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November 15, 2018

Via Federal Express
Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street
Second Floor
Harrisburg, Pennsylvania 17120

Re: PUC Docket No. M-2015-2515691
Phase III Energy Efficiency and Conservation Program Annual Report for June 1, 2017 through May 31, 2018

Dear Secretary Chiavetta:

In accordance with Section IV.E.2 of the Commission's Opinion and Order Letter dated March 17, 2016 (Docket No. M-2015-2515691), enclosed is PECO's Phase III Annual Energy Efficiency & Conservation Report for the period June 1, 2017 through May 31, 2018.

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.

Please acknowledge receipt of the foregoing on the enclosed copy of this letter.

If you have any further questions regarding this matter, please call me at 215-841-5777.

Sincerely,

cc: 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

Enclosures

NAVIGANT

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

Program Year 9

(June 1, 2017 - May 31, 2018)

For Pennsylvania Act 129 of 2008

Energy Efficiency and Conservation Plan

Prepared for:

PECO
An Exelon Company

Prepared by:
Navigant Consulting, Inc.
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Boulder, Colorado 80302

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November 15, 2018

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ACRONYMS

AMI	Advanced Metering Infrastructure
AC	Air Conditioner
ASHP	Air Source Heat Pump
BDR	Behavioral Demand Response
CAC	Central Air Conditioner
C&I	Commercial and Industrial
CAP	Customer Assistance Program
CDO	Commercial Date of Operation
CF	Coincidence Factor
CFL	Compact Fluorescent Lamp
CfP	Call for Projects
CHP	Combined Heat and Power
CI	Confidence Interval
CSP	Conservation Service Provider or Curtailment Service Provider
C_V	Coefficient of Variation
DLC	Direct Load Control
DR	Demand Response
DRA	Demand Response Aggregator
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
EEMF	Energy Efficiency Marketing Firm
EM&V	Evaluation, Measurement, and Verification
EPA	US Environmental Protection Agency
EUL	Effective Useful Life
FPL	Federal Poverty Level
G/E/NP	Government/Education/Non-Profit
GIS	Geographic Information System
HE	Hour Ending
HER	Home Energy Report
HIM	High Impact Measure
HOU	Hours of Use
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
ISR	In-Service Rate
kW	Kilowatt

kWh	Kilowatt-Hour
LDV	Lagged Dependent Variable
LED	Light-Emitting Diode
LEEP	Low-Income Energy Efficiency Program (Phase II)
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification
MW	Megawatt
MWh/yr	Megawatt-hour
NPV	Net Present Value
NTG	Net-to-Gross
O&M	Operations and Maintenance
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
PSD	Performance Systems Development
PUF	Part-Use Factor
PY	Program Year: e.g., PY8, from June 1, 2016, to May 31, 2017
PYRTD	Program Year Reported to Date
PYVTD	Program Year Verified to Date
RCT	Randomized Controlled Trial
RFP	Request for Proposals
RPPM	Regression with Pre-Program Matching
RR	Realization Rate
RTD	Phase III to Date Reported Gross Savings
RTO	Regional Transmission Organization
RUL	Remaining Useful Lifetime
SF	Single-family
SIDS	Smart Ideas Data System
SKU	Stock Keeping Unit
SWE	Statewide Evaluator
T&D	Transmission and Distribution
TRC	Total Resource Cost
TRM	Technical Reference Manual
VFD	Variable Frequency Drive
VTD	Phase III to Date Verified Gross Savings
VTD + CO	Phase III to Date Verified Gross Savings plus Carryover from Phase II

STRATUM ABBREVIATIONS

Program	Solution	Stratum Name	Abbreviated Stratum Name
Residential EE	Lighting, Appliances & HVAC	Appliances	Appliances
		HVAC	HVAC
		Standard LED	Standard LED
		Specialty LED	Specialty LED
	Appliance Recycling	Refrigerators	Refrigerators
		Freezers	Freezers
		Room Air Conditioners (AC)	Room ACs
	Residential Whole Home	Very Small Projects (<342 kWh), PY8	Very Small Projects, PY8
		Very Small Projects (<342 kWh), PY9	Very Small Projects, PY9
		Small Projects (343 kWh-1,128 kWh), PY8	Small Projects, PY8
		Small Projects (343 kWh-1,128 kWh), PY9	Small Projects, PY9
		Medium Projects (1,129 kWh-1,789 kWh), PY8	Medium Projects, PY8
		Medium Projects (1,129 kWh-1,789 kWh), PY9	Medium Projects, PY9
		Large Projects (>1,790 kWh), PY8	Large Projects, PY8
		Large Projects (>1,790 kWh), PY9	Large Projects, PY9
	Residential New Construction	Solution Total	Solution Total
	Behavior	Solution Total	Solution Total
	Residential Multifamily Targeted	Multisector – C&I and Residential: Buildings with common areas in the C&I segments and units in residential segment	Multisector
		Large – Residential: Buildings in residential market segment with a single decision maker for all projects in the building	Large Residential
		Small – Residential: Projects in residential market segment with individual decision makers	Small Residential
Residential Low-Income EE	Low-Income Whole Home	Large SF (>1,790 kWh)	Large SF
		Medium SF (780 kWh-1,789 kWh)	Medium SF
		Small SF (260 kWh-779 kWh)	Small SF
		Very Small SF (<259 kWh)	Very Small SF
		Multifamily (all)	Multifamily
	Lighting	Solution Total	Solution Total

Program	Solution	Stratum Name	Abbreviated Stratum Name
Small C&I EE	Equipment and Systems	Very high impact measures (project savings ≥ 3 million kWh)	Very High Impact
		High impact and/or high uncertainty measures (200,000 ≤ project savings < 3 million)	High Impact/Uncertainty
		Medium impact and/or medium uncertainty measures (70,000 ≤ project savings < 200,000)	Medium Impact/Uncertainty
		Low impact measures (project savings < 70,000)	Low Impact
	Small C&I New Construction	Very high impact measures (project savings ≥ 3 million kWh)	Very High Impact
		High impact and/or high uncertainty measures (300,000 ≤ project savings < 3 million)	High Impact/Uncertainty
		Low and medium-impact and/or medium-uncertainty measures (<300,000)	Low/Medium Impact/Uncertainty
	Small C&I Multifamily Targeted	Small – C&I: Buildings in small C&I market segment	Small
		Multisector – C&I and Residential: Buildings with common areas in the C&I segments and units in residential segment	Multisector
	Whole Building	Medium impact/uncertainty measures	Medium Impact/Uncertainty
		Low impact/uncertainty measures	Low Impact/Uncertainty
Large C&I EE	Equipment and Systems	Very high impact measures (project savings ≥ 3 million kWh)	Very High Impact
		High impact and/or high uncertainty measures (700,000 ≤ project savings < 3 million)	High Impact/Uncertainty
		Medium impact and/or medium uncertainty measures (200,000 ≤ project savings < 700,000)	Medium Impact/Uncertainty
		Low impact measures (project savings < 200,000)	Low Impact
	Large C&I New Construction	Very high impact measures (project savings ≥ 3 million kWh)	Very High Impact
		High impact and/or high uncertainty measures (300,000 ≤ project savings < 3 million)	High Impact/Uncertainty
		Low and Medium-impact and/or medium-uncertainty measures (< 300,000)	Low/Medium Impact/Uncertainty
	Large C&I Multifamily Targeted	Large – C&I: Buildings in large C&I market segment	Large

Program	Solution	Stratum Name	Abbreviated Stratum Name
		Multisector – C&I and Residential: Buildings with common areas in the C&I segments and units in residential segment.	Multisector
	Large C&I Data Centers	All Projects	Census
Combined Heat and Power	**CHP**	Census	Census

TYPES OF SAVINGS

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

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

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

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

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

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

Annual Savings: Energy and demand savings expressed on an annual basis, or the amount of energy and/or peak demand an EE&C measure or program can be expected to save over the course of a typical year. Annualized savings are noted as MWh/year or MW/year. The Pennsylvania Technical Reference Manual (TRM) provides algorithms and assumptions to calculate annual savings, and Act 129 compliance

targets for consumption reduction are based on the sum of the annual savings estimates of installed measures or behavior change.

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

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

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

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

1. **Phase III to Date Reported (RTD):** The sum of the reported gross savings recorded to date in Phase III of Act 129 for an EE&C program or portfolio.
2. **Phase III to Date Verified (VTD):** The sum of the verified gross savings recorded to date in Phase III of Act 129 for an EE&C program or portfolio, as determined by the impact evaluation finding of the independent evaluation contractor.
3. **Phase III to Date Preliminary Savings Achieved (PSA):** The sum of the verified gross savings (VTD) from previous program years in Phase III where the impact evaluation is complete plus the reported gross savings from the current program year (PYTD). For PY8, the PSA savings will always equal the PYTD savings because PY8 is the first program year of the phase (no savings will be verified until the PY8 final annual report).
4. **Phase III to Date Preliminary Savings Achieved + Carryover (PSA+CO):** The sum of the verified gross savings from previous program years in Phase III plus the reported gross savings from the current program year plus any verified gross carryover savings from Phase II of Act 129. This is the best estimate of an EDC's progress toward the Phase III compliance targets.
5. **Phase III to Date Verified + Carryover (VTD + CO):** The sum of the verified gross savings recorded to date in Phase III plus any verified gross carryover savings from Phase II of Act 129.

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

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

1. INTRODUCTION

Pennsylvania Act 129 of 2008, signed on October 15, 2008, mandated energy savings and demand reduction goals for the largest electric distribution companies (EDCs) in Pennsylvania for Phase I (2008-2013). 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.

Implementation of Phase III of the Act 129 programs began on June 1, 2016. This report documents the progress and effectiveness of the Phase III EE&C accomplishments for PECO in Program Year 9 (PY9), 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, reported gross, verified gross, and verified net impacts of the energy efficiency (EE) programs in PY9. Compliance with Act 129 savings goals are ultimately based on verified gross savings. This report also includes estimates of cost-effectiveness according to the total resource cost (TRC) test.[1] 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 gross verified and net verified savings.

For select program solution offerings (solutions), Navigant also performed targeted process evaluation activities to examine targeted research. This report presents relevant key findings and recommendations identified by the process evaluation and documents any changes to EE&C program delivery to be considered based on the recommendations.

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 for the EE programs. PECO reported the verified gross DR impacts for PY9 as well as the cumulative DR performance of the EE&C program to date for Phase III of Act 129 in the *Semiannual Report to the Pennsylvania Public Utility Commission*[2] filed July 16, 2018. Section 3.6 of this report includes PECO's previously reported DR performance results for PY9.

[1] The Pennsylvania TRC test for Phase I was adopted by PUC order at Docket No. M-2009-2108601 on June 23, 2009 (2009 PA TRC Test Order). The TRC Test Order for Phase I was later 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.

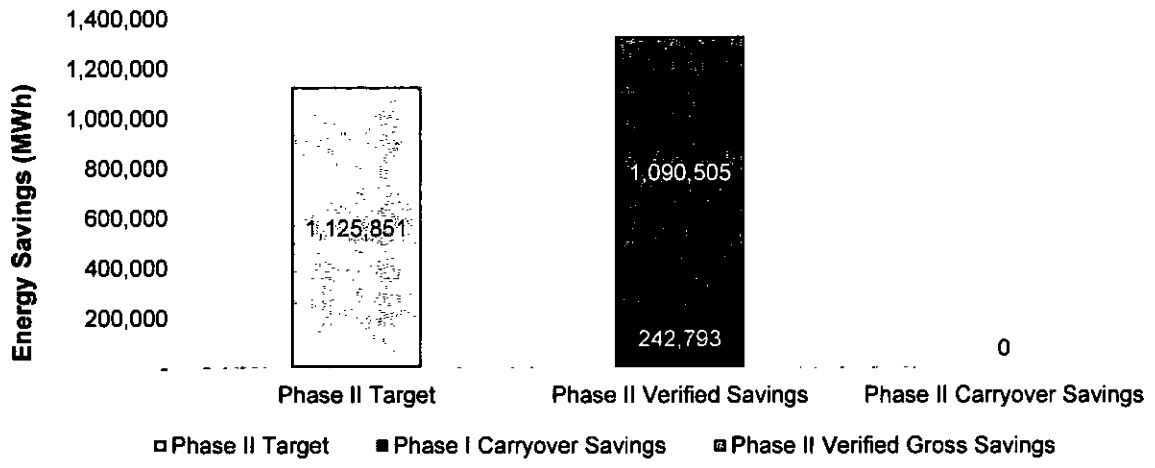
[2] Semiannual Report to the Pennsylvania Public Utility Commission, http://www.puc.pa.gov/pcdocs/1577535.pdf.

2. SUMMARY OF ACHIEVEMENTS

2.1 Carryover Savings from Phase II of Act 129

PECO reported zero portfolio-level carryover savings from Phase II to Phase III. The Commission's Phase III Implementation Order[3] allowed EDCs to carry over 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, it was not eligible to carry over savings from Phase II toward its Phase III overall compliance target.[4]

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



Sources: Smart Ideas Data System (SIDS) database, Conservation Service Provider (CSP) tracking data

The Commission's Phase III Implementation Order[5] 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.[6] PECO carried over 0 MWh/yr of G/E/NP and 0 MWh/yr of low-income

[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.

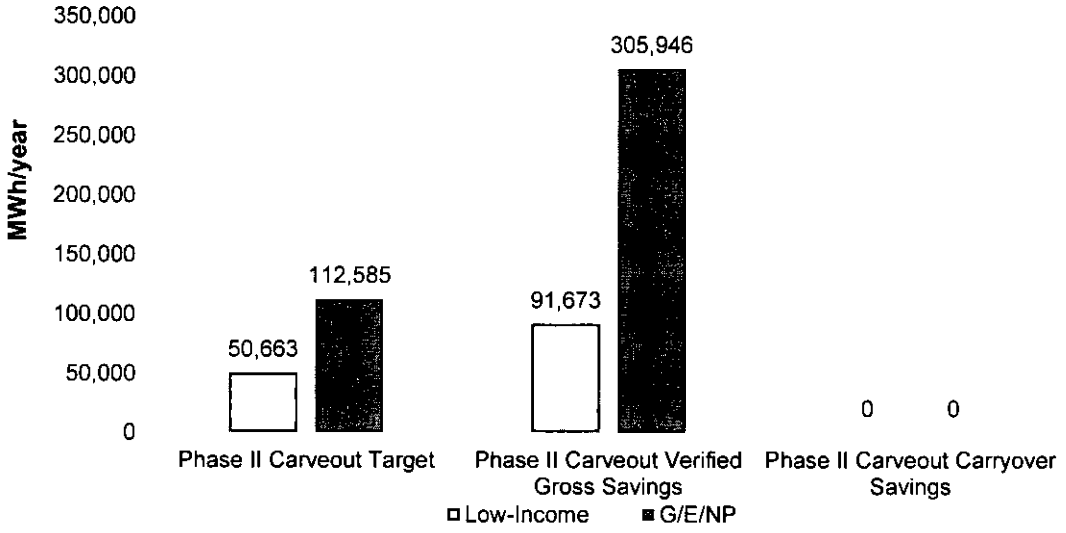
[4] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Compliance Order*, at Docket No. M-2012-2289411, (*Phase II Compliance Determination Order*), entered August 3, 2017.

[5] 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.

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

customer segment savings.[7] Figure 2-2 shows the calculation of carryover savings for the low-income and G/E/NP targets.[8]

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



Sources: Navigant analysis

2.2 Phase III Energy Efficiency Achievements to Date

In PY9, starting on June 1, 2017 and ending on May 31, 2018, PECO has claimed the following savings:

- 398,756.9 MWh/yr of reported gross electric energy savings (PYRTD)
- 42.11 MW of reported gross peak demand savings (PYRTD) from EE programs
- 388,018.8 MWh/yr of verified gross electric energy savings (PYVTD)
- 49.92 MW of verified gross peak demand savings (PYVTD) from EE programs

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

- 610,289.0 MWh/yr of reported gross electric energy savings (RTD)
- 62.91 MW of reported gross peak demand savings (RTD) from EE programs
- 598,707.4 MWh/yr of verified gross electric energy savings (VTD)
- 78.56 MW of verified gross peak demand savings (VTD) from EE programs

[7] 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.

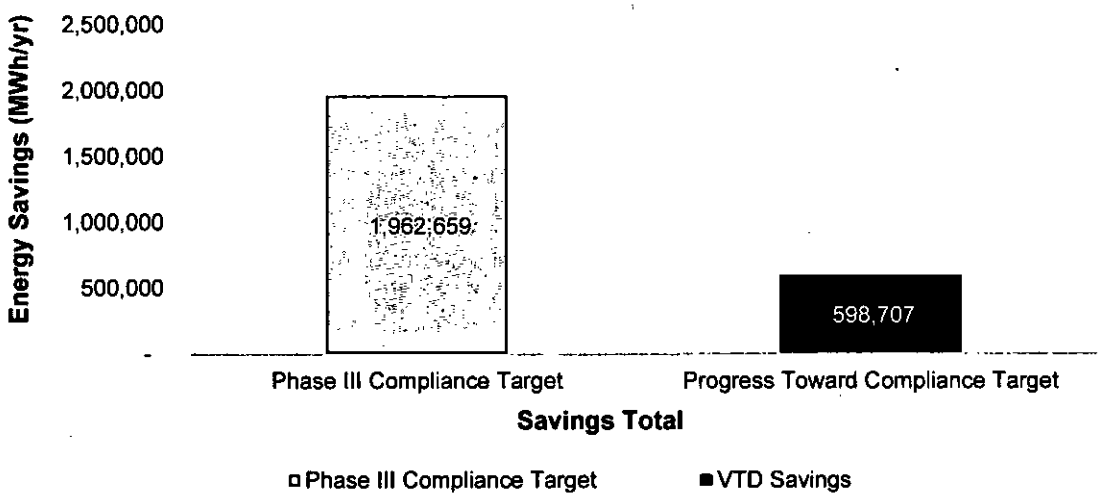
[8] Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Compliance Order*.

Including carryover savings from Phase II, PECO has achieved:

- 598,707.4 MWh/yr of VTD plus portfolio-level CO energy savings
    - This represents 30.5% of the May 31, 2021 energy savings compliance target of 1,962,659 MWh/yr

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

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

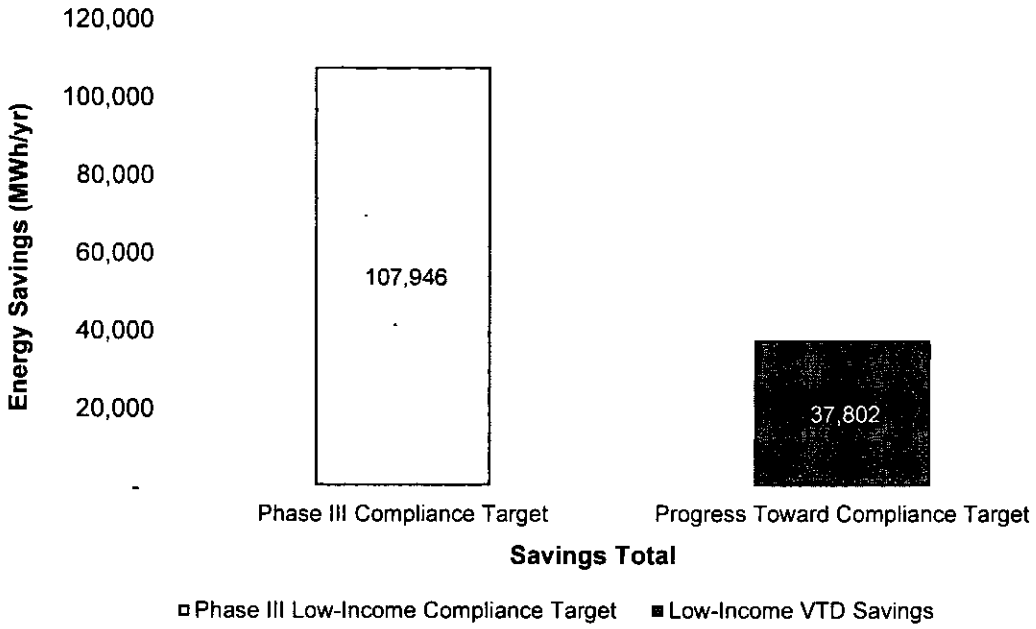


Source: Navigant analysis

The Phase III Implementation Order directed EDCs to offer conservation measures to the low-income customer segment based on the proportion of electric sales attributable to low-income households. The proportionate number of measures targeted for PECO is 8.8%. PECO offers 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 targeted.

The PA PUC also established a low-income energy savings target of 5.5% of the portfolio savings goal. The low-income savings target for PECO is 107,946 MWh/yr and is based on verified gross savings. Figure 2-4 compares the VTD performance for the low-income customer segment to the Phase III savings target. Based on the latest available information, PECO has achieved 35.0% of the Phase III low-income energy savings target of 107,946 MWh/yr.

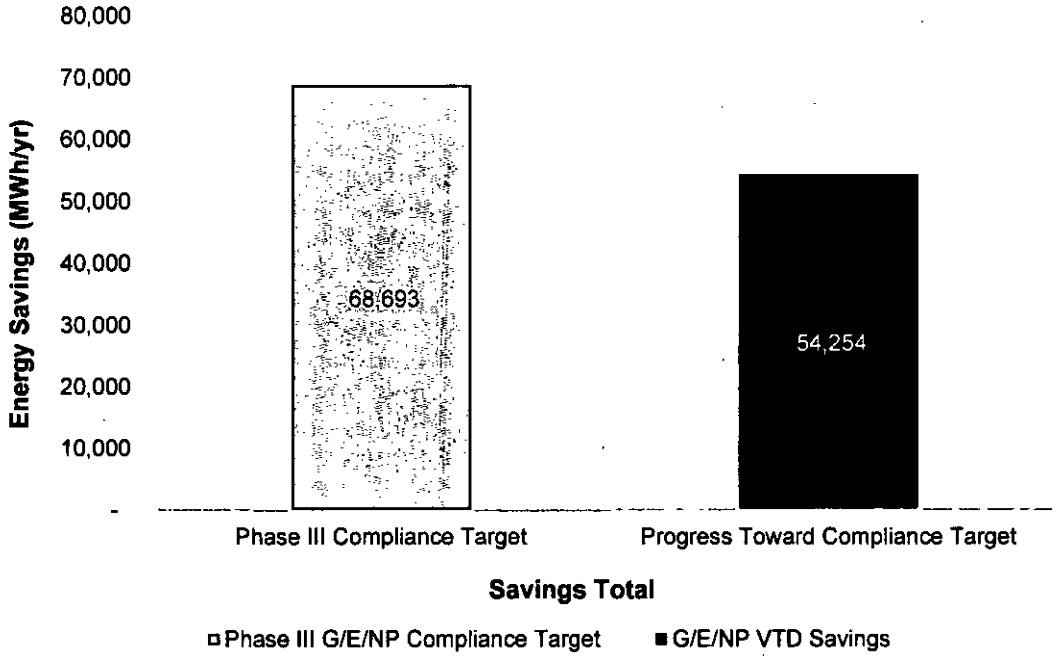
Figure 2-4. EE&C Plan Performance toward Phase III Low-Income Compliance Target



Source: Navigant analysis

The Phase III Implementation Order established a G/E/NP energy savings target of 3.5% of the portfolio savings goal. The G/E/NP savings target for PECO is 68,693 MWh/yr and is based on verified gross savings. Figure 2-5 compares the VTD performance for the G/E/NP customer segment to the Phase III savings target. Based on the latest available information, PECO has achieved 79.0% of the Phase III G/E/NP energy savings target of 68,939 MWh/yr.

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



Source: Navigant analysis

2.3 Phase III DR Achievements to Date

The Phase III DR performance target for PECO is 161 MW. Compliance targets for DR programs are based on average performance across events and are established at the system level, which means 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 PY9, PECO called three DR events: one on June 13, July 20, and July 21. The average performance for these three events is presented in Table 2-1. The results presented below match those in the amended standalone DR Report, submitted in June 2018.[9] To date, PECO has achieved an average of 149.42 MW in verified demand savings. The full methodology and results are available in the standalone report.

[9] PECO. *Annual Report to the Pennsylvania Public Utility Commission Demand Response Performance Report Only*. June 13, 2018. https://www.peco.com/SiteCollectionDocuments/PECOAct129PhIIIPY9AmendedDRReport.pdf

Table 2-1. Summary of Verified Demand Savings for DR by Customer Segment

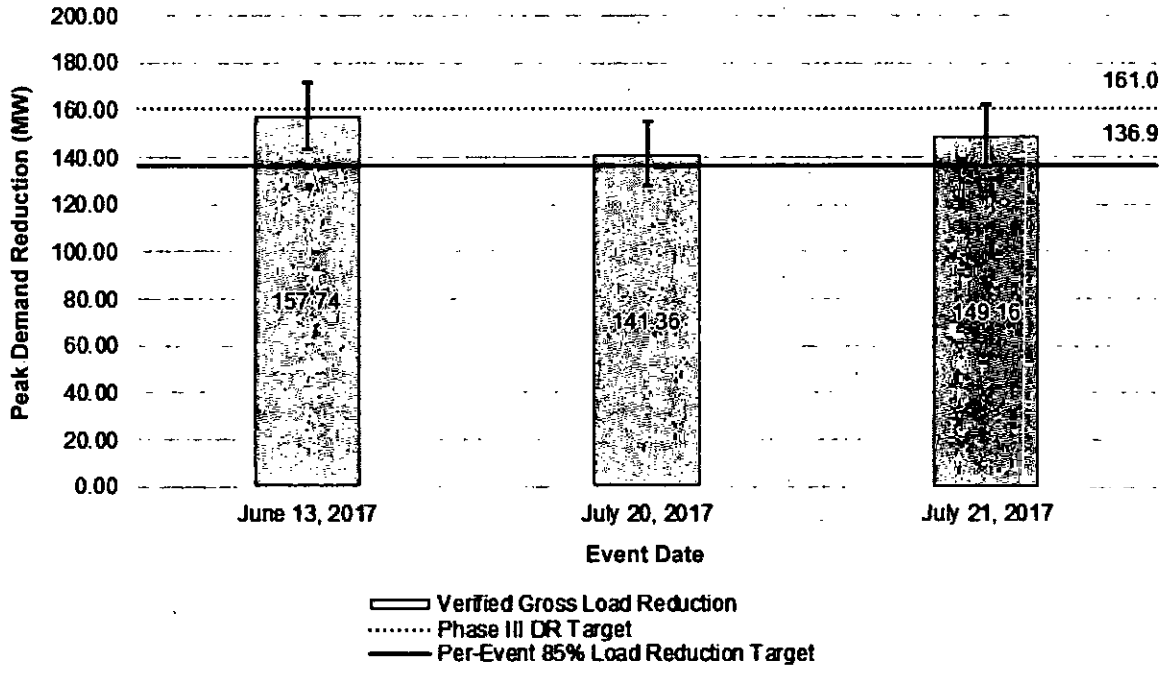
Event	Hour Ending (HE)	Residential DR Program (Verified MW)	Small C&I DR Program (Verified MW)	Large C&I DR Program (Verified MW)	Average Portfolio (Verified MW)
Event 1 June 13, 2017	HE15	37.16	0.00	116.60	153.76
	HE16	39.03	0.00	136.59	175.63
	HE17	38.29	0.00	125.58	163.87
	HE18	43.63	0.00	94.07	137.70
	Average Event Impact by Program	**39.53**	**0.00**	**118.21**	**157.74**
	Error Margin at 90% CI	***±1.77***	***±0.00***	***±13.81***	***±13.90***
Event 2 July 20, 2017	HE15	34.74	0.00	116.32	151.06
	HE16	34.07	0.00	118.73	152.79
	HE17	28.48	0.00	116.77	145.25
	HE18	36.65	0.00	79.71	116.36
	Average Event Impact by Program	**33.48**	**0.00**	**107.88**	**141.36**
	Error Margin at 90% CI	***±2.47***	***±0.00***	***±13.53***	***±13.75***
Event 3 July 21, 2017	HE14	22.76	0.00	104.00	126.76
	HE15	22.72	0.00	143.05	165.77
	HE16	24.19	0.00	132.03	156.22
	HE17	23.68	0.00	124.51	148.19
	Average Event Impact by Program	**23.34**	**0.00**	**125.83**	**149.16**
	Error Margin at 90% CI	***±1.83***	***±0.00***	***±13.31***	***±13.43***
Average Program Year Impact (PYVTD)		**32.12**	**0.00**	**117.31**	**149.42**
Average Phase III Impact (VTD)*					**149.42**

*Average Phase III impacts (VTD) are based on an average of all events and not an average of program years.

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 PY9 to the event-specific minimum and average targets. In each of the three events, PECO exceeded the minimum compliance reduction target.

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 through Table 2-5 present the participation, savings, and spending results by customer sector for PY9 and Phase III. The residential, small commercial and industrial (C&I), and large C&I sectors (also referred to as customer segments or rate classes) are defined by PECO tariff. The residential low-income and G/E/NP customer segments (Table 2-4 and Table 2-5) were defined by statute (66 Pa. C.S. § 2806.1). The residential low-income segment is primarily a subset of the residential customer class; however, it also includes low-income-qualified residents in master-metered buildings in the small C&I and large C&I sectors. The G/E/NP segment is a subset of the small C&I and large C&I sectors.

Table 2-2 provides the PY9 participation counts and spending totals for PECO's programs for the three sectors (residential, small C&I, and large C&I) inclusive of all low-income and G/E/NP segments.

Table 2-2. PY9 Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I	Total
No. of Participants	1,541,813	3,382	748	**1,545,943**
PY9 Energy Realization Rate (RR)	0.97	1.01	0.97	**0.97**
PYVTD MWh/yr	254,914	50,405	82,700	**388,019**
PY9 Demand RR	1.35	0.97	0.97	**1.19**
PYVTD MW (EE)	32.09	6.03	11.79	**49.91**
PYVTD MW (DR)	32.12	0.00	117.31	**149.43**
Incentives ($1,000)	$11,206	$2,387	$3,871	**$17,464**

Source: Navigant analysis

Table 2-3 provides the Phase III to-date participation counts and spending totals for PECO's programs for the three sectors (residential, small C&I, and large C&I) inclusive of all low-income and G/E/NP segments.

Table 2-3. Phase III Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I	Total
No. of Participants	2,727,442	4,284	918	**2,732,644**
P3TD Energy RR	0.97	1.05	0.97	**0.98**
VTD MWh/yr	418,709	71,330	108,669	**598,707**
P3TD Demand RR	1.41	1.04	0.98	**1.25**
VTD MW (EE)	53.22	9.60	15.74	**78.56**
VTD MW (DR)	32.12	0.00	117.31	**149.43**
Incentives ($1,000)	$19,229	$3,166	$4,885	**$27,280**

Source: Navigant analysis

Table 2-4 provides a summary of the savings, spending, and participation values for the low-income and G/E/NP customer segment carveouts only. PECO tracks activities for two low-income segments that contribute to the low-income carveout:

- PECO customers at 50% or below the federal poverty line (FPL)
- PECO customers at 51% to 150% of the FPL

The low-income totals correspond to achievements shown in Figure 2-4, and the G/E/NP totals correspond to achievements shown in Figure 2-5.

Table 2-4. PY9 Summary Statistics by Carveout

Parameter	Low-Income (0%-50% FPL)	Low-Income (51%-150% FPL)	Low-Income Total	G/E/NP Total
No. of Participants	2,424	119,378	**121,802**	**352**
PY9 Energy RR	0.76	0.70	**0.71**	**0.96**
PYVTD MWh/yr	3,206	17,423	**20,628**	**42,382**
Incentives ($1,000)	$0	$554	**$554**	**$2,536**
Program (Non-Incentive) Costs ($1,000)	$1,333	$6,583	**$7,916**	**$103**

Source: Navigant analysis

Table 2-5 summarizes the carveout performance since the beginning of Phase III.

Table 2-5. Phase III Summary Statistics by Carveout

Parameter	Low-Income (0%-50% FPL)	Low-Income (51%-150% FPL)	Low-Income Total	G/E/NP Total
No. of Participants	4,363	181,824	**186,187**	**438**
P3TD Energy RR	0.84	0.76	**0.72**	**1.31**
VTD MWh/yr	5,747	32,055	**37,802**	**54,254**
Incentives ($1,000)	$1	$904	**$905**	**$3,091**
Program (Non-Incentive) Costs ($1,000)	$2,224	$12,135	**$14,359**	**$130**

Source: Navigant analysis

2.5 Summary of Participation by Program

Participation is defined differently for each program and solution depending on the program delivery channel and data tracking practices. Table 2-6 provides the current participation totals by program and solution for PY9 and for Phase III to date.

Table 2-6. EE&C Portfolio Participation by Program and Solution

Program and Solution	PYTD Participation	P3TD Participation
Lighting, Appliances & HVAC	907,348	1,616,125
Appliance Recycling	16,120	24,612
Whole Home	5,365	7,724
New Construction	560	871
Behavioral	423,651	820,360
Multifamily Targeted	6,390	10,627
Residential EE Total	**1,359,434**	**2,480,319**

Program and Solution	PYTD Participation	P3TD Participation
Lighting	110,731	167,058
Whole Home	11,071	19,129
Low-Income EE Total	**121,802**	**186,187**
Equipment and Systems	1,055	1,489
New Construction	41	64
Whole Building	299	435
Data Centers	0	0
Multifamily Targeted	173	236
Small C&I EE Total	**1,568**	**2,224**
Equipment and Systems	368	490
New Construction	39	60
Data Centers	3	3
Multifamily Targeted	56	72
Large C&I EE Total	**466**	**625**
CHP	**2**	**2**
Residential DR	**60,846**	**61,440[a]**
Small C&I DR	**1,564**	**1,586[a]**
Large C&I DR	**261**	**261[a]**
Portfolio Total	**1,545,943**	**2,732,644**

[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 summarized by program and solution as described here.

2.5.1 Residential EE Program

Five solutions and one targeted market segment make up the Residential EE Program:

- Lighting, Appliances & HVAC Solution
- Appliance Recycling Solution
- Whole Home Solution
- New Construction Solution
- Behavioral Solution
- Multifamily Targeted Market Segment

PECO defined participation counts in each solution as follows:

- For the **Lighting, Appliances & HVAC Solution**, upstream lighting participation is defined as the sum of 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 the **Appliance Recycling Solution**, a participant is defined as 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 the **Residential Whole Home Solution**, a participant is defined as a unique customer project number for non-adjusted records with a project type that does not include Other Installations or Central Air Conditioner (CAC) Other Installations.
- For the **Residential New Construction Solution**, a participant is defined as a new home.
- For the **Behavioral Solution**, a participant is defined as a utility account included in the program's treatment group.
- For the **Multifamily Targeted Market Segment**, a participant is defined as a unique project number and typically represents one apartment unit.

2.5.2 Low-Income EE Program

Two solutions make up the Low-Income EE Program:

- Lighting Solution
- Whole Home Solution

Low-income participants are those participants with incomes at or below 150% of the FPL. PECO defined participation counts in each solution as follows:

- For the **Lighting Solution**, 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, which can be a single bulb or a multi-pack of bulbs.
- For the **Low-Income Whole Home Solution**, a participant is defined as the following:
    - A unique audit number (for both multifamily and single-family audits).
    - A low-income Appliance Recycling 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.
    - Product giveaways are also part of the Whole Home Solution but are not included in the participant count.

2.5.3 Small C&I EE Program

Four solutions and two targeted market segments make up the Small C&I EE Program:

- Equipment and Systems Solution
- Whole Building Solution
- Behavioral Solution[10]
- New Construction Solution
- Data Centers Targeted Market Segment
- Multifamily Targeted Market Segment

PECO has defined participation counts in each active solution as follows:

- For the **Small C&I Equipment and Systems Solution**, 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 **Small C&I Whole Building Solution**, 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 **Small C&I New Construction Solution**, 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 project number. More than one measure per participant is permitted, with the impact sample defined on the building level. A building consists of multiple projects in the dwellings and common areas of master-metered multifamily buildings.

2.5.4 Large C&I EE Program

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
- Multifamily Targeted Market Segment

[10] The Behavioral Solution is not currently active.

PECO defined participation counts in each solution or market segment as follows:

- For the **Large C&I Equipment and Systems Solution**, 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 **Large C&I New Construction Solution**, 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 project number. More than one measure per participant is permitted, with the impact sample defined on the building level. A building consists of multiple projects in the dwellings and common areas of master-metered multifamily buildings.

2.5.5 CHP Program

The Combined Heat and Power (CHP) Program consists of the CHP Solution only. PECO defined a participant in the solution as an activity with a unique project number.

2.5.6 Demand Response Programs

Three solutions make up the Residential DR Program; however, only the Direct Load Control (DLC) Solution is currently active. PECO defined a participant for Residential DLC as a unique account number where device status is install or swap and the measure code is CACS (central air conditioner switch). One participant may have more than one DLC device installed at the home. The categories not included in the participant count include disconnect, opt-out, and removal.

