)

Impact Coefficient and Energy Savings

Figure 100 through Figure 105 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY11. For the treatment group homes, only homes that were active in PY11 are included in the “pre period” portion of the figure. As has been noted, the regression model used to estimate the impact the HER program has on daily usage controls for potential pre period differences.

Figure 100: July 2012 LI Cohort Usage Comparison

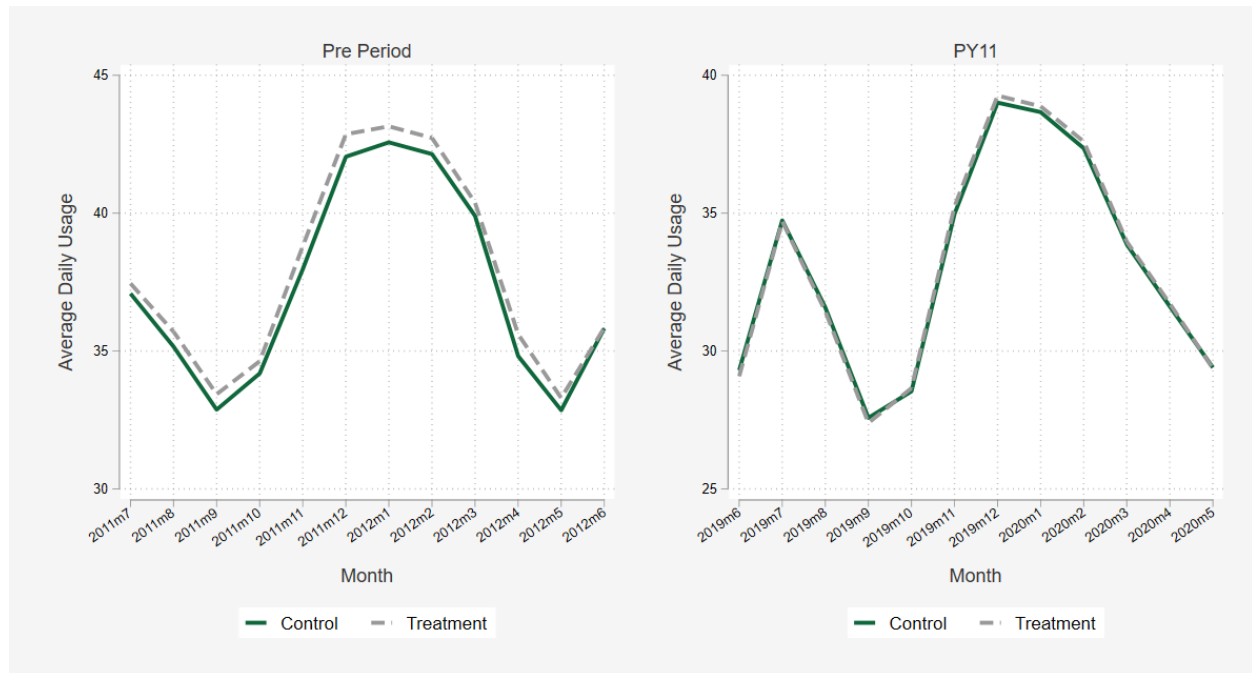


Figure 101: July 2012 Residential Cohort Usage Comparison

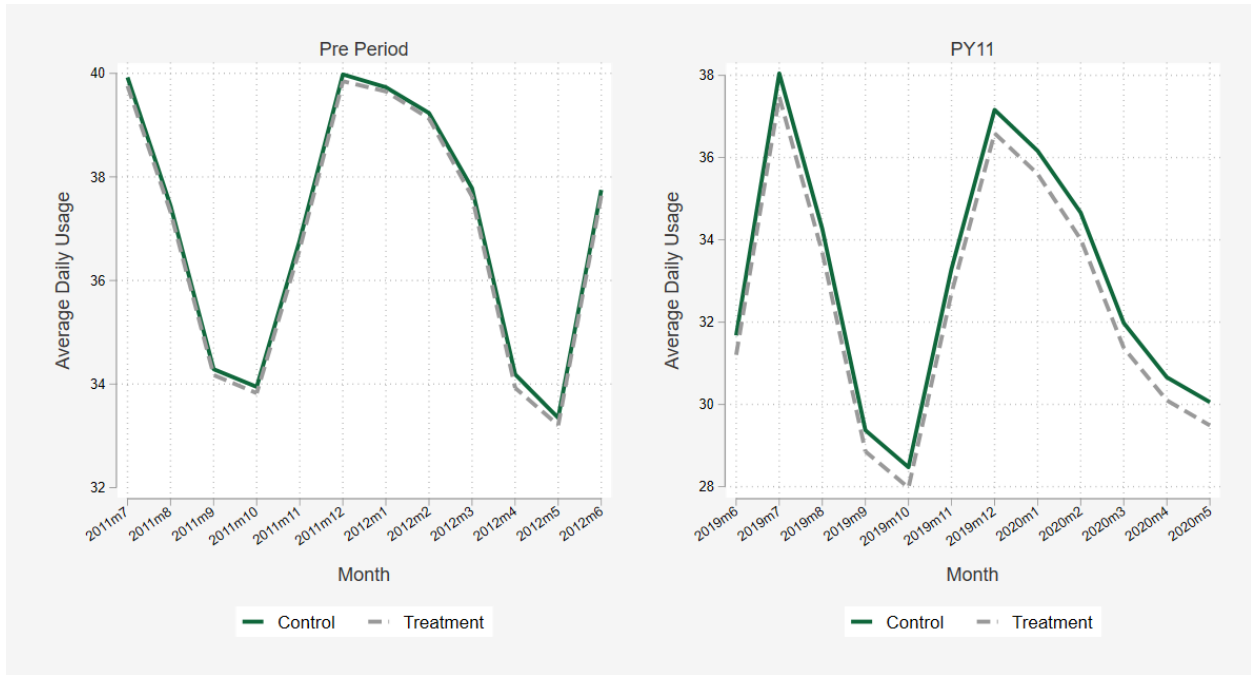


Figure 102: January 2014 LI Cohort Usage Comparison

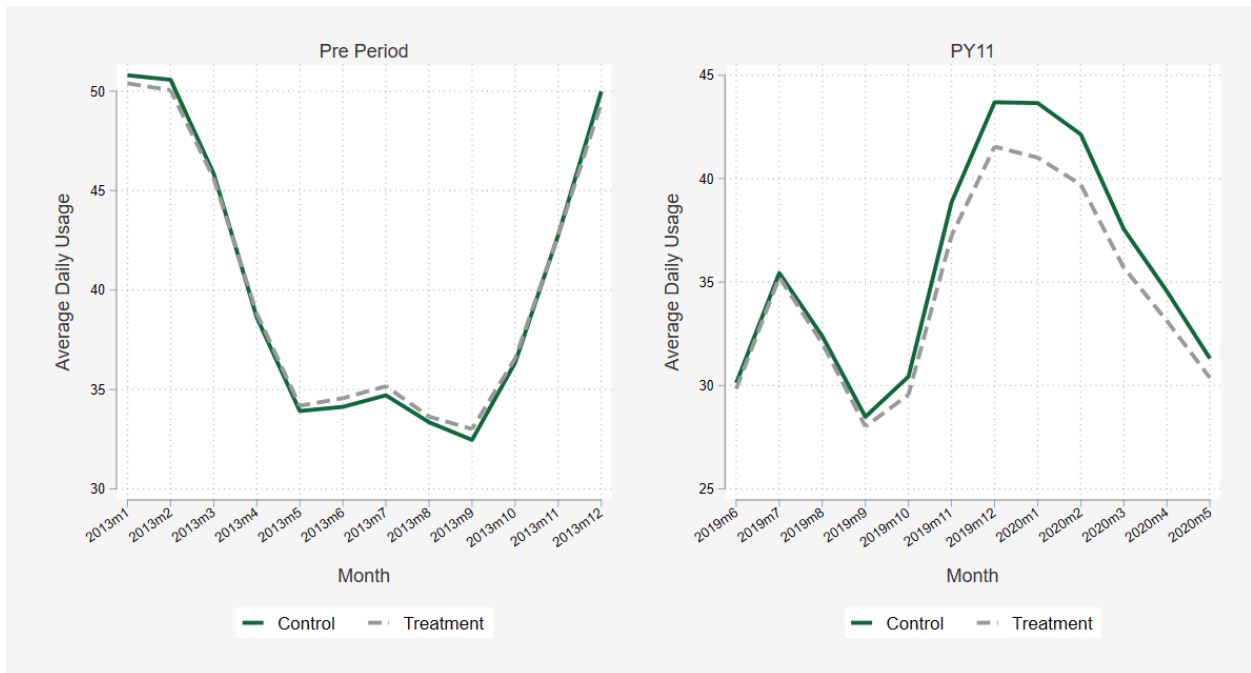


Figure 103: January 2014 Residential Cohort Usage Comparison

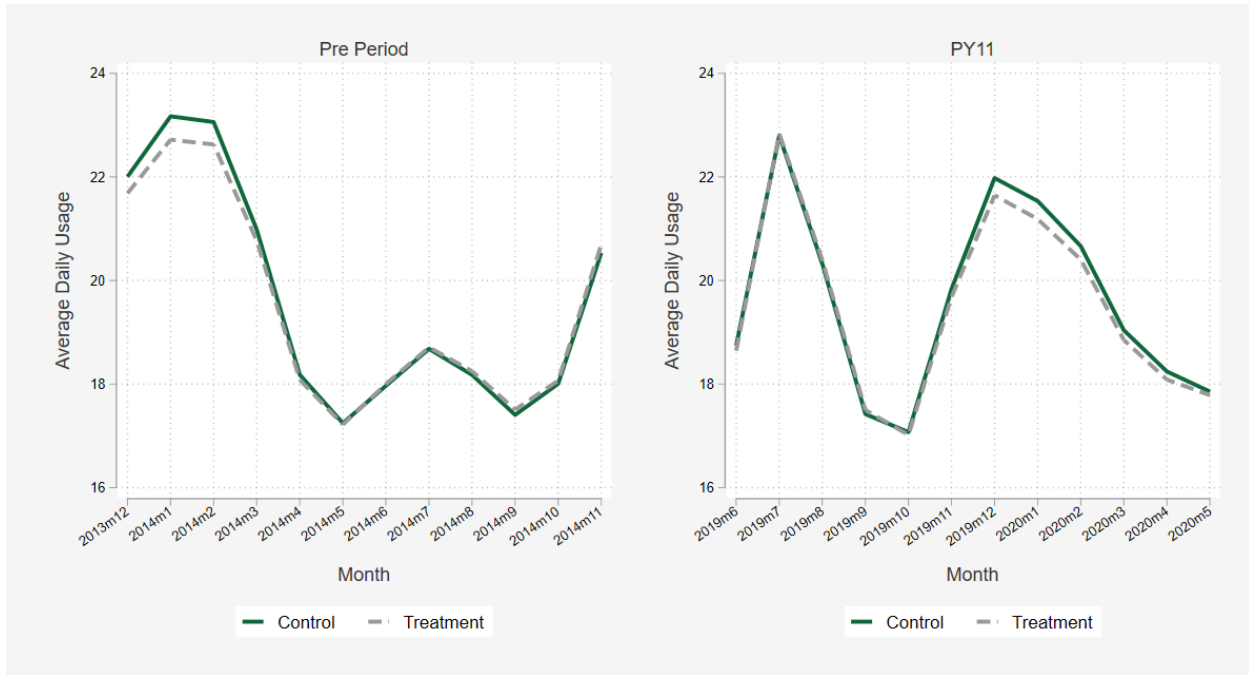


Figure 104: December 2014 LI Cohort Usage Comparison

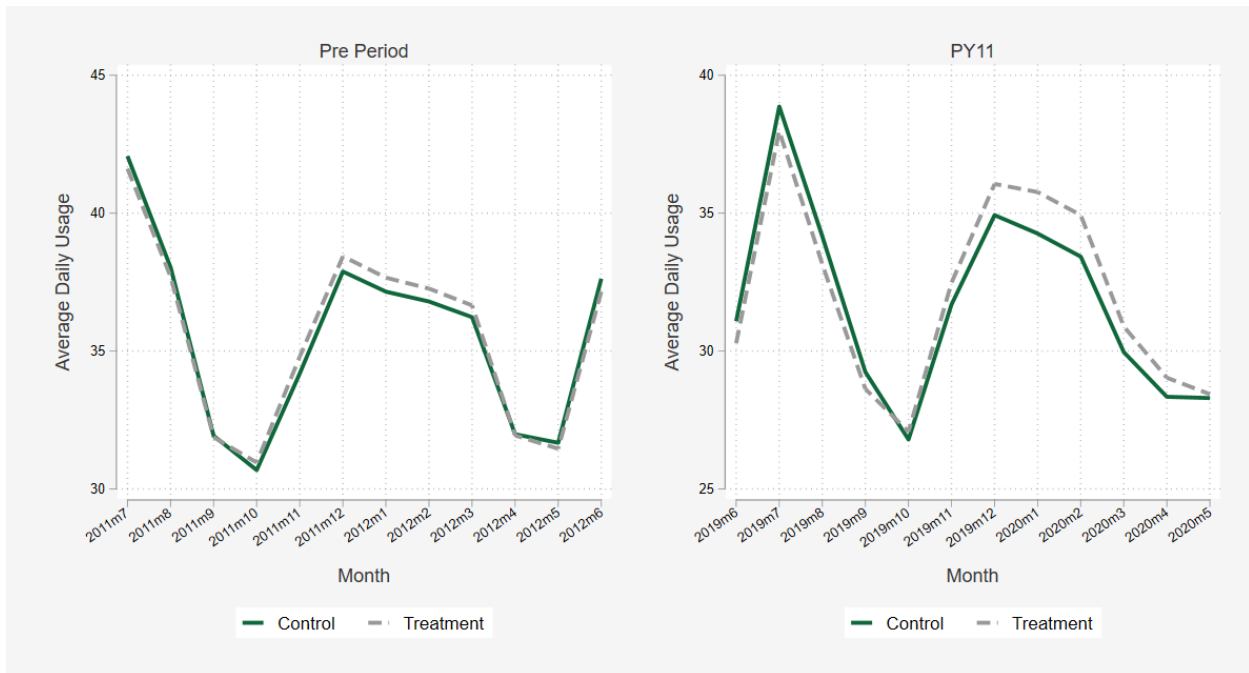


Figure 105: December 2014 Residential Cohort Usage Comparison

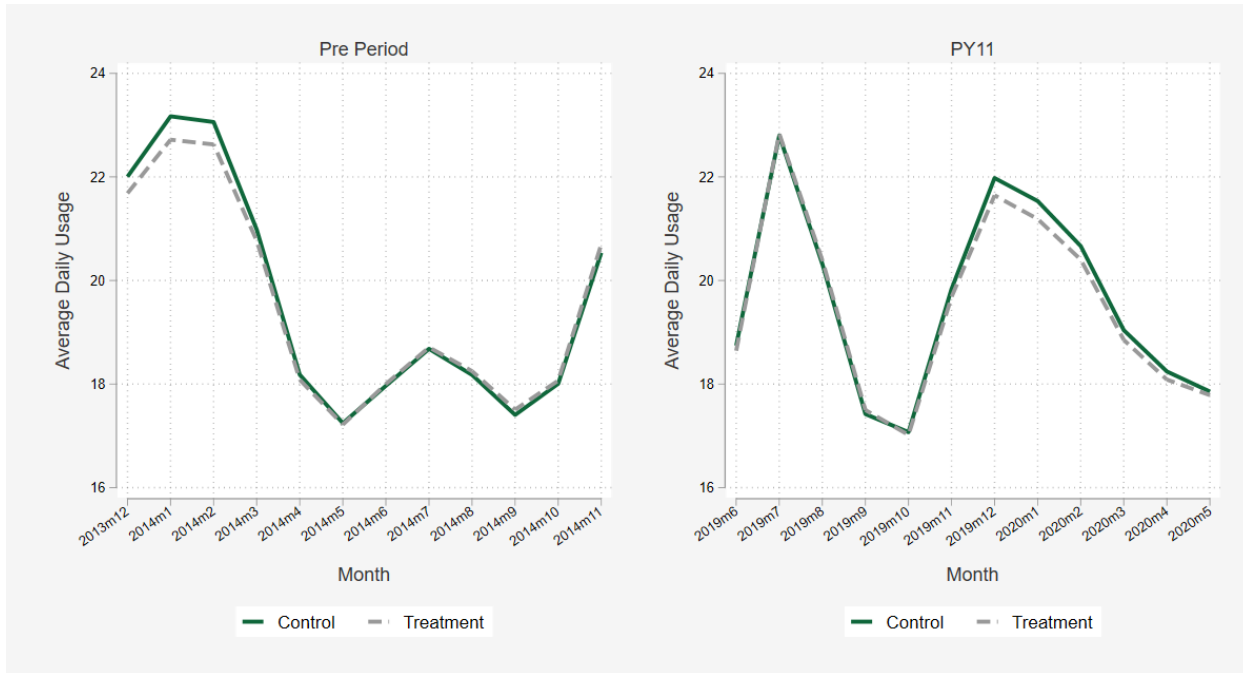


Table 198 shows PY11 impact estimates for each cohort. Note that a different impact estimate was calculated for each month in PY11 – the estimates shown in the table reflect the averages of the PY11 monthly estimates (weighted by month duration). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the LI July 2012 cohort saved 0.29 kWh per day, on average, during PY11.

Table 198: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
LI	July 2012	-0.29	-0.29
Residential	July 2012	-0.47	-0.47
LI	January 2014	-0.94	-0.94
Residential	January 2014	-0.30	-0.30
LI	December 2014	-0.05	-0.05
Residential	December 2014	-0.04	-0.04

Using the impact estimates shown above, Table 199 shows ADM's and the SWE's aggregate energy savings (MWh) for each cohort after correcting for dual participation in other energy-efficiency programs and applying the upstream adjustment factors. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 199: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE – ADM)
LI	July 2012	1,096	1,095	-1
Residential	July 2012	6,260	6,271	11
LI	January 2014	487	487	0
Residential	January 2014	5,846	5,845	-2
LI	December 2014	163	163	0
Residential	December 2014	421	415	-6
Total		14,272	14,275	3

Demand Savings

Table 200 shows ADM's and the SWE's aggregate peak demand savings (MW) for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

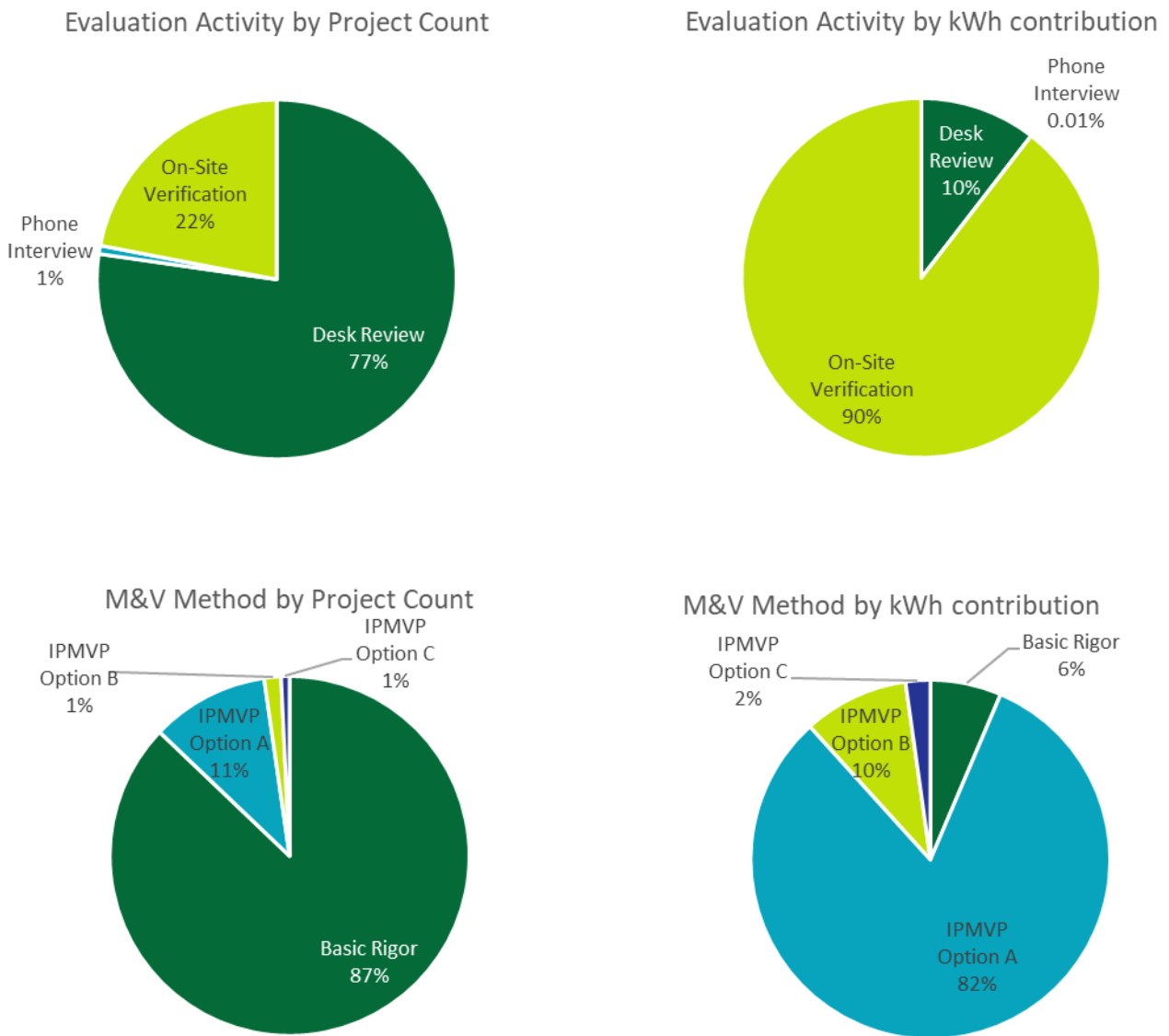
Table 200: Demand Savings Comparison

Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE – ADM)
LI	July 2012	0.12	0.12	0.00
Residential	July 2012	0.69	0.70	0.00
LI	January 2014	0.06	0.06	0.00
Residential	January 2014	0.66	0.66	0.00
LI	December 2014	0.02	0.02	0.00
Residential	December 2014	0.05	0.05	0.00
Total		1.60	1.60	0.00

F.4.2 Non-Residential Audit Activities

Figure 106 provides a summary of the evaluation activities and M&V approaches utilized by Penelec’s evaluation contractor, ADM, in their PY11 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY11, Penelec’s evaluation contractor completed site visits to 22% of projects, and these projects represented 90% of total evaluated energy savings. A total of 29 site visits were conducted, a lesser number than PY10. IPMVP Options A and B were employed for the majority (92%) of total evaluated energy savings. Basic Rigor (verification only) was employed for all appliance recycling projects and direct install projects, and a small selection of custom, lighting, and prescriptive projects.

