



Semiannual Report to the Pennsylvania Public Utility Commission Phase III of Act 129

**Program Year 12
(June 1, 2020 - May 31, 2021)**

**For Pennsylvania Act 129 of 2008
Energy Efficiency and Conservation Plan**

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March 15, 2021

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Acronyms

AC	Air Conditioner
BMS	Building Management System
CAC	Central Air Conditioner
C&I	Commercial and Industrial
CAP	Customer Assistance Program
CDO	Commercial Date of Operation
CF	Coincidence Factor
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CI	Confidence Interval
CRAC	Computer Room Air Conditioning
CSP	Conservation Service Provider, Curtailment Service Provider
CV	Coefficient of Variation
DLC	Direct Load Control
DR	Demand Response
DRA	Demand Response Aggregator
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
EEMF	Energy Efficiency Marketing Firm
EFLH	Effective Full Load Hour
EM&V	Evaluation, Measurement, and Verification
EPA	US Environmental Protection Agency
EUL	Effective Useful Life
FPL	Federal Poverty Level
G/E/NP	Government/Education/Non-Profit
HER	Home Energy Report
HERS	Home Energy Rating System
HIM	High Impact Measure
HOU	Hours of Use
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IMP	Interim Measure Protocols
kW	Kilowatt
kWh	Kilowatt-Hour
LAH	Lighting, Appliances & HVAC
LDV	Lagged Dependent Variable

LED	Light-Emitting Diode
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification
MSRP	Manufacturer Suggested Retail Price
MW	Megawatt
MWh	Megawatt-Hour
MWh/yr	Megawatt-Hour per Year
NPV	Net Present Value
NTG	Net-to-Gross
O&M	Operations and Maintenance
P3TD	Phase III to Date
PA PUC	Pennsylvania Public Utility Commission
PILD	PECO Instant Lighting Discounts
PSA	Phase III to Date Preliminary Savings Achieved; equal to VTD + PYRTD
PSA+CO	PSA Savings plus Carryover from Phase II
PSD	Performance Systems Development
PUF	Part-Use Factor
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
QC	Quality Control
RCT	Randomized Control Trial
RTD	Phase III to Date Reported Gross Savings
RTO	Regional Transmission Organization
RUL	Remaining Useful Lifetime
SEER	Seasonal Energy Efficiency Ratio
SF	Single-Family
SIDS	Smart Ideas Data System
SKU	Stock Keeping Unit
SSMVP	Site-Specific Measurement and Verification Plan
SWE	Statewide Evaluator
T&D	Transmission and Distribution
TRC	Total Resource Cost
TRM	Technical Reference Manual
UEC	Unit Energy Consumption
UPS	Uninterruptible Power Supply
VFD	Variable Frequency Drive
VTD	Phase III to Date Verified Gross Savings
VTD + CO	Phase III to Date Verified Gross Savings plus Carryover from Phase II

Types of Savings

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

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

Reported Gross: Also referred to as *ex ante* (Latin for “beforehand”) savings. The energy and peak demand savings values calculated by the electric distribution company (EDC) or its program implementation conservation service providers (ICSPs) 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 multiyear cycle, the reported savings for a program year where evaluated results are not available are characterized as unverified reported gross until the impact evaluation is completed and verified savings can be calculated and reported.

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

Verified Net: Also referred to as *ex post net savings*. The energy and peak demand savings estimates reported by the independent evaluation contractor after applying 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/yr or MW/yr. The Pennsylvania Technical Reference Manual (TRM) provides algorithms and assumptions to calculate annual savings, and Act 129 compliance targets for consumption reduction are based on the sum of the annual savings estimates of installed measures or behavior change.

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

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

- 1. 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.
- 2. 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.
- 3. 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).
- 4. 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 plus any verified gross carryover savings from Phase II of Act 129. This is the best estimate of an EDC's progress toward the Phase III compliance targets.
- 5. 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.

Per guidance from the Pennsylvania Statewide Evaluator (SWE), all demand savings that were achieved from energy efficiency measures are shown in this report without line losses (i.e., at the meter). All demand savings that were achieved from demand response (DR) measures are shown in this report with line losses (i.e., at the generator).

Note that all values in the report are summed prior to rounding. Therefore, table totals may not equal the sum of all rows.

1. Introduction

Pennsylvania Act 129 of 2008, signed on October 15, 2008, mandated energy savings and demand reduction goals for the largest electric distribution companies (EDCs) in Pennsylvania for Phase I (2008 through 2013). Phase II of Act 129 began in 2013 and concluded in 2016. In late 2015, each EDC filed a new Energy Efficiency and Conservation (EE&C) Plan with the Pennsylvania Public Utility Commission (PA PUC) detailing the proposed design of its portfolio for Phase III. These plans were updated based on stakeholder input and subsequently approved by the PUC in 2016.

Implementation of Phase III of the Act 129 programs began on June 1, 2016. This report documents the progress of the Phase III EE&C accomplishments for PECO in Program Year 12 (PY12), as well as the cumulative accomplishments of the Phase III programs since inception. This report also documents the energy savings carried over from Phase II. The Phase II carryover savings count toward EDC savings compliance targets for Phase III.

This report details the participation, spending, and reported gross impacts of the energy efficiency (EE) programs in PY12. Compliance with Act 129 savings goals will ultimately be based on verified gross savings. PECO has retained Guidehouse Inc. (Guidehouse), as an independent evaluation contractor for Phase III of Act 129. Guidehouse is responsible for the measurement and verification (M&V) of the savings and the calculation of verified gross savings. The verified gross savings for PY12 EE programs will be reported in the final annual report to be filed on November 15, 2021.

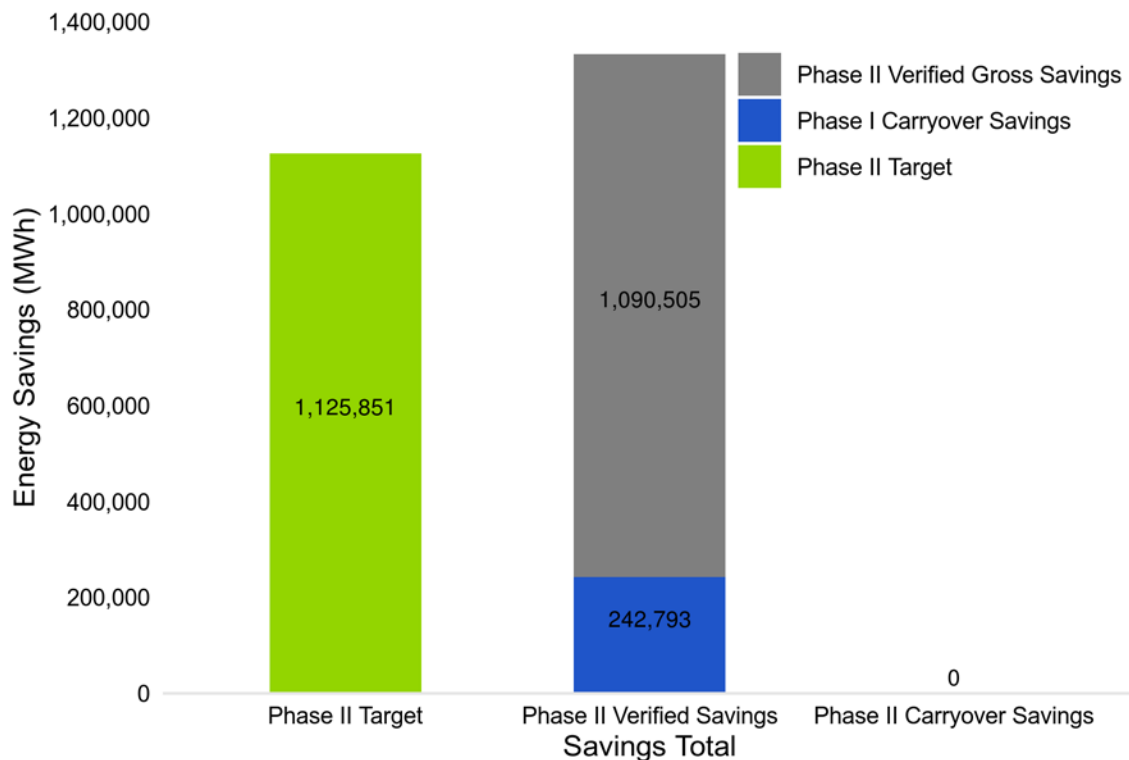
Phase III of Act 129 includes a demand response (DR) goal for PECO. DR events are limited to the months of June through September, which are the first 4 months of the Act 129 program year. Because the DR season is completed early in the program year, it is possible to complete the independent evaluation of verified gross savings for DR sooner than is possible for EE programs. Section 6.2 of this report includes the verified gross DR impacts for PY12 and the cumulative DR performance of the EE&C program to date for Phase III of Act 129. Guidehouse worked with the Statewide Evaluator (SWE) throughout the report's development to address questions related to compliance as they arose and appreciates the SWE's collaboration to ensure this final report is accurate and agreeable to relevant parties.

2. Summary of Achievements

2.1 The Carryover Savings from Phase II of Act 129

PECO has reported zero portfolio-level carryover savings from Phase II to Phase III. The Commission’s Phase III Implementation Order¹ allowed EDCs to carryover savings achieved within Phase II that were in excess of the Phase II portfolio savings target. Phase I carryover savings cannot be counted in the calculation of Phase II carryover savings. Figure 2-1 compares PECO’s Phase II verified gross savings total to the Phase II compliance target to illustrate the carryover calculation. Because PECO’s Phase II verified gross savings did not exceed PECO’s Phase II target, they were not eligible to carry over savings from Phase II toward their Phase III overall compliance target.²

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



Sources: PECO’s eTrack database, Conservation Service Provider (CSP) tracking data

The Commission’s Phase III Implementation Order also allowed EDCs to carry over savings in excess of the Phase II government, educational, and non-profit (G/E/NP) savings goal and excess savings from the low-income customer segment.³ PECO carried over 0 MWh/yr of

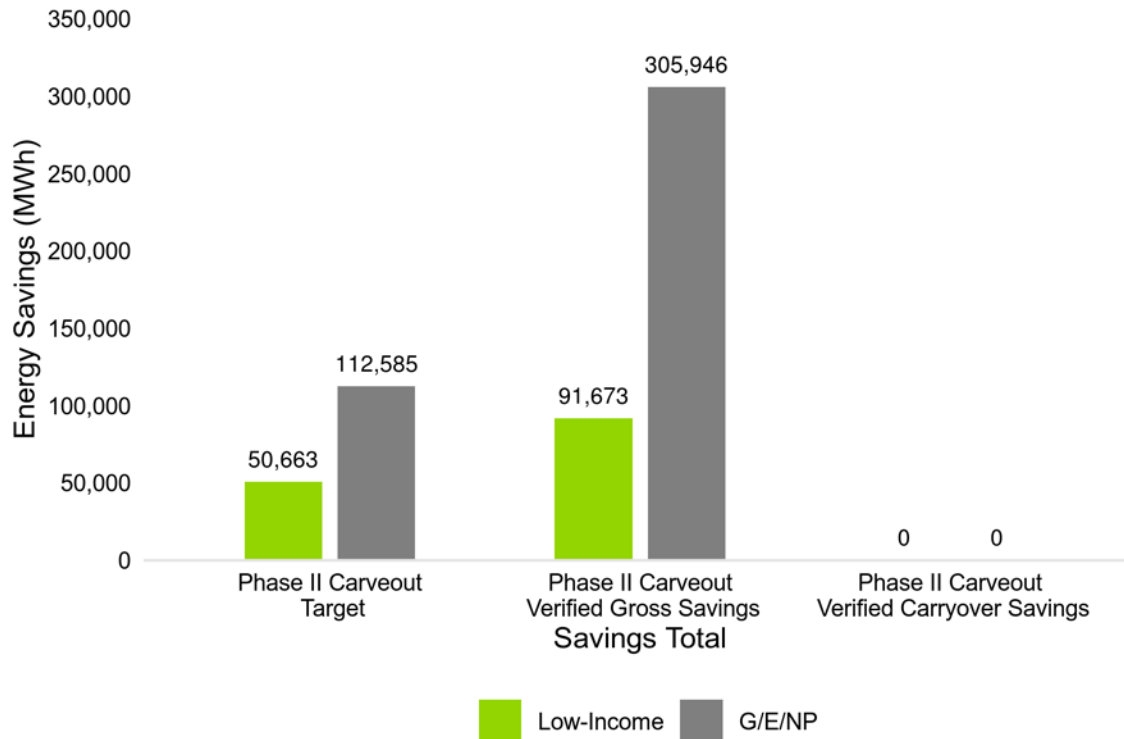
¹ PA PUC, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (Phase III Implementation Order), June 11, 2015.

² PA PUC, *Energy Efficiency and Conservation Program Compliance Order*, at Docket No. M-2012-2289411, (Phase II Compliance Determination Order), August 3, 2017.

³ Proportionate to those savings achieved by dedicated low-income programs in Phase III.

G/E/NP and 0 MWh/yr of low-income customer segment savings.⁴ Figure 2-2 shows the calculation of carryover savings for the low-income and G/E/NP targets.

Figure 2-2. Customer Segment-Specific Carryover from Phase II



Source: Guidehouse analysis

2.2 Phase III Energy Efficiency Achievements to Date

Since the beginning of PY12 on June 1, 2020, PECO has claimed:

- 181,233 MWh/yr of reported gross electric energy savings (PYRTD)
- 21.94 MW of reported gross peak demand savings (PYRTD) from EE programs

Since the beginning of Phase III of Act 129 on June 1, 2016, PECO has achieved the following savings:

- 1,663,800 MWh/yr of reported gross electric energy savings (RTD)
- 188.59 MW of reported gross peak demand savings (RTD) from EE programs
- 1,690,160 MWh of gross electric energy savings (PSA)
 - This total includes verified gross savings from all Phase III program years and the PYTD reported gross savings from PY12.
- 227.69 MW of gross peak demand savings (PSA) from EE programs

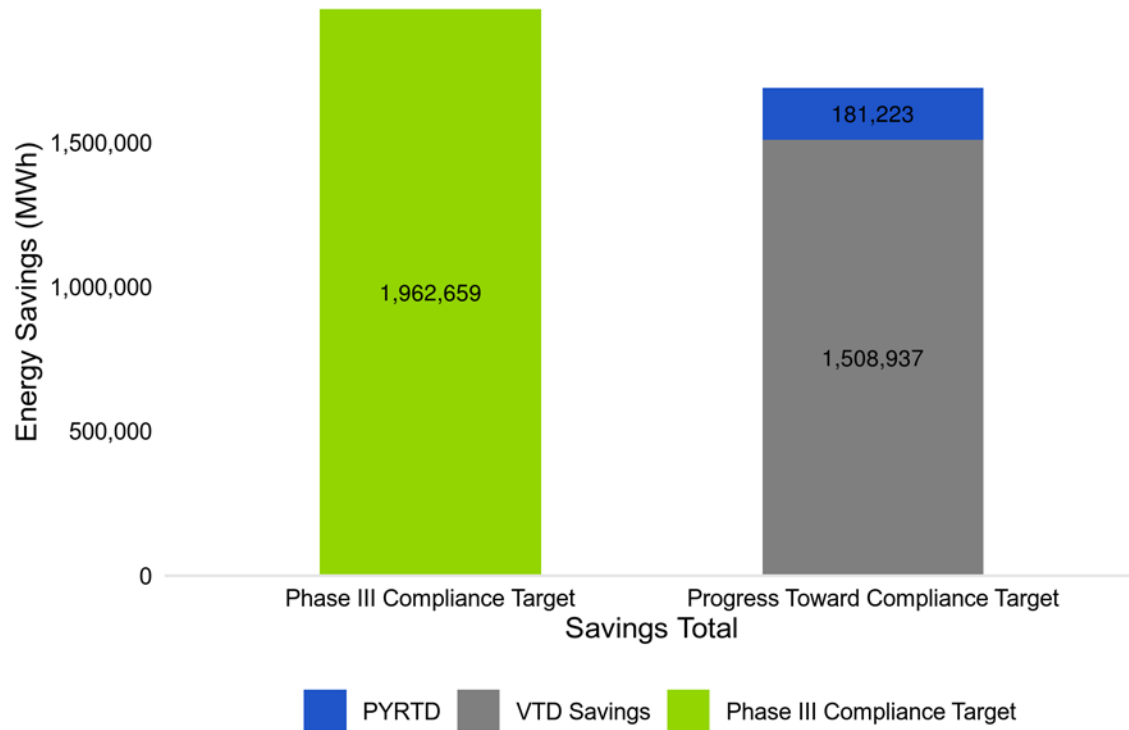
⁴ PA PUC, *Energy Efficiency and Conservation Program Compliance Order*, at Docket No. M-2012-2289411, August 3, 2017.

Including carryover savings from Phase II, PECO has achieved:

- 1,690,160 MWh of PSA+CO energy savings recorded to date in Phase III
 - This represents 86.1% of the May 31, 2021 energy savings compliance target of 1,962,659 MWh

Figure 2-3 summarizes PECO’s progress toward the Phase III portfolio compliance target.