The Small C&I DR Program consists of the Small C&I DLC Solution. PECO defined a participant for Small C&I DLC as a unique account number where device status is install or swap and the measure code is PCT (program-controlled thermostat). One participant may have more than one DLC device installed on the premise. The categories not included in the participant count include disconnect, opt-out, and removal.

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

2.6 Summary of Impact Evaluation Results

During PY9, Navigant completed impact evaluations for all active EE programs and solutions in the PECO portfolio.

Table 2-7 summarizes the realization rates (RRs) and net-to-gross (NTG) ratios by program and solution.

Table 2-7. Impact Evaluation Results Summary

Program and Solution	Energy RR	Demand RR	NTG Ratio
Lighting, Appliances & HVAC	1.01	1.03	0.49
Appliance Recycling	0.91	0.91	0.37
Whole Home	1.40	1.28	0.89
New Construction	1.00	1.00	0.87
Behavioral	0.96	-*	1.00
Multifamily Targeted	0.81	0.72	0.86
Residential EE Total	**0.99**	**1.45**	**0.68**
Lighting	1.00	1.00	1.00
Whole Home	0.81	0.88	1.00
Low-Income EE Total	**0.85**	**0.90**	**1.00**
Equipment and Systems	0.98	0.94	0.75
New Construction	1.03	1.08	0.27
Whole Building	1.01	0.66	0.98
Data Centers	-	-	-
Multifamily Targeted	0.62	0.65	0.65
Small C&I EE Total	**0.96**	**0.87**	**0.75**
Equipment and Systems	0.96	0.97	0.80
New Construction	1.03	1.07	0.41
Data Centers	0.99	0.98	0.80
Multifamily Targeted	0.89	0.88	0.65
Large C&I EE Total	**0.96**	**0.97**	**0.77**
CHP	**1.14**	**0.97**	**0.89**
Portfolio Total	**0.97**	**1.19**	**0.73**

* For the residential behavioral solution, the implementer does not report demand savings, however the SWE requires PECO to verify demand savings. As a result, there is no demand realization rate for the behavioral solution. However, the verified demand savings do get added to the residential program savings. As a result, the demand realization rate for the residential program is greater than the demand realization rate for each individual solution in the program.

Source: Navigant analysis

Findings from NTG research are not used to adjust compliance savings in Pennsylvania. Instead, NTG research provides directional information for program planning purposes. Table 2-8 presents NTG findings for the high impact measures (HIMs) studied in PY9.[11]

[11] HIMs represent measure categories or technologies of high importance in the PECO portfolio. In Phase III, the SWE suggested EDCs oversample HIMs to help program planners make decisions concerning those measures for downstream programs only. EDCs were to identify three to five measures for study within each program year based on energy impact, level of uncertainty, prospective value, funding, or other parameters.

Table 2-8. HIM NTG Summary

HIM	Free Ridership	Spillover	NTG Ratio	Associated Program and Solution
ENERGY STAR® LED	0.16	0.04	0.88	Residential EE - Whole Home
Furnace: Fuel Switching: Electric Heat to Gas/Propane/Oil Heat	0.25	0.00	0.75	Residential EE - Whole Home
Variable Speed Pool Pumps	0.00	0.00	1.00	Residential EE - Whole Home
Lighting Improvements – ENERGY STAR® LED	0.39	0.00	0.61	Small C&I EE - Equipment & Systems
Lighting Improvements – Delamping	0.23	0.00	0.77	Small C&I EE - Equipment & Systems
New Construction Lighting – Lighting Power Density (LPD)	0.72	0.00	0.28	Small C&I EE - New Construction
Lighting Improvements – ENERGY STAR LED	0.39	0.00	0.61	Large C&I EE - Equipment & Systems
Variable Frequency Drives (VFDs)	0.63	0.00	0.38	Large C&I EE - Equipment & Systems
New Construction Lighting – LPD	0.61	0.00	0.39	Large C&I EE - New Construction

Source: Navigant analysis

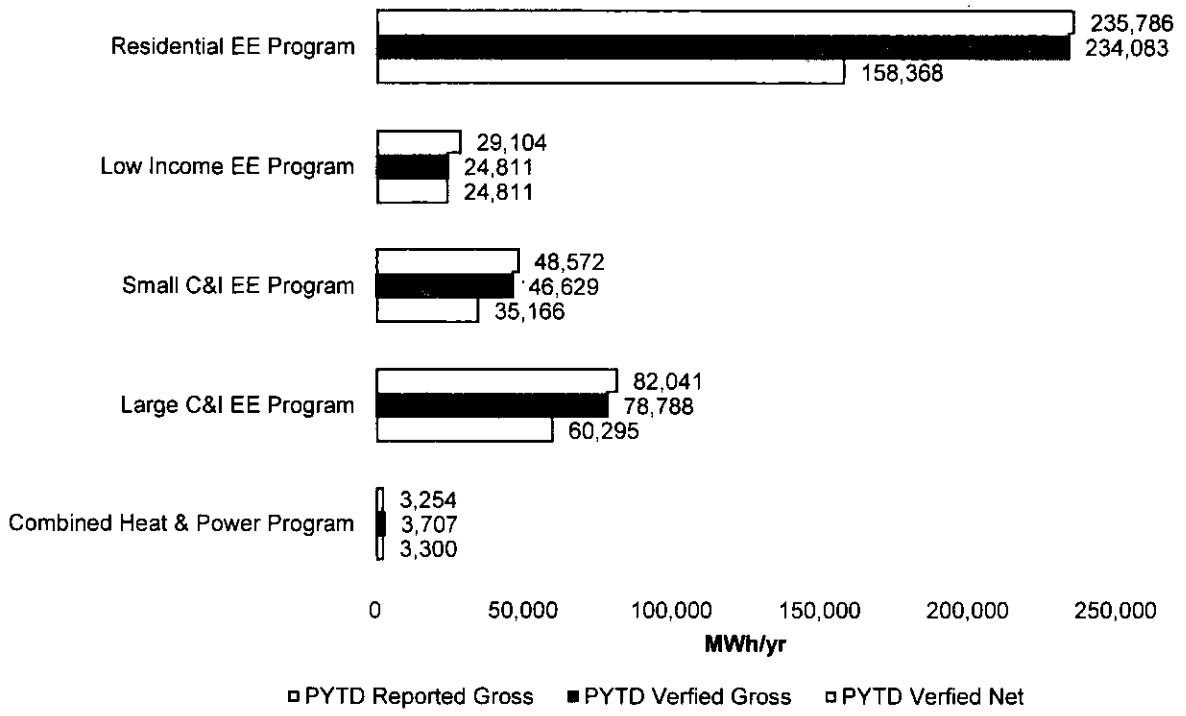
2.7 Summary of Energy Impacts by Program

Act 129 compliance targets are based on annualized savings estimates (MWh/yr). Each program year the annual savings achieved by EE&C program activity are recorded as incremental annual—or first-year—savings and are added to EDCs' progress toward compliance. Incremental annual savings estimates are presented in Section 2.7.1. Lifetime energy savings incorporate the effective useful life (EUL) of installed measures and estimate the total energy savings associated with EE&C program activity. Lifetime savings are used in the TRC test by program participants when assessing the economics of upgrades and by the SWE when calculating the emissions benefits of Act 129 programs. Section 2.7.2 presents the lifetime energy savings by program.

2.7.1 Incremental Annual Energy Savings by Program

Figure 2-7 presents a summary of the PYTD energy savings by program for PY9. The energy impacts in this report are presented at the meter level and do not reflect adjustments for T&D losses. The verified gross savings are adjusted by the energy RR, and the verified net savings are adjusted by both the RR and the NTG ratio.

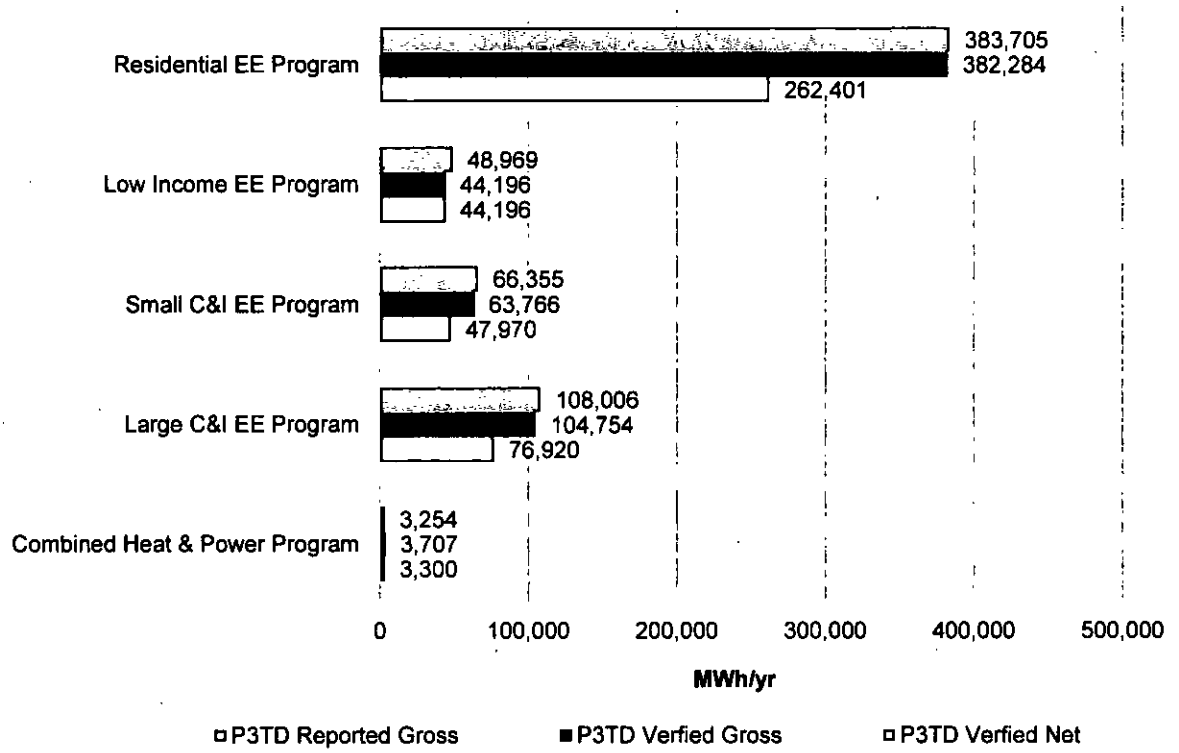
Figure 2-7. PYTD Energy Savings by Program



Source: Navigant analysis

Figure 2-8 presents a summary of the energy savings by program for Phase III of Act 129.

Figure 2-8. P3TD Energy Savings by Program



Source: Navigant analysis

A summary of energy impacts by program through PY9 is presented in Table 2-9.

Table 2-9. Summary of Incremental Annual Energy Savings by EE Program

Program and Solution	PYRTD (MWh/yr)	PYVTD Gross (MWh/yr)	PYVTD Net (MWh/yr)	RTD (MWh/yr)	VTD Gross (MWh/yr)	VTD Net (MWh/yr)
Lighting, Appliances & HVAC	125,928	127,067	62,256	197,467	201,230	97,912
Appliance Recycling	15,946	14,512	5,305	24,476	22,480	8,245
Whole Home	7,028	9,829	8,714	9,737	9,829	8,714
New Construction	1,452	1,451	1,258	2,190	2,182	1,623
Behavioral	81,934	78,396	78,396	144,358	141,781	141,781
Multifamily Targeted	3,499	2,828	2,440	5,477	4,783	4,126

Program and Solution	PYRTD (MWh/yr)	PYVTD Gross (MWh/yr)	PYVTD Net (MWh/yr)	RTD (MWh/yr)	VTD Gross (MWh/yr)	VTD Net (MWh/yr)
Residential EE Total	235,786	234,083	158,367	383,705	382,284	262,401
Lighting	5,945	5,942	5,942	9,086	9,084	9,084
Whole Home	23,159	18,869	18,869	39,883	35,113	35,113
Low-Income EE Total	29,104	24,811	24,811	48,969	44,196	44,196
Equipment and Systems	36,299	35,436	26,730	49,230	47,844	36,529
New Construction	2,615	2,689	719	4,437	4,562	1,300
Whole Building	6,523	6,568	6,465	8,875	8,848	8,518
Data Centers	0	0	0	0	0	0
Multifamily Targeted	3,134	1,937	1,252	3,813	2,512	1,623
Small C&I EE Total	48,572	46,629	35,166	66,355	63,766	47,970
Equipment and Systems	73,405	70,358	55,998	93,872	90,960	69,662
New Construction	4,958	5,104	2,071	9,074	9,105	4,151
Data Centers	510	507	404	510	507	404
Multifamily Targeted	3,167	2,819	1,822	4,550	4,182	2,702
Large C&I EE Total	82,041	78,788	60,295	108,006	104,754	76,920
CHP	3,254	3,707	3,300	3,254	3,707	3,300
Portfolio Total	**398,757**	**388,019**	**281,939**	**610,289**	**598,707**	**434,787**

Source: Navigant analysis

2.7.2 Lifetime Energy Savings by Program

Table 2-10 presents the PYVTD and VTD lifetime energy savings by program. Lifetime energy savings are calculated by multiplying the annual energy savings by the EUL. Per the PA 2016 TRC Order, the measure EUL does not exceed 15 years for any measure in the portfolio. Additionally, early replacement measures are subject to a dual baseline calculation, leading to modified lifetime savings. For these measures, savings relative to the in-place baseline equipment are used for the remaining useful lifetime (RUL) of the base equipment. After the RUL, savings relative to code equipment are used for the remainder of the efficient measure's EUL.

Table 2-10. Summary of Lifetime Energy Savings by EE Program

Program	PYVTD Gross Lifetime Energy (MWh/yr)	PYVTD Net Lifetime Energy (MWh/yr)	VTD Gross Lifetime Energy (MWh/yr)	VTD Net Lifetime Energy (MWh/yr)
Residential EE	1,597,733	866,744	2,571,443	1,366,001
Low-Income EE	185,020	185,020	326,906	326,906
Small C&I EE	463,601	350,880	664,878	499,432
Large C&I EE	952,322	724,619	1,261,902	921,532
CHP	55,612	49,495	55,612	49,495
Portfolio Total	**3,254,287**	**2,176,759**	**4,880,742**	**3,163,366**

Source: Navigant analysis

2.8 Summary of Demand Impacts by Program

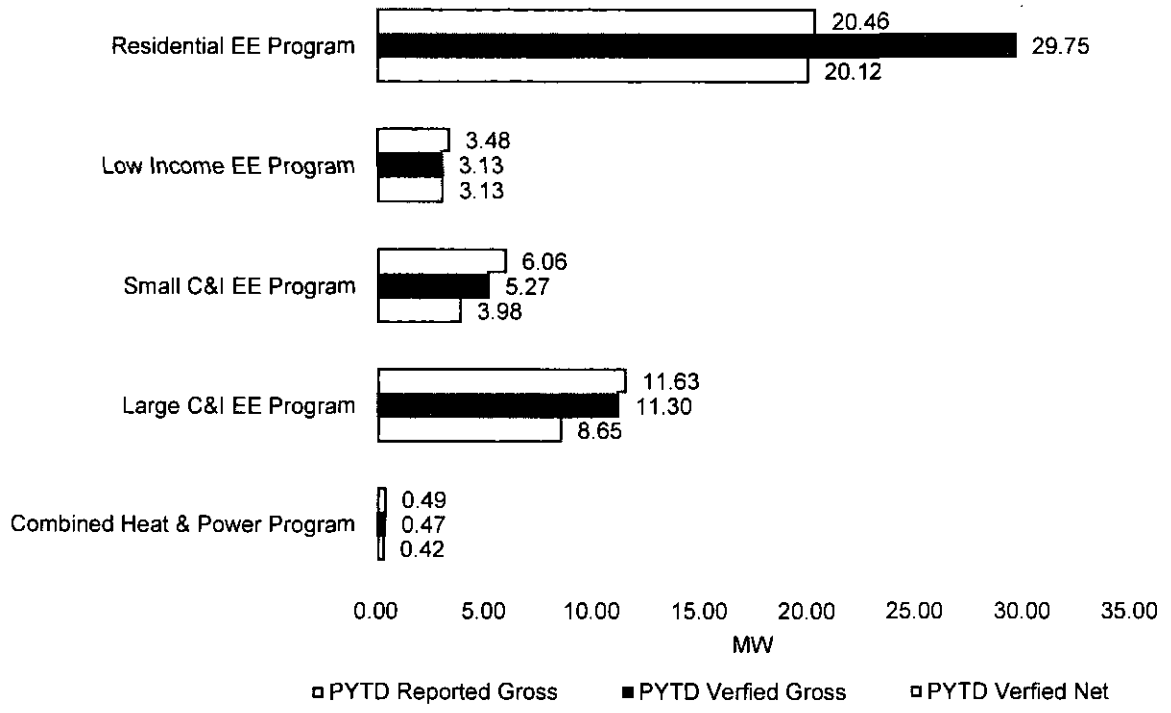
PECO's Phase III EE&C programs achieve peak demand reductions in two primary ways. The first is through coincident reductions from EE measures, and the second is through dedicated DR offerings that exclusively target temporary demand reductions on peak days. EE reductions coincident with system peak hours are reported and used to calculate benefits in the 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 the following subsections.

2.8.1 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 through August. Unlike Phase I and Phase II Act 129 reporting, in this report the peak demand impacts from EE are presented at the meter level and do not reflect adjustments for T&D losses. Figure 2-9 presents a summary of the PYTD demand savings by EE program for PY9.

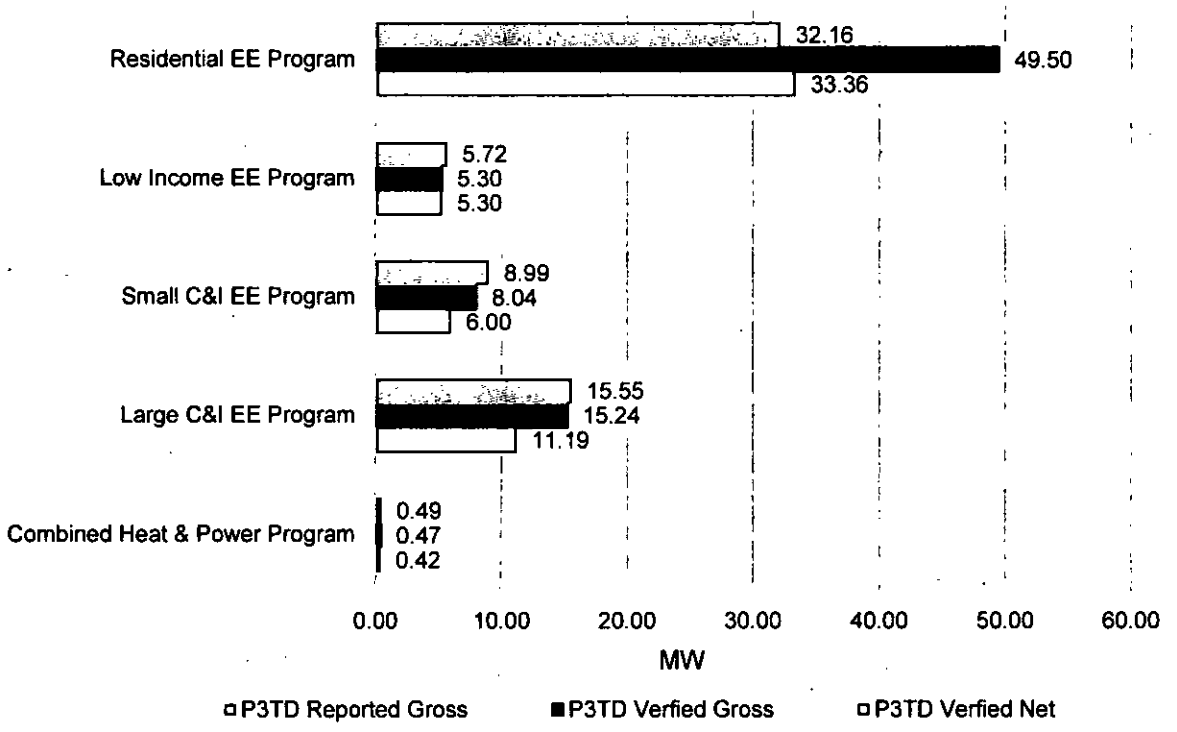
Figure 2-9. PYTD Demand Savings by EE Program



Source: Navigant analysis

Figure 2-10 presents a summary of the P3TD demand savings by EE program for Phase III of Act 129.

Figure 2-10. P3TD Demand Savings by EE Program



Source: Navigant analysis

A summary of the peak demand impacts by EE program through the current reporting period are presented in Table 2-11.

Table 2-11. Summary of Demand Savings by EE Program

Program and Solution	PYRTD (MW)	PYVTD Gross (MW)	PYVTD Net (MW)	RTD (MW)	VTD Gross (MW)	VTD Net (MW)
Lighting, Appliances & HVAC	16.32	16.77	8.22	26.08	27.78	13.51
Appliance Recycling	2.45	2.24	0.82	3.62	3.32	1.22
Whole Home	0.80	1.03	0.91	1.08	1.03	0.91
New Construction	0.43	0.43	0.37	0.68	0.62	0.47
Behavioral	0.00	8.95	8.95	0.00	16.19	16.19
Multifamily Targeted	0.45	0.32	0.28	0.69	0.57	0.49
Residential EE Total	**20.46**	**29.75**	**19.55**	**32.16**	**49.50**	**32.78**
Lighting	0.70	0.70	0.70	1.07	1.07	1.07

Program and Solution	PYRTD (MW)	PYVTD Gross (MW)	PYVTD Net (MW)	RTD (MW)	VTD Gross (MW)	VTD Net (MW)
Whole Home	2.78	2.43	2.43	4.65	4.23	4.23
Low-Income EE Total	**3.48**	**3.13**	**3.13**	**5.72**	**5.30**	**5.30**
Equipment and Systems	3.99	3.73	2.82	6.04	5.63	4.32
New Construction	0.42	0.46	0.12	0.82	0.86	0.25
Whole Building	1.29	0.85	0.83	1.71	1.25	1.20
Data Centers	-	-	-	-	-	-
Multifamily Targeted	0.36	0.23	0.145	0.43	0.30	0.19
Small C&I EE Total	**6.06**	**5.27**	**3.92**	**8.99**	**8.04**	**5.95**
Equipment and Systems	10.53	10.21	8.12	13.82	13.52	10.32
New Construction	0.65	0.69	0.28	1.11	1.15	0.52
Data Centers	0.03	0.03	0.03	0.03	0.03	0.03
Multifamily Targeted	0.42	0.37	0.24	0.59	0.55	0.35
Large C&I EE Total	**11.63**	**11.30**	**8.67**	**15.55**	**15.24**	**11.22**
CHP	**0.49**	**0.47**	**0.42**	**0.49**	**0.47**	**0.42**
Portfolio Total	**42.11**	**49.92**	**35.69**	**62.91**	**78.56**	**55.67**

Source: Navigant analysis

2.8.2 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. Phase III DR events are initiated according to the following guidelines:

- Curtailment events shall be limited to the months of June through September.
- Curtailment events shall be called for the first 6 days of each program year (starting in PY9) in which the peak hour of PJM's day-ahead forecast for the PJM regional transmission organization (RTO) is greater than 96% of the PJM RTO summer peak demand forecast for the months of June through September.
- Each curtailment event shall last 4 hours.
- Each curtailment event shall be called such that it will occur during the day's forecasted 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.

Phase III DR programs began operating in PY9; therefore, no DR program savings were reported for PY8. The peak demand impacts from DR starting in PY9 are presented at the system level and reflect

adjustments to account for T&D losses. PECO uses the following line loss percentages/multipliers by sector:[12]

- Residential = 107.99% or 1.0799
- Small C&I = 107.99% or 1.0799
- Large C&I = 107.99% or 1.0799

Table 2-12 summarizes the demand reductions for each of the DR programs in PECO's EE&C Plan and for the DR portfolio. 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 2-12. Summary of Demand Savings for DR Programs by Customer Segment and Event

Event Date	Event Start Time	Event End Time	Program Name			
			Residential DR (MW)	Small C&I DR (MW)	Large C&I DR (MW)	Portfolio (MW)
June 13, 2017	2:00 p.m.	6:00 p.m.	39.53	0.00	118.21	157.74
July 20, 2017	2:00 p.m.	6:00 p.m.	33.48	0.00	107.88	141.36
July 21, 2017	1:00 p.m.	5:00 p.m.	23.34	0.00	125.83	149.16
PYVTD – Average PY9 DR Event Performance			**32.12**	**0.00**	**117.31**	**149.42**
VTD – Average Phase III DR Event Performance*			**32.12**	**0.00**	**117.31**	**149.42**

*P3TD impacts are based on an average of all events and not an average of program years.

Source: Navigant analysis

2.9 Summary of Fuel Switching Impacts

Act 129 allows EDCs to achieve electric savings by converting electric equipment to non-electric equipment. Table 2-13 lists the fuel switching measures offered in Phase III, while Table 2-14 provides the key fuel switching metrics to date.

[12] Pennsylvania Public Utility Commission, "Section 1.14 Transmission and Distribution System Losses," *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.

Table 2-13. List of Fuel Switching Measures

Fuel Switching Measures Implemented in PY9
Electric Clothes Dryer to ENERGY STAR Gas Clothes Dryer
Electric Clothes Dryer to Gas Clothes Dryer
Electric Furnace to Gas Furnace
Electric Range to Gas Range
Electric Water Heater to Gas Water Heater
ASHP to Gas Furnace
Electric Baseboard to ENERGY STAR Fossil Fuel Furnace
Electric Furnace to ENERGY STAR Fossil Fuel Furnace
Electric Water Heater to ENERGY STAR Gas Water Heater
CHP

Source: Navigant analysis

Table 2-14. Summary of Fuel Switching Measure Portfolio Impacts

Parameter	PYVTD	VTD
Total No. of Units Implemented	236	377
Gross Energy Savings via Fuel Switching (MWh/yr)	4,825	4,920
Fossil Fuel Consumption Change (MMBtu/yr)	18,034	20,352
P3TD Incentive Spending ($1,000)	$289	$334

Source: Navigant analysis

2.10 Summary of Cost-Effectiveness Results

TRC benefit-cost ratios are calculated by comparing total net present value (NPV) TRC benefits and total NPV TRC costs. TRC costs are materially different from the EDC spending and cost recovery tables presented in Section 4. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment—not just the portion covered by the EDC rebate. Table 2-15 through Table 2-18 show the gross and net TRC ratios by program and for the portfolio. The Navigant team calculated the benefits using gross and net verified impacts, where appropriate. Costs and benefits for PY9 results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 2-15. Summary PY9 Gross TRC Results by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits - Costs)
Residential EE	$78,469	$36,358	2.16	$42,110
Low-Income EE	$10,887	$9,266	1.17	$1,621
Small C&I EE	$18,363	$22,570	0.81	-$4,207
Large C&I EE	$35,871	$35,333	1.02	$539

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits - Costs)
CHP	$1,962	$7,920	0.25	-$5,958
Residential DR	$3,249	$3,191	1.02	$49
Small C&I DR	$0	$154	0.00	-$154
Large C&I DR	$11,835	$1,579	7.50	$10,256
Portfolio Total [1]	**$160,626**	**$126,609**	**1.27**	**$34,017**

[1] The portfolio total benefits include crosscutting costs.

Source: Navigant analysis

Table 2-16. Summary PY9 Net TRC Results by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits - Costs)
Residential EE	$42,466	$27,797	1.53	$14,669
Low-Income EE	$10,887	$9,266	1.17	$1,621
Small C&I EE	$13,785	$17,882	0.77	-$4,097
Large C&I EE	$27,290	$28,416	0.96	-$1,126
CHP	$1,746	$7,052	0.25	-$5,306
Residential DR	$3,240	$3,191	1.02	$49
Small C&I DR	$0	$154	0.00	-$154
Large C&I DR	$11,835	$1,579	7.50	$10,256
Portfolio Total [1]	**$111,249**	**$105,576**	**1.05**	**$5,673**

[1] The portfolio total benefits include crosscutting costs.

Source: Navigant analysis

Table 2-17. Summary P3TD Gross TRC Results by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits - Costs)
Residential EE	$121,317	$60,717	2.00	$60,600
Low-Income EE	$16,428	$16,216	1.01	$212
Small C&I EE	$25,552	$28,781	0.89	-$3,229
Large C&I EE	$45,713	$45,448	1.01	$265
CHP	$1,823	$7,375	0.25	-$5,552
Residential DR	$3,011	$6,167	0.49	-$3,156
Small C&I DR	$0	$219	0.00	-$219
Large C&I DR	$10,999	$3,209	3.43	$7,790
Portfolio Total [1]	**$224,843**	**$186,599**	**1.20**	**$38,243**

[1] The portfolio total benefits include crosscutting costs.

Source: Navigant analysis

Table 2-18. Summary P3TD Net TRC Results by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits - Costs)
Residential EE	$64,480	$46,582	1.38	$17,898
Low-Income EE	$16,428	$16,216	1.01	$212
Small C&I EE	$19,086	$23,156	0.82	-$4,069
Large C&I EE	$33,274	$36,410	0.91	-$3,136
CHP	$1,622	$6,568	0.25	-$4,946
Residential DR	$3,011	$6,167	0.49	-$3,156
Small C&I DR	$0	$219	0.00	-$219
Large C&I DR	$10,999	$3,209	3.43	$7,790
Portfolio Total [1]	**$148,900**	**$156,994**	**0.95**	**-$8,094**

[1] The portfolio total benefits include crosscutting costs.

Source: Navigant analysis

2.11 Comparison of Performance to Approved EE&C Plan

Table 2-19 presents program year and P3TD expenditures by program compared to the budget estimates set forth in the EE&C Plan. All values shown are the sum of nominal dollars.

Table 2-19. Comparison of Expenditures to Phase III EE&C Plan by Program ($1,000)

Program	Phase III Budget from EE&C Plan through PY9	P3TD Actual Expenditures	Ratio (Actual/Plan)
Residential EE	$39,400	$45,818	116%
Low-Income EE	$14,000	$16,275	116%
Small C&I EE	$17,900	$13,725	77%
Large C&I EE	$21,500	$14,642	68%
CHP	$10,900	$254	2%
Residential DR	$5,000	$7,854	157%
Small C&I DR	$400	$289	72%
Large C&I DR	$7,000	$3,779	54%
Portfolio Total	**$116,100**	**$102,636**	**88%**

Source: Navigant analysis

Table 2-20 compares Phase III verified gross program savings to the energy savings projections filed in the EE&C Plan.

Table 2-20. Comparison of Energy Savings to Phase III EE&C Plan by Program

Program	EE&C Plan through PY9 (MWh/yr)	VTD Gross Savings (MWh/yr)	Ratio (Actual/Plan)
Residential EE	267,906	382,284	1.43
Low-Income EE	45,871	44,196	0.96
Small C&I EE	153,456	63,766	0.42
Large C&I EE	190,398	104,754	0.55
CHP	160,516	3,707	0.02
Portfolio Total	**818,147**	**598,707**	**0.73**

Source: Navigant analysis

The list below briefly discusses key reasons why programs exceeded or fell short of projected gross energy savings in PY9.

- The Residential EE Program exceeded its projections due to the Lighting component of the Lighting, HVAC & Appliance Solution and the Behavior Solution. The remaining Residential EE Program Solutions did not achieve their projected savings. As of the writing of this report, Navigant and PECO are continuing to work through ongoing process evaluation results to identify the drivers of solution-specific shortfalls; this work will stretch into PY10 research. At this time, Navigant is able to report that changes in the Phase III EE&C Plan from Phase II resulted in lags in implementation adjustments and participation rates. For example, changes in the incentive structure for some measures and changes in CSP roles resulted in a slow start to the Phase, and in some cases, the program year. This is discussed in Section 3.1 of this report.
- The Low-Income EE Program attained most of its planned savings in PY9, but neither of the program's solutions met their savings projections; additionally, the Low-Income carveout forecast was not achieved for this year. The Low-Income EE Program transitioned to a single Whole Home Solution in PY9 because the Lighting Solution was suspended. The program is adjusting implementation tactics to increase Whole Home Solution savings, including expanding partnerships with other utility and income-eligible programs to identify and comprehensively serve households and expanding the lighting giveaway activity. These issues are discussed in Section 3.2 of this report.
- The Small and Large C&I Programs each fell short of projections across all solutions. Halfway through PY9, PECO increased incentive amounts for key measures to address the participation lag and Navigant is in the process of tracking any changes to participation rates attributed that increase. For data centers, participants are incentivized to wait until full occupancy—in this case, server occupancy—before applying to the program, to derive the maximum amount of incentive money. Separately, participants in the New Construction Solution indicate that the long lead time associated with their projects presents a challenge and indicate a desire for PECO to engage earlier—ideally in the planning or budgeting phases of their projects. These issues are discussed in Sections 3.3 and 3.4 of this report.
- The CHP Program underwent a significant rebranding in PY8 with changes to its customer outreach and enrollment processes. The rebranding process took longer than expected, delaying

the program launch into the fourth quarter of PY8. The program has successfully recruited new participants in PY9. However, program delivery success this program year will not be realized until later in the phase due to the 18- to 24-month construction timeline of CHP projects. Navigant conducted targeted process evaluation research in PY9 to identify opportunities to enhance program delivery and increase participation.

- The DR Programs achieved 85% of the Phase III compliance reduction target for each of the three DR events in PY9. PECO's average DR performance for the program year was 149.4 MW, 7% below the Phase III compliance reduction target of 161 MW. Performance was lower than anticipated in all three programs: Large C&I, Small C&I DLC, and Residential DLC. Large C&I performance was low due to moderate underperformance of some larger participants, and lower participation than expected across both CSPs. The Residential and Small C&I DLC programs also performed below target, in part because the targets were based on overestimated savings per participant. The Commission's Phase III Implementation Order established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each DR event. For PECO, this is a 136.9 MW minimum for each DR event. In PY9, all three DR events performed above this minimum threshold.

As mentioned, Navigant and PECO are working on targeted process evaluation activities to identify potential changes to the Phase III programs on an ongoing basis. There are no official, significant program changes to report at this time; however, Navigant has made program-specific recommendations, which are discussed in subsequent sections of this report.

2.12 Findings and Recommendations

The PY9 impact and process evaluation activities Navigant completed led to a variety of recommendations for program improvement. Table 2-21 shows 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. Detailed findings and recommendations for each program and solution are discussed in subsequent sections of this report.

Table 2-21. Summary of Evaluation Recommendations

Evaluation Activity	Finding	Recommendation
Savings Estimations	Navigant's solution-specific evaluations noted several instances where savings estimation methodologies could be improved. While PECO has made improvements to-date, opportunities remain. For example, Navigant's impact verification resulted in some adjustments for CSP application of TRM guidance or to account for more accurate data sources (e.g., hours of use (HOUs) estimates). The team also conducted extensive research to verify savings for several measures where information was not readily available (e.g., ENERGY STAR certifications) and deep dives into tracking data when measure specifications were not easily accessible for compliance-related computations (e.g., ductless mini-split heat pumps savings).	PECO should continue to work with Navigant to identify and pursue opportunities to improve data collection and organization within data tracking systems. Such improvements will streamline compliance related activities, add transparency to PECO's achievements, and help PECO leverage data in more ways to improve programs and customer engagement.
Participant, PECO Staff, and CSP Interviews	Navigant interviewed PECO staff and CSPs and surveyed participants to understand program awareness levels and how participants engage with PECO's offerings. Navigant identified some instances where participants desired more information about programs, where they perceived incentives as too low (e.g., Equipment and Systems, New Construction, and Data Center solutions), or where long lead times to incentive payments might discourage participation (e.g., Residential New Construction and Data Centers solutions).	The PY9 evaluation activities identified several avenues for PECO to explore to increase participation levels and acceptance of programs during the remainder of Phase III. These are described in the various program-specific sections of this report.

Source: Navigant analysis

3. EVALUATION RESULTS BY PROGRAM

This section documents the gross impact, net impact, and process evaluation activities conducted in PY9 along with the outcomes of those activities. Not every program receives an evaluation every program year. Table 3-1 shows a breakdown of the evaluation activity plan, with a check indicating the type of evaluation Navigant will conduct for each program over each year.