Figure 106: 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 201 provides a summary of the evaluation activities Penelec's evaluation contractor used across strata for all projects by initiative.

Table 201: Summary of Penelec's PY11 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	Phone Interview	On-Site Verification
Appliance Turn-In	58	85%	58	0	0
Appliance Recycling-1	58	85%	58	-	-
Custom	22	101%	15	0	7
Custom-1	18	110%	13	-	5
Custom-2	1	86%	1	-	-
Custom-Certainty	3	100%	1	-	2
Direct Install	6	104%	6	0	0
Direct Install-1	2	104%	2	-	-
Direct Install-2	4	104%	4	-	-
Lighting	26	101%	5	1	20
Lighting-1	6	93%	4	1	1
Lighting-2	8	109%	1	-	7
Lighting-3	9	97%	-	-	9
Lighting-Certainty	3	97%	-	-	3
Prescriptive	20	101%	18	0	2
Prescriptive-1	19	101%	17	-	2
Prescriptive-2	1	100%	1	-	-
TOTAL	132		102	1	29

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.4.2.1 Appliance Turn-In Initiative

The evaluation contractor conducted phone surveys to verify projects in this initiative. No site visits were conducted for these projects. Impacts were calculated through desk reviews and TRM calculations using project-specific data from the tracking system or verification surveys when available. TRM default values were used in absence of project-specific data.

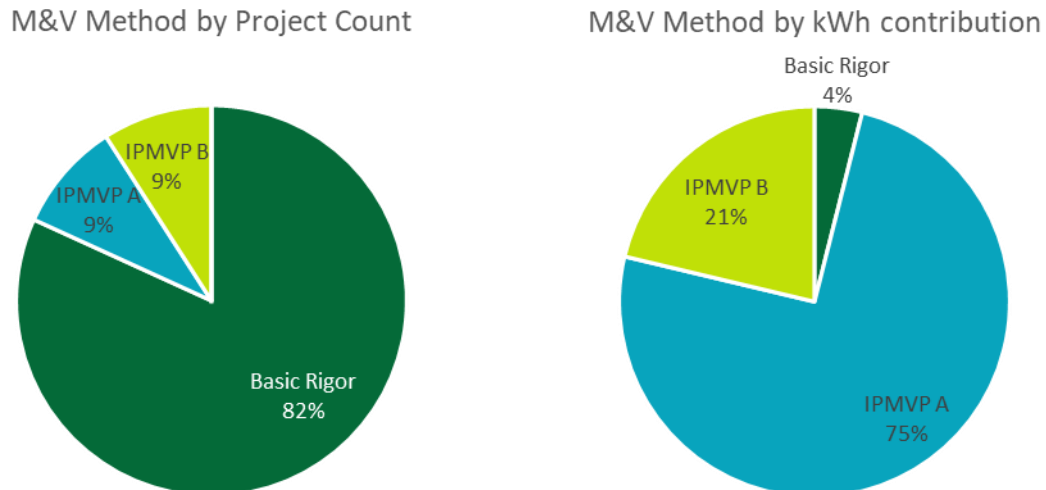
F.4.2.2 Custom Initiative

Evaluation activities for this initiative include desk reviews, site visits and/or IPMVP evaluation methods for the large majority of sampled projects. Basic rigor was employed for some smaller projects. For larger projects, site visits were 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.

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.

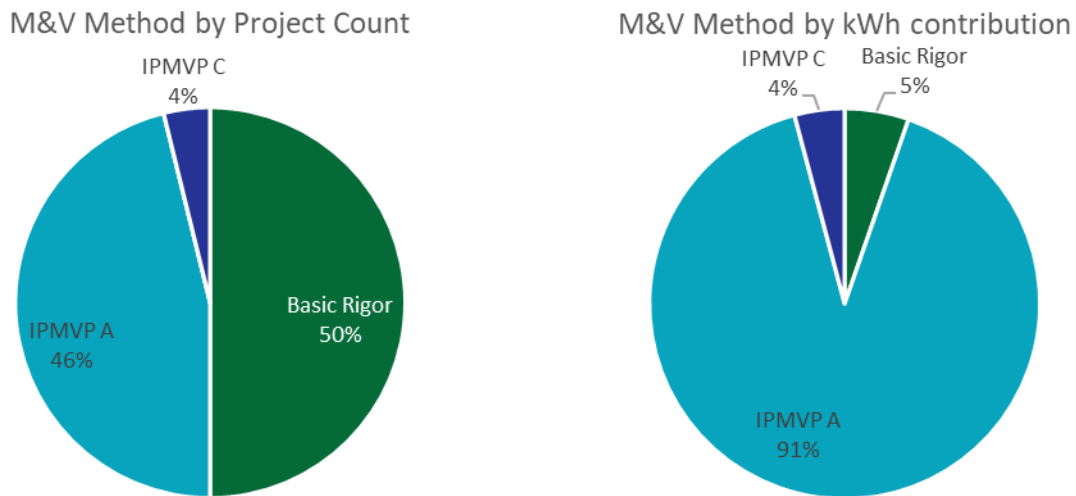
The distribution of rigor across the sample strata is in keeping with Table 3-2 of the Phase III Evaluation Framework, whereby enhanced rigor methods are to be reserved for measures with the highest impact and/or level of uncertainty. IPMVP Option A and B were employed to evaluate 96% of the sampled energy savings, as shown in [Figure 107](#).

Figure 107: Summary of Penelec's C&I Custom Program M&V Methods



F.4.2.3 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. 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 108: Summary of Penelec's C&I Lighting Program M&V Methods

IPMVP Options A and C were employed for nearly half of projects but made up 95% of evaluated energy savings in the PY11 sample.

F.4.2.4 Prescriptive Initiative

Evaluation activities for this initiative include verification site visits and application of TRM-based savings calculation methodologies. Only two of the sampled prescriptive projects received a site-visit this program year. Prior to site visits, all sampled projects undergo a full documentation review. This documentation review included identification of the appropriate TRM protocol and the defined key input parameters.

Penelec's evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 50 MWh of annual energy savings. Nineteen of the PY11 sampled projects were in the Prescriptive-1 stratum, with only one project assigned to the Prescriptive-2 stratum.

IPMVP-based methods were not employed for this initiative. All projects were evaluated using engineering algorithms or on-site verification visits in most cases.

F.4.2.5 Direct Install Initiative

The sole evaluation activity for the Direct Install initiative is a desk review using TRM-based savings algorithms to quantify savings. There are two strata in the Direct Install initiative, with a threshold of 20 MWh set for the Direct Install-2 stratum. In PY11, Penelec sampled six of its seven total projects, four in the Direct Install-2 stratum and two in the Direct Install-1 stratum. A realization rate of 104% was achieved for this initiative.

F.4.2.6 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 202 provides an overview of the SWE milestones for the audit of Penelec’s site inspection efforts.

Table 202: Penelec Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Energy Attainment Percentage
3	15,701,484	2	2	100%

Overall, the SWE agreed with the methods of calculation employed by Penelec’s evaluation contractor, ADM. The SWE verified two LED projects and one custom VSD project with ride-along visits in PY11. The calculations and accompanying reports were easy to follow and showed evidence that the TRM was being followed appropriately. Of the three projects reviewed, the SWE made no recommendations to the evaluator’s final savings, thus reaching an attainment percentage of 100% for both energy and demand.

F.4.2.7 Verified Savings Desk Reviews

Table 203 provides an overview of the SWE milestones for the verified savings review of evaluated Penelec projects.

Table 203: Penelec Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
1	1,852,905	289.3	100%	100%

The SWE asserts that ADM conducted appropriate M&V efforts, and that sufficient documentation supporting savings analyses was provided. For the one project reviewed, the SWE found no basis for recommending adjustments to energy or demand savings.

F.5 DR

Penelec does not have a DR target for Phase III of Act 129.

F.6 NTG

F.6.1 Residential Programs

ADM and Tetra Tech estimated a PY11 NTG for the HVAC and Residential Appliances Programs using participant surveys. NTG was estimated with the recommended UMP protocol.

The Energy Efficiency Kits Program NTG research consisted of participant surveys from PY8, PY9, and PY10. The PY8 and PY9 Energy Efficiency Kit NTG data was gathered from Opt-In Kit component of the program. The data was weighted by program substrata contribution to the program gross verified impacts and applied to the common NTG formula.

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 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 beivies, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 204: 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	--
PY8	EE Kits	0.20	0.03	0.83	--
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	--
Estimated	HVAC	0.49	0.01	0.52	79
Estimated	Residential Appliances	0.47	0.07	0.60	70

F.6.2 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 PY11 Evaluation Plan and SWE Phase III Evaluation Framework.

F.6.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY11. C&I NTG values were evaluated in PY10 and those values were applied to the C&I Programs for PY11. It has been previously concluded that all PY10 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 205: Summary of NTG Estimates for Penelec C&I Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Small Energy Solutions for Business Lighting	0.26	0.03	0.77	--
PY10	Small Energy Solutions for Business Custom	0.17	0.04	0.84	--
PY10	Small Energy Solutions for Business Prescriptive	0.53	0.0	0.47	--
PY10	Small Energy Solutions for Business Appliance Turn-In	0.53	0.0	0.47	--
PY10	Small Energy Solutions for Business Direct Install	0.26	0.03	0.77	--
PY10	Small Energy Solutions for Business Total	--	--	0.78	--
PY10	Large Energy Solutions for Business Lighting	0.26	0.03	0.77	--
PY8	Large Energy Solutions for Business Custom	0.17	0.04	0.84	--
PY10	Large Energy Solutions for Business Prescriptive	0.53	0.0	0.47	--
PY10	Large Energy Solutions for Business Total	--	--	0.80	--

F.7 TRC

Table 206 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Penelec's PY11 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 PY11 annual report and the model itself was well-organized and documented.

Both gross and net TRC ratios decreased across nearly all categories from PY10. The only exceptions were the gross TRC ratio for Large C&I Energy Solutions and the net TRC ratio for the Energy Efficient Homes program. The largest decrease in cost-effectiveness occurred in the LI Energy Efficiency program.

Table 206: Summary of Penelec's PY11 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	\$983	\$586	1.68	\$462	\$586	0.79
Energy Efficient Homes	\$7,239	\$4,064	1.78	\$6,425	\$4,019	1.60
Energy Efficient Products	\$11,974	\$8,724	1.37	\$4,145	\$4,366	0.95
LI Energy Efficiency	\$1,030	\$1,845	0.56	\$1,030	\$1,845	0.56
C&I Energy Solutions for Business - Small	\$12,193	\$11,678	1.04	\$9,515	\$9,423	1.01
C&I Energy Solutions for Business - Large	\$15,970	\$13,539	1.18	\$12,750	\$10,973	1.16
Governmental & Institutional Tariff	\$228	\$347	0.66	\$175	\$290	0.60
Portfolio Total	\$49,617	\$40,784	1.22	\$34,502	\$31,503	1.10

Five 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 EEP program was cost-effective under gross verified savings, but not cost-effective under net verified savings, while the LI Energy Efficiency and Governmental & Institutional Tariff programs were not cost-effective under gross or net verified savings.

F.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. First, to calculate natural gas prices, Penelec used the AEO average natural gas price for all users in the entire United States region rather than the AEO average natural gas price for all users in the Middle Atlantic region, as the SWE recommends. Second, the AEO natural gas prices were not converted to nominal dollars before the NPV was calculated. Penelec resolved both of these issues in the PY11 TRC model.
- 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 to Friday 8 a.m. to 8 p.m.). 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 to Friday, 7a.m. to 11 p.m.) 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 NPV 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).

- The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the DEER, company assumptions, and actual project costs as gathered from the PY11 evaluation. The SWE spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with Penelec'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 SO, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the TRC 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 DR 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 would appear 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 105 in FirstEnergy's PY11 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 PY9 and PY10, 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 56 million gallons per year of water saving, which translates to approximately \$2,613,000 in NPV lifetime avoided costs.
- In PY11, 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 207 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. FirstEnergy used one

year of pre-EISA savings and fourteen years of post-EISA savings for standard lamps and two years of pre-shift and thirteen years of post-shift savings for specialty lamps.

Table 207: Penelec Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.22	1.10
Without Dual Baseline	1.41	1.17

F.8 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 Penn Power Audit Detail

G.1 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 several memos updating their sampling and evaluation approach for several programs, including for EEP appliance retailers, HVAC and appliance participants and HVAC contractors, as well as the LI direct install program and the PY12 process evaluation for the BDR program. The SWE reviewed and approved these plans with minor comments and suggestions.

In addition to reviewing FirstEnergy's evaluation memos, the SWE reviewed and approved several surveys and interview guides for the EEP appliances and HVAC programs, the residential BDR program, the LI direct install program, and the C&I DR program.

The ADM team also submitted a memo to the SWE outlining ADM's proposed EM&V methods in response to the COVID-19 outbreak.

G.2 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 $\pm 5\%$ at the 85% confidence level, then there is an 85% chance that the true value of savings for the population is between 950 MWh/year and 1,050 MWh/year. All programs that rely on sampling to calculate verified savings must include the relative precision to quantify the sampling uncertainty.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of $\pm 15\%$ 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 208](#) lists each initiative and the corresponding relative precision of the PY11 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 208: Relative Precision of Penn Power PY11 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (\pm)
Residential Appliance Turn-In (ATI)	6.80%
LI ATI	15.50%
C&I ATI	24.80%
Res Energy Efficiency Kits	13.80%
LI Energy Efficiency Kits	0.00%
Res Direct Install	5.50%
LI Direct Install	11.00%
Res Upstream Lighting	8.20%
Res Upstream Electronics	0.00%
Res HVAC	7.91%
Residential Appliances	18.40%
LI Appliances	49.60%
Residential New Construction	15.00%
C&I Lighting	12.40%
C&I Custom	10.00%
C&I Prescriptive	4.50%

Four of the sampling initiatives shown in [Table 208](#) failed to meet the requirement of $\pm 15\%$ precision at the 85% confidence level. The poor precision in LI ATI was largely a function of sample size, with only 23 projects sampled. With a population of 154 projects for PY11, the SWE does not view the sample design or resulting precision as an issue. In the C&I ATI program, eight of fourteen total projects were surveyed. Because the population is so small, the precision can vary greatly if there are any outliers within the sample or in the remaining population. The high relative precisions in the Residential and LI Appliances initiatives were caused by conservative ex-ante savings values for clothes washers (93 kWh/unit) and heat pump water heaters (1,289 kWh per unit). The Residential New Construction initiative passed, but the relative precision was at the 15% threshold. Penn Power adjusted some of its verification processes in response to the COVID-19 pandemic. After March 2020, ADM replaced on-site visits with phone interviews, video conferences, and data loggers.

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.4](#).

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 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 $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 209](#) shows the absolute precisions of the behavioral program components.

Table 209: Absolute Precisions of Penn Power PY11 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (\pm)
Residential	0.23%
LI	0.76%

DR programs offered by Penn Power in PY11 include BDR targeted at residential customers and the DR Program for both small and large C&I customers. The relative precision of the PY11 verified DR savings was $\pm 27.8\%$ at the 90% confidence level for the Penn Power DR portfolio.

G.3 REPORTED GROSS SAVINGS AUDITS

G.3.1 Tracking Data Review

This section of the memo summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in Penn Power's PY11 Annual Report. Specifically, the values we examined are:

- Reported gross energy savings (MWh) for each program;
- Reported gross peak demand savings (MW) for each program;
- Participation for each program; and
- Incentive dollars for each program.

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 PY11 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.5](#), and our findings

regarding the HER components of the Energy Efficient Homes and LIEEPs can be found in [Appendix G.4.1.3](#).

[Table 210](#) 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 PY11 Annual Report and ‘No’ otherwise. For each program, the SWE was able to replicate the values provided by Penn Power.

Table 210: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-in	815	815	Yes
Energy Efficient Homes	1,080	1,080	Yes*
Energy Efficient Products	15,828	15,828	Yes
LI Energy Efficiency	493	493	Yes*
C&I Energy Solutions for Business – Small	16,149	16,149	Yes
C&I Energy Solutions for Business – Large	5,376	5,376	Yes
Governmental & Institutional Tariff	2	2	Yes
Portfolio Total	39,743	39,743	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

[Table 211](#) 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 211: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-in	0.10	0.10	Yes
Energy Efficient Homes	0.49	0.49	Yes*
Energy Efficient Products	1.99	1.99	Yes
LI Energy Efficiency	0.06	0.06	Yes*
C&I Energy Solutions for Business – Small	2.14	2.14	Yes
C&I Energy Solutions for Business – Large	0.61	0.61	Yes
Governmental & Institutional Tariff	0.00	0.00	Yes
Portfolio Total	5.39	5.39	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

[Table 212](#) 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 six participants. Note that Residential Behavioral DR program participants are removed from the Energy Efficiency Homes participant counts.

Table 212: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-in	745	745	Yes
Energy Efficient Homes	893	893	Yes*
Energy Efficient Products	126,929	126,929	Yes
LI Energy Efficiency	910	910	Yes*
C&I Energy Solutions for Business – Small	265	265	Yes
C&I Energy Solutions for Business – Large	26	26	Yes
Governmental & Institutional Tariff	1	1	Yes
Portfolio Total	129,769	129,769	Yes*

*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 213](#) 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: \$1,959,000 in the Annual Report and \$1,949,000 in the tracking data.

Table 213: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-in	\$41	\$41	Yes
Energy Efficient Homes	\$296	\$287	No
Energy Efficient Products	\$586	\$608	No
LI Energy Efficiency	\$15	\$15	Yes
C&I Energy Solutions for Business – Small	\$760	\$737	No
C&I Energy Solutions for Business – Large	\$261	\$26	Yes
Governmental & Institutional Tariff	\$0	\$0	Yes
Portfolio Total	\$1,959	\$1,949	No

G.3.2 Project File Reviews

G.3.2.1 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 PY11 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 214 presents a summary of SWE's residential project file reviews.

Table 214: Penn Power PY11 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 Program	Appliance Turn In Program	22	✓	✓	✓	✓
Energy Efficient Homes Program	School Education	11	✓	✓	✓	✓
Energy Efficient Homes Program	EE Kits	8	✓	✓	✓	✓
Energy Efficient Homes Program	Audits	8	✓	✓	✓	✓
Energy Efficient Homes Program	New Homes	24	✓	✓	✓	✓
Energy Efficient Products Program	HVAC	24	✓	✓	✓	✓
Energy Efficient Products Program	Appliances and Electronics	26	✓	✓	✓	✓
Energy Efficient Products Program	Midstream Appliances	8	✓	✓	✓	✓
Energy Efficient Products Program	Lighting	24	✓	✓	✓	✓
LI Energy Efficiency Program	Weatherization	28	✓	✓	✓	✓
Appliance Turn In Program	Appliance Turn In Program	22	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all First Energy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below, is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

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

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q4 because none were reported for that period.

EE Kits

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q2 through Q4 because none were reported during those periods.

Audits

The Audit project files reviewed mostly aligned with tracking data, but the SWE observed minor discrepancies in tracking the total number of kits that the program is responsible for. The SWE also observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings, however the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q2 through Q4 because none were reported during those periods.

New Homes

REM/Rate reports' kWh savings tended to match tracking but overestimated peak kW by 28% for all FE utilities. It should be noted that reported savings includes lighting and appliance savings; however, the evaluator addresses this during the verified savings review.

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.¹⁰³

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.

Midstream Appliances

The Midstream Appliance project files that the SWE reviewed matched the tracking data.

Appliances

The Appliance files typically matched the tracking data, but the SWE will confirm during the verified savings review, as in PY9 and PY10, that default TRM savings are used only for reported ex-ante savings, while model-specific TRM values are used in verified savings calculations. Reviewed ex-ante savings were based on TRM defaults.

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).

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.