Figure 2-3. EE&C Plan Performance toward Phase III Portfolio Compliance Target

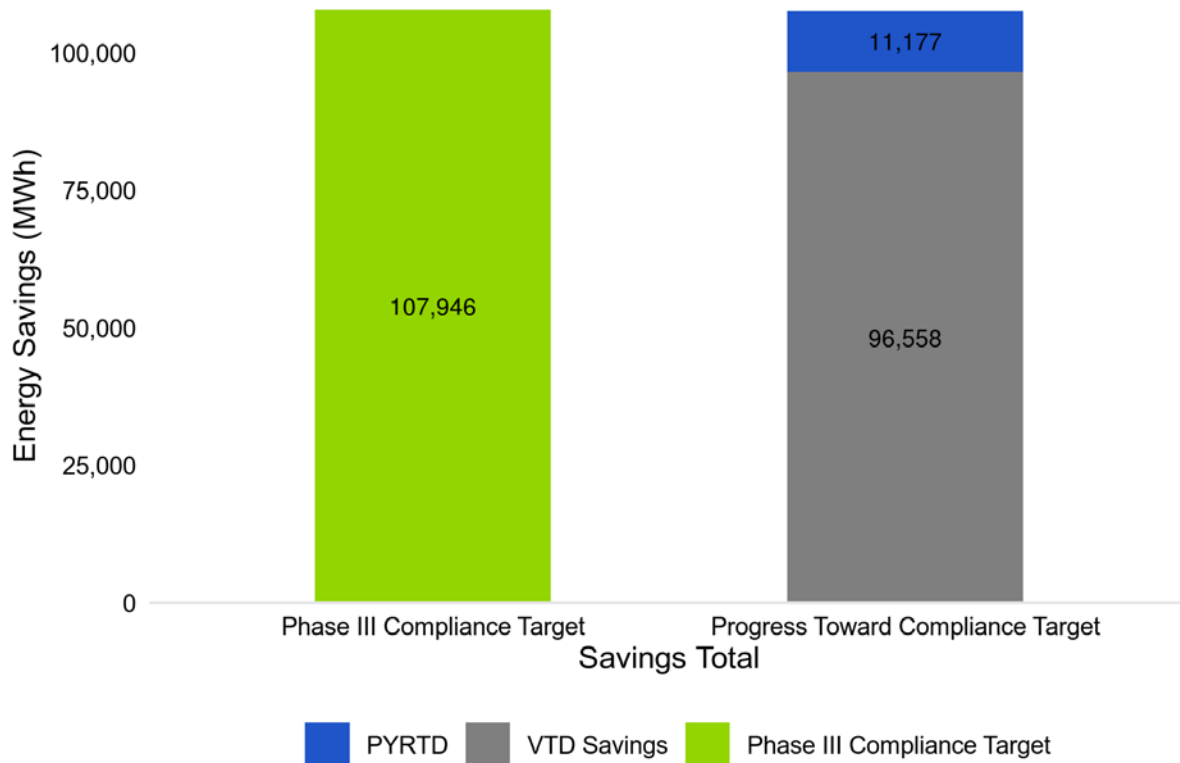


Source: Guidehouse analysis

The Phase III Implementation Order directed EDCs to offer conservation measures to the low-income customer segment based on the proportion of electric sales attributable to low-income households. The proportionate number of measures targeted for PECO is 8.8%. PECO offers a total of 269 EE&C measures to its residential and non-residential customer classes. There are 117 measures available to the low-income customer segment at no cost to the customer. This represents 43.5% of the total measures offered in the EE&C Plan and exceeds the proportionate number of measures target.

The PA PUC also established a low-income energy savings target of 5.5% of the portfolio savings goal. The Phase III low-income savings target for PECO is 107,946 MWh. Figure 2-4 compares the PSA+CO performance to date for the low-income customer segment to the Phase III savings target. Based on the latest available information, PECO has achieved 99.8% of the Phase III low-income energy savings target.

Figure 2-4. EE&C Plan Performance toward Phase III Low-Income Compliance Target^[1]

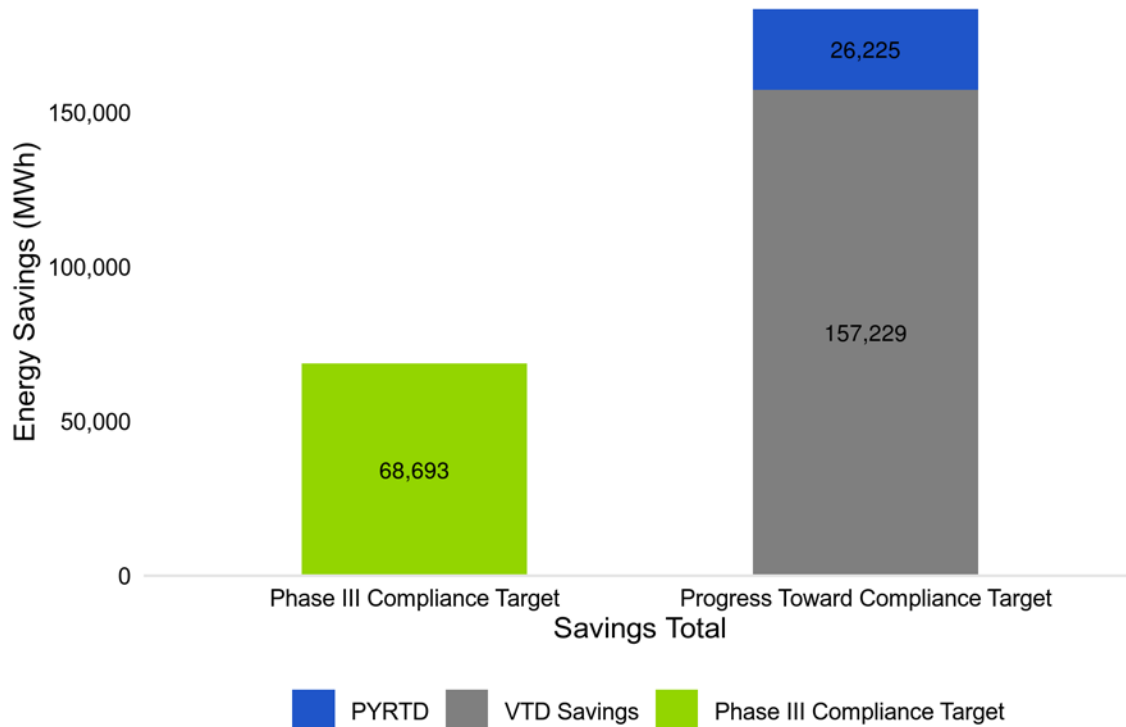


^[1] The PY11 Annual Report included a presentation error showing VTD low-income energy savings of 96,560 MWh instead of 96,558 MWh in one figure. The presentation error is corrected in the figure above. The other figures and tables in the PY11 Annual Report included the correct VTD low-income energy savings.

Source: Guidehouse analysis

The Phase III Implementation Order established a G/E/NP energy savings target of 3.5% of the portfolio savings goal. The G/E/NP savings target for PECO is 68,693 MWh. Figure 2-5 compares the PSA+CO performance to date for the G/E/NP customer segment to the Phase III savings target. Based on the latest available information, PECO has achieved the Phase III G/E/NP energy savings target.

Figure 2-5. EE&C Plan Performance against Phase III G/E/NP Compliance Target



Source: Guidehouse analysis

2.3 Phase III DR Achievements to Date

The Phase III DR performance target for PECO is 161 MW. Compliance targets for DR programs are based on average performance across events and are established at the system level, which means the load reductions measured at the customer meter must be escalated to reflect transmission and distribution (T&D) losses.

In PY12, PECO called five DR events: July 20, July 27, July 29, August 25, and August 27.⁵ The average performance for these five events is presented in Table 2-1.⁶ The full methodology and results are available in the standalone PY12 DR report, submitted to the SWE on March 15, 2021. Table 2-1 shows a summary of the DR performance to date.

⁵ PECO voluntarily implemented PY12 DR activities per PA PUC. *Petition to Amend the Commission’s June 19, 2015 Implementation Order. M-2014-2424864*. May 21, 2020. <https://www.puc.pa.gov/pcdocs/1665150.docx>. Because of the voluntary nature of the program, PECO chose to run 2-hour, rather than 4-hour, events for the Residential and Small C&I DR programs in PY12. The Large C&I program continued with 4-hour events.

⁶ For the Residential and Small C&I DR Programs, the event performance in PY12 is the average over the 2 hours of curtailment. Previous year performances are the average over 4 hours of curtailment.

Table 2-1. Phase III to Date DR Performance by Event

PY	Event Date	Residential DR (MW) ^[1]	Small C&I DR (MW) ^[1]	Large C&I DR (MW) ^[2]	Portfolio (MW)	Relative Precision at 90% CI
PY9	June 13, 2017	39.53	0.00	127.97	167.50	10.9%
PY9	July 20, 2017	33.48	0.00	121.89	155.37	11.0%
PY9	July 21, 2017	23.34	0.00	140.83	164.17	10.3%
PY10	July 2, 2018	38.93	0.00	149.25	188.18	10.2%
PY10	July 3, 2018	33.84	0.00	144.67	178.51	10.7%
PY10	August 6, 2018	25.07	1.15	175.12	201.34	10.6%
PY10	August 28, 2018	30.69	0.92	159.52	191.12	11.3%
PY10	September 4, 2018	29.99	0.77	137.79	168.55	11.4%
PY10	September 5, 2018	29.52	0.84	129.54	159.91	11.9%
PY11	July 17, 2019	34.36	0.86	120.04	155.26	6.1%
PY11	July 18, 2019	11.06	1.02	121.63	133.71	5.9%
PY11	July 19, 2019	34.93	1.18	120.89	157.00	5.8%
PY11	August 19, 2019	24.90	0.98	126.17	152.05	5.6%
PY12	July 20, 2020	30.24	1.08	147.31	178.63	7.5%
PY12	July 27, 2020	28.58	0.66	139.01	168.25	8.2%
PY12	July 29, 2020	27.48	0.46	150.48	178.42	6.7%
PY12	August 25, 2020	23.07	0.90	117.09	141.06	8.4%
PY12	August 27, 2020	25.82	0.33	110.17	136.32	9.2%
PYVTD - Average PY12 DR Event Performance (Voluntary)		27.04	0.69	132.81	160.54	7.9%
PY9-PY11 – Average Phase III DR Event Performance (Compliance)		29.97	0.59	136.56	167.13	10.0%
P3TD - Average Phase III DR Event Performance (Voluntary and Compliance)		29.16	0.62	135.52	165.30	9.5%

^[1] For the Residential and Small C&I DR programs, the event performance in PY12 is the average over the 2 hours of curtailment. Previous year performances are the average over the 4 hours of curtailment.

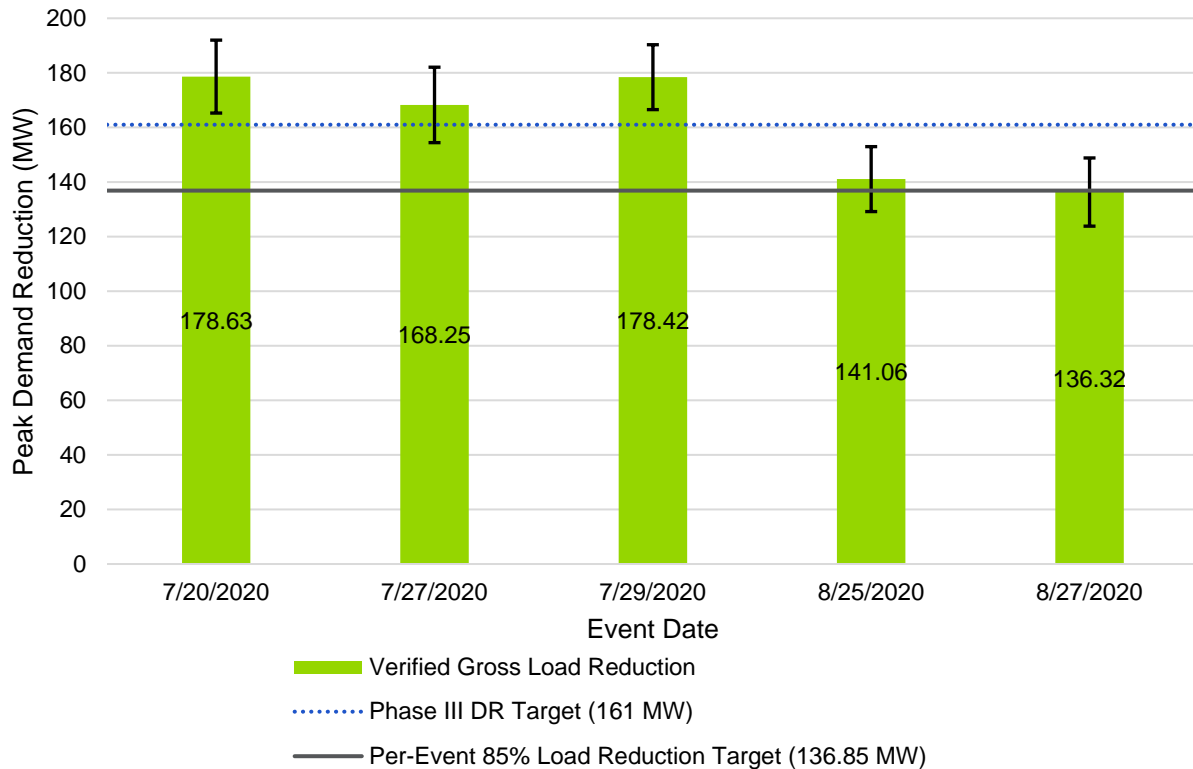
^[2] Verified impacts for the Large C&I DR Program for PY9, PY10, and PY11 have been revised based on corrected interval data provided by PECO. In January 2020, PECO notified Guidehouse of potential issues with the interval data provided for the PY9 through PY11 evaluations, where certain data may not represent actual consumption because of unique meter configurations at different participant sites. After a review of all sites and activities to date, the evaluation team found that 16, 25, and six sites were affected in PY9, PY10, and PY11, respectively. At the request of PECO and in consultation with the SWE, Guidehouse applied evaluation methods prescribed for PY11 to revise verified impacts for the affected sites; impacts for unaffected sites remain unchanged. These revisions increased the PY9-PY11 average performance by 1.6 MW (1.0%).

Source: Guidehouse analysis

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. For PECO,

this translates to a 136.9 MW minimum for each DR event. Figure 2-6 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. PECO's voluntary curtailment efforts in PY12 exceeded the 85% minimum target for all events except for the final event on August 27, 2020. The August 27 event fell short of the 85% target by 0.5 MW, which appears to be driven by decreased curtailment from Large C&I customers compared with the three July events. The 85% target is within the margin of error of the verified impacts for the final event.

Figure 2-6. PY12 Event Performance Compared to 85% Per-Event Target



Source: Guidehouse analysis

2.4 Phase III Performance by Customer Segment

Table 2-2 presents the participation, savings, and spending by customer sector for PY12. The residential, small commercial and industrial (C&I), and large C&I sectors are defined by EDC tariff, and the residential low-income and G/E/NP customer segment carve-outs are defined by statute (66 Pa. C.S. § 2806.1). The residential low-income segment is a subset, and not additive, of the residential customer class; however, some low-income savings may occur on a small C&I or large C&I meter due to participation of low-income occupants living in multifamily, master-metered buildings. Similar to the low-income segment, the G/E/NP customer segment will include customers who are part of the small C&I or large C&I rate classes and is not additive to the portfolio. Table 2-2 represents the cumulative savings, spending, and participation by customer sector, inclusive of all low-income and G/E/NP participation. Table 2-3 represents the savings, spending, and participation values for the low-income and G/E/NP customer segment carve-outs only.

Table 2-2. PY12 Summary Statistics by Customer Segment

Customer Segment	No. of Participants	PYRTD MWh	PYRTD MW (EE)	PYVTD MW (DR)	Incentives (\$1,000)
Residential	744,983	100,202	8.75	27.04	\$6,077
Small C&I	3,540	37,593	6.04	0.69	\$2,464
Large C&I	1,144	43,428	7.16	132.81	\$3,117
Total	749,667	181,223	21.94	160.54	\$11,658

Source: Guidehouse analysis

Table 2-3. PY12 Summary Statistics by Carve-Out

Carve-Out	No. of Participants	PYRTD MWh	PYRTD MW (EE)	PYVTD MW (DR)	Incentives (\$1,000)
Low-Income (0-50% of FPL)	689	1,288	0.14	0.0	\$0
Low-Income (51-150% of FPL)	2,884	9,889	1.09	0.0	\$63
G/E/NP	1,740	26,225	4.13	0.0	\$2,246

Source: Guidehouse analysis

Table 2-4 and Table 2-5 summarize plan performance by sector and customer segment carve-outs since the beginning of Phase III.

Table 2-4. Phase III Summary Statistics by Customer Segment

Customer Segment	No. of Participants ^[1]	PSA MWh	PSA MW (EE)	PSA MW (DR) ^[2]	Incentives (\$1,000)
Residential	5,195,343	1,054,857	129.40	29.97	\$48,256
Small C&I	12,437	246,564	39.07	0.59	\$12,989
Large C&I	5,092	388,739	59.23	136.56	\$21,263
Total	5,212,872	1,690,160	227.69	167.13	\$82,509

^[1] DR participation and Behavioral participation are 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 and Behavioral programs for Phase III is equal to the highest program year participation count for each of the three programs.

^[2] The DR savings presented are from PY9-PY11 as PY12 DR activities were voluntary (see footnote 5).

Source: Guidehouse analysis

Table 2-5. Phase III Summary Statistics by Carveout

Carve-Out	No. of Participants	PSA MWh	PSA MW (EE)	PSA MW (DR)	Incentives (\$1,000)
Low-Income (0-50% of FPL)	11,840	13,765	1.55	0.00	\$3,640
Low-Income (51-150% of FPL)	211,858	93,969	10.99	0.00	\$22,937
G/E/NP	7,141	183,453	27.18	0.00	\$2,652

Source: Guidehouse analysis

3. Updates and Findings

3.1 Implementation Updates and Findings

This section summarizes PECO's EE&C Plan and program implementation updates, as well as findings available at the time of this report's writing. PECO's EE&C Plan remains generally unchanged through the second half of PY12.

