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PECO
An Exelon Company

January 15, 2019

VIA FEDERAL EXPRESS

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street, 2nd Floor
Harrisburg, PA 17120

Re: PUC Docket No. M-2015-2515691
Phase III Energy Efficiency and Conservation Program Semi-Annual Report for June 1, 2018 through May 31, 2019 and Demand Response Only Performance Annual Report

Dear Secretary Chiavetta:

In accordance with Section IV.D.2 of the Commission's Opinion and Order Letter dated March 17, 2016 (Docket No. M-2015-2515691), enclosed is PECO's ("PECO" or "the Company") Phase III Semi-Annual Energy Efficiency & Conservation Report for the period June 1, 2018 through May 31, 2019.

PECO is providing a copy of the report to the Act 129 Statewide Evaluator (NMR Group) and is also posting the report on the PECO website.

Also, enclosed is the Annual Report of PECO Energy Company ("PECO" or "the Company") concerning the performance of its Act 129 Phase III demand response ("DR") programs for June 1, 2018 to May 31, 2019. For your convenience PECO is providing the DR verified impact results in the final Annual Report template, which include the evaluation findings, as required.
If you have any questions regarding this filing, please do not hesitate to contact me at 215.841.5777.

Sincerely,

Enclosures

CC: K. Brown, Law Bureau
D. Gill, Depuy Director, Bureau of Technical Utility Services
J. Sherrick, Policy & Planning/Conservation Supervisor
K. G. Sophy, Director, Office of Special Assistants
P. T. Diskin, Director, Bureau of Technical Utility Services
K. Monaghan, Director, Bureau of Audits
R. Kanaskie, Director, Bureau of Investigation & Enforcement
Office of Consumer Advocate
Office of Small Business Advocate
McNees, Wallace & Nurick

NAVIGANT

Semiannual Report to the Pennsylvania Public Utility Commission

Phase III of Act 129

Program Year 10

(June 1, 2018 – May 31, 2019)

For Pennsylvania Act 129 of 2008

Energy Efficiency and Conservation Plan

Prepared for:

PECO
An Exelon Company

Submitted by:
Navigant Consulting, Inc.
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January 15, 2019

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ACRONYMS

AC	Air Conditioner
BDR	Behavioral Demand Response
C&I	Commercial and Industrial
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CSP	Conservation Service Provider or Curtailment Service Provider
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
EM&V	Evaluation, Measurement, and Verification
EPA	Environmental Protection Agency
EUL	Effective Useful Life
G/E/NP	Government/Education/Non-Profit
HVAC	Heating, Ventilation, and Air Conditioning
ICSP	Implementation Conservation Service Provider
kW	Kilowatt
kWh	Kilowatt-Hour
LED	Light-Emitting Diode
LI	Low-Income
LIURP	Low-Income Usage Reduction Program
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
PSA	Phase III to Date Preliminary Savings Achieved; Equal to VTD + PYTD
PSA+CO	PSA 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
PYTD	Program Year to Date
PYVTD	Program Year Verified to Date
RTD	Phase III to Date Reported Gross Savings
RTO	Regional Transmission Organization
SKU	Stock Keeping Unit

SWE	Statewide Evaluator
T&D	Transmission and Distribution
TRC	Total Resource Cost
TRM	Technical Reference Manual
VTD	Phase III to Date Verified Gross Savings

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 estimate may differ from the gross savings estimate due to adjustments for the effects of free riders, changes in codes and standards, market effects, participant and nonparticipant spillover, and other causes of changes in energy consumption or demand not directly attributable to the EE&C program.

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

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

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

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

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

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

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

- **Phase III to Date Reported (RTD):** The sum of the reported gross savings recorded to date in Phase III of Act 129 for an EE&C program or portfolio.
- **Phase III to Date Verified (VTD):** The sum of the verified gross savings recorded to date in Phase III of Act 129 for an EE&C program or portfolio, as determined by the impact evaluation finding of the independent evaluation contractor.
- **Phase III to Date Preliminary Savings Achieved (PSA):** The sum of the verified gross savings (VTD) from previous program years in Phase III where the impact evaluation is complete plus the reported gross savings from the current program year (PYTD). For example, for Program Year 10 (PY10), the PSA savings equal the PYTD savings and the verified savings from PY8 and PY9.
- **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.

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 10 (PY10), 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 PY10. Compliance with Act 129 savings goals will ultimately be based on verified gross savings. PECO has retained Navigant Consulting, Inc. (Navigant) as an independent evaluation contractor for Phase III of Act 129. Navigant is responsible for the measurement and verification (M&V) of the savings and the calculation of verified gross savings. The verified gross savings for PY10 EE programs will be reported in the final annual report to be filed on November 15, 2019.

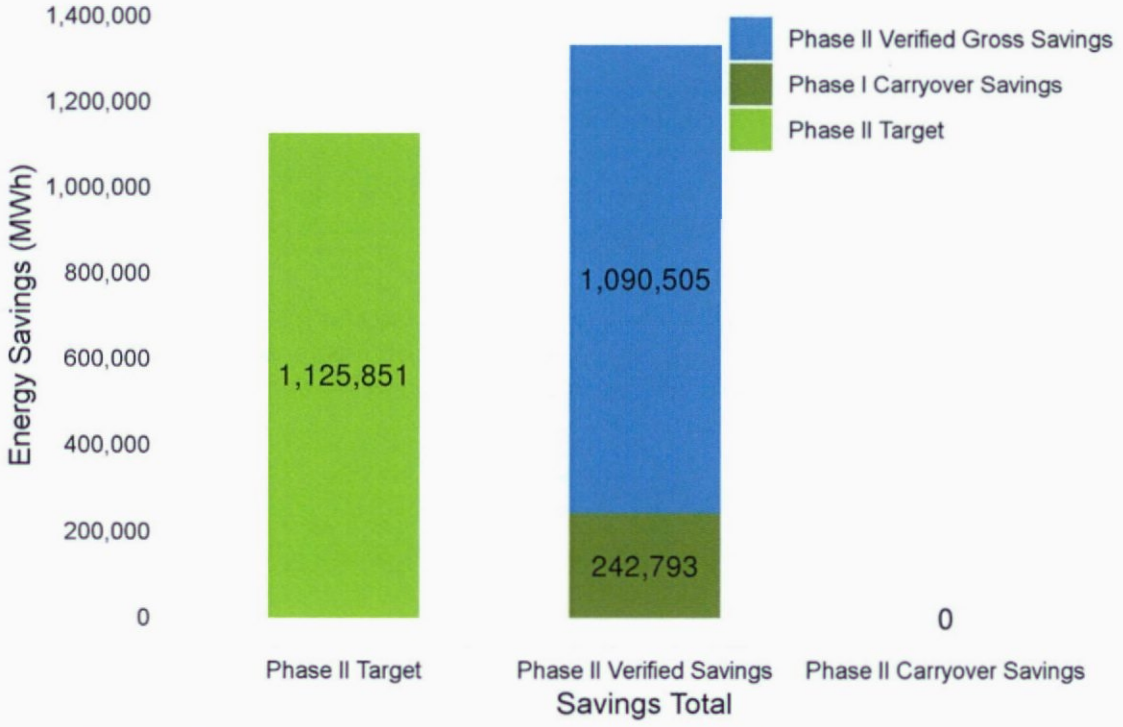
Phase III of Act 129 includes a demand response (DR) goal for PECO. DR events are limited to the months of June through September, which are the first 4 months of the Act 129 program year. Because the DR season is completed early in the program year, it is possible to complete the independent evaluation 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 PY10 and the cumulative DR performance of the EE&C program to date for Phase III of Act 129.

2. SUMMARY OF ACHIEVEMENTS

2.1 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 Order[1] 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



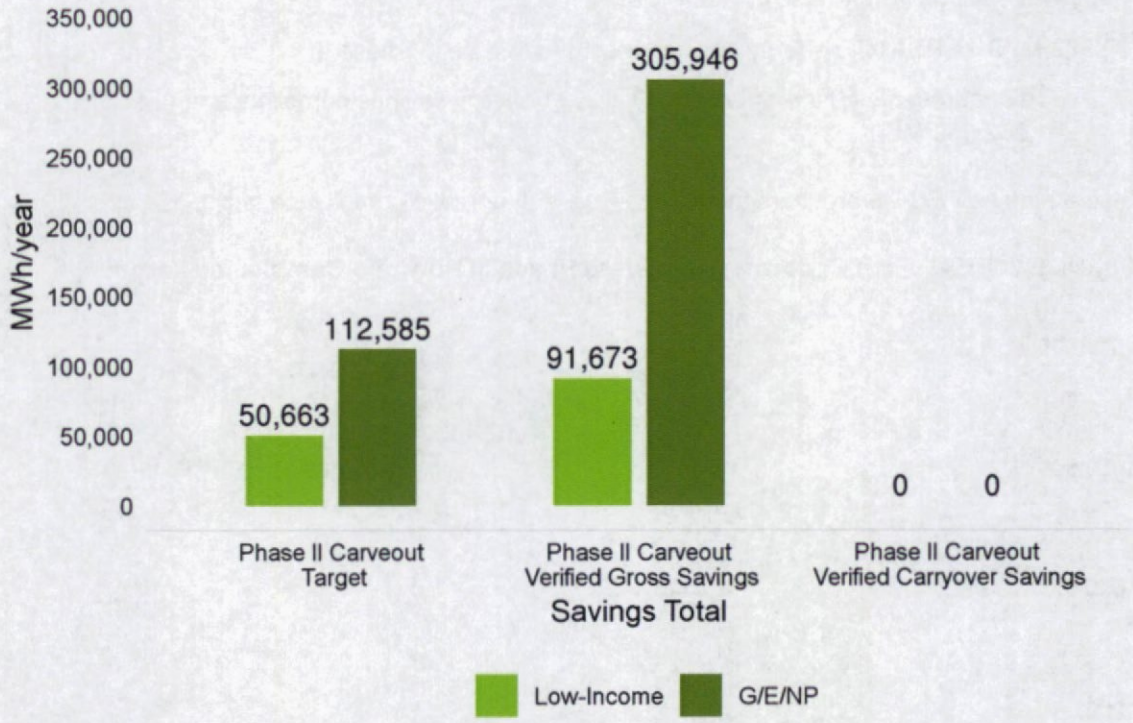
Sources: PECO's eTrack database, Conservation Service Provider (CSP) tracking data

[1] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (*Phase III Implementation Order*), entered June 11, 2015.

[2] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Compliance Order*, at Docket No. M-2012-2289411, (*Phase II Compliance Determination Order*), entered August 3, 2017.

The Commission's Phase III Implementation Order[3] 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.[4] PECO carried over 0 MWh of G/E/NP and 0 MWh of low-income customer segment savings.[5] Figure 2-2 shows the calculation of carryover savings for the low-income and G/E/NP targets.[6]

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



Sources: PECO's eTrack database, CSP tracking data

2.2 Phase III Energy Efficiency Achievements to Date

Since the beginning of PY10 on June 1, 2017, PECO has claimed:

- 201,275 MWh of reported gross electric energy savings (PYRTD)
- 21.32 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:

- 811,564 MWh of reported gross electric energy savings (RTD)

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[3] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (*Phase III Implementation Order*), entered June 11, 2015.

[4] Proportionate to those savings achieved by dedicated low-income programs in Phase III.

[5] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Compliance Order*, at Docket No. M-2012-2289411, (*Phase II Compliance Determination Order*), entered August 3, 2017.

[6] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Compliance Order*, 2017.