As during PY9 and PY10 SWE review, ADM worked with the SWE to clarify the base wattage variable for specialty bulbs, which depends on bulb shape and lumen range when using TRM tables and equations. However, the tracking data did not break out bulb shape enough to make this determination.¹⁰⁴

ADM has confirmed in previous program years that this issue is corrected during the verified savings calculations, which are entirely independent from these ex-ante calculations. The model numbers are used to pull in all bulb information, including specific shape, from a compiled database, primarily using ENERGY STAR data.

LI WARM

The SWE observed some project files that only included certain measures in the tracking data and left out additional measures that were 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.

¹⁰³ 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.

¹⁰⁴ For example, a specialty bulb at 500 lumens could have a base wattage of 40, 45, 60, or 65 depending on the shape, but there is no way to tell which value should be used without more specific shape categories being used. ADM confirmed that this is addressed in the verified savings calculations.

Q2 project files consisted of a link to a program website with limited information about the project. The website required a login to access the more-detailed information that the SWE requires to conduct the same level of review as with static project files. To ensure consistency and thoroughness in its evaluation, the SWE will want to confirm with the evaluation team that they can produce static project files for each quarter.

G.3.2.2 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 PY11. 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 215](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 215: Penn Power PY11 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	3	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Custom – SCI	3	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program – Small	Food Service	1	✓	✓	✓	✗	✗	-
Governmental & Institutional Tariff Program	Lighting – Gov't	1	✓	✓	✓	✓	✓	-
C&I Energy Solutions for Business Program – Large	Lighting – LCI	3	✓	✓	✓	✗	✓	-
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 a few project files lacked documentation indicating final approved program savings. Finally, baseline project data was limited or unavailable for one Custom – LCI project and one Food Service 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.

- **Lighting – Gov’t**
 - Documentation on custom hours of use missing.
- **Food Service**
 - Workbook calculator locked; SWE cannot verify calculations. Freezer savings seem too low for one project.
- **Lighting – SCI**
 - Invoice quantity does not align with workbook calculator for two projects.

Despite the minor issues discussed with the above project files, the SWE did find most projects to contain sufficient data to review and understand the project and have confidence the reported savings were being assessed accurately.

G.4 VERIFIED GROSS SAVINGS AUDITS

G.4.1 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 that were used to verify savings for the residential programs. [Table 216](#) provides a summary of the evaluation and M&V approaches used by Penn Power in their PY11 verified savings calculations.

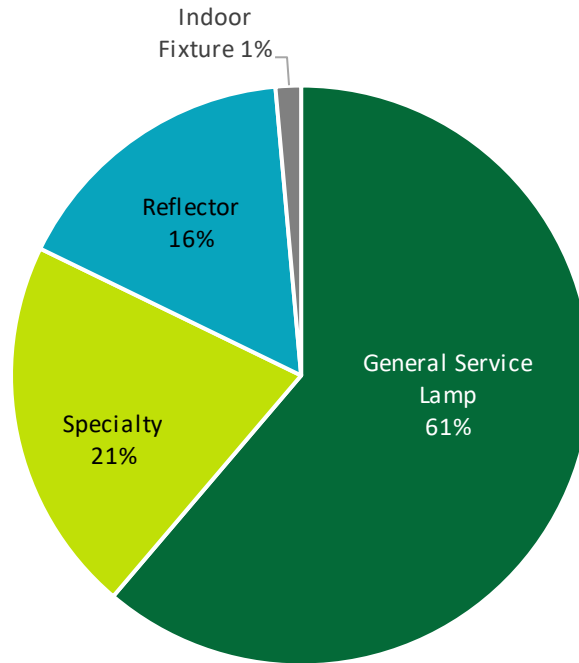
Table 216: Residential Program Evaluation Activities – Penn Power

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.4.1.1 Upstream Lighting & Cross-Sector Sales

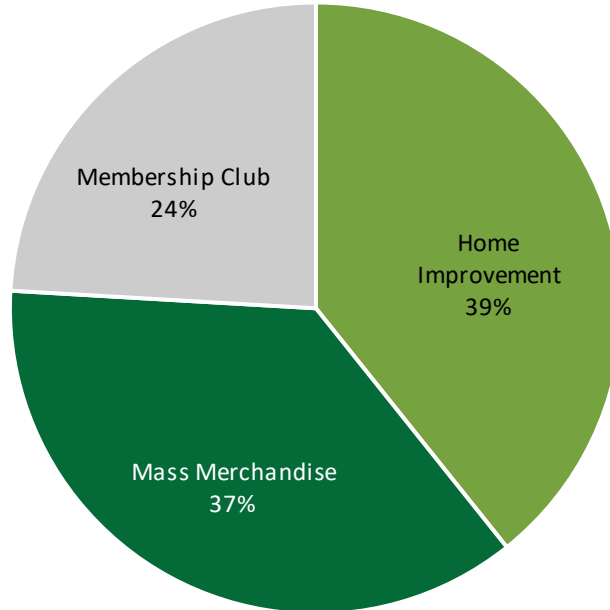
Customers purchased almost 400,000 efficient light bulbs and fixtures through Penn Power's PY11 upstream lighting program. [Figure 109](#) displays the distribution of sales by product type. Over three-fifths (61%) of the products were general service lamps.

Figure 109: Penn Power PY11 Upstream Lighting Sales by Product Type



Penn Power's PY11 upstream light bulbs and fixtures were sold through home improvement (39%), mass merchandise stores (37%) and membership clubs (24%, [Figure 110](#)).

Figure 110: Penn Power PY11 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY11 impact analysis for Penn Power's Upstream Lighting Initiative before the PY11 Penn Power Annual Report was submitted to the PUC on February 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 PY11 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 PY11 upstream lighting analysis.

G.4.1.2 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

The SWE audited each of the four components of the Energy Efficient Homes Program: Energy Efficiency Kits, HERs (reported in [Section G.4.1.3](#) of this appendix), Residential Direct Install, and New Homes by using the gross impact data submitted by FirstEnergy. Overall, the SWE audits concluded that the correct TRM algorithms were applied and verified savings were correct for all program kits and direct install measures.

The SWE had previously identified a small error in the New Homes subprogram in which ENERGY Star dishwasher savings were incorporating an incorrect TRM default value for homes with gas water heaters, but this error has been corrected in 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.4.1.1](#) 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 vales 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 PY11 annual report.

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. However, population and sample sizes in the annual request data did not match those included in the annual report.

G.4.1.3 Behavior

Approximately 13% of Penn Power’s verified gross energy savings for PY11 came from HERs issued to just under 25,000 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 PY11. By cohort, [Table 217](#) shows average kWh savings and average percent savings per participant in PY11. Note that the ‘Number of Participants’ column shows the average number of participants during PY11.

Table 217: Average PY11 kWh Savings per Participant

Sector	Cohort Start Date	Number of Participants	Average PY11 kWh Savings	Average PY11 % Savings
LI	July 2012	1,813	226	1.89%
Residential	July 2012	15,937	194	1.66%
LI	January 2014	700.75	215	1.31%
Residential	January 2014	6,440	393	2.33%

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, and energy and demand savings.

Calendarization

The first step the SWE 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 218](#) shows summary statistics calculated for ADM’s calendarized data and the SWE’s calendarized data.¹⁰⁵ The distribution of average daily kWh is basically identical in the two data sets.

Table 218: Comparison of Calendarized Data

Variable	Mean	5 th Percentile	25 th Percentile	75 th Percentile	95 th Percentile
Average Daily kWh – ADM	35.96	12.48	21.34	44.61	78.12
Average Daily kWh – SWE	35.96	12.48	21.34	44.61	78.12

¹⁰⁵ The table only summarizes PY11 records.

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 219](#) 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 LI cohort was the only group to have statistically significant pre-treatment differences between the treatment and control groups. In prior years, differences for this cohort were not statistically significant, but customers move over time and the make-up of the experimental cells change. The impact estimation method accounts for the differences in pre-treatment consumption.

Table 219: Group Equivalence in the Pre Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
LI	July 2012	35.4	35.6	0.59
Residential	July 2012	35.7	35.5	0.21
LI	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, uncalendarized 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 2020. We removed any records with a billing end date prior to March 1, 2020, then counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Participant counts, by cohort and month, are shown in [Table 220](#).

Table 220: Penn Power PY11 HER Participant Counts by Cohort and Month

Month	July 2012 LI	July 2012 Residential	January 2014 LI	January 2014 Residential
Jun-19	1,879	16,269	729	6,573
Jul-19	1,861	16,180	722	6,536
Aug-19	1,844	16,105	717	6,514
Sep-19	1,829	16,046	712	6,494
Oct-19	1,817	15,983	708	6,460
Nov-19	1,809	15,927	700	6,440
Dec-19	1,806	15,879	697	6,420
Jan-20	1,798	15,847	692	6,402
Feb-20	1,790	15,810	687	6,379
Mar-20	1,782	15,762	683	6,367
Apr-20	1,773	15,734	682	6,353
May-20	1,767	15,699	680	6,341

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 PY11, 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 be applied to the homes with insufficient pre period data. The SWE believes this is the correct approach. (Note that the underlying assumption here is that homes without sufficient pre period data do not systematically differ from homes with sufficient pre period data.)

Impact Coefficients and Energy Savings

Figure 111 through Figure 114 compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY11. For the treatment group homes, only homes that were active in PY11 are included in the “pre period” portion of the figure. As has been noted, the regression model used to estimate the impact the HER program has on daily usage controls for potential pre period differences.

Figure 111: July 2012 LI Cohort Usage Comparison

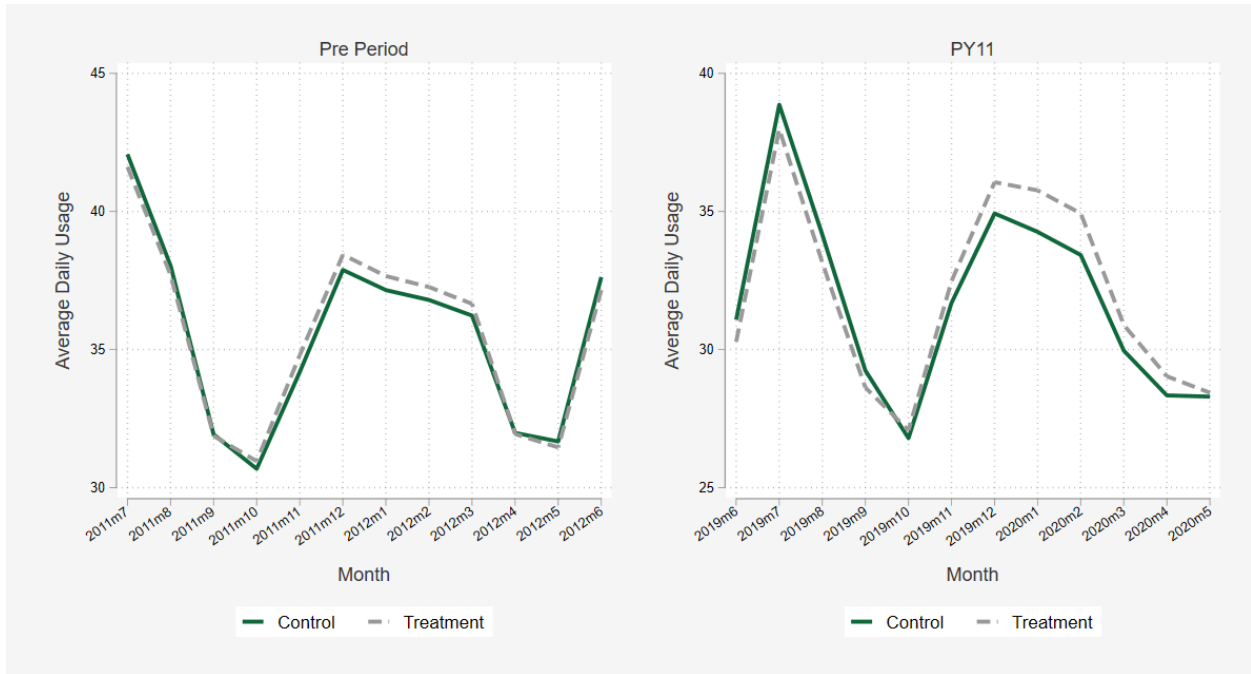


Figure 112: July 2012 Residential Cohort Usage Comparison

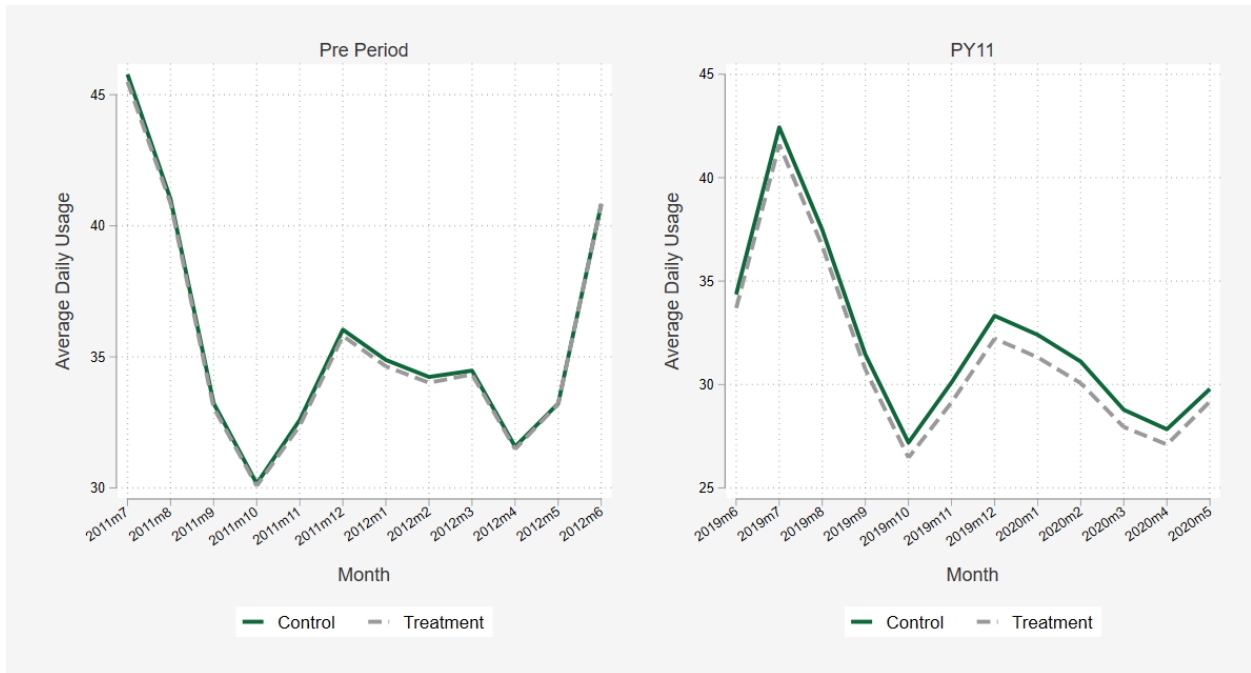


Figure 113: January 2014 LI Cohort Usage Comparison

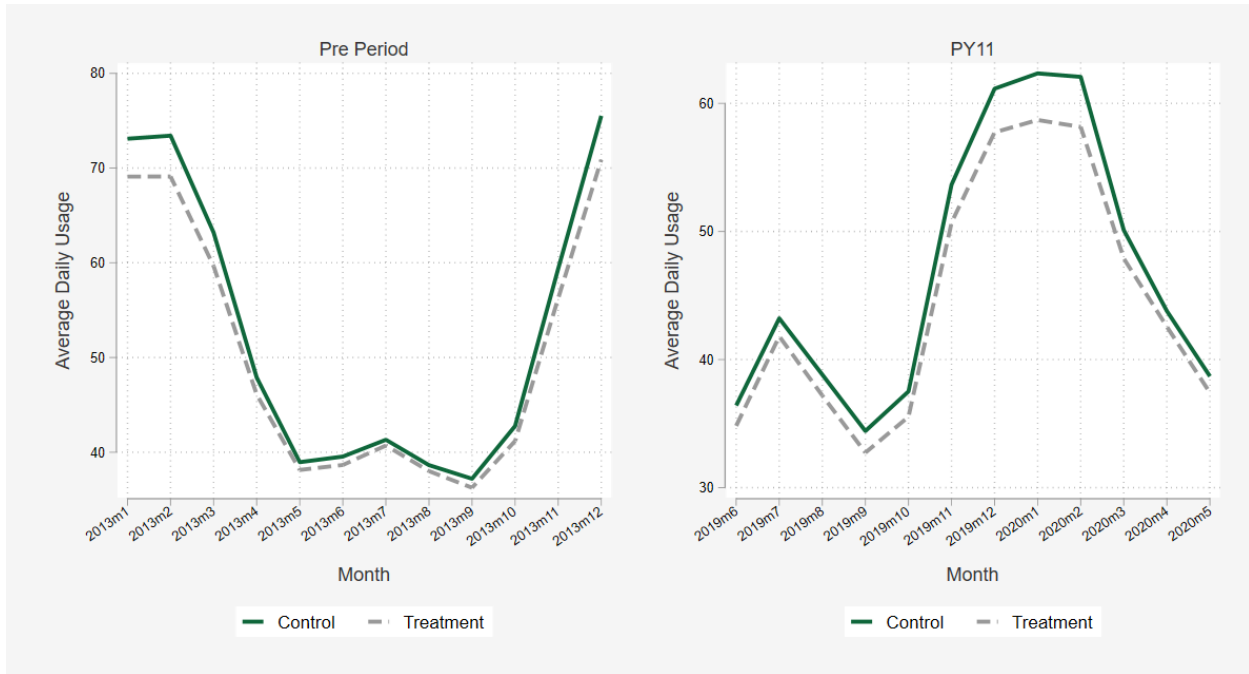


Figure 114: January 2014 Residential Cohort Usage Comparison

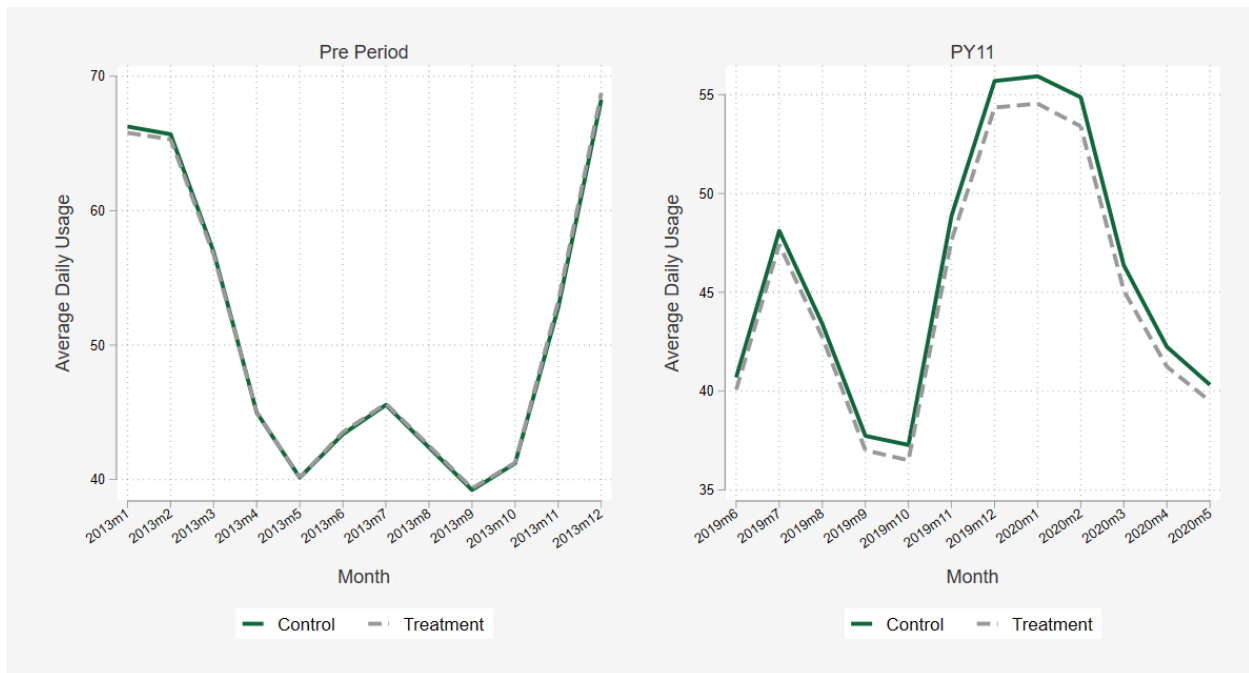


Table 221 shows PY11 impact estimates for each cohort. Note that a different impact estimate was calculated for each month in PY11 – the estimates shown in the table reflect the averages of the PY11 monthly estimates (weighted by month duration). Using the first impact estimate as an example, the practical interpretation is as follows: treatment group homes in the residential July

2012 cohort saved 0.66 kWh per day, on average, during PY11. The average impact estimate for the LI July 2012 cohort is positive, indicative of an increase in consumption.

Table 221: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
LI	July 2012	-0.46	-0.45
Residential	July 2012	-0.70	-0.70
LI	January 2014	-0.51	-0.51
Residential	January 2014	-1.17	-1.15

Using the impact estimates shown above, [Table 222](#) shows ADM's and the SWE's aggregate energy savings (MWh) for each cohort after correcting for dual participation in other energy-efficiency programs and applying the upstream adjustment factors. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MWh savings estimates.