- **Residential EE Program:** The residential program continues to represent the majority of savings in the portfolio in PY12. The program includes multiple solutions that are implemented by ARCA, CLEARResult, Franklin Energy, Oracle, and PSD.
 - **Behavioral Solution:** Oracle implements the Behavioral Solution and has been active since PY8. The Behavioral Solution continues to represent a significant portion of the Residential EE Program reported savings.
 - **Lighting, Appliance & HVAC Solution:** The Lighting, Appliance & HVAC Solution, implemented by CLEARResult, continues to represent a significant portion of the Residential EE Program's reported savings, with the majority of the solution's savings originating from LED measures. CFL offerings were discontinued during PY8. Non-lighting measures, including appliances and HVAC, represent less than 10 percent of solution savings.
 - **Appliance Recycling Solution:** The Appliance Recycling Solution, implemented by ARCA, offers rebates for refrigerators, freezers, and room air conditioners (ACs). The utility offers \$75 rebates for each working refrigerator or freezer picked up for recycling. The utility offers \$10 rebates per room AC recycled with the pickup of a refrigerator or freezer.
 - **Whole Home Solution:** The Whole Home Solution, implemented by CLEARResult, offers participants a low-cost home energy assessment that includes direct installation of a range of deemed measures such as lighting, water conservation, smart strips, etc. In addition, the Whole Home Solution provides incentives for ceiling, attic, and wall insulation, air and duct sealing, and mechanical equipment (e.g., fuel switching from electric heat to natural gas heat pump water heaters).
 - **Multifamily Targeted Market Segment:** The Multifamily Targeted Market Segment includes projects and savings related to residential EE occurring within the dwellings of multifamily buildings. The projects and savings for master-metered multifamily facilities are allocated to the Small C&I EE and Large C&I EE Programs. Franklin Energy implements the Multifamily Targeted Market Segment.
 - **New Construction Solution:** The Residential New Construction Solution's activities continue to represent a smaller share of the Residential EE Program's savings activities. This solution is intended to accelerate the adoption of EE in the design, construction, and operation of new single-family homes, duplexes, and townhomes by leveraging the US Environmental Protection Agency's (EPA's) ENERGY STAR Homes certification. The program also includes an

additional above-code track (Code-Plus) designed to transition builders toward ENERGY STAR standards. The New Construction Solution is implemented by PSD.

- **Low-Income EE Program:** CMC Energy Services and ARCA, Inc. implement the Low-Income Whole Home Solution in PY12.
 - **Whole Home Solution:** The Whole Home Solution encompasses several activities to deliver energy savings services to income eligible households including PECO's Free Home Energy Check Up with free measure direct installation, low-income multifamily building audit and measure direct installation, appliance recycling, and distribution of free energy efficiency products at events targeting income eligible households. For customers with electric heat and domestic hot water, Home Energy Check Up measures include improving mechanical systems, water heaters and the thermal performance of building envelopes. Additionally, the solution supports the Low-Income Usage Reduction Program (LIURP) and Philadelphia Gas Works income-eligible weatherization program providing additional free efficient electric EE products for direct installation.
 - **Lighting Solution:** The Lighting Solution was closed on December 31, 2017.
- **Small C&I EE Program:** ICF, Franklin, and SmartWatt have implemented projects during Phase III in three of the program's solutions and two targeted market segments: Equipment and Systems Solution, New Construction Solution, Whole Building Solution, Multifamily Targeted Market Segment, and the Data Center Targeted Market Segment. Each of these solutions typically includes a mixture of lighting improvements, lighting controls, HVAC, compressed air, refrigeration, and custom projects. The Equipment and Systems Solution targets existing buildings, while the New Construction Solution is for new buildings and major retrofits. The Whole Building Solution encourages direct-install projects that target entire facilities, while the Multifamily Targeted Market Segment focuses on the commercially metered common areas in multifamily residential buildings.
- **Large C&I EE Program:** ICF and Franklin have implemented projects during Phase III in two of the program's solutions and two targeted market segments: Equipment and Systems Solution, New Construction Solution, Multifamily Targeted Market Segment, and the Data Center Targeted Market Segment. Each of these solutions typically includes a mixture of lighting improvements, lighting controls, HVAC, compressed air, refrigeration, and custom projects. The Equipment and Systems Solution targets existing buildings, while the New Construction Solution is for new buildings and major retrofits. The Multifamily Targeted Market Segment focuses on the commercially metered common areas in multifamily residential buildings, while the Data Center Targeted Market Segment primarily targets efficient HVAC projects in data centers and other IT facilities.
- **CHP Program:** PECO is currently processing applications for combined heat and power (CHP) projects. The program is tracking two projects that have projected completion dates within Phase III including one megawatt-scale project with a high certainty of completion during PY12. The program is also tracking a megawatt-scale project that has completed the construction phase but may not reach steady-state operation in PY12 due to load attrition resulting from COVID-19.

- **Residential DR Program:** The Residential DR Program ran five DR events during the summer of 2020: July 20, July 27, July 29, August 25, and August 27. As in years past, the program is implemented by Itron. This year, as in PY11, the incentive is \$40 per direct load control (DLC) unit per year.
- **Small C&I DR Program:** The Small C&I DR Program ran five DR events during the summer of 2020: July 20, July 27, July 29, August 25, and August 27. As in years past, the program is implemented by Itron. This year, as in PY11, the incentive is \$40 per thermostat per year.
- **Large C&I DR Program:** The Large C&I DR Program ran five DR events during the summer of 2020: July 20, July 27, July 29, August 25, and August 27. The program is implemented by two CSPs: CPower and Enel X.

3.2 Evaluation Updates and Findings

Guidehouse is working on revisions to the Phase III evaluation plan and sampling plan for each program and solution. The team is conducting interviews with PECO staff and CSPs and reviewing program tracking databases and engineering files for each solution. These activities inform the design of participant surveys exploring customer satisfaction and experience, and the verification of measure installations for specific solutions per the evaluation plan. Guidehouse's progress on each program and solution is summarized below.

- **Residential EE Program:** Guidehouse is currently updating evaluation plans ahead of the PY12 activities for the Residential EE Program's solutions. Guidehouse is preparing data collection tools and processes to aid phone verification and survey research anticipated for PY12. Activities from PY11, recent findings and conclusions, and SWE feedback inform the team's research plan updates for PY12 that will support both impact and process evaluation efforts.
- **Low-Income EE Program:** Guidehouse conducted on-site verification visits in PY9 and phone verification in PY10 and PY11. The team is currently updating evaluation plans for PY12 activities, which will include phone verification. As part of that planning, Guidehouse is preparing to conduct program database reviews and preparing data collection tools and processes to aid the verification research anticipated for PY12. Low-Income EE Program evaluation activities are focused on the Whole Home Solution.
- **Small C&I EE Program:** Guidehouse updated its data collection tools and processes to ensure faster and more robust data collection as well as more collaboration with the SWE. Impact evaluations for all solutions are ongoing. Over the next several months, Guidehouse will continue to review the solution measure data, call and visit sampled project sites, and continue the evaluation process for PY12.
- **Large C&I EE Program:** Guidehouse updated its data collection tools and processes to ensure faster and more robust data collection as well as more collaboration with the SWE. Guidehouse has also been working with ICF and DNVGL to review large and complex projects before incentives will be reserved. Impact evaluations for all solutions are ongoing. Over the next several months, Guidehouse will review the solution measure data, call and visit sampled project sites, and continue the evaluation process for PY12.

- **CHP Program:** The CHP Program expects at least two projects to be completed during PY12. Prior targeted research by Guidehouse found that CHP projects take 18-24 months to construct which limits the ability of the program to recruit new participants able to complete projects within Phase III.
- **Residential DR Program:** The team evaluated peak load reductions for DR events on all summer event days in 2020. Peak load reduction evaluation findings are reported in the separate DR Annual Report.
- **Small C&I DR Program:** The team evaluated peak load reductions for DR events on all summer event days in 2020. Peak load reduction evaluation findings are reported in the separate DR Annual Report.
- **Large C&I DR Program:** The team evaluated peak load reductions for DR events on all summer event days in 2020. Peak load reduction evaluation findings are reported in the separate DR Annual Report.

4. Summary of Participation by Program

Table 4-1 provides the current participation totals for PY12 and Phase III. Certain programs and solutions define participation differently depending on the delivery channel and data tracking practices. 7.2 Appendix A includes an overview of the different participation definitions by program and solution.

Table 4-1. EE&C Plan Participation by Program

Program and Solution	PYTD Participation	P3TD Participation
LAH	326,485	4,327,410
Appliance Recycling	5,541	64,805
Whole Home	1,126	20,284
New Construction	471	2,933
Behavioral	355,753	466,381 ^[1]
Multifamily Targeted	1,503	30,262
Residential EE	690,879	4,912,075
Lighting	3,573	56,640
Whole Home	0	167,058
Low-Income EE	3,573	223,698
Equipment & Systems	1,527	7,447
Whole Building	68	1,035
C&I New Construction	33	249
Multifamily Targeted	33	482
Data Center	0	2
Small C&I EE Program	1,661	9,215
Equipment & Systems	729	4,159
C&I New Construction	21	164
Multifamily Targeted	12	169
Data Center	0	4
Large C&I EE Program	762	4,496
CHP	0	6
Residential DR	50,919	61,440^[1]
Small C&I DR	1,517	1,586^[1]
Large C&I DR	356	356^[1]
Portfolio Total	749,667	5,212,872

^[1] DR participation and Behavioral participation are 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 and Behavioral programs for Phase III is equal to the highest program year participation count for each program.

Sources: PECO's eTrack database, CSP tracking data

5. Summary of Energy Impacts by Program

Figure 5-1 presents a summary of the PYTD reported gross energy savings by program for PY12. The energy impacts in this report are presented at the meter level and do not reflect adjustments for T&D losses.

Figure 5-1. PYTD Reported Gross Energy Savings by Program

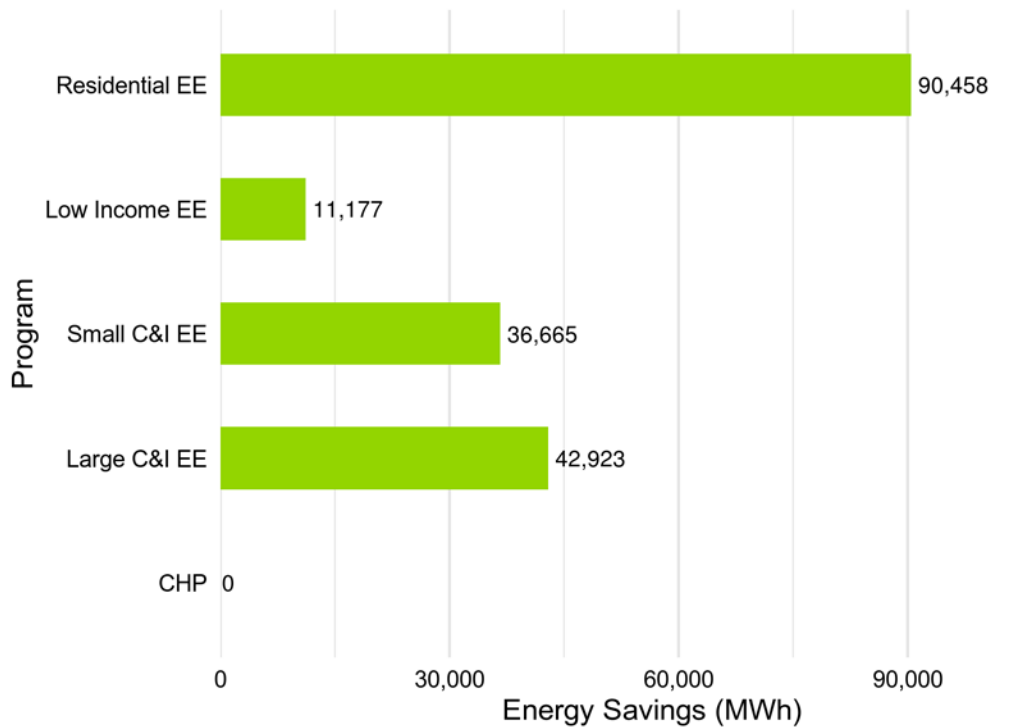


Figure 5-2 presents a summary of the PSA gross energy savings by program for Phase III of Act 129. PSA savings include verified gross savings from previous program years and the PYTD savings from the current program year.

Figure 5-2. PSA Energy Savings by Program for Phase III

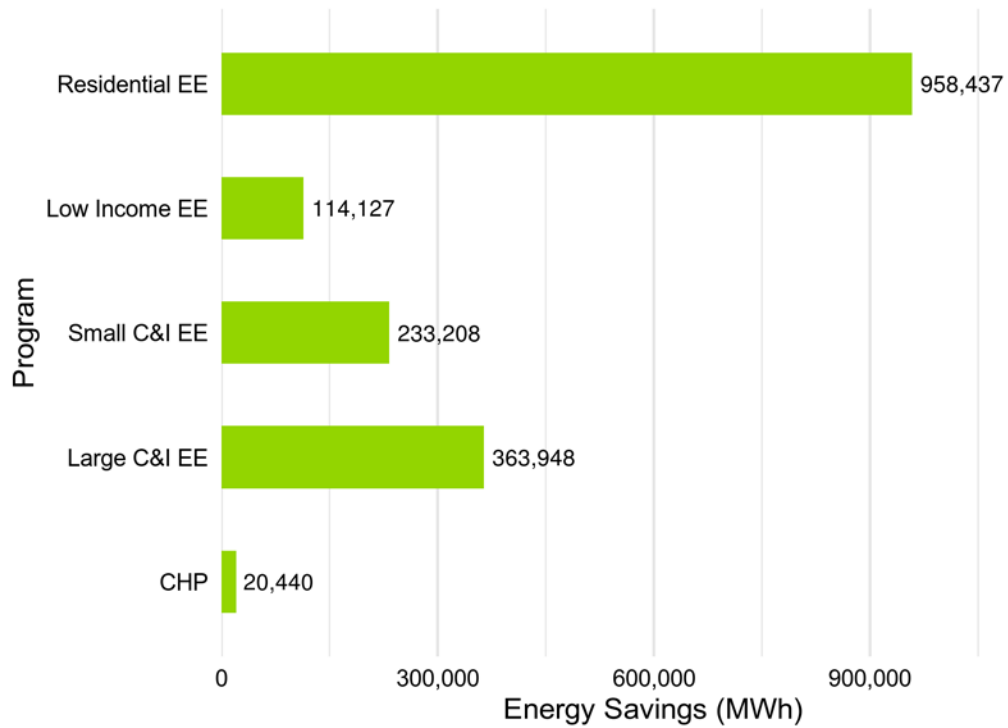


Table 5-1 presents a summary of energy impacts by program and solution through the current reporting period.

Table 5-1. Energy Savings by Program and Solution (MWh)

Program and Solution	PYRTD	RTD	VTD	PSA
LAH	43,533	526,185	489,817	533,350
Appliance Recycling	5,440	64,500	59,575	65,015
Whole Home	1,915	25,476	22,208	24,123
New Construction	846	7,002	5,921	6,767
Behavioral	37,871	294,115	277,963	315,834
Multifamily Targeted	854	13,609	12,495	13,349
Residential EE Program	90,458	930,886	867,979	958,437
Whole Home	11,177	112,663	93,869	105,046
Lighting	0	9,086	9,081	9,081
Low Income EE Program	11,177	121,749	102,950	114,127
Equipment and Systems	27,257	166,386	147,318	174,575
New Construction	2,541	14,871	12,907	15,448
Whole Building	5,187	31,782	25,895	31,082
Data Centers Targeted	0	119	50	50
Multifamily Targeted	1,680	13,270	10,373	12,052
Small C&I EE Program	36,665	226,427	196,543	233,208
Equipment and Systems	38,694	314,365	281,058	319,752
New Construction	2,923	29,864	27,382	30,305
Data Centers Targeted	0	546	529	529
Multifamily Targeted	1,305	13,514	12,056	13,361
Large C&I EE Program	42,923	358,288	321,025	363,948
CHP Program	0	26,450	20,440	20,440
Portfolio Total	181,223	1,663,800	1,508,937	1,690,160

Sources: PECO's eTrack database, CSP tracking data

6. Summary of Demand Impacts by Program

PECO's Phase III EE&C programs achieve peak demand reductions primarily in two ways. The first is through coincident reductions from EE measures and the second is through dedicated DR offerings that exclusively target temporary demand reductions on peak days. EE reductions coincident with system peak hours are reported and used in the calculation of benefits in the Total Resource Cost (TRC) test but do not contribute to Phase III peak demand reduction compliance goals. Phase III peak demand reduction targets are exclusive to DR programs.

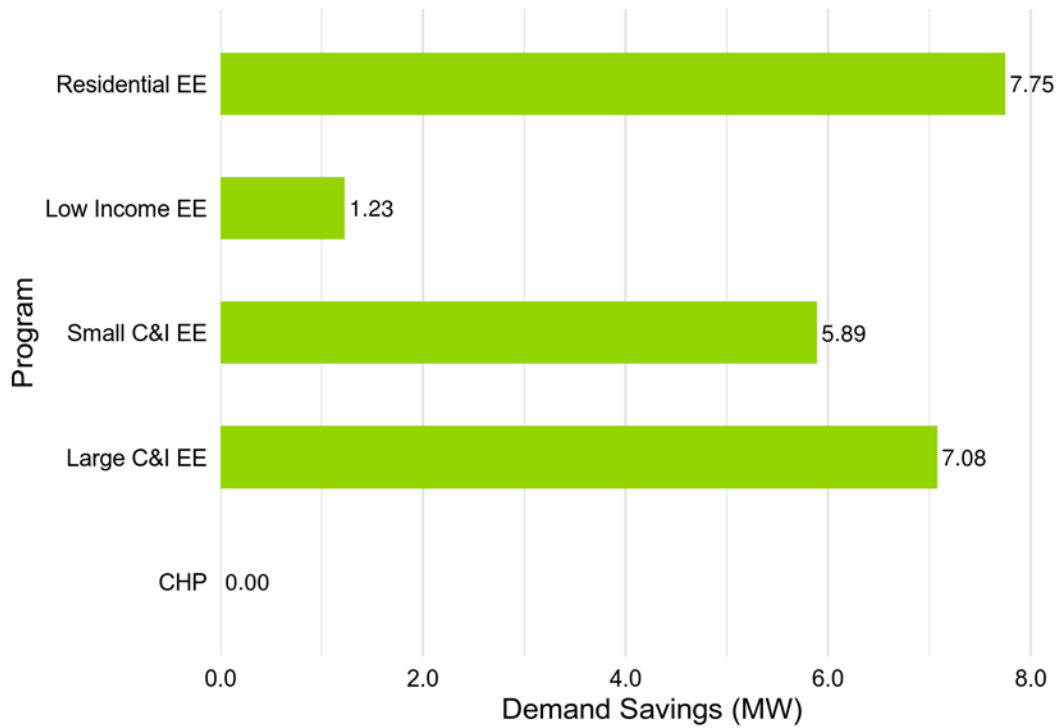
The two types of peak demand reduction savings are also treated differently for reporting purposes. Peak demand reductions from EE are generally additive across program years, meaning that the P3TD savings reflect the sum of the first-year savings in each program year. Conversely, DR goals are based on average portfolio impacts across all events, so cumulative DR performance is expressed as the average performance of each of the DR events called in Phase III to date.⁷ Because of these differences, demand impacts from EE and DR are reported separately in Sections 6.1 and 6.2.