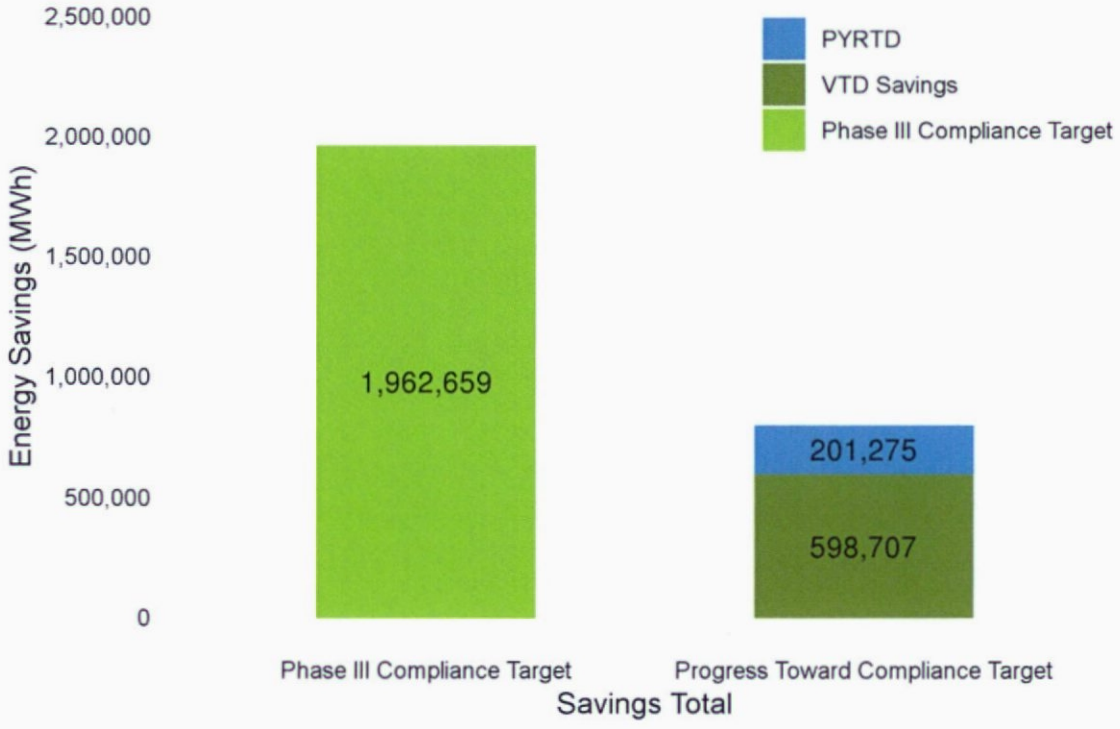
- 84.22 MW of reported gross peak demand savings (RTD) from EE programs
- 799,982 MWh of gross electric energy savings (PSA)
    - This total includes verified gross savings from all Phase III program years and the PYTD reported gross savings from PY10
- 99.87 MW of gross peak demand savings (PSA) from EE programs

Including carryover savings from Phase II, PECO has achieved:

- 799,982 MWh of PSA+CO energy savings recorded to date in Phase III
    - This represents 40.8% 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

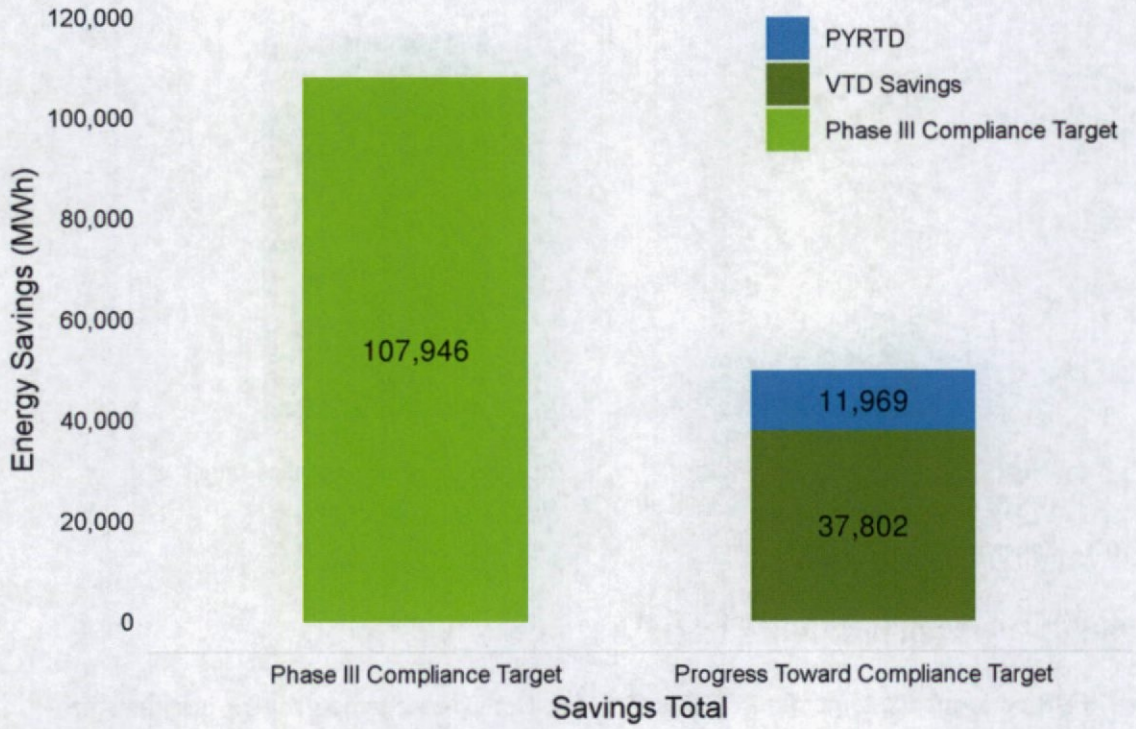


Sources: PECO's eTrack, CSP tracking data

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 46.1% of the Phase III low-income energy savings target.

Figure 2-4. EE&C Plan Performance Toward Phase III Low-Income Compliance Target



Sources: PECO's eTrack database, CSP tracking data

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 111% of the Phase III G/E/NP energy savings target.

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

Sources: PECO's eTrack database, CSP tracking data

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.

Act 129 DR events are triggered by PJM's day-ahead load forecast. When the day-ahead forecast is above 96% of the peak load forecast for the year, a DR event is initiated for the following day.

In PY10, PECO called six DR events, on July 2, July 3, August 6, August 28, September 4, and September 5. The average performance for these six events is presented in Table 2-1. The full methodology and results will be made available in the standalone PY10 DR report, to be submitted to the Statewide Evaluator (SWE) January 15, 2019. Table 2-1 shows a summary of the DR performance to date.

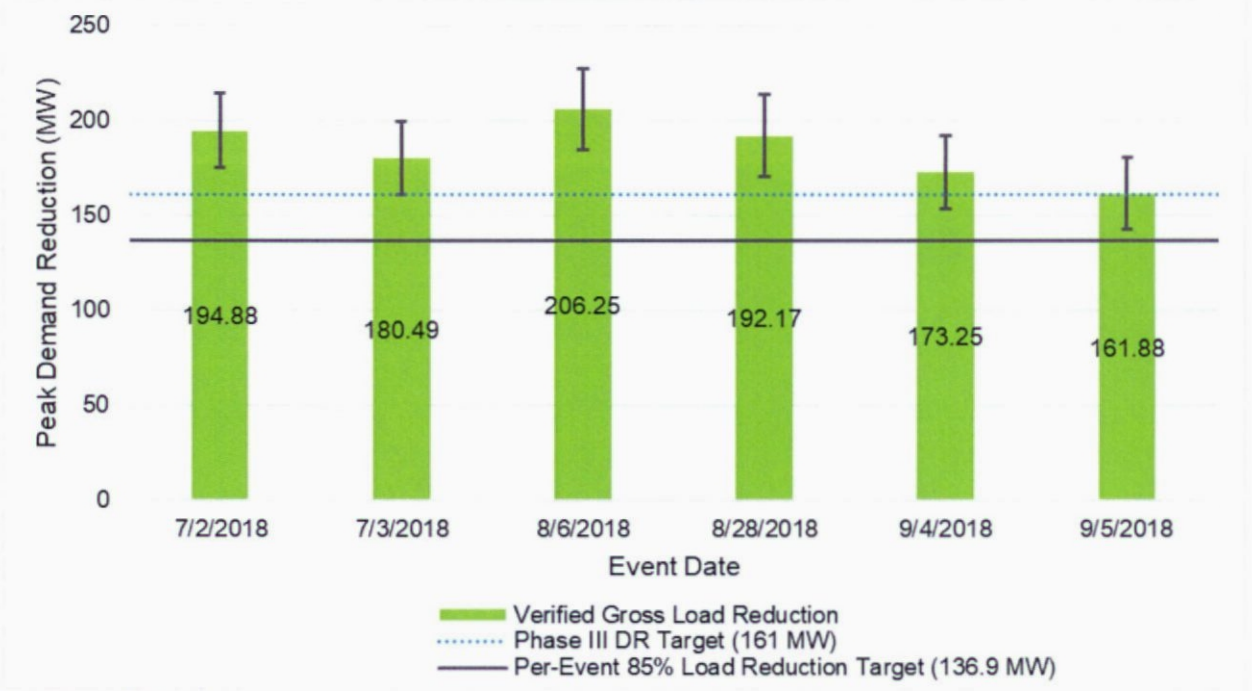
Table 2-1. Phase To Date DR Performance by Event

PY	Event Date	Residential DR (MW)	Small C&I DR (MW)	Large C&I DR (MW)	Portfolio (MW)	Relative Precision at 90% Confidence
PY9	June 13, 2017	39.53	0.00	118.21	157.74	8.8%
PY9	July 20, 2017	33.48	0.00	107.88	141.36	9.6%
PY9	July 21, 2017	23.34	0.00	125.82	149.16	8.9%
PY10	July 2, 2018	38.90	0.00	155.98	194.88	10.0%
PY10	July 3, 2018	33.73	0.00	146.76	180.49	10.8%
PY10	August 6, 2018	24.97	1.15	180.12	206.25	10.4%
PY10	August 28, 2018	30.50	0.92	160.76	192.17	11.3%
PY10	September 4, 2018	29.79	0.77	142.69	173.25	11.1%
PY10	September 5, 2018	29.28	0.84	131.75	161.88	11.8%
PYVTD - Average PY10 DR Event Performance		**31.19**	**0.61**	**153.01**	**184.82**	**10.9%**
P3TD - Average Phase III DR Event Performance		**31.50**	**0.41**	**141.11**	**173.02**	**10.3%**

Source: Navigant 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 PY10 to the event-specific minimum and average targets.

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



Source: Navigant analysis

2.4 Phase III Performance by Customer Segment

Table 2-2 presents the participation, savings, and spending by customer sector for PY10. 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. PY10 Summary Statistics by Customer Segment

Customer Segment	Parameter				
	No. of Participants	PYRTD MWh	PYRTD MW (EE)	PYVTD MW (DR)	Incentives ($1,000)
Residential	986,744	133,374	11.72	31.19	$7,088
Small C&I	2,321	25,111	4.14	0.61	$1,406
Large C&I	691	42,790	5.46	152.88	$2,393
Total	989,756	201,275	21.32	184.69	$10,887

Sources: PECO's eTrack database, CSP tracking data

Table 2-3. PY10 Summary Statistics by Carve-Out

Carve-Out	Parameter				
	No. of Participants	PYRTD MWh	PYRTD MW (EE)	PYVTD MW (DR)	Incentives ($1,000)
Low-Income (0-50% of FPL)	2,139	2,361	0.26	0.00	$0
Low-Income (51-150% of FPL)	8,338	9,608	1.16	0.00	$72
G/E/NP	315	22,257	2.94	0.00	$1,505

Sources: PECO's eTrack database, CSP tracking data

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	Parameter				
	No. of Participants	PSA MWh	PSA MW (EE)	PSA MW (DR)	Incentives ($1,000)
Residential	3,658,156	552,083	64.94	31.50	$26,317
Small C&I	5,178	96,440	13.74	0.41	$4,572
Large C&I	1,348	151,459	21.20	141.02	$7,278
Total	3,664,682	799,982	99.87	172.93	$38,167

Sources: PECO's eTrack database, CSP tracking data

Table 2-5. Phase III Summary Statistics by Carve-Out

Carve-Out	Parameter				
	No. of Participants	PSA MWh	PSA MW (EE)	PSA MW (DR)	Incentives ($1,000)
Low-Income (0-50% of FPL)	6,502	8,108	0.94	0.00	$1
Low-Income (51-150% of FPL)	190,162	41,662	5.03	0.00	$976
G/E/NP	753	76,511	9.30	0.00	$4,596

Sources: PECO's eTrack database, CSP tracking data

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.