Table 222: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE-ADM)
LI	July 2012	409	408	-1
Residential	July 2012	3,093	3,096	3
LI	January 2014	151	151	0
Residential	January 2014	2,532	2,529	-2
Total		6,185	6,184	-1

Readers will note that the 2012 LI cohort produced positive energy savings although the impact estimate for this cohort indicated an increase in consumption during PY11. This is due to an adjustment made for the 2012 cohorts that ADM discussed with the SWE in 2017. Essentially, savings for the 2012 LI and Residential cohorts are summed and then redistributed based on the relative share of pre-treatment aggregate consumption for these cohorts.

Demand Savings

Table 223 shows ADM's and the SWE's aggregate peak demand savings (MW) for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

Table 223: Demand Savings Comparison

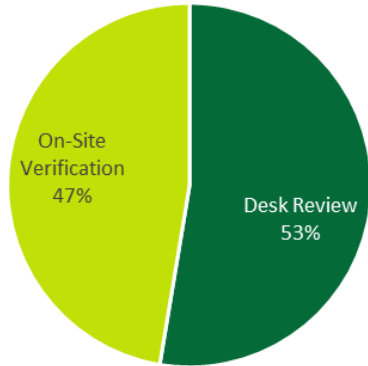
Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE-ADM)
LI	July 2012	0.05	0.05	0.00
Residential	July 2012	0.34	0.35	0.00
LI	January 2014	0.02	0.02	0.00
Residential	January 2014	0.28	0.28	0.00
Total		0.69	0.69	0.00

G.4.2 Non-Residential Audit Activities

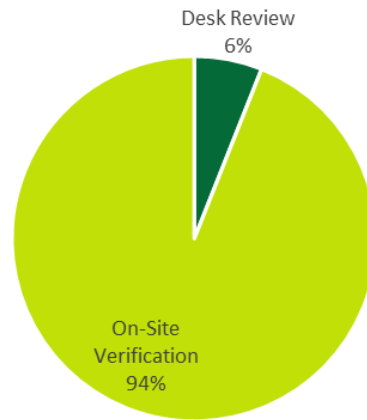
Figure 115 provides a summary of the evaluation activities and M&V approaches utilized by Penn Power's evaluation contractor, ADM, in their PY11 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY11, Penn Power's evaluation contractor completed site visits to 47% of projects, and these projects represented 94% of total evaluated energy savings. A total of 27 site visits were conducted. IPMVP Option A was employed for the majority (85%) of total evaluated energy savings. Basic Rigor (verification only) was employed for all appliance recycling projects and direct install projects and a selection of smaller custom, lighting, and prescriptive projects.

Figure 115: Summary of Penn Power’s C&I Evaluation Activities

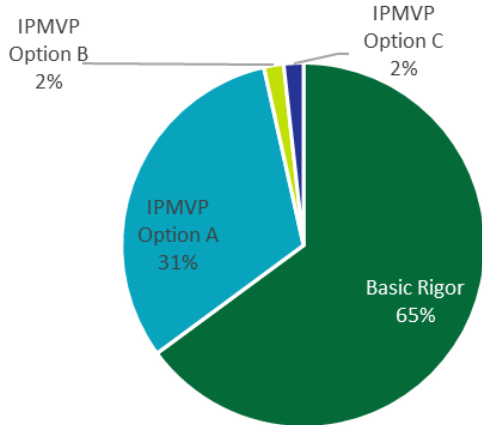
Evaluation Activity by Project Count



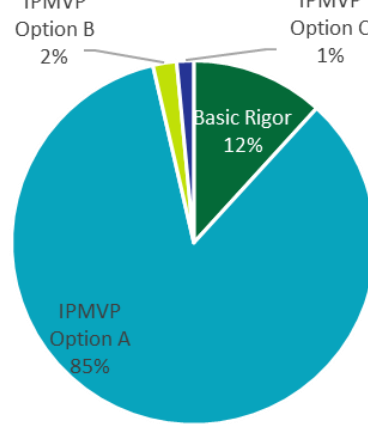
Evaluation Activity by kWh contribution



M&V Method by Project Count



M&V Method by kWh contribution



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 224](#) provides a summary of the evaluation activities Penn Power’s evaluation contractor used across strata for all projects by initiative.

Table 224: Summary of Penn Power's PY11 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	Phone Interview	On-Site Verification
Appliance Turn-in	8	108%	8	0	0
Appliance Recycling-1	8	108%	8	-	-
Custom	17	105%	8	0	9
Custom-1	15	103%	8	-	7
Custom-2	1	88%	-	-	1
Custom-Certainty	1	147%	-	-	1
Direct Install	1	95%	1	0	0
Direct Install-2	1	95%	1	-	-
Lighting	26	100%	8	0	18
Lighting-1	8	99%	5	-	3
Lighting-2	7	120%	2	-	5
Lighting-3	6	87%	1	-	5
Lighting-Certainty	5	100%	-	-	5
Prescriptive	5	112%	5	0	0
Prescriptive-1	4	105%	4	-	-
Prescriptive-2	1	116%	1	-	-
TOTAL	57		30	0	27

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.4.2.1 Appliance Turn-In Initiative

The evaluation contractor conducted phone surveys to verify projects in this initiative. No site visits were conducted for these projects. Impacts were calculated through desk reviews and TRM calculations using project-specific data from the tracking system or verification surveys when available. TRM default values were used in absence of project-specific data.

G.4.2.2 Custom Initiative

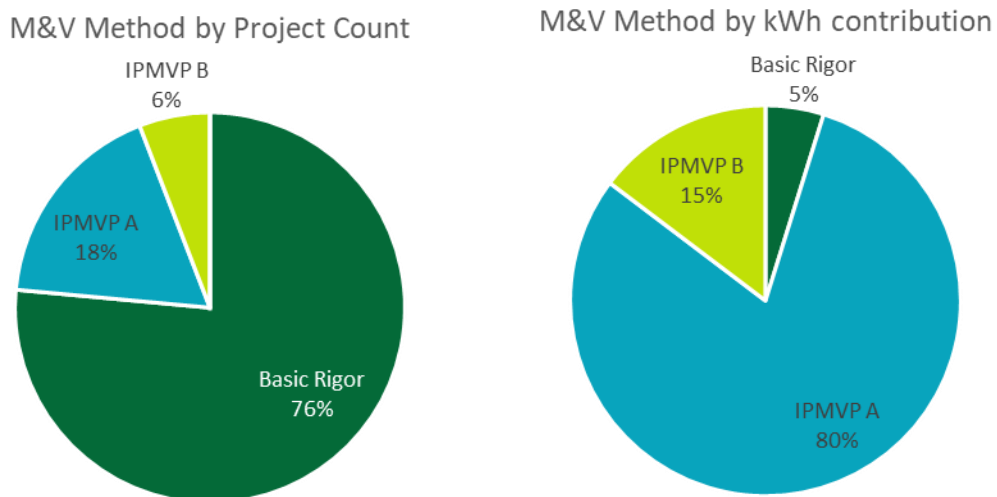
Evaluation activities for this initiative include desk reviews, site visits, and/or IPMVP Options for all sampled projects. Site visits are always conducted for larger projects unless the evaluation can be satisfactorily conducted remotely using data provided by the customer (EMS data, billing data,

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 80% of savings in the sample, as shown in [Figure 116](#).

Figure 116: Summary of Penn Power’s C&I Custom Program M&V Methods

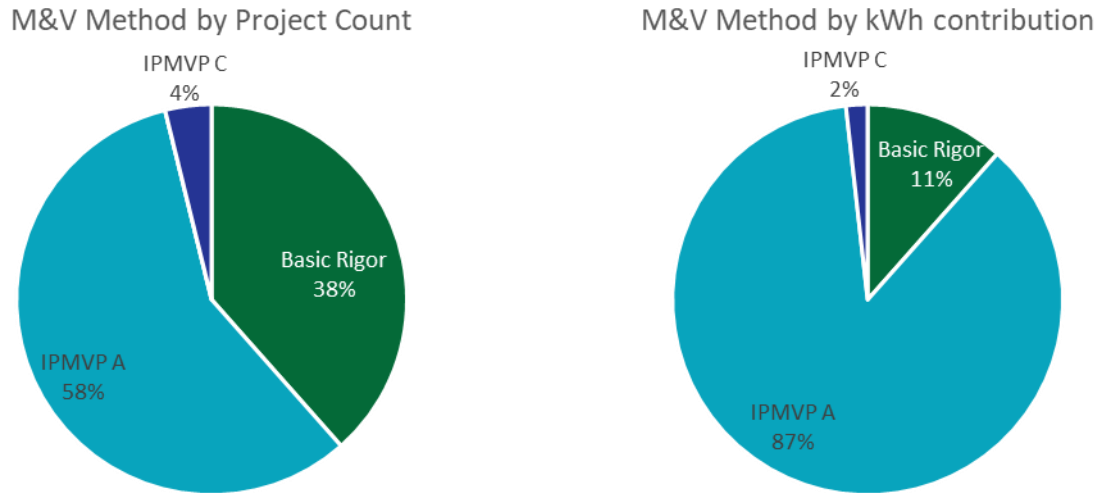


G.4.2.3 Lighting Initiative

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.

IPMVP Option A using standalone data loggers to measure lighting hours of use was employed for 58% of projects evaluated in this initiative, and made up 87% of evaluated energy savings, per [Figure 117](#).

Figure 117: Summary of Penn Power’s C&I Lighting Program M&V Methods

G.4.2.4 Prescriptive Initiative

Evaluation activities for this initiative include verification site visits and application of TRM-based savings calculation methodologies. None of the sampled prescriptive projects received a site-visit this program year. Prior to site visits, all sampled projects undergo a full documentation review. This documentation review includes identification of the appropriate TRM protocol and the defined key input parameters.

Penn Power’s evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 50 MWh of annual energy savings. Four of the PY11 sampled projects were in the Prescriptive-1 stratum, with only one project assigned to the Prescriptive-2 stratum.

IPMVP-based methods were not employed for this initiative. All projects were evaluated using basic rigor through engineering algorithms and TRM-based savings calculation methodologies.

G.4.2.5 Direct Install Initiative

The sole evaluation activity for the Direct Install initiative is a desk review using TRM-based savings algorithms to quantify savings. There are two strata in the Direct Install initiative, with a threshold of 20 MWh set for the Direct Install-2 stratum. In PY11, Penn Power sampled its only project for this initiative, which was in the Direct Install-2 stratum. A realization rate of 95% was achieved for this initiative.

G.4.2.6 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 225 provides an overview of the SWE milestones for the audit of Penn Power's site inspection efforts.

Table 225: Penn Power Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Attainment Percentage
2	529,414	1	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 custom methods were being reasonably applied. The SWE agreed with all engineering decisions made by the evaluators. The SWE's energy savings of the two custom projects with ride-along audits reached a 100% attainment percentage of the evaluator's energy savings.

G.4.2.7 Verified Savings Desk Reviews

In PY11, no verified savings desk reviews were conducted for Penn Power.

G.5 DR

According to the Phase III Implementation Order, Penn Power's Phase III DR compliance target is 17 MW. Note that compliance is determined based on the average MW performance across all DR event hours in 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 Penn Power, this translates to a 14.45 MW minimum performance level for any given DR event. 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. Penn Power called DR events on the four days those guidelines required during summer 2019.

In PY11, 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 BDR component had approximately 30,000 homes in the treatment group, though this number declined throughout the summer.

Table 226 shows Penn Power's performance across the four events during the 2019 DR season. Penn Power's PY11 average performance (35.2 MW) was comfortably above its Phase III target. Regarding the per-event target of 14.45 MW, the average impact for each of the four DR events exceeded this value. The large uncertainty bands for the large C&I sites (and portfolio total) were mainly attributable to large customers with volatile loads.

Table 226: 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 17, 2019	15	18	0.0	15.4	1.4	16.8±10.1
July 18, 2019	16	19	0.0	38.6	2.0	40.7±18.7
July 19, 2019	15	18	0.0	31.0	2.3	33.3±21.6
August 19, 2019	15	18	0.0	48.6	1.4	50.0±25.0
PYVTD - Average PY11 DR Event Performance						35.2±9.8
VTD - Average Phase III DR Event Performance						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 three C&I sites selected by the SWE, the hourly load data needed to replicate the ADM impact estimates. Note that these three sites accounted for approximately 72% of Penn Power's gross verified PY11 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 WSAs;
- Hourly load and weather data for approximately ~49,000 residential accounts (~30,000 treatment group accounts and ~19,000 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 PY11 gross verified savings estimates recommends that the Commission adopt them when assessing compliance with Phase III targets.

G.5.1 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 four of the nine participants. ADM's verified gross peak demand savings generated by these sites are shown in [Table 227](#). Note that these values are adjusted for line losses (by a multiplier of 1.0545). For each DR event hour during the 2019 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 227](#) 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 227: Penn Power PY11 DR Savings by Program

Program	PYVTD Gross MW	VTD Gross MW
C&I – Small	0.0	0.1
C&I – Large	44.0	39.7
Energy Efficient Homes	2.1	2.1
Total	46.1	41.9

G.5.2 Residential BDR

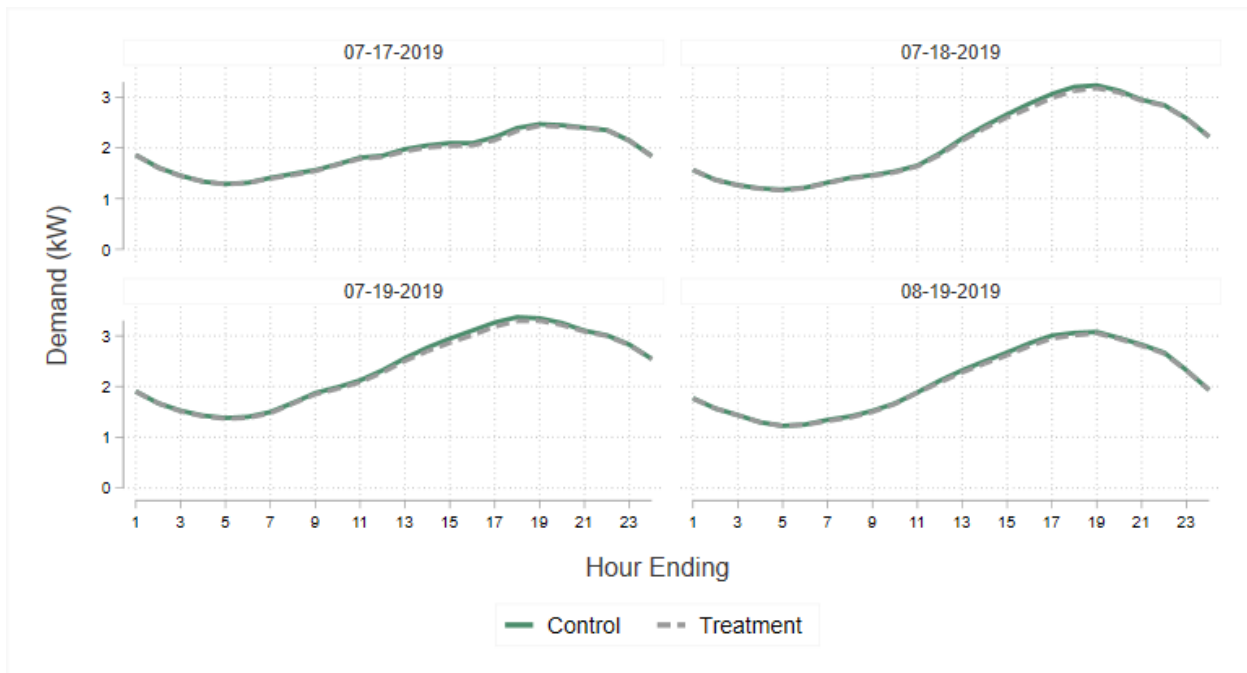
Penn Power's behavioral DR program operates as a RCT – customers were randomly selected and placed into control and treatment groups. As of the beginning of the 2019 summer DR season, there were 29,557 premises in the treatment group and 18,854 premises in the control group. Some of these homes were added in 2017 and some were added in 2019. [Table 228](#) shows counts by start date as of the beginning of the 2019 DR season. At the end of the DR season, these numbers were 28,565 and 18,240, respectively.

Table 228: Residential BDR Customer Counts

Date Added	Active Treatment Accounts	Active Control Accounts
5/24/2017	25,456	16,429
5/22/2019	4,101	2,605
Total	29,557	18,854

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 is not 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 in PY11, see [Figure 118](#). In this figure, control group and treatment group loads for each PY11 DR event day are compared. The impact is small but separation between the experimental cells can be seen in the late afternoon. With nearly 30,000 homes in the treatment group, small impacts add up.

Figure 118: Penn Power Residential BDR



G.5.2.1 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 119 shows the average hourly load profiles for the two experimental cells in each cohort during the baseline periods. Note that the customers added in 2019 have a different baseline period than the customers added in 2017, but both periods straddle April and May. As can be seen, the two groups used energy in the baseline period in an approximately identical fashion.

Figure 119: Penn Power Baseline Equivalence

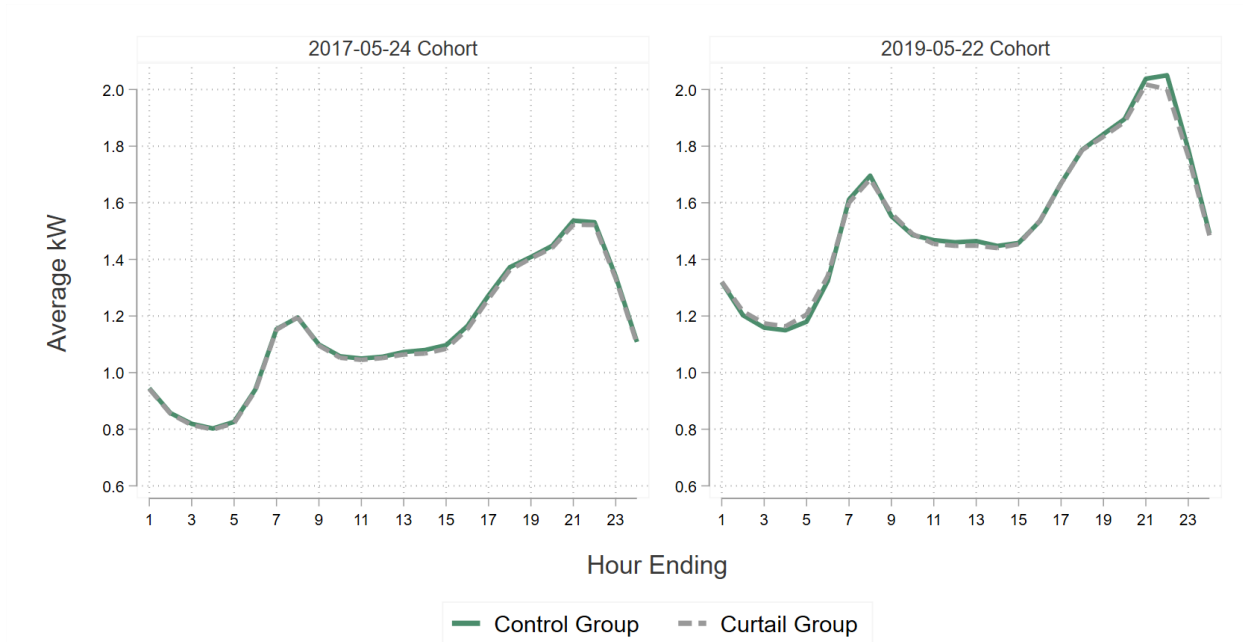


Table 229 shows average daily kWh for the control and treatment groups during the baseline period. A significance test suggests the difference between mean daily consumption values is not statistically significant (p-value = 0.31). The table also shows the average demand for the two groups during common event hours. Like the average daily kWh values, the difference between the average demand values is not statistically significant (p-value = 0.14).