Table 3-1. Evaluation Activity Matrix

Program	Solution	PY8			PY9			PY10			PY11			PY12		
		Gross	Net	Process	Gross	Net	Process	Gross	Net	Process	Gross	Net	Process	Gross	Net	Process
Residential EE	Lighting, Appliances & HVAC	√	√	√	√		√	√	√	√	√	√	√	√	√	√
	Appliance Recycling	√	√	√	√			√	√	√	√	√	√	√	√	√
	Whole Home	√			√	√	√	√			√	√	√			
	New Construction				√	√	√	√			√	√	√	√		
	Multifamily Targeted	√	√	√	√			√	√	√	√			√	√	√
	Behavioral	√		√	√			√		√	√			√		√
Residential Low-Income EE	Whole Home	√		√	√			√		√	√			√		
	Lighting	√		√												
Small C&I EE	Equipment and Systems	√			√	√	√	√			√	√	√	√		
	New Construction	√			√	√	√	√			√	√	√			
	Whole Building				√	√	√				√	√	√			
	Behavioral							√		√	√			√		√
	Data Center Targeted	√			√	√	√	√			√	√	√	√		
	Multifamily Targeted	√	√	√	√			√	√	√	√				√	√
Large C&I EE	Equipment and Systems	√			√	√	√	√			√	√	√	√		
	New Construction	√			√	√	√	√			√	√	√			
	Data Center Targeted	√			√	√	√	√			√	√	√			

Program	Solution	PY8			PY9			PY10			PY11			PY12		
		Gross	Net	Process	Gross	Net	Process	Gross	Net	Process	Gross	Net	Process	Gross	Net	Process
	Multifamily Targeted	√	√	√	√			√	√	√	√				√	√
Combined Heat and Power	Combined Heat and Power	√			√	√	√	√			√	√	√	√		
DR	Residential DR	√			√	√	√	√	√		√	√	√	√	√	
	Small C&I DR	√			√	√	√	√	√		√	√	√	√	√	
	Large C&I DR				√	√	√	√	√		√	√	√	√	√	

Source: Navigant analysis

3.1 Residential EE Program

The PECO Residential EE Program is designed to offer residential customers opportunities to save energy across all their electric end uses and to market those opportunities in ways that minimize lost savings opportunities. The program encompasses a comprehensive series of solutions designed to influence customer behavior and purchasing decisions.

The Residential EE Program represents 59% of PECO's PY9 portfolio reported energy savings and consists of six solutions or initiatives that contribute to those savings. Savings are achieved through a range of delivery mechanisms and methods including upstream incentives (i.e., manufacturer buy-downs), downstream incentives (e.g., mail-in rebates), appliance removal and recycling, in-home audits, direct install measures, efficient building construction, and changes in household behaviors. PECO relies on six CSPs to deliver the program savings, listed here with their corresponding solution:

1. Lighting, Appliances & HVAC Solution – CLEAResult and Ecova
2. Appliance Recycling Solution – ARCA
3. Whole Home Solution – CLEAResult and Ecova
4. New Construction Solution – Performance Systems Development (PSD)
5. Multifamily Targeted Market Segment – Franklin
6. Behavioral Solution – Oracle

Midway through PY9 (January 2018) implementation of the Whole Home major measure rebate and the Lighting, Appliances & HVAC Solution switched from Ecova to CLEAResult. This change was unconnected to CLEAResult's subsequent announcement to acquire Ecova.

Marketing for the six solutions in the Residential EE Program is handled through a separate energy efficiency marketing firm (EEMF), ICF. The EEMF markets PECO's range of Residential EE Program offerings delivered through the six solutions with consistent approaches and messaging. Marketing from a crosscutting perspective is intended to promote all savings opportunities available to residential customers.

3.1.1 Participation and Reported Savings by Customer Segment

This section provides the total Residential EE Program results for PY9, including participation, energy and demand savings, and incentive costs. Table 3-2 presents the participation counts and incentive payments for the Residential EE Program in PY9 by customer segment.

Table 3-2. Residential EE Program Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I
PYTD No. of Participants	1,359,169	246	19
PYRTD MWh/yr	235,361	213	212
PYRTD MW	20.39	0.04	0.03
PY9 Incentives ($1,000)	$7,813	$17	$11

Source: Navigant analysis

3.1.2 Gross Impact Evaluation

The Residential EE Program's gross impact evaluation activities involved different approaches tailored to each solution's characteristics to verify the reported gross savings values for PY9. First, Navigant reviewed each solution's program tracking data to verify proper application of Pennsylvania Technical Reference Manual[13] (PA TRM or TRM) algorithms in reported savings values. The evaluation team completed these reviews for the full population of PY9's implemented Residential EE Program measures. Next, the team identified appropriate evaluation activities for each solution depending on the nature of the participants, implementation, and the level of information accompanying the reported savings. A goal of the evaluation activities was to verify a given measure was implemented. Additionally, for partially deemed measures, the evaluation verified certain measure characteristics that inform gross energy and demand impact estimations—in particular, those characteristics where the PA TRM does not provide default or deemed values for EDCs to use for savings estimations. The evaluation activities varied for each solution and for specific strata within some solutions. Activities included engineering file reviews of program applications and invoices, participant phone verifications, onsite field verifications, billing and regression analyses, or a combination of these activities.

Onsite verification field activities occurred for the Whole Home Solution. Master-metered multifamily projects and individually metered residential projects within the Multifamily Targeted Market Segment also received onsite visits for verification.

Navigant drew samples from each solution for gross impact evaluation activities according to the sampling plans. The team developed and sought approval for representative samples that complied with the Phase III Evaluation Framework, the PA TRM, and industry standards, as well as those that helped PECO meet SWE and Commission requirements.

The following provides a summary of the activities conducted for each solution and for specific components or sampled strata within a given solution. Appendix D contains additional detail on the gross impact evaluation approaches used for the Residential EE Program's individual solutions.

- Lighting, Appliances & HVAC Solution
    - Lighting
        - Invoice reviews and record-level savings calculation
        - Verification of ENERGY STAR certification

[13] 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.

    - Appliances and HVAC
        - Engineering file reviews and phone verification (for HVAC measures)
        - Phone verification (for Appliance measures)
- Appliance Recycling Solution
    - Phone verification
    - Regression analysis
- Whole Home Solution
    - Engineering file reviews and onsite verification (large projects)
    - Engineering file reviews and phone verification (small and medium projects)
- New Construction Solution
    - Engineering file review and building simulation modeling
- Multifamily Targeted Market Segment
    - Engineering file reviews and onsite verification (residential projects that contribute to the Residential EE Program and master-metered non-residential projects that contribute to the Small C&I EE and Large C&I EE Programs)
- Behavioral Solution
    - Billing analysis
        - For Home Energy Report (HER) program participants in the test and control groups using a lagged dependent variable (LDV) model
        - For AC Saver cohort recipients included in the Behavioral Solution that used a regression with pre-program matching (RPPM) method to estimate savings related to HERs
    - Peak demand impacts
        - Accounting for average peak demand impacts resulting from HERs[14]
    - Double counted analysis
        - Accounting for Behavioral Solution participant activities within other PECO EE solutions

Table 3-3 provides the sampling frame for the gross impact evaluation of the Residential EE Program in PY9.

[14]The Behavioral Solution implementer, Oracle, does not report demand savings. Navigant completes this analysis as part of its annual reporting, as required by the SWE. An RR cannot be calculated due to the lack of reported savings.

Table 3-3. Residential EE Program Gross Impact Sample Design for PY9

Solution	Stratum Name	Population Size	Achieved Sample Size	Verification Method
Lighting, Appliances & HVAC	Appliances	10,009	43	File Review and Phone Survey
	HVAC	11,217	40	File Review and Phone Survey
	Standard LED	479,372	N/A	PY8 Analysis
	Specialty LED	407,322	N/A	PY8 Analysis
	Solution Total	**907,920**	**83**	
Appliance Recycling	Refrigerators	3,741	11	File Review and Phone Verification Survey
	Freezers	3,927	9	File Review and Phone Verification Survey
	Room ACs	966	5	File Review and Phone Verification Survey
	Solution Total	**8,634**	**25**	
Whole Home	Very Small Projects, PY8	272	0	N/A
	Very Small Projects, PY9	506	0	N/A
	Small Projects, PY8	1,237	22	Engineering File Review with Phone Verification
	Small Projects, PY9	2,457	75	Engineering File Review with Phone Verification
	Medium Projects, PY8	533	12	Engineering File Review with Phone Verification
	Medium Projects, PY9	1,110	19	Engineering File Review with Phone Verification
	Large Projects, PY8	328	18	Engineering File Review with Onsite Verification
	Large Projects, PY9	727	28	Engineering File Review with Onsite Verification
	Solution Total	**7,170**	**174**	
New Construction	**Solution Total**	**560**	**66**	File Review and Building Energy Simulation
Behavioral	**Solution Total**	**423,651**	**N/A**	
Multifamily Targeted	Multisector	23	6	File Review and Onsite
	Large Residential	36	4	File Review and Onsite
	Small Residential	1,558	6	File Review and Onsite
	Solution Total	**1,617**	**16**	
Total Program	**All**	**1,349,552**	**364**	

Source: Navigant analysis

Table 3-4 summarizes the reported and verified energy savings results along with the coefficient of variation (C_v) and relative precision for each stratum sampled for the Residential EE Program in PY9.

The PY8 reported energy and demand savings for the Residential Whole Home Solution were 2,709 MWh/yr and 0.28 MW. However, this solution is evaluated on a 2-year basis, resulting in a PY8 RR of 0.00. These PY8 savings were evaluated with the PY9 evaluation activity; this report verifies combined savings for both PY8 and PY9. Navigant shows both the PY8 and PY9 verified energy and demand savings in Table 3-4 and Table 3-5, respectively. These tables also include the RRs on a stratum and solution level, which is calculated by dividing the total PY8 and PY9 verified savings by the reported PY9 savings only.

Table 3-4. Residential EE Program Gross Results for Energy

Solution	Stratum Name	Reported Gross Energy Savings (MWh/yr)	Verified Gross Energy Savings (MWh/yr)	Energy RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Lighting, Appliances & HVAC	Appliances	1,008	997	0.99	0.15	1.5%
	HVAC	4,396	4,408	1.00	0.05	0.5%
	Standard LED	63,540	64,088	1.01	0.08	0.6%
	Specialty LED	56,983	57,574	1.01	0.14	0.9%
	Solution Total	**125,928**	**127,067**	**1.01**	**0.06**	**0.3%**
Appliance Recycling	Refrigerators	13,035	12,602	0.97	0.00	0.0%
	Freezers	2,508	1,507	0.60	0.00	0.1%
	Room ACs	403	403	1.00	0.03	2.6%
	Solution Total	**15,946**	**14,512**	**0.91**	**0.01**	**0.4%**
Whole Home*	Very Small Projects, PY8	0	54	0.81	0.00	100.0%
	Very Small Projects, PY9	103	101	0.98	0.00	100.0%
	Small Projects, PY8	0	882	1.08	0.03	0.9%
	Small Projects, PY9	1,791	1,753	0.98	0.03	0.5%
	Medium Projects, PY8	0	743	0.86	0.02	0.7%
	Medium Projects, PY9	1,744	1,744	1.00	0.01	0.5%
	Large Projects, PY8	0	809	0.84	0.01	0.3%
	Large Projects, PY9	3,390	3,742	1.10	0.01	0.2%
	Solution Total	**7,028**	**9,829**	**1.40**	**0.78**	**8.5%**
New Construction	**Solution Total**	**1,452**	**1,451**	**1.00**	**0.00**	**0.0%**
Behavior	**Solution Total**	**81,934**	**78,396**	**0.96**	**N/A**	**N/A**
Multifamily Targeted	Multisector	998	797	0.80	0.37	26.0%
	Large Residential	1,768	1,578	0.89	0.06	5.5%
	Small Residential	733	452	0.62	0.44	30.4%
	Solution Total	**3,499**	**2,828**	**0.81**	**0.22**	**8.2%**
Total Program	**All**	**235,786**	**234,083**	**0.99**	**0.16**	**0.7% [90% CI]**

*The RRs for the PY8 strata for the Whole Home Solution represent PY8 reported savings divided by the associated stratum savings verified later in PY9. The Reported Gross Energy Savings (MWh/yr) are zero, representing no savings reported for that stratum in PY9. The reported PY8 savings can be found in the PY8 annual report.

Source: Navigant analysis

Table 3-5 summarizes the reported and verified demand savings results along with the C_v and relative precision for each stratum sampled for the Residential EE Program in PY9.

Table 3-5. Residential EE Program Gross Results for Demand

Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Lighting, Appliances & HVAC	Appliances	0.17	0.17	0.99	0.12	1.2%
	HVAC	1.95	1.95	1.00	0.05	0.5%
	Standard LED	7.49	7.63	1.02	0.08	0.6%
	Specialty LED	6.71	7.02	1.05	0.14	0.9%
	Solution Total	**16.32**	**16.77**	**1.03**	**0.06**	**0.3%**
Appliance Recycling	Refrigerators	1.51	1.41	0.94	0.00	0.0%
	Freezers	0.28	0.17	0.59	0.00	0.0%
	Room ACs	0.66	0.66	1.00	0.00	0.0%
	Solution Total	**2.45**	**2.24**	**0.91**	**0.00**	**0.0%**
Whole Home*	Very Small Projects, PY8	0.00	0.01	0.77	0.00	100%
	Very Small Projects, PY9	0.01	0.01	0.98	0.00	100%
	Small Projects, PY8	0.00	0.10	1.07	0.13	4.1%
	Small Projects, PY9	0.21	0.21	0.98	0.11	1.8%
	Medium Projects, PY8	0.00	0.10	0.88	0.00	0.0%
	Medium Projects, PY9	0.22	0.22	1.00	0.00	0.0%
	Large Projects, PY8	0.00	0.03	0.49	0.62	22.1%
	Large Projects, PY9	0.36	0.35	0.99	0.10	2.7%
	Solution Total	**0.80**	**1.03**	**1.28**	**0.65**	**7.1%**
New Construction	**Solution Total**	**0.43**	**0.43**	**1.00**	**0.00**	**0.0%**
Behavior	**Solution Total**	**0.00**	**8.95**	**-****	**N/A**	**N/A**
Multifamily Targeted	Multisector	0.13	0.08	0.64	0.61	42.2%
	Large Residential	0.23	0.19	0.84	0.07	7.2%
	Small Residential	0.09	0.05	0.55	0.51	35.6%
	Solution Total	**0.45**	**0.32**	**0.72**	**0.30**	**11.4%**
Total Program	**All**	**20.46**	**29.75**	**1.45**	**0.11**	**0.5% [90% CI]**

*The RRs for the PY8 strata for the Whole Home Solution represent PY8 reported savings divided by the associated stratum savings verified later in PY9. The Reported Gross Energy Savings (MWh/yr) are zero, representing no savings reported for that stratum in PY9. The reported PY8 savings can be found in the PY8 annual report.

** For the Residential Behavioral Solution, the implementer does not report demand savings; however, the SWE requires PECO to verify demand savings. As a result, there is no demand RR for the Behavioral Solution. However, the verified demand savings do get added to the Residential Program savings. As a result, the demand RR for the Residential Program is greater than the demand RR for each individual solution in the program.

Source: Navigant analysis

Factors leading to variations between the reported and verified savings and the observed RRs for the Residential EE Program are detailed in Appendix D for each solution. Overall, the Lighting, Appliances & HVAC Solution and the Behavioral Solution are the most significant drivers of the program-level results and RRs, as these two Solutions represent almost 90% of the program savings.

3.1.3 Net Impact Evaluation

The Residential EE Program's net impact evaluation activities used several methods to estimate free ridership, spillover, market effects, and NTG ratios. Navigant relied on consistent, crosscutting approaches as well as ones tailored to certain solutions' characteristics. The primary objective of the net savings analysis was to determine the program's net effect on customer electricity usage. The evaluation team derived net program impacts by estimating a NTG ratio that quantifies the percentage of the gross program impacts that can reliably be attributed to the program. The team conducted primary NTG research through surveys for the Whole Home and Residential New Construction Solutions in PY9. The evaluation team also interviewed trade allies for the Appliances and HVAC portion of the Lighting, Appliances & HVAC Solution and asked them a battery of NTG questions to gather feedback on their view of the residential market.

Free ridership is defined as those participants who would have implemented a measure or purchased equipment anyway, without program support or a rebate. The questions determining free ridership focus on the influence of key program interventions. These interventions vary by solution but can include discounted prices, program information regarding efficient products, placement of program-discounted products in stores, and the customer's perception of what they would most likely have done in the absence of the program.

Spillover is defined as those participants who were influenced by the program to purchase and install additional energy efficient equipment that saves electricity without a rebate or other program support. Navigant analyzed participant responses to a battery of spillover questions. The intent of these questions was to identify what types and amounts of equipment customers purchased and installed on their own to inform a quantitative estimate of program spillover within the overall NTG calculation.[15]

Market effects represent a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of EE products, services, or practices and is casually related to market intervention(s).

Navigant surveyed some PECO program and solution participants online to gather information about free ridership and spillover. The evaluation team developed survey instruments consistent with the Phase III

[15] The NTG surveying effort for the Whole Home Solution did not capture the quantity of the respondent's identified spillover measures in the survey instrument, required to fully quantify spillover activities. This omission occurred in error. However, through the survey effort, the team found that 48 respondents reported taking spillover-related actions. Of that group, 38 provided clear enough responses where a determination of the presence or absence of spillover could be made. Of the 38, 32 indicated evidence of program spillover. Among participants who implemented spillover measures, the average attribution score for program influence on their actions was 84%. Navigant found roughly similar trends during previous surveying in PY7 for the similar Smart House Call program (i.e., 18 of 33 respondents indicating evidence of spillover had an average attribution score of 92%). The majority of spillover projects include the installation of LED bulbs in both PY7 and PY9, so the team applied an average number of units (LED installations) from PY7 to the PY9 LED projects to estimate the PY9 spillover results.

Evaluation Framework's guidance on net impact evaluation techniques[16] and guidance from the Uniform Methods Project on estimating net savings.[17] The team carefully reviewed and managed samples across solutions to reduce the likelihood that a respondent participating in multiple solutions during PY9 would be contacted to complete multiple surveys. Survey instruments also captured feedback about customer experiences from participants to inform the process evaluation.

Table 3-6 provides the sampling frame for the net impact evaluation of the Residential EE Program in PY9, where sampling occurred.

Table 3-6. Residential EE Program Net Impact Sample Design for PY9

Solution	Stratum Name and Boundaries	Population Size	Achieved Sample Size	Response Rate	Verification Method
Whole Home	Very Small Projects, PY8	272	N/A	N/A	N/A
	Very Small Projects, PY9	506	N/A	N/A	N/A
	Small Projects, PY8	1,237	19	1.5%	Phone Survey
	Small Projects, PY9	2,457	68	2.8%	Phone Survey
	Medium Projects, PY8	533	15	2.8%	Phone Survey
	Medium Projects, PY9	1,110	27	2.4%	Phone Survey
	Large Projects, PY8	328	3	0.9%	Phone Survey
	Large Projects, PY9	727	13	1.8%	Phone Survey
	Solution Total	**7,170**	**145**	**2.0%**	

Source: Navigant analysis

Table 3-7 summarizes the reported and verified energy savings results, the calculated NTG results, and the C_V and relative precision for each stratum sampled for the Residential EE Program in PY9.

[16] Pennsylvania PUC. *Phase III Evaluation Framework*. Section 3.4. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

[17] The Uniform Methods Project. *Estimating Net Savings: Common Practices*. NREL. https://www.nrel.gov/docs/fy14osti/62678.pdf

Table 3-7. Residential EE Program Net Energy Savings Impact Evaluation Results for PY9

Solution	Stratum Name	Verified Gross Energy Savings (MWh/yr)	Verified Net Energy Savings (MWh/yr)	Free Ridership Rate	Spillover Rate	NTG Ratio	Achieved Sample C_V or Error Ratio	Relative Precision at 85% Confidence Interval
Lighting, Appliances & HVAC	Appliances	997	654	0.55	0.21	0.66	1.72	28.9%
	HVAC	4,408	2,485	0.46	0.03	0.56	0.28	4.7%
	Standard LED	64,088	32,680	0.53	0.04	0.51	0.45	3.4%
	Specialty LED	57,574	26,436	0.58	0.04	0.46	0.40	2.6%
	Solution Total	**127,067**	**62,256**	**0.55**	**0.04**	**0.49**	**0.44**	**1.5%**
Appliance Recycling	Refrigerators	12,602	4,370	0.65	0.00	0.35	1.41	15.9%
	Freezers	1,507	748	0.50	0.00	0.50	1.00	21.3%
	Room ACs	403	187	0.54	0.00	0.46	1.08	53.5%
	Solution Total	**14,512**	**5,305**	**0.63**	**0.00**	**0.37**	**1.57**	**15.3%**
Whole Home	Very Small Projects, PY8	54	45	0.23	0.08	0.85	0.00	100.0%
	Very Small Projects, PY9	101	90	0.19	0.08	0.89	0.00	100.0%
	Small Projects, PY8	882	746	0.23	0.08	0.85	0.13	4.4%
	Small Projects, PY9	1,753	1,553	0.19	0.08	0.89	0.36	6.3%
	Medium Projects, PY8	743	678	0.13	0.04	0.91	0.14	5.3%
	Medium Projects, PY9	1,744	1,479	0.16	0.01	0.85	0.19	5.6%
	Large Projects, PY8	809	763	0.06	0.00	0.94	0.44	58.6%
	Large Projects, PY9	3,742	3,359	0.12	0.01	0.90	0.12	5.3%
	Solution Total	**9,829**	**8,714**	**0.15**	**0.03**	**0.89**	**0.39**	**4.7%**
New Construction	**Solution Total**	**1,451**	**1,258**	**0.13**	**0.00**	**0.87**	**0.48**	**17.0%**
Behavior	**Solution Total**	**78,396**	**78,396**	**0.00**	**0.00**	**1.00**	**N/A**	**N/A**

Solution	Stratum Name	Verified Gross Energy Savings (MWh/yr)	Verified Net Energy Savings (MWh/yr)	Free Ridership Rate	Spillover Rate	NTG Ratio	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Multifamily Targeted	Multisector	797	688	0.16	0.02	0.86	0.05	0.9%
	Large Residential	1,578	1,361	0.16	0.02	0.86	0.05	1.2%
	Small Residential	452	390	0.16	0.02	0.86	0.06	1.4%
	Solution Total	**2,828**	**2,440**	**0.16**	**0.02**	**0.86**	**0.05**	**0.6%**
Total Program	**All**	**234,083**	**158,368**	**0.35**	**0.02**	**0.68**	**0.49**	**1.7% [90% CI]**

* Navigant only conducted NTG research in PY9 for the Whole Home and Residential New Construction solutions. NTG results for all other solutions come from PY7 or PY8 research.

Source: Navigant analysis

Factors leading to these NTG ratios for the Residential EE Program include very high reported levels of free ridership among LAH participants who said they would have purchased energy efficient products (e.g., LED bulbs, ENERGY STAR appliances, and efficiency HVAC equipment) without the incentive from PECO. Other solutions, such as Whole Home, reported lower free ridership scores, but these have less impact on the program overall since LAH is such a significant driver of program savings.

3.1.3.1 High Impact Measure Research

High impact measures (HIMs) represent measure categories or technologies of high importance in the PECO portfolio. In Phase III, the SWE suggested EDCs oversample HIMs to help program planners make decisions concerning those measures for downstream programs only.[18] EDCs were to identify three to five measures for study within each program year based on energy impact, level of uncertainty, prospective value, funding, or other parameters. The SWE stated that HIMs should be sampled at 85% confidence and 15% absolute precision to ensure an adequate sample size for statistically valid, measure-level NTG estimates. Below is a description of the methodology used to determine the HIMs in PY9.

Navigant identified HIMs through several steps involving careful review of program- and solution-level savings, energy impact, and value to PECO. The evaluation team conducted NTG and HIM analysis for the Whole Home Solution in the Residential Program for PY9. The team identified HIMs that aligned with PECO's Phase III planning document for the Whole Home Solution, including ENERGY STAR LEDs, fuel switching from electric to fossil fuel heating, and variable speed pool pumps. Table 3-8 shows the results of the HIM analysis in PY9.

Table 3-8. Residential EE Program HIM NTG Summary

Solution	HIM	Free Ridership Rate	Spillover Rate	NTG Ratio
Whole Home	ENERGY STAR LED	0.16	0.04	0.88
Whole Home	Furnace: Fuel Switching: Electric Heat to Gas/Propane/ Oil Heat	0.25	0.00	0.75
Whole Home	Variable Speed Pool Pumps	0.00	0.00	1.00

Source: Navigant analysis

3.1.4 Verified Savings Estimation by Solution

Table 3-9 shows the RRs and NTG ratios applied to the reported energy and demand savings estimates to calculate the verified savings estimates for each solution and the total Residential EE Program in PY9.

[18] Pennsylvania PUC. *Phase III Evaluation Framework.* Section 3.4.1.4. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 3-9. PYTD and P3TD Savings Summary for the Residential EE Program

Solution/Program Name	Savings Type	Energy (MWh/yr)	Demand (MW)
Lighting, Appliances & HVAC	PYRTD	125,928	16.32
	PYVTD Gross	127,067	16.77
	PYVTD Net	62,256	8.22
	RTD	197,467	26.08
	VTD Gross	201,230	27.78
	VTD Net	97,912	13.51
Appliance Recycling	PYRTD	15,946	2.45
	PYVTD Gross	14,512	2.24
	PYVTD Net	5,305	0.82
	RTD	24,476	3.62
	VTD Gross	22,480	3.32
	VTD Net	8,245	1.22
Whole Home	PYRTD	7,028	0.80
	PYVTD Gross	9,829	1.03
	PYVTD Net	8,714	0.91
	RTD	9,737	1.08
	VTD Gross	9,829	1.03
	VTD Net	8,714	0.91
New Construction	PYRTD	1,452	0.43
	PYVTD Gross	1,451	0.43
	PYVTD Net	1,258	0.37
	RTD	2,190	0.68
	VTD Gross	2,182	0.62
	VTD Net	1,623	0.47
Behavioral	PYRTD	81,934	0.00
	PYVTD Gross	78,396	8.95
	PYVTD Net	78,396	8.95
	RTD	144,358	0.00
	VTD Gross	141,781	16.19
	VTD Net	141,781	16.19

Solution/Program Name	Savings Type	Energy (MWh/yr)	Demand (MW)
Multifamily Targeted Market Segment	PYRTD	3,499	0.45
	PYVTD Gross	2,828	0.34
	PYVTD Net	2,440	0.29
	RTD	5,477	0.69
	VTD Gross	4,783	0.58
	VTD Net	4,126	0.50
Residential EE Program	PYRTD	235,786	20.46
	PYVTD Gross	234,083	29.75
	PYVTD Net	158,368	19.55
	RTD	383,705	32.16
	VTD Gross	382,284	49.50
	VTD Net	262,401	32.78

Source: Navigant analysis

3.1.5 Process Evaluation

Navigant performed targeted process evaluation tasks for the Residential EE Program during PY9 building on the PY8 activities. The PY9 process evaluation efforts included in-depth interviews with key PECO and CSP staff, in-depth interviews with trade allies, and a detailed review of program databases and tracking systems across all solutions. The PY9 evaluation also included residential participant and builder surveys for the Whole Home and New Construction Solutions, respectively. This section summarizes the evaluation methods, data collection techniques, sample design, and key results related to these PY9 activities.

PECO and CSP staff provided essential information about the program design and how the program actually is experienced compared to the EE&C Plan. Navigant conducted in-depth interviews with all PECO solution leads and CSPs at part of the PY9 evaluation and communicated with staff on an ongoing basis as needed. The evaluation team developed interview instruments to include questions of interest to the evaluation and to allow for free-flowing conversations to obtain candid feedback from the interviewees.

In addition to interviews with staff and CSPs, Navigant conducted trade ally interviews of a sample of non-lighting HVAC installer firms in the Appliances and HVAC components (i.e., the non-lighting components of the Lighting, Appliances & HVAC Solution) to understand trade ally experience and engagement, HVAC market trends, installer involvement, and overall participation.

Navigant developed all survey instruments according to SWE requirements and has the SWE review and approve each in advance of fielding.[19] In general, the evaluation team defined the survey population for each solution's participants based on the program tracking databases provided by PECO. In some cases, demographic and geographic information, data on installed measures, installation dates, and estimated

[19] The survey instruments included more questions than are presented in this compliance report. Navigant and PECO are analyzing findings from these additional questions to inform continuous process improvements to the programs, solutions, and customer experience and will include relevant results in subsequent reports as findings and recommendations are formalized.

savings were used for sample design and the subsequent analysis of results. The team developed a sample sufficient to provide 85/15 confidence/precision for the survey results.

The evaluation team developed the various in-depth interview and participant and builder survey instruments by creating crosscutting, generic instruments intended to capture general information consistently. For example, the generic participant survey instrument contained a battery of satisfaction questions so that sentiments across solutions and program years could be compared. The team then augmented and customized the instruments to meet the specific research needs of each solution and program year.

Navigant is working with PECO to refine Residential EE Program process and customer journey maps for the Appliances and HVAC component of Lighting, Appliance, & HVAC, Multifamily Targeted Market Segment, and the Low-Income Whole Home and Appliance Recycling Solutions, in alignment with the Evaluation Plan. Solution process and customer journey maps for the remaining Residential New Construction and Whole Home Solutions are being developed and will be integrated into a portfolio process and customer journey map. These process and journey maps document the intent of the program and compare the intended plan to current program activities based on data collected via PY8 and PY9 surveys.

The following provides a summary of the process evaluation activities conducted for each Residential EE solution.

- Lighting, Appliances & HVAC Solution
  - Lighting
    - PECO staff interviews[20]
  - Non-Lighting Appliances and HVAC components
    - PECO and CSP staff interviews
    - Trade ally in-depth interviews
- Appliance Recycling Solution
  - PECO and CSP staff interviews
- Whole Home Solution
  - PECO and CSP staff interviews
  - Phone survey: Navigant used phone surveys to assess how customers heard about the Whole Home Solution, their satisfaction with the solution and PECO overall, and their awareness of other PECO solutions.
- New Construction Solution
  - PECO and CSP staff interviews
  - Builder online survey: Navigant used online surveys to assess how builders heard about the New Construction Solution, their satisfaction with the solution and PECO overall, and their awareness of other PECO solutions.
- Behavioral Solution
- PECO and CSP staff interviews
- Multifamily Targeted Market Segment

[20] Due to the changeover from Ecova to CLEAResult in PY9, CSP staff interviews will be conducted in PY10.

- PECO and CSP staff interviews
- Program Tracking Data Review

Table 3-10 provides the customer survey sample details for each Residential EE solution. The Whole Home Solution population data for the survey stratification variables of interest and the stratum characteristics of actual survey participants completed do not closely match those found in the Whole Home Solution population size. To align the stratification variables of interest to the actual achieved sample, Navigant weighted the survey data to align more closely with the Whole Home Solution populations size as shown in the table below.

Table 3-10. Residential EE Program Customer Survey Sample Design for PY9[21]

Solution	Stratum	Population Size	Target Sample Size	Achieved Sample Size	Achieved Sample %	Weight
Whole Home*	Very Small Projects, PY8	272	0	N/A	N/A	N/A
	Very Small Projects, PY9	506	0	N/A	N/A	N/A
	Small Projects, PY8	1,237	25	19	76.0%	1.48
	Small Projects, PY9	2,457	30	67	223.3%	0.82
	Medium Projects, PY8	533	25	15	60.0%	0.81
	Medium Projects, PY9	1,110	25	27	108.0%	0.93
	Large Projects, PY8	328	20	3	15.0%	2.48
	Large Projects, PY9	727	20	13	65.0%	1.27
	Solution Total	**7,170**	**145**	**144**	**99.0%**	

*The Whole Home sample stratification boundaries (min/max kWh ranges) changed slightly from the original SWE-approved sampling memo.
Source: Navigant analysis

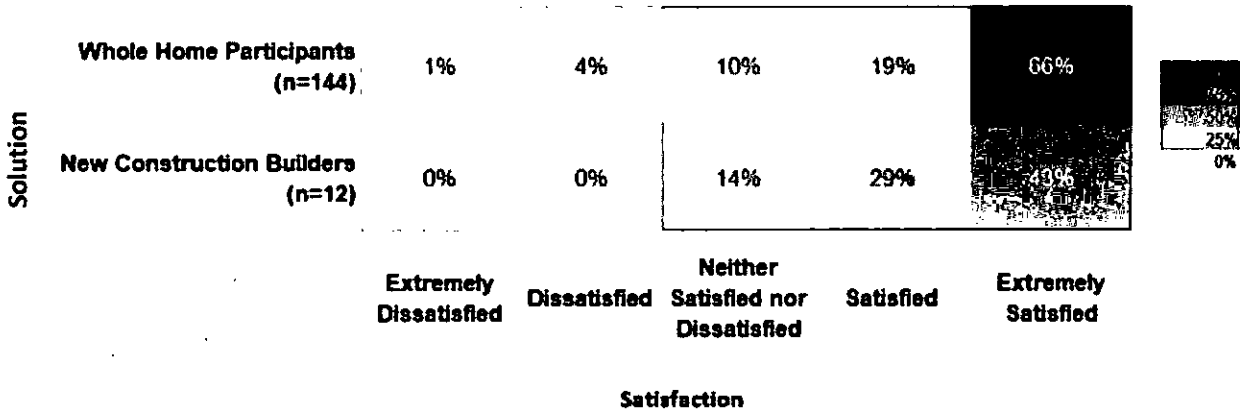
3.1.5.1 Key Findings from Process Evaluation

For PY9, Navigant surveyed Whole Home Solution participants and New Construction Solution builder participants to measure satisfaction and assess the PECO Residential EE Program's effectiveness at encouraging the participation needed to achieve energy savings and participation goals. This section includes results from several cross-solution metrics including satisfaction and marketing effectiveness. Appendix D includes detailed findings relevant to each specific solution.

Whole Home Solution participants and New Construction Solution participant builders were asked about their overall satisfaction with their relevant solution. Average satisfaction across the two solutions was 4.4 on a 5-point scale, with 1 representing extremely dissatisfied and 5 representing extremely satisfied. As shown in Figure 3-1, participant customers and builders were generally satisfied or extremely satisfied with the program. Eighty percent of Whole Home participants and 72% of New Construction builders stated they were satisfied with their participation in their respective solutions. Whole Home customers (7%) expressed some level of dissatisfaction with their involvement in the solution, while New Construction builders expressed no dissatisfaction.

[21] Navigant designed the survey samples to achieve 15% relative precision at the 85% confidence level at the solution level for NTG ratios and satisfaction ratings.

Figure 3-1. Overall Satisfaction by Residential EE Solution



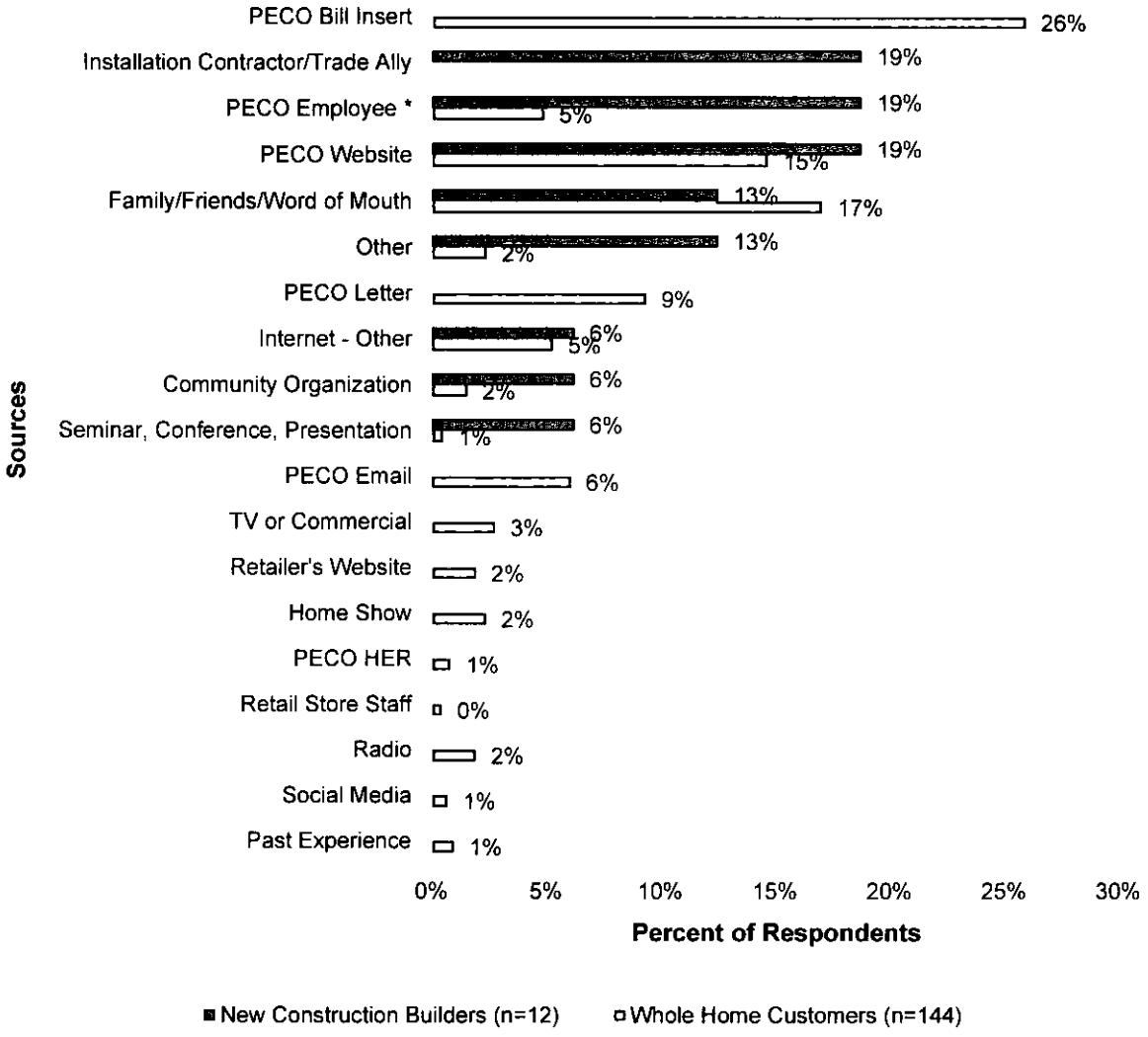
Question: Using a scale of 1 to 5, with 5 meaning extremely satisfied and 1 meaning extremely dissatisfied, how would you rate your OVERALL satisfaction with the [Solution] program?