- **Behavioral Solution:** Oracle implements the Behavioral Solution and has been active throughout PY8, PY9, and into PY10. Similar to PY9, 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 CLEAResult, 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 offers rebates for refrigerators, freezers, and room air conditioners (ACs). The utility offered $50 rebates per refrigerator or freezer picked up for recycling through February 1, 2018 and a $75 rebate thereafter. The utility offers $10 rebates per room AC recycled with the pickup of a refrigerator or freezer.
- **Whole Home Solution:** The Whole Home Solution 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.
- **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.
- **Low-Income EE Program:** CMC Energy Services, the Energy Coordinating Agency (ECA) and ARCA, Inc. are implementing the Low-Income Whole Home Solution in PY10. Ecova implemented the Low-Income Lighting Solution in PY8 and PY9.
    - **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. Additionally, the solution supports the Low-Income Usage Reduction Program (LIURP) providing additional free efficient electric products for direct installation. For customers with electric

heat and domestic hot water, the Home Energy Check Up measures include improving mechanical systems and the thermal performance of building envelopes and water heaters.

  - **Lighting Solution:** The Lighting Solution was closed on December 31, 2017.

- **Small C&I EE Program:** ICF, Franklin, and SmartWatt have implemented projects in three of the program's solutions and one targeted market segment: the Equipment and Systems Solution, New Construction Solution, Whole Building Solution, and the Multifamily Targeted Market Segment. Each of these programs 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 in three of the program's solutions and one targeted market segment: the Equipment and Systems Solution, New Construction Solution, Data Center Solution, and the Multifamily Targeted Market Segment. Each of these programs 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 Solution primarily targets efficient HVAC projects in data centers and other IT facilities.
- **CHP Program:** PECO is currently accepting and processing applications for combined heat and power (CHP) projects. PECO held a CHP informational session in Q1 of PY10. The event was well attended, and the program manager is actively cultivating project leads. The program is tracking five projects that are nearing completion and expects to report savings for them by the end of PY10.
- **Residential DR Program:** The Residential DR Program ran six DR events during the summer of 2018: July 2, July 3, August 6, August 28, September 4, and September 5. As in years past, the program is implemented by Itron (formerly Comverge). This year, and for the remainder of Phase III, the incentive is $40 per direct load control (DLC) unit per year.
- **Small C&I DR Program:** The Small C&I DR Program ran six DR events during the summer of 2018: July 2, July 3, August 6, August 28, September 4, and September 5. As in years past, the program is implemented by Itron (formerly Comverge). This year, and for the remainder of Phase III, the incentive is $40 per thermostat per year.
- **Large C&I DR Program:** The Large C&I DR Program ran six DR events during the summer of 2018: July 2, July 3, August 6, August 28, September 4, and September 5. The program is implemented by two CSPs: CPower and EnelX (formerly EnerNOC).

3.2 Evaluation Updates and Findings

Navigant 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. At this time, Navigant is primarily focused on these evaluation

planning activities particularly for EE programs and solutions. Additionally, the team has completed the DR program evaluation for PY10. Navigant's progress on each program and solution is summarized below.

- **Residential EE Program:** Navigant is currently updating evaluation plans ahead of the PY10 activities for the Residential EE Program's solutions. Navigant is preparing data collection tools and processes to aid onsite and phone verification and survey research anticipated for PY10. Activities from PY9, recent findings and conclusions, and SWE feedback inform the team's research plan updates for PY10 that will support both impact and process evaluation efforts.
- **Low-Income EE Program:** Navigant conducted on-site verification visits in PY9, and the team is currently updating evaluation plans for PY10 activities. As part of that planning, Navigant is preparing to conduct program database reviews and preparing data collection tools and processes to aid phone verification and survey research anticipated for PY10. Low-Income EE Program evaluation activities are focused on the Whole Home Solution.
- **Small C&I EE Program:** Navigant 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, Navigant will continue to review the solution measure data, call and visit sampled project sites, and continue the evaluation process for PY10.
- **Large C&I EE Program:** Navigant updated its data collection tools and processes to ensure faster and more robust data collection as well as more collaboration with the SWE. Navigant has also been working with ICF to review large and complex projects before incentives will be reserved. Impact evaluations for all solutions are ongoing. Over the next several months, Navigant will review the solution measure data, call and visit sampled project sites, and continue the evaluation process for PY10.
- **CHP Program:** The CHP Program does not currently have any participants. Navigant performed a review of the new program materials, conducted market research, and provided feedback on increasing participation. Navigant is also working with PECO's engineering subcontractor to improve project documentation and tracking.
- **Residential DR Program:** The team evaluated peak load reductions for DR events on all summer event days in 2018. 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 2018. 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 2018. 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 PY10 and Phase III. Certain programs and solutions define participation differently depending on the delivery channel and data tracking practices.

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

Program and Solution	PYTD Participation	P3TD Participation
Lighting, Appliances & HVAC	536,677	2,152,802
Appliance Recycling	10,090	34,702
Whole Home	3,148	10,872
New Construction	315	1,186
Behavioral	364,409	1,184,769
Multifamily Targeted	5,817	16,444
Residential EE Total	**920,456**	**3,400,775**
Lighting	0	167,058
Whole Home	10,477	29,606
Low-Income EE Total	**10,477**	**196,664**
Equipment and Systems	467	1,956
New Construction	25	89
Whole Building	152	587
Data Centers	2	2
Multifamily Targeted	53	289
Small C&I EE Total	**699**	**2,923**
Equipment and Systems	265	755
New Construction	24	84
Data Centers	1	4
Multifamily Targeted	29	101
Large C&I EE Total	**319**	**944**
CHP	**0**	**2**
Residential DR	**56,030**	**61,440[a]**
Small C&I DR	**1,427**	**1,586[a]**
Large C&I DR	**348**	**348[a]**
Portfolio Total	**989,756**	**3,664,682**

[a] 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.

Sources: PECO's eTrack database, CSP tracking data

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

- For Lighting, Appliance & HVAC, upstream lighting participation is defined as the sum of the stock keeping unit (SKU) sales. A SKU describes a sold lighting product, which can be a single bulb or a multi-pack of bulbs. For the appliance 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 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 federal poverty level. PECO has defined participation counts in each solution as follows:

- For Lighting, there was no activity in PY10. 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 Check Ups and Low-Income Usage Reduction Program: 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.

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 whose accounts are disconnected, have opted out of the program, or for whom the DLC device was removed are 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 whose accounts are disconnected, have opted out of the program, or for whom the DLC device was removed are not counted as participants.

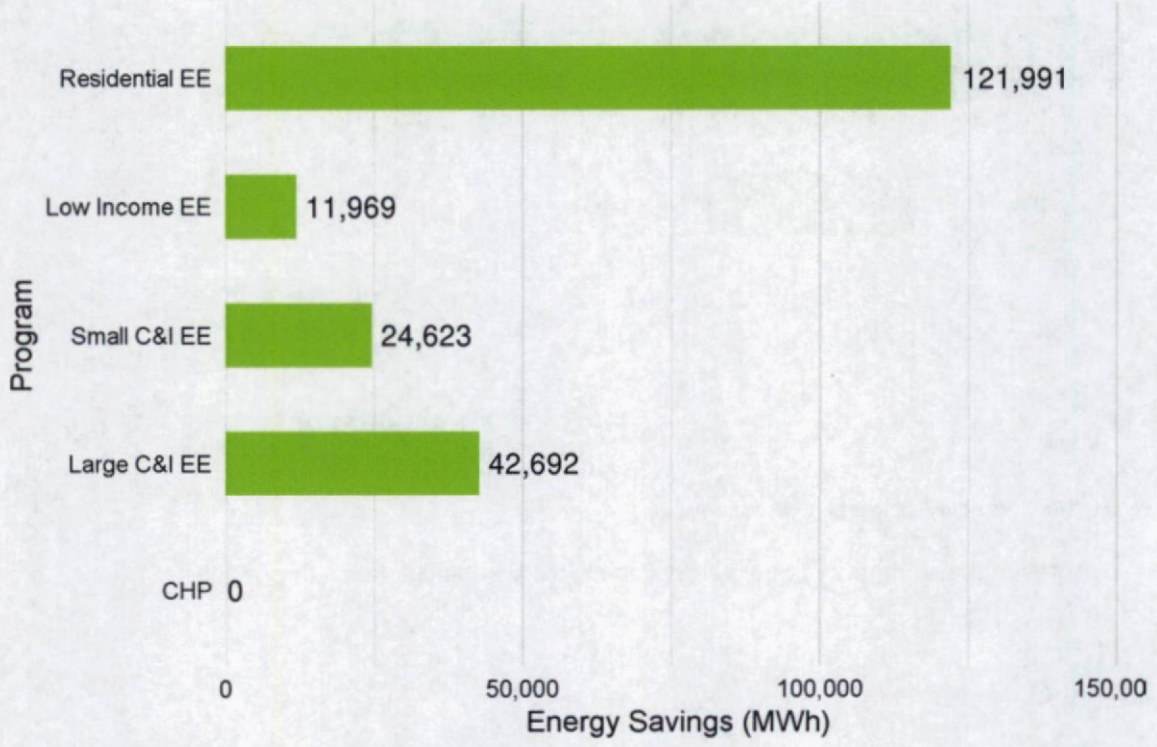
The Large C&I DR Program consists of the Demand Response Aggregator (DRA) Solution. PECO has defined participation counts in the solution as follows:

- 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.

5. SUMMARY OF ENERGY IMPACTS BY PROGRAM

Figure 5-1 presents a summary of the PYTD reported gross energy savings by program for PY10. The energy impacts in this report are presented at the meter level and do not reflect adjustments for T&D losses.