Table 229: Equivalence Check

Group	Average Daily kWh	Average kW During Event Hours
Control	28.32	1.27
Treatment	28.17	1.26
Combined	28.23	1.26

G.5.2.2 Impact Estimation

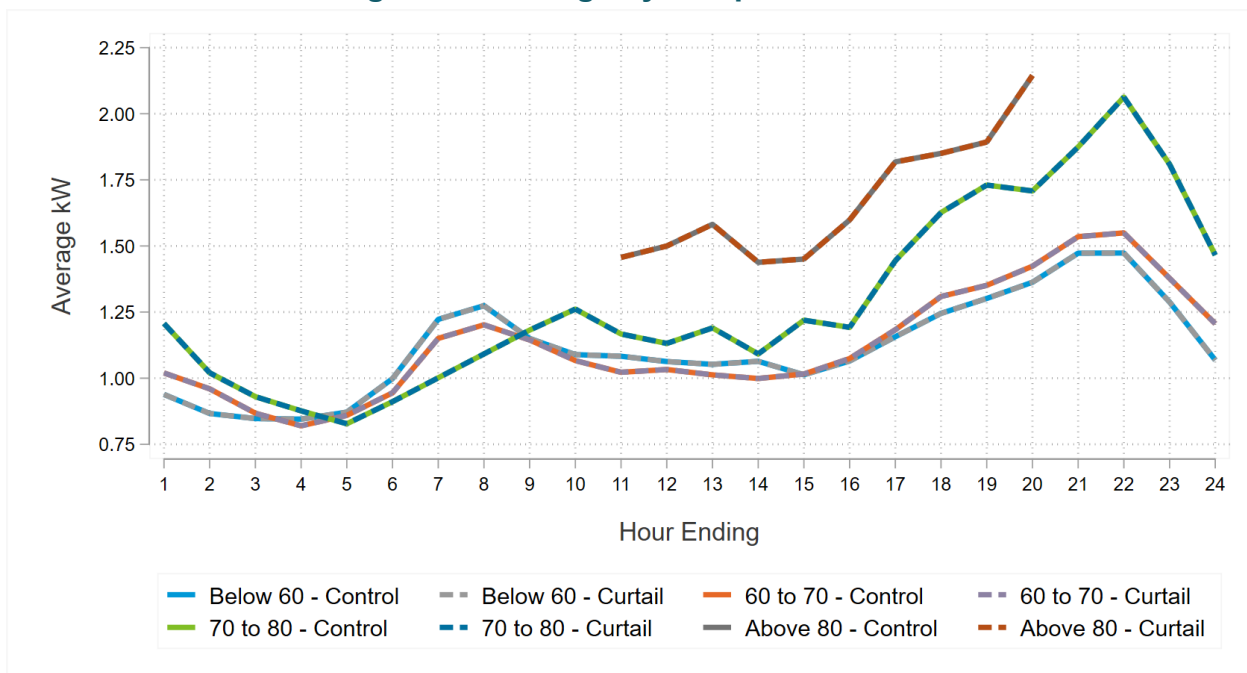
Savings calculations for the residential BDR component relied on a control group comparison and regression modeling. The regression model only used data from event hours on event days. Explanatory variables included date and hour fixed effects, an interaction between the treatment indicator variable and the date/time fixed effects, and three lag variables. The lag variables are customer-specific constants that were calculated based on consumption during a 30-day period that spanned April and May of 2017 for the 2017 cohort and April and May of 2019 for the 2019 cohort. Steps taken in producing these lag variables are as follows:

- Limit the load data to 2:00 p.m. to 6:00 p.m. 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 120 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 120: Usage by Temperature Bin



G.5.2.3 Findings

Table 230 shows the relevant regression coefficients (treatment effect by hour and date), participant counts, and aggregate impacts. Note that neither the regression coefficients nor the aggregate impacts are adjusted for line losses in this table. The practical interpretation of the first regression coefficient in the table (-0.040) 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 regression coefficients with a few other regression model specifications and found the results to be robust.

Table 230: Regression Output and Participant Counts

Date	Hour	Coefficient	Participants	Aggregate Impact (MW)
7/17/2019	15	-0.040	29,150	1.16
	16	-0.029	29,150	0.85
	17	-0.045	29,150	1.31
	18	-0.042	29,150	1.22
7/18/2019	16	-0.073	29,142	2.13
	17	-0.062	29,142	1.81
	18	-0.062	29,142	1.81
7/19/2019	19	-0.045	29,142	1.30
	15	-0.067	29,132	1.94
	16	-0.076	29,132	2.23
	17	-0.067	29,132	1.95
8/19/2019	18	-0.061	29,132	1.79
	15	-0.041	28,849	1.19
	16	-0.042	28,849	1.22
	17	-0.045	28,849	1.30
	18	-0.034	28,849	0.98

The average aggregate impact across the 16 event hours was -1.51 MW. Multiplying this value by Penn Power's line loss multiplier for residential customers (1.0949) yields an average savings estimate of 1.7 MW per event hour. This is slightly less than the PYVTD gross MW value calculated by ADM (1.8 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.5.3 C&I

G.5.3.1 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 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 231](#) provides an illustration.

Table 231: CBL-of-CBLs Illustration

CBL Type	CBL	Non-Event Day RRMSE	Inverse Square of RRMSE	Weight
10-of-10	1,100	7.1%	198.37	35.7%
10-of-10 with WSA	1,200	7.2%	192.90	34.7%
20-of-20	1,300	7.8%	164.37	29.6%

Thus, the CBL-of-CBLs value would be: $1,100 \times 0.357 + 1,200 \times 0.347 + 1,300 \times 0.296 = 1,193.90$.

G.5.3.2 Weather Sensitive Adjustments (WSAs)

Several of the baseline types that ADM considered involved a WSA (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 6/1/2019 and the last DR event of PY11 (which occurred on 8/19/2019);
- 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).

The WSA is only applied if the outdoor air temperature exceeds 75 degrees. Additionally, two distinct WSA coefficients were calculated for each participant. In prior program years, event hours were the same for each event. In PY11, one 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.

G.5.3.3 Findings

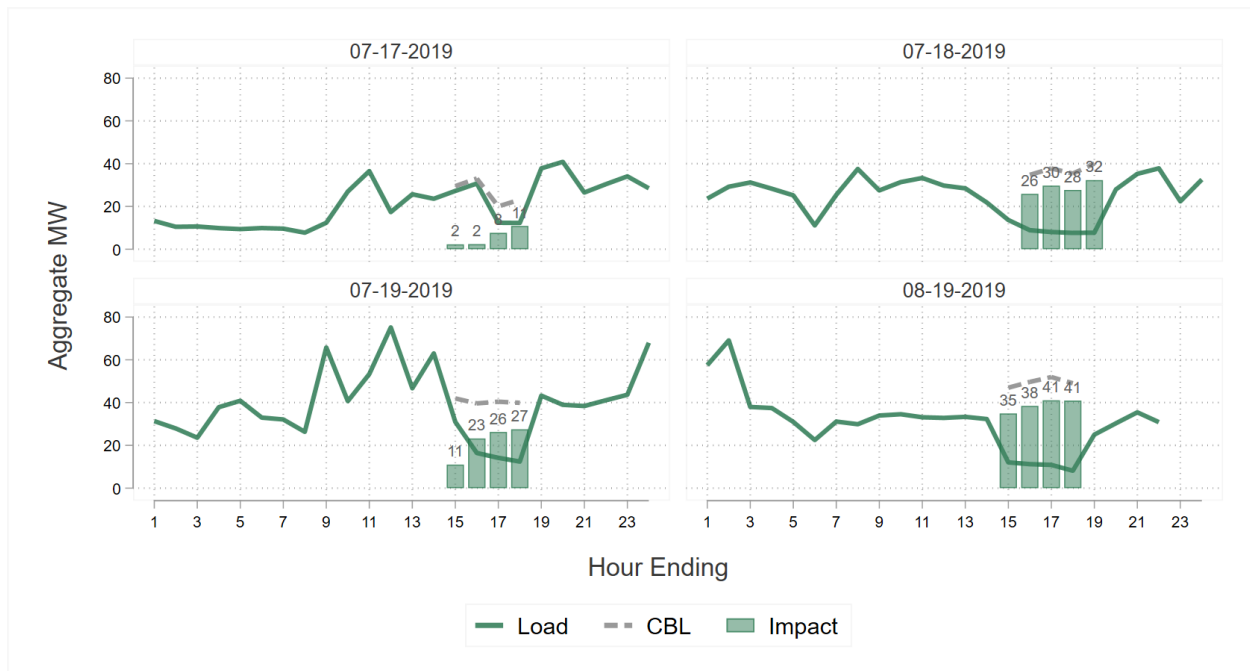
Using the load and temperature data provided by ADM, the SWE team was able to replicate all values that feed into the savings estimate – all WSA coefficients, all WSAs, all interim CBLs, and all CBL-of-CBLs. Table 232 provides a summary of the results.

Table 232: Penn Power C&I DR Audit Summary

Group	Count	Gross MW Impact - ADM	Gross MW Impact - SWE	% of Total Savings
In SWE Sample	2	25.2	25.2	75.3%
Not in SWE Sample	7	8.2	---	24.7%
Total	9	33.4	---	100%

By event day, Figure 121 shows the aggregate load, CBL, and DR impacts (expressed as positive values) for the two 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 121: Aggregate Load, CBL, and Impacts for Sampled Sites



G.5.4 Conclusion

The SWE agrees with the baseline selection procedures and found no errors in the calculations for the three C&I sites examined. For the residential BDR component, the ADM team leveraged an LS 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 estimates when assessing compliance at the end of Phase III.

G.6 NTG

G.6.1 Residential Programs

ADM and Tetra Tech estimated a PY11 NTG for the HVAC and Residential Appliances Programs using participant surveys. NTG was estimated with the recommended UMP protocol.

The Energy Efficiency Kits Program NTG research consisted of participant surveys from PY8, PY9, and PY10. The PY8 and PY9 Energy Efficiency Kit NTG data was gathered from Opt-In Kit component of the program. The data was weighted by program substrata contribution to the program gross verified impacts and applied to the common NTG formula.

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 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 beives, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 233: 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	--
PY10	Energy Efficiency Kits	0.22	0.05	0.83	--
RCT	HERs	--	--	1	--
PY10	Direct Install	0.19	0.20	1	--
PY10	New Homes	--	0.0	0.73	--
PY10	Upstream Lighting	0.74	0.0	0.26	--
PY10	Upstream Electronics	--	--	0.58	--
Estimated	HVAC	0.53	0.08	0.55	67
Estimated	Residential Appliances	0.56	0.12	0.56	76

G.6.2 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 PY11 Evaluation Plan and SWE Phase III Evaluation Framework.

G.6.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY11. C&I NTG values were evaluated in PY10 and those values were applied to the C&I Programs for PY11. It has been previously concluded that all PY10 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 234: 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	0.21	0.01	0.79	--
PY10	Small Energy Solutions for Business Custom	0.47	0.0	0.52	--
PY10	Small Energy Solutions for Business Prescriptive	0.60	0.0	0.40	--
PY10	Small Energy Solutions for Business Appliance Turn-In	0.49	0.0	0.51	--
PY10	Small Energy Solutions for Business Direct Install	0.21	0.01	0.79	--
PY10	Small Energy Solutions for Business Total	--	--	0.77	--
PY10	Large Energy Solutions for Business Lighting	0.21	0.01	0.79	--
PY8	Large Energy Solutions for Business Custom	0.47	0.0	0.52	--
PY10	Large Energy Solutions for Business Prescriptive	0.60	0.0	0.40	--
PY10	Large Energy Solutions for Business Total	--	--	0.72	--

G.7 TRC

Table 235 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for Penn Power's PY11 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 PY11 annual report and the model itself was well-organized and documented.

Both gross and net TRC ratios decreased across all categories from PY10, with the largest change occurring in the LI Energy Efficiency program.

Table 235: Summary of Penn Power's PY11 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	\$250	\$151	1.65	\$127	\$151	0.84
Energy Efficient Homes	\$2,228	\$1,581	1.41	\$1,739	\$1,403	1.24
Energy Efficient Products	\$5,324	\$3,124	1.70	\$1,605	\$1,421	1.13
LI Energy Efficiency	\$199	\$530	0.37	\$199	\$530	0.37
C&I Energy Solutions for Business - Small	\$6,852	\$5,643	1.21	\$5,275	\$4,446	1.19
C&I Energy Solutions for Business - Large	\$2,292	\$2,113	1.08	\$1,628	\$1,539	1.06
Governmental & Institutional Tariff	\$1	\$24	0.05	\$1	\$23	0.04
C&I DR Program – Small	\$0	\$8	0.00	\$0	\$8	0.00
C&I DR Program – Large	\$1,471	\$431	3.41	\$1,471	\$431	3.41
Portfolio Total	\$18,618	\$13,605	1.37	\$12,046	\$9,953	1.21

Of Penn Power's nine EE&C programs offered, six were found to be cost-effective and three were not cost-effective using gross verified savings. Using net verified savings, five of the nine programs were found to be cost-effective and four were not cost-effective. The Appliance Turn-in program was cost-effective using gross verified savings, but not cost-effective using net verified savings, while the LI Energy Efficiency, C&I DR – Small, and Governmental & Institutional Tariff programs were not cost-effective under gross or net verified savings. Two of the programs that were non-cost-effective, the Governmental & Institutional Tariff and the C&I DR – Small programs, had very low participation and hence both very low net costs and benefits.

G.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. First, to calculate natural gas prices, Penn Power used the AEO average natural

gas price for all users in the entire United States region rather than the AEO average natural gas price for all users in the Middle Atlantic region, as the SWE recommends. Second, the AEO natural gas prices were not converted to nominal dollars before the NPV was calculated. Penn Power resolved both of these issues in the PY11 TRC model.

- 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 to Friday 8 a.m. to 8 p.m.). 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 to Friday, 7 a.m. to 11 p.m.) 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 NPV 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).
- The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the DEER, company assumptions, and actual project costs as gathered from the PY11 evaluation. The SWE spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with Penn Power'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 SO, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the TRC 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 DR 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 would appear 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 106 in FirstEnergy's PY11 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 PY9 and PY10, 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 56 million gallons per year of water saving, which translates to approximately \$2,613,000 in NPV lifetime avoided costs.
- In PY11, 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 236](#) 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. FirstEnergy used one year of pre-EISA savings and fourteen years of post-EISA savings for standard lamps and two years of pre-shift and thirteen years of post-shift savings for specialty lamps.

Table 236: Penn Power Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.37	1.21
Without Dual Baseline	1.62	1.30

G.8 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 West Penn Power Audit Detail

H.1 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 several memos updating their sampling and evaluation approach for several programs, including for EEP appliance retailers, HVAC and appliance participants and HVAC contractors, as well as the LI direct install program and the PY12 process evaluation for the BDR program. The SWE reviewed and approved these plans with minor comments and suggestions.

In addition to reviewing FirstEnergy's evaluation memos, the SWE reviewed and approved several surveys and interview guides for the EEP appliances and HVAC programs, the residential BDR program, the LI direct install program, and the C&I DR program.

The ADM team also submitted a memo to the SWE outlining ADM's proposed EM&V methods in response to the COVID-19 outbreak.

H.2 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 $\pm 5\%$ at the 85% confidence level, then there is an 85% chance that the true value of savings for the population is between 950 MWh/year and 1,050 MWh/year. All programs that rely on sampling to calculate verified savings must include the relative precision to quantify the sampling uncertainty.

The Phase III Evaluation Framework established a maximum allowable level of sampling uncertainty of $\pm 15\%$ 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 237](#) lists each initiative and the corresponding relative precision of the PY11 gross verified savings estimate for all initiatives that include sampling uncertainty.

Table 237: Relative Precision of West Penn PY11 Gross Verified Energy Savings Estimates by Sampling Initiative

Initiative	Relative Precision at 85% Confidence Level (\pm)
Residential Appliance Turn-In (ATI)	3.2%
LI ATI	6.8%
C&I ATI	11.5%
Res Energy Efficiency Kits	8.3%
LI Energy Efficiency Kits	31.5%
Res Direct Install	11.7%
LI Direct Install	9.2%
Res Upstream Lighting	8.0%
Res Upstream Electronics	0.0%
Res HVAC	5.7%
Residential Appliances	22.0%
LI Appliances	85.2%
Residential New Construction	15.0%
C&I Lighting	12.0%
C&I Custom	13.2%
C&I Prescriptive	12.2%

Three of the sampling initiatives shown in [Table 237](#) failed to meet the requirement of $\pm 15\%$ precision at the 85% confidence level. West Penn Power's LI Energy Efficiency Kits initiative only had a sample size of one in PY11, resulting in a high relative precision estimate. The high relative precisions in the Residential and LI Appliances initiatives were caused by conservative ex-ante savings values for clothes washers (93 kWh/unit) and heat pump water heaters (1,289 kWh per unit). The Residential New Construction initiative passed, but the relative precision was at the 15% threshold. West Penn Power adjusted some of its verification processes in response to the COVID-19 pandemic. After March 2020, ADM replaced on-site visits with phone interviews, video conferences, and data loggers.

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 H.4](#).

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 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 $\pm 0.5\%$ at the 95% confidence level (two-tailed). [Table 238](#) shows the absolute precisions of the behavioral program components.

Table 238: Absolute Precisions of West Penn PY11 Behavioral Subprogram Gross Verified Energy Savings Estimates

Stratum	Absolute Precision at 95% Confidence Level (\pm)
Residential	0.25%
LI	0.98%

DR programs offered by West Penn Power in PY11 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 $\pm 17.9\%$ at the 90% confidence level for the DR portfolio.

H.3 REPORTED GROSS SAVINGS AUDITS

H.3.1 Tracking Data Review

This section of the memo summarizes the SWE's assessment of the reported gross savings, participation counts, and incentives reported in West Penn Power's PY11 Annual Report. Specifically, the values we examined are:

- Reported gross energy savings (MWh) for each program,
- Reported gross peak demand savings (MW) for each program,
- Participation for each program, and
- Incentive dollars for each program.

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 PY11 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.5](#), and our findings regarding the HER components of the Energy Efficient Homes and LIEEPs can be found in [Appendix H.4.1.3](#).

Table 239 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 PY11 Annual Report and “No” otherwise. For each program, the SWE was able to replicate the values reported by West Penn Power.

Table 239: MWh Savings by Program

Program	Annual Report MWh	Tracking Data MWh	Match
Appliance Turn-in	3,787	3,787	Yes
Energy Efficient Homes	3,127	3,127	Yes*
Energy Efficient Products	40,255	40,255	Yes
LI Energy Efficiency	2,002	2,002	Yes*
C&I Energy Solutions for Business – Small	31,387	31,387	Yes
C&I Energy Solutions for Business – Large	26,250	26,250	Yes
Governmental & Institutional Tariff	865	865	Yes
Portfolio Total	107,673	107,673	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 240 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 240: MW Savings by Program

Program	Annual Report MW	Tracking Data MW	Match
Appliance Turn-in	0.51	0.51	Yes
Energy Efficient Homes	0.97	0.97	Yes*
Energy Efficient Products	5.46	5.46	Yes
LI Energy Efficiency	0.24	0.24	Yes*
C&I Energy Solutions for Business – Small	4.38	4.38	Yes
C&I Energy Solutions for Business – Large	3.53	3.53	Yes
Governmental & Institutional Tariff	0.02	0.02	Yes
Portfolio Total	15.11	15.11	Yes*

*The Energy Efficient Homes and LIEEPs have HER components that are not represented in this table.

Table 241 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 241: Participation by Program

Program	Annual Report Participants	Tracking Data Participants	Match
Appliance Turn-in	3,535	3,535	Yes
Energy Efficient Homes	3,990	3,996	No*
Energy Efficient Products	355,744	355,744	Yes
LI Energy Efficiency	2,495	2,495	Yes*
C&I Energy Solutions for Business – Small	765	765	Yes
C&I Energy Solutions for Business – Large	103	103	Yes
Governmental & Institutional Tariff	84	84	Yes
Portfolio Total	366,716	366,722	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 242](#) summarizes the SWE’s comparison of incentive dollars in the program tracking data to the program totals in West Penn’s Annual Report. The SWE replicated incentive dollars or calculated directionally similar values for all seven programs. The portfolio totals are also approximately equal: \$5,666,000 in the Annual Report and \$5,576,000 in the tracking data.

Table 242: Incentives by Program (\$1,000)

Program	Annual Report Incentives	Tracking Data Incentives	Match
Appliance Turn-in	\$201	\$202	Yes
Energy Efficient Homes	\$786	\$700	No
Energy Efficient Products	\$1,783	\$1,843	No
LI Energy Efficiency	\$64	\$64	Yes
C&I Energy Solutions for Business – Small	\$1,547	\$1,481	No
C&I Energy Solutions for Business – Large	\$1,270	\$1,271	Yes
Governmental & Institutional Tariff	\$15	\$15	Yes
Portfolio Total	\$5,666	\$5,576	No

H.3.2 Project File Reviews

H.3.2.1 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 PY11 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 243](#) presents a summary of SWE's residential project file reviews.

Table 243: West Penn Power PY11 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 Program	Appliance Turn In Program	22	✓	✓	✓	✓
Energy Efficient Homes Program	School Education	11	✓	✓	✓	✓
Energy Efficient Homes Program	Energy Efficiency Kits	8	✓	✓	✓	✓
Energy Efficient Homes Program	Audits	8	✓	✓	✓	✓
Energy Efficient Homes Program	New Homes	24	✓	✓	✓	✓
Energy Efficient Products Program	HVAC	24	✓	✓	✓	✓
Energy Efficient Products Program	Appliances and Electronics	26	✓	✓	✓	✓
Energy Efficient Products Program	Midstream Appliances	8	✓	✓	✓	✓
Energy Efficient Products Program	Lighting	24	✓	✓	✓	✓
LI Energy Efficiency Program	Weatherization	28	✓	✓	✓	✓

¹ The number of files reviewed reflects the total number for all First Energy EDCs.

² It should be noted that while typically the data matches, there were minor discrepancies found and are detailed in the paragraphs below.

As detailed above, the requested number of project files and supporting details were submitted for the residential programs. Below, is a summary of the project file reviews, including issues or discrepancies found between the project file packages and quarterly tracking data.

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

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings; however, the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q4 because none were reported for that period.

Energy Efficiency Kits

Reviewed project files were mostly aligned with tracking data, but the SWE observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings; however, the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q2 through Q4 because none were reported during those periods.

Audits

The Audit project files reviewed mostly aligned with tracking data, but the SWE observed minor discrepancies in tracking the total number of kits that the program is responsible for. The SWE also observed minor discrepancies when attempting to replicate savings for electric kits that include DHW measures. Project files did not provide enough information to replicate faucet aerator and showerhead savings; however, the specification sheets for these kits will be further assessed during the annual review. The SWE did not review project files for Q2 through Q4 because none were reported during those periods.