Note: Refused and Do Not Know responses have been excluded.

Source: Navigant analysis

The evaluation team's examination into key sources of information reveals that PECO bill inserts, PECO employees, and the PECO website play an important role in participants and builders learning about the Residential EE Program and their relevant solutions. As seen in Figure 3-2, 26% of Whole Home participants learned about their respective solution from PECO bill inserts received in the mail. Whole Home Solution participants stated word of mouth from family and friends (17%) and the PECO website (15%) were also effective sources of information in learning more about the program. Compared to PY8 Residential EE Program results, the influence of word of mouth (9%) and the PECO website (8%) on participants increased significantly—by 8 and 5 percentage points, respectively. New Construction participant builders mentioned contractors or trade allies (19%), PECO employees (19%), and PECO's website (19%) as the main sources of information about PECO's program offerings. These results also indicate that, in particular, the PECO website (11%) has been instrumental in influencing more residential participants to learn about the Residential EE Program, an increase of 2 percentage points from PY8 findings (9%).

Figure 3-2. Sources of Residential EE Solution Awareness



*PECO Employee includes a PECO account representative and a customer service representative.

Question: How did you learn about the [SOLUTION] program? Multiple responses allowed; sum of percentages will not add up to 100%.

Other includes a Home Energy Rating System Rater (HERS) rater and a LEED certification energy auditor.

Source: Navigant analysis

3.1.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-11. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 3-11. Summary of Residential EE Program Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$8,933	$13,507
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$10,364	$17,102
	Cost Subtotal	**$19,297**	**$30,610**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$458	$794
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$5,416	$9,479
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$11,009	$19,570
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$16,884**	**$29,843**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$178	$265
	Cost Subtotal	**$178**	**$265**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$36,358**	**$60,717**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$46,344	$70,963
	Lifetime Electric Capacity Benefits	$15,301	$24,411
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$16,824	$25,943
	Benefits Total	**$78,469**	**$121,317**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**2.16**	**2.00**

[1] Includes direct install equipment costs and costs for EE&C kits.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management, legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
Source: Navigant analysis

Table 3-12 presents program financials and cost-effectiveness on a net savings basis.

Table 3-12. Summary of Residential EE Program Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$8,933	$13,507
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$1,827	$3,002
	Cost Subtotal	**$10,760**	**$16,509**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$458	$794
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$5,416	$9,479
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$11,009	$19,570
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$16,884**	**$29,843**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$154	$230
	Cost Subtotal	**$154**	**$230**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$27,797**	**$46,582**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$25,485	$38,357
	Lifetime Electric Capacity Benefits	$8,343	$13,015
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$8,638	$13,108

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Benefits Total	**$42,466**	**$64,480**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**1.53**	**1.38**

[1] Includes direct install equipment costs and costs for EE&C kits.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

3.1.7 Status of Recommendations

The impact and process evaluation activities in PY9 led to the following findings and recommendations from Navigant to PECO, along with a summary of how PECO plans to address the recommendations in program delivery. Table 3-13 presents those solution level findings and recommendations along with an Appendix Reference in the far-right column. The references point to Appendix D.1, which provides additional details on findings, recommendations, and associated analysis conducted by Navigant for each solution.

Table 3-13. Summary of Findings and Recommendations for Residential EE Program

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Lighting, Appliances & HVAC Solution (Lighting Component)	Navigant updated baseline wattage for several (114 out of 912) unique SKUs based on bulb characteristics identified in the eTrack databases, the PA TRM savings assumptions, and the evaluation team's understanding of Energy Independence and Security Act (EISA) exempt products.	Navigant will work with PECO and the CSP to explore the best approach for documenting bulb characteristics in the eTrack database so that the mapping to the PA TRM baseline wattages is transparent.	**Under Consideration**. PECO understands that these existing data requirements and inputs will need to be thoroughly reviewed and parameters analyzed. PECO's program does not incentivize Linear/T8 LEDs	Residential EE Appendix D.1
Lighting, Appliances & HVAC Solution (Lighting Component)	There is opportunity to improve the process for verifying program bulb ENERGY STAR certification by incorporating additional bulb information into the tracking system.	Navigant will work with PECO to explore approaches for incorporating the ENERGY STAR unique identifier for each program bulb record in the tracking system. This will provide greater transparency about the bulb certification status and streamline verification for future evaluations.	**Under Consideration.** CSP was able to provide the "key" (unique identifier) within a day of the request so that verification could be done. PECO agrees that we can work together to try and incorporate this unique identifier into the data feed for lighting.	Residential EE Appendix D.1
Lighting, Appliances & HVAC Solution (Non-Lighting Component)	There is opportunity to improve data tracking practices within the eTrack database for ductless mini-split heat pumps (DHP). These opportunities include clarifying input headers and confirming proper accounting for child versus parent DHP units.	Navigant is currently working with PECO and the CSP to identify and implement the best approaches for improving these data tracking efforts.	**Being Implemented**. DHP is currently under investigation by PECO implementation team and the CSP. An adjustment will be made for those DHPs identified as irregular, and all future invoicing resolved for PY10.	Residential EE Appendix D.1
Appliance Recycling	The CSP's method for calculating the pre-1990 independent variable of the TRM deemed value algorithm approach did not reflect the new 2016 TRM requirement to use EDC-gathered data when calculating the deemed UECs used in the program tracking data for refrigerators and freezers.	While live updates to the deemed UEC to incorporate each new unit is prohibitive, Navigant recommends the CSP update the value of the pre-1990 independent variable and, therefore, the deemed refrigerator and freezer UECs to reflect the EDC-gathered data after the entire stock for the program year is finalized.	**Will be Implemented.** PECO will work with Navigant to develop a process for all TRM updates and values to ensure CSPs are reporting correctly.	Residential EE Appendix D.1

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Appliance Recycling	Phone verification identified customers who reported that their appliance did not meet the program requirement that the appliance was in working condition at the time of pickup. However, Navigant's review of PECO's processes found that PECO has numerous QA/QC procedures in place to ensure that recycled appliances are indeed working at the time of pickup including examples from PECO call scripts, training materials, and program documents documenting orders cancelled due to the working condition of the appliance.	Navigant recommends PECO add a data field to the form used when picking up appliances that specifies whether the appliance was working at the time of pickup and that PECO includes this data in eTrack. Additionally, Navigant suggests including a screening question in the online pickup scheduling form to pre-screen out customers whose appliances do not meet this program requirement. This finding will be explored further in the PY10 evaluation.	**Will be Implemented.** PECO will work with Implementation CSP and Navigant to add an additional data field to form signed by customer confirming unit is working at the time of pickup. Also, PECO will work with Navigant to develop an appropriate question around this issue.	Residential EE Appendix D.2
Whole Home	Reported lighting measure savings were calculated with a 1.00 in-service rate (ISR) rather than the default TRM value of 0.92.	Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.	**Will be Implemented.** PECO is working with Navigant and CLEAResult to correct the ISR value for future projects.	Residential EE Appendix D.3
Whole Home	There is room for improvement in how the CSP calculates savings for heat pump water heaters. The TRM algorithm uses EFbase and EFee constant values, which resulted in negative savings for larger size tanks.	Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.	**Implemented.** Working with Navigant to determine the root cause. From early indications this has been corrected with the transition of CSP's from Ecova to CLEAResult.	Residential EE Appendix D.3
Whole Home	Solution goals to convert in-home assessments and audits to major measure installations would require more promotional and customer facing program materials.	Consider directly promoting the comfort and financial (energy saving) benefits of major measure installation to customers in Whole Home Solution materials and on the website. Promote the potential savings and incentives for major measures along with the benefits of an initial in-home assessment to encourage project conversion.	**Implemented**. We have recently implemented changes in the post follow process to encourage customers to move forward with recommended measures.	Residential EE Appendix D.3

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Whole Home	Conversion rates from in-home assessment and audit recommendations to major mechanical measures installations (heat pumps, water heaters, pool pumps, etc.) are tracked in various places due to the complexities of multiple CSPs implementing the solution.	Formalize major measure recommendation tracking and monitor conversion rates for major measure installations. Identify areas where customers may need additional follow up after initial audit recommendations to encourage conversion.	**Being Implemented**. With the changeover to a singular CSP (CLEAResult), PECO has a centralized system that better tracks the flow of information. PECO will revisit the conversion rates to major measures installation and work with marketing vendor to create a lead customer tracking follow up mechanism.	Residential EE Appendix D.3
Whole Home	Of participants, 90% indicated they are likely to recommend the PECO program to others. Participants primarily heard of the Whole Home Solution through bill inserts and word of mouth.	Use direct follow-up participant outreach to maximize referrals through the recently launched Refer-a-Friend marketing initiative.	**Being Implemented.** Though collaboration with the EEMF and CSP, PECO in the process of evaluating the effectiveness of the recently implemented Refer-a-Friend initiative. Once in place, we overall impact towards reaching more customers.	Residential EE Appendix D.3
New Construction	Navigant surveyed customers about the New Home Rebates Program. Some responses indicted participants are less satisfied with marketing assistance and training opportunities because they are unaware that these services are offered through the program.	PECO should consider more direct outreach with builders to inform them about marketing and training opportunities through the program.	**Implemented**. Working with the CSP and EEMF marketing, PECO developed a builder kit that helps to address some of these issues. PECO is developing a more extensive outreach program for the builders, specifically for sales and marketing of energy efficient housing.	Residential EE Appendix D.4
New Construction	The evaluation team analyzed open-ended survey responses describing reasons for lower participant builder satisfaction with the time it takes to receive a rebate. Over 33% of builders indicated that it takes about 3 to 6 months to receive a rebate.	PECO should continue to monitor incentive processing time to identify and minimize bottlenecks and ensure that builders are promptly receiving rebates. Should the average rebate delivery time lag beyond the 60-day goal, PECO and Navigant should identify and propose solutions to the reasons for the delay.	**Being Implemented.** Working with each respective party to identify where the breakdown is occurring, so that corrective actions can be taken.	Residential EE Appendix D.4

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Multifamily Targeted	Measures are tracked by project, but projects in the same multifamily building complex are not tracked by a unique identifier.	Create an ID field in eTrack that groups all the projects in a multifamily community under a unique ID.	**Being Implemented**. PECO and ANB are working to create a unique tracking capability for all MF projects.	Residential EE Appendix G
Multifamily Targeted	There is room for correction in the hours-of-use (HOU) assumption used by the CSP. In short, the CSP should use space specific deemed HOU from the TRM.	Navigant will work with PECO and the CSP to explore appropriate approaches for including space specific deemed HOU into the data tracking system.	**Being Implemented.** PECO will look into the HOU specifications and work with Franklin to ensure that space type is clearly defined in the project documentation	Residential EE Appendix G

Source: Navigant analysis

3.2 Residential Low-Income EE Program

The Residential Low-Income Energy Efficiency (Low-Income EE) Program offers a comprehensive array of participant solutions and activities to achieve PECO's goal of helping income-eligible customers save energy. The Low-Income EE Program targets PECO residential electric customers with a household income of less than or equal to 150% of the FPL to meet the 5.5% low-income energy saving carveout requirement. Additionally, PECO targets Customer Assistance Program (CAP) customers with high usage and incomes of 0%-50% of the FPL per the February 17, 2016 Joint Petition for Settlement agreement.

The Low-Income EE Program consists of two solutions:

- Whole Home Solution
- Lighting Solution

Savings are achieved through a range of delivery mechanisms and methods including midstream incentives (retailer buy-downs), product giveaways, in-home audits, and direct install measures. PECO relies on three CSPs to deliver the program savings, listed here with their corresponding solution:

1. Whole Home Solution – CMC and ARCA
2. Lighting Solution[22] – Ecova

PECO's Low-Income EE Program refers eligible customers to the Residential EE Program's Appliance Recycling Solution when appropriate. Appliance Recycling Solution savings from referred customers who are on the CAP rate and at or below 150% of the FPL are applied toward the Low-Income carveout requirement through the Whole Home Solution.

PECO's income-qualified customers are also eligible to benefit from the Residential EE Program's Behavioral Solution. Low-income participation in the Behavioral Solution and associated savings are reported through the Residential EE Program and are not applied toward the Low-Income carveout requirement.

3.2.1 Participation and Reported Savings by Customer Segment

This section provides the Low-Income EE Program results for PY9, including participation, energy and demand savings, and incentive costs. Table presents the participation counts and incentive payments for the Low-Income EE Program in PY9 by customer segment.

[22] The Low-Income Lighting Solution was suspended effective January 1, 2018.

Table 3-14. Low-Income EE Program Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I
PYTD No. of Participants	121,798	4	0
PYRTD MWh/yr	28,191	912	0
PYRTD MW	3.33	0.14	0.00
PY9 Incentives ($1,000)	$554	0	0

Source: Navigant analysis

3.2.2 Gross Impact Evaluation

The Low-Income EE Program's gross impact evaluation activities relied on different approaches tailored to each solution's unique characteristics to verify the reported PY9 gross savings values. First, each solution's program tracking data was reviewed to verify proper application of TRM algorithms in reported savings values. The Navigant team completed these reviews for the full population of implemented PY9 Low-Income EE Program measures. Next, the team identified appropriate evaluation activities for each solution depending on the nature of the participants, implementation strategies, and the level of information accompanying the reported savings. The primary goal of the evaluation activities was to verify the implementation of a given measure occurred.

The evaluation activities varied for each solution and for specific strata within some solutions. Activities included engineering file reviews of program applications and invoices, site visit verifications, geographic information system (GIS) surveys, or a combination of these activities.

Navigant then drew samples from each solution for these gross impact evaluation activities. The team developed and sought approval for representative samples that complied with the Phase III Evaluation Framework, the PA TRM, and industry standards and that helped PECO meet the SWE and Commission requirements.

The following provides a summary of the activities conducted for each solution and for specific components or sampled strata within a given solution.

- Whole Home Solution
  - Engineering file reviews
  - Site visit verification (for projects with direct installation measures only)
- Lighting Solution
  - Invoice reviews and record-level savings calculations
  - Application of the PY8 GIS analysis results to allocate Low-Income Carveout savings based on assessed customer income levels

Table 3-15 provides the sampling frame for the gross impact evaluation of the Low-Income EE Program in PY9.

Table 3-15. Low-Income EE Program Gross Impact Sample Design for PY9

Solution	Stratum Name	Population Size	Achieved Sample Size	Verification Method
Whole Home	Large SF	1,178	9	Engineering file review and onsite verification
	Medium SF	2,821	6	Engineering file review and onsite verification
	Small SF	2,239	5	Engineering file review and onsite verification
	Very Small SF	631	1	Engineering file review
	Multifamily	346	19	Engineering file review and onsite verification
	Other	13,091	N/A	N/A
	Solution Total	**20,306**	**40**	
Lighting	**Solution Total**	**110,731**	**N/A**	
Total Program	**All**	**131,037**	**40**	

SF: Single-family

Source: Navigant analysis

Table 3-16 summarizes the reported and verified energy (MWh/yr) savings results, along with the C_v and relative precision for each stratum sampled for the Low-Income EE Program in PY9.

Table 3-16. Low-Income EE Program Gross Results for Energy

Solution	Stratum Name	Reported Gross Energy Savings (MWh/yr)	Verified Gross Energy Savings (MWh/yr)	Energy RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Whole Home	Large SF	9,776	8,222	0.84	0.37	19.9%
	Medium SF	8,821	7,296	0.83	0.41	28.3%
	Small SF	3,915	2,937	0.75	0.34	26.8%
	Very Small SF	288	192	0.67	0.69	100.0%
	Multifamily	359	222	0.62	0.54	18.7%
	Solution Total	**23,159**	**18,869**	**0.81**	**0.73**	**17.0%**
Lighting	**Solution Total**	**5,945**	**5,942**	**1.00**	**0.00**	**0.0%**
Total Program	**All**	**29,104**	**24,811**	**0.85**	**0.73**	**19.5% [90% CI]**

Source: Navigant analysis

Table 3-17 summarizes the reported and verified demand (MW) savings results, along with the C_v and relative precision for each stratum sampled for the Low-Income EE Program in PY9.

Table 3-17. Low-Income EE Program Gross Results for Demand

Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Whole Home	Large SF	1.12	1.21	1.08	1.12	59.3%
	Medium SF	1.08	0.81	0.75	0.46	32.1%
	Small SF	0.50	0.35	0.69	0.42	33.0%
	Very Small SF	0.03	0.02	0.53	0.69	100.0%
	Multifamily	0.05	0.05	0.94	1.83	63.3%
	Solution Total	**2.78**	**2.43**	**0.88**	**0.85**	**19.6%**
Lighting	**Solution Total**	**0.70**	**0.70**	**1.00**	**0.00**	**0.0%**
Total Program	**All**	**3.48**	**3.13**	**0.90**	**0.85**	**22.5% [90% CI]**

Source: Navigant analysis

The overall evaluation resulted in a reduction to reported savings. Additionally, the Lighting Solution evaluation (PY8 GIS analysis) resulted in a reduction of Low-Income EE Program savings allocated to the Low-Income carveout.

3.2.3 Net Impact Evaluation

Net impacts were not assessed for the Low-Income EE Program.

3.2.3.1 High Impact Measure Research

HIM measures were not assessed for the Low-Income EE Program in PY9.

3.2.4 Verified Savings Summary by Solution

Table 3-18 shows the RRs and NTG ratios applied to the reported energy and demand savings estimates to calculate the verified savings estimates for each solution and the total Low-Income EE Program in PY9. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 3-18. PYTD and P3TD Savings Summary for the Low-Income EE Program

Solution/Program Name	Savings Type	Energy (MWh/yr)	Demand (MW)
Whole Home	PYRTD	23,159	2.78
	PYVTD Gross	18,869	2.43
	PYVTD Net	18,869	2.43
	RTD	39,883	4.65
	VTD Gross	35,113	4.23
	VTD Net	35,113	4.23
Lighting	PYRTD	5,945	0.70
	PYVTD Gross	5,942	0.70
	PYVTD Net	5,942	0.70
	RTD	9,086	1.07
	VTD Gross	9,084	1.07
	VTD Net	9,084	1.07
Low-Income EE Program	PYRTD	29,104	3.48
	PYVTD Gross	24,811	3.13
	PYVTD Net	24,811	3.13
	RTD	48,969	5.72
	VTD Gross	44,196	5.30
	VTD Net	44,196	5.30

Source: Navigant analysis

3.2.5 Process Evaluation

In PY9, Navigant's process evaluation activities for the Low-Income EE Program included in-depth interviews with key PECO and CSP staff and a detailed review of program materials including program databases, tracking systems, and other documents. This section summarizes the evaluation methods, data collection techniques, sample design, and key results related to these PY9 activities.

The PECO and CSP staff provided essential information about the program design and how the program experience on the ground compares with the EE&C Plan. The evaluation team conducted in-depth interviews at the beginning of the PY9 evaluation and communicated with staff on an ongoing basis as needed. The team developed interview instruments to include questions of interest to the evaluation and to allow for free-flowing conversations to obtain candid feedback from the interviewees.

Navigant is working with PECO to refine the Low-Income Whole Home Solution process and customer journey maps in alignment with the Evaluation Plan. Process and customer journey maps will be integrated into a portfolio process and customer journey map. These process and journey maps document the intent of the program and compare the intended plan to current program activities based on data collected via PY8 and PY9 surveys and will be presented in a future report when complete.

The following provides a summary of the process evaluation activities conducted for both Low-Income EE solutions.

- Lighting Solution
    - PECO and CSP staff interviews
- Whole Home Solution
    - PECO and CSP staff interviews

3.2.5.1 Key Findings from Process Evaluation

The Low-Income EE Program attained most of its planned savings in PY9, but neither of the program's solutions met their savings projections. Additionally, the Low-Income carveout forecast was not achieved for this year. The Low-Income Program transitioned to a single Whole Home Solution in PY9 because the Lighting Solution was suspended, likely contributing to the shortfall for PY9. The program is adjusting implementation tactics to increase Whole Home Solution savings, including expanding partnerships with other utility and income-eligible programs to identify and comprehensively serve households and expanding the lighting giveaway activity. PECO has made additional adjustments to serve income-eligible customers, including the following:

- Shift from program-/solution-specific marketing and phone support to a centralized marketing entity—the EEMF and call center for managing Whole Home Solution outreach and scheduling activities.
- The Phase II Low-Income Energy Efficiency Program (LEEP) components were replaced with an umbrella Whole Home Solution, which coordinates a set of activities in support of income-eligible customers. These activities include the following:
    - Free home energy check-ups, providing site visits, education, and direct installation of energy efficient products

- Collaboration with property owners to deliver services to income-eligible customers living in multifamily buildings, consistent with the home energy check-up. This effort includes large private property owners and the city's public housing authority.
- Collaboration with complementary income-eligible programs (such as the Philadelphia Gas Works and Weatherization Agencies) to identify income-eligible customers and serve through a single outreach effort.
- Workshops delivered to income-eligible multifamily buildings providing energy education and energy kits.
- Collaboration with the Low-Income Usage Reduction Program (LIURP), providing complementary efficient products to increase the LIURP service offering's comprehensiveness.
- LED lighting giveaways through community events in collaboration with community partner organizations. In PY9, PECO expanded distribution to include food banks serving income-eligible customers.
- Direct customer referrals to the Appliance Recycling Solution.

3.2.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-19. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 3-19. Summary of Low-Income EE Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$6,041	$9,715
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$6	-$49
	Cost Subtotal	**$6,048**	**$9,666**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$74	$144
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$571	$1,175
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Program Delivery (CSP Costs) [5]	$2,573	$5,232
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$3,218**	**$6,551**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$9,266**	**$16,216**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$5,633	$9,495
	Lifetime Electric Capacity Benefits	$1,816	$2,871
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$3,438	$4,062
	Benefits Total	**$10,887**	**$16,428**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**1.17**	**1.01**

[1] Includes direct install equipment costs and costs for EE&C kits.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

Table 3-20 presents program financials and cost-effectiveness on a net savings basis.

Table 3-20. Summary of Low-Income EE Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$6,041	$9,715
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$6	-$49
	Cost Subtotal	**$6,048**	**$9,666**

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$74	$144
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$571	$1,175
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$2,573	$5,232
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$3,218**	**$6,551**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$9,266**	**$16,216**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$5,633	$9,495
	Lifetime Electric Capacity Benefits	$1,816	$2,871
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$3,438	$4,062
	Benefits Total	**$10,887**	**$16,428**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**1.17**	**1.01**

[1] Includes direct install equipment costs and costs for EE&C kits.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

3.2.7 Status of Recommendations

The impact and process evaluation activities in PY9 led to the following findings and recommendations from Navigant to PECO, along with a summary of how PECO plans to address the recommendations in program delivery. Table 3-21 presents those solution level findings and recommendations along with an Appendix Reference in the far-right column. The references point to the Residential Low-Income EE Program appendix which provides additional details on findings, recommendations, and associated analysis conducted by Navigant for the solution.

Table 3-21. Summary of Findings and Recommendations for Residential Low-Income EE Program

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Whole Home	Low-income-qualified multifamily buildings are not identified in the tracking database. Specifically, individual residential apartment projects within a multifamily building are not identified as part of a common multifamily building.	PECO and the CSP should assign a multifamily building ID for projects that are in the same multifamily building.	**Being Implemented.** PECO will work with Navigant, Implementation and ANB teams to assign a multifamily ID for projects in the same multi-family building.	Low Income EE Appendix E.1
Whole Home	Tenants in Low Income MF buildings are receiving direct install measures; however, there are no common area measures indicated as installed.	If needed to meet Phase III Low-Income targets, consider developing onsite staff training, skills, and tracking mechanisms to identify and implement common area opportunities.	**Being Implemented**. In PY9, 902 MWh were achieved at a Spend of $875k in common space. A process as mentioned above will ensure these measures are indicated in the tracking data.	Low Income EE Appendix E.1
Whole Home	There is room for improvement in how the CSP calculates savings for reported heat pump water heaters. The TRM algorithm uses EFbase and EFee constant values, which resulted in negative savings for larger size tanks.	Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.	**Being Implemented.** PECO will work with Navigant to develop a process for all TRM updates and values to ensure CSPs are reporting correctly.	Low Income EE Appendix E.1

Source: Navigant analysis

3.3 Small C&I EE Program

The Small C&I EE Program offers a comprehensive and crosscutting array of opportunities to assist small C&I customers in reducing their energy consumption and costs. The program encompasses a variety of energy solutions and measures to achieve this goal. The Small C&I EE Program is made up of four solutions and two targeted market segments, listed with the solution and segment implementers below:

- Equipment and Systems Solution – ICF
- New Construction Solution – ICF
- Whole Building Solution – SmartWatt
- Behavioral Solution – not implemented in PY9
- Data Centers Targeted Market Segment – ICF
- Multifamily Targeted Market Segment – Franklin

The Behavioral Solution was not implemented in PY9 and had no corresponding evaluation activities. The Data Centers Targeted Market Segment had no participation in PY9.

Common measures within the Small C&I EE Program include efficient lighting equipment, lighting controls, HVAC equipment, variable frequency drives (VFDs), refrigeration, and building automation systems, among others. Several solutions cut across multiple programs, and participation rules vary according to program rules.

3.3.1 Participation and Reported Savings by Customer Segment

This section provides the Small C&I EE Program results for PY9, including participation, energy and demand savings, and incentive costs. Table 3-22 presents the participation counts and incentive payments for the Small C&I EE Program in PY9 by customer segment.

Table 3-22. Small C&I EE Program Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I
PYTD No. of Participants	0	1,568	0
PYRTD MWh/yr	0	48,572	0
PYRTD MW	0.00	6.06	0.00
PY9 Incentives ($1,000)	$0	$2,255	$0

Source: Navigant analysis

In general, PECO has seen lower-than-planned participation numbers to date in the Equipment and Systems, New Construction, and Data Center segments. Results obtained from a C&I customer experience survey indicate that incentives are generally perceived as too low, although this is a common sentiment among utility customers in general. PECO has attempted to address the participation lag in this area by implementing an incentive adjustment for key lighting and custom measures aimed at improving savings generation.

3.3.2 Gross Impact Evaluation

In PY9, the Small C&I gross impact evaluation consisted of desk reviews, phone verifications, onsite verifications, and onsite metering for a sample of projects. Summaries of verification activities for each solution and targeted market segment follow:

Equipment and Systems. The evaluation team conducted ex post verification for 41 projects in the Small C&I Equipment and Systems PY9 evaluation sample. Verifying these 41 projects aligns with the Small C&I Evaluation Plan for Phase III, which called for a total Small C&I Equipment and Systems sample of 40 projects.

New Construction. The evaluation team conducted ex post verification for 12 projects in the New Construction Solution during PY9. The New Construction sample includes both small and large C&I projects; the combined sample was conducted across PY8 and PY9. The PY9 sample included one small C&I project and 11 large C&I projects, whereas the PY8 sample included seven small C&I projects and 10 large C&I projects. The verification of these 29 projects was one short of the evaluation plan for Phase III, which called for a total New Construction sample of 30 projects across the 2-year period. However, as quoted in Table 3-23, the achieved sample still meets a high precision threshold.

Multifamily Targeted Market Segment. The evaluation team conducted ex post verification for 31 multifamily communities consisting of 213 verified projects in the Multifamily Targeted Market Segment PY9 evaluation sample. The sampling memo submitted before beginning the PY9 evaluation activities called for a total Multifamily targeted sample of 32 communities. Due to limited access at certain apartment units and the unavailability of maintenance staff to escort the field technicians, one community was not verified.

Whole Building. The evaluation team conducted ex post verification on 34 projects in the Small C&I Whole Building PY9 evaluation sample. These 34 projects represent the population of Whole Building participants across two strata with 15 medium impact projects (>= 30 MWh/yr) and 19 small impact projects (<30 MWh/yr) sampled. This sample draw aligns with the Small C&I Evaluation Plan for Phase III, which called for a total Small C&I Whole Building verified sample of 33 projects.

Behavioral and Data Centers. There were no impact verification activities for the Behavioral Solution or Data Centers Targeted Market Segment in PY9. The Behavioral Solution was not implemented in PY9, and there was no participation in the Data Centers Targeted Market Segment in PY9.

Table 3-23. Small C&I EE Program Gross Impact Sample Design for PY9

Solution	Stratum Name	Population Size	Achieved Sample Size	Verification Method
Equipment and Systems	Very High Impact	0	0	N/A
	High Impact/Uncertainty	26	13	Onsite Survey with Metering or Onsite Verification only
	Medium Impact/Uncertainty	113	15	Onsite or Phone Verification only
	Low Impact	924	13	Onsite or Phone Verification only
	Solution Total	**1,063**	**41**	
New Construction	Very High Impact	0	0	N/A
	High Impact/Uncertainty	2	2	Onsite Survey with Metering or Onsite Verification only
	Low/Medium Impact/Uncertainty	62	6	Onsite or Phone Verification only
	Solution Total	**64**	**8**	
Multifamily Targeted	Small	35	8	File Review and Onsite
	Multisector	23	6	File Review and Onsite
	Solution Total	**58**	**14**	
Whole Building	Medium Impact/Uncertainty	76	15	Engineering File Review with Onsite Verification
	Low Impact/Uncertainty	223	19	Engineering File Review with Telephone Verification
	Solution Total	**299**	**34**	
Total Program	**All**	**1,484**	**97**	

Source: Navigant analysis

Table 3-24 summarizes the reported and verified energy savings results, along with the C_v and relative precision for each stratum sampled for the Small C&I EE Program in PY9.

Overall, the Small C&I EE Program achieved PY9 gross RRs of 0.96 for energy and 0.87 for demand. The program-level relative precision was 5% at 90% confidence for energy and 5% at 90% confidence for demand. The goal of 15% precision at 85% confidence was met for both energy and demand. Some solutions within the Small C&I Program involve evaluations over a 2-year sampling period. Navigant followed its predefined sampling plan to ensure the 2-year goals for relative precision were also achieved.

Table 3-24. Small C&I EE Program Gross Results for Energy

Solution	Stratum Name	Reported Gross Energy Savings (MWh/yr)	Verified Gross Energy Savings (MWh/yr)	Energy RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Equipment and Systems	Very High Impact	0	0	-	N/A	N/A
	High Impact/Uncertainty	12,080	11,032	0.91	0.21	9.1%
	Medium Impact/Uncertainty	11,828	10,910	0.92	0.20	7.9%
	Low Impact	12,391	13,493	1.09	0.56	24.1%
	Solution Total	**36,299**	**35,436**	**0.98**	**0.41**	**9.5%**
New Construction	Very High Impact	0	0	-	N/A	N/A
	High Impact/Uncertainty	432	447	1.03	0.00	0.0%
	Low/Medium Impact/Uncertainty	2,183	2,242	1.03	0.08	5.6%
	Solution Total	**2,615**	**2,689**	**1.03**	**0.07**	**4.1%**
Multifamily Targeted	Small	2,364	1,323	0.56	0.40	22.7%
	Multisector	769	615	0.80	0.37	26.0%
	Solution Total	**3,134**	**1,937**	**0.62**	**0.42**	**17.0%**
Whole Building	Medium Impact/Uncertainty	3,635	3,524	0.97	0.12	4.9%
	Low Impact/Uncertainty	2,889	3,044	1.05	0.14	5.0%
	Solution Total	**6,523**	**6,568**	**1.01**	**0.13**	**3.4%**
Total Program	**All**	**48,572**	**46,629**	**0.96**	**0.47**	**7.9% [90% CI]**

Source: Navigant analysis

Table 3-25 summarizes the reported and verified demand savings results, along with the C_v and relative precision for each stratum sampled for the Small C&I EE Program in PY9.

Table 3-25. Small C&I EE Program Gross Results for Demand

Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Achieved Sample C_V or Error Ratio	Relative Precision at 85% Confidence Interval
Equipment and Systems	Very High Impact	0.00	0.00	-	N/A	N/A
	High Impact/Uncertainty	0.43	0.33	0.77	1.17	49.7%
	Medium Impact/Uncertainty	1.81	1.46	0.81	0.48	19.0%
	Low Impact	1.75	1.94	1.11	0.52	22.1%
	Solution Total	**3.99**	**3.73**	**0.94**	**0.60**	**13.7%**
New Construction	Very High Impact	0.00	0.00	-	N/A	N/A
	High Impact/Uncertainty	0.01	0.01	1.03	0.00	0.0%
	Low/Medium Impact/Uncertainty	0.41	0.45	1.08	0.22	15.0%
	Solution Total	**0.42**	**0.46**	**1.08**	**0.22**	**12.4%**
Multifamily Targeted	Small	0.27	0.15	0.56	0.38	21.9%
	Multisector	0.08	0.08	0.94	0.61	37.1%
	Solution Total	**0.36**	**0.23**	**0.65**	**0.44**	**17.8%**
Whole Building	Medium Impact/Uncertainty	0.68	0.48	0.71	0.29	11.5%
	Low Impact/Uncertainty	0.61	0.36	0.60	0.47	16.1%
	Solution Total	**1.29**	**0.85**	**0.66**	**0.37**	**9.3%**
Total Program	**All**	**6.06**	**5.27**	**0.87**	**0.62**	**10.5% [90% CI]**

Source: Navigant analysis

The majority of the 41 Small C&I Equipment and Systems projects and one Small C&I New Construction project achieved RRs for both demand and energy within 20% of the expected values. Nine projects had verified energy savings values fall above 120% or below 80% of the reported values, while three additional projects fell outside the same zone for demand savings only. Navigant analyzed these projects to capture any trends in the verified data. The following factors led to variation between the reported and verified savings and to the observed RRs.

- For Equipment and Systems and New Construction, the most common discrepancy between ex ante and ex post calculations was in annual HOU. Of the 12 flagged projects 10 reported annual runtime that was significantly different from the reported values. In many cases, ex ante calculations reported a deemed savings value based on building type, but ex post verification revealed runtime that was more than 10% different. The evaluation team uncovered discrepancies both higher and lower than reported. In addition, discrepancies discovered during peak demand hours or summertime operating schedules had the additional consequence of changing the demand calculation, sometimes significantly.
- Other discrepancy types were unique to the sampled subset of projects. One lighting project was confirmed to be a one-for-one retrofit rather than a two-for-one retrofit, which singularly halved energy and demand savings. Another project did not account for pre-existing occupancy sensors when calculating savings. Overall, these types of discrepancies appear to be one-off occurrences and are unlikely to constitute a trend.
- The most common discrepancy for Multifamily Targeted Market Segment projects in the Small C&I EE Program was a mismatch in the quantities of expected and verified lighting measures. The efficient bulbs were not found in the sockets during onsite verification because they were removed for renovations to the common areas or the property manager was not aware of any more installations than what was verified. The RR discrepancy for in-unit bulbs also resulted from a difference in the HOU assumption.

3.3.3 Net Impact Evaluation

The Small C&I EE Program net impact evaluation activities used several methods to estimate free ridership, spillover, market effects, and NTG ratios for each solution. Navigant relied on consistent, crosscutting approaches as well as ones tailored to certain solutions' characteristics. The primary objective of the net savings analysis was to determine the program's net effect on customer electricity usage. The evaluation team derived net program impacts by estimating a NTG ratio that quantifies the percentage of the gross program impacts that can reliably be attributed to the program.

Free ridership is defined as those participants who would have implemented a measure or purchased equipment anyway, without program support or a rebate. The key questions determining free ridership focus on the influence of key program interventions. These interventions vary by solution but can include discounted prices, program information regarding efficient products, and the customer's perception of what they would most likely have done in the absence of the program.