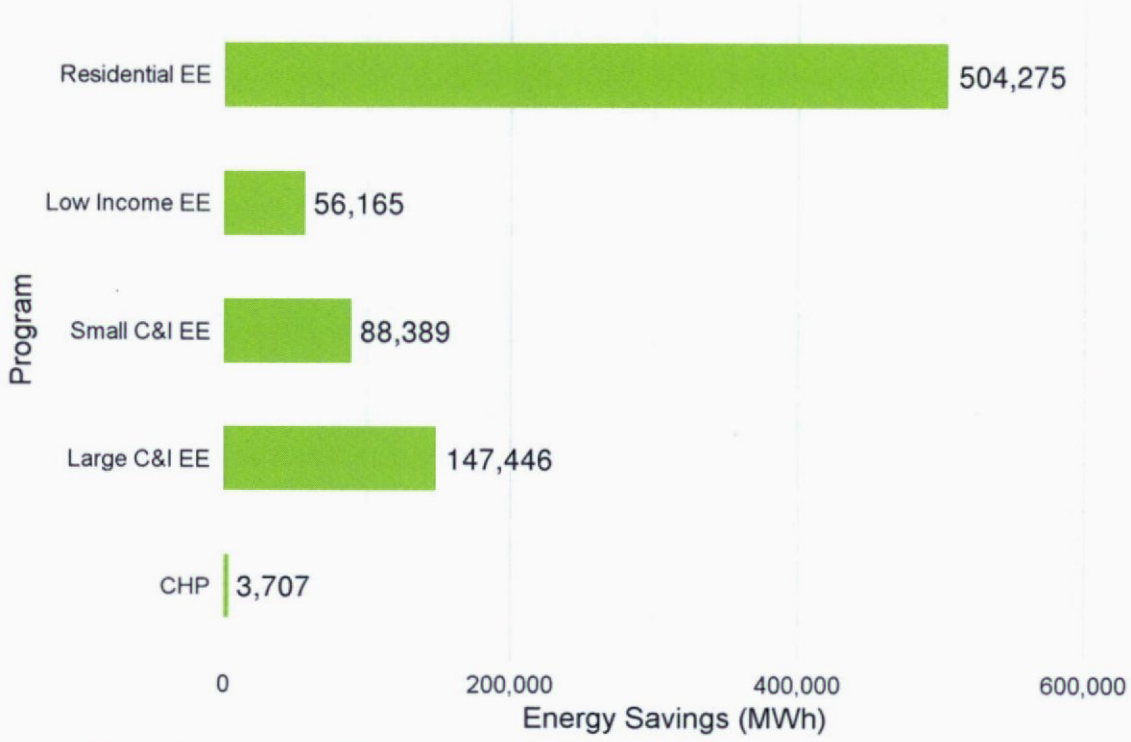
Figure 5-1. PYTD Reported Gross Energy Savings by Program



Sources: PECO's eTrack database, CSP tracking data

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



Sources: PECO's eTrack database, CSP tracking data

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
Lighting, Appliances & HVAC	56,477	253,945	201,230	257,707
Appliance Recycling	9,975	34,451	22,480	32,455
Whole Home	4,088	13,825	9,829	13,917
New Construction	766	2,955	2,182	2,947
Behavioral	48,268	192,626	141,781	190,049
Multifamily Targeted	2,417	7,894	4,783	7,199
Residential EE Total	**121,991**	**505,696**	**382,284**	**504,275**
Lighting	0	9,086	9,084	9,084
Whole Home	11,969	51,852	35,113	47,081
Low-Income EE Total	**11,969**	**60,938**	**44,196**	**56,165**
Equipment and Systems	17,039	66,269	47,844	64,883
New Construction	1,156	5,593	4,562	5,718
Whole Building	3,811	12,685	8,848	12,659
Data Centers	119	119	0	119
Multifamily Targeted	2,498	6,311	2,512	5,010
Small C&I EE Total	**24,623**	**90,977**	**63,766**	**88,389**
Equipment and Systems	36,495	130,367	90,960	127,454
New Construction	4,279	13,353	9,105	13,384
Data Centers	36	546	507	543
Multifamily Targeted	1,883	6,433	4,182	6,064
Large C&I EE Total	**42,692**	**150,699**	**104,754**	**147,446**
CHP	**0**	**3,254**	**3,707**	**3,707**
Portfolio Total	**201,275**	**811,564**	**598,707**	**799,982**

Sources: PECO's eTrack database, CSP tracking data

6. SUMMARY OF DEMAND IMPACTS BY PROGRAM

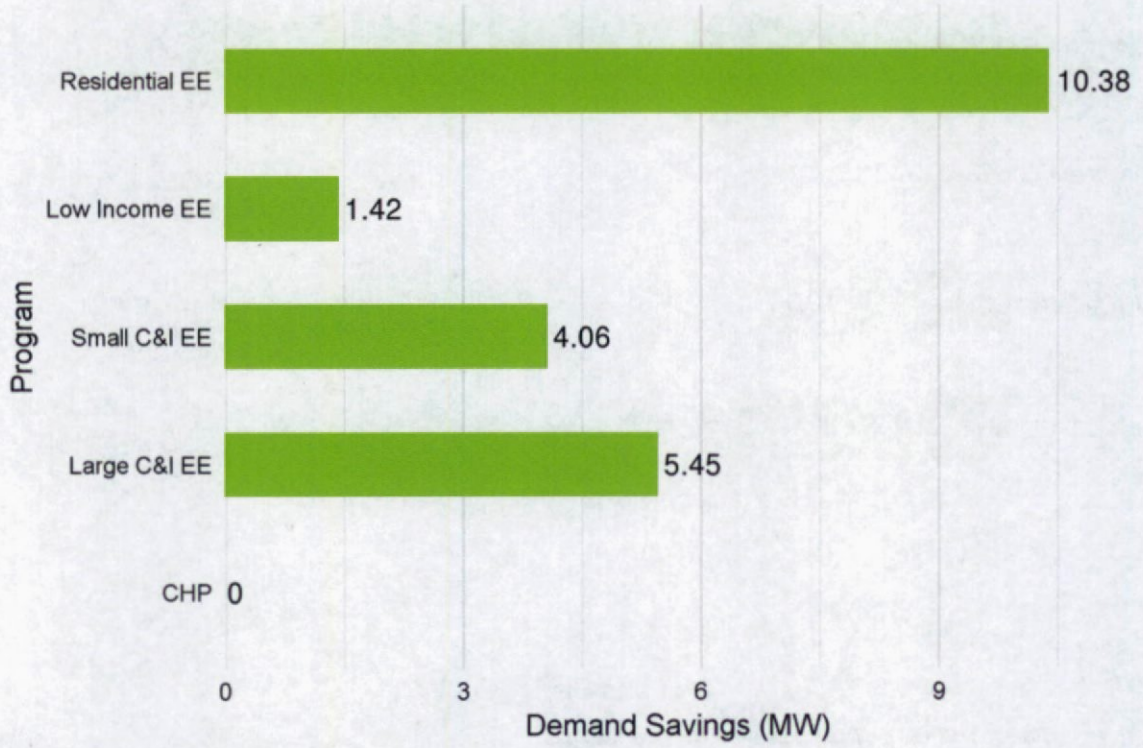
PECO's Phase III EE&C programs achieve peak demand reductions primarily in two ways. The first is through coincident reductions from EE measures and the second is through dedicated DR offerings that exclusively target temporary demand reductions on peak days. EE reductions coincident with system peak 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. 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 PY10.

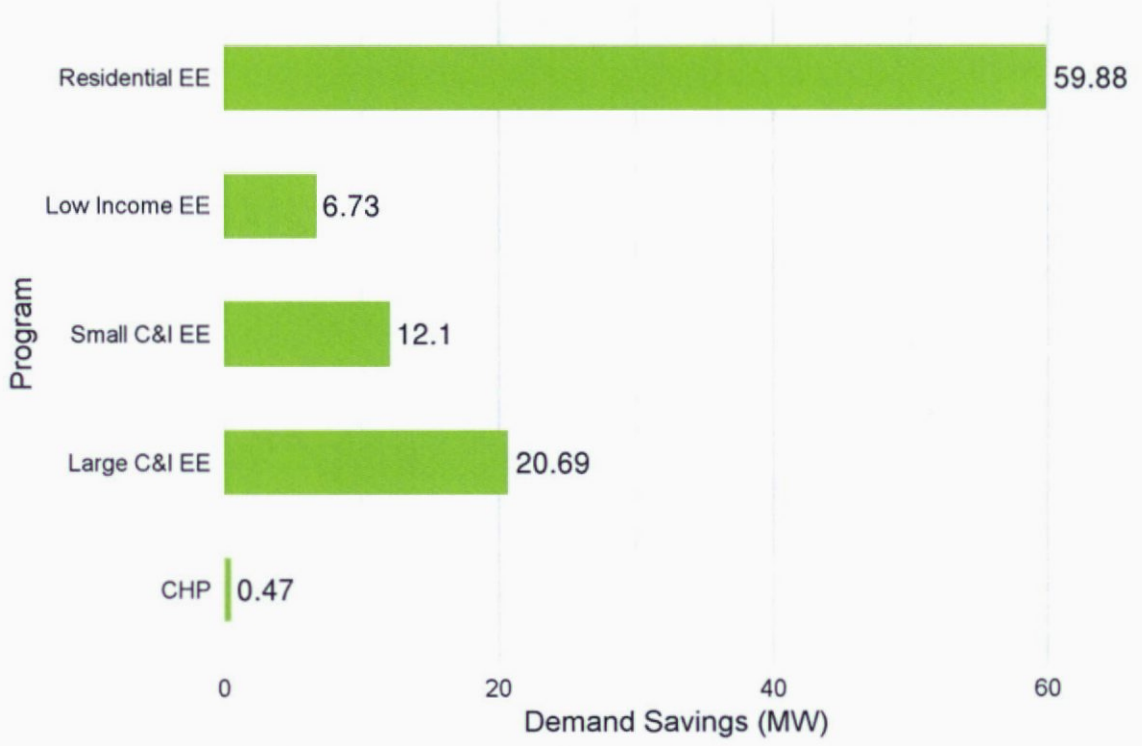
Figure 6-1. PYRTD Gross Demand Savings by EE Program



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
Lighting, Appliances & HVAC	7.84	33.92	27.78	35.62
Appliance Recycling	1.46	5.09	3.32	4.78
Whole Home	0.53	1.61	1.03	1.56
New Construction	0.24	0.92	0.62	0.86
Behavioral	0.00	0.00	16.19	16.19
Multifamily Targeted	0.31	1.00	0.57	0.88
Residential EE Total	**10.38**	**42.54**	**49.50**	**59.88**
Lighting	0.00	1.07	1.07	1.07
Whole Home	1.42	6.07	4.23	5.66
Low-Income EE Total	**1.42**	**7.14**	**5.30**	**6.73**
Equipment and Systems	2.85	8.89	5.63	8.48
New Construction	0.19	1.01	0.86	1.04
Whole Building	0.81	2.52	1.25	2.07
Data Centers	0.02	0.02	0.00	0.02
Multifamily Targeted	0.19	0.62	0.30	0.49
Small C&I EE Total	**4.06**	**13.05**	**8.04**	**12.10**
Equipment and Systems	4.71	18.53	13.52	18.22
New Construction	0.50	1.62	1.15	1.65
Data Centers	0.00	0.04	0.03	0.04
Multifamily Targeted	0.24	0.82	0.55	0.78
Large C&I EE Total	**5.45**	**21.00**	**15.24**	**20.69**
CHP	**0.00**	**0.49**	**0.47**	**0.47**
Portfolio Total	**21.32**	**84.22**	**78.56**	**99.87**

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 PY10 through PY12; there is no PY8 peak demand reduction target. Phase III DR events are initiated according to the following guidelines[7]:

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 PY10) 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.

[7] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (*Phase III Implementation Order*), entered June 11, 2015.

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.[8] PECO uses the following line loss percentages/multipliers by sector.

- Residential = 7.4% or 1.0799
- 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. The Phase III to date column is calculated as an average of all events to date, so years with more or fewer events will not be weighted disproportionately.

Table 6-2. PY10 DR PYVTD Performance by Event

PY	Event Date	Residential DR	Small C&I DR	Large C&I DR	Portfolio	Relative Precision at 90% CI
PY10	July 2, 2018	38.90	0.00	155.98	194.88	10.0%
PY10	July 3, 2018	33.73	0.00	146.76	180.49	10.8%
PY10	August 6, 2018	24.97	1.15	180.12	206.25	10.4%
PY10	August 28, 2018	30.50	0.92	160.76	192.17	11.3%
PY10	September 4, 2018	29.79	0.77	142.69	173.25	11.1%
PY10	September 5, 2018	29.28	0.84	131.75	161.88	11.8%
PYVTD - Average PY10 DR Event Performance		**31.19**	**0.61**	**153.01**	**184.82**	**10.9%**

Sources: Navigant analysis

[8] 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.