New Homes

REM/Rate reports' kWh savings tended to match tracking but overestimated peak kW by 28% for all FE utilities. It should be noted that reported savings includes lighting and appliance savings; however, the evaluator addresses this during the verified savings review.

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.¹⁰⁶

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.

Midstream Appliances

The Midstream Appliance project files that the SWE reviewed matched the tracking data.

Appliances

The Appliance files typically matched the tracking data; however, the SWE observed a minor discrepancy in one reviewed invoice. The quarterly tracking data showed a refrigerator and dehumidifier associated with the account, whereas the project file uploads only corroborated the dehumidifier install.

The SWE will confirm during the verified savings review, as in PY9 and PY10, that default TRM savings are used only for reported ex-ante savings, while model-specific TRM values are used in verified savings calculations. Reviewed ex-ante savings were based on TRM defaults.

Finally, the SWE encountered issues in tracking projects by account number, likely due to automatic truncation in spreadsheet software (e.g., scientific notation reverted to number formatting).

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

As during PY9 and PY10 SWE review, ADM worked with the SWE to clarify the base wattage variable for specialty bulbs, which depends on bulb shape and lumen range when using TRM tables and equations. However, the tracking data did not break out bulb shape enough to make this determination.¹⁰⁷

ADM has confirmed in previous program years that this issue is corrected during the verified savings calculations, which are entirely independent from these ex-ante calculations. The model numbers are used to pull in all bulb information, including specific shape, from a compiled database, primarily using ENERGY STAR data.

¹⁰⁶ 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.

¹⁰⁷ For example, a specialty bulb at 500 lumens could have a base wattage of 40, 45, 60, or 65 depending on the shape, but there is no way to tell which value should be used without more specific shape categories being used. ADM confirmed that this is addressed in the verified savings calculations.

LI WARM

The LI WARM files that the SWE reviewed matched the tracking data. However, Q2 project files consisted of a link to a program website with limited information about the project. The website required a login to access the more-detailed information that the SWE requires to conduct the same level of review as with static project files. To ensure consistency and thoroughness in its evaluation, the SWE will want to confirm with the evaluation team that they can produce static project files for each quarter.

H.3.2.2 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 PY11. 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 244](#) presents an overview of the results of the SWE's C&I project file reviews.

Table 244: West Penn Power PY11 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
C&I Energy Solutions for Business Program - Large	Custom - LCI	3	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Small	Custom - SCI	3	✓	✓	✓	✓	-	✓
C&I Energy Solutions for Business Program - Small	Food Service	2	✓	✓	✓	✓	✗	-
C&I Energy Solutions for Business Program - Large	HVAC - SCI	2	✓	✓	✓	✓	✗	-
Governmental & Institutional Tariff Program	Lighting - Govt	3	✓	✓	2/3	✓	✓	-
C&I Energy Solutions for Business Program - Large	Lighting - LCI	4	✓	✓	3/4	✓	✓	-
C&I Energy Solutions for Business Program - Small	Lighting - SCI	4	✓	✓	3/4	✓	✓	-

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 many project files lacked documentation indicating project approvals and rebate forms indicating final approved program savings. Finally, baseline project data was limited or unavailable for three reviewed projects (two Food Service projects and one HVAC – SCI 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 for both projects reviewed; SWE cannot verify calculations.
- **HVAC - SCI**
 - Workbook calculator locked for both projects reviewed; SWE cannot verify calculations.
 - Capacity of one RTU unit wrongly input in calculation workbook compared to spec sheet.
- **Lighting – Gov’t**
 - Invoice quantities do not align with calculation workbook quantities for three fixtures in one project.
- **Lighting – LCI**
 - Invoice lamp quantity does not align with workbook calculator for one project.
 - Varying wattages between cut sheets for one fixture in same project listed above.
- **Lighting – SCI**
 - Invoice quantity does not align with workbook calculator for one fixture in 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.4 VERIFIED GROSS SAVINGS AUDITS

H.4.1 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 that were used to verify savings for the residential programs. [Table 245](#) provides a summary of the evaluation and M&V approaches used by West Penn Power in their PY11 verified savings calculations.

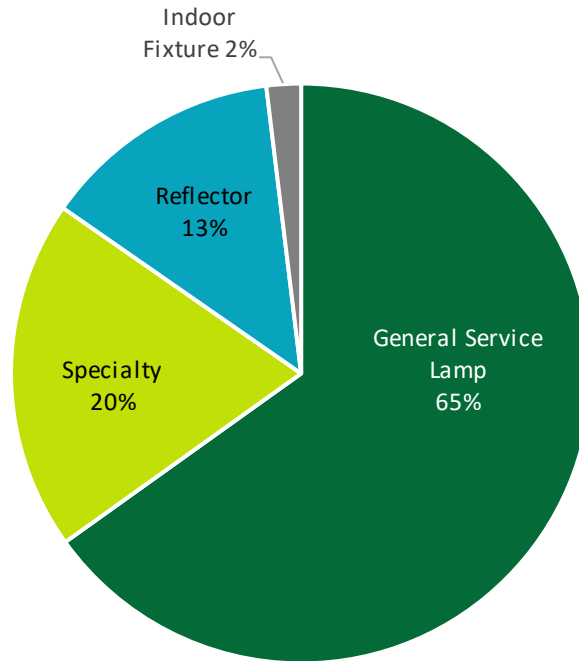
Table 245: Residential Program Evaluation Activities – West Penn Power

Program/ Subprogram	Surveys	Site Visits	Desk Review ^a	Billing Analysis
Appliance Turn-In				
Appliance Turn-in (LI & Non-LI)	✓	--	✓	--
Energy Efficiency Homes				
Energy Efficiency Kits	✓	--	✓	--
Energy Efficiency Kits-LI	✓	--	✓	--
HERs	--	--	✓	✓
Residential Direct Install	✓	--	✓	--
Residential New Construction	--	✓	✓	--
Upstream Lighting				
Upstream Lighting	✓	--	✓	--
Energy Efficiency Products				
Upstream Electronics	--	--	✓	--
HVAC	✓	--	✓	--
Appliances	✓	--	✓	--
Appliances- LI	✓	--	✓	--
LI WARM				
LI WARM- Extra Measures	--	✓	✓	✓
LI WARM- Multifamily	--	✓	✓	✓
LI WARM- Plus	--	✓	✓	✓

H.4.1.1 Upstream Lighting & Cross-Sector Sales

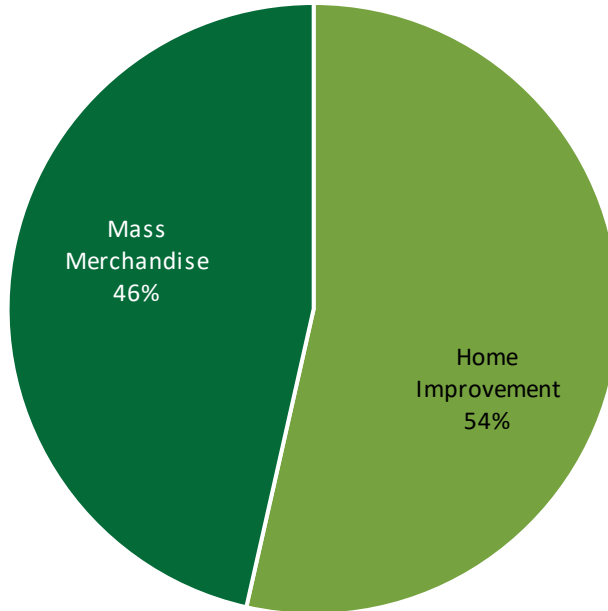
Customers purchased over one million efficient light bulbs and fixtures through West Penn Power's PY11 upstream lighting program. Figure 122 displays the distribution of sales by product type. Just over three-fifths (65%) of the products were general service lamps.

Figure 122: West Penn Power PY11 Upstream Lighting Sales by Product Type



West Penn Power's PY11 upstream light bulbs and fixtures were sold through home improvement (54%) and mass merchandise (46%, [Figure 123](#)).

Figure 123: West Penn Power PY11 Upstream Lighting Sales by Retail Channel



Audit Findings

ADM provided the PY11 impact analysis for West Penn Power's Upstream Lighting Initiative before the PY11 West Penn Power Annual Report was submitted to the PUC on February 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 PY11 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 PY11 upstream lighting analysis.

H.4.1.2 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

The SWE audited each of the four components of the Energy Efficient Homes Program: Energy Efficiency Kits, HERs (reported in [Appendix H.4.1.3](#)), Residential Direct Install, and New Homes by using the gross impact data submitted by FirstEnergy. Overall, the SWE audits concluded that the correct TRM algorithms were applied and verified savings were correct for all program kits and direct install measures.

The SWE had previously identified a small error in the New Homes subprogram in which ENERGY Star dishwasher savings were incorporating an incorrect TRM default value for homes with gas water heaters, but this error has been corrected in 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.4.1.1](#) 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 PY11 annual report.

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. However, population and sample sizes in the annual request data did not match those included in the annual report.

H.4.1.3 Behavior

Approximately 15% of West Penn Power's verified gross energy savings for PY10 came from HERs issued to around 160,000 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 PY11. By cohort, [Table 246](#) shows average kWh savings and average percent savings per participant in PY11. Note that the "Number of Participants" column shows the average number of participants during PY11.

Table 246: Average PY11 kWh Savings per Participant

Sector	Cohort Start Date	Number of Participants	Average PY11 kWh Savings	Average PY11 % Savings
LI	June 2012	9,580	125	0.84%
Residential	June 2012	106,483	95	0.65%
LI	January 2014	3,275	136	1.03%
Residential	January 2014	16,263	259	1.46%
Residential	December 2014	24,494	143	1.07%

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, and energy and demand savings.

Calendarization

The first step the SWE 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 247](#) shows summary statistics calculated for ADM's calendarized data and the SWE's calendarized data.¹⁰⁸ The distribution of average daily kWh is basically identical in the two data sets.

¹⁰⁸ The table only summarizes PY11 records.

Table 247: Comparison of Calendarized Data

Variable	Mean	5 th Percentile	25 th Percentile	75 th Percentile	95 th Percentile
Average Daily kWh – ADM	39.95	14.16	24.38	49.69	84.27
Average Daily kWh – SWE	39.95	14.16	24.38	49.69	84.27

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 248](#) 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 248: Group Equivalence in the Pre Period

Sector	Cohort Start Date	Average Daily kWh – Control	Average Daily kWh – Treated	P-value
LI	June 2012	44.2	43.9	0.68
Residential	June 2012	42.4	42.5	0.81
LI	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, uncalendarized 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 2020. We removed any records with a billing end date prior to March 1, 2020, then counted the number of unique IDs in the remaining records. Using this method, we calculated participant counts that matched the reported counts.

Participant counts, by cohort and month, are shown in [Table 249](#).

Table 249: West Penn Power PY11 HER Participant Counts by Cohort and Month

Month	June 2012 LI	June 2012 Residential	January 2014 LI	January 2014 Residential	November 2014 Residential
Jun-19	9,888	108,454	3,438	16,635	25,133
Jul-19	9,817	108,007	3,398	16,538	24,978
Aug-19	9,753	107,576	3,356	16,461	24,838
Sep-19	9,697	107,185	3,317	16,382	24,742
Oct-19	9,623	106,799	3,289	16,312	24,587
Nov-19	9,571	106,430	3,266	16,248	24,506
Dec-19	9,530	106,148	3,253	16,205	24,411
Jan-20	9,498	105,907	3,236	16,162	24,312
Feb-20	9,456	105,694	3,216	16,114	24,235
Mar-20	9,413	105,461	3,194	16,075	24,146
Apr-20	9,373	105,163	3,172	16,029	24,049
May-20	9,338	104,974	3,161	15,990	23,991

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 PY11, 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 be applied to the homes with insufficient pre period data. The SWE believes this is the correct approach. (Note that the underlying assumption here is that homes without sufficient pre period data do not systematically differ from homes with sufficient pre period data.)

Impact Coefficients and Energy Savings

[Figure 124](#) through [Figure 128](#) compare average daily usage between control group homes and treatment group homes. The figures show usage in both the pre period and in PY11. For the treatment group homes, only homes that were active in PY11 are included in the "pre period" portion of the figure. As has been noted, the regression model used to estimate the impact the HER program has on daily usage controls for potential pre period differences.