Spillover is defined as those participants who were influenced by the program to purchase and install additional energy efficient equipment that saves electricity without a rebate or other program support. The evaluation team analyzed participant responses to a battery of spillover questions. The intent of these questions was to identify what types and amounts of equipment customers purchased and installed on their own to inform a quantitative estimate of program spillover within the overall NTG calculation.

Market effects represent a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of EE products, services, or practices and is casually related to market intervention(s).

Navigant surveyed PECO program and solution participants in-person, via telephone, or via an online survey to gather information about free ridership and spillover. The evaluation team developed survey instruments consistent with the Phase III Evaluation Framework's guidance on net impact evaluation techniques[23] and guidance from the Uniform Methods Project on estimating net savings.[24] The team carefully reviewed and managed samples across solutions to reduce the likelihood that a respondent participating in multiple solutions during PY9 would be contacted multiple times to respond to the survey. Survey instruments also captured feedback about customer experiences from participants to inform the process evaluation. Many solutions or strata within solutions added question batteries to the online surveys or site visits to inform the gross impact verification.

Each of the Small C&I solutions also conducted NTG evaluations in PY9, except for the Multifamily Targeted Market Segment, which relied on NTG data from PY8. Those NTG processes are detailed in Section 3.1.3 in Table 3-7.

Table 3-26 provides the sampling frame for the net impact evaluation of the Small C&I EE Program in PY9.

[23] Pennsylvania PUC. *Phase III Evaluation Framework.* Section 3.4. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

[24] The Uniform Methods Project. *Estimating Net Savings: Common Practices.* NREL. https://www.nrel.gov/docs/fy14osti/62678.pdf

Table 3-26. Small C&I EE Program Net Impact Sample Design for PY9

Solution	Stratum Name	Population Size	Achieved Sample Size	Response Rate	Verification Method
Equipment and Systems	Very High Impact	0	N/A	N/A	N/A
	High Impact/Uncertainty	18	5	27.8%	Onsite Survey with Metering or Onsite Verification only
	Medium Impact/Uncertainty	55	5	9.1%	Onsite or Phone Verification only
	Low Impact	189	16	8.5%	Onsite or Phone Verification only
	Solution Total	**262**	**26**	**9.9%**	
New Construction	**Solution Total**	**27**	**5**	**18.5%**	N/A
Whole Building	Medium Impact/Uncertainty	76	10	13.2%	Engineering File Review with Onsite Verification
	Low Impact/Uncertainty	223	32	14.3%	Engineering File Review with Phone Verification
	Solution Total	**299**	**42**	**14.0%**	
Total Program	**All**	**588**	**71**	**12.4%**	

Source: Navigant analysis

Table 3-27 summarizes the reported and verified energy savings results, the calculated NTG results, and the C_v and relative precision for each stratum sampled for the Small C&I EE Program in PY9.

Table 3-27. Small C&I EE Program Net Energy Savings Impact Evaluation Results for PY9

Solution Name	Stratum Name	Verified Gross Energy Savings (MWh/yr)	Verified Net Energy Savings (MWh/yr)	Free Ridership Rate	Spillover Rate	NTG Ratio	Achieved Sample C_V or Error Ratio	Relative Precision at 85% Confidence Interval
Equipment and Systems	Very High Impact	0	0	-	-	-	N/A	N/A
	High Impact/Uncertainty	11,032	5,938	0.46	0.00	0.54	0.09	7.4%
	Medium Impact/Uncertainty	10,910	10,440	0.04	0.00	0.96	0.05	4.0%
	Low Impact	13,493	10,352	0.23	0.00	0.77	0.16	6.2%
	Solution Total	**35,436**	**26,730**	**0.25**	**0.00**	**0.75**	**0.10**	**2.9%**
New Construction	**Solution Total**	**2,689**	**726**	**0.73**	**0.00**	**0.27**	**0.10**	**7.9%**
Small C&I Multifamily Targeted	Small	1,323	855	0.35	0.00	0.65	0.01	0.7%
	Multisector	615	397	0.35	0.00	0.65	0.01	0.7%
	Solution Total	**1,937**	**1,252**	**0.35**	**0.00**	**0.65**	**0.01**	**0.3%**
Whole Building	Medium Impact/Uncertainty	3,524	3,530	0.08	0.08	1.00	0.13	6.2%
	Low Impact/Uncertainty	3,044	2,935	0.10	0.06	0.96	0.22	5.6%
	Solution Total	**6,568**	**6,465**	**0.09**	**0.07**	**0.98**	0.18	4.1%
Total Program	**All**	**46,629**	**35,166**	**0.26**	**0.01**	**0.75**	**0.14**	**2.54% [90% CI]**

Source: Navigant analysis

Very high reported levels of free ridership among New Construction participants who said they were already planning to complete their projects to the incentivized levels with little regard for the rebate led to these NTG ratios for the Small C&I EE Program. There were also low reported levels of free ridership among Whole Building participants who said they would not have completed any energy efficient upgrades without help from PECO.

3.3.3.1 High Impact Measure Research

HIMs represent measure categories or technologies of high importance in the PECO portfolio. In Phase III, the SWE suggested EDCs oversample HIMs to help program planners make decisions concerning those measures for downstream programs only.[25] EDCs were to identify three to five measures for study within each program year based on energy impact, level of uncertainty, prospective value, funding, or other parameters. The SWE stated that HIMs should be sampled at 85% confidence and 15% absolute precision to ensure an adequate sample size for statistically valid, measure-level NTG estimates. Below is a description of the methodology used to determine the HIMs in PY9.

Navigant identified HIMs through several steps involving careful review of program- and solution-level savings, energy impact, and value to PECO. In PY9, Navigant conducted NTG and HIM analysis for the Small C&I Equipment & Systems, Small C&I New Construction, and Small C&I Whole Building Solutions in the non-residential sector. The evaluation team identified HIMs aligned with PECO's Phase III planning document, using both the measure category[26] and end-use subcategory for these solutions, including ENERGY STAR LEDs, delamping of lighting fixtures, and lighting power density improvements for new construction lighting. Table 3-28 shows the measures identified as HIMs in PY9 and the summary results of the NTG research conducted for each HIM.[27]

Table 3-28. Small C&I EE Program HIM NTG Summary

Solution	HIM	Free Ridership Rate	Spillover Rate	NTG Ratio
Small C&I Equipment & Systems	Lighting Improvements - LED	0.39	0.00	0.61
Small C&I Equipment & Systems	Lighting Improvements - Delamping	0.23	0.00	0.77
Small C&I New Construction	Lighting Power Density - New Construction Lighting	0.72	0.00	0.28

Source: Navigant analysis

3.3.4 Verified Savings Estimation by Solution

Table 3-29 shows the RRs and NTG ratios applied to the reported energy and demand savings estimates to calculate the verified savings estimates for each solution and the total Residential EE Program in PY9. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

[25] Pennsylvania PUC. *Phase III Evaluation Framework.* Section 3.4.1.4. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

[26] PECO Phase III data refers to measure categories as the Measure Name.

[27] The design of the Small C&I Whole Building solution tracks participation and savings at the project level to meet the 1-year payback requirements of the program. Therefore, the PECO Phase III Plan does not provide guidance on measures of importance to use for HIM analysis.

Table 3-29. PYTD and P3TD Savings Summary for the Small C&I EE Program

Solution/Program Name	Savings Type	Energy (MWh/yr)	Demand (MW)
Equipment and Systems	PYRTD	36,299	3.99
	PYVTD Gross	35,436	3.73
	PYVTD Net	26,730	2.82
	RTD	49,230	6.04
	VTD Gross	47,844	5.63
	VTD Net	36,529	4.32
New Construction	PYRTD	2,615	0.42
	PYVTD Gross	2,689	0.46
	PYVTD Net	719	0.12
	RTD	4,437	0.82
	VTD Gross	4,562	0.86
	VTD Net	1,300	0.25
Whole Building	PYRTD	6,523	1.29
	PYVTD Gross	6,568	0.85
	PYVTD Net	6,465	0.83
	RTD	8,875	1.71
	VTD Gross	8,848	1.25
	VTD Net	8,518	1.20
Multifamily Targeted Market Segment	PYRTD	3,134	0.36
	PYVTD Gross	1,937	0.23
	PYVTD Net	1,252	0.15
	RTD	3,813	0.43
	VTD Gross	2,512	0.30
	VTD Net	1,623	0.19
Small C&I EE Program	PYRTD	48,572	6.06
	PYVTD Gross	46,629	5.27
	PYVTD Net	35,166	3.92
	RTD	66,355	8.99
	VTD Gross	63,766	8.04
	VTD Net	47,970	5.95

Source: Navigant analysis

3.3.5 Process Evaluation

Navigant conducted a detailed review of program materials including program databases, tracking systems, and other documents across all Small C&I EE Program solutions. PECO and CSP staff also

provided essential information about the program design and how the program experience on the ground—particularly in PY9—compares with the EE&C Plan. The evaluation team conducted in-depth interviews at the beginning of the PY9 evaluation and communicated with staff on an ongoing basis as needed. The team developed interview instruments to include questions of interest to the evaluation and to allow for free-flowing conversations to obtain candid feedback from the interviewees.

In addition to conducting interviews with PECO and CSP staff, Navigant also deployed customer experience surveys to Small and Large C&I EE Program participants. Participants in all solutions and targeted market segments—except the Multifamily Targeted Market Segment—received in-person, online, or telephone surveys to collect their feedback on a series of questions designed to gauge customer satisfaction, program channeling efforts, ways to improve customer engagement, firmographic details, and to inform the NTG analysis. The evaluation team developed survey instruments by creating crosscutting questions intended to consistently capture general participant feedback. For example, the instruments contained a battery of satisfaction questions so that sentiments across solutions could be compared. The team then augmented and customized the instruments to meet the specific research needs of each solution. Navigant developed a sample sufficient to provide 85/15 confidence/precision for the survey results.

Responses among the Small C&I EE Program were markedly similar to those from Large C&I EE Program participants. As such, the general findings across both Large and Small C&I EE Programs will be detailed here. Separate Large C&I EE Program insights are provided in Section 3.4.5, as applicable.

The following provides a summary of the process evaluation activities conducted for each C&I EE solution.

- Equipment and Systems Solution
  - PECO and CSP staff interviews
  - Solution materials review
  - In-person, telephone, or onsite survey: Navigant used surveys to assess customer awareness of the incentive offerings, their satisfaction with the application, the level of effort required to receive their incentive, communication with PECO staff, and the program overall.
- New Construction Solution
  - PECO and CSP staff interviews
  - Solution materials review
  - In-person, telephone, or onsite survey: Navigant used surveys to assess customer awareness of the incentive offerings, their satisfaction with the application, the level of effort required to receive their incentive, communication with PECO staff, and the program overall.
- Data Centers Targeted Market Segment
  - PECO and CSP staff interviews
  - Solution materials review
  - Note that there was no participation in the Small C&I EE program's Data Centers Targeted Market Segment. The Large C&I EE Large Program had three PY9 participants that were not interviewed because the population was too small to extrapolate meaningful information.

- Whole Building Solution
  - PECO and CSP staff interviews
  - Phone surveys of participants to assess how customers heard about the solution; their satisfaction with the program, solution, and PECO overall; and awareness of other PECO solutions.
- Multifamily Targeted Market Segment
  - PECO and CSP staff interviews
  - Program tracking data review

Table 3-30 provides the customer experience survey sample details for each Small C&I EE solution.

Table 3-30. Small C&I EE Program Customer Experience Survey Sample Design for PY9[28]

Solution	Stratum	Population Size	Achieved Sample Size	Verification Method
Equipment and Systems	High Impact/Uncertainty	18	5	Onsite Survey with Metering or Onsite Verification only
	Medium Impact/Uncertainty	55	5	Onsite or Phone Verification only
	Low Impact	189	16	Onsite or Phone Verification only
	Solution Total	**262**	**26**	
New Construction*	**Solution Total**	**27**	**5**	Onsite or Phone Verification only
Whole Building	Medium Impact/Uncertainty	76	10	Engineering File Review with Onsite Verification
	Low Impact/Uncertainty	223	32	Engineering File Review with Telephone Verification
	Solution Total	299	42	
Total Program		**588**	**73**	

*Target sample size for New Construction includes the Large C&I and Small C&I populations combined.

Source: Navigant analysis

3.3.5.1 Key Findings from Process Evaluation

In PY9—as continued from previous PY8 trends—the Large and Small C&I EE Programs performed below the goals outlined in the EE&C Plan. Navigant's process evaluation work in PY9 revealed several avenues to stimulate customer interest and participation, including increased incentive values. This section of the report includes findings that apply to both Large and Small C&I and several Small C&I cross-solution metrics including satisfaction, marketing effectiveness, and barriers to participation. Section 3.4.5 includes findings relevant to Large C&I only, and Appendix D includes more detailed findings relevant to specific solutions.

[28] Navigant designed survey samples to achieve 15% relative precision at the 85% confidence level at the solution level for NTG ratios and satisfaction ratings.

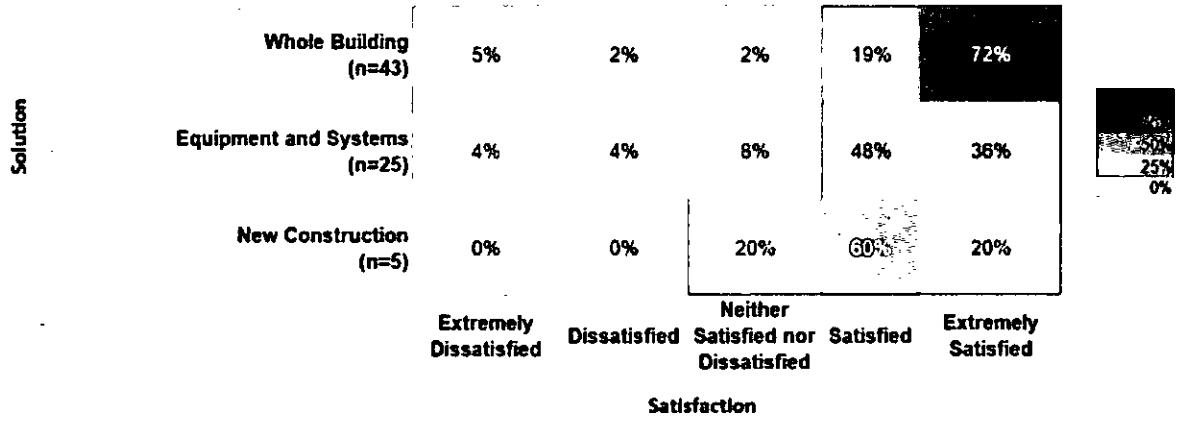
Across the Large and Small C&I Program solutions, the customer experience surveys indicate that participants in the Equipment and Systems Solution and the New Construction Solution have an interest in more information about exactly how much energy their projects save or *could save* and how that relates to financial details like payback periods. A similarly strong desire exists for information about what their neighbors, competitors, or comparable facilities are doing in terms of energy efficiency.

A desire for earlier PECO engagement exists among participants across multiple solutions. Both Equipment and Systems and New Construction participants reported that the planning phase is the ideal time for PECO to become involved in suggesting energy efficiency retrofits as well as providing information about costs and incentives. New Construction participants, in particular, have a desire for early PECO intervention: they report their programs take over 2 years, on average, from planning to completion.

PECO should explore how to engage earlier in the new construction process. Early engagement may be significant sources of portfolio savings. PECO may target, for example, the top 100 New Construction customers to provide additional support outside of the trade ally network allowing PECO to influence customer decision-making prior to project initiation.

Specific to the Small C&I program, satisfaction among program participants across solutions was high, with a large majority of participants reporting that they are either extremely satisfied or satisfied with the program as a whole (Figure 3-3).

Figure 3-3. Overall Satisfaction by Small C&I EE Solution



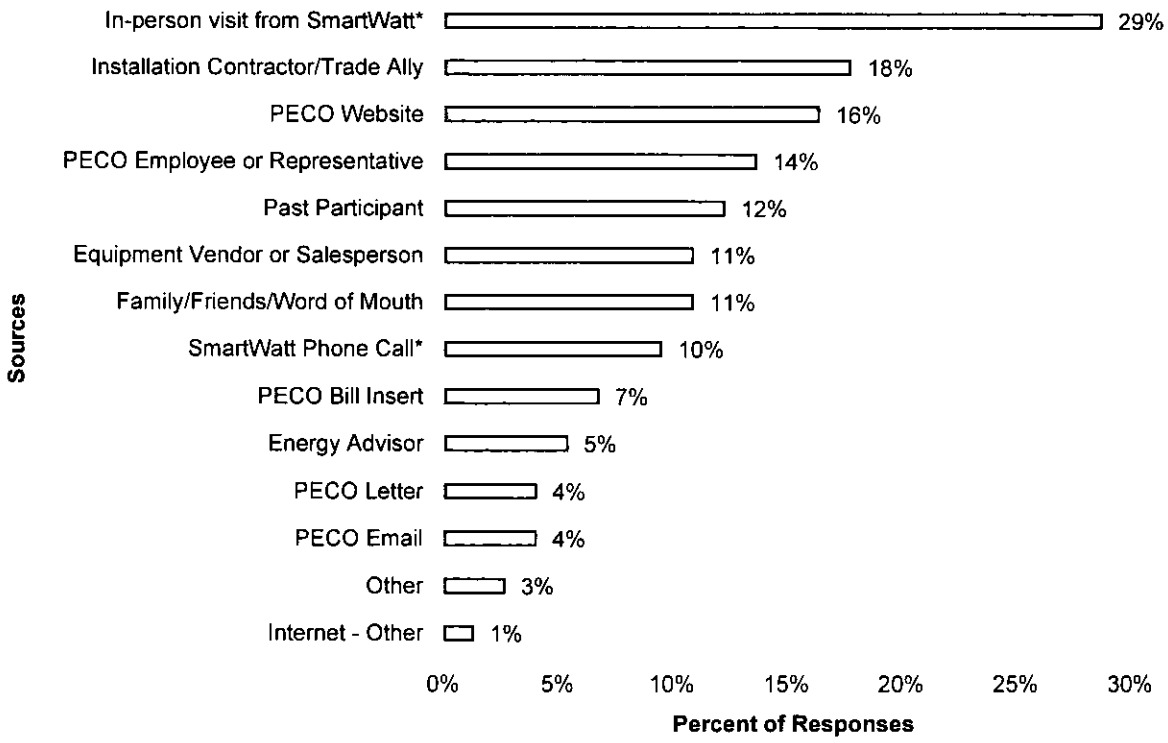
Question: Using a scale of 1 to 5, with 5 meaning Extremely Satisfied and 1 meaning Extremely Dissatisfied, how would you rate your overall satisfaction with [Solution]?
Source: Navigant analysis

Satisfaction is also high for many individual program components across the solutions, such as the amount of direct PECO communication, the PECO website, the chosen implementation contractors, and the chosen measures. Customers reported slightly lower satisfaction (mean satisfaction <4 out of 5) for the measures included for eligibility in the program, the incentive amount, and the amount of effort required to complete the incentive process. In PY9, PECO made an adjustment to offer higher incentives for key measures within the C&I programs, which may address customer satisfaction with the incentive amount—at least for certain measures. PECO should continue to prioritize ways to streamline the

incentive or assist customers with the incentive process, as well as review their measure offerings to see if additional measures may be included.

The evaluation team examined sources of awareness across all solutions in the Small C&I Program to understand effective channels for reaching this segment. Looking across all solutions, the leading source of awareness for any solution within the Small C&I Program was in-person visits from SmartWatt (29%). In-person visits from SmartWatt are specific to the Whole Building Solution. Other leading sources of awareness included installation contractors (18%), the PECO website (16%), PECO employees or representatives (14%), and past participants (12%) —respondents who had participated in the program before (Figure 3-4). These sources of awareness were more commonly reported for the Equipment and Systems and New Construction Solutions. Notably, three out of five of the most common sources of awareness involve person-to-person outreach.

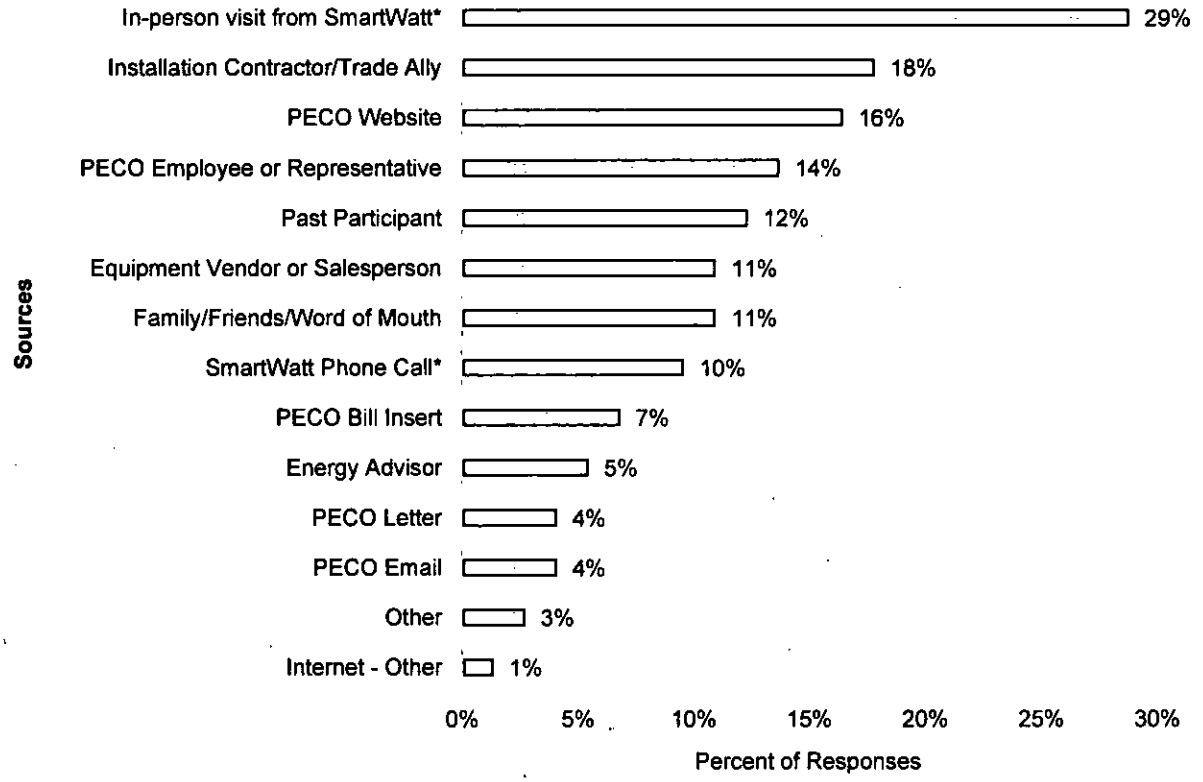
Figure 3-4. Sources of Small C&I Awareness, n=73



*Marketing specific to the Whole Building Solution.
Question: How did you learn about the [Solution] program? Multiple responses allowed; sum of percentages will not add up to 100%.
Source: Navigant analysis

Navigant also asked participants which source of awareness had the greatest influence on their decision to participate. The top five sources of awareness matched the responses for the five most *influential* sources of awareness (Figure 3-5), although more respondents mentioned PECO employees and past participation as influential as compared to installation contractors and the PECO website.

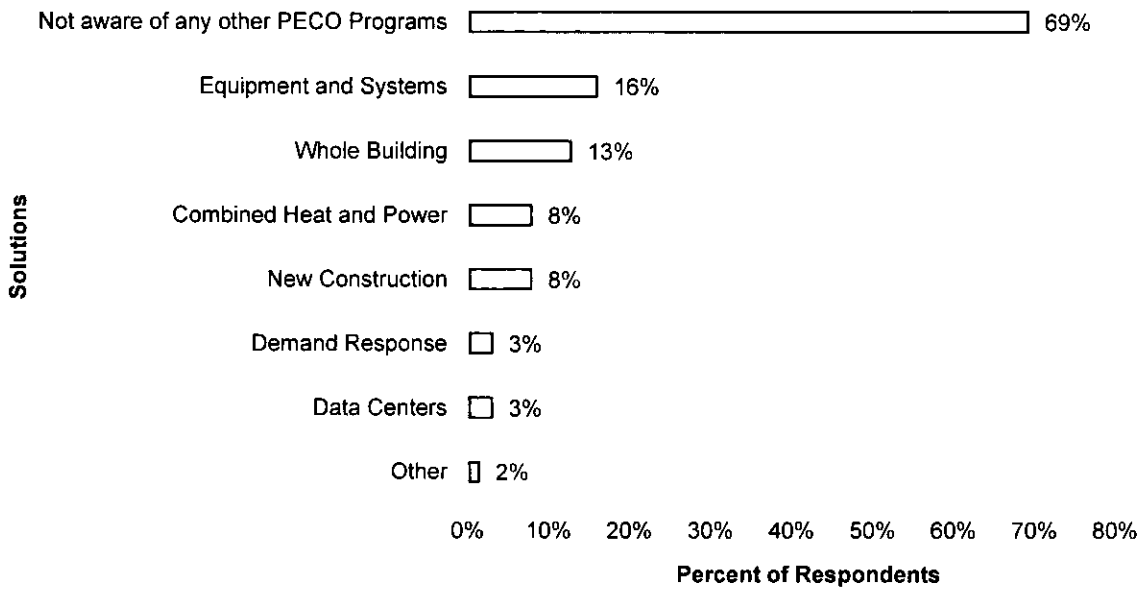
Figure 3-5. Sources of Small C&I Awareness, n=72



*Marketing specific to the Whole Building Solution.
Question: Thinking of the ways you heard about the [Solution], which one was most influential in your decision to participate in the program?
Source: Navigant analysis

Respondents were also asked if they were aware of any other PECO solutions. Almost all of respondents were not aware of any other PECO programs, indicating an opportunity to increase channeling between the different offerings for this segment. The most common solution that participants had heard of was Equipment and Systems, which was the solution with the highest recognition among Whole Building participants and the only solution that New Construction participants recognized. Whole Building was the solution with the second highest recognition and was the most commonly recognized solution among Equipment and Systems participants (Figure 3-6).

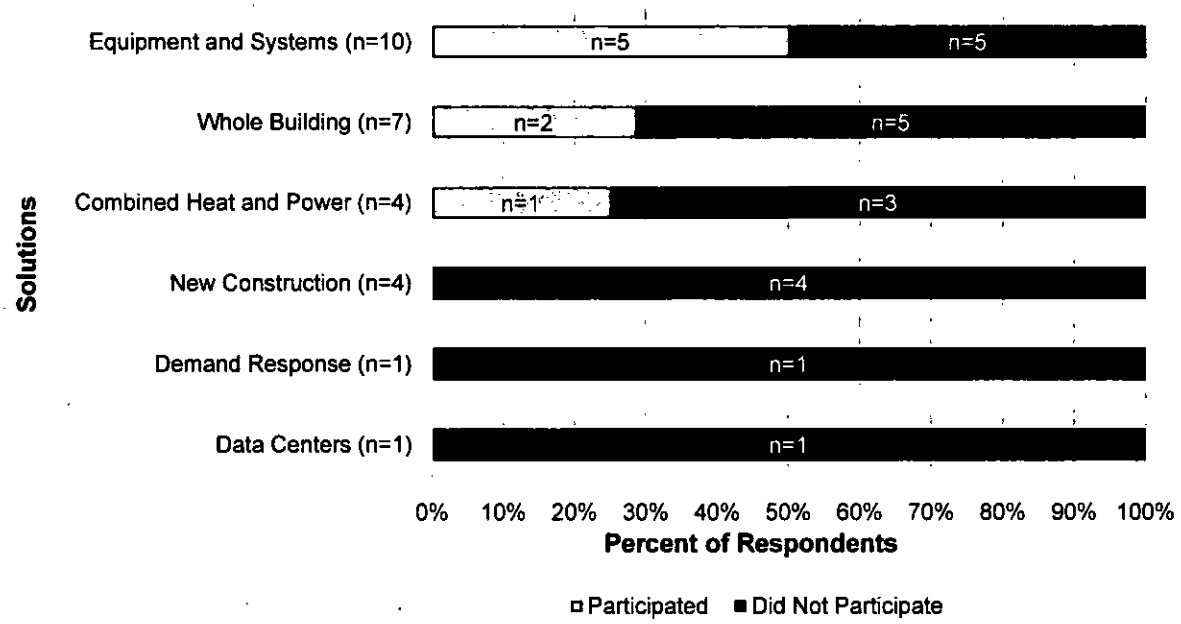
Figure 3-6. Small C&I Participant Awareness of Other Solutions, n=62



Question: Have you heard of any of PECO's other programs or incentive opportunities to help you save energy and money at your business?
Other response includes solar panels.
Source: Navigant analysis

Only a handful of respondents reported participating in another solution. Those respondents reported also participating in the Equipment and Systems, Whole Building, and Combined Heat and Power Solutions (Figure 3-7).

Figure 3-7. Small C&I Solution Participation Conditional on Awareness



Question: Have you participated in [PREVIOUS RESPONSE]?
Source: Navigant analysis

The customer experience surveys indicate that participants in both the Equipment and Systems Solution and the New Construction Solution have an interest in more information about exactly how much energy their projects save or *could save* as well as how that relates to financial details like payback periods. A similarly strong desire exists for information about what their neighbors, competitors, or comparable facilities are doing in terms of energy efficiency.

Further details on many of the specific questions and customer responses asked in the survey can be found in Appendix F.

3.3.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-31. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 3-31. Summary of Small C&I Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$3,621	$4,447
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$14,229	$16,871
	Cost Subtotal	**$17,851**	**$21,318**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$191	$372
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$1,920	$2,581
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$2,608	$4,511
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$4,719**	**$7,463**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	$0	$0
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$22,570**	**$28,781**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$13,369	$18,111
	Lifetime Electric Capacity Benefits	$4,334	$6,366
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$659	$1,074
	Benefits Total	**$18,363**	**$25,552**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.81**	**0.89**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

Table 3-32 presents program financials and cost-effectiveness on a net savings basis.

Table 3-32. Summary of Small C&I Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$3,621	$4,447
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$9,542	$11,246
	Cost Subtotal	**$13,163**	**$15,692**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$191	$372
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$1,920	$2,581
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$2,608	$4,511
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$4,719**	**$7,463**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$17,882**	**$23,156**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$10,118	$13,606
	Lifetime Electric Capacity Benefits	$3,226	$4,700
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$441	$780
	Benefits Total	**$13,785**	**$19,086**

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.77**	**0.82**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

3.3.7 Status of Recommendations

The impact and process evaluation activities in PY9 led to the following findings and recommendations from Navigant to PECO, along with a summary of how PECO plans to address the recommendations in program delivery. Table 3-33 presents those solution level findings and recommendations along with an Appendix Reference in the far-right column. The references point to the Small and Large C&I EE Programs appendix which provides additional details on findings, recommendations, and associated analysis conducted by Navigant for each solution.

Table 3-33. Summary of Findings and Recommendations for Small C&I EE Program

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Equipment and Systems **New Construction** **Data Centers**	PECO has seen lower than planned participation numbers to date in the Equipment and Systems, New Construction, and Data Center segments. Results obtained from a C&I customer experience survey indicate that incentives are generally perceived as too low, although this is a common sentiment among utility customers participation lag in this area by implementing an incentive adjustment for key lighting and custom measures aimed at improving savings generation.	Navigant is in the process of monitoring the effects that the PY9 incentive adjustment is having on participation rates. It is still early in the process to be able to provide definitive analysis about the adjustment strategy, but Navigant and PECO should continue to monitor progress through PY10. In addition, Navigant recommends that PECO and the CSP revisit and potentially create additional tracking metrics to document the lead generation and conversion cycle. This may help to pinpoint areas for improvement when targeting customers for program participation.	**Being Considered.** PECO and ICF are looking at a variety of ways to better track customer participation and conversion cycles. PECO is exploring ways to create additional metrics.	Small and Large C&I EE Appendix F.1, F.2, F.4
New Construction	New Construction projects often involve significant planning and lead time, often resulting in longer-term commitments than retrofit projects. A majority of New Construction survey respondents—four out of seven—responded that their projects took more than two years from planning to completion. When asked when PECO could be most influential in an organization's decision-making process, 5 out of 6 Small and Large C&I New Construction participants mentioned the planning phase or budgeting phase.	PECO should explore how to engage earlier in the new construction process.	**Under Investigation.**	Small and Large C&I EE Appendix F.2
Equipment and Systems	In some cases, the reported HOU was based on deemed hours rather than more accurate HOU estimates easily obtained by interviewing the customer. This may lead to inaccurate ex ante calculations and a risk of low RRs upon verification. In addition, when such discrepancies arise during peak summer hours, the demand savings estimates are also at risk of low RRs.	Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.	**Being Implemented.** PECO will work with CSP to ensure they get all the necessary data from the customer.	Small and Large C&I EE Appendix F.1

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Data Centers Targeted Market Segment	Most data center energy savings are derived from the load on the equipment—i.e., the greater the load, the larger the savings. This is potentially causing customers to delay program engagement until load is realized. In the Small C&I Program, there were no data center projects in either PY8 or PY9.	PECO should explore the customer decision-making process as related to data center projects to identify barriers to participation and to develop solutions to increase savings from this solution.	**Being Considered.** PECO will explore the existing data center project pipeline and determine how to incentivize higher participation.	Small and Large C&I EE Appendix F.4

Source: Navigant analysis

3.4 Large C&I EE Program

The Large C&I EE Program offers a comprehensive and crosscutting array of opportunities to assist large C&I customers in reducing their energy consumption and costs. The program encompasses a variety of energy solutions and measures to achieve this goal. The Large C&I EE Program is made up of two solutions and two targeted market segments, listed with the solution and segment implementers below:

- Equipment and Systems Solution – ICF
- New Construction Solution – ICF
- Data Centers Targeted Market Segment – ICF
- Multifamily Targeted Market Segment – Franklin

Common measures within the Large C&I EE Program include efficient lighting equipment, lighting controls, HVAC equipment, VFDs, refrigeration, and building automation systems, among others. Several solutions cut across multiple programs, and participation rules vary according to program rules.

3.4.1 Participation and Reported Savings by Customer Segment

This section provides the Large C&I EE Program results for PY9, including participation, energy and demand savings, and incentive costs. Table 3-34 presents the participation counts and incentive payments for the Large C&I EE Program in PY9 by customer segment.

Table 3-34. Large C&I EE Program Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I
PYTD No. of Participants	0	0	466
PYRTD MWh/yr	0	0	82,041
PYRTD MW	0.00	0.00	11.63
PY9 Incentives ($1,000)	$0	$0	$3,648

Source: Navigant analysis

3.4.2 Gross Impact Evaluation

In PY9, the Large C&I gross impact evaluation consisted of desk reviews, phone verifications, onsite verifications, and onsite metering for a sample of projects. Summaries of verification activities for each solution and targeted market segment follow:

Equipment and Systems. The evaluation team conducted ex post verification for 35 projects in the Large C&I Equipment and Systems PY9 evaluation sample. Verifying these 35 projects aligns with the Large C&I Evaluation Plan for Phase III, which called for a total Small C&I Equipment and Systems sample of 35 projects.

New Construction. The evaluation team conducted ex post verification for 12 PY9 projects in the New Construction Solution. The New Construction sample includes a combination of both small C&I and large C&I projects; a combined sample was conducted across PY8 and PY9. The PY9 sample included one

small C&I project and 11 large C&I projects. The verification of 29 projects across PY8 and PY9 falls one project short of the evaluation plan, which called for a total New Construction sample of 30 projects across the 2-year period. However, as quoted in Table , the achieved sample still meets a very high precision threshold, and has been acknowledged by the SWE.

Multifamily Targeted Market Segment. The evaluation team conducted ex post verification for 31 multifamily communities that consisted of 213 verified projects in the Multifamily Targeted Market Segment PY9 evaluation sample. The sampling memo submitted before beginning the PY9 evaluation activities called for a total Multifamily targeted sample of 32 communities. Due to limited access at certain apartment units and unavailability of maintenance staff to escort the field technicians, projects at one community were not verified.

Data Centers. The evaluation team conducted ex post verification for all three projects in the Large C&I Data Centers PY9 evaluation sample. The verification of these three projects aligns with the Large C&I Evaluation Plan for Phase III, which called for a census evaluation of all Data Center projects.

Table 3-35 provides the sampling frame for the gross impact evaluation of the Large C&I EE Program in PY9.