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 PY10 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 template[9] 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 Cost ($1,000)
Residential EE	$4,369	$2,673	$5,958	$13,000
Low-Income EE	$72	$401	$3,706	$4,179
Small C&I EE	$1,287	$1,197	$1,906	$4,390
Large C&I EE	$2,385	$386	$2,216	$4,987
CHP	$0	$0	$14	$14
Residential DR	$2,669	$0	$774	$3,442
Small C&I DR	$106	$0	$16	$122
Large C&I DR	$0	$0	$7,083	$7,083
Common Portfolio Costs[a]	N/A	N/A	N/A	$5,476
Portfolio Total	$10,887	$4,657	$21,674	$42,694
SWE Costs[b]	N/A	N/A	N/A	$0
Total	**$10,887**	**$4,657**	**$21,674**	**$42,694**

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

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

Sources: PECO's eTrack database, CSP tracking data

[9] http://www.puc.pa.gov/pcdocs/1372426.doc Section 10

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

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 Cost ($1,000)
Residential EE	$16,885	$14,006	$27,927	$58,818
Low-Income EE	$977	$1,121	$18,356	$20,454
Small C&I EE	$4,191	$5,524	$8,399	$18,114
Large C&I EE	$7,046	$1,699	$10,884	$19,629
CHP	$211	$0	$57	$269
Residential DR	$8,513	$32	$2,751	$11,296
Small C&I DR	$343	$2	$66	$411
Large C&I DR	$0	$63	$10,799	$10,862
Common Portfolio Costs[a]	N/A	N/A	N/A	$24,667
Portfolio Total	$38,167	$22,447	$79,239	$164,521
SWE Costs[b]	N/A	N/A	N/A	$700
Total	**$38,167**	**$22,447**	**$79,239**	**$165,221**

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

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

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 Category[10]

Cost Recovery Sector	Rate Classes Included	PYTD Spending ($1,000)	P3TD Spending ($1,000)
Residential	R, RH, and CAP	$23,081	$101,748
Small C&I	GS	$5,657	$23,797
Large C&I	PD, HT, and EP	$13,939	$38,902
Municipal	SLE, AL, and TLCL	$17	$76
Portfolio Total		**$42,694**	**$164,521**

Source: PECO

[10] Excludes SWE costs.

NAVIGANT

Annual Report to the Pennsylvania Public Utility Commission Demand Response Performance Report Only

Phase III of Act 129

Program Year 10

(June 1, 2018 - May 31, 2019)

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January 15, 2019

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ACRONYMS

AMI	Advanced Metering Infrastructure
BDR	Behavioral Demand Response
C&I	Commercial and Industrial
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CSP	Conservation Service Provider or Curtailment Service Provider
CV	Coefficient of Variation
DLC	Direct Load Control
DR	Demand Response
DRA	Demand Response Aggregator
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
EUL	Effective Useful Life
G/E/NP	Government, Educational, and Non-Profit
GNI	Government, Non-Profit, Institutional
HER	Home Energy Report
HIM	High Impact Measure
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light-Emitting Diode
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-hour
NPV	Net Present Value
NTG	Net-to-Gross

P3TD	Phase III to Date
PA PUC	Pennsylvania Public Utility Commission
PSA	Phase III to Date Preliminary Savings Achieved; equal to VTD + PYRTD
PSA+CO	PSA savings plus Carryover from Phase II
PY	Program Year: e.g., PY8, from June 1, 2016 to May 31, 2017
PYRTD	Program Year Reported to Date
PYVTD	Program Year Verified to Date
RCT	Randomized Control Trial
RR	Realization Rate
RTD	Phase III to Date Reported Gross Savings
RTO	Regional Transmission Organization
SWE	Statewide Evaluator
T&D	Transmission and Distribution
TRC	Total Resource Cost
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 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 EE programs.

PECO has retained Navigant Consulting, Inc. (Navigant) as an independent evaluation contractor for Phase III of Act 129. Navigant 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 10 (PY10) and the cumulative accomplishments of the Phase III DR 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, reported gross, verified gross, and verified net impacts of the DR programs in PY10. Compliance with Act 129 savings goals are ultimately based on verified gross savings. This report also includes estimates of cost-effectiveness accorded to the Total Resource Cost (TRC) test.[1]

[1] The Pennsylvania Total Resource Cost Test (TRC) Test for Phase I was adopted by the Public Utilities Commission (PUC) order at Docket No. M-2009-2108601 on June 23, 2009 (*2009 PA TRC Test Order*). The TRC Test Order for Phase I later was refined in the same docket on August 2, 2011 (2011 PA TRC Test Order). The 2013 TRC Order for Phase II of Act 129 was issued on August 30, 2012. The 2016 TRC Test Order for Phase III of Act 129 was adopted by PUC order at Docket No. M-2015-2468992 on June 11, 2015.

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[2]:

- 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 PY10) 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.
- Each curtailment event shall last 4 hours.
- Each curtailment event shall be called such that it will occur 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 percentages/multipliers by sector.[3]

- Residential = 107.99% or 1.0799
- Small Commercial and Industrial (C&I) = 107.99% or 1.0799
- Large C&I = 107.99% or 1.0799

For Phase III, event days are called when the PJM day-ahead peak load forecast reaches 96%. Based on the day-ahead forecasts, PECO called six events during the summer of 2018: July 2, July 3, August 6, August 28, September 4, and September 5.

Compliance targets for DR programs were established at the system level, which indicates the load reductions measured at the customer meter must be escalated to reflect T&D losses. The peak demand impacts presented in this report have been adjusted for line losses.

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.

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[2] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (*Phase III Implementation Order*), entered June 11, 2015.

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

PJM's day-ahead load forecast triggers Act 129 DR events. When the day-ahead forecast is above 96% of the peak load forecast for the year, a DR event is initiated for the following day. In PY10, there were six DR events called. Table 2-1 lists the days that DR events were called along with the verified gross demand reductions achieved by each event. Table 2-1 also lists the average DR performance for PY9, PY10, and for Phase III to date. PECO's average DR performance to date is 173.12 MW, which exceeds the Phase III compliance reduction target of 161 MW by 8% (108% of target achieved to date).

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

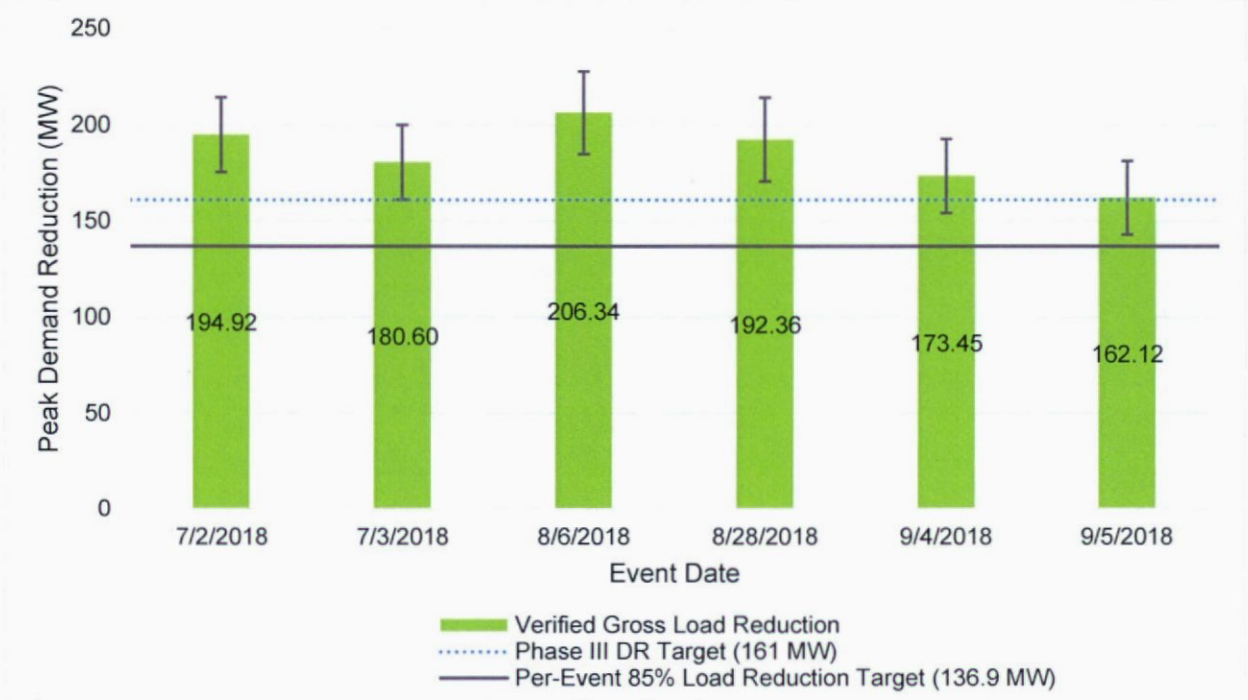
PY	Event Date	Residential DR (MW)	Small C&I DR (MW)	Large C&I DR (MW)	Portfolio (MW)	Relative Precision at 90% Confidence
PY9	June 13, 2017	39.53	0.00	118.21	157.74	8.8%
PY9	July 20, 2017	33.48	0.00	107.88	141.36	9.6%
PY9	July 21, 2017	23.34	0.00	125.82	149.16	8.9%
PY10	July 2, 2018	38.93	0.00	155.98	194.92	10.0%
PY10	July 3, 2018	33.84	0.00	146.76	180.60	10.8%
PY10	August 6, 2018	25.07	1.15	180.12	206.34	10.4%
PY10	August 28, 2018	30.69	0.92	160.76	192.36	11.3%
PY10	September 4, 2018	29.99	0.77	142.69	173.45	11.1%
PY10	September 5, 2018	29.52	0.84	131.75	162.12	11.8%
PYVTD - Average PY10 DR Event Performance		**31.34**	**0.61**	**153.01**	**184.96**	**10.9%**
PhaseTD - Average Phase III DR Event Performance		31.60	0.41	141.11	173.12	10.3%

Source: Navigant analysis

The PA PUC 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 137 MW minimum for each DR event. Figure 2-1 compares the performance of each of the DR events in PY10 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 in accordance with the protocols specified in the evaluation framework.[4] Table 2-2 presents the margins of error. PECO exceeded the 85% minimum target for all events in PY10.

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

Figure 2-1. PY10 DR Event Performance Compared to 85% Per-Event Target



Source: Navigant analysis

Table 2-2. PY10 DR Event Performance with Margin of Error (MOE)

Event Date	Verified Gross Load Reduction	Margin of Error (MW)	MOE Upper Value (MW)	MOE Lower (MW)
7/2/2018	194.92	19.45	214.37	175.47
7/3/2018	180.60	19.42	200.02	161.19
8/6/2018	206.34	21.38	227.73	184.96
8/28/2018	192.36	21.76	214.12	170.61
9/4/2018	173.45	19.30	192.75	154.14
9/5/2018	162.12	19.15	181.27	142.97

Source: Navigant 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 current participation totals for PY10 and Phase III.

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

Program Name	Program Year					
	PY8	PY9	PY10	PY11	PY12	Phase III to Date
Residential DR	61,440	60,846	56,030			61,440[a]
Small C&I DR	1,586	1,564	1,427			1,586[a]
Large C&I DR	-	261	348			348[a]
Portfolio Total	**63,026**	**62,671**	**57,805**			**63,374**

[a] 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: Navigant analysis

The nuances of the participant definition vary by program or solution and are included below.

Residential DR Program

The Residential DR Program consists of the Residential Direct Load Control (DLC) Solution. PECO defined the solution's participation counts 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 whose accounts are disconnected, have opted out of the program, or for whom the DLC device was removed are not counted as participants.

Small C&I DR Program

The Small C&I DR Program consists of the Small C&I DLC Solution. PECO defined the solution's participation counts 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 whose accounts are disconnected, have opted out of the program, or for whom the DLC device was removed are not counted as participants.