6.1 Energy Efficiency

Act 129 defines peak demand savings from EE as the average expected reduction in electric demand from 2:00 p.m. to 6:00 p.m. EDT on non-holiday weekdays from June to August. The peak demand impacts from EE in this report are presented at the meter level and do not reflect adjustments for T&D losses. Figure 6-1 presents a summary of the PYRTD reported gross peak demand savings by EE program for PY12.

⁷ For the Residential and Small C&I DR programs, the event performance in PY12 is the average over the 2 hours of curtailment. Previous year performances are the average over 4 hours of curtailment.

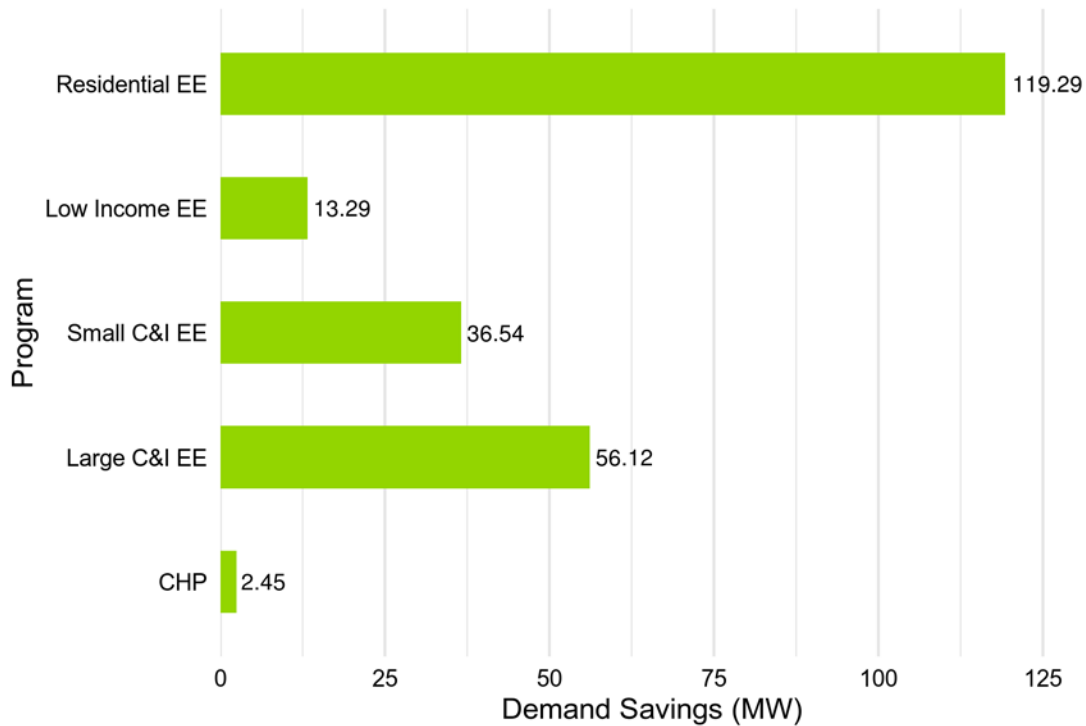
Figure 6-1. PYRTD Gross Demand Savings by EE Program



Sources: PECO's eTrack database, CSP tracking data

Figure 6-2 presents a summary of the PSA gross demand savings by EE program for Phase III of Act 129.

Figure 6-2. PSA Demand Savings by EE Program for Phase III



Sources: PECO's eTrack database, CSP tracking data

Table 6-1 presents a summary of the peak demand impacts by EE program and solution through the current reporting period.

Table 6-1. Peak Demand Savings by EE Program and Solution (MW)

Program and Solution	PYRTD	RTD	VTD	PSA
LAH	6.20	68.89	65.23	71.43
Appliance Recycling	0.75	9.31	8.43	9.18
Whole Home	0.29	3.14	2.68	2.98
New Construction	0.41	2.44	1.93	2.35
Behavioral	0.00	0.00	31.73	31.73
Multifamily Targeted	0.09	1.72	1.54	1.63
Residential EE Program	7.75	85.51	111.54	119.29
Whole Home	1.23	13.16	10.99	12.22
Lighting	0.00	1.07	1.07	1.07
Low-Income EE Program	1.23	14.23	12.06	13.29
Equipment and Systems	4.26	23.94	22.90	27.15
New Construction	0.39	2.63	2.23	2.62
Whole Building	1.04	6.52	4.46	5.51
Data Centers Targeted	0.00	0.02	0.01	0.01
Multifamily Targeted	0.19	1.37	1.06	1.26

Program and Solution	PYRTD	RTD	VTD	PSA
Small C&I EE Program	5.89	34.48	30.66	36.54
Equipment and Systems	6.42	46.02	42.72	49.13
New Construction	0.51	3.85	4.82	5.32
Data Centers Targeted	0.00	0.04	0.04	0.04
Multifamily Targeted	0.16	1.68	1.47	1.62
Large C&I EE Program	7.08	51.58	49.04	56.12
CHP Program	0.00	2.80	2.45	2.45
Portfolio Total	21.94	188.59	205.75	227.69

Sources: PECO's eTrack database, CSP tracking data

6.2 Demand Response

Act 129 defines peak demand savings from DR as the average reduction in electric demand during the hours when a DR event is initiated. Act 129 peak demand reduction targets were set for PY9 through PY12; there was no PY8 peak demand reduction target; PY12 targets were made voluntary.⁸ Phase III DR events are initiated according to the following guidelines:⁹

1. Curtailment events shall be limited to the months of June through September.
2. Curtailment events shall be called for the first 6 days of each program year (starting in PY9) in which the peak hour of PJM's day-ahead forecast for the PJM regional transmission organization (RTO) is greater than 96% of the PJM RTO summer peak demand forecast for the months of June through September.
3. Each curtailment event shall last 4 hours. AC Saver (Residential and Small C&I sector) curtailment events were 2 hours for the voluntary PY12.
4. Each curtailment event shall be called such that it will occur during the day's forecast peak hour(s) above 96% of PJM's RTO summer peak demand forecast.
5. Once six curtailment events have been called in a program year, the peak demand reduction program shall be suspended for that program year.

The peak demand impacts from DR in this report are presented at the system level and reflect adjustments to account for T&D losses. The PA 2016 Technical Reference Manual (TRM) specified the T&D line loss adjustment factors that each EDC must use for Act 129 Phase III.¹⁰ PECO uses the following line loss percentages/multipliers by sector.

- Residential = 7.4% or 1.0799

⁸ PECO voluntarily implemented PY12 DR activities per PA PUC. *Petition to Amend the Commission's June 19, 2015 Implementation Order. M-2014-2424864*. May 21, 2020. <https://www.puc.pa.gov/pcdocs/1665150.docx>

⁹ PA PUC, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (Phase III Implementation Order), entered June 11, 2015.

¹⁰ 2016 PA TRM. *Pennsylvania Public Utility Commission Technical Reference Manual; State of Pennsylvania Act 129 Energy Efficiency and Conservation Program and Act 213 Alternative Energy Portfolio Standards*. Section 1.14 Transmission and Distribution System Losses. June 2016, Errata Update February 2017.

- Small C&I = 7.4% or 1.0799
- Large C&I = 7.4% or 1.0799

Table 6-2 summarizes the demand reductions for each of the DR programs in PECO's EE&C Plan and for the DR portfolio as a whole. Verified gross demand savings are the average performance across all Phase III DR events independent of how many events occurred in a given program year.

Table 6-2. PY12 DR PYVTD Performance by Event

PY	Event Date	Residential DR (MW) ^[1]	Small C&I DR (MW) ^[1]	Large C&I DR (MW)	Portfolio (MW)	Relative Precision at 90% CI
PY12	July 20	30.24	1.08	147.31	178.63	7.5%
PY12	July 27	28.58	0.66	139.01	168.25	8.2%
PY12	July 29	27.48	0.46	150.48	178.42	6.7%
PY12	August 25	23.07	0.90	117.09	141.06	8.4%
PY12	August 27	25.82	0.33	110.17	136.32	9.2%
PYVTD – Average PY12 DR Event Performance (Voluntary)		27.04	0.69	132.81	160.54	7.9%

^[1] For the Residential and Small C&I DR programs, the event performance in PY12 is the average over the 2 hours of curtailment.

Source: Guidehouse analysis

7. Summary of Finances

Section 7 provides an overview of the expenditures associated with PECO's portfolio and the recovery of those costs from ratepayers.

7.1 Program Financials

Program-specific and portfolio total finances for PY12 are shown in Table 7-1. The columns in Table 7-1 and Table 7-2 are adapted from the Direct Program Cost categories in the Commission's EE&C Plan template¹¹ for Phase III. EDC Materials, Labor, and Administration includes costs associated with an EDC's own employees. ICSP Materials, Labor, and Administration includes both the program implementation contractor and the costs of any other outside vendors EDCs employ to support program delivery.

Table 7-1. PYTD Financials

Program	Incentives to Participants and Trade Allies (\$1,000)	EDC Materials, Labor, and Administration (\$1,000)	ICSP Materials, Labor, and Administration (\$1,000)	Total Costs (\$1,000)
Residential EE	\$3,668	\$4,082	\$4,423	\$12,174
Low-Income EE	\$52	\$41	\$1,783	\$1,876
Small C&I EE	\$2,357	\$1,597	\$2,275	\$6,229
Large C&I EE	\$3,115	\$670	\$2,168	\$5,953
CHP	\$0	\$0	\$0	\$0
Residential DR	\$2,373	\$1	\$629	\$3,003
Small C&I DR	\$92	\$0	\$19	\$111
Large C&I DR	\$0	\$1	\$4,990	\$4,991
Common Portfolio Costs ^[1]				\$4,597
Portfolio Total	\$11,658	\$6,392	\$16,287	\$38,935
SWE Costs ^[2]	N/A	N/A	N/A	\$0
Total	\$11,658	\$6,392	\$16,287	\$38,935

^[1] Includes the administrative CSP, tracking system, general administration, and clerical cost; EDC program management; CSP program management; general management; oversight of major accounts; and technical assistance.

^[2] Statewide evaluation costs are outside of the 2% spending cap.

Sources: PECO's eTrack database, CSP tracking data

Table 7-2 shows program-specific and portfolio total finances since the inception of Phase III.

¹¹ <http://www.puc.pa.gov/pcdocs/1372426.doc> Section 10.

Table 7-2. Phase III to Date Financials

Program	Incentives to Participants and Trade Allies (\$1,000)	EDC Materials, Labor, and Administration (\$1,000)	ICSP Materials, Labor, and Administration (\$1,000)	Total Costs (\$1,000)
Residential EE	\$33,762	\$27,953	\$49,255	\$110,970
Low-Income EE	\$1,257	\$1,128	\$32,186	\$34,571
Small C&I EE	\$12,327	\$10,531	\$17,792	\$40,650
Large C&I EE	\$20,093	\$4,353	\$20,629	\$45,075
CHP	\$1,143	\$0	\$93	\$1,236
Residential DR	\$13,393	\$34	\$5,275	\$18,702
Small C&I DR	\$534	\$2	\$152	\$688
Large C&I DR	\$1	\$67	\$18,220	\$18,288
Common Portfolio Costs ^[1]				\$42,950
Portfolio Total	\$82,510	\$44,069	\$143,602	\$313,131
SWE Costs ^[2]	N/A	N/A	N/A	\$700
Total	\$82,510	\$44,069	\$143,602	\$313,831

^[1] Includes the administrative CSP, tracking system, general administration, and clerical cost; EDC program management; CSP program management; general management; oversight of major accounts; and technical assistance.

^[2] Statewide evaluation costs are outside of the 2% spending cap.

Sources: PECO's eTrack database, CSP tracking data

7.2 Cost Recovery

Act 129 allows Pennsylvania EDCs to recover EE&C Plan costs through a cost recovery mechanism. PECO's cost recovery charges are organized separately by four customer sectors to ensure that the electric rate classes that finance the programs are the rate classes that receive the direct energy and conservation benefits. Cost recovery is necessarily tied to the way customers are metered and charged for electric service. Readers should be mindful of the differences between Table 7-3 and Section 2. For example, the low-income customer segment is a subset of PECO's residential tariff(s) and may also include low-income customers in master-metered, multifamily facilities and is, therefore, not listed in Table 7-3.

Table 7-3. EE&C Plan Expenditures by Cost Recovery Category¹²

Cost Recovery Segment	Rate Classes Included	PYTD Spending (\$1,000)	P3TD Spending (\$1,000)
Residential	R, RH, and CAP	\$18,803	\$180,010
Small C&I	GS	\$7,433	\$51,806
Large C&I	PD, HT, and EP	\$12,685	\$81,185
Municipal	SLE, AL, and TLCL	\$15	\$131
Portfolio Total		\$38,935	\$313,130

Source: PECO

¹² Excludes SWE costs.

Appendix A. Participation Counts

Across PECO's portfolio, there are differences in how participation is calculated across solutions and CSPs, ranging from:

- Number of measures sold (see Lighting, Appliances & HVAC – Lighting)
- Number of rebates issued (see Lighting, Appliances & HVAC – Appliances and HVAC)
- Number of unique premises served (see Whole Home)
- Number of orders on distinct days (see Appliance Recycling)
- Number of participants (see Residential New Construction and Behavioral)
- Number of utility accounts served (see Multifamily Targeted Market Segment)
- Number of projects (see Small and Large C&I EE Solutions)

Table A-1 provides an overview of the different participation definitions by program and solution.

Table A-1. Overview of Participation Definitions

Program	Solution	Conservation Service Provider	Participation Definition
Residential	LAH (Lighting)	CLEAResult	Sum number of total lamp packs sold
	LAH (Appliances and HVAC)	CLEAResult	Count of rebates issued
	Whole Home	CLEAResult	Count of unique premise ID
	Appliance Recycling	ARCA	Count of all orders on distinct days
	New Construction	PSD	Sum No. of participants
	Behavioral	Oracle	Sum No. of participants
	Multifamily Targeted Market Segment	Franklin	Distinct count of utility account ID by program, solution, and invoice number
Low-Income	Whole Home	CMC	Count of unique premise numbers for component 1 and 2
	Whole Home	ARCA	Count of all orders on distinct days
	Whole Home	ECA	Count unique premise numbers

Program	Solution	Conservation Service Provider	Participation Definition
Small C&I	Equipment and Systems	ICF	Count of unique project number
	New Construction	ICF	Count of unique project number
	Whole Building	SmartWatt	Count of unadjusted projects
	Multifamily Targeted Market Segment	Franklin	Distinct count of utility account ID by program, solution, and invoice number
Large C&I	Equipment and Systems	ICF	Count of unique project number
	New Construction	ICF	Count of unique project number
	Data Centers Targeted Market Segment	ICF	Count of unique project number
	Multifamily Targeted Market Segment	Franklin	Distinct count of utility account ID by program, solution, and invoice number

Source: Guidehouse analysis

Five solutions and one targeted market segment make up the Residential EE Program: Lighting, Appliances & HVAC Solution, Appliance Recycling Solution, Whole Home Solution, New Construction Solution, Behavioral Solution, and the Multifamily Targeted Market Segment. PECO defined participation counts in each solution as follows:

- For Lighting, Appliances & HVAC, upstream lighting participation is defined as the sum of the SKU sales. A SKU describes a sold lighting product, which can be a single bulb or a multi-pack of bulbs. For the Appliances and HVAC participants, participation is defined as the total number of non-adjusted records in PECO's tracking data with an associated bill account number. A record may represent one or more rebated items (e.g., a single participant purchasing multiple thermostats during the same purchase event).
- For Appliance Recycling, a participant is a customer who schedules a pickup for one or more units. If the same customer initiates multiple pickup orders during the year, each order is counted as an individual participant. However, if a customer initiates more than one order in the same day it counts as a single participant.
- For Residential Whole Home, a participant is considered a unique project number for non-adjusted records with a project type that does not include other installations or central air conditioner (CAC) other installations.
- For Residential New Construction, a participant is a new home.
- For Behavioral, a participant is a utility account included in the program's treatment group.
- For the Multifamily Targeted Market Segment, a participant is a unique combination of utility account ID and invoice number.

Two solutions make up the Low-Income EE Program: Lighting and Whole Home. Low-income participants are those participants with incomes at or below 150% of the FPL. PECO has defined participation counts in each solution as follows:

- The Low-Income Lighting Program was discontinued in PY9. For Phase III, participation is defined as a package of one or more light bulbs identified by a unique SKU number. As in the Residential EE Program, a SKU describes a sold lighting product that can be a single bulb or a multi-pack of bulbs.
- For Low-Income Whole Home, a participant is considered:
 - Free Home Energy Checkups and Low-Income Usage Reduction Program (LIURP): A unique premise number (for both multifamily and single-family audits).
 - Appliance Recycling: A low-income Appliance Recycling customer who schedules pickup for one or more units. If the same customer initiates multiple pickup orders during the year, each order is counted as an individual participant. However, if a customer initiates more than one order in the same day it counts as a single participant.
 - Product giveaways are also part of the Whole Home Solution but are not included in the participant count.

Four solutions and two targeted market segments make up the Small C&I EE Program: Equipment and Systems Solution, Whole Building Solution, Behavioral Solution, New Construction Solution, Data Centers Targeted Market Segment, and Multifamily Targeted Market Segment. The Behavioral Solution is not currently active. PECO has defined participation counts in each active solution as follows:

- For Small C&I Equipment and Systems, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For Small C&I Whole Building, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For Small C&I New Construction, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For the Data Centers Targeted Market Segment, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For the Multifamily Targeted Market Segment, participation is defined as an activity with a unique combination of utility account ID and invoice number. More than one measure per participant is permitted. A building may consist of multiple participants with measures installed in the dwellings and common areas of master-metered multifamily buildings.