Table 3-35. Large C&I EE Program Gross Impact Sample Design for PY9

Solution	Stratum Name	Population Size	Achieved Sample Size	Verification Method
Equipment and Systems	Very High Impact	3	3	Onsite Survey with Metering
	High Impact/Uncertainty	18	10	Onsite Survey with Metering or Onsite Verification only
	Medium Impact/Uncertainty	66	11	Onsite or Phone Verification only
	Low Impact	285	11	Onsite or Phone Verification only
	Solution Total	**372**	**35**	
New Construction	Very High Impact	0	0	
	High Impact/Uncertainty	2	2	Onsite Survey with Metering or Onsite Verification only
	Low/Medium Impact/Uncertainty	62	6	Onsite or Phone Verification only
	Solution Total	**64**	**8**	
Multifamily Targeted	Large	42	7	File Review and Onsite Verification
	Multisector	0	0	N/A
	Solution Total	**42**	**7**	
Data Centers	**Solution Total**	**3**	**3**	Onsite Survey with Metering
Total Program	**All**	**481**	**53**	

Source: Navigant analysis

Table 3-36 summarizes the reported and verified energy savings results, along with the C_v and relative precision for each stratum sampled for the Large C&I Program in PY9.

Table 3-36. Large C&I EE Program Gross Results for Energy

Solution	Stratum Name	Reported Gross Energy Savings (MWh/yr)	Verified Gross Energy Savings (MWh/yr)	Energy RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Equipment and Systems	Very High Impact	9,533	11,249	1.18	0.00	0.0%
	High Impact/Uncertainty	22,522	20,282	0.90	0.00	7.3%
	Medium Impact/Uncertainty	22,733	19,599	0.86	0.15	15.7%
	Low Impact	18,617	19,228	1.03	0.33	14.2%
	Solution Total	**73,405**	**70,358**	**0.96**	**0.24**	**5.9%**
New Construction	Very High Impact	0	0	-	N/A	N/A
	High Impact/Uncertainty	1,625	1,681	1.03	0.03	2.2%
	Low/Medium Impact/Uncertainty	3,333	3,423	1.03	0.03	5.7%
	Solution Total	**4,958**	**5,104**	**1.03**	**0.12**	**3.8%**
Multifamily Targeted	Large	3,167	2,819	0.89	0.06	4.0%
	Multisector	0	0	-	N/A	N/A
	Solution Total	**3,167**	**2,819**	**0.89**	**0.06**	**4.0%**
Data Centers	**Solution Total**	**510**	**507**	**0.99**	**0.00**	**0.0%**
Total Program	**All**	**82,041**	**78,788**	**0.96**	**0.28**	**0.7% [90% CI]**

Source: Navigant analysis

Table 3-37 summarizes the reported and verified demand savings results, along with the C_v and relative precision for each stratum sampled for the Large C&I Program in PY9.

Table 3-37. Large C&I EE Program Gross Results for Demand

Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Equipment and Systems	Very High Impact	1.30	1.57	1.21	0.00	0.0%
	High Impact/Uncertainty	2.94	2.36	0.80	0.18	9.0%
	Medium Impact/Uncertainty	3.56	2.64	0.74	0.80	37.5%
	Low Impact	2.74	3.64	1.33	0.81	38.3%
	Solution Total	**10.53**	**10.21**	**0.97**	**0.64**	**15.9%**
New Construction	Very High Impact	0.00	0.00	-		
	High Impact/Uncertainty	0.21	0.21	1.03	0.02	1.7%
	Low/Medium Impact/Uncertainty	0.44	0.47	1.08	0.45	17.8%
	Solution Total	**0.65**	**0.69**	**1.07**	**0.32**	**10.6%**
Large C&I Multifamily Targeted	Large	0.42	0.37	0.88	0.14	8.7%
	Multisector	0.00	0.00	-	N/A	N/A
	Solution Total	**0.42**	**0.37**	**0.88**	**0.14**	**8.7%**
Data Centers	**Solution Total**	**0.03**	**0.03**	**0.98**	**0.00**	**0.0%**
Total Program	**All**	**11.63**	**11.30**	**0.97**	**0.76**	**15.7% [90% CI]**

Source: Navigant analysis

The majority of the 35 Large C&I Equipment and Systems projects and 11 New Construction projects achieved RRs for both demand and energy within 20% of the expected values. Thirteen projects had verified energy savings values fall above 120% or below 80% of the reported values, with an additional three projects falling outside of that same range for demand savings. Navigant analyzed these projects to capture any trends in the verified data. The following factors led to variation between the reported and verified savings and led to the observed RRs.

- For Equipment and Systems and New Construction, the most significant change between ex ante and ex post calculations related to ex ante calculation methodologies that Navigant deemed at least partially unreliable. Eight of the 13 flagged projects fell into this category, with three projects using unreliable second and third order regression curves, one project using theoretical data despite the presence of measured data, and one project not weather normalizing when appropriate. Several other projects did not possess calculations in enough detail to interpret.
- Additionally, five of the 13 flagged projects reported annual runtime that was significantly different from the reported values. In many cases, ex ante calculations reported a deemed savings value based on building type, but ex post verification revealed runtime that was more than 10% different. Navigant uncovered discrepancies both higher and lower than reported. In some cases, the change in schedule also affected the demand savings calculations.
- Other minor discrepancies were found but were either limited to one or two projects or their impacts were too minor to reflect upon the overall population.
- The most common discrepancy for Multifamily Targeted Market Segment projects in the Small C&I EE program was a mismatch in the quantities of expected and verified lighting measures. The RR discrepancy for in-unit bulbs resulted from a difference in the HOU assumption.

3.4.3 Net Impact Evaluation

The Large C&I EE Program net impact evaluation activities used several methods to estimate free ridership, spillover, market effects, and NTG ratios for each solution. Navigant relied on consistent, crosscutting approaches as well as ones tailored to certain solutions' characteristics. The primary objective of the net savings analysis was to determine the program's net effect on customer electricity usage. The evaluation team derived net program impacts by estimating a NTG ratio that quantifies the percentage of the gross program impacts that can reliably be attributed to the program.

Free ridership is defined as those participants who would have implemented a measure or purchased equipment anyway, without program support or a rebate. The key questions determining free ridership focus on the influence of key program interventions. These interventions vary by solution but can include discounted prices, program information regarding efficient products, and the customer's perception of what they would most likely have done in the absence of the program.

Spillover is defined as those participants who were influenced by the program to purchase and install additional energy efficient equipment that saves electricity without a rebate or other program support. The evaluation team analyzed participant responses to a battery of spillover questions. The intent of these questions was to identify what types and amounts of equipment customers purchased and installed on their own to inform a quantitative estimate of program spillover within the overall NTG calculation.

Market effects represent a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of EE products, services, or practices and is casually related to market intervention(s).

PECO program and solution participants were surveyed in-person, via telephone, or via online surveys to gather information about free ridership and spillover. Navigant developed survey instruments consistent with the Phase III Evaluation Framework's guidance on net impact evaluation techniques[29] and guidance from the Uniform Methods Project on estimating net savings.[30] The evaluation team carefully reviewed and managed samples across solutions to reduce the likelihood that a respondent participating in multiple solutions during PY9 would be contacted multiple times to respond to the survey. Survey instruments also captured feedback about customer experiences from participants to inform the process evaluation. Many solutions or strata within solutions added question batteries to the online surveys or site visits to inform the gross impact verification.

Each of the Large C&I components conducted NTG evaluations in PY9. Those NTG processes are detailed in Section 3.1.3 in Table 3-7. Table 3-38 provides the sampling frame for the net impact evaluation of the Large C&I Program in PY9.

Table 3-38. Large C&I EE Program Net Impact Sample Design for PY9

Solution	Stratum Name	Population Size	Achieved Sample Size	Response Rate	Verification Method
Equipment and Systems	Very High Impact	3	2	67%	Onsite Survey with Metering
	High Impact/Uncertainty	15	5	33%	Onsite Survey with Metering or Onsite Verification only
	Medium Impact/Uncertainty	20	4	20%	Onsite or Phone Verification only
	Low Impact	136	17	13%	Onsite or Phone Verification only
	Solution Total	**174**	**28**	**16%**	
New Construction	**Solution Total**	**23**	**5**	**22%**	Onsite or Phone Verification only
Multifamily	Large	N/A	N/A	N/A	N/A
	Multisector	N/A	N/A	N/A	N/A
	Solution Total	**N/A**	**N/A**	**N/A**	
Data Centers	**Solution Total**	**N/A**	**N/A**	**N/A**	**N/A**
Total Program	**All**	**197**	**33**	**17%**	-

Source: Navigant analysis

[29] Pennsylvania PUC. *Phase III Evaluation Framework.* Section 3.4. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

[30] The Uniform Methods Project. *Estimating Net Savings: Common Practices.* NREL. https://www.nrel.gov/docs/fy14osti/62678.pdf

Table 3-39 summarizes the reported and verified energy savings results, the calculated NTG results, and the C_v and relative precision for each stratum sampled for the Large C&I Program in PY9.

Table 3-39. Large C&I EE Program Net Energy Savings Impact Evaluation Results for PY9

Solution Name	Stratum Name	Verified Gross Energy Savings (MWh/yr)	Verified Net Energy Savings (MWh/yr)	Free Ridership Rate	Spillover Rate	NTG Ratio	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
Equipment and Systems	Very High Impact	11,249	11,249	0.00	0.00	1.00	0.00	0.0%
	High Impact/Uncertainty	20,282	14,023	0.38	0.07	0.69	0.09	6.4%
	Medium Impact/Uncertainty	19,599	17,888	0.09	0.00	0.91	0.05	5.9%
	Low Impact	19,228	12,839	0.34	0.01	0.67	0.16	12.4%
	Solution Total	**70,358**	**55,998**	**0.23**	**0.02**	**0.80**	**0.12**	**3.4%**
New Construction	**Solution Total**	**5,104**	**2,071**	**0.59**	**0.00**	**0.41**	**0.53**	**42.1%**
Multifamily Targeted Market Segment	Large	2,819	1,822	0.35	0.00	0.65	0.01	0.7%
	Multisector	0	0	-	-	-	N/A	N/A
	Solution Total	**2,819**	**1,822**	**0.35**	**0.00**	**0.65**	**0.01**	**0.8%**
Data Centers	**Solution Total**	**507**	**404**	**0.23**	**0.02**	**0.80**	**0.16**	**12.4%**
Total Program	**All**	**78,788**	**60,295**	**0.25**	**0.02**	**0.77**	**0.15**	**4.2% [90% CI]**

Source: Navigant analysis

Factors leading to these NTG ratios for the Large C&I EE Program include high reported levels of free ridership among New Construction participants who said they were already planning to complete their projects to the incentivized levels, with little regard for the rebate, which is not uncommon for this type of solution, where influencing the early planning stage of a project can be difficult and competing interests from builders and customers can shift focus away from the benefits of energy efficiency.

3.4.3.1 High Impact Measure Research

HIMs represent measure categories or technologies of high importance in the PECO portfolio. In Phase III, the SWE suggested EDCs oversample HIMs to help program planners make decisions concerning those measures for downstream programs only.[31] EDCs were to identify three to five measures for study within each program year based on energy impact, level of uncertainty, prospective value, funding, or other parameters. The SWE stated that HIMs should be sampled at 85% confidence and 15% absolute precision to ensure an adequate sample size for statistically valid, measure-level NTG estimates. Below is a description of the methodology used to determine the HIMs in PY9.

Navigant identified HIMs through several steps involving careful review of program- and solution-level savings, energy impact, and value to PECO. In PY9, Navigant conducted NTG and HIM analysis for the Large C&I Equipment & Systems and Large C&I New Construction Solutions in the non-residential sector. Navigant identified HIMs that align with PECO's Phase III planning document using both the measure category[32] and end-use subcategory for these solutions, including ENERGY STAR LEDs, variable frequency drives, and lighting power density improvements for new construction lighting. Table 3-40 shows the measures identified as HIMs in PY9, and the summary results of the NTG research conducted for each HIM.

Table 3-40. Large C&I EE Program Savings by Measure Category and HIM End-Use Subcategory

Solution	HIM	Free Ridership Rate	Spillover Rate	NTG Ratio
Large C&I Equipment & Systems	Lighting Improvements - LED	0.39	0.00	0.61
Large C&I Equipment & Systems	Variable Frequency Drive (VFD) Improvements	0.63	0.00	0.38
Large C&I New Construction	Lighting Power Density - New Construction Lighting	0.61	0.00	0.39

Source: Navigant analysis

3.4.4 Verified Savings Estimation by Solution

Table 3-41 shows the RRs and NTG ratios applied to the reported energy and demand savings estimates to calculate the verified savings estimates for each solution and the total Residential EE Program in PY9. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

[31] Pennsylvania PUC. *Phase III Evaluation Framework*. Section 3.4.1.4. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

[32] PECO Phase III data refers to measure categories as the Measure Name.

Table 3-41. PYTD and P3TD Savings Summary for the Large C&I EE Program

Solution Name	Savings Type	Energy (MWh/yr)	Demand (MW)
Equipment and Systems	PYRTD	73,405	10.53
	PYVTD Gross	70,358	10.21
	PYVTD Net	55,998	8.12
	RTD	93,872	13.82
	VTD Gross	90,960	13.52
	VTD Net	69,662	10.32
New Construction	PYRTD	4,958	0.65
	PYVTD Gross	5,104	0.69
	PYVTD Net	2,071	0.28
	RTD	9,074	1.11
	VTD Gross	9,105	1.15
	VTD Net	4,151	0.52
Whole Building	PYRTD	510	0.03
	PYVTD Gross	507	0.03
	PYVTD Net	404	0.03
	RTD	510	0.03
	VTD Gross	507	0.03
	VTD Net	404	0.03
Multifamily Targeted Market Segment	PYRTD	3,167	0.42
	PYVTD Gross	2,819	0.37
	PYVTD Net	1,822	0.24
	RTD	4,550	0.59
	VTD Gross	4,182	0.55
	VTD Net	2,702	0.35
Small C&I EE Program	PYRTD	82,041	11.63
	PYVTD Gross	78,788	11.30
	PYVTD Net	60,295	8.67
	RTD	108,006	15.55
	VTD Gross	104,754	15.24
	VTD Net	76,920	11.22

Source: Navigant analysis

3.4.5 Process Evaluation

As in the Small C&I EE Program, Navigant conducted a detailed review of program materials including program databases, tracking systems, and other documents across all Large C&I EE Program solutions. In addition to conducting interviews with PECO and CSP staff, Navigant also deployed customer experience surveys to Small and Large C&I EE Program participants in the New Construction and Equipment and Systems Solutions. Participants received in-person, online, or telephone surveys to collect their feedback on a series of questions designed to gauge customer satisfaction, program

channeling efforts, ways to improve customer engagement, firmographic details, and to inform the NTG analysis, as discussed earlier in Section 3.4.3. The team developed the various in-depth interview and participant survey instruments by creating crosscutting, generic instruments intended to consistently capture general participant feedback. For example, the generic participant survey instrument contained a battery of satisfaction questions so that sentiments across solutions could be compared. The evaluation team then augmented and customized the instruments to meet the specific research needs of each solution. Navigant developed a sample sufficient to provide 85/15 confidence/precision for the survey results.

PECO and CSP staff provided essential information about the program design and how the program experience on the ground—particularly in PY9—compares with the EE&C Plan. The evaluation team conducted in-depth interviews at the beginning of the PY9 evaluation and communicated with staff on an ongoing basis as needed. The team developed interview instruments to include questions of interest to the evaluation and to allow for free-flowing conversations to obtain candid feedback from the interviewees.

The following provides a summary of the process evaluation activities conducted for each C&I EE solution.

- Equipment and Systems Solution
  - PECO and CSP staff interviews
  - Solution materials review
  - In-person, telephone, or onsite survey: Navigant used surveys to assess customer awareness of the incentive offerings, their satisfaction with the application, the level of effort required to receive their incentive, communication with PECO staff, and the program overall.
- New Construction Solution
  - PECO and CSP staff interviews
  - Solution materials review
  - In-person, telephone, or onsite survey: Navigant used surveys to assess customer awareness of the incentive offerings, their satisfaction with the application, the level of effort required to receive their incentive, communication with PECO staff, and the program overall.
- Data Centers Targeted Market Segment
  - PECO and CSP staff interviews
  - Solution materials review
  - Note that there was no participation in the Small C&I EE program's Data Centers Targeted Market Segment. The Large C&I EE Program had three PY9 participants that were not interviewed because the population was too small to extrapolate meaningful information.

Table 3-42 provides the customer experience survey sample details for each Small C&I EE solution.

Table 3-42. Large C&I EE Program Customer Experience Survey Sample Design for PY9[33]

Solution	Stratum	Population Size	Achieved Sample Size	Response Rate
Equipment and Systems	Very High Impact	3	2	67%
	High Impact/Uncertainty	15	5	33%
	Medium Impact/Uncertainty	20	4	20%
	Low Impact	136	17	13%
	Solution Total	**174**	**28**	**16%**
New Construction	**Solution Total**	**200**	**5**	**3%**
Total Program		**374**	**33**	**9%**

*Target sample size for New Construction includes the Large C&I and Small C&I populations combined.
Source: Navigant analysis

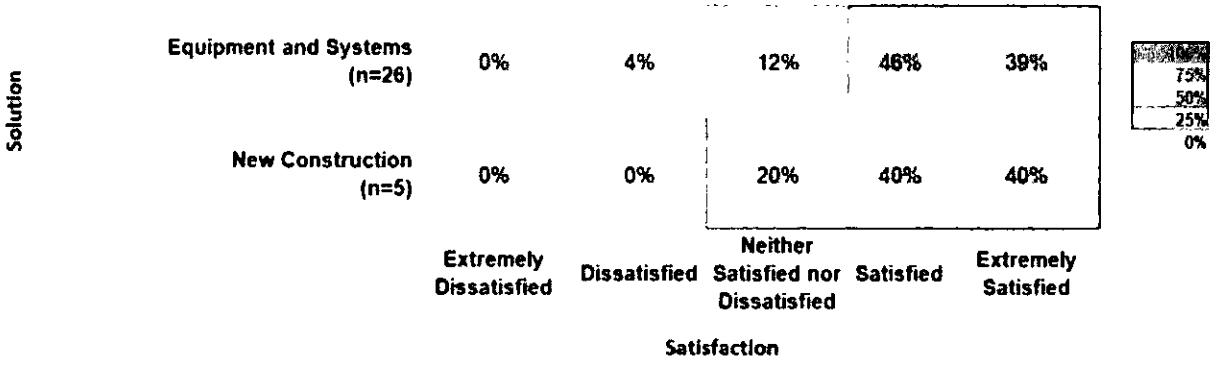
3.4.5.1 Key Findings from Process Evaluation

In PY9—as continued from previous PY8 trends—the Large and Small C&I EE Programs performed below the goals outlined in the EE&C Plan. Navigant's process evaluation work in PY9 revealed several avenues to stimulate customer interest and participation, including increased incentive values. This section of the report includes several Large C&I cross-solution metrics including satisfaction, marketing effectiveness, and barriers to participation. Section 3.3.7 includes findings that apply to both Large C&I and Small C&I, and Appendix D includes more detailed findings relevant to specific solutions.

In general, satisfaction among Large C&I EE Program participants was high, with a large majority of participants reporting that they are either extremely satisfied or satisfied with the program as a whole.

[33] Navigant designed survey samples to achieve 15% relative precision at the 85% confidence level at the solution level for NTG ratios and satisfaction ratings.

Figure 3-8. Overall Satisfaction by Large C&I EE Solution

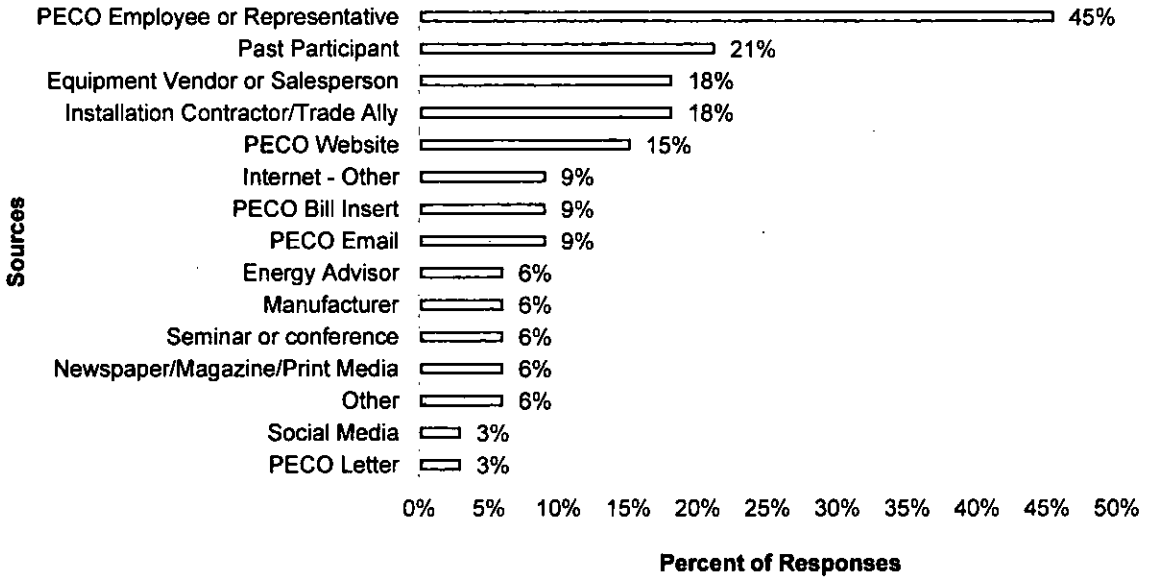


Question: Using a scale of 1 to 5, with 5 meaning Extremely Satisfied and 1 meaning Extremely Dissatisfied, how would you rate your overall satisfaction with [Solution]?
Source: Navigant analysis

Satisfaction is also high for many individual program components, such as the amount of direct PECO communication, the PECO website, the chosen implementation contractors, and the chosen measures. Customers reported slightly lower satisfaction (mean satisfaction <4 out of 5) for the measures included for eligibility in the program, the incentive amount, and the amount of effort required to complete the incentive process.

The leading source of awareness across the Large C&I EE program were PECO employees or representatives (45%), past participants (21%), equipment vendors or salespersons (18%), installation contractors (18%), and the PECO website (15%). These trends were primarily driven by Equipment and Systems, which accounted for 28 out of 33 participants.

Figure 3-9. Sources of Large C&I EE Program Awareness, n=33

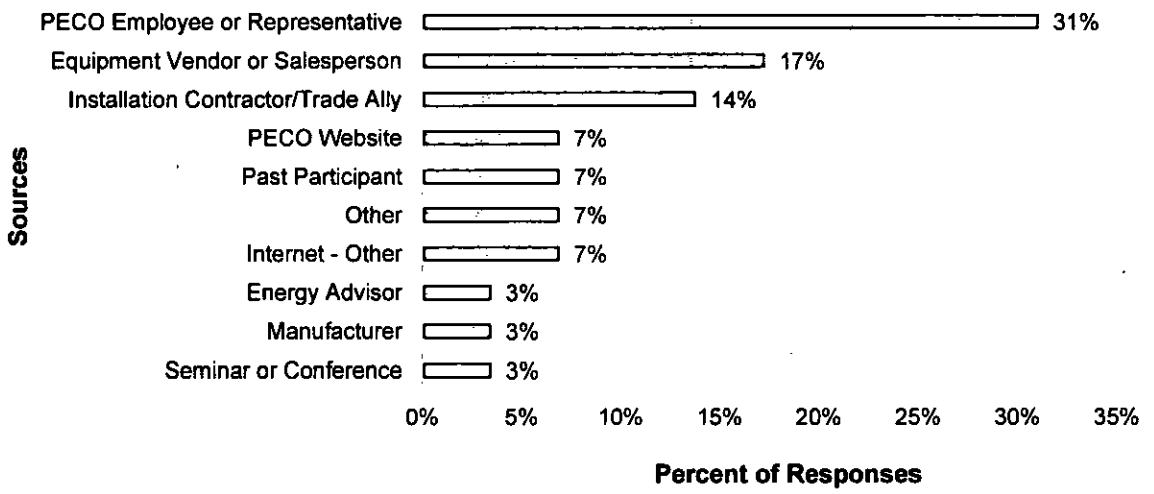


Question: How did you learn about the [SOLUTION] program? Multiple responses allowed; sum of percentages will not add up to 100%.

Source: Navigant analysis

Respondents were asked what source was most influential in their decision to participate. PECO Employees or Representatives, Equipment Vendors, and Installation contractors/trade allies were most commonly identified as the most influential reasons for participating.

Figure 3-10. Most Influential Awareness Source on Participation Large C&I, n=29

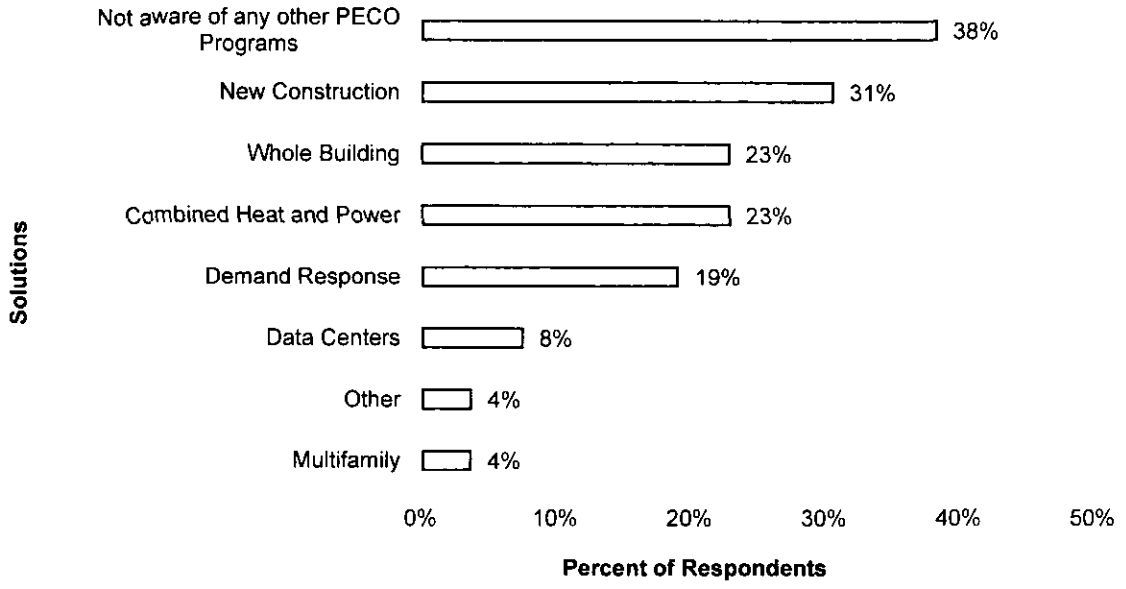


Question: Thinking of the ways you heard about the [SOLUTION], which one was most influential in your decision to participate in the program?

Source: Navigant analysis

Respondents were also asked if they were aware of other PECO solutions. Just over one-third of Large C&I EE Program participants said they were not aware of any other PECO solutions, which is a far lower percentage than observed in the Small C&I EE Program. The most recognized solutions included the New Construction, Whole Building, and Combined Heat and Power Solutions, all recognized by close to one-quarter of participants.

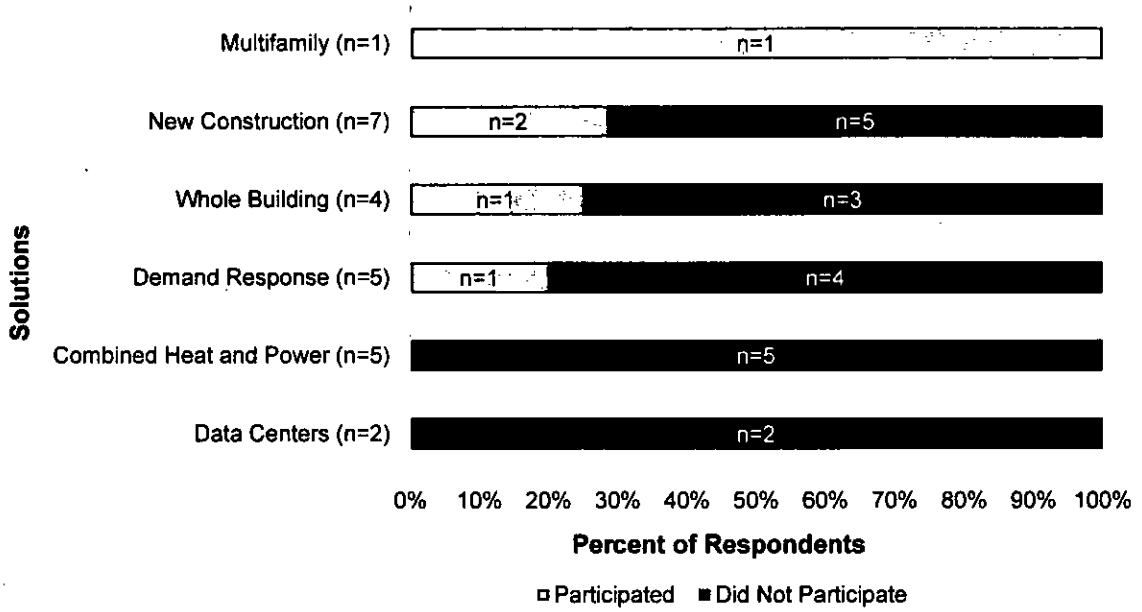
Figure 3-11. Large C&I Participant Awareness of Other Solution, n=26



Question: Have you heard of any of PECO's other programs or incentive opportunities to help you save energy and money at your business?
Multiple responses allowed; sum of percentages will not add up to 100%.
Source: Navigant analysis

Respondents were also asked what other solutions they had participated in. Only participants from Equipment and Systems reported participating in other solutions; these respondents reported participating in the Multifamily, New Construction, and Demand Response offerings.

Figure 3-12. Large C&I EE Solution Participation Conditional on Awareness



Question: Have you participated in [PREVIOUS RESPONSE]?
Source: Navigant analysis

Further details on many of the specific questions and customer responses asked in the survey can be found in Appendix F.

3.4.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table . Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

During the PY9 TRC evaluation process, Navigant recategorized load shape assignments for certain Large C&I EE Program measures. Updates changed the PY8 gross and net TRCs from 0.99 to 0.98 and 0.80 to 0.79, respectively. The updated load shape assignments are applicable to the PYTD and P3TD results shown in Table 3-43 and Table 3-44.

Table 3-43. Summary of Large C&I Program Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$4,017	$4,922
	EDC Incentives to Trade Allies	$0	$0

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$25,748	$30,257
	Cost Subtotal	**$29,765**	**$35,179**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$68	$194
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$1,115	$2,261
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$4,385	$7,814
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$5,568**	**$10,269**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$35,333**	**$45,448**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$27,059	$33,905
	Lifetime Electric Capacity Benefits	$9,313	$11,875
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	-$500	-$66
	Benefits Total	**$35,871**	**$45,713**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**1.02**	**1.01**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

Table 3-44 presents program financials and cost-effectiveness on a net savings basis.

Table 3-44. Summary of Large C&I Program Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$4,017	$4,922
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$18,831	$21,219
	Cost Subtotal	**$22,849**	**$26,141**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$68	$194
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$1,115	$2,261
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$4,385	$7,814
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$5,568**	**$10,269**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$28,416**	**$36,410**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$20,607	$24,729
	Lifetime Electric Capacity Benefits	$7,122	$8,691
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	-$439	-$146
	Benefits Total	**$27,290**	**$33,274**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.96**	**0.91**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.
[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for direct install programs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
Source: Navigant analysis

3.4.7 Status of Recommendations

The impact and process evaluation activities in PY9 led to the following findings and recommendations from Navigant to PECO, along with a summary of how PECO plans to address the recommendations in program delivery. Table 3-45 presents those solution level findings and recommendations along with an Appendix Reference in the far-right column. The references point to the Small and Large C&I EE Programs appendix which provides additional details on findings, recommendations, and associated analysis conducted by Navigant for each solution.

Table 3-45. Summary of Findings and Recommendations for Large C&I EE Program

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Equipment and Systems **New Construction** **Data Centers**	As in the Small C&I Program, PECO has seen lower than planned participation numbers to date in the large Equipment and Systems, New Construction, and Data Center segments. Results obtained from a C&I customer experience survey indicate that incentives are generally perceived as too low, although this is a common sentiment among utility customers in general. PECO has attempted to address customer satisfaction in this area by implementing an incentive adjustment for key lighting and custom measures aimed at improving savings generation.	Navigant is in the process of monitoring the effects that the PY9 incentive adjustment is having on customer satisfaction and participation rates. It is still early in the process to be able to provide definitive analysis about the adjustment strategy, but Navigant and PECO should continue to monitor progress through PY10. In addition, Navigant recommends that PECO and the implementer revisit and potentially create additional tracking metrics to document the lead generation and conversion cycle. This may help to pinpoint areas for improvement when targeting customers for program participation.	**Being Implemented.** PECO and ICF are looking at a variety of ways to better track customer participation and conversion cycles. PECO is exploring ways to create additional metrics.	Small and Large C&I EE Appendix F.1, F.2, F.4
New Construction	New Construction projects often involve significant planning and lead time, often resulting in longer-term commitments than retrofit projects. Most New Construction survey respondents—four out of seven—responded that their projects took more than two years from planning to completion. When asked when PECO could be most influential in an organization's decision-making process, five out of six Small and Large C&I New Construction participants mentioned the planning or budgeting phases.	PECO should explore how to engage earlier in the new construction process.	**Under Investigation.**	Small and Large C&I EE Appendix F.2

Solution	Finding	Recommendation	EDC Status	Appendix Reference
Equipment and Systems New Construction	Several of the larger stratum projects experienced discrepancies between reported and verified savings due to the methodology used to calculate the reported savings. In multiple instances, a regression methodology was used to extrapolate energy consumption. In another case, the reported savings were calculated by the CSP based on theoretical data rather than actual measured data gathered by the implementer. While there were discrepancies both on the high and the low ends, the net effect of these discrepancies was to lower the overall RRs.	Navigant is working with PECO and the implementer to identify more reliable methodologies to characterize these types of projects. Navigant will remain in contact with the CSP to sort out any future methodological discrepancies.	**Being Implemented.**	Small and Large C&I Appendix F1 and Appendix F.2
Data Centers Targeted Market Segment	Most data center energy savings are derived from the load on the equipment—i.e., the greater the load, the larger the savings. This is potentially causing customers to delay program engagement until load is realized. In the Large C&I Program, there were no data center projects in PY8 and only three in PY9.	PECO should explore the customer decision-making process as related to data center projects to identify barriers to participation and to develop solutions to increase savings from this solution.	**Under Consideration.** PECO will explore the existing data center project pipeline and determine how to incentivize for higher participation.	Small and Large C&I Appendix F.4

Source: Navigant analysis

3.5 Combined Heat and Power Program

The PECO CHP Program is designed to influence customer behavior and purchasing decisions. CHP technologies generate electric and thermal energy from a single fuel source. Customers with steady baseload electricity usage coupled with steady thermal demand can realize significant efficiencies and savings by incorporating CHP (sometimes referred to as cogeneration) in their facilities. The best economics are realized for CHP systems sized to match the minimum electric and thermal loads. PECO designed the CHP Program to ensure participating customers install CHP projects that maximize operational savings and minimize operations and maintenance costs.

The CHP Program has three types of incentives that are distributed at key milestones in the design, construction, and operation phases:

- **Design:** Incentives based on proposed system capacity.
- **Capacity:** Incentives based on a declining tiered incentive rate by installed capacity. Each tier has a fixed incentive per kW paid toward the incremental capacity within each tier.
- **Performance:** Incentives are based on a fixed per kWh basis based on actual energy production. The kWh production is determined during a monitoring period that begins after the commercial date of operation (CDO) and is designed to capture the typical system operational performance. Savings for all projects are claimed upon implementation and can be adjusted based on the performance monitoring results.

PECO delivers the program directly through a Call for Projects (CfP) mechanism, which is loosely structured around a typical request for proposals (RFP) process. Potential participates are invited to apply during several application windows, known as Calls. The frequency of calls depends on program participation. Once a call period has closed, PECO evaluates each project based on scoring criteria involving strength of schedule, likelihood of completion, and cost-effectiveness during a given program year. Projects with the highest scores are given priority to enroll in the program.

Participation is counted on a project basis. Projects that consist of multiple prime movers at a single facility are classified as a single project.

3.5.1 Participation and Reported Savings by Customer Segment

This section provides the total CHP Program results for PY9, including participation, energy and demand savings, and incentive costs. Table 3-46 presents the participation counts and incentive payments for the CHP Program in PY9 by customer segment.

Table 3-46. CHP Program Summary Statistics by Customer Segment

Parameter	Residential	Small C&I	Large C&I
PYTD No. of Participants	0	0	2
PYRTD MWh/yr	0	0	3,254
PYRTD MW	0.00	0.00	0.49
PY9 Incentives ($1,000)	$0	$0	$211

Source: Navigant analysis

3.5.2 Gross Impact Evaluation

The CHP Program gross impact evaluation involved onsite verification, telephone interviews with program participants, interviews with other CHP project developers who either have active CHP projects or may have such projects in the future, and interviews with the PECO program manager. Navigant conducted a census of two participants and calculated gross impacts according to the CHP chapter of the Uniform Methods Project.[34]

Participants in the CHP program are required to log the parameters necessary to calculate electricity generation net of parasitic loads (such as pumps necessary to operate the heat recovery systems) and thermal energy recovery. The evaluation team uses this data to develop the estimates of system capacity and annual generation on which PECO bases its capacity and performance incentives.