Large C&I DR Program

The Large C&I DR Program consists of the Demand Response Aggregator (DRA) Solution. PECO defined the solution's participation counts as follows:

> 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 annual report filed in November 2019.

Table 2-4. DR Impact Evaluation Results Summary

Program Name	Parameter	Program Year					
		PY8	PY10	PY10	PY11	PY12	Phase III to Date
Residential DR	Energy RR	N/A	N/A	N/A			N/A
	Demand RR	N/A	N/A	N/A			N/A
	NTG Ratio	1	1	1			1
Small C&I DR	Energy RR	N/A	N/A	N/A			N/A
	Demand RR	N/A	N/A	N/A			N/A
	NTG Ratio	1	1	1			1
Large C&I DR	Energy RR	N/A	N/A	N/A			N/A
	Demand RR	N/A	1.12	1.32			1.26
	NTG Ratio	1	1	1			1

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

Source: Navigant analysis

Table 2-5 summarizes the PYVTD and VTD demand reductions for each of the DR programs 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	Phase III to Date
Reported Gross Demand Savings (MW)	Residential	N/A	N/A	N/A			N/A
	Small C&I	N/A	N/A	N/A			N/A
	Large C&I	N/A	104.80	116.17			112.38
	Total	**N/A**	**104.80**	**116.17**			**112.38**
Verified Gross Demand Savings (MW)	Residential	N/A	32.12	31.19			31.60
	Small C&I	N/A	0.00	0.61			0.41
	Large C&I	N/A	117.30	153.01			141.11
	Total	**N/A**	**149.42**	**184.82**			**173.12**
Relative Precision of Verified Gross Demand Savings at 90% Confidence Interval	Residential	N/A	N/A	N/A			N/A
	Small C&I	N/A	N/A	N/A			N/A
	Large C&I	N/A	112%	132%			126%
	Total	**N/A**	**112%**	**132%**			**126%**

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

Source: Navigant analysis

2.4 Summary of Cost-Effectiveness Results

A detailed breakdown of program finances and cost-effectiveness will be presented in the Annual PY10 Report filed in November 2019, once full program year expenditures are complete.

2.5 Summary of Findings and Recommendations

The PY10 evaluation activities completed by Navigant led to a variety of recommendations for program improvement. Table 2-6 lists the overarching recommendations that affect more than one program, the evaluation activity(s) that uncovered the finding, and Navigant's recommendation(s) to PECO to address the finding.

Table 2-6. Summary of Evaluation Recommendations

Program	Finding	Recommendation	EDC Status
Residential	A large percentage of the AMI meter data contained integers	Prioritize the conversion for the AC Saver Watt-hour population	In process
Small Commercial DR	Technical issues within the CSP software prevented events 1 and 2 from being executed successfully	Work with Small C&I Program CSP to identify the cause of the technical issues and establish a plan for preventing the issue in the future	Under consideration
Large C&I	Meter data was unavailable for two sites, limiting the ability to evaluate impacts for those sites	Investigate issues with onsite metering equipment for those sites in advance of the PY11 DR season	In process

Source: Navigant analysis

2.6 Residential DR Program

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

The Residential DLC Program is implemented by Itron (formerly Comverge). 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 55,000 residential participants. In PY10 and for the remainder of Phase III, participants receive 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 pre-program matching (RPPM) to estimate demand savings. This method is described below.

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 for evaluating 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, Navigant 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 non-participating 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 non-participant 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 argument[5] 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 non-program differences between participants and their matches during the event and snapback (post-event) periods. In this context, the development of a matched control group is a useful pre-processing 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.

Matching Period Identification

Navigant determined the period for which participant and non-participant consumption values were compared to select matches. To do so, Navigant selected as the matching days the non-event, non-holiday weekdays with the most similar temperature profiles to each of Act 129's 6 event days in PY10. Navigant compared the hourly dry-bulb temperature profile of each event day to those of all non-event, non-holiday weekdays in summer 2018 (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. Matching was conducted with replacement allowing for the same non-

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

event day may be paired up with more than one event day. Table 2-7 outlines the selected non-event match day for each of the 6 event days.

Table 2-7. Residential DR Program Selected Match Days

Event Day	Matched Non-Event Day
July 2, 2018	August 29, 2018
July 3, 2018	September 6, 2018
August 6, 2018	July 11, 2018
August 28, 2018	July 16, 2018
September 4, 2018	August 29, 2018
September 5, 2018	September 6, 2018

Source: Navigant analysis

Selecting Matched Controls

For a given participant, the non-participant 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 6 event days. Participants and non-participants missing data in their hourly matching day load profile were excluded from the algorithm.

Matching was conducted with replacement: one non-participant could act as a match for multiple participants. If a non-participant was used as a control for multiple participants, that non-participant's data was included in the estimation set as many times as participants for which it acts as a control – i.e., if a non-participant was selected as a control customer for three participants, that customer's data appeared 3 times in the estimation set.

Regression Model

Once the matched control group was established, the next step in the impact analysis was to predict the baseline energy use for participants for the hours corresponding to each DLC event period. The hourly impacts were estimated 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 variable.

Equation 2-1. Residential Lagged Dependent Variable Regression

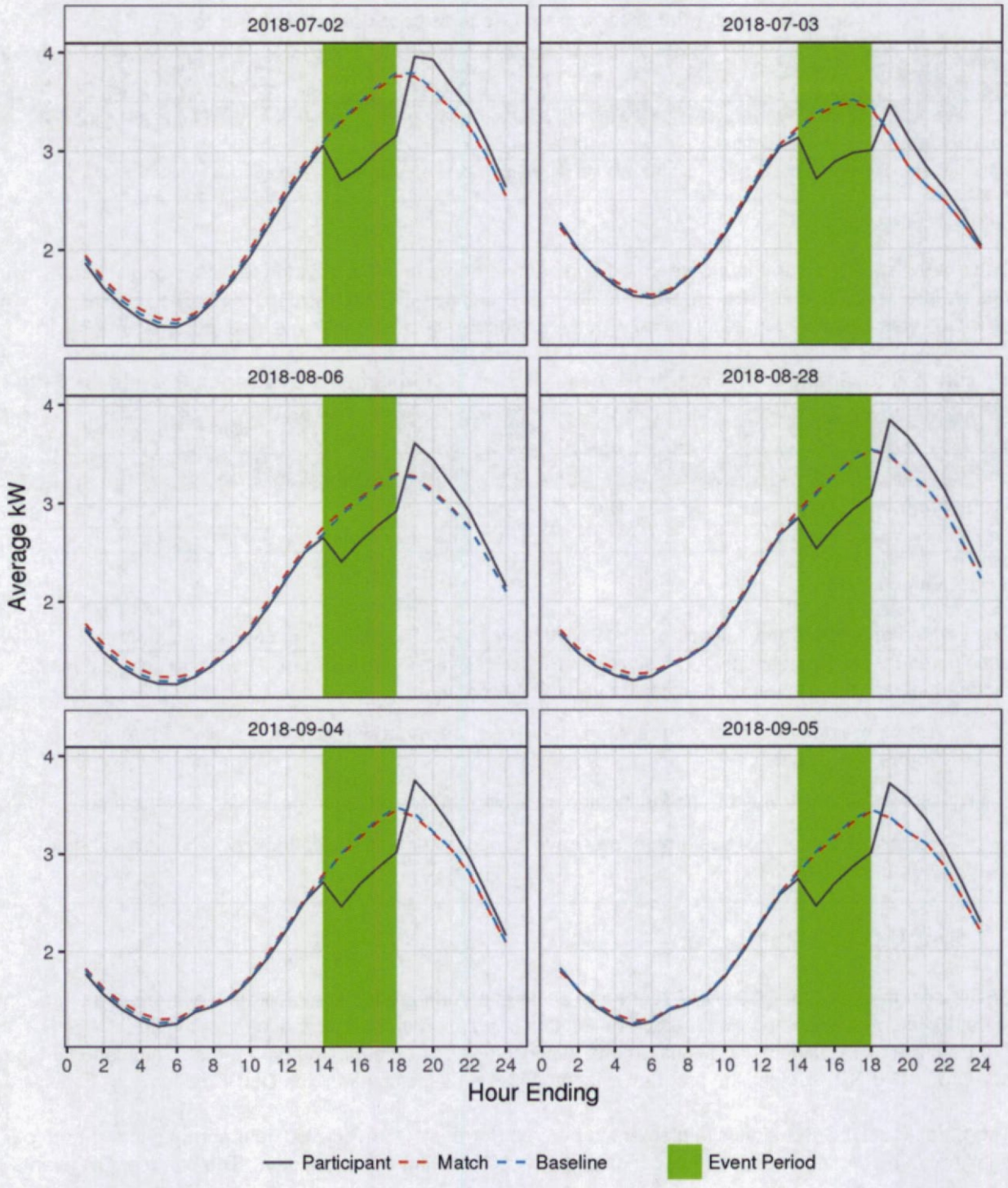
$$y_{i,t} = \sum_{e=1}^{E}\sum_{h=1}^{H=24} \beta_{1,e,h} E_{e,t} hour_{h,t} + \sum_{h=1}^{H=24} \beta_{2,h} hour_{h,t} prekW_{i,t,e} + \sum_{e=1}^{E}\sum_{c=1}^{C} \gamma_{1,e,c} E_{e,t} C_{i,c,t} + \sum_{e=1}^{E}\sum_{s=1}^{S} \gamma_{2,e,s} E_{e,t} SB_{i,s,t} + \varepsilon_{i,t}$$

Where:

$y_{i,t}$	=	The consumption of customer *i* in hour *t* of the sample.
$E_{e,t}$	=	A set of E dummy variables, one for each event day.
$hour_{h,t}$	=	A set of H = 24 dummy variables, each equal one when *t* is the t-th hour of the day and zero otherwise. This is a time-wise fixed effect when interacted with the event dummy variables.
$prekW_{i,t,e}$	=	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 one when customer *i* is a DR participant and hour *t* is the *c*-th curtailment hour of the event, and zero otherwise.
$SB_{i,s,t}$	=	A set of S dummy variables intended to capture the impact of snapback. Equivalent to the $C_{i,c,t}$ except that they apply to the hours following the event, rather than during the event. Navigant 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 non-participant loads (red dashed) for all customers and illustrates the reduction in load in each hour of the event period.

Figure 2-2. PY10 Residential DR Average Actual Load and Estimated Baseline Load by Event



Source: Navigant analysis

Table 2-8 provides the sampling frame for the gross impact evaluation of the Residential DR Program in PY10.

Table 2-8. Residential DR Program Gross Impact Sample Design for PY10

Stratum Solution	Stratum Name	Percentage of Program Reported Savings	Population Size	Achieved Sample Size	Verification Method
Total Program	Residential	100%	56,030	56,029	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: Navigant analysis

Table 2-9 provides a summary of reported and verified demand (MW) savings results, along with the relative precision for each stratum sampled for the Residential DR Program in PY10. The relative precision was calculated in accordance with the protocols specified in the evaluation framework.[6]

Table 2-9. Residential DR Program Gross Demand Savings Impact Evaluation Results for PY10

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	31.34	N/A	1%

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

Source: Navigant analysis

The verified gross demand savings of 31.19 MW represents 83% of the expected savings of the 37.5 MW anticipated 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 time of system peak through the curtailment of space-cooling loads. The eligible population and target markets for the Small C&I DR Program are all PECO small C&I customers; this includes customers in the government, educational, and non-profit (G/E/NP) sector. The program encompasses a single solution: the DLC Solution.

The Small C&I DLC Solution is implemented by Itron (formerly Comverge). The program shifts load to off-peak hours by cycling participant air conditioners by 50% during DR event days. The summer DR events

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

had over 1,400 small C&I participants. In PY10 and for the remainder of Phase III, participants receive an incentive of $40 per DLC unit per year.