Two solutions and two targeted market segments make up the Large C&I EE Program: Equipment and Systems Solution, New Construction Solution, Data Centers Targeted Market Segment, and Multifamily Targeted Market Segment. PECO has defined participation counts in each solution as follows:

- For Large C&I Equipment and Systems, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For Large C&I New Construction, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For the Data Centers Targeted Market Segment, participation is defined as an activity with a unique project number. More than one measure per participant is permitted, with the impact sample defined on the project level.
- For the Multifamily Targeted Market Segment, participation is defined as an activity with a unique combination of utility account ID and invoice number. More than one measure per participant is permitted. A building may consist of multiple participants with measures installed in the dwellings and common areas of master-metered multifamily buildings.

The CHP Program consists of the CHP Solution only. PECO has defined participation counts in the solution as follows:

- For CHP, participation is defined as an activity with a unique project number. Projects that consist of multiple prime movers at a single facility are classified as a single project.

Three solutions make up the Residential DR Program; however, only the DLC Solution is currently active. PECO has defined participation counts in the solution as follows:

- For Residential 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 who have opted out of the program, removed the DLC device, or whose accounts were disconnected were not counted as participants.

The Small C&I DR Program consists of the Small C&I DLC Solution. PECO has defined participation counts in the solution as follows:

- For Small C&I 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 PCT (programmable communicating thermostat). One participant may have more than one DLC device installed on the premise. Customers that have opted out of the program, removed the DLC device, or have disconnected accounts were not counted as participants.

The Large C&I DR Program consists of the DRA Solution. PECO has defined participation counts in the solution as follows:

- For DRA, a participant is defined as a large C&I customer (defined by PECO account number) enrolled with a DR program CSP for at least 1 hour of at least one event occurring in any given program year.

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Annual Report to the Pennsylvania Public Utility Commission Phase III of Act 129 – Demand Response Performance Only

Program Year 12
(June 1, 2020 – May 31, 2021)

For Pennsylvania Act 129 of 2008
Energy Efficiency and Conservation Plan

Prepared for:



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March 15, 2021

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Acronyms

AMI	Advanced Metering Infrastructure
C&I	Commercial and Industrial
CACS	Central Air Conditioner Switch
CBL	Customer Baseline
CDH	Cooling Degree Hours
CSP	Curtailement Service Provider
DLC	Direct Load Control
DR	Demand Response
DRA	Demand Response Aggregator
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
G/E/NP	Government, Educational, and Nonprofit
HOT	Hold-Out Test
kW	Kilowatt
kWh	Kilowatt-hour
LMP	Locational Marginal Price
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-hour
NTG	Net-to-Gross
P3TD	Phase III to Date
PA PUC	Pennsylvania Public Utility Commission
PLC	Programmable Communicating Thermostat
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
RMSE	Root Mean Squared Error
RPPM	Regression with Preprogram Matching
RR	Realization Rate
RTD	Phase III to Date Reported Gross Savings
RTO	Regional Transmission Organization
SWE	Statewide Evaluator
T&D	Transmission and Distribution

TRM	Technical Reference Manual
VTD	Phase III to Date Verified Gross Savings

1. Introduction

Pennsylvania Act 129 of 2008, signed on October 15, 2008, mandated energy savings and demand reduction goals for the largest electric distribution companies (EDCs) in Pennsylvania for Phase I (2008 through 2013). Phase II of Act 129 began in 2013 and concluded in 2016. In late 2015, each EDC filed a new energy efficiency and conservation (EE&C) plan with the Pennsylvania Public Utilities Commission (PA PUC) detailing the proposed design of its portfolio for Phase III. These plans were updated based on stakeholder input and subsequently approved by the PA PUC in 2016. Phase III of Act 129 includes a demand response (DR) goal for PECO.

Implementation of Phase III of the Act 129 programs began on June 1, 2016. DR events are limited to the months of June through September, which are the first 4 months of the Act 129 program year. Because the DR season is completed early in the program year, it is possible to complete the independent evaluation of verified gross savings for DR sooner than is possible for energy efficiency (EE) programs.

PECO has retained Guidehouse Inc. (Guidehouse) as an independent evaluation contractor for Phase III of Act 129. Guidehouse is responsible for the measurement and verification (M&V) of the savings and calculation of gross verified and net verified savings. This report documents the progress and effectiveness of the Phase III DR accomplishments for PECO in program year 12 (PY12) and the cumulative accomplishments of the Phase III DR programs since inception.

This report details the participation, evaluation methodology, reported gross, and verified gross impacts of PECO's DR programs in PY12. Compliance with Act 129 savings goals are ultimately based on verified gross savings.

2. DR Program Evaluation Results

Act 129 defines peak demand savings from DR as the average reduction in electric demand during the hours when a DR event is initiated. Phase III DR events are initiated according to the following guidelines:¹

- Curtailment events shall be limited to the months of June through September.
- Curtailment events shall be called for the first 6 days of each program year (starting in PY9) in which the peak hour of PJM’s day-ahead forecast for the PJM regional transmission organization (RTO) is greater than 96% of the PJM RTO summer peak demand forecast for the months of June through September.
- AC Saver curtailment events were 2 hours for PY12² and LCI events were 4 hours.
- Each curtailment event shall be called such that it occurs during the day’s forecast peak hour(s) above 96% of the PJM RTO summer peak demand forecast.
- Once six curtailment events have been called in a program year, the peak demand reduction program shall be suspended for that program year.

The peak demand impacts from DR are presented at the system level and reflect adjustments to account for transmission and distribution (T&D) losses. PECO uses the following line loss multipliers by sector.³

- Residential = 107.99%
- Small Commercial and Industrial (C&I) = 107.99%
- Large C&I = 107.99%

For Phase III, PECO calls event days when the PJM day-ahead peak load forecast reaches 96%. Based on the day-ahead forecasts, PECO called five events during the summer of 2020: July 20, July 27, July 29, August 25, and August 27.

2.1 Phase III DR Achievements to Date

PECO’s Phase III DR performance target is 161 MW. Compliance targets for DR programs are based on average performance across events and were established at the system level. This means the load reductions measured at the customer meter must be escalated to reflect T&D losses.

In PY12, PECO called five DR events. Table 2-1 lists the days PECO called DR events and the verified gross demand reductions achieved by each event. Table 2-1 also presents the average DR performance for PY9-PY11, PY12, and Phase III to date (P3TD). PECO’s average PY9-

¹ PA PUC, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864 (*Phase III Implementation Order*), entered June 11, 2015.

² PECO voluntarily implemented PY12 DR activities per PA PUC. *Petition to Amend the Commission’s June 19, 2015 Implementation Order. M-2014-2424864*. May 21, 2020. <https://www.puc.pa.gov/pcdocs/1665150.docx>

³ PA PUC, *Technical Reference Manual; State of Pennsylvania Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards*, Section 1.14, “Transmission and Distribution System Losses,” dated June 2016, errata update February 2017.

PY11 DR performance is 167.13 MW, which exceeds the Phase III compliance reduction target of 161 MW by 4% (104% of target achieved to date).

Table 2-1. Phase to Date DR Performance by Event

PY	Event Date	Residential DR (MW)	Small C&I DR (MW)	Large C&I DR (MW) ^[1]	Portfolio (MW)	Relative Precision at 90% Confidence
PY9	June 13, 2017	39.53	0.00	127.97	167.50	10.9%
PY9	July 20, 2017	33.48	0.00	121.89	155.37	11.0%
PY9	July 21, 2017	23.34	0.00	140.83	164.17	10.3%
PY10	July 2, 2018	38.93	0.00	149.25	188.18	10.2%
PY10	July 3, 2018	33.84	0.00	144.67	178.51	10.7%
PY10	August 6, 2018	25.07	1.15	175.12	201.34	10.6%
PY10	August 28, 2018	30.69	0.92	159.52	191.12	11.3%
PY10	September 4, 2018	29.99	0.77	137.79	168.55	11.4%
PY10	September 5, 2018	29.52	0.84	129.54	159.91	11.9%
PY11	July 17, 2019	34.36	0.86	120.04	155.26	6.1%
PY11	July 18, 2019	11.06	1.02	121.63	133.71	5.9%
PY11	July 19, 2019	34.93	1.18	120.89	157.00	5.8%
PY11	August 19, 2019	24.90	0.98	126.17	152.05	5.6%
PY12	July 20, 2020	30.24	1.08	147.31	178.63	7.5%
PY12	July 27, 2020	28.58	0.66	139.01	168.25	8.2%
PY12	July 29, 2020	27.48	0.46	150.48	178.42	6.7%
PY12	August 25, 2020	23.07	0.90	117.09	141.06	8.4%
PY12	August 27, 2020	25.82	0.33	110.17	136.32	9.2%
PYVTD – Average PY12 DR Event Performance		27.04	0.69	132.81	160.54	7.9%
PY9-PY11 – Average Phase III DR Event Performance (Compliance)		29.97	0.59	136.56	167.13	10.0%
P3TD – Average Phase III DR Event Performance		29.16	0.62	135.52	165.30	9.5%

^[1] Verified impacts for the Large C&I DR Program for PY9, PY10, and PY11 have been revised based on corrected interval data provided by PECO. In January 2020, PECO notified Guidehouse of potential issues with the interval data provided for the PY9 through PY11 evaluations, where certain data may not represent actual consumption because of unique meter configurations at different participant sites. After a review of all sites and activities to date, the evaluation team found that 16, 25, and six sites were affected in PY9, PY10, and PY11, respectively. At the request of PECO and in consultation with the Statewide Evaluator (SWE), Guidehouse applied evaluation methods prescribed for PY11 to revise verified impacts for the affected sites; impacts for unaffected sites remain unchanged. These revisions increased the PY9-PY11 average performance by 1.6 MW (1.0%).

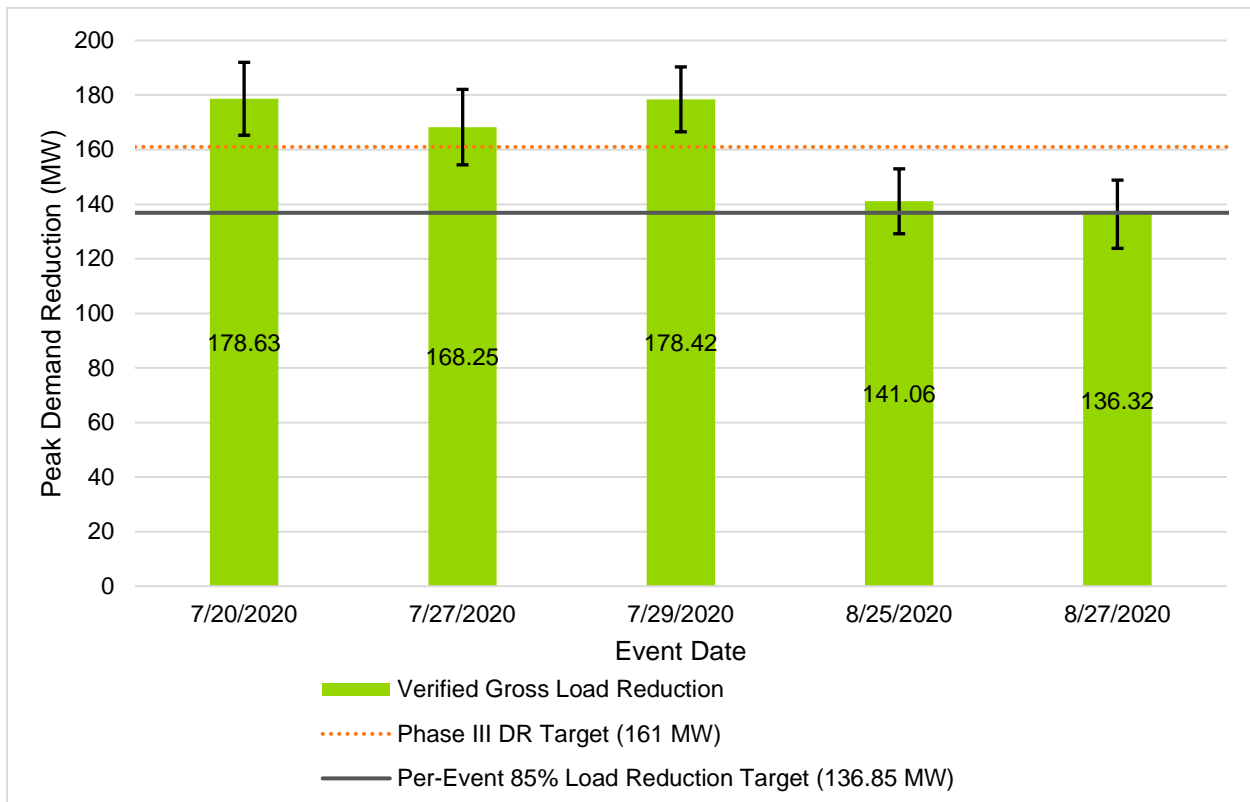
Source: Guidehouse analysis

The PA PUC'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. For PECO,

this translates to a 136.85 MW minimum for each DR event. Figure 2-1 compares the performance of each of the DR events in PY12 to the event-specific minimum and average targets. The error bars in this figure represent the margin of error for the verified gross load reduction, calculated per the protocols specified in the Phase III Evaluation Framework.⁴

Table 2-2 presents the margins of error. PECO exceeded the 85% minimum target for all events in PY12 except for the final event on August 27, 2020. The August 27 event fell short of the 85% minimum by 0.5 MW, which appears to be driven by decreased curtailment from large C&I customers compared with the three July events. The 85% minimum target is within the margin of error of the verified impacts for the final event.

Figure 2-1. PY12 DR Event Performance Compared to 85% Per-Event Target



Source: Guidehouse analysis

⁴ NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC, *Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs*, prepared for the Pennsylvania Public Utility Commission, http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf.

Table 2-2. PY12 DR Event Performance with Margin of Error

Event Date	Verified Gross Load Reduction (MW)	Margin of Error (MW)	Margin of Error Upper Value (MW)	Margin of Error Lower Value (MW)
July 20, 2020	178.63	13.36	192.00	165.27
July 27, 2020	168.25	13.83	182.08	154.42
July 29, 2020	178.42	11.89	190.31	166.53
August 25, 2020	141.06	11.90	152.96	129.16
August 27, 2020	136.32	12.50	148.82	123.82

Source: Guidehouse analysis

2.2 Summary of DR Participation by Program

Participation is defined differently for certain programs depending on the program delivery channel and data tracking practices. Table 2-3 provides the participation totals for PY12 and Phase III.

Table 2-3. EE&C Portfolio DR Participation by Program

Program Name	Program Year					
	PY8	PY9	PY10	PY11	PY12	P3TD
Residential DR	61,440	60,846	56,030	53,924	50,919	61,440 ^[1]
Small C&I DR	1,586	1,564	1,427	1,312	1,517	1,586 ^[1]
Large C&I DR	-	261	348	340	356	356 ^[1]
Portfolio Total	63,026	62,671	57,805	55,576	52,792	63,382

^[1] 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.

Source: Guidehouse analysis

The nuances of the participant definition vary by program or solution and are included in the following sections.

2.2.1 Residential DR Program

The Residential DR Program consists of the Residential Direct Load Control (DLC) Solution. For Residential 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 who have opted out of the program, removed the DLC device, or whose accounts were disconnected were not counted as participants.

2.2.2 Small C&I DR Program

The Small C&I DR Program consists of the Small C&I DLC Solution. For Small C&I 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 PCT (programmable communicating thermostat). One participant may have more than one DLC device installed on the premise. Customers that have opted out of the program, removed the DLC device, or have disconnected accounts were not counted as participants.

2.2.3 Large C&I DR Program

The Large C&I DR Program consists of the Demand Response Aggregator (DRA) Solution. For DRA, a participant is defined as a Large C&I customer (defined by PECO account number) enrolled with a DR program curtailment service provider (CSP) for at least 1 hour of at least one event occurring in any given program year.

2.3 Summary of Impact Evaluation Results

Table 2-4 summarizes the realization rates (RRs) and net-to-gross (NTG) ratios by program or evaluation initiative. EE program information for this section will be included in the PY12 Annual Report filed in November 2021.

Table 2-4. DR Impact Evaluation Results Summary

Program Name	Parameter	Program Year					
		PY8	PY9	PY10	PY11	PY12	P3TD
Residential DR	Energy RR	N/A	N/A	N/A	N/A	N/A	N/A
	Demand RR	N/A	N/A	N/A	N/A	N/A	N/A
	NTG Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Small C&I DR	Energy RR	N/A	N/A	N/A	N/A	N/A	N/A
	Demand RR	N/A	N/A	N/A	N/A	N/A	N/A
	NTG Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Large C&I DR	Energy RR	N/A	N/A	N/A	N/A	N/A	N/A
	Demand RR	N/A	1.24	1.29	1.01	1.04	1.14
	NTG Ratio	1.00	1.00	1.00	1.00	1.00	1.00

Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

Table 2-5 summarizes the program year verified to date (PYVTD) and Phase III to date verified gross savings (VTD) demand reductions for each DR program in the EE&C Plan and for the DR portfolio as a whole. VTD demand reductions are the average performance across all Phase III DR events independent of how many events occurred in a given program year. The relative precision columns in Table 2-5 indicate the margin of error (at the 90% confidence interval) around the PYVTD and VTD demand reductions.