Figure 124: July 2012 LI Cohort Usage Comparison

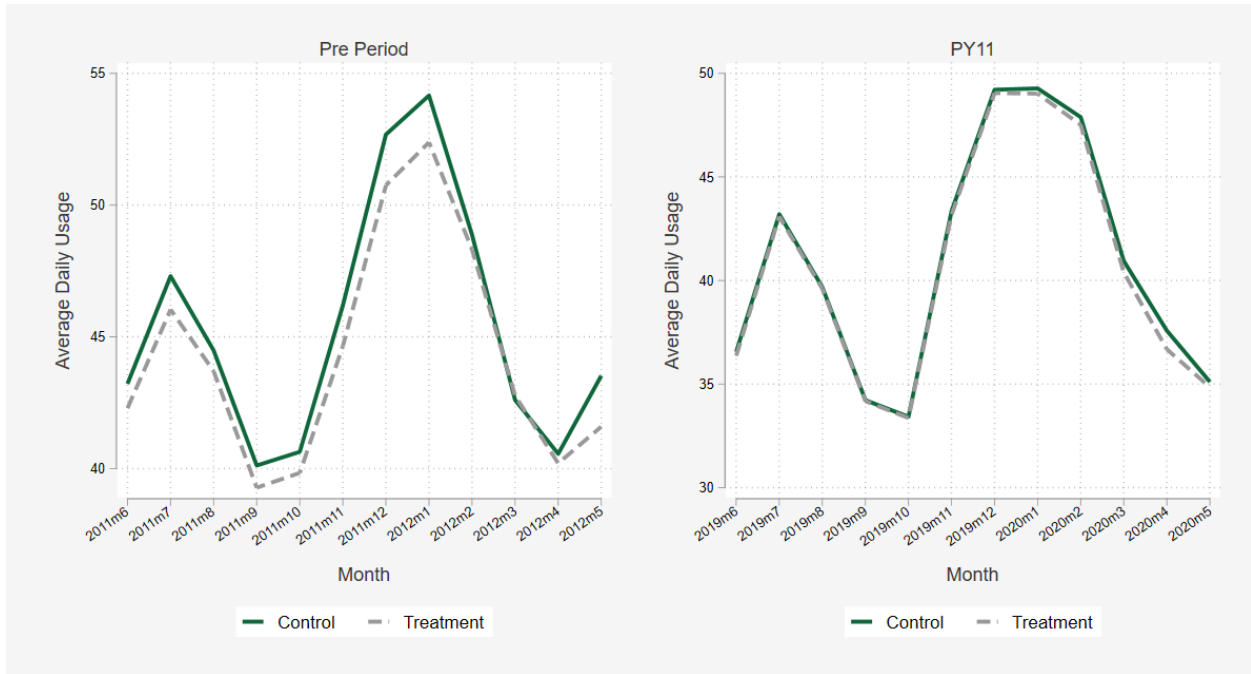


Figure 125: July 2012 Residential Cohort Usage Comparison

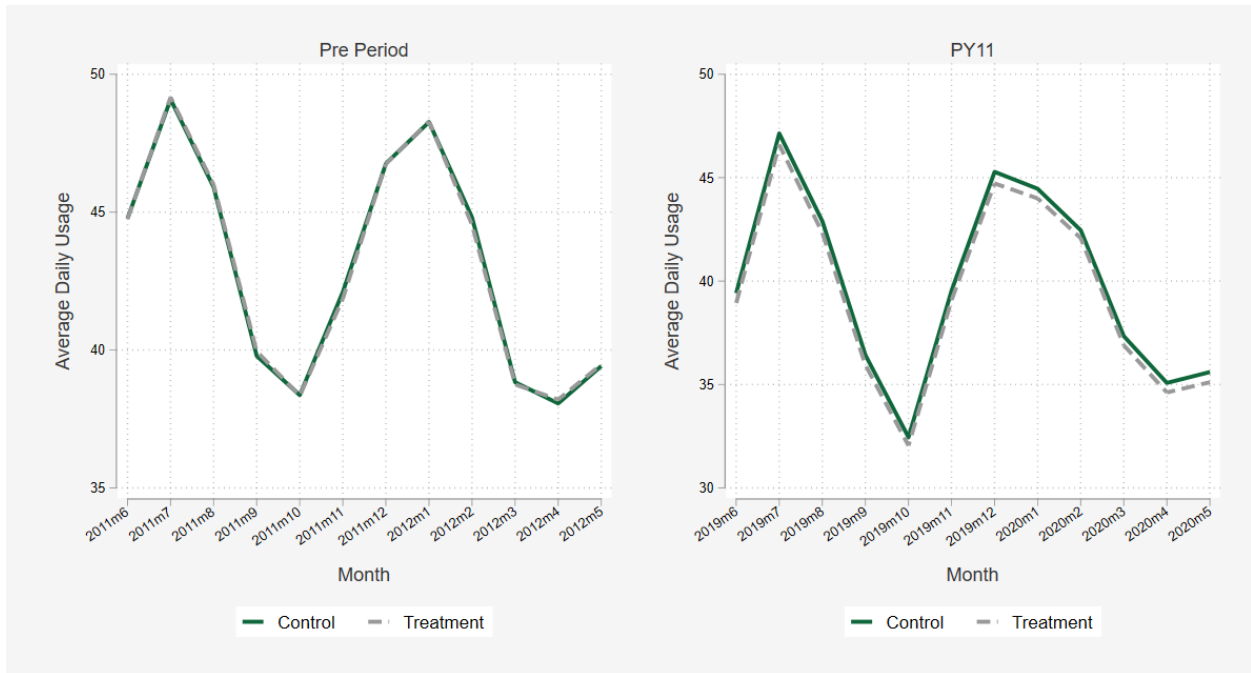


Figure 126: January 2014 LI Cohort Usage Comparison

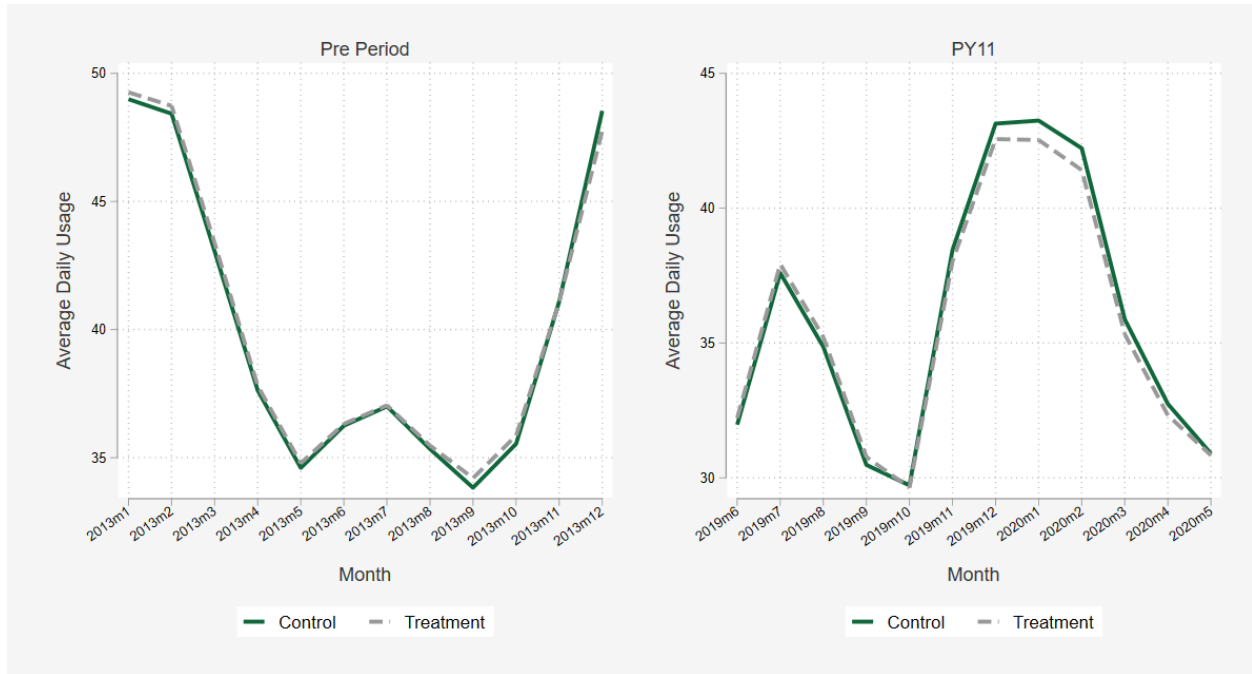


Figure 127: January 2014 Residential Cohort Usage Comparison

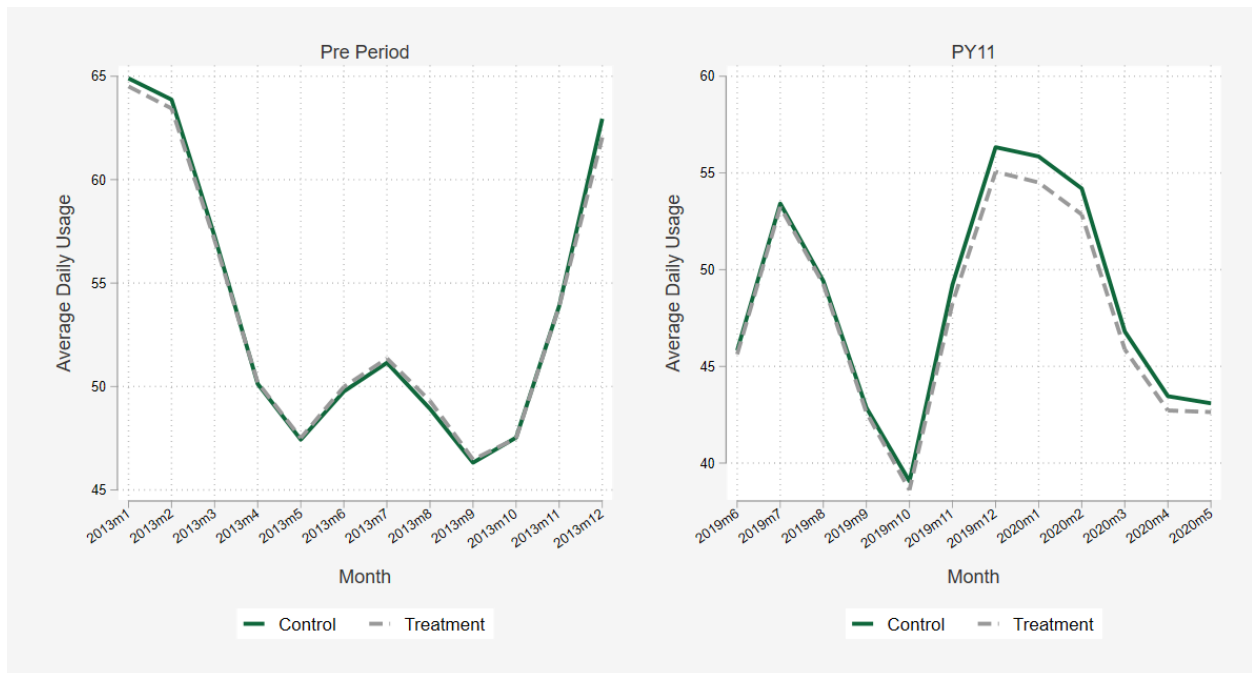


Figure 128: December 2014 Residential Cohort Usage Comparison

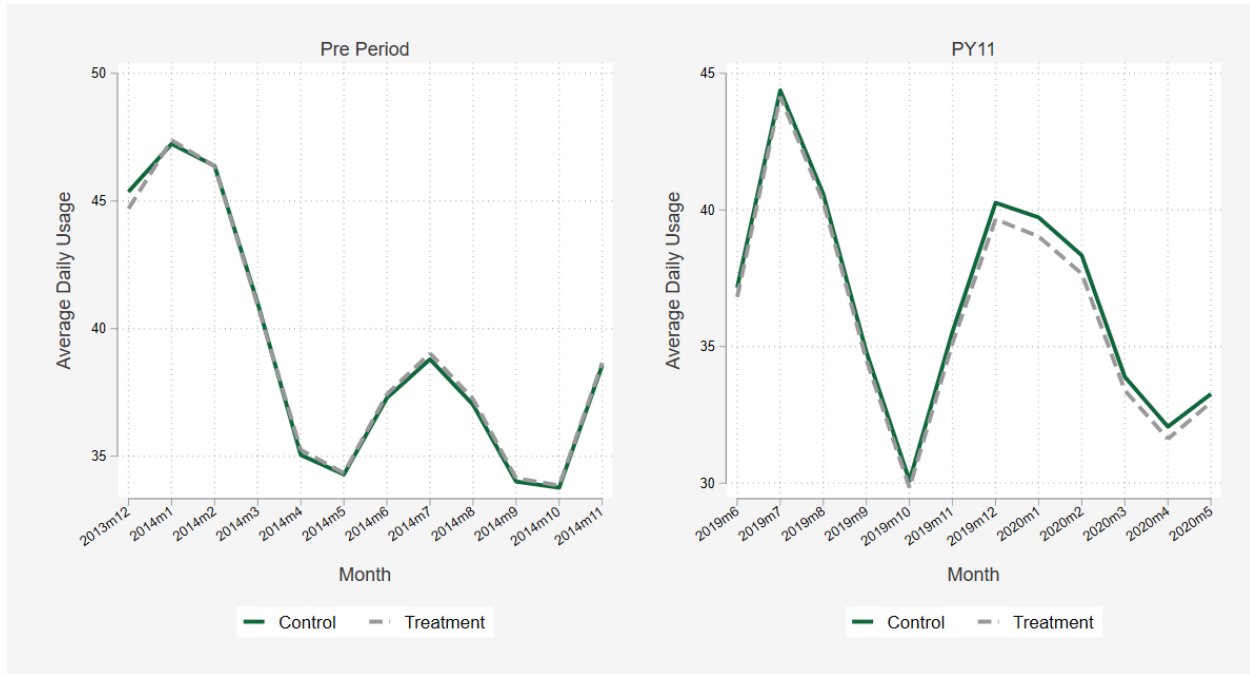


Table 250 shows PY11 impact estimates for each cohort. Note that a different impact estimate was calculated for each month in PY11 – the estimates shown in the table reflect the averages of the PY11 monthly estimates (weighted by month duration). Using the second impact estimate as an example, the practical interpretation is as follows: treatment group homes in the residential June 2012 cohort saved 0.36 kWh per day, on average, during PY11. The average impact estimate for the LI June 2012 cohort is positive, indicative of an increase in consumption.

Table 250: Impact Coefficients

Sector	Cohort Start Date	ADM Impact Estimate (kWh saved per home per day)	SWE Impact Estimate (kWh saved per home per day)
LI	June 2012	0.18	0.15
Residential	June 2012	-0.44	-0.44
LI	January 2014	-0.43	-0.46
Residential	January 2014	-0.81	-0.81
Residential	December 2014	-0.31	-0.31

Using the impact estimates shown above, Table 251 shows ADM’s and the SWE’s aggregate energy savings (MWh) for each cohort after correcting for dual participation in other energy-efficiency programs and applying the upstream adjustment factors. Differences in the estimates can be attributed to noise. The SWE approves of ADM’s MWh savings estimates.

Table 251: Energy Savings Comparison

Sector	Cohort Start Date	ADM MWh Savings	SWE MWh Savings	Difference (SWE – ADM)
LI	June 2012	1,200	1,196	-4
Residential	June 2012	10,064	10,052	-12
LI	January 2014	447	446	0
Residential	January 2014	4,208	4,210	2
Residential	December 2014	3,503	3,497	-6
Total		19,421	19,400	-21

Readers will note that the 2012 LI cohort produced positive energy savings, although the impact estimate for this cohort indicated an increase in consumption during PY11. This is due to an adjustment made for the 2012 cohorts that ADM discussed with the SWE in 2017. Essentially, savings for the 2012 LI and Residential cohorts are summed and then redistributed based on the relative share of pre-treatment aggregate consumption for these cohorts.

Demand Savings

Table 252 shows ADM's and the SWE's aggregate peak demand savings (MW) for each cohort. Differences in the estimates can be attributed to noise. The SWE approves of ADM's MW savings estimates.

Table 252: Demand Savings Comparison

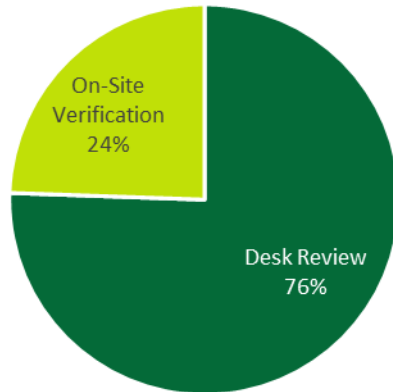
Sector	Cohort Start Date	ADM MW Savings	SWE MW Savings	Difference (SWE – ADM)
LI	June 2012	0.13	0.13	0.00
Residential	June 2012	1.05	1.05	0.00
LI	January 2014	0.05	0.05	0.00
Residential	January 2014	0.48	0.48	0.00
Residential	December 2014	0.39	0.39	0.00
Total		2.11	2.10	0.00

H.4.2 Non-Residential Audit Activities

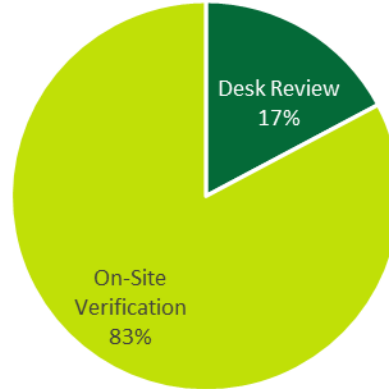
Figure 129 provides a summary of the evaluation activities and M&V approaches utilized by West Penn Power's evaluation contractor, ADM, in their PY11 verified savings calculations, summarized by total evaluated project counts and separately by energy savings contribution. For PY11, West Penn Power's evaluation contractor completed site visits to 24% of projects, and these projects represented 83% of total evaluated energy savings. A total of 33 site visits were conducted, a lesser number than PY10. IPMVP Option A was employed for the majority (67%) of total evaluated energy savings. Basic Rigor (verification only) was employed for all appliance recycling projects and direct install projects and a small subset of custom, lighting, and prescriptive projects.

Figure 129: Summary of West Penn Power’s C&I Evaluation Activities

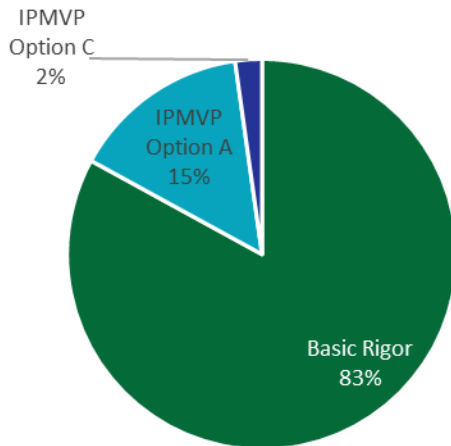
Evaluation Activity by Project Count



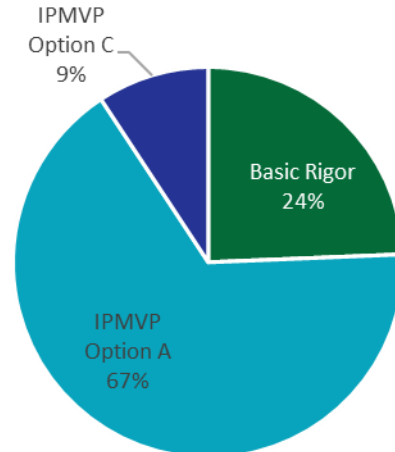
Evaluation Activity by kWh contribution



M&V Method by Project Count



M&V Method by kWh contribution



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 253](#) provides a summary of the evaluation activities West Penn Power’s evaluation contractor used across strata for all projects by initiative.

Table 253: Summary of West Penn Power's PY11 C&I Evaluation Activities by Initiative

Initiative / Strata	Sample Quantity	RR	Desk Review	Phone Interview	On-Site Verification Only
Appliance Turn-In	60	90%	60	0	0
Appliance Recycling-1	60	90%	60	-	-
Custom	19	108%	14	0	5
Custom-1	14	107%	13	-	1
Custom-2	1	152%	1	-	-
Custom-Certainty	4	100%	-	-	4
Direct Install	2	86%	2	0	0
Direct Install-1	2	86%	2	-	-
Lighting	35	98%	11	0	24
Lighting-1	7	88%	7	-	-
Lighting-2	5	92%	-	-	5
Lighting-3	14	103%	4	-	10
Lighting-Certainty	9	99%	-	-	9
Prescriptive	19	102%	15	0	4
Prescriptive-1	18	102%	14	-	4
Prescriptive-2	1	100%	1	-	-
TOTAL	135		102	0	33

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

H.4.2.1 Appliance Turn-In Initiative

The evaluation contractor conducted phone surveys to verify projects in this initiative. No site visits were conducted for these projects. Impacts were calculated through desk reviews and TRM calculations using project-specific data from the tracking system or verification surveys when available. TRM default values were used in absence of project-specific data.

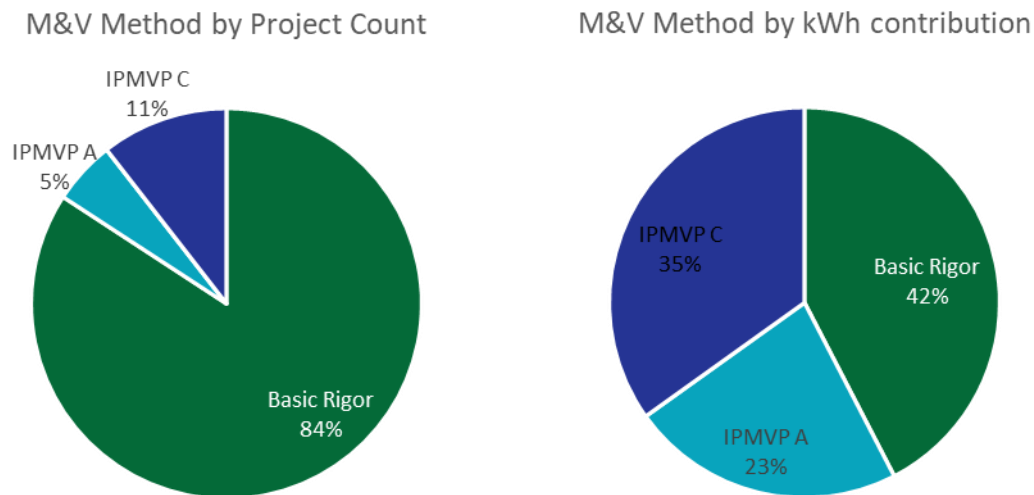
H.4.2.2 Custom Initiative

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 58% of the evaluated energy savings for the projects in the sample, as shown in [Figure 130](#).

Figure 130: Summary of West Penn Power's C&I Custom Program M&V Methods



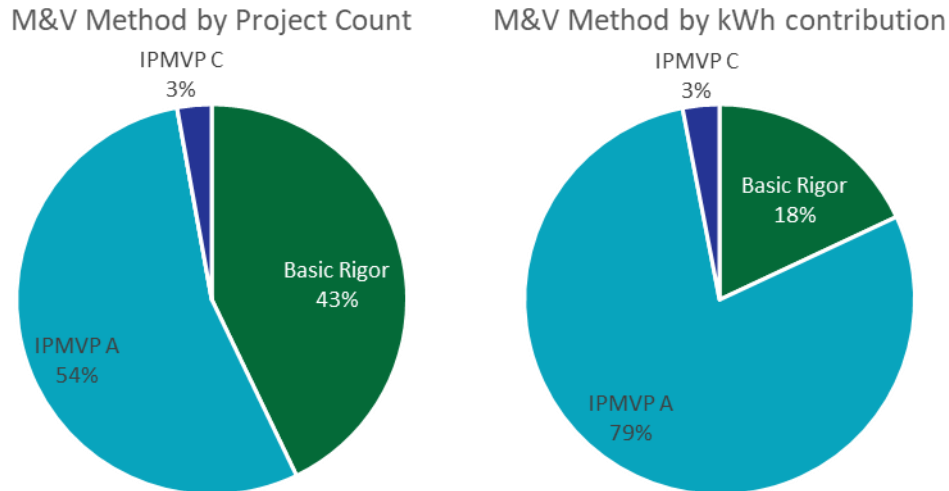
H.4.2.3 Lighting Initiative

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 79% of the evaluated savings in this initiative, as illustrated in [Figure 131](#).

Figure 131: Summary of West Penn Power’s C&I Lighting Program M&V Methods



H.4.2.4 Prescriptive Initiative

Evaluation activities for this initiative include verification site visits and application of TRM-based savings calculation methodologies. In PY11, four of West Penn Power’s sampled prescriptive projects received a site visit. Prior to site visits, all sampled projects undergo a full documentation review. This documentation review includes identification of the appropriate TRM protocol and the defined key input parameters.

West Penn Power’s evaluation contractor employed two strata for projects in the Prescriptive initiative, with the threshold set at 50 MWh of annual energy savings. Eighteen of the PY11 sampled projects were in the Prescriptive-1 stratum, with only one project assigned to the Prescriptive-2 stratum.

IPMVP-based methods were not employed for this initiative. All projects were evaluated using basic rigor through engineering algorithms and TRM-based savings calculation methodologies.

H.4.2.5 Direct Install Initiative

The sole evaluation activity for the Direct Install initiative is a desk review using TRM-based savings algorithms to quantify savings. There are two strata in the Direct Install initiative, with a threshold of 20 MWh set for the Direct Install-2 stratum. In PY11, West Penn Power sampled its only two projects in the Direct Install-1 stratum. A realization rate of 87% was achieved for this initiative.

H.4.2.6 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 254 provides an overview of the SWE milestones for the audit of West Penn Power's site inspection efforts.

Table 254: West Penn Power Ride-along Audit Milestones

Site Inspections Audited	Energy Savings Audited (kWh)	Field Engineers Observed	Measure Types Observed	Attainment Percentage
3	1,893,034	2	3	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 was being followed appropriately for two lighting projects and custom methodologies were appropriately chosen for a custom compressed air project. Of the three 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.4.2.7 Verified Savings Desk Reviews

Table 255 provides an overview of the SWE milestones for the verified savings review of evaluated West Penn Power projects.

Table 255: West Penn Power Verified Savings Desk Review Milestones

Projects Reviewed	Energy Savings Reviewed (kWh)	Demand Reduction Reviewed (kW)	kWh Attainment Percentage	kW Attainment Percentage
2	1,003,753	140.70	100%	100%

Overall, the SWE found that West Penn Power's evaluation contractor demonstrated general adherence to the TRM for the lighting project and employed sound engineering methods to evaluate the custom process project. The SWE asserts that ADM conducted appropriate M&V efforts, and that sufficient documentation supporting savings analyses was provided. Among the projects reviewed, the SWE found no basis for recommending adjustments to energy or demand savings and determined a 100% attainment percentage.

H.5 DR

According to the Phase III Implementation Order, West Penn Power's Phase III DR compliance target is 64 MW. Note that 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 West Penn Power, this translates to a 54.4 MW minimum performance level for any given DR event. 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. West Penn Power called DR events on the four days those guidelines required during summer 2019.

In PY11, West Penn Power had active DR programs in both the residential and C&I customer classes. On the C&I side, there were 47 participants: 32 categorized as large C&I sites and 15 categorized as small C&I sites. The residential BDR component had nearly 57,000 homes in the treatment group, though this number declined throughout the summer.

Table 256 shows West Penn Power's performance across the four events during the 2019 DR season. West Penn Power's PY11 average performance (96.1 MW) was comfortably above its Phase III target of 64 MW. (The Phase III average, 112.4 MW, is also comfortably above the Phase III target.) Regarding the per-event target of 54.4 MW, impacts for each event day exceeded this value. The large size of the error bounds is attributable to large C&I customers with highly volatile loads.

Table 256: 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 17, 2019	15	18	0.7	88.2	3.4	92.3±38.1
July 18, 2019	16	19	1.0	124.4	3.0	128.4±40.3
July 19, 2019	15	18	1.0	93.5	3.6	98.0±35.3
August 19, 2019	15	18	0.8	62.2	2.7	65.7±20.5
PYVTD - Average PY11 DR Event Performance						96.1±17.2
VTD - Average Phase III DR Event Performance						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 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 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 65% of West Penn Power’s gross verified PY11 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 WSAs;
- Hourly load and weather data for approximately ~77,000 residential accounts (~57,000 treatment group accounts and ~21,000 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 PY11 gross verified savings estimates and recommends that the Commission adopt them when assessing compliance with Phase III targets.

H.5.1 Replicate Program Totals

West Penn Power’s PY11 C&I DR program had 47 participants. ADM’s verified gross peak demand savings generated by these sites are shown in [Table 257](#). Note that these values are adjusted for line losses (by a multiplier of 1.079). For each DR event hour during the 2019 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 257](#) also shows verified gross peak demand savings attributable to the residential BDR program (also adjusted for line losses).