2.7.1 Gross Impact Evaluation

For the Small C&I DR Program, the evaluation plan aligned the small commercial model as closely as possible with the residential model. However, the pool of small commercial participants and non-participants are more heterogenous, making it difficult to perform matching. Navigant therefore employed a within-subjects approach with a fixed-effects model, similar to the PY9 evaluation methodology. The two approaches differ in their construction of the estimated baseline. For the residential sector, the estimated baseline is derived from the event-day consumption patterns of non-participating customers, whereas for the Small C&I Program, the estimated baseline is derived from the non-event-day consumption patterns of the participants themselves.

Within-Subjects Regression

When the development of 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 used to estimate the counterfactual (the baseline). Navigant 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, Navigant found a matching non-event day with the most similar hourly temperature profile, based on Euclidean distance. Navigant further constrained non-event day matches to share the same month as the corresponding event day.

The event dates included in the regressions were August 6, August 28, September 4, and September 5. The non-event dates included in the regression were August 7, August 29, and September 6. The event days July 2 and July 3 were excluded from the model, and Navigant did not estimate impacts for these events. Due to reported technical issues, the event on July 2 was cancelled midway through, and the event on July 3 was not called at all.

Equation 2-1 shows the within-subjects regression equation. This model estimates customer load as a function of the event hours, cooling degree hours, normalized heat buildup, and snapback effect in post-event hours. Variables included in the within-subjects regression were demeaned by hour and account, effectively making the model in Equation 2-1 a fixed-effects specification. Navigant estimated a separate regression for each hour of the day between 9 a.m. and 10 p.m., eastern prevailing time (hours ending 10 through 22).

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

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

Where:

i	=	Customer.
t	=	Hour ending.
$y_{i,t}$	=	Hourly demand for customer i during hour-ending t.
$hour_{h,t}$	=	A set of 24 dummy variables, each equal to 1 when hour-ending t is the h-th hour of the sample and 0 otherwise. These are a time-wise fixed effects.
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 6 indicated variables equal to 1 when the date of the sample is equal to the date of event e and 0 otherwise. These are event-day fixed effects.
$C_{i,c,t}$	=	A set of C dummy variables, capturing the impacts of event curtailment. Each variable is equal to one when customer *i* is a DR participant and hour *t* is the *c*-th curtailment hour of the event, and zero otherwise.
$SB_{i,c,t}$	=	A set of S dummy variables intended to capture the impact 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 commercial air conditioning cycling programs, but this term is included to verify that assumption. Navigant applied these variables to all hours following the end of the curtailment event up to midnight of the event day.
$cdh_{i,t}$	=	Is the number of cooling degree hours in during hour-ending *i*. The base for this calculation is 65°F.
$hbu_{i,t}$	=	Is 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 adjustment[7] as:

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

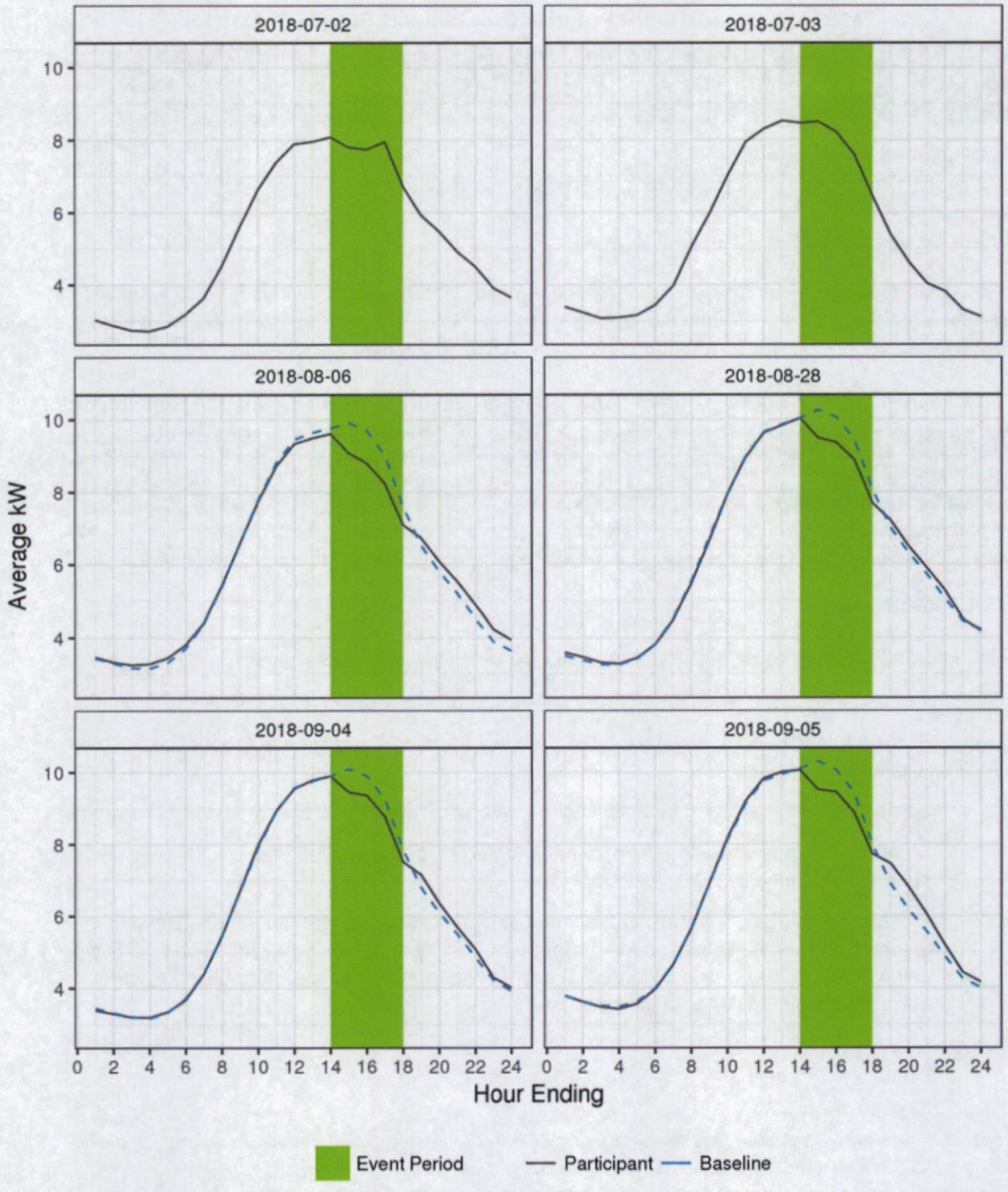
Where *T* is the dry-bulb temperature in degrees Fahrenheit and *RH* is relative humidity in percent.

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. No baseline or impacts were estimated for events 1 and 2, due to reported technical issues in deploying the event signal.

[7] 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. PY10 Small C&I Average Actual Load and Estimated Baseline Load by Event



Source: Navigant analysis

Table 2-10 provides the sampling frame for the gross impact evaluation of the Small C&I DR Program in PY10.

Table 2-10. Small C&I DR Program Gross Impact Sample Design for PY10

Stratum Solution	Stratum Name	Percentage of Program Reported Savings	Population Size	Achieved Sample Size	Verification Method
Total Program	Small C&I	99%	1,427	1,414	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: Navigant analysis

Table 2-11 provides a summary of reported and verified demand (MW) savings results, along with the relative precision for each stratum sampled for the Small C&I DR Program in PY10. The relative precision was calculated in accordance with the protocols specified in the evaluation framework.[8]

Table 2-11. Small C&I DR Program Gross Demand Savings Impact Evaluation Results for PY10

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	0.61	N/A	12%

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

Source: Navigant analysis

The following are possible factors that may have led to the low verified savings:

- Technical issues in the CSP software prevented events 1 and 2 from successful execution.
- Some 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.
- Air conditioning DLC for small to medium businesses typically delivers modest savings (for example, in Navigant's evaluation of Southern California Edison's Air Conditioning DR program,[9] estimated impacts on the hottest event day—average event temperature 96.8°F—were approximately 0.4 kW per customer).[10]

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

[9] Navigant Consulting, Prepared for Southern California Edison, *2014 Load Impact Evaluation of Southern California Edison's Residential and Commercial Summer Discount Plan (SDP) Programs*, March 2015.

[10] Approximately three-quarters of participants were subject to 100% cycling, with the rest subject to 50% cycling.

2.8 Large C&I DR Program

PECO designed the Large C&I DR Program to engage customers in demand reduction through demand response aggregation across multiple customers. The eligible population and target markets for the PECO Large C&I DR Program are all PECO large C&I electric customers, including those in the G/E/NP sector. The program encompasses a single solution, the DRA Solution, and is implemented by two CSPs, EnelX (formerly EnerNOC) and CPower.

2.8.1 Gross Impact Evaluation

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

Customer Baselines

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

Additionally, qualifying non-event days are eligible for inclusion in the baseline only if the participant's average demand between 2 p.m. and 6 p.m. eastern prevailing time 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 look-back window. Z will be set as a decreasing function of Y; as Y increases, Z falls. Z is defined in the function below:

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

This means that when the look-back window (Y) is 2 days, both day's 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 the other day). When the baseline window (Y) is 4 days, Z is 25%, and 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.

Regression Models

Navigant tested 33 regression model specifications, which consisted of a based model and 32 combinations of additional variables. The base model accounts for a basic set of demand patterns and is specified as follows:

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

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

Where:

y_t	=	The given customer's demand in hour of sample *t*.
$hour_{h,t}$	=	Twenty-four dummy variables capturing the hours of the day. Equal to one where hour *t* is the h-th hour of the day, and zero otherwise.
$Month_{m,t}$	=	Four dummy variables capturing the month. Equal to one when hour of sample *t* falls in month *m*, and zero otherwise.
$DoW_{d,t}$	=	Five dummy variables capturing the day of the week. Equal to one when hour of sample *t* falls in day of the week *d* and zero 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.[11] 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 one when hour of sample t falls in the c-th event hour of the summer of 2018, and zero otherwise. Each dummy variable takes a value of one 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:

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 2-13.

$spline_{s,t}$ = 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.[12] The cdh_t value interacted with the spline (see Table 2-13) in the equation will the difference between the observed CDH and the lower threshold of the given spline, or zero (whichever is higher).For example, where s is equal to two, cdh_t is equal 30 and the spline threshold is equal to 20, $spline_{1,t}$ would take a value of one (dummy) and be multiplied by 20, and $spline_{2,t}$ would also take a value of one (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 the table below.

$EMA6cdh_t$ = An exponential moving average of cdh_t observed in the six-hour period leading up to, and including, hour t. This variable is represented as "ema_6_cdh" in the table below.

$EMA24cdh_t$ = Identical to $EMA6cdh_t$, except for 24, instead of, six hours. This variable is represented as "ema_24_cdh" in the table below.

$daLMP_t$ = The day-ahead PJM forecast of the locational marginal price (LMP) of power for hour t. This variable is represented as "da_lmp" in the table below.

$rtLMP_t$ = The real-time PJM LMP for hour t. This variable is represented as "rt_lmp" in Table 2-13.

Table 2-13 provides the 32 additional model specifications that were tested for each participant, in addition to the core base model shown in Equation 2-3. All of the variables shown in Table 2-13 will be added to the core or base model for testing.[13] Interactions of multiple variables are represented as multiplications (e.g., "cdh*hour"). The $hour_{q,t}$ variable from Equation 2-3 is represented below as "hour," the $Month_{m,t}$ variable is represented as "month," and the $DoW_{d,t}$ is represented as "dow."

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[11] As per the memorandum from the Phase III SWE team of 2017-04-26 ("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.

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

[13] For example, Spec #1 would include all the variables listed in Equation 2-3, but would also include an interaction between the hourly dummies and the cooling degree hour term.