Table 2-5. Summary of Demand Savings by DR Program

Parameter	DR Program Name	Program Year					
		PY8	PY9	PY10	PY11	PY12	P3TD
Reported Gross Demand Savings (MW)	Residential	N/A	N/A	N/A	N/A	N/A	N/A
	Small C&I	N/A	N/A	N/A	N/A	N/A	N/A
	Large C&I	N/A	104.80	116.17	121.38	127.82	118.67
	Total	N/A	104.80	116.17	121.38	127.82	118.67
Verified Gross Demand Savings (MW)	Residential	N/A	32.12	31.34	26.31	27.04	29.16
	Small C&I	N/A	0.00	0.61	1.01	0.69	0.62
	Large C&I	N/A	130.23	149.31	122.18	132.81	135.52
	Total	N/A	162.35	181.27	149.50	160.54	165.30
Relative Precision of Verified Gross Demand Savings at 90% Confidence Interval	Residential	N/A	6%	3%	3%	3%	4%
	Small C&I	N/A	N/A	16%	27%	19%	31%
	Large C&I	N/A	13%	13%	7%	10%	12%
	Total	N/A	11%	11%	6%	8%	9%

Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

2.4 Summary of Cost-Effectiveness Results

A detailed breakdown of program finances and cost-effectiveness will be presented in the PY12 Annual Report filed in November 2021, once full program year expenditures are complete.

2.5 Findings and Recommendations

PECO's DR programs are ending after the PY12 season. Therefore, Guidehouse is not making recommendations to address in future seasons.

2.6 Residential DR Program

The PECO Residential DR Program encompassed opportunities designed to engage customers in demand reduction. The eligible population and target markets for the PECO Residential DR Program were all PECO residential electric customers. The program encompassed three solutions: Residential DLC, Smart Thermostats for DR Savings, and Behavioral DR Savings. Only the Residential DLC Solution was active.

The Residential DLC Program was implemented by Itron. It was designed to shift participant loads from peak to off-peak hours by cycling their central air conditioner during DR events by 50%. The summer DR events had over 50,000 residential participants. In PY12, participants received an incentive of \$40 per DLC unit per year.

2.6.1 Gross Impact Evaluation

For the Residential DR Program, the evaluation team used a technique known as regression with preprogram matching (RPPM) to estimate demand savings. This method is described as follows.

Billing analysis employs econometric regression methods to estimate the net demand savings from the program by using hourly or sub-hourly advanced metering infrastructure (AMI) data. The 2016 Technical Reference Manual (TRM) specifies that billing analysis based on an experimental design (e.g., randomized control trials, or RCTs) is the preferred method to evaluate impacts from residential DR programs. This method is not feasible for the Residential DLC Program during Phase III because the program was launched in Phase I and all participants in that program were enrolled without randomization or the creation of a control group.

Thus, Guidehouse chose a comparison group analysis, a form of quasi-experimental design, to verify achievement of the Phase III demand reduction targets as outlined in the 2016 PA TRM. A comparison group analysis, also referred to as RPPM, uses loads from a group of nonparticipating customers and matches them to similar participating customers with respect to observable characteristics—e.g., non-event weekday consumption.

In program evaluation, the basic logic of matching is to balance the participant and nonparticipant samples by matching on the exogenous covariates known to have a high correlation with the outcome variable. Doing so increases the efficiency of the estimate and reduces the potential for model specification bias.

Formally, the argument⁵ is that if the outcome variable Y is independently distributed conditional on X and D (conditional independence assumption), where X is a set of exogenous variables and D is the program variable, then the analyst can gain some power in the estimate of savings. The analyst can also reduce potential model specification bias by assuring that the distribution of X is the same for treatment and control observations.

Regression analysis is used to control for remaining nonprogram differences between participants and their matches during the event and snapback (post-event) periods. In this context, developing a matched control group is a useful preprocessing step in a regression analysis and assures that the distributions of the covariates (i.e., the explanatory variables on which the output variable depends) for the treatment group are the same as those for the comparison group that provides the baseline measure of the output variable. Typically, the control variables that have the highest correlation with a customer's energy use during the evaluation period—and thus, the primary variables for matching—represent the customer's energy use in a similar period in the past.

⁵ Daniel Ho, Kosuke Imai, Gary King, and Elizabeth Stuart, "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference," *Political Analysis*, Volume 15 (2007): 199-236.
Alberto Abadie. and Guido W. Imbens, "Bias-Corrected Matching Estimators for Average Treatment Effects," *Journal of Business and Economic Statistics*, Volume 29 (2011): 1-11.

2.6.1.1 Matching Period Identification

Guidehouse determined the period for which participant and nonparticipant consumption values were compared to select matches. To do so, the evaluation team selected the non-event, non-holiday weekdays with the most similar temperature profiles to each of Act 129’s five event days in PY12 as the matching days. The team compared the hourly dry-bulb temperature profile of each event day to those of all non-event, non-holiday weekdays in summer 2020 (June through September). The non-event, non-holiday weekday with a temperature profile that had the shortest Euclidean distance from the given event day was selected as the match for that event day. Guidehouse conducted matching with replacement, allowing for the same non-event day may be paired up with more than one event day. Table 2-6 outlines the selected non-event match day for each of the five event days.

Table 2-6. Residential DR Program Selected Match Days

Event Day	Matched Non-Event Day
July 20, 2020	July 21, 2020
July 27, 2020	July 21, 2020
July 29, 2020	July 28, 2020
August 25, 2020	August 10, 2020
August 27, 2020	July 2, 2020

Source: Guidehouse analysis

2.6.1.2 Data Cleaning

Before selecting the matches, the evaluation team conducted the data cleaning steps outlined in Table 2-7 for participants and the potential nonparticipant matches. Guidehouse attributed savings to 50,919 participants. After data cleaning, 46,940 were included in the team’s analysis, representing 92% of the participants’ attributed savings.

Table 2-7. Residential DR Program Data Cleaning

Cleaning Level	Cleaning Steps
Meter (Customer Account, Premise, and Meter ID)	<ul style="list-style-type: none"> Remove customer meters with any observation of more than 20 kW in a single hour Remove customer meters with any observation of less than -20 kW in a single hour Remove customer meters where more than 50% of the observations are 0 kW
Customer (Customer Account and Premise ID)	<p>After aggregating across meters for the same customer:</p> <ul style="list-style-type: none"> Remove customers with any observation of more than 20 kW in a single hour Remove customers with any observation of less than -20 kW in a single hour Remove customers where more than 50% of the observations are 0 kW Remove customers with mean kilowatt usage greater than the 99th percentile of kilowatt usage across all customers Remove customers with mean kilowatt usage less than the 1st percentile of kilowatt usage across all customers

Cleaning Level	Cleaning Steps
Customer by Day (Customer Account and Premise ID by Day)	<ul style="list-style-type: none"> Remove days with more or less than 24 observations Remove days with more observations of 0 kW than the 99th percentile of 0 kW readings in a day across all customers

Source: Guidehouse analysis

2.6.1.3 Selecting Matched Controls

For a given participant, the nonparticipant whose average hourly consumption patterns on the matching period days had the shortest Euclidean distance from the participant was selected as that participant’s match. That is, participants were matched based on a vector of 24 average hourly consumption values, and the same match was used for a given participant across all five event days. Participants and nonparticipants missing data in their hourly matching day load profile were excluded from the algorithm.

The evaluation team conducted matching with replacement: one nonparticipant could act as a match for multiple participants. If a nonparticipant was used as a control for multiple participants, that nonparticipant’s data was included in the estimation set as many times as participants for which it acted as a control—i.e., if a nonparticipant was selected as a control customer for three participants, that customer’s data appeared three times in the estimation set.

2.6.1.4 Regression Model

Once the matched control group was established, the next step was to predict the baseline energy use for participants for the hours corresponding to each DLC event period. The team estimated hourly impacts using regression analysis, which implicitly estimates impacts as the difference between the estimated baseline and the observed actuals.

Equation 2-1 shows the lagged dependent variable model regression equation. This model estimates customer load as a function of the event hours, snapback effect in post-event hours, lagged non-event day usage, and hourly fixed effects. Only event day data was included in the regression model, although matched non-event day data informs the baseline through the lagged usage (*prekW*) variable.

Equation 2-1. Residential Lagged Dependent Variable Regression

$$y_{i,d,t} = \sum_{e=1}^E \sum_{h=1}^{H=24} \beta_{1,e,h} E_{e,t} \text{hour}_{h,t} + \sum_{h=1}^{H=24} \beta_{2,h} \text{hour}_{h,t} \text{prekW}_{i,t,e} + \sum_{e=1}^E \sum_{c=1}^C \gamma_{1,e,c} E_{e,t} C_{i,c,t} + \sum_{e=1}^E \sum_{s=1}^S \gamma_{2,e,s} E_{e,t} SB_{i,s,t} + \varepsilon_{i,t}$$

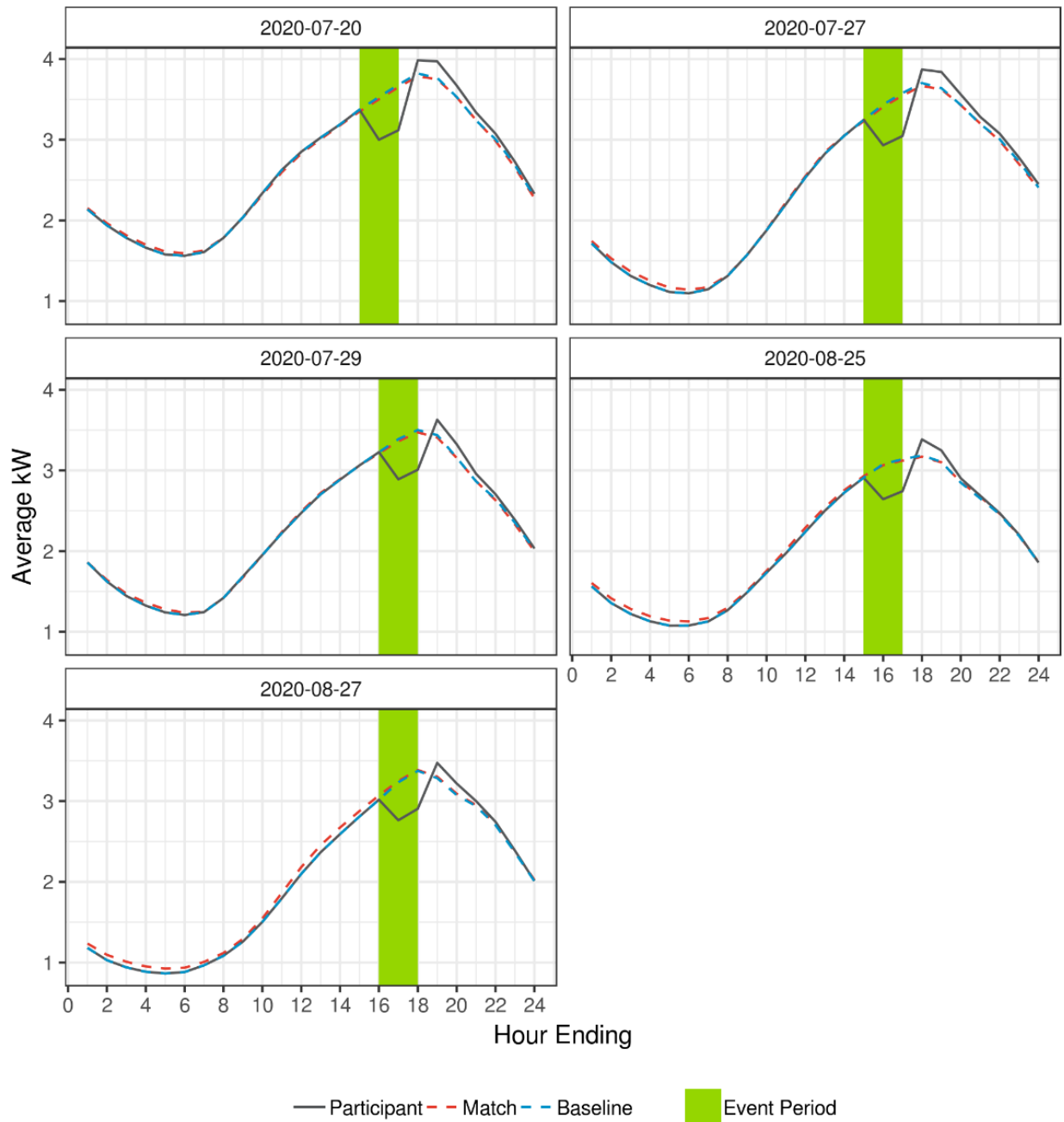
Where:

- i* = Customer.
- d* = Day.
- t* = Hour-ending.
- y_{i,d,t}* = Hourly demand for customer *i* during hour-ending *t* on day *d*.
- E_{e,t}* = A set of E dummy variables, one for each event day.

- $hour_{h,t}$ = A set of 24 dummy variables, each equal to 1 when t is the h -th hour of the day and 0 otherwise. This is a time-wise fixed effect.
- $prekW_{i,t,e}$ = Customer i 's hourly consumption in the matching period that corresponds to hour t of the matched event day.
For example, if hour t is hour-ending 13 on the first Act 129 day, then this variable would take the value of that same customer's consumption in hour-ending 13 of the corresponding non-event day used for matching purposes.
- $C_{i,c,t}$ = A set of C dummy variables, capturing the impacts of event curtailment. Each variable is equal to 1 when customer i is a DR participant and hour t is the c -th curtailment hour of the event, and 0 otherwise.
- $SB_{i,s,t}$ = A set of S dummy variables, capturing the impacts of snapback. Equivalent to the $C_{i,c,t}$ except that they apply to the hours following the event rather than during the event. Guidehouse applied these variables to all hours following the end of the curtailment event up to midnight of the event day.
- β, γ = Parameter estimates. These values are the estimated relationship between demand and the variable for which the beta represents.

Figure 2-2 compares the average estimated baseline (blue dashed), the actual loads (solid black), and the matched nonparticipant loads (red dashed) for all customers and illustrates the reduction in load in each hour of the event period.

Figure 2-2. PY12 Residential DR Average Actual Load and Estimated Baseline Load by Event



Source: Guidehouse analysis

Table 2-8 provides the sampling frame for the gross impact evaluation of the Residential DR Program in PY12.

Table 2-8. Residential DR Program Gross Impact Sample Design for PY12

Stratum Solution	Stratum Name	Percentage of Program Reported Savings	Population Size	Achieved Sample Size	Verification Method
Total Program	Residential	92%	50,919	46,940	RPPM

Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

Table 2-9 summarizes reported and verified demand (MW) savings results, along with the relative precision for each stratum sampled for the Residential DR Program in PY12. The evaluation team calculated the relative precision per the protocols specified in the Phase III Evaluation Framework.⁶

Table 2-9. Residential DR Program Gross Demand Savings Impact Evaluation Results for PY12

Stratum Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Relative Precision at 90% Confidence Interval
Total Program	Residential	N/A	27.04	N/A	3%

Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

The verified gross demand savings of 27.04 MW represents 72% of the expected savings (37.5 MW) for the Residential DLC Solution in PECO’s Phase III EE&C Plan. The following are possible factors that led to the lower-than-expected verified savings:

- Some residential air conditioners may have been replaced and the DLC switch not reconnected to the new appliance.
- Some switches may be malfunctioning, reducing the overall average impact per customer.
- Some percentage of customers may have turned off or uninstalled their switch to avoid being curtailed altogether.

2.7 Small C&I DR Program

PECO designed its Small C&I DR Program to achieve demand reductions at times of system peak by curtailing space cooling loads. The eligible population and target markets for the Small C&I DR Program were all PECO small C&I customers; this included customers in the Government, Educational, and Nonprofit (G/E/NP) sector. The program encompassed a single solution: the DLC Solution.

⁶ NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC, *Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs*, prepared for the Pennsylvania Public Utility Commission, http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf.

The Small C&I DLC Solution was implemented by Itron. The program shifted load to off-peak hours by cycling participant air conditioners by 50% during DR event days. The summer DR events had over 1,500 small C&I participants. In PY12, participants received an incentive of \$40 per DLC unit per year.

2.7.1 Gross Impact Evaluation

For the Small C&I DR Program, the Phase III Evaluation Plan⁷ aligned the Small C&I model as closely as possible with the Residential model. However, the pool of small C&I participants and nonparticipants were more heterogenous, making it difficult to perform matching. Therefore, Guidehouse employed a within-subjects approach with a fixed-effects model, as used throughout Phase III. The two approaches differ in their construction of the estimated baseline. For the Residential sector, the estimated baseline was derived from the event day consumption patterns of nonparticipating customers, whereas for the Small C&I sector, the estimated baseline was derived from the non-event day consumption patterns of the participants themselves.

2.7.1.1 Data Cleaning

Before running the regression, Guidehouse conducted the data cleaning steps outlined in Table 2-10. The evaluation team attributed savings to 1,517 participants. After data cleaning, 1,356 were included in the team’s analysis, representing 89% of the participants’ attributed savings.

Table 2-10. Small C&I DR Program Data Cleaning

Cleaning Level	Cleaning Steps
Meter (Customer Account, Premise, and Meter ID)	<ul style="list-style-type: none"> Remove customer meters with any observation of more than 600 kW in a single hour Remove customer meters with any observation of less than -20 kW in a single hour Remove customer meters where more than 50% of the observations are 0 kW
Customer (Customer Account and Premise ID)	<p>After aggregating across meters for the same customer:</p> <ul style="list-style-type: none"> Remove customers with any observation of more than 600 kW in a single hour Remove customers with any observation of less than -20 kW in a single hour Remove customers where more than 50% of the observations are 0 kW Remove customers with mean kilowatt usage greater than the 99th percentile of kilowatt usage across all customers Remove customers with mean kilowatt usage less than the 1st percentile of kilowatt usage across all customers
Customer by Day (Customer Account and Premise ID by Day)	<ul style="list-style-type: none"> Remove days with more or less than 24 observations Remove days with more observations of 0 kW than the 99th percentile of 0 kW readings in a day across all customers

Source: Guidehouse analysis

2.7.1.2 Within-Subjects Regression

When developing the counterfactual (baseline) from a separate population in a program is not possible, a within-subjects approach using an individual’s usage on non-event weekdays can be

⁷ PECO. *Phase III Evaluation Plan, Energy Efficiency and Conservation Portfolio*. Revised March 3, 2020.

used to estimate the counterfactual (the baseline). Guidehouse selected a subset of available data to create a sample of non-event weekdays and customers that best represent usage on event days. For each event, the evaluation team found the non-event day with the most similar hourly temperature profiles based on Euclidean distance.⁸

Table 2-11 shows the event days and matched non-event days included in the model. The non-event days could be matched to more than one event day, but the data was not duplicated for that day in the regression model. Overall, the model included the five event days and four unique non-event dates.