Table 3-47 summarizes the reported and verified energy savings results, along with the C_v and relative precision for each stratum sampled for the CHP Program in PY9.

[34] Simons, G.; Barsun, S. "Chapter 23: Combined Heat and Power Evaluation Protocol," *The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures.* 2017. National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy17osti/68579.pdf

Table 3-47. CHP Program Gross Results for Energy

Solution	Stratum Name	Reported Gross Energy Savings (MWh/yr)	Verified Gross Energy Savings (MWh/yr)	Energy RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
CHP	**Census**	3,254	3,707	1.14	0.00	0.00%
Total Program	**All**	**3,254**	**3,707**	**1.14**	**0.00**	**0.00% [90% CI]**

Source: Navigant analysis

Table 3-48 summarizes the reported and verified demand savings results, along with the C_v and relative precision for each stratum sampled for the CHP Program in PY9.

Table 3-48. CHP Program Gross Results for Demand

Solution	Stratum Name	Reported Gross Demand Savings (MW)	Verified Gross Demand Savings (MW)	Demand RR	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
CHP	**Census**	0.49	0.47	0.97	0.00	0.00%
Total Program	**All**	0.49	0.47	0.97	**0.00**	**0.00% [90% CI]**

Source: Navigant analysis

Overall, the variations between the reported and verified savings and the observed RRs for the CHP Program are good. The demand RR reflects the use of gross nameplate generator capacity rather than actual net generator output of the system in PECO's claimed savings.

3.5.3 Net Impact Evaluation

The CHP Program net impact evaluation uses the free ridership, spillover, market effects, and NTG ratios from PY7. The evaluation team used the PY7 values because the participants with completed projects in PY9 enrolled in the Smart Onsite program, the predecessor to the current CHP program, during Phase II. That is, the PY7 ratios were applicable. The net impact evaluation methodologies are detailed in the PECO *EDC Program Year 7 Annual Report*[35].

Table 3-49 summarizes the reported and verified energy savings results, the calculated NTG results, and the C_v and relative precision for each stratum sampled for the CHP Program in PY9.

Table 3-49. CHP Program Net Energy Savings Impact Evaluation Results for PY9

Solution Name	Stratum Name	Verified Gross Energy Savings (MWh/yr)	Verified Net Energy Savings (MWh/yr)	Free Ridership Rate	Spillover Rate	NTG Ratio	Achieved Sample C_v or Error Ratio	Relative Precision at 85% Confidence Interval
CHP	**Census**	**3,707**	**3,300**	**0.11**	**0.00**	**0.89**	0.00	0.0%
Total Program	**All**	**3,707**	**3,300**	**0.11**	**0.00**	**0.89**	**0.00**	**0.0% [90% CI]**

Source: Navigant analysis

[35] EDC Program Year 7 Annual Report, www.puc.pa.gov/pcdocs/1489722.docx.

3.5.3.1 High Impact Measure Research

There were no HIM measures included in the CHP Program evaluation.

3.5.4 Verified Savings Summary by Solution

Table 3-50 shows the RRs and NTG ratios applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the CHP Program in PY9. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 3-50. PYTD and P3TD Savings Summary for the CHP Program

Solution/Program Name	Savings Type	Energy (MWh/yr)	Demand (MW)
CHP Program	PYRTD	3,254	0.49
	PYVTD Gross	3,707	0.47
	PYVTD Net	3,300	0.42
	RTD	3,254	0.49
	VTD Gross	3,707	0.47
	VTD Net	3,300	0.42

Source: Navigant analysis

3.5.5 Process Evaluation

Process evaluations for CHP in PY9 focused on research activities to support program administration and delivery to PECO customers. Navigant plans on conducting additional process evaluation work in PY10 to support and monitor performance of the program.

PECO authorized Navigant to conduct quick turnaround market research to understand to what extent the current economic environment and program mechanics are affecting program participation. Navigant interviewed market actors and reviewed economic factors such as spark spreads to derive actionable recommendations. These recommendations were designed to maximize the opportunity to build a project pipeline that will allow PECO to realize CHP savings by the end of Phase III. The results of this research have been shared with PECO and the key recommendations are presented in Table .

3.5.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-51. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 3-51. Summary of CHP Program Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$211	$197
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$7,048	$6,551
	Cost Subtotal	**$7,260**	**$6,747**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$0	$0
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$28	$41
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$28**	**$41**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$632	$587
	Cost Subtotal	**$632**	**$587**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$7,920**	**$7,375**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$1,517	$1,409
	Lifetime Electric Capacity Benefits	$445	$414
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$1,962**	**$1,823**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.25**	**0.25**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management, legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
Source: Navigant analysis

Table 3-52 presents program financials and cost-effectiveness on a net savings basis.

Table 3-52. Summary of CHP Program Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$211	$197
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	$6,250	$5,808
	Cost Subtotal	**$6,461**	**$6,005**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$0	$0
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$28	$41
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$28**	**$41**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$562	$522
	Cost Subtotal	**$562**	**$522**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$7,052**	**$6,568**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$1,350	$1,254
	Lifetime Electric Capacity Benefits	$396	$368

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$1,746**	**$1,622**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.25**	**0.25**

[1] Includes direct install equipment cost.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

3.5.7 Status of Recommendations

The impact and process evaluation activities in PY9 led to the following findings and recommendations from Navigant to PECO, along with a summary of how PECO plans to address the recommendations in program delivery.

Table 3-53. Summary of Findings and Recommendations for CHP Program

Solution	Finding	Recommendation	EDC Status
CHP	The ex-ante savings analyses did not include any estimates of thermal impacts or confirm to what extent the incentivized systems approach the system efficiency guidance.	PECO should confirm to what extent supporting documentation is consistent with program guidance.	**Under Consideration.** PECO will look through the CHP application requirements and ensure that all future projects in the pipeline have a thermal efficiency input.
CHP	Interviews with CHP market actors indicated a general lack of awareness of PECO's CHP program.	PECO should continue to focus on prioritizing relationship building with CHP stakeholders, including facility owners, contractors, and project developers.	**Being implemented.** Our relaunch strategy has attempted to address this.
CHP	Lack of developer interest in the program is reducing program participation. According to Navigant's market review, PECO's incentives are comparable to other programs within the region. However, some developers indicated that they feel PECO's incentives should be higher to move the market.	Research the effect increasing the incentive levels may have on program participation. Due to the long lead times associated with CHP project development changes to current incentive levels may not result in meaningful impact in Phase III. However, an incentive level change could be an effective way to posture the program for better participation in Phase IV.	**Under Consideration.** PECO will be considering the incentive structure modifications when developing strategy for the future Phase IV.

CHP	The TRC is significantly lower than prior program years. This is mostly attributable to an approximately three-fold increase in net participation cost on a per kilowatt (kW) basis. The increase in participation cost is likely the result of including non-CHP specific costs.	PECO should review itemized invoices to determine what costs are attributable to the CHP project and clearly define their accounting methods and criteria.	**Will be Implemented.** PECO agrees that submitted and accepted cost data should accurately reflect CHP related expenses – will focus efforts on all project certifications going forward.

Source: Navigant analysis

3.6 Demand Response Programs

PECO's DR Programs include Residential DR, Small C&I DR, and Large C&I DR. These three programs encompass opportunities designed to engage customers across all sectors to reduce demand.

The Residential DR Program's eligible population and target markets 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 (previously Comverge). It has been designed to shift participant loads from peak to off-peak hours by cycling their air conditioner during DR event days. For Residential DLC, a participant is defined as a unique account number where device status is install or swap and the measure code is CACS (central air conditioner switch). One participant may have more than one DLC device installed at the home. The categories not included in the participant count include disconnect, opt-out, and removal. The PY9 summer DR events had over 61,000 residential participants. In PY9 and for the remainder of Phase III, the incentive is $40 per DLC unit per year.

PECO designed its Small C&I DR Program to engage customers to reduce demand through DLC of major electrical end-use equipment during designated peak load hours. 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 G/E/NP sector. The Small C&I DLC Solution is also implemented by Itron (previously Comverge). The program shifts load off peak hours by cycling participant air conditioners during DR event days. A participant is defined as a unique account number where device status is install or swap and the measure code is PCT (program-controlled thermostat). One participant may have more than one DLC device installed on the premise. The categories not included in the participant count include disconnect, opt-out, and removal. The PY9 summer DR events had over 1,500 small C&I participants. In PY9 and for the remainder of Phase III, the incentive is $40 per DLC unit per year.

PECO designed the Large C&I DR Program to engage customers to reduce demand through DR 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 is implemented by two CSPs: EnerNOC and CPower. In PY9, 261 Large C&I customers participated in the program.

For Phase III, event days for all programs are called when the PJM day-ahead peak load forecast reaches 96%. Based on the day-ahead forecasts, PECO called three events during the summer of 2017: June 13 (2:00 p.m.-6:00 p.m.), July 20 (2:00 p.m.-6:00 p.m.), and July 21 (1:00 p.m.-5:00 p.m.).

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

3.6.1 Participation and Reported Savings by Customer Segment

Table 3-54 presents the participation counts, reported peak demand savings, and EDC expenditures for the three DR program in PY9 by customer segment.

Table 3-54. PY9 DR Program by Customer Segment

Parameter	Residential (Residential DR Program)	Small C&I (Small C&I DR Program)	Large C&I (Large C&I DR Program)
PYTD No. of Participants	60,846	1,564	261
PYRTD MWh/yr	0	0	0
PYRTD MW	0.00	0.00	0.00
PY9 Incentives ($1,000)	$2,839	$115	$0

Source: Navigant analysis

3.6.2 Gross Impact Evaluation

The standalone DR report,[36] submitted to the commission on June 13, 2018, provides a detailed discussion of the impact evaluation methodology and results. Table 3-55 lists the days that DR events were called along with the verified gross demand reductions achieved by each event. It also lists the average DR performance for PY9 and for Phase III to date. PECO's average DR performance to date is 149.4 MW, which is below the Phase III compliance reduction target of 161 MW by 7% (93% of target achieved).

Table 3-55. PY9 DR PYVTD Performance by Event

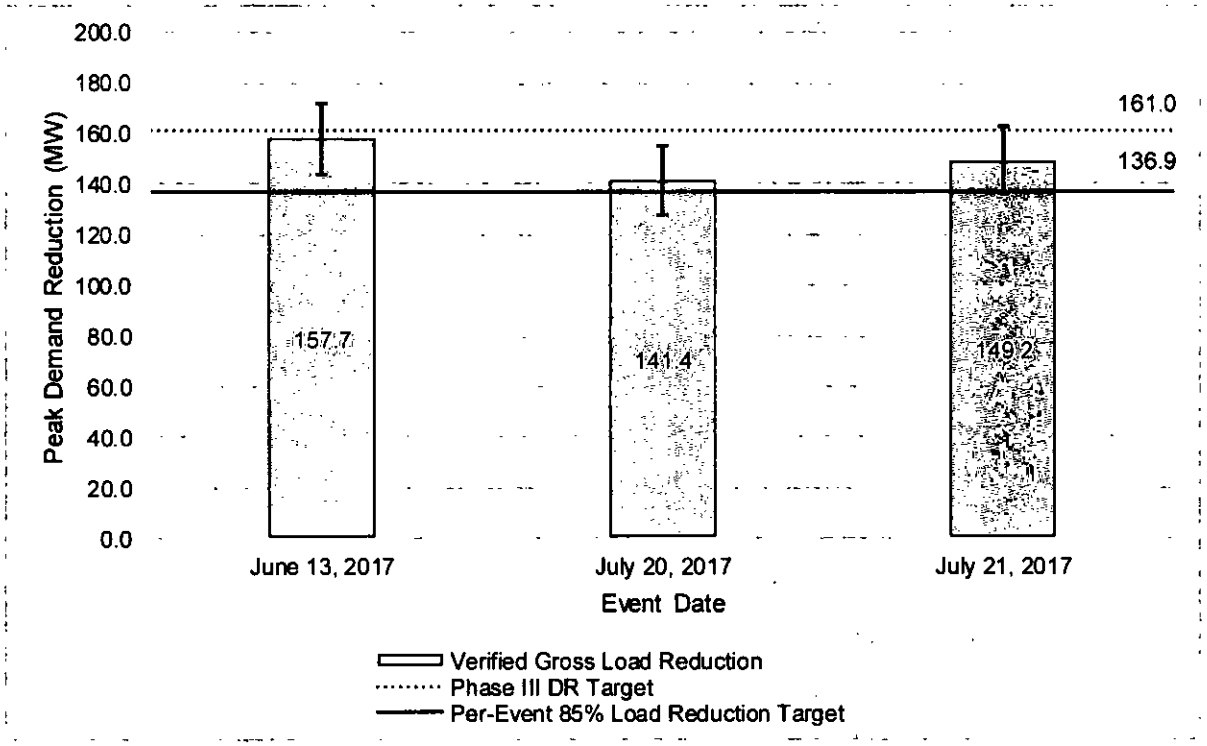
Event Date	Event Start Time	Event End Time	Program Name			
			Residential DR (MW)	Small C&I DR (MW)	Large C&I DR (MW)	Portfolio (MW)
June 13, 2017	2:00 p.m.	6:00 p.m.	39.5	0.0	118.2	157.7
July 20, 2017	2:00 p.m.	6:00 p.m.	33.5	0.0	107.9	141.4
July 21, 2017	1:00 p.m.	5:00 p.m.	23.3	0.0	125.8	149.2
PYVTD – Average PY9 DR Event Performance			**32.1**	**0.0**	**117.3**	**149.4**
VTD – Average Phase III DR Event Performance			**32.1**	**0.0**	**117.3**	**149.4**

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 137 MW minimum for each DR event. Figure 3-13 shows PY9 event performance relative to the compliance target.

[36] PECO. *Annual Report to the Pennsylvania Public Utility Commission Demand Response Performance Report Only*. June 13, 2018. https://www.peco.com/SiteCollectionDocuments/PECOAct129PhIIIPY9AmendedDRReport.pdf

Figure 3-13. Event Performance Compared to 85% Per-Event Target



Source: Navigant analysis

3.6.3 Process Evaluation

Navigant conducted a full process evaluation in PY9. The methodology and results are available in the standalone PY9 DR report,[37] filed on June 13, 2018.

3.6.4 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-56 for Residential DR. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

[37] PECO. *Annual Report to the Pennsylvania Public Utility Commission Demand Response Performance Report Only*. June 13, 2018. https://www.peco.com/SiteCollectionDocuments/PECOAct129PhIIIPY9AmendedDRReport.pdf

Table 3-56. Summary of Residential DR Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$2,839	$5,644
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	-$710	-$1,411
	Cost Subtotal	**$2,129**	**$4,233**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$1	$32
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$1,061	$1,903
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$1,062**	**$1,935**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$3,191**	**$6,167**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$0	$0
	Lifetime Electric Capacity Benefits	$3,240	$3,011
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$3,240**	**$3,011**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**1.02**	**0.49**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
Source: Navigant analysis

Table 3-57 presents program financials and cost-effectiveness on a net savings basis for Residential DR.

Table 3-57. Summary of Residential DR Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$2,839	$5,644
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	-$710	-$1,411
	Cost Subtotal	**$2,129**	**$4,233**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$1	$32
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$1,061	$1,903
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$1,062**	**$1,935**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$3,191**	**$6,167**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$0	$0
	Lifetime Electric Capacity Benefits	$3,240	$3,011

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$3,240**	**$3,011**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**1.02**	**0.49**

[1] Includes direct install equipment costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-58 for Small C&I DR. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 3-58. Summary of Small C&I DR Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$115	$229
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	-$29	-$57
	Cost Subtotal	**$86**	**$172**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$0	$2
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$68	$45
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$68**	**$47**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$154**	**$219**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$0	$0
	Lifetime Electric Capacity Benefits	$0	$0
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$0**	**$0**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.00**	**0.00**

[1] Includes direct install equipment cost.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

Table 3-59 presents program financials and cost-effectiveness on a net savings basis for Small C&I DR.

Table 3-59. Summary of Small C&I DR Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$115	$229
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	-$29	-$57
	Cost Subtotal	**$86**	**$172**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$0	$2
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$68	$45
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$68**	**$47**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$154**	**$219**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$0	$0
	Lifetime Electric Capacity Benefits	$0	$0
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$0**	**$0**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**0.00**	**0.00**

[1] Includes direct install equipment costs and costs.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.
[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
Source: Navigant analysis

A detailed breakdown of program finances and cost-effectiveness is presented in Table 3-60 for Large C&I DR. Navigant calculated TRC benefits using gross verified impacts. Costs and benefits for PYTD results are expressed in 2017 dollars while Phase to date values are expressed as a net present value in 2016 using a discount rate of 7.6%.

Table 3-60. Summary of Large C&I DR Finances – Gross Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$1,836	$1,707
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	-$459	-$427
	Cost Subtotal	**$1,377**	**$1,280**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$2	$63
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$200	$1,866
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$201**	**$1,929**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$1,579**	**$3,209**

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$0	$0
	Lifetime Electric Capacity Benefits	$11,835	$10,999
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$11,835**	**$10,999**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**7.50**	**3.43**

[1] Large C&I DR incentives were not clearly tracked by the CSP during PY9. Navigant conservatively estimates that $1,836,256 of the total $2,037,729 program spending should be considered incentives based on the 2016 TRC Guidance document. This value is used as the basis for the calculation of incremental costs. Therefore, program spending break outs for the purpose of TRC calculations do not match PECO's PY9 Preliminary Annual Report.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

Table 3-61 presents program financials and cost-effectiveness on a net savings basis for Large C&I DR.

Table 3-61. Summary of Large C&I DR Finances – Net Verified

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
NPV of Incremental Measure Costs ($1,000)	EDC Incentives to Participants [1]	$1,836	$1,707
	EDC Incentives to Trade Allies	$0	$0
	Participant Costs (Net of Incentives/Rebates Paid by Utilities)	-$459	-$427
	Cost Subtotal	**$1,377**	**$1,280**
NPV of Program Overhead Costs ($1,000)	Design and Development (EDC Costs) [2]	$0	$0
	Design and Development (CSP Costs) [2]	$0	$0
	Administration, Management, and Technical Assistance (EDC Costs) [3]	$2	$63
	Administration, Management, and Technical Assistance (CSP Costs) [3]	$0	$0

Category	Parameter	PYTD ($1,000)	P3TD ($1,000)
	Marketing (EDC Costs) [4]	$0	$0
	Marketing (CSP Costs) [4]	$0	$0
	Program Delivery (EDC Costs) [5]	$0	$0
	Program Delivery (CSP Costs) [5]	$200	$1,866
	EDC Evaluation Costs	$0	$0
	SWE Audit Costs	$0	$0
	Cost Subtotal	**$201**	**$1,929**
NPV of Fossil Fuel Impacts from Fuel Switching ($1,000)	Increased Fossil Fuel Consumption	$0	$0
	Cost Subtotal	**$0**	**$0**
Total NPV of Costs [6] ($1,000)	**Cost Total**	**$1,579**	**$3,209**
Total NPV of Benefits [7] ($1,000)	Lifetime Electric Energy Benefits	$0	$0
	Lifetime Electric Capacity Benefits	$11,835	$10,999
	Lifetime Non-Electric Benefits (Fossil Fuel, Water, O&M)	$0	$0
	Benefits Total	**$11,835**	**$10,999**
TRC Benefit-Cost Ratio [8]	**Benefits Total/Costs Total**	**7.50**	**3.43**

[1] Large C&I DR incentives were not clearly tracked by the CSP during PY9. Navigant conservatively estimates that $1,836,256 of the total $2,037,729 program spending should be considered incentives based on the 2016 TRC Guidance document. This value is used as the basis for the calculation of incremental costs. Therefore, program spending break outs for the purpose of TRC calculations do not match PECO's PY9 Preliminary Annual Report.

[2] Includes direct costs attributable to plan and advance the programs.

[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

[4] Includes the marketing CSP and marketing costs by program CSPs. EDC marketing costs broken out as a percentage of sector lifetime savings. This is an adjustment from the Preliminary Annual Report.

[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs.

[6] Total TRC Costs includes Total EDC Costs and Participant Costs.

[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase II are not to be included as a part of Total TRC Benefits for Phase III.

[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Source: Navigant analysis

3.6.5 Status of Recommendations

The impact and process evaluation activities in PY9 led to the following findings and recommendations from Navigant to PECO, along with a summary of how PECO plans to address the recommendations in program delivery.

Table 3-62. Summary of Findings and Recommendations for the Three DR Programs

Program(s)	Finding	Recommendation	EDC Status
Residential and Small Commercial DR	Event performance was lower than projected.	Investigate program DR event signal reception and DLC switch and PCT operability.	**Being implemented.** PECO re-engaged previously installed metering to evaluate DLC switch operability.
Large C&I	Event performance was slightly lower than projected.	Consider reviewing available resources versus PY9 achieved load reductions and review shortfalls with CSPs toward developing a plan to ensure better target achievement for PY10.	**Implemented.** PECO worked with CSPs to recruit additional participants in PY10 and to revise commitments of repeat participants to better align with PY9 performance.
Residential and Small Commercial DR	Advanced metering infrastructure (AMI) data contained a large percentage of integers.	Investigate data quality and data query procedures.	**Implemented.** PECO conducted a root cause analysis of the data and meters.
Residential DR	Some customers reported that they would like more information about the program.	Consider increasing communication with customers so they feel more engaged with the program: • Invite customers to opt in to event notification emails • Send an end-of-season report to customers that explains the dates events were called and the system impacts of the program	**Under consideration.** PECO is exploring this recommendation.
Residential and Small Commercial DR	Customers are interested in saving energy but have low awareness of other program offerings.	Market additional EE opportunities to encourage program channeling.	**Under consideration.** PECO is exploring this recommendation.

Source: Navigant analysis

4. 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 governed by a tariffed rate class, so it is necessarily tied to the way customers are metered and charged for electric service. Readers should be mindful of the differences between Table 4-1 and Section 2.4. For example, the low-income customer segment is a subset of PECO's residential tariff(s) and, therefore, is not listed in Table 4-1.

Table 4-1. EE&C Plan Expenditures by Cost Recovery Category[38]

Parameter	Cost Recovery Sector	Rate Classes Included	Program Year					
			PY8	PY9	PY10	PY11	PY12	Phase III to Date [1]
EE&C Plan Expenditures ($1,000 Nominal)	Residential	R, RH, and CAP	$35,450	$43,217	-	-	-	$78,667
	Small C&I	GS	$7,035[2]	$11,105	-	-	-	$18,140
	Large C&I	PD, HT, and EP	$9,713	$15,250	-	-	-	$24,963
	Municipal	SLE, AL, and TLCL	$28	$31	-	-	-	$59
	Portfolio Total	**All**	**$52,225**	**$69,602**	**-**	**-**	**-**	**$121,827**

[1] Phase to date values expressed as the sum of nominal dollars.
[2] As noted in the PY9 Preliminary Annual Report, Navigant determined that the rounded financial expenditure for the Small C&I EE program was $882 above actual expenditures. The correction of this value, reflected here, results in a decrease in reported PY8 portfolio expenditures from 52,226 to 52,225 (in $1,000 units).
Source: PECO

[38] SWE costs not included.

APPENDIX A. UPSTREAM LIGHTING CROSS-SECTOR SALES

Navigant completed its analysis of the upstream lighting cross-sector sales estimation as part of the PY8 evaluation for the Lighting, Appliances & HVAC Solution. Navigant applied the PY8 cross-sector sales values to PY9. Details about the evaluation, including the cross-sector sales assumptions for the solution, can be found in Appendix D.1 of this report.

APPENDIX B. SITE INSPECTION SUMMARY

Table B-1 presents the site inspection summary and common discrepancies found during the evaluation.

Table B-1. PY9 Site Inspection Summary

Program/Solution	Inspection Firm	Number of Inspections Conducted	Number of Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
Residential Whole Home	Navigant	26	23	Ex ante calculation methodology, pre/post fixture quantities
Low-Income Whole Home	Navigant	40	27	Pre/post fixture quantities
Small C&I/ Equipment and Systems [1]	Navigant/INCA	6	1	HOU, pre/post fixture quantities
Small C&I/ New Construction [1]	Navigant/INCA	1	1	Summer HOU
Small C&I/ Whole Building [1]	Navigant	15	3	HOU
Large C&I/ Equipment and Systems [1]	Navigant/INCA	20	8	Ex ante calculation methodology, HOU, pre/post fixture specifications
Large C&I/ New Construction [1]	Navigant/INCA	1	0	Fixtures types and quantities
Large C&I/ Data Centers [1]	Navigant/INCA	2	1	Ex ante calculation methodology
Multifamily Targeted [2]	Navigant/Mondre Energy	31	16	Pre/post fixture quantities, space-specific HOU
Total		**142**	**80**	

[1] For C&I projects, many projects had small discrepancies from the reported values, with few projects showing 100% RRs for both energy and demand savings. The numbers listed here include projects whose energy or demand savings were more than 20% different from the ex-ante results.

[2] For Multifamily Targeted, the evaluation team conducted site inspections for projects under all three programs: Residential EE, Large C&I EE, and Small C&I EE. The buildings were sub-sampled at a project level. If field technicians observed a large discrepancy at a single sub-sampled project, the team reported the building as having a discrepancy from reported values.

APPENDIX C. HER IMPACT EVALUATION DETAIL

Navigant completed an analysis of the Behavioral Solution (i.e., the HER impact evaluation) as part of its overall solution-level evaluation. Details about the evaluation, including the regression analysis results, can be found in Appendix D.5 of this report.

APPENDIX D. RESIDENTIAL EE PROGRAM DETAIL

The following appendix subsections provide additional detail on the evaluation sample design, methods, and activities deployed in PY9 for select Residential EE Program solutions. The reader should refer to the body of the report for key evaluation findings, results, and conclusions. Additional and select details are provided here to give readers more context and background about the research efforts undertaken for PY9.

- Lighting, Appliances & HVAC Solution
- Appliance Recycling Solution
- Whole Home Solution
- New Construction Solution
- Behavioral Solution

The Multifamily Targeted Market Segment also contributes to the Residential EE Program; however, evaluation details for that solution are included in a separate section—Appendix G—given its cross-program nature.

D.1 Lighting, Appliances & HVAC Solution

The Lighting, Appliances & HVAC Solution offers customers energy savings opportunities through a retail pathway that assists customers in purchasing the most efficient technology when they are shopping for new products. The solution provides upstream incentives in the form of point of purchase discounts to increase the market share of ENERGY STAR-qualified LEDs and downstream incentives in the form of rebates for appliances sold through retail and HVAC installer sales channels. Appliances and HVAC equipment rebated by the program include central air conditioners (ACs), central heat pumps, and high efficiency furnace fans. The solution also distributes educational materials that increase customer awareness and acceptance.

The conservation service provider (CSP) for this solution changed midway through PY9. Ecova implemented the program in Q1 and Q2 of PY9. CLEAResult became the implementer in January 2018 and handled the CSP duties for Q3 and Q4 for PY9.

The upstream lighting component's participation is defined as the sum of stock keeping unit (SKU) sales. A SKU describes a sold lighting product that can be a single bulb or a multi-pack of bulbs. For Appliances and HVAC participants, participation is defined as the total number of non-adjusted records in PECO's tracking data. A record may represent one or more rebated items (e.g., a single participant purchasing multiple thermostats during the same purchase event).

D.1.1 Lighting

The following subsection presents the evaluation details and findings for the lighting component of the Lighting, Appliances & HVAC Solution. Navigant conducted the following activities to verify the gross impacts and to review the CSP databases for reporting accuracy.

- Database reviews
    - Record-level Technical Reference Manual (TRM) review
    - ENERGY STAR certification verification
    - Invoice review
    - Incentive analysis

Overall, these analysis activities verified the solution's reported savings through a bulb-level, bottom-up recalculation of energy and demand impacts for all program bulbs incented by PECO during PY9.

Record-Level Technical Reference Manual (TRM) Review

Navigant applied energy and demand savings algorithms to verified input parameters as outlined in the Pennsylvania TRM (PA TRM) to calculate impacts. The evaluation team used commercial and industrial (C&I) facility lighting usage assumptions as described in the PA TRM to calculate savings for the portion of bulbs purchased by non-residential customers as estimated by the in-store intercept efforts. The team adjusted baseline wattages for some bulbs based on bulb characteristics and the TRM methodology for assigning baseline watts; all other TRM parameters were applied consistent with the methodology outlined in the TRM. The methodology Navigant applied to verify and update baseline wattages is as follows:

1. The evaluation team generated a list of unique bulb model/description/lumens/watts/type from the tracking data, resulting in 912 unique models.
2. Using the bulb type and lumens, the team applied baseline wattages based on the TRM assumptions.
3. Navigant reviewed the bulb classification and reclassified products as necessary to determine an appropriate baseline wattage. When the lumen values fell out of the ranges specified in the TRM, the team applied an equivalent baseline wattage equal to the advertised replacement wattage on the product. Adjustments were made for the following products:
    a. Linear fluorescent fixture (1 model) – Navigant applied a baseline following the commercial TRM lighting assumptions assuming a T8 baseline.
    b. LED fixtures (25 models) – Navigant assumed common halogen General service lamps (GSLs) as replacements for bulbs with common fixtures based on lumen output and marketing descriptions.
    c. Globe (19 models) – Navigant classified these products as non-exempt rather than exempt.
    d. High Lumens (3 models) – Navigant found reflectors with an output higher than 1300 lumens and applied advertised replacement wattages.

e. Candelabra base (4 models) – Navigant found specialty decorative products with candelabra bases that should be classified as exempt products.

f. Downlight fixtures (45 models) – Navigant classified downlight fixtures as R20 and BR30 equivalent based on common replacements in the market.

g. Small reflectors (17 models) – For reflectors smaller than 2.5 inches, Navigant applied advertised replacement wattages because these products are not detailed in the TRM.

Overall, these adjustments had a minor (<1%) effect on the verified program savings. Additionally, Navigant incorporated cross-sector sales as a final step to calculate verified savings. These values are borrowed from the PY8 evaluation; the evaluation team did not perform primary research into these values in PY9. The cross-sector sales values were applied on a per-retailer and per-bulb type basis, as detailed in Table D-1.

Table D-1. Cross-sector Sales of Standard and Specialty LEDs

Stratum	Retailers	Cross-Sector Sales – Standard LED	Cross-Sector Sales – Specialty LED
Ba	Ace Hardware, BJs Wholesale Club, Costco, Do It Best, Home Depot, Lowes, Sam's Club, True Value	0.007	0.02
Bb	Batteries Plus, Dollar General, Dollar Tree, Target, Walgreens, Walmart	0.002	0.011
Bc	Giant food stores, Goodwill, Grocery Outlet, Habitat Restore, hard to reach, independents	0	0

Source: Navigant analysis

ENERGY STAR Certification Verification

Program requirements stipulate that only ENERGY STAR-certified products should be incented through the Lighting Solution; therefore, Navigant independently reviewed the unique SKUs for all PY9 program bulbs to ensure they meet this requirement. Navigant performed several automated and manual checks to verify ENERGY STAR certification:

1. Navigant generated a list of unique SKUs and compared it against the current (as of August 2018) ENERGY STAR bulb and fixture lists for direct matches based on model number.
2. The evaluation team then compared the list against an archived (December 2017) ENERGY STAR bulb and fixture list for additional direct matches based on model number.
3. As a final automated check, Navigant performed a fuzzy match where model number is present in one of the ENERGY STAR database fields representing additional model info.
4. The team manually reviewed any remaining unmatched SKUs (33 total) using web searches based on product information. Of these products, Navigant found that all are advertised as ENERGY STAR-certified or could be matched to ENERGY STAR-certified products based on similarities between model numbers and detailed bulb information.

Navigant could confirm all of the program bulbs in PY9 as ENERGY STAR-certified models. The majority (879 out of 912 unique SKUs) mapped directly or indirectly based on model number, with manual searches confirming the remainder.

Invoice Review

Navigant verified program database-reported incentive spend against PECO-provided retailer invoices. The team did not find any discrepancies based on incentives paid. Because only incentives were provided in the invoice documentation, Navigant could not directly verify quantities; thus, incentives are deemed as an appropriate surrogate for quantity.

Incentive Analysis

Navigant analyzed the minimum, maximum, and average incentive for each retailer and bulb type combination to ensure that incentives align with PECO's Phase III Energy Efficiency and Conservation (EE&C) Plan. The evaluation team found no cases where the incentives fell outside of plan guidelines.

Navigant also conducted a pricing and incentive review to compare the per-bulb incentives with the manufacturer suggested retail price (MSRP) and the expected retail price.[39] The team expected that the MSRP less the per-package incentive equals the expected retail price. However, this equation does not hold true for 10.0% of records. Furthermore, there were 1,299 cases where the expected retail price was higher than the MSRP (0.8% of records). Navigant found similar issues in PY8 and discussed opportunities for improvement. The PECO representative explained that there could be a manufacturer rebate that could bring down the expected retail price even more than the PECO incentive. Navigant recommends that PECO continue to work with the CSP and manufacturers to encourage maintenance of accurate inputs, communication of other manufacturer rebates, and updates to prices as often as possible. The team also recommends that PECO work with the CSP to institute a quality control (QC) check as part of data processing that would indicate an error when the MSRP is lower than the expected retail price, which should never be the case.

Table D-2 summarizes the results of these desk review activities.

[39] The expected retail price is the actual price that the customer pays after the PECO incentive and any other incentive, such as a manufacturer rebate.

Table D-2. Residential Lighting Summary of Desk Review Activities and Findings

Activity	Finding	Description
Record-Level Savings Review	Navigant could not replicate claimed energy and demand savings.	Navigant could not directly replicate claimed energy and demand savings for 767 records (out of 156,107) due to inconsistencies in reported baseline wattage, affecting less than 1% of savings.
	There were difficulties classifying some bulbs (114 out of 912).	Navigant adjusted baseline wattages for some linear LED fixtures, LED fixtures, globe models, candelabra base models, downlight kits, and small reflectors. The effects of this adjustment are minor (<1%) and demonstrate that the program overall is accurately characterizing impacts.
ENERGY STAR Certification Verification	No issues; difficulty identifying some products based on model number.	All program bulbs in PY9 were confirmed as ENERGY STAR-certified models. The majority (879 out of 912 unique SKUs) mapped directly or indirectly based on model number, with manual searches confirming the remainder.
Invoice Review	No issues.	Navigant reviewed the incentives to confirm that the invoiced amount from manufacturers equals the invoiced amount in the CSP data. The evaluation team found no discrepancies.
Incentive Analysis	No issues; opportunity to improve accuracy of MSRP and expected retail price after incentives in databases.	Navigant compiled the minimum, maximum, and average incentive for each retailer/bulb category/bulb type combination to ensure that incentives align with PECO's Phase III EE&C Plan. The team found no cases where the incentives fell outside of plan guidelines.

Source: Navigant analysis

D.1.2 Appliances & HVAC

The following subsections present the evaluation details and findings for the non-lighting, downstream rebate components of the Lighting, Appliances & HVAC Solution (i.e., Appliances and HVAC components).

Gross Impacts

Navigant conducted the following activities to verify the gross impacts and to review the CSP database for reporting accuracy:

- Engineering desk reviews for all strata
  - Record-level TRM review
  - Invoice review
- Engineering file reviews and phone verification for the HVAC component
  - HVAC participant project file review

- HVAC participant phone verification

- Phone survey verification for the Appliances component
  - Verification survey to collect installation rates for Appliance participants

Engineering Desk Reviews

Navigant's reviews included quarterly verification of program-reported savings in the program tracking database. The evaluation team applied energy and demand savings algorithms to verify that the input parameters, as laid out in the PA TRM, used to calculate impacts were accurately reported within the program tracking data. The team completed these desk reviews for a census of non-lighting measures for the Appliances and HVAC component.

Table D-3 summarizes the results of these desk review activities.

Table D-3. Residential Non-Lighting Summary of Desk Review Activities

Impact Activity	Finding	Description
Record-Level Savings Review	Column headers for EFLHcool and EFLHheat factors in the CLEAResult data were transposed.	Navigant reviewed the inputs for the TRM algorithms used to calculate energy savings and found the column headers for EFLHcool and EFLHheat were transposed. The raw data under the EFLHcool header was heating factors, and the data under the EFLHheat was cooling factors. This appears to be a labeling issue in the eTrack database and is not impacting the actual energy calculations from CLEAResult.
	There are irregularities in the savings estimates for ductless heat pumps (DHPs) in the eTrack database due to improper accounting of outdoor air handlers (or parent units) and indoor room units (or child units).	PECO is currently working with the new CSP to resolve these issues. Navigant will track the progress of this effort in PY10.
Invoice Review	No issues.	Navigant reviewed the incentives to confirm that the invoice amounts in the PECO tracking database match those from the CSP data. The team found no discrepancies.