Table 2-13: Large C&I Incremental Variables Tested

Spec #	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
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_lmp*hour			
26	da_lmp*hour	cdh*hour		
27	da_lmp*hour	cdh*hour	ema_6_cdh*hour	
28	da_lmp*hour	cdh*hour	ema_24_cdh*hour	
29	rt_lmp*hour			
30	rt_lmp*hour	cdh*hour		
31	rt_lmp*hour	cdh*hour	ema_6_cdh*hour	
32	rt_lmp*hour	cdh*hour	ema_24_cdh*hour	

Data from May through September were included in the regression models. For all models, the following dates were excluded:

As in the CBL methodology, all 33 regression model specifications in Table 2-13 (the core/base model and 32 additions) exclude from the estimation dataset:

- Weekends and holidays
- Days in which the given participant also participated in PJM's Economic or Emergency DR events
- Days on which participants are notified of Act 129 events
- Days on which the participant facility is closed.

PECO provided Navigant with program participant operation and maintenance schedules and dates of planned facility closures, where possible. Navigant excluded these dates from the estimation dataset. In addition, Navigant tested the following data exclusions for all 33 model specifications:

- Excluding all non-event days in which the average customer demand during the typical event window (12 p.m.–8 p.m., EDT) is in the bottom 10% of the distribution.
- Excluding all non-event days in which the average customer demand during the typical event window (12 p.m.–8 p.m., EDT) is in the bottom 20% of the distribution.
- Excluding all non-event days in which the average customer demand during the typical event window (12 p.m.–8 p.m., EDT) is in the bottom 30% of the distribution.
- Excluding all non-event days in which the average customer demand during the typical event window (12 p.m.–8 p.m., EDT) is in the bottom 40% of the distribution.

Each of these exclusions was applied 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, 165 different sets of parameters were estimated for regression models—33 specifications, once with no additional exclusions, and 4 times with different exclusion rules.

Model Testing and Selection

Navigant implemented a protocol to select the best model for each participant to estimate impacts on all event days. For each participant, the same model was used 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 the selection of 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—days on which no Act 129 events take place.

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 is no apparent response to PJM 5CP pricing[14]
- Excluding days in which participants received 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. Note that the HOT days selected for one participant may be very 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, a baseline was estimated 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, a baseline[15] was estimated using each of the regression specifications nominated for testing (per Table 2-13) along with the four different sets of exclusions. Each regression was re-estimated 3 times for each customer, once for each HOT Act 129 event. A HOT Act 129 event was only considered an event for testing purposes if the accuracy of the regression's prediction for that event that was being tested. This 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
The selection criterion metric, root mean squared error (RMSE), was calculated 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, all tested CBLs and regression models were ranked 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.

Large Participants

Navigant investigated the top 12 largest customers who account for over 50% of the expected demand response. In consultation with PECO and the SWE, Navigant 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, Navigant made ad hoc adjustments for three large customers. These adjustments included dropping certain data due to known metering issues and altering the model specification to account for idiosyncratic use patterns.

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

[15] 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 zero.

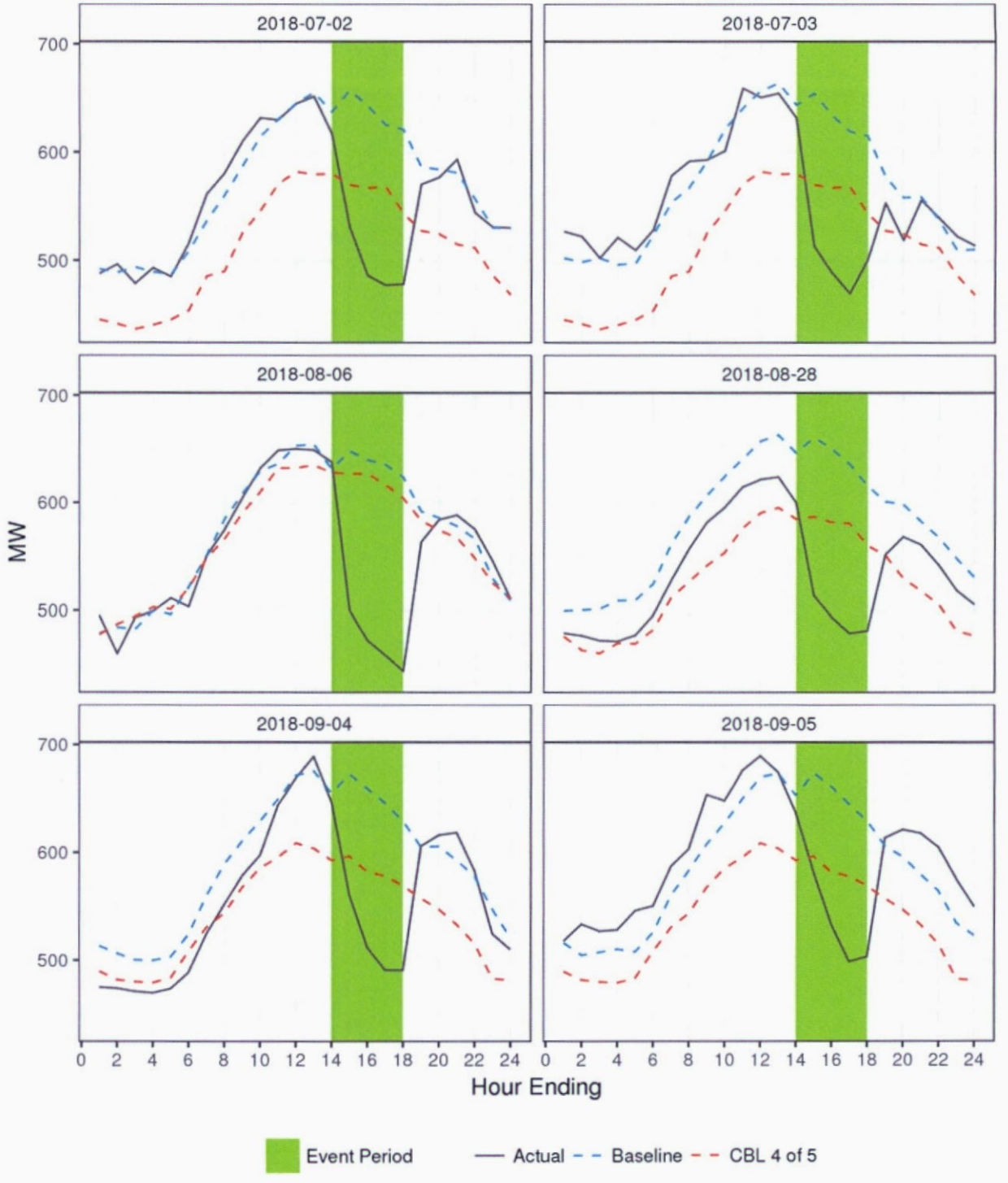
Participants Missing Interval Data

Navigant identified two accounts with poor data quality resulting from faulty metering, which caused the team to be unable to develop verified impact values for these sites. The sites were originally contracted at 5 MW and 2 MW, respectively. In consultation with the SWE, Navigant used the CSP reported value and applied the reported/verified realization rate (132%) to account for the difference between the CSP estimate and the higher impacts found using the full evaluation methodology.

Impact Results

Figure 2-4 shows the aggregated results of the regression analysis, representing the sum of all analyzed accounts, 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. The discrepancy observed in event 4 (2018-08-06) can be ascribed to uncharacteristic demand on this day for the largest customer in the program. The red dashed line represents the aggregated baseline calculated using only the 4-of-5 CBL methodology. Note that in all events, the 4-of-5 CBL method would have underpredicted total impacts, in most cases by a significant margin.

Figure 2-4. PY10 Large C&I Aggregated Actual Load and Estimated Baseline by Event



Source: Navigant analysis

Table 2-14 provides the sampling frame for the gross impact evaluation of the Large C&I DR Program in PY10. In total, a regression method was selected for 287 participants, while a CBL method was selected for 59 participants.

Table 2-14. Large C&I DR Program Gross Impact Sample Design for PY10

Stratum Solution	Stratum Name	Percentage of Program Reported Savings	Population Size	Achieved Sample Size	Verification Method
Total Program	Large C&I DR	99%	348	346[16]	Regression or CBL

Source: Navigant analysis

Table 2-15 provides a summary of reported and verified demand (MW) savings results, along with the relative precision for each stratum sampled for the Large C&I DR Program in PY10. The relative precision was calculated in accordance with the protocols specified in the evaluation framework.[17]

Table 2-15. Large C&I DR Program Gross Demand Savings Impact Evaluation Results for PY10

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	116.17	153.01	132%	5%

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

Source: Navigant analysis

The variance in performance by event can be attributed to the program's sensitivity to the performance of a few large customers. For example, events 3 and 4 exhibited higher than expected savings due to the overperformance of a few large customers, while event 6 showed the least savings due to a few large customers opting out of the event.

[16] The achieved sample size excludes the two accounts missing interval data, as previously discussed.

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

APPENDIX A. DEMAND RESPONSE PROGRAMS

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

Table A-1. PY10 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	HE15	36.74	0.00	137.82	174.56
2-Jul-18	HE16	40.37	0.00	169.82	210.19
	HE17	39.89	0.00	160.93	200.81
	HE18	38.73	0.00	155.37	194.10
	Average Event Impact by Program	**38.93**	**0.00**	**155.98**	**194.92**
	Error Margin at 90% CI	***1.14***	***0.00***	***19.42***	***19.45***
Event 2	HE15	40.41	0.00	151.76	192.16
3-Jul-18	HE16	35.65	0.00	155.89	191.54
	HE17	32.71	0.00	157.56	190.27
	HE18	26.59	0.00	121.85	148.44
	Average Event Impact by Program	**33.84**	**0.00**	**146.76**	**180.60**
	Error Margin at 90% CI	***1.01***	***0.00***	***19.39***	***19.42***
Event 3	HE15	29.16	1.26	157.39	187.82
6-Aug-18	HE16	25.42	1.39	179.31	206.12
	HE17	23.73	1.19	190.08	215.00
	HE18	21.96	0.77	193.72	216.44
	Average Event Impact by Program	**25.07**	**1.15**	**180.12**	**206.34**
	Error Margin at 90% CI	***0.86***	***0.18***	***21.36***	***21.38***
Event 4	HE15	33.31	1.17	159.74	194.22
28-Aug-18	HE16	31.09	1.06	169.03	201.17
	HE17	30.20	0.86	169.52	200.59
	HE18	28.14	0.57	144.75	173.46
	Average Event Impact by Program	**30.69**	**0.92**	**160.76**	**192.36**
	Error Margin at 90% CI	***0.84***	***0.14***	***21.74***	***21.75***

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	HE15	32.79	0.99	128.05	161.83
4-Sep-18	HE16	29.87	0.82	124.36	155.06
	HE17	29.89	0.74	168.28	198.90
	HE18	27.42	0.51	150.06	178.00
	Average Event Impact by Program	**29.99**	**0.77**	**142.69**	**173.45**
	Error Margin at 90% CI	***0.82***	***0.14***	***19.29***	***19.30***
Event 6	HE15	33.54	1.19	117.79	152.52
5-Sep-18	HE16	29.53	0.94	113.60	144.08
	HE17	28.77	0.83	158.37	187.98
	HE18	26.24	0.41	137.25	163.90
	Average Event Impact by Program	**29.52**	**0.84**	**131.75**	**162.12**
	Error Margin at 90% CI	***0.68***	***0.14***	***19.14***	***19.15***
Average Program Year Impact (PYVTD)		**31.34**	**0.61**	**153.01**	**184.96**
Average Phase III Impact (VTD)*		***31.60***	***0.41***	***141.11***	***173.12***

Source: Navigant analysis

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