Table 2-11. Small C&I DR Program Selected Match Days

Event Day	Matched Non-Event Day
July 20, 2020	July 21, 2020
July 27, 2020	July 21, 2020
July 29, 2020	July 28, 2020
August 25, 2020	August 10, 2020
August 27, 2020	July 2, 2020

Source: Guidehouse analysis

Equation 2-2 shows the within-subjects regression equation. This model estimates customer load as a function of the event hours, cooling degree hours (CDH), normalized heat buildup, and snapback effect in post-event hours.

Equation 2-2. Small C&I Within-Subjects Regression

$$y_{i,d,t} = \sum_{h=1}^{H=24} \beta_{1,h} hour_{h,t} + \sum_{i=1}^I \beta_{2,i} I_i + \sum_{e=1}^E \beta_{3,e} E_{e,t} + \sum_{e=1}^E \sum_{c=1}^C \gamma_{1,e,c} E_{e,t} C_{i,c,t} + \sum_{e=1}^E \sum_{s=1}^S \gamma_{2,e,s} E_{e,t} SB_{i,s,t} + \beta_4 cdh_{i,t} + \beta_5 hbu_{i,t} + \varepsilon_{i,t}$$

Where:

- i = Customer.
- d = Day.
- t = Hour-ending.
- $y_{i,d,t}$ = Hourly demand for customer i during hour-ending t on day d .
- $hour_{h,t}$ = A set of 24 dummy variables, each equal to 1 when t is the h -th hour of the day and 0 otherwise. This is a time-wise fixed effect.
- I_i = A set of indicator variables equal to 1 when the sample is for customer i and 0 otherwise. These are customer fixed effects.
- $E_{e,t}$ = A set of E dummy variables, one for each event day.
- $C_{i,c,t}$ = A set of C dummy variables, capturing the impacts of event curtailment. Each variable is equal to 1 when customer i is a DR participant and hour t is the c -th curtailment hour of the event, and 0 otherwise.

⁸ Guidehouse tested including up to three non-event days for each event but found it resulted in a worse estimate of baseline usage from the regression.

- $SB_{i,s,t}$ = A set of S dummy variables, capturing the impacts of snapback. Equivalent to the $C_{i,c,t}$ except that they apply to the hours following the event rather than during the event. Typically, no snapback is observed for Small C&I air conditioning cycling programs, but this term is included to verify that assumption. Guidehouse applied these variables to all hours following the end of the curtailment event up to midnight of the event day.
- $cdh_{i,t}$ = The number of cooling degree hours during hour-ending i . The base for this calculation is 65°F.
- $hbu_{i,t}$ = The normalized heat buildup term during hour-ending i . Normalized heat buildup is calculated as follows:

$$HeatBuildup = \frac{\sum_1^{72} (0.96)^t * (HeatIndex\ t\ hours\ prior)}{1,000}$$

Heat index is calculated according to the National Oceanic and Atmospheric Administration formula with no adjustment⁹ as:

$$\begin{aligned} Heat\ Index &= -42.379 + 2.04901523 * T + 10.14333127 * RH \\ &- .22475541 * T * RH - .00683783 * T * T - .05481717 * RH \\ &* RH + .00122874 * T * T * RH + .00085282 * T * RH * RH \\ &- .00000199 * T * T * RH * RH \end{aligned}$$

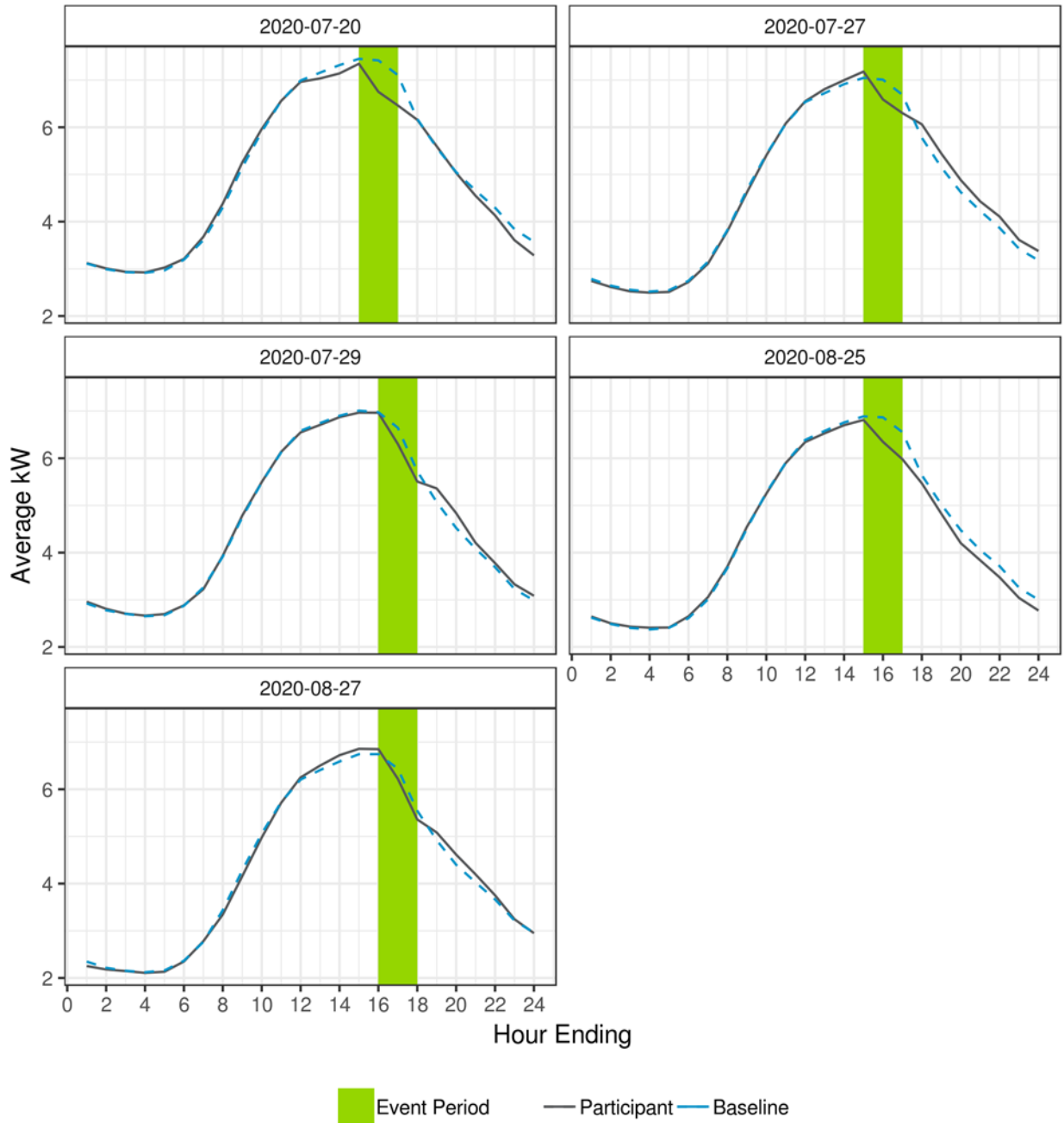
Where T is the dry-bulb temperature in degrees Fahrenheit and RH is relative humidity in percent.

- β, γ = Parameter estimates. These values are the estimated relationship between demand and the variable for which the parameter represents.

Figure 2-3 compares the average estimated baseline (blue dashed) and actual loads (solid black) for all customers and illustrates the reduction in load in each hour of the event period.

⁹ National Weather Service, "The Heat Index Equation," National Oceanic and Atmospheric Administration, http://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml.

Figure 2-3. PY12 Small C&I Average Actual Load and Estimated Baseline Load by Event



Source: Guidehouse analysis

Table 2-12 provides the sampling frame for the gross impact evaluation of the Small C&I DR Program in PY12.

Table 2-12. Small C&I DR Program Gross Impact Sample Design for PY12

Stratum Solution	Stratum Name	Percentage of Program Reported Savings	Population Size	Achieved Sample Size	Verification Method
Total Program	Small C&I	89%	1,517	1,356	Within-Subjects Regression

Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

Table 2-13 summarizes reported and verified demand (MW) savings results, along with the relative precision for each stratum sampled for the Small C&I DR Program in PY12. The evaluation team calculated the relative precision per the protocols specified in the Phase III Evaluation Framework.¹⁰

Table 2-13. Small C&I DR Program Gross Demand Savings Impact Evaluation Results for PY12

Stratum Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Relative Precision at 90% Confidence Interval
Total Program	Small C&I	N/A	0.68	N/A	19%

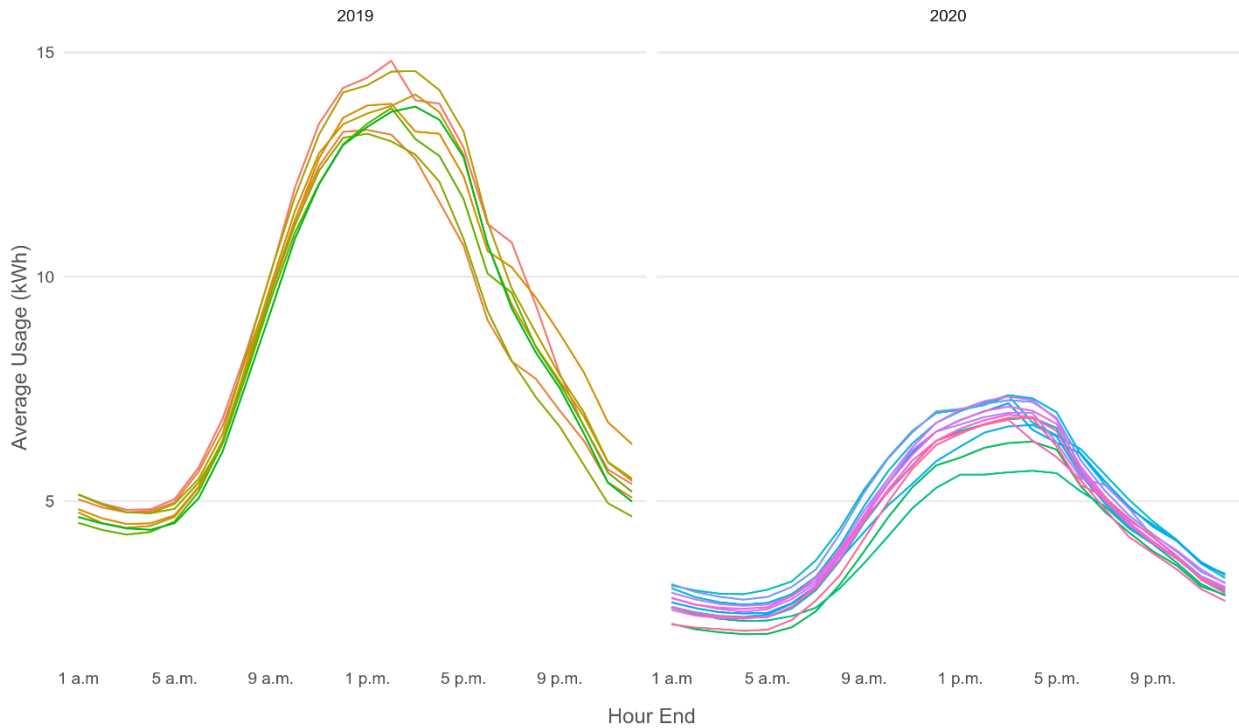
Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

The verified gross demand savings of 0.68 MW represents 57% of the expected savings (1.2 MW) for the Small C&I DLC Solution in PECO’s Phase III EE&C Plan. As Figure 2-4 shows, usage for the Small C&I sector was significantly affected by the coronavirus pandemic in the summer of 2020. Each line in this figure is an event or non-event day from the summer of 2019 (PY11) or 2020 (PY12). Usage in 2020 was approximately half what it was in the summer of 2019.

¹⁰ NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC, *Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs*, prepared for the Pennsylvania Public Utility Commission, http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf.

Figure 2-4. Small C&I DR Average Load Shape Comparison between 2019 and 2020 Event and Selected Non-Event Days



Source: Guidehouse analysis

2.8 Large C&I DR Program

PECO designed the Large C&I DR Program to engage customers in demand reduction through DR aggregation across multiple customers. The eligible population and target markets for the PECO Large C&I DR Program were all PECO large C&I electric customers, including those in the G/E/NP sector. The program encompassed a single solution, the DRA Solution, and was implemented by two CSPs: Enel X and CPower.

2.8.1 Gross Impact Evaluation

Guidehouse implemented a combination approach to estimate gross demand impacts for the Large C&I Program using day-averaging models (customer baselines, or CBLs) and a variety of within-subjects regression (individual customer regressions). The evaluation team applied a testing protocol to select the best method to estimate the baseline for each customer by finding the one that most accurately predicted the actual baseline in an out-of-sample non-event period.

2.8.1.1 Customer Baselines

A CBL is the simple arithmetic mean of loads from the same hour on non-event days. Guidehouse calculated the 12 X-of-Y CBLs listed in Table 2-14. The term X-of-Y indicates that the baseline is delivered by the average event window demand on the X days in which demand was highest within a Y day window. The term X-of-Y days of the same day of week indicates the baseline is delivered by the average event window demand on the X number of prior days falling

with the highest event window demand from within the Y number of days that fall on the same day of the week as the event.

Table 2-14. CBLs Tested

CBL Number	CBL
1	2-of-2
2	2-of-3
3	3-of-3
4	4-of-4
5	5-of-5
6	10-of-10
7	3-of-5
8	4-of-5
9	7-of-10
10	2-of-2 of same day of week
11	3-of-3 of same day of week
12	4-of-4 of same day of week

Source: Guidehouse analysis

Only non-event days occurring prior to the given event day qualified for inclusion in the baseline. Non-event days were limited to those that fit the following conditions:

- A non-event, non-holiday weekday
- Not a day in which the given customer participated in a PJM Economic or Emergency DR event
- Not a day on which the participant was notified of an Act 129 event
- Not a day on which the participant’s facility was closed

Qualifying non-event days are eligible for inclusion in the baseline only if the participant’s average demand between 2 p.m. and 7 p.m. eastern prevailing time¹¹ is more than Z% of average demand in all the qualifying days within the selected Y days baseline window, where Z is defined as a function of the Y number days in the lookback window. Z is set as a decreasing function of Y; as Y increases, Z falls. Z is defined in the following function:

$$Z = \frac{1}{\min\{Y, 6.5\}}$$

This means that when the lookback window (Y) is 2 days, both days average baseline demand must be greater than or equal to half of the average demand across the two periods (i.e., the baseline period with the lower demand must have demand greater than one-third the demand of

¹¹ The 2 p.m.-7 p.m. period was chosen to span the range of hours in which events occurred in PY12.

the other day). When the baseline window (Y) is 4 days, Z is 25%; when the baseline window extends to 7 or more days, the value of Z flattens out at 15%.

Days that failed to meet the eligibility criterion were replaced by the next most proximate previous qualifying and eligible day. If an insufficient number of eligible days were found from within the 30 qualifying days that precede the event, the baseline reverted to the most proximate set of days satisfying the CBL criteria.

2.8.1.2 Regression Models

Guidehouse tested 34 regression model specifications, consistent with the PY11 evaluation. The 34 specifications from PY11 consisted of one base model, 32 combinations of additional variables, and one simplified version of the base model. The base model accounts for a basic set of demand patterns and is specified in Equation 2-3.

Equation 2-3. Large C&I Base Regression Model

$$y_t = \sum_{h=1}^{24} \beta_{h,1} hour_{h,t} + \sum_{m=1}^4 \sum_{h=1}^{24} \beta_{h,m,3} hour_{h,t} Month_{m,t} + \sum_{d=1}^5 \sum_{h=1}^{24} \beta_{h,d,4} hour_{h,t} DoW_{d,t} + \sum_{c=1}^C \gamma_c C_{c,t} + \varepsilon_t$$

Where:

- y_t = The given customer’s demand in hour of sample t .
- $hour_{h,t}$ = 24 dummy variables capturing the hours of the day. Equal to 1 where hour t is the h -th hour of the day and 0 otherwise.
- $Month_{m,t}$ = Four dummy variables capturing the month. Equal to 1 when hour of sample t falls in month m and 0 otherwise.
- $DoW_{d,t}$ = Five dummy variables capturing the day of the week. Equal to 1 when hour of sample t falls in day of the week d and 0 otherwise. Holidays and weekdays are excluded from the estimation set.
- $C_{c,t}$ = C number of dummy variables that capture the individual event periods for which the given customer meter participated.¹² The number of variables ($c = C$) is equal to the number of hourly periods in which the given participant meter elected to participate in Act 129 events.
Equal to 1 when hour of sample t falls in the c -th event hour of the summer of 2020, and 0 otherwise. Each dummy variable takes a value of 1 only once in a given participant’s time series.
- α, β, γ = Are all uniquely estimable parameters of the regression equation estimating (in each case) the conditional mean effect of the variable to which it is attached on the dependent variable y_t .

The additional variables in model specifications include the following:

¹² As per the 2017-04-26 memorandum from the Phase III SWE team (“Frequently Asked Questions Regarding Act 129 Demand Response”), participating meters may elect to participate for only some of the event hours, providing they submit their planned participation prior to the beginning of an event.