Table 257: West Penn Power PY11 DR Savings by Program

Program	PYVTD Gross MW	VTD Gross MW
C&I – Small	1.2	1.7
C&I – Large	134.3	115.9
Energy Efficient Homes	3.1	2.0
Total	138.5	119.6

H.5.2 Residential BDR

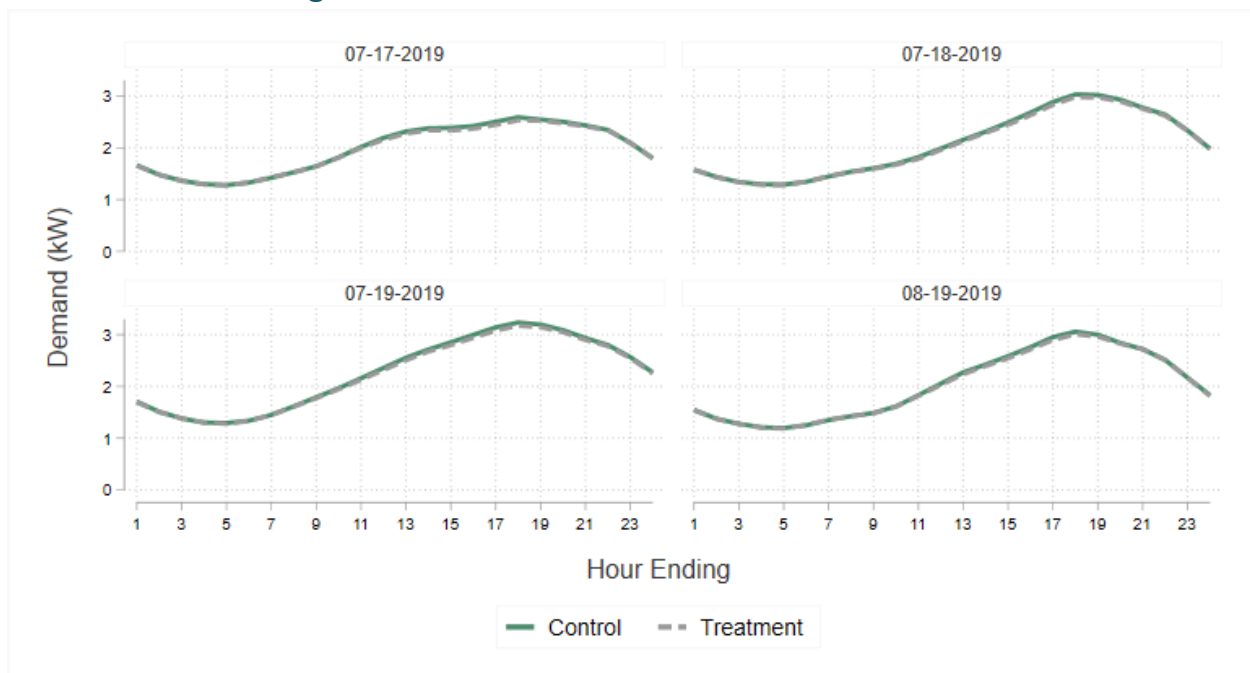
West Penn Power’s behavioral DR program operates as a RCT – customers were randomly selected and placed into control and treatment groups. As of the beginning of the 2019 summer DR season, there were 56,565 premises in the treatment group and 20,908 premises in the control group. Some of these homes were added in 2018 and some were added in 2019. [Table 258](#) shows counts by start date as of the beginning of the 2019 DR season. At the end of the DR season, these numbers were 54,306 and 20,126, respectively.

Table 258: Residential BDR Customer Counts

Date Added	Active Treatment Accounts	Active Control Accounts
5/19/2018	47,387	17,529
5/22/2019	9,178	3,379
Total	56,565	20,908

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 is not 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 130](#). In this figure, control group and treatment group loads for each PY11 DR event day are compared. The impact is small, but separation between the experimental cells can be seen in the late afternoon. With nearly 57,000 homes in the treatment group, small impacts add up

Figure 132: West Penn Power Residential BDR



H.5.2.1 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 that the customers added in 2019 have a different baseline period than the customers added in 2018, but both periods straddle April and May. Figure 133 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 133: West Penn Power Baseline Equivalence

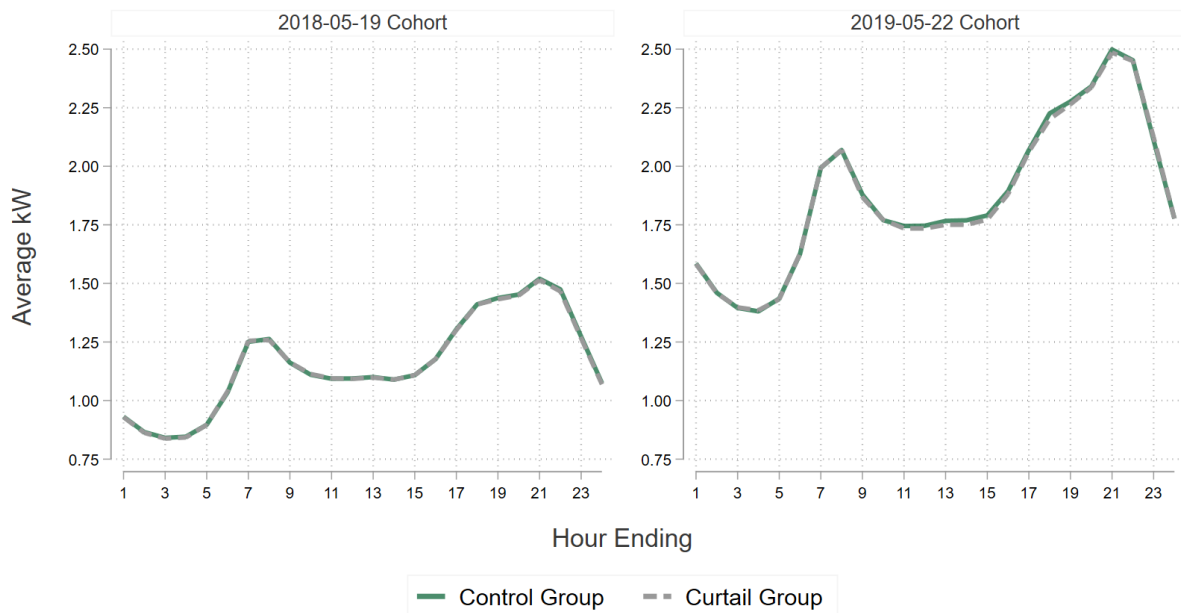


Table 259 shows average daily kWh for the control and treatment groups during the baseline period. A significance test suggests the difference between mean daily consumption values is not statistically significant (p-value = 0.78). The table also shows the average demand for the two groups during common event hours. Like the average daily kWh values, the difference between the average demand values is not statistically significant (p-value = 0.71).

Table 259: Equivalence Check

Group	Average Daily kWh	Average kW During Event Hours
Control	29.23	1.36
Treatment	29.19	1.36
Combined	29.20	1.36

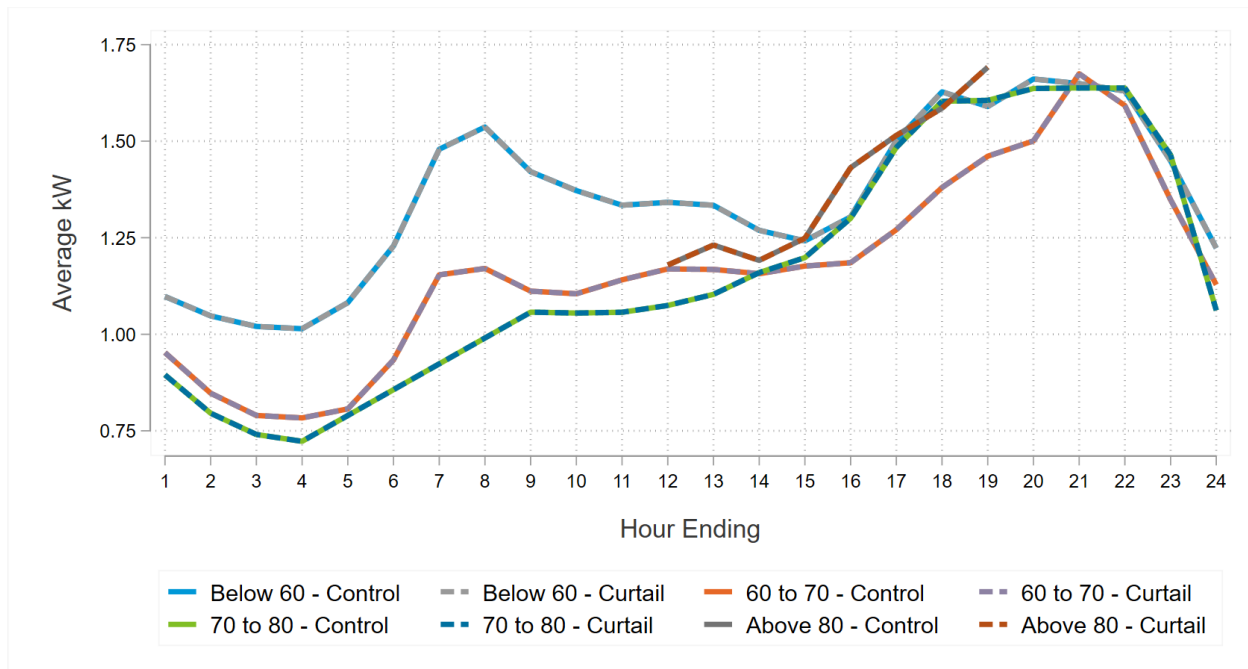
H.5.2.2 Impact Estimation

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 that were calculated based on consumption during a 30-day period that spanned April and May of 2018 for the 2018 cohort and April and May of 2019 for the 2019 cohort. Steps taken in producing these lag variables are as follows:

- Limit the load data to 2:00 p.m. to 6:00 p.m. 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 134 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 134: Usage by Temperature Bin



H.5.2.3 Findings

Table 260 shows the relevant regression coefficients (treatment effect by hour and date), participant counts, and aggregate impacts. Note that neither the regression coefficients nor the aggregate impacts are adjusted for line losses in this table. The practical interpretation of the first regression coefficient in the table (-0.051) is that average demand in the treatment group was about 0.05 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 regression coefficients with a few other regression model specifications and found the results to be robust.

Table 260: Regression Output and Participant Counts

Date	Hour	Coefficient	Participants	Aggregate Impact (MW)
7/17/2019	15	-0.051	55,686	2.86
	16	-0.052	55,686	2.92
	17	-0.055	55,686	3.07
	18	-0.056	55,686	3.10
7/18/2019	16	-0.049	55,670	2.70
	17	-0.050	55,670	2.81
	18	-0.051	55,670	2.82
	19	-0.043	55,670	2.37
7/19/2019	15	-0.055	55,648	3.04
	16	-0.058	55,648	3.22
	17	-0.061	55,648	3.37
	18	-0.060	55,648	3.32
8/19/2019	15	-0.041	54,910	2.23
	16	-0.040	54,910	2.20
	17	-0.050	54,910	2.76
	18	-0.047	54,910	2.60

The average impact across the 16 event hours was -2.84 MW. Multiplying this value by West Penn Power's line loss multiplier for residential customers (1.0943) yields an average savings estimate of 3.1 MW per event hour. This falls just short of the PYVTD gross MW value calculated by ADM (3.2), but the difference could simply be a matter of rounding (and the value calculated by ADM is certainly within the confidence bands of the value calculated by the SWE). The SWE does not view this difference as an issue.

H.5.3 C&I

H.5.3.1 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 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 261](#) provides an illustration.

Table 261: CBL-of-CBLs Illustration

CBL Type	CBL	Non-Event Day RRMSE	Inverse Square of RRMSE	Weight
10-of-10	1,100	7.1%	198.37	35.7%
10-of-10 with WSA	1,200	7.2%	192.90	34.7%
20-of-20	1,300	7.8%	164.37	29.6%

Thus, the CBL-of-CBLs value would be: $1,100 \times 0.357 + 1,200 \times 0.347 + 1,300 \times 0.296 = 1,193.90$.

H.5.3.2 Weather Sensitive Adjustments (WSAs)

Several of the baseline types that ADM considered involved a WSA (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 6/1/2019 and the last DR event of PY11 (which occurred on 8/19/2019);
- 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).

The WSA is only applied if the outdoor air temperature exceeds 75 degrees. Additionally, two distinct WSA coefficients were calculated for each participant. In prior program years, event hours were the same for each event. In PY11, one 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.5.3.3 Findings

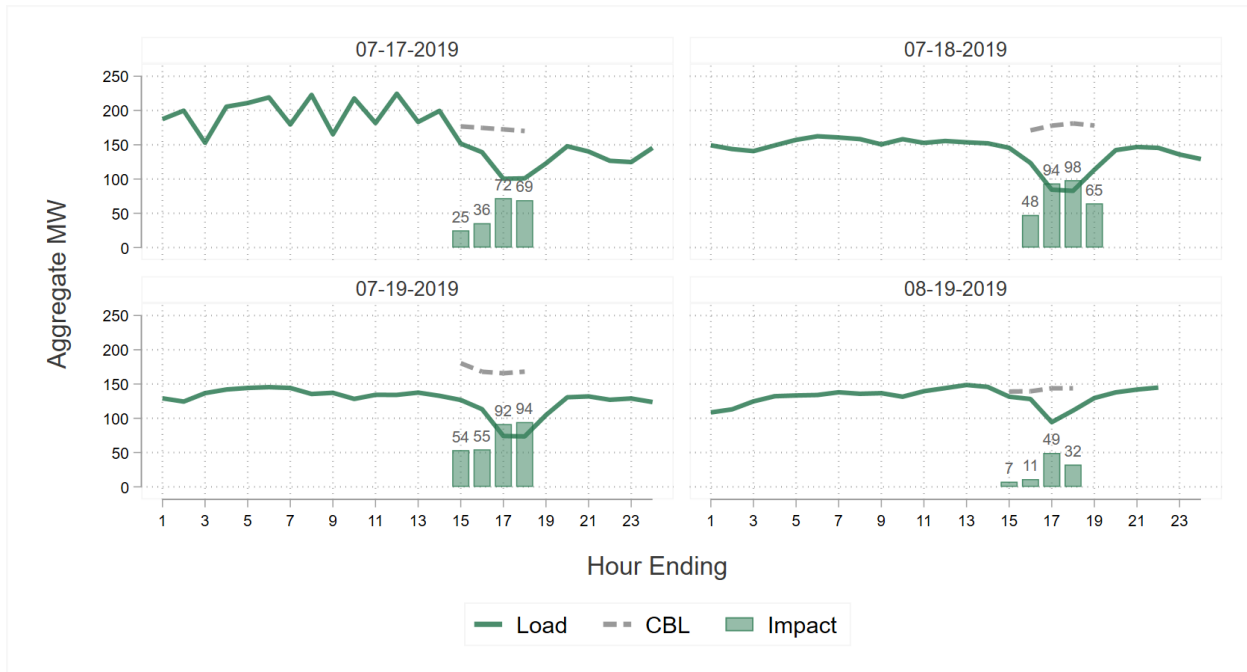
For the seven sites in our sample, the SWE was able to reproduce all inputs that feed into the savings. [Table 262](#) provides a summary of the results.

Table 262: 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	60.8	60.8	65.4%
Not in SWE Sample	40	32.2	---	34.6%
Total	47	93.0	---	100%

By event day, [Figure 135](#) 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 7/17 but are relatively stable across the other three event days. On each day, the load shed is obvious and the CBL-of-CBLs is reasonable.

Figure 135: Aggregate Load, CBL, and Impacts for Sampled Sites



H.5.4 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 an LS 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 when assessing compliance at the end of Phase III.

H.6 NTG

H.6.1 Residential Programs

ADM and Tetra Tech estimated a PY11 NTG for the HVAC and Residential Appliances Programs using participant surveys. NTG was estimated with the recommended UMP protocol.

The Energy Efficiency Kits Program NTG research consisted of participant surveys from PY8, PY9, and PY10. The PY8 and PY9 Energy Efficiency Kit NTG data was gathered from Opt-In Kit component of the program. The data was weighted by program substrata contribution to the program gross verified impacts and applied to the common NTG formula.

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 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 beives, and the common NTG formula recommended in the Phase III Evaluation Framework.

Table 263: Summary of NTG Estimates for West Penn Residential Program

Approach	Program	Free-Ridership	SO	NTG	Sample Size
PY10	Appliance Turn-in	0.52	0.0	0.48	--
PY8	EE Kits	0.21	0.15	0.94	--
RCT	HERs	--	--	1	--
PY10	Direct Install	0.20	0.24	1.04	--
PY10	New Homes	--	0.0	0.73	--
PY10	Upstream Lighting	0.77	0.0	0.23	--
PY10	Upstream Electronics	0.77	0.0	0.23	--
Estimated	HVAC	0.48	<0.01	0.52	62
Estimated	Residential Appliances	0.49	0.14	0.65	74

H.6.2 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 PY10 Evaluation Plan and SWE Phase III Evaluation Framework.

H.6.3 C&I Programs

Tetra Tech did not conduct any NTG C&I research in PY11. C&I NTG values were evaluated in PY10 and those values were applied to the C&I Programs for PY11. It has been previously concluded that all PY10 NTG values were correctly constructed using data collected in keeping with the Pennsylvania Evaluation Framework using common formula to estimate NTG.

Table 264: Summary of NTG Estimates for West Penn 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	0.44	0.0	0.56	--
PY10	Small Energy Solutions for Business Prescriptive	0.57	0.0	0.43	--
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	--	--	0.65	--
PY10	Large Energy Solutions for Business Lighting	0.34	>0.01	0.66	--
PY10	Large Energy Solutions for Business Custom	0.44	0.0	0.56	--
PY10	Large Energy Solutions for Business Prescriptive	0.57	0.0	0.43	--
PY10	Large Energy Solutions for Business Total	--	--	0.65	--

H.7 TRC

Table 265 presents TRC NPV benefits, TRC NPV costs, and the TRC ratios for West Penn Power's PY11 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 PY11 annual report and the model itself was well-organized and documented.

Both gross and net TRC ratios decreased across nearly all categories from PY10, except for the Energy Efficient Homes program. The largest decrease in cost-effectiveness occurred in the LI Energy Efficiency program.

Table 265: Summary of West Penn's PY11 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	\$1,188	\$647	1.84	\$570	\$647	0.88
Energy Efficient Homes	\$6,528	\$4,444	1.47	\$5,811	\$4,097	1.42
Energy Efficient Products	\$14,049	\$11,050	1.27	\$4,084	\$5,255	0.78
LI Energy Efficiency	\$779	\$3,584	0.22	\$779	\$3,584	0.22
C&I Energy Solutions for Business - Small	\$14,021	\$13,063	1.07	\$8,891	\$8,839	1.01
C&I Energy Solutions for Business - Large	\$11,436	\$9,343	1.22	\$7,388	\$6,327	1.17
Governmental & Institutional Tariff	\$293	\$309	0.95	\$193	\$231	0.84
C&I DR Program – Small	\$63	\$41	1.55	\$63	\$41	1.55
C&I DR Program – Large	\$4,054	\$1,584	2.56	\$4,054	\$1,584	2.56
Portfolio Total	\$52,411	\$44,063	1.19	\$31,833	\$30,605	1.04

Seven 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 Energy Efficient Products and Appliance Turn-In programs were cost-effective under gross verified savings, but not cost-effective under net verified savings, while the LI Energy Efficiency and Governmental & Institutional Tariff programs were not cost-effective under gross or net verified savings.

H.7.1 Notes from the TRC Model Review

All four FirstEnergy companies utilized the same TRC model template but had independent inputs specific to that company.

- In PY10, the SWE found two issues with the natural gas price forecast used in the TRC model. First, to calculate natural gas prices, West Penn Power used the AEO average natural gas price for all users in the entire United States region rather than the AEO average natural gas price for all users in the Middle Atlantic region, as the SWE recommends. Second, the AEO natural gas prices were not converted to nominal dollars

before the NPV was calculated. West Penn Power resolved both of these issues in the PY11 TRC model.

- 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 to Friday 8 a.m. to 8 p.m.). 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 to Friday, 7 a.m. to 11 p.m.) 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 NPV 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).
- The incremental costs were derived from the SWE Incremental Cost Database, historic actuals, the DEER, company assumptions, and actual project costs as gathered from the PY11 evaluation. The SWE spot checked the incremental costs used in the TRC model and found them to be generally reasonable and consistent with West Penn Power’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 SO, as well as the application of the NTG in the calculation of TRC benefits and costs, were consistent with the TRC 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 DR 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 would appear that West 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 107 in FirstEnergy’s PY11 Annual Report). However, in their 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 PY9 and PY10, 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 51 million gallons per year of water saving, which translates to approximately \$2,441,000 in NPV lifetime avoided costs.
- In PY11, 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 266](#) 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. FirstEnergy used one year of pre-EISA savings and fourteen years of post-EISA savings for standard lamps and two years of pre-shift and thirteen years of post-shift savings for specialty lamps.

Table 266: West Penn Portfolio TRC with and without Dual Baseline Calculations

	Gross TRC	Net TRC
Dual Baseline	1.19	1.04
Without Dual Baseline	1.38	1.10

H.8 PROCESS

FirstEnergy's evaluation contractor, ADM/Tetra Tech, took unified process evaluation approaches to these programs across the four FirstEnergy EDCs, including West Penn, 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.

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 267: PA Statewide Energy-Efficiency Budgets and Expenditures

EDC	Actual PY11 Expenditures	Approved Budget for PY11
PECO	\$68,895	\$72,632
PPL	\$50,324	\$63,625
Duquesne Light	\$16,075	\$18,793
FE: Met-Ed	\$14,760	\$25,054
FE: Penelec	\$14,402	\$24,878
FE: Penn Power	\$4,245	\$5,976
FE: West Penn	\$16,307	\$22,645
Statewide	\$185,008	\$233,604

Table 268: PA Statewide Gross Verified Annual and Lifetime MWh Savings

EDC	Gross Verified Annual Savings	Gross Verified Lifetime Savings
PECO	479,702	3,378,745
PPL	369,322	4,125,812
Duquesne Light	97,349	937,701
FE: Met-Ed	143,078	1,170,063
FE: Penelec	136,889	1,211,849
FE: Penn Power	48,148	416,391
FE: West Penn	132,110	1,146,555
Statewide	1,406,597	12,387,116

Table 269: PA Statewide Net Verified Annual and Lifetime MWh Savings

EDC	Net Verified Annual Savings	Net Verified Lifetime Savings
PECO	330,948	2,230,782
PPL	285,690	3,008,006
Duquesne Light	62,251	584,461
FE: Met-Ed	88,857	699,868
FE: Penelec	92,653	889,037
FE: Penn Power	29,321	286,515
FE: West Penn	74,717	684,693
Statewide	964,437	8,383,361