- cdh_t = Cooling degree hours (base – 65°F) observed in the hour in which hour t falls. This variable is represented as cdh in Table 2-15.
- $spline_{s,t}$ = A set of S dummy variables acting as a temperature spline to be applied in a manner similar to that outlined in *PJM Manual 19*.¹³ The cdh_t value interacted with the spline (see Table 2-15) in the equation will be the difference between the observed CDH and the lower threshold of the given spline, or 0 (whichever is higher). For example, where s is equal to 2, cdh_t is equal 30, and the spline threshold is equal to 20, $spline_{1,t}$ would take a value of 1 (dummy) and be multiplied by 20, and $spline_{2,t}$ would also take a value of 1 (dummy) and be multiplied by 10 (30 minus 20). A spline break of 23 was determined for all customers based on the distribution of average event window cdh_t values observed in summer under analysis. This set of variables is represented as spline in Table 2-15.
- $EMA6cdh_t$ = An exponential moving average of cdh_t observed in the 6-hour period leading up to, and including, hour t . This variable is represented as ema_6_cdh in Table 2-15.
- $EMA24cdh_t$ = Identical to $EMA6cdh_t$, except for 24, instead of, 6 hours. This variable is represented as ema_24_cdh in Table 2-15.
- $daLMP_t$ = The day-ahead PJM forecast of the locational marginal price (LMP) of power for hour t . This variable is represented as da_lmp in Table 2-15.
- $rtLMP_t$ = The real-time PJM LMP for hour t . This variable is represented as rt_lmp in Table 2-15.

Table 2-15 provides the 32 additional model specifications tested for each participant in addition to the core base model shown in Equation 2-3. All of the variables Table 2-15 shows were added to the core or base model for testing.¹⁴ Interactions of multiple variables are represented as multiplications (e.g., “ $cdh*hour$ ”). The $hour_{q,t}$ variable from Equation 2-3 is represented in the table as “hour,” the $Month_{m,t}$ variable is represented as “month,” and the $DoW_{d,t}$ is represented as “dow.”

Table 2-15. Large C&I Incremental Variables Tested

Spec No.	Var1	Var2	Var3	Var4
1	$cdh*hour$			
2	$cdh*hour*spline$			
3	$cdh*hour$	$ema_6_cdh*hour$		
4	$cdh*hour*spline$	$ema_6_cdh*hour$		
5	$cdh*hour*spline$	$ema_6_cdh*spline$		
6	$cdh*hour$	$ema_24_cdh*hour$		
7	$cdh*hour*spline$	$ema_24_cdh*hour$		
8	$cdh*hour*spline$	$ema_24_cdh*hour*spline$		
9	$cdh*hour$		$hour*month*cdh$	$hour*dow*cdh$

¹³ Resource Adequacy Planning, *PJM Manual 19: Load Forecasting and Analysis Revision 32*, <https://www.pjm.com/-/media/documents/manuals/m19.ashx>.

¹⁴ For example, Spec No. 1 included all the variables listed in Equation 2-3 but would also include an interaction between the hourly dummies and the cooling degree hour term.

Spec No.	Var1	Var2	Var3	Var4
10	cdh*hour*spline		hour*month*cdh	hour*dow*cdh
11	cdh*hour	ema_6_cdh*hour	hour*month*cdh	hour*dow*cdh
12	cdh*hour*spline	ema_6_cdh*hour	hour*month*cdh	hour*dow*cdh
13	cdh*spline*hour	ema_6_cdh*spline	hour*month*cdh	hour*dow*cdh
14	cdh*hour	ema_24_cdh*hour	hour*month*cdh	hour*dow*cdh
15	cdh*hour*spline	ema_24_cdh*hour	hour*month*cdh	hour*dow*cdh
16	cdh*hour*spline	ema_24_cdh*hour*spline	hour*month*cdh	hour*dow*cdh
17	cdh*hour		hour*month*cdh*spline	hour*dow*cdh*spline
18	cdh*hour*spline		hour*month*cdh*spline	hour*dow*cdh*spline
19	cdh*hour	ema_6_cdh*hour	hour*month*cdh*spline	hour*dow*cdh*spline
20	cdh*hour*spline	ema_6_cdh*hour	hour*month*cdh*spline	hour*dow*cdh*spline
21	cdh*spline*hour	ema_6_cdh*spline	hour*month*cdh*spline	hour*dow*cdh*spline
22	cdh*hour	ema_24_cdh*hour	hour*month*cdh*spline	hour*dow*cdh*spline
23	cdh*hour*spline	ema_24_cdh*hour	hour*month*cdh*spline	hour*dow*cdh*spline
24	cdh*hour*spline	ema_24_cdh*hour*spline	hour*month*cdh*spline	hour*dow*cdh*spline
25	da_imp*hour			
26	da_imp*hour	cdh*hour		
27	da_imp*hour	cdh*hour	ema_6_cdh*hour	
28	da_imp*hour	cdh*hour	ema_24_cdh*hour	
29	rt_imp*hour			
30	rt_imp*hour	cdh*hour		
31	rt_imp*hour	cdh*hour	ema_6_cdh*hour	
32	rt_imp*hour	cdh*hour	ema_24_cdh*hour	

Source: Phase III Evaluation Plan¹⁵

The simplified model specification is defined in Equation 2-4 and was added, in consultation with the SWE in PY11, as one that may perform better for certain sites.

Equation 2-4. Large C&I Simple Regression Model

$$y_t = \sum_{h=1}^{24} \beta_{h,1} hour_{h,t} + \sum_{m=1}^4 \beta_{m,3} Month_{m,t} + \sum_{d=1}^5 \beta_{d,4} DoW_{d,t} + \sum_{c=1}^C \gamma_c C_{c,t} + \varepsilon_t$$

Where all terms are defined as in Table 2-15. Data from June through August was included in the regression models. As in the CBL methodology, all 33 regression model specifications in Table 2-15 (the base model and 32 additions) and the simplified base model exclude the following from the estimation dataset:

- Weekends and holidays

¹⁵ PECO, Phase III Evaluation Plan, Energy Efficiency and Conservation Portfolio, Revised March 3, 2020.

- Days in which the given participant also participated in PJM’s Economic or Emergency DR events
- Days on which the participant was notified of an Act 129 event
- Days on which the participant’s facility was closed

PECO provided Guidehouse with program participant operation and maintenance schedules and dates of planned facility closures, where possible. The evaluation team excluded these dates from the estimation dataset. In addition, for all regressions the team tested excluding all non-event days in which the average customer demand during the typical peak period (12 p.m.- 8 p.m. EDT) was in the bottom:

- 10% of the distribution
- 20% of the distribution
- 30% of the distribution
- 40% of the distribution

Guidehouse applied each of these exclusions after the other exclusions. For example, if there were 140 days in the period of interest and 40 were dropped due to the exclusion rules that apply to all regressions, then the bottom 10% of days dropped would be 10 days (10% of 140 minus 40). Thus, for every customer, 170 different sets of parameters were estimated for regression models—34 specifications, once with no additional exclusions and 4 times with different exclusion rules.

2.8.1.3 Model Testing and Selection

The evaluation team implemented a protocol to select the best model for each participant to estimate impacts on all event days. For each participant, the team used the same model to estimate impacts on all event days. The testing and model selection procedure followed the following five steps:

Step 1: Select Hold-Out Test Event Days

The first step was selecting hold-out test (HOT) or simulated event days. The testing protocol ranks the accuracy of the alternative approaches based on how accurately those approaches can predict baseline demand on days when baseline demand is observed (i.e., days on which no Act 129 event occurred).

HOT event days were selected using the PJM day-ahead forecast, specifically the 3 days in the given summer:

- With the highest day-ahead PJM demand forecast
- In which the given participant did not participate in PJM Economic or Emergency DR
- In which there was no apparent response to PJM 5CP pricing¹⁶

¹⁶ Determined through visual inspection and comparison of the candidate day load profile with proximate day profiles. Although 5CP days (5 coincident peak days) are not explicitly dropped when estimating regressions, it is important that they be dropped from HOT event days because leaving them in may bias the model testing process toward a lower, less accurate baseline.

- In which participants did not receive notification of a true Act 129 event

The purpose of these exclusions is to remove the potential confounding effects of other non-baseline customer behavior in reaction to market or program signals. The HOT days selected for one participant may be different from those selected for another participant (e.g., one participant may participate in PJM DR and another may not).

Step 2: Estimate CBLs

For each HOT event and participant pair, the evaluation team estimated a baseline using each of the CBLs nominated for testing. These CBLs were estimated per the qualification and exclusion rules described above. For the purposes of this testing and the qualification rules, only the HOT event day for which the baseline was being calculated was considered an event. This allowed the CBL being tested to still take advantage of the information in proximate, similar non-event days to help develop the baseline.

Step 3: Estimate Regression Baselines

For each HOT event and participant pair, the team estimated a baseline¹⁷ using each of the regression specifications nominated for testing (per Table 2-15) along with the five different sets of exclusions. Each regression was re-estimated 3 times for each customer, once for each HOT Act 129 event independently. When testing each HOT Act 129 event, all other HOT event days were considered non-event days, which allowed the regression being tested to still take advantage of the information in proximate, similar non-event days to help develop the baseline.

Step 4: Calculate Metric for Selection Criterion

Guidehouse calculated the selection criterion metric, root mean squared error (RMSE), for every participant baseline approach pair based on the observed prediction errors during the event window of the HOT event days.

Step 5: Rank Models by Selection Criterion

For each participant, the evaluation team ranked all tested CBLs and regression models by their predictive accuracy. The selected model for each participant was the one with the highest predictive accuracy (lowest RMSE) over all HOT event days.

2.8.1.4 Large Participants

Guidehouse investigated 20 large customers that account for over 50% of the expected demand response. In consultation with PECO and the SWE, the evaluation team looked at individual load patterns for these participants to determine if adjustments to the methodology would yield a more accurate model. Based on this investigation and discussions with the SWE, the team made common sense adjustments for two large customers. These adjustments included dropping certain data due to known metering issues and altering the model specification to account for idiosyncratic use patterns.

¹⁷ In this case, the baseline is defined by the predicted values output by the estimated equation when the variable values for the event dummy variables $C_{(c,t)}$ are set to 0.

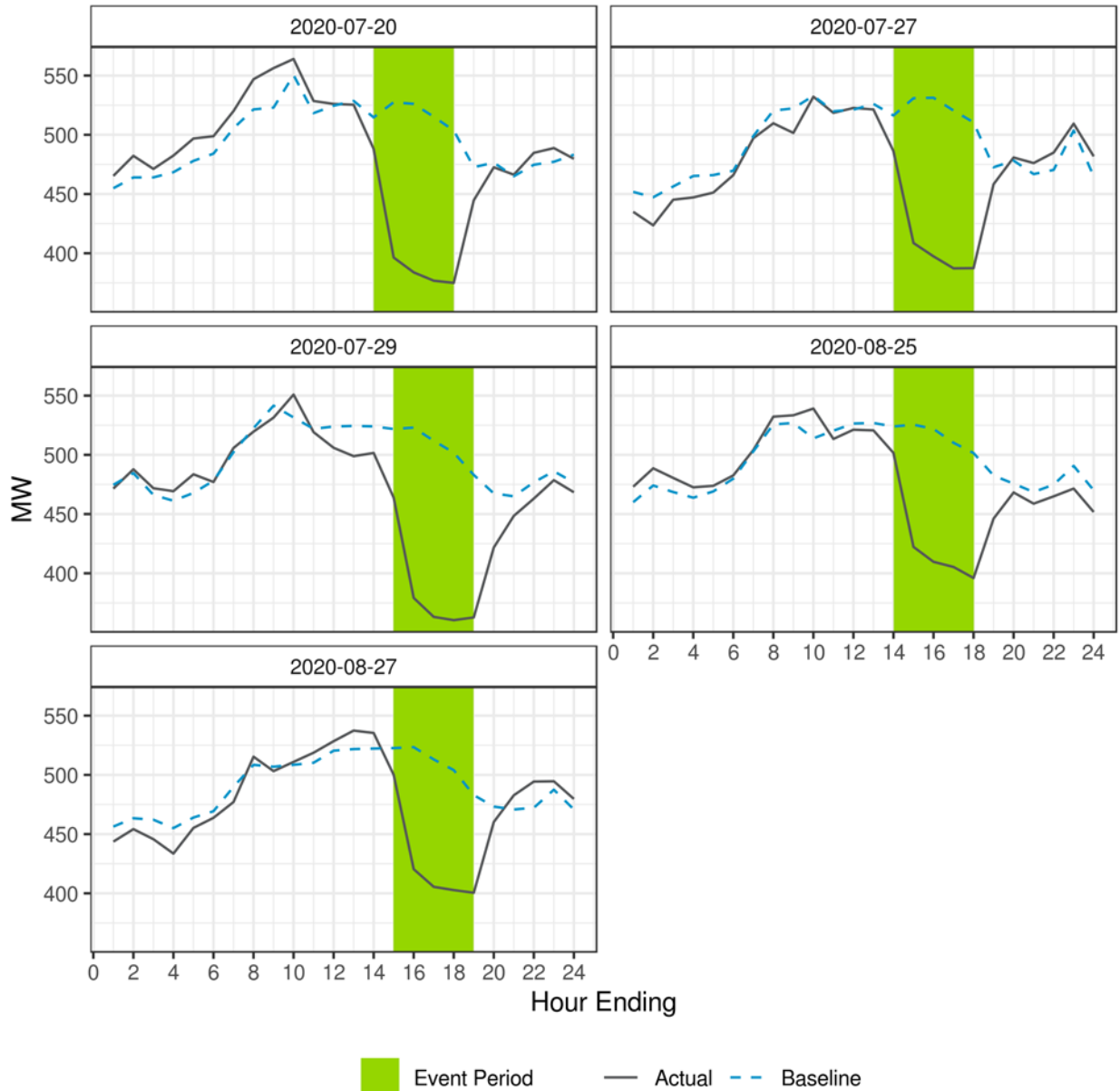
2.8.1.5 Participants Missing Interval Data

The evaluation team identified one account with poor data quality resulting from faulty metering, which caused the team to be unable to develop verified impact values for the site. The site was originally enrolled for 5 MW of curtailment. In consultation with the SWE, Guidehouse used the CSP-reported value and applied the reported/verified realization rate (1.04) to account for the difference between the CSP estimate and the impacts found using the full evaluation methodology.

2.8.1.6 Impact Results

Figure 2-5 shows the aggregated results of the regression analysis, representing the sum of all analyzed accounts and comparing actual demand (solid black) to the estimated baseline (dashed blue). For all events, the regression models appear to accurately represent the aggregate baseline demand in all hours.

Figure 2-5. PY12 Large C&I Aggregated Actual Load and Estimated Baseline by Event



Source: Guidehouse analysis

Table 2-16 provides the sampling frame for the gross impact evaluation of the Large C&I DR Program in PY12. In total, a regression method was selected for 295 participants, while a CBL method was selected for 60 participants.

Table 2-16. Large C&I DR Program Gross Impact Sample Design for PY12

Stratum Solution	Stratum Name	Percentage of Program Reported Savings	Population Size	Achieved Sample Size	Verification Method
Total Program	Large C&I DR	100%	356	355 ¹⁸	Regression or CBL

Source: Guidehouse analysis

Table 2-17 summarizes reported and verified demand (MW) savings results, along with the relative precision for each stratum sampled for the Large C&I DR Program in PY12. The evaluation team calculated the relative precision per the protocols specified in the Phase III Evaluation Framework.¹⁹

Table 2-17. Large C&I DR Program Gross Demand Savings Impact Evaluation Results for PY12

Stratum Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Relative Precision at 90% Confidence Interval
Total Program	Large C&I DR	127.82	132.81	1.04	10%

Note: Values in tables may not reconcile exactly with the sum of more detailed level results or previously reported results due to rounding.

Source: Guidehouse analysis

In PY12, the program underperformed relative to enrolled curtailment (approximately 146 MW). This result can be attributed to lessened curtailment in the two August events and the program’s sensitivity to the performance of a few large customers. One very large customer, enrolled for 10 MW of curtailment, frequently curtailed their load from approximately 10 a.m. to 10 p.m. This curtailment was factored into their estimated baseline and, as a result, the customer had an average impact of 0.7 MW on event days.

¹⁸ The achieved sample size excludes the one account missing interval data, as discussed previously.

¹⁹ NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC, *Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs*, prepared for the Pennsylvania Public Utility Commission, http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf.

Appendix A. DR Event and Hour Impacts

Table A-1 presents the event and hour impacts for the DR programs (Residential, Small C&I, and Large C&I).

Table A-1. PY12 DR Event Hourly Results Summary Table

Event	Hour-Ending (HE)	Residential DR Program (Verified MW)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Average Portfolio (Verified MW)
Event 1 20-Jul-20	HE15	-	-	141.17	141.17
	HE16	29.14	1.10	151.22	181.46
	HE17	30.79	1.05	148.97	180.81
	HE18	-	-	139.13	139.13
	Average Event Impact by Program	30.24	1.08	147.31	178.63
	Error Margin at 90% CI	0.67	0.14	13.35	13.36
Event 2 27-Jul-20	HE15	-	-	129.15	129.15
	HE16	27.48	0.69	140.45	168.62
	HE17	29.13	0.64	142.11	171.88
	HE18	-	-	132.10	132.10
	Average Event Impact by Program	28.58	0.66	139.01	168.25
	Error Margin at 90% CI	0.73	0.12	13.81	13.83
Event 3 29-Jul-20	HE16	-	-	155.29	155.29
	HE17	27.48	0.56	158.79	186.83
	HE18	26.93	0.36	152.80	180.09
	HE19	-	-	130.66	130.66
	Average Event Impact by Program	27.48	0.46	150.48	178.42
	Error Margin at 90% CI	0.65	0.13	11.87	11.89
Event 4 25-Aug-20	HE15	-	-	111.39	111.39
	HE16	24.17	0.85	119.23	144.25
	HE17	21.97	0.93	115.11	138.01
	HE18	-	-	116.97	116.97
	Average Event Impact by Program	23.07	0.90	117.09	141.06
	Error Margin at 90% CI	0.73	0.13	11.88	11.90

Event	Hour-Ending (HE)	Residential DR Program (Verified MW)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Average Portfolio (Verified MW)
Event 5 27-Aug-20	HE16	-	-	110.19	110.19
	HE17	25.82	0.34	117.03	143.19
	HE18	25.82	0.31	114.06	140.19
	HE19	-	-	94.82	94.82
	Average Event Impact by Program	25.82	0.33	110.17	136.32
	Error Margin at 90% CI	0.84	0.13	12.47	12.50
Average Program Year Impact (PYVTD)		27.04	0.69	132.81	160.54
Average Phase III Impact (VTD)*		29.16	0.62	135.52	165.30

CI = confidence interval

Source: Guidehouse analysis

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