Source: Navigant analysis

Engineering File Reviews and Phone Verification

This activity included a detailed engineering review of project files for HVAC participants in the Appliances and HVAC component, as well as phone calls to participants to verify equipment installation. The evaluation team requested a sample of 70 project files from the CSP to complete the necessary 40 reviews to achieve 15% relative precision at the 85% confidence level for the non-lighting HVAC measures, as detailed in the PY9 Sample Design Memo. Using the current PA TRM, the team calculated energy and demand savings from the details within each project file and compared it to the tracking database. The project files contained details beyond the program tracking database such as the participant application and contractor invoicing and specification details. From these details, Navigant

confirmed, for example, equipment input capacities (e.g., tons or kBtu/hour) and efficiencies (e.g., seasonal energy efficiency ratio [SEER] or energy factor [EF]).

Phone Survey Verification

Navigant conducted 43 phone surveys with a sample of Appliance participants and asked them to verify the installation of their rebated energy efficient equipment. The team found only one participant who removed their dehumidifier because it was malfunctioning. Otherwise, all other installations were verified and in operation.

Process Evaluation

As discussed in the Residential EE Program section, Navigant performed targeted process evaluation for the Residential EE Program and its solutions during PY9. For the Appliances and HVAC component, this included the following:

- PECO and CSP staff interviews
- Phone interviews with trade allies operating in the PECO service territory and participating in the LAH solution. These interviews gathered feedback on trade ally satisfaction with the program, interaction with PECO staff, and free ridership and spillover questions used to estimate net to gross (NTG) from the trade ally perspective.

PECO and CSP Staff Interviews

Interviews with PECO and CSP staff mainly covered the change in CSP from Ecova to CLEAResult. The interviews brought the Navigant team up to speed on the current state of the transition and provided the opportunity to establish relationships to build on in PY10.

Trade Ally Interviews

Navigant interviewed 12 appliance and HVAC trade allies across the PECO service territory to better understand the downstream rebate component of the Lighting, Appliances & HVAC solution from the trade ally perspective. The evaluation team segmented the trade ally interview sample into three strata based on activity with the program, as outlined in Table D-4.

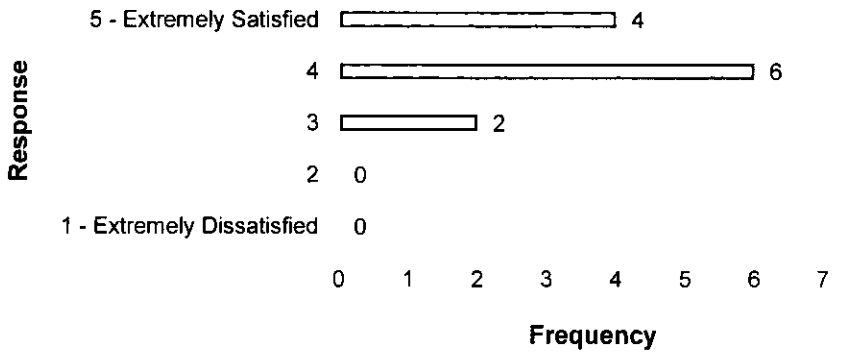
Table D-4. Appliances and HVAC Trade Ally Interview Sample

Solution	Stratum	Population Size	Target Sample Size	Achieved Sample Size
Appliances and HVAC Component	High program activity (top 50% of kWh savings)	24	4	4
	Medium program activity (next 25% of kWh savings)	44	3	3
	Low program activity (last 25% of kWh savings)	331	5	5
	Solution Total	**399**	**12**	**12**

Source: Navigant analysis

Results from the trade ally interviews revealed strong satisfaction with the Home Rebates Program overall, with an average score of 4.2 on a 1-5 scale. Figure D-1 shows the frequency of these responses.

Figure D-1. Trade Ally Satisfaction



Source: Navigant analysis

Trade allies scored other aspects of the program on a 1-5 satisfaction scale as well:

- Responsiveness of PECO staff – mean 4.0
- Rebate application requirements – mean 4.1
- Time to process rebate applications – mean 3.4
- Program marketing and advertising – mean 3.7
- PECO in general – mean 4.1

Navigant probed trade allies to expand on their satisfaction scores. Feedback for the lowest scoring aspect of the program—time to process rebate applications—included dissatisfaction with the length of the rebate application, and the time it takes their customers to receive their rebate checks. Trade allies also requested more online functionality for the application to make it easier to complete. The CSP is

working to resolve the lag time for processing rebates and is also working on a new, more intuitive online application. Navigant will work with PECO to track the progress of these solutions in PY10.

Navigant asked TAs about their interactions with PECO staff and the CSP. A little over half (58%) of the twelve respondents expressed confusion about who to contact with questions or concerns regarding the program. When trade allies did reach out to PECO or the CSP, one fifth (2 out of 10 respondents) reported receiving a satisfactory response regarding their issue.

The evaluation team also asked about the perception of the rebate amounts offered by the Home Rebate Program, and trade allies had a slightly different opinion on rebate amounts as compared to their customers. Half (50%) of trade allies thought the rebates were enough to entice their customers to participate in the program, while 33% said they were too low. The other 17% did not have an opinion on the matter. However, when asked what their customers thought about the rebate amounts, 83% of trade allies said their customers were happy to get money back for energy efficient equipment and had no complaints about the rebate amount. The other 17% said their customers were unhappy about the rebate amount and also reported that these customers noticed that the rebate amounts recently went down.

Navigant also asked the 12 trade allies free ridership and spillover questions including whether they would offer the types of energy efficient equipment they do if the program did not exist, as well as whether they think customers would purchase high efficient equipment without the program. The team used the results to establish NTG estimates from the TA perspective and compared the results to the customer reported NTG results for the Lighting, Appliances & HVAC Solution calculated in PY8. Table D-5 shows the results. Interestingly, trade allies assumed the customer NTG estimate (0.64) would be larger than the customer reported NTG estimate (0.56) indicating some success in influencing customer decision-making around energy efficiency purchases. When considering their own decision-making, the trade ally reported NTG estimate (0.52) was in line with the customer estimate, but slightly lower showing slightly less attribution to the program.

Table D-5. Lighting, Appliances & HVAC Trade Ally NTG Comparison

	Free Ridership	Spillover	NTG Ratio
Trade Ally Decision-making	0.48	0.00	0.52
Trade Ally Perception of Customer Decision-making	0.36	0.00	0.64
Customer reported NTG for LAH (from PY8)	**0.46**	**0.03**	**0.56**

Source: Navigant analysis

D.1.3 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Lighting, Appliances & HVAC Solution.

- **Finding**: Navigant updated baseline wattage for several (114 out of 912) unique SKUs based on bulb characteristics identified in the eTrack databases, the PA TRM savings assumptions, and the evaluation team's understanding of EISA-exempt products.
    - **Recommendation**: Navigant will work with PECO and the CSP to explore the best approach for documenting bulbs characteristics in the eTrack database so that the mapping to the PA TRM baseline wattages is transparent. This includes TRM measure reference, TRM measure category, and defining characteristics such as bulb shape, base size, and presence of special features. Fixtures commonly used in place of R20 and BR30 bulbs should use the corresponding R20 and BR30 baseline assumptions. Linear LED products should use the T8 baseline outlined in the commercial section of the PA TRM. All other products that cannot be classified directly in the PA TRM should use package labeling and appropriate least-efficient common substitutes using reasonable discretion and providing rationale.
- **Finding**: There is opportunity to improve the process for verifying program bulb ENERGY STAR certification by incorporating additional bulb information into the tracking system.
    - **Recommendation**: Navigant will work with PECO to explore approaches for incorporating the ENERGY STAR unique identifier for each program bulb record in the tracking system. This will provide greater transparency about the bulb certification status and streamline verification for future evaluations.
- **Finding:** There is opportunity to improve data tracking practices within the eTrack database for ductless mini-split heat pumps (DHP). These opportunities include clarifying input headers and confirming proper accounting for child versus parent DHP units.
    - **Recommendation:** Navigant is currently working with PECO and the CSP to identify and implement the best approaches for improving these data tracking efforts.
- **Finding:** Results from the 12 trade ally interviews conducted in PY9 for the Appliances and HVAC component of the solution included and found that satisfaction with the program overall was high with 88% of trade allies rating it a 4 or a 5 on a scale of 1 through 5 with 5 being extremely satisfied. Trade allies reported that their interactions with the solution are positive, and that their customers generally like the solution.

D.2 Appliance Recycling Solution

The Appliance Recycling Solution helps customers recycle energy-wasting appliances by removing and recycling operating, inefficient refrigerators, freezers, and room ACs from residential customer sites at no cost to participants. PECO expanded the solution's offering to include room AC recycling for those participants recycling at least one refrigerator or freezer for Phase III.

ARCA is the CSP for this solution. 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.

Additionally, customers may be referred to the Appliance Recycling Solution through other solution activities. For example, Low-Income Whole Home auditors may identify a qualifying appliance and

recommend Appliance Recycling. A customer who implements Whole Home measures and recycles an appliance would be considered a participant in both solutions.

D.2.1 Gross Impact Evaluation

The Appliance Recycling Solution relied on three evaluation tasks to verify the gross impacts for the solution in PY9. First, Navigant conducted an algorithm review using the default coefficients and independent variable values specified in Table 2-78 of the Pennsylvania TRM. The evaluation team performed this review on a census of recycled units in the program tracking data to determine whether proper application of these deemed values was used when calculating program savings in the tracking data. The team calculated lower deemed annual unit energy consumption (UEC) values than were recorded in the tracking data—953 kWh/yr. for refrigerators and 833 kWh/yr. for freezers. This discrepancy is the result of incorrect inputs for the pre-1990 independent variable, which the TRM specifies should be calculated using EDC data gathering and not a prescribed deemed value. The AC annual UEC, 159 kWh/yr., is specified in the TRM and was correctly applied in the tracking data. However, it should be noted that the three deemed UEC values are only a check and do not factor into the final verified savings.

Second, the evaluation team refined the deemed gross verified savings to account for the program's specific appliance stock characteristics—average age, number of cubic feet, and configuration, among others—as recorded in the program tracking data. In this case, the regression analysis used the coefficients detailed in the PA TRM but used an average of the program appliance stock's characteristics as inputs for the algorithm's independent variables. This analysis was also conducted on a census of recycled units and did not require sampling. The results of the analysis produced the annual UEC for refrigerators and freezers in the EDC's territory for the program year. The regression analysis of the recycled stock calculated a higher UEC for refrigerators than the deemed value—1,109 kWh/yr. It also calculated a higher UEC for freezers—1,087 kWh/yr. As specified by the TRM, the deemed value of 159 kWh/yr. was used for the UEC for ACs.

Finally, the team conducted a phone-based survey to verify the appliance characteristics recorded in the tracking data and to gather additional data as input to the Part-Use Factor (PUF). Survey respondents reported a lower PUF than the default values: 84% for refrigerators and 48% for freezers. The PUF for ACs was not calculated because it is not a component of the savings algorithm specified in the PA TRM for ACs. The PUF for refrigerators and freezers is the primary driving factor for the solution's verified savings.

The regression UEC, coupled with the PUF, forms the basis for the gross verified savings related to compliance. This product yields a gross savings per unit that, multiplied by the number of units recycled during the program year, yields the solution's verified savings.

For refrigerators, Navigant verified gross energy and demand savings of 12,591,140 kWh and 1,409 kW. For freezers, the evaluation team verified gross energy and demand savings of 12,602 MWh/yr and 1.41 MW. Finally, the team verified gross energy and demand savings for ACs based on their deemed values of 403 MWh/yr and .66 MW. Overall, the energy and demand RRs for the Appliance Recycling Solution are 0.91 and 0.91, respectively.

Navigant verified a total gross energy and demand savings of 14,512 MWh/yr and 2.2 MW, respectively.

D.2.2 Net Impact Evaluation

The Appliance Recycling Solution's net impact evaluation was informed by the NTG ratio calculated in PY8, as indicated in the Evaluation Plan. A detailed description of how these ratios are calculated can be found in the PY8 report. In summary:

- Navigant applied a NTG ratio of 0.35 for refrigerators, 0.50 for freezers, and 0.46 for room ACs.
- The net savings per refrigerator, freezer, and room AC were 4,370 MWh/yr, 748 MWh/yr, and 187 MWh/yr per year, respectively.

The relatively low NTG values are due to the majority of respondents in the PY8 NTG survey that indicated they would have transferred their appliance to a second party in the absence of the program. The survey also found that 64% of respondents replaced their recycled units and that the program's offering induced 5% of respondents to seek out new replacement units. The program achieved an NTG ratio of 0.37 for PY8, and this was also used for PY9, resulting in total solution net savings of 5,305 MWh/yr.

D.2.3 Process Evaluation

As discussed in Section 3.1.5, Navigant performed targeted process evaluation for the Residential EE Program and its solutions during PY9. For the Appliance Recycling Solution, this work included PECO and CSP staff interviews.

The staff and CSP interviews revealed that the main programmatic update for PY9 was establishing a new recycling center after the previous center shut down with the dissolution of JACO. The new center will be run directly by ARCA, the program's CSP, and provides opportunities to improve program quality and efficiency.

The program also saw a decrease in customer satisfaction according to the program's internal call center surveys when ARCA returned to using subcontractors instead of in-house employees for appliance pickups. In response, PECO is actively working with ARCA to implement more training and decrease subcontractor turnover.

Finally, PECO increased the rebate amount from $50 to $75 per refrigerator or freezer on February 1, 2018 in response to below-target program savings. As of April 2018, PECO saw an increase in order pickups from 250 orders/week to 550 orders/week.

D.2.4 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Appliance Recycling Solution.

- **Finding:** The CSP's method for calculating the pre-1990 independent variable of the TRM deemed value algorithm approach did not reflect the new 2016 TRM requirement to use EDC-gathered data when calculating the deemed UECs used in the program tracking data for refrigerators and freezers.

- **Recommendation**: While live updates to the deemed UEC to incorporate each new unit is prohibitive, Navigant recommends the CSP update the value of the pre-1990 independent variable as specified in the TRM and, therefore, the deemed refrigerator and freezer UECs to reflect the EDC-gathered data after the entire stock for the program year is finalized and before the eTrack data is submitted for evaluation. The previous year's deemed UEC can be used through the program year as a proxy until the stock is finalized.

- **Finding:** The phone verification identified customers who reported that their appliance did not meet the program requirement that the appliance was in working condition at the time of pickup. However, Navigant's review of PECO's processes found that PECO has numerous QA/QC procedures in place to ensure that recycled appliances are indeed working at the time of pickup, including examples from PECO of call scripts, training materials, and program documents showing orders were cancelled due to the non-working condition of the appliance.
  - **Recommendation:** Navigant recommends that PECO add a data field to the form used when picking up appliances that specifies whether or not the appliance was working at the time of pickup and that PECO includes this data in eTrack. Additionally, the team suggests including a screening question in the online pickup scheduling form to facilitate a pre-screen of customers whose appliances do not meet this program requirement. This finding will be explored in the PY10 evaluation.

D.3 Whole Home Solution

PECO's comprehensive Whole Home Solution is for customers who want to understand how to improve the energy performance of their entire home. This solution offers an onsite pathway through a general walkthrough assessment available to all PECO residential customers and a more comprehensive audit—including blower door test and combustion safety test—to PECO residential electric heat customers or customers with central AC. Participating customers are sorted into one of these two categories based on the outcome of an initial screening call with CSP staff. During the assessment or audit site visits, customers receive direct installation of efficient products (such as lighting, power strips, pipe insulation for electric domestic hot water tanks). Additionally, customers with electric heat may be eligible for additional thermal envelope improvements (insulation and air sealing).

Customers may also participate through a retail pathway available for larger HVAC measures:

- Fuel switching: electric heat to gas, propane, or oil heat
- Fuel switching: electric hot water to fossil fuel water heater
- Heat pump water heater
- Variable speed pool pump

Customers may be directed to the retail pathway through the walkthrough assessment or audit or through direct reference from customer service or a contractor. Customers may participate in one or the other or both pathways. Two CSPs implemented these solutions for PY8 and through one-half of PY9, when a single CSP was contracted to deliver the Whole Home Solution. Historically, customers participating in both pathways were not identified as such in the tracking database due to implementation by independent CSPs.

A combined PY8 and PY9 evaluation was conducted for PECO's Whole Home Solution. This report presents findings for both program years.

D.3.1 Impact Evaluation Methodology

The impact evaluation focused on verifying reported savings and determining the degree to which reported and verified savings are consistent with planned savings.

Site visits and phone verification surveys were used to confirm measure installation. Large projects (defined as reported savings >1,790 kWh) were sampled for onsite verifications. In coordination with the process evaluation phone surveys, a combination of small projects (343-1,128 kWh), medium projects (1,129-1,789 kWh), and large projects (>1,790 kWh) were sampled for phone verification. The evaluation team sampled PY8 and PY9 independently to ensure accuracy across the two program years. Very small projects (<342 kWh) were not sampled; instead, small project strata realization rates (RRs) were applied to the very small project strata for each program year.

Navigant used a random sample of projects from the population of program participants in the PY8 and PY9 tracking database for its sampling strategy. The evaluation team selected sampled projects based on project size and program year to ensure the sample reflected the participant population.

The team calculated verified savings for large projects with onsite verification. The analysis used installed product data collected onsite (including equipment size, wattage, flow rate, location, etc.) applied to TRM algorithms. Differences between reported and verified savings were due to the following reasons:

1. Unverified measures: 17% of light bulbs and 36% of water conservation devices were not verified as installed.
2. In-service rates (ISRs): ISRs were not applied to the reported lighting savings.
3. Lighting verified savings were calculated based on verified conditions including verified wattage to one-tenth of a watt and locational-specific HOU.
4. Domestic water heaters: Verified savings were calculated based on verified tank size and location.
5. The evaluation team did not calculate reported heat pump water heater savings based on TRM algorithms by the CSP. The TRM algorithm resulted in verified savings of just 35% of reported savings. Larger tanks use EFbase and EFee constant values that result in negative savings. The team suggests reviewing this measure in more detail to confirm the TRM defaults and assess the overall measure for use in the program.

D.3.2 Process Evaluation

Navigant completed a process evaluation for the Whole Home Solution to assess both PY8 and PY9 activities. The evaluation team reviewed program materials, conducted in-depth interviews with PECO and CSP staff, and conducted phone surveys with participant customers.

D.3.3 Process Evaluation Methodology

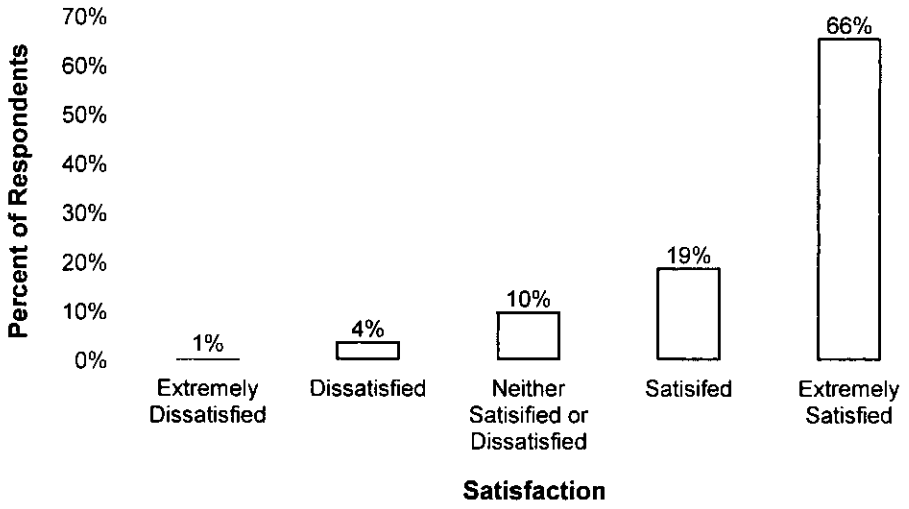
The evaluation team used in-depth interviews with PECO and CSP staff instrumental to the delivery of the Whole Home Solution to collect data regarding program implementation in both PY8 and PY9. The interviews focused on implementation strategies, data tracking, program management, and areas for program improvement. The team also conducted phone surveys with participating customers in conjunction with impact evaluation verifications to better understand customer perceptions of the program and to measure free ridership and spillover. Navigant sampled participants based four project sizes, across both program years, creating eight strata. This methodology captured customer experiences from different project types (direct installation, direct installation with major thermal shell measures, or a rebated major measure such as heat pump water heater or pool pump). Sampling methodology is discussed in Section 3.2.2.

D.3.4 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Whole Home Solution.

- **Finding**: Reported lighting measure savings were calculated with a 1.00 In Service Rate (ISR) rather than the default TRM value of 0.92.
    - **Recommendation**: Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.
- **Finding**: There is room for improvement in how the CSP calculates savings for heat pump water heaters. The TRM algorithm uses EFbase and EFee constant values which resulted in negative savings for larger size tanks.
    - **Recommendation**: Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.
- **Finding:** Solution goals to convert in-home assessments and audits to major measure installations would require more promotional and customer facing program materials.
    - **Recommendation:** Consider directly promoting the comfort and financial (energy saving) benefits of major measure installation to customers in Whole Home Solution materials and on the website. Promote the potential savings and incentives for major measures along with the benefits of an initial in-home assessment to encourage project conversion.
- **Finding**: Conversion rates from in-home assessment and audit recommendations to major mechanical measures installations (heat pumps, water heaters, pool pumps, etc.) are tracked in various places in the plan due to the complexities of multiple CSPs implementing the solution.
    - **Recommendation**: Formalize major measure recommendation tracking and monitor conversion rates for major measure installations. Identify areas where customers may need additional follow up after initial audit recommendations to encourage conversion.
- **Finding:** Participants were asked their overall satisfaction with their participation in the Whole Home Solution. The average participant satisfaction was 4.5 on a 5-point scale, with 1 representing extremely dissatisfied and 5 representing extremely satisfied. Overall, the program received very high satisfaction ratings from participants. Of participants, 85% were satisfied or extremely satisfied with the program, while only 5% indicated dissatisfaction (Figure D-2). This finding reflects positively on the program.

Figure D-2. Overall Satisfaction by Whole Home Participants, n=144



Question: Using a scale of 1 to 5, with 5 meaning extremely satisfied and 1 meaning extremely dissatisfied, how would you rate your OVERALL satisfaction with the [Solution] program?

Note: Refused and Do Not Know responses have been excluded.

Source: Navigant analysis

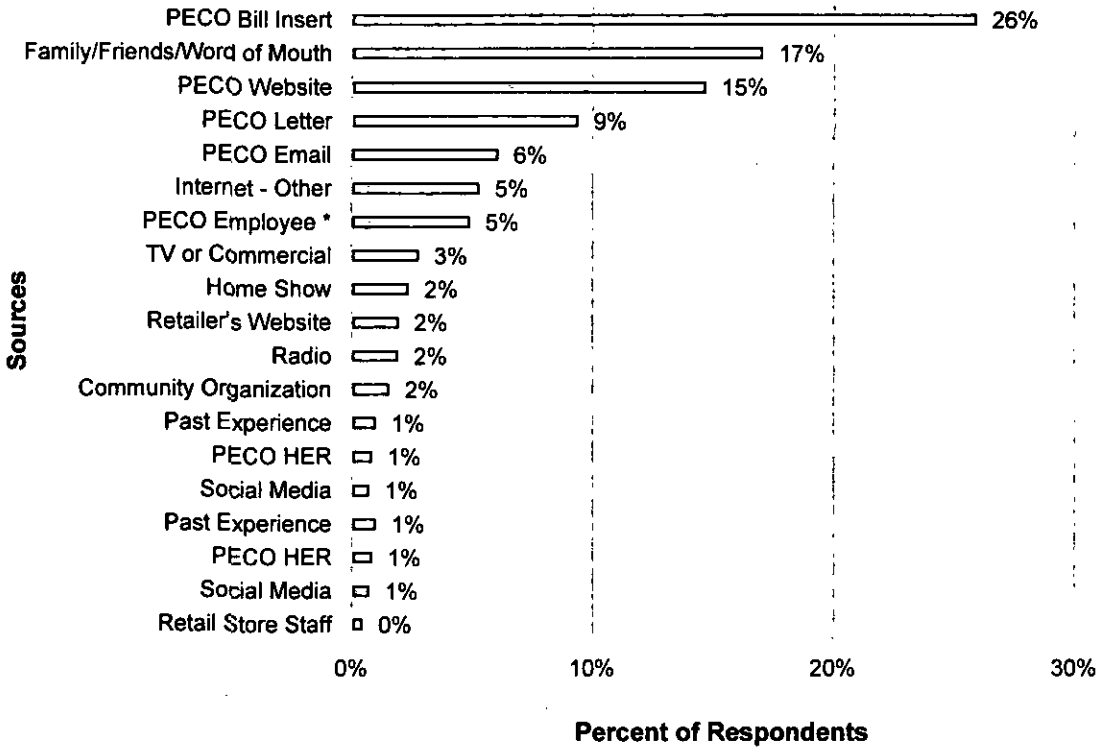
When rating the program, 10% of respondents expressed being neither satisfied nor dissatisfied. After analyzing the verbatim responses, Navigant identified common themes amongst these participants. Some respondents indicated the audit service was too general and they did not receive the service they expected for the cost of the audit. These respondents expected an extensive audit and felt this was not provided to them by the contractor. Some participants also expressed dissatisfaction because it did not result in a lower energy bill, which was the primary purpose of participation.

- **Finding:** Survey respondents were asked about the sources from which they learned about the program. Of respondents, 26% heard about the program through PECO bill inserts, while 17% learned about the program through word of mouth (Figure D-3). These resources were also the most influential in a customer's decision to participate in the program. PECO bill inserts (23%) were cited by Whole Home solution participants as the most significant informational source contributing to their decision to participate. Word of mouth through family and friends and other sources such as PECO emails and TV and radio advertising were the second most influential responses. Over the past year, the PECO website (14%) has also been instrumental in influencing more residential participants, an increase of four percentage points from PY8 findings (9%).

  Additionally, 90% of respondents indicated they are likely to recommend the program to others. Taken together, participants have identified word of mouth as an influential source of program information and are also willing to tell others about their positive program experience.

  - **Recommendation**: Consider formalizing the recently launched Refer-a-Friend marketing initiative with additional follow-up outreach to encourage participant referrals.

Figure D-3. Sources of Program Awareness for Whole Home Solution, n=144

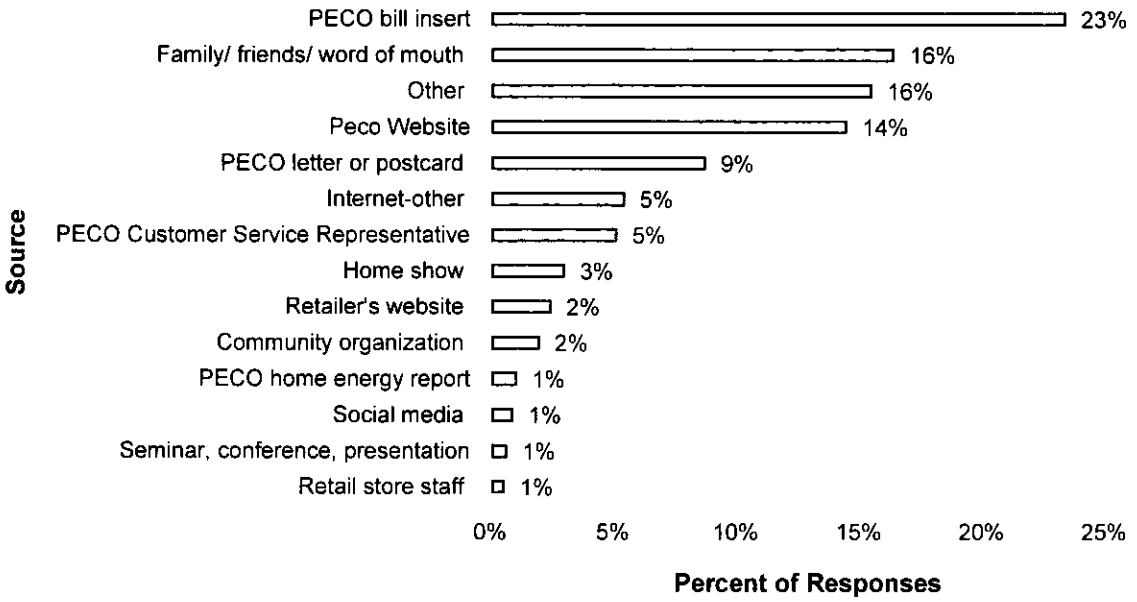


Question: How did you learn about the [Solution] program? Multiple responses allowed; sum of percentages will not add up to 100%.

Note: Refused and Do Not Know responses have been excluded. Responses were recoded to other common themes indicated in verbatim responses. These included: Radio, Past Experience, TV or Commercial, and PECO email.

Source: Navigant analysis

Figure D-4. Awareness Source Influence on Whole Home Solution Participation, n=144



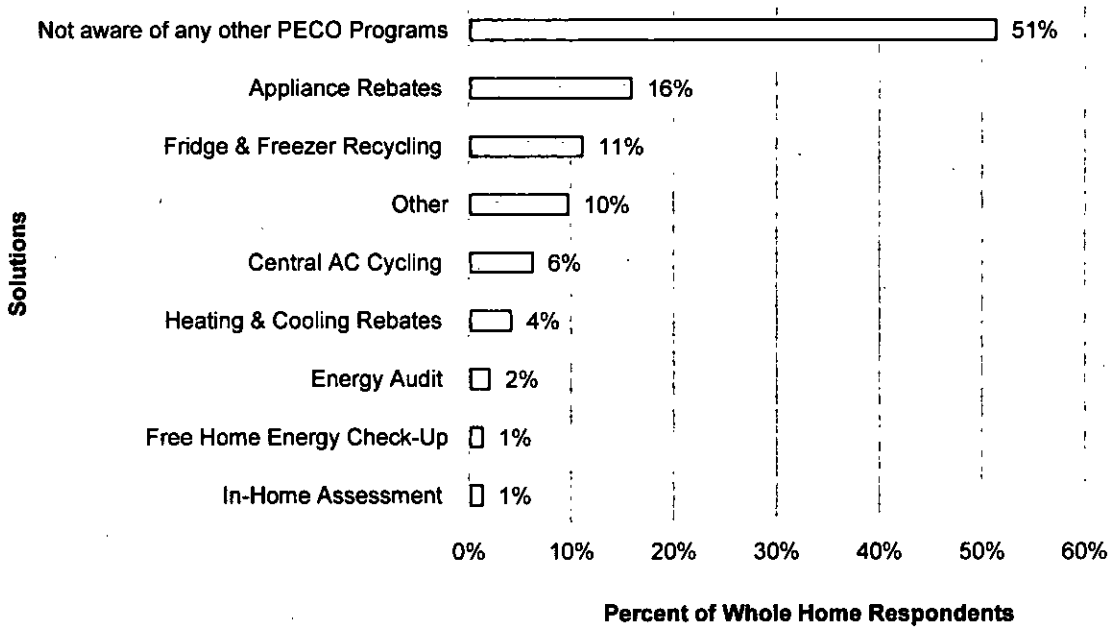
Question: Thinking of the ways you heard about the [Solution] program, which one was most influential in your decision to participate in the program? One response allowed.

Other includes: PECO email, and TV/radio commercials

Source: Navigant analysis

- **Finding:** The customer survey also investigated program participant awareness of other PECO solutions to understand various channeling pathways throughout the portfolio. Whole Home Solution participants were asked via an open-ended question whether they had heard of any other PECO solutions. Like PY8 results, the largest portion (51%) indicated they had not heard of a solution other than the one in which they participated, as seen in Figure D-5, while 16% recalled hearing of appliance rebates. The Other category includes various responses, such as mentions of insulation and door sealing and the Customer Assistance Program (CAP) and Low-Income Home Energy Assistance Program (LIHEAP) programs. These findings indicate that, in general, there is more opportunity for Residential EE Program participants to learn about PECO's other offerings during the course of their experience within their respective solution.

Figure D-5. Whole Home Participant Awareness of Other Solutions, n=144

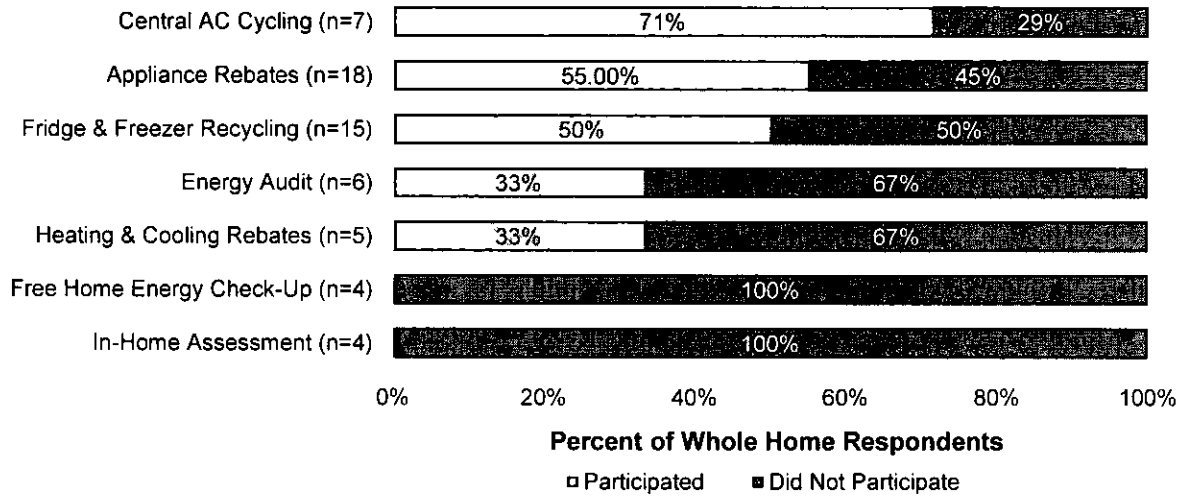


Question: Have you heard of any of PECOs other solutions to help you save energy and money in your home? Multiple responses allowed; sum of percentages will not add up to 100%. Other category includes individual mentions of insulation and door sealing, and the CAP and LIHEAP programs.

Source: Navigant analysis

- **Finding:** Of the customers that recalled a solution other than the one in which they participated, most residential customers (86%) mentioned participating in the Demand Response Solution and more than half had participated in the appliance rebate of the Lighting, Appliances, & HVAC Solution, as seen in Figure D-6. Most customers who had heard of the free home energy check-up (100%), in-home assessments (100%), and fridge and freezer recycling (80%) offerings reported they not pursue additional participation in these solutions.

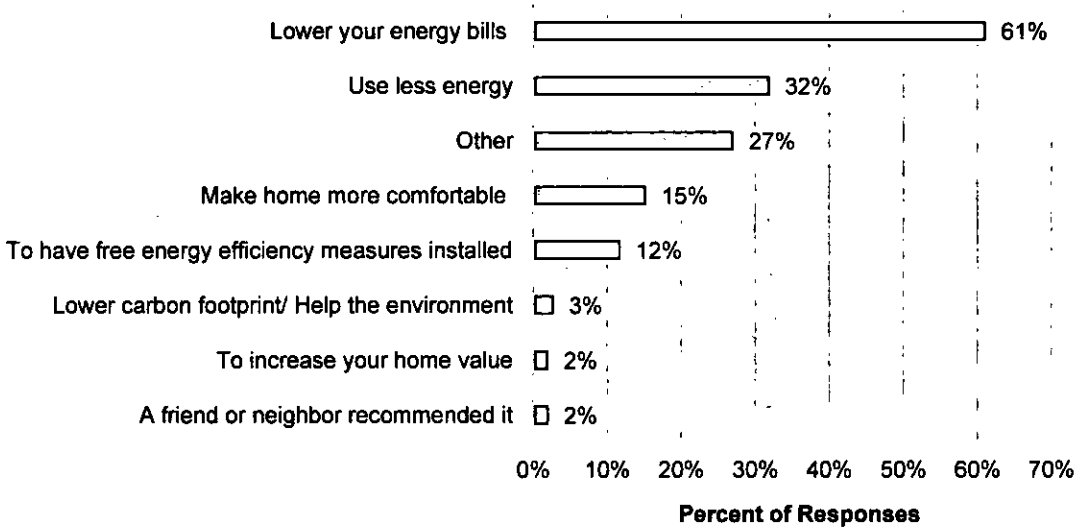
Figure D-6. Whole Home Solution Participation Conditional on Awareness



Question: Have you participated in PECO's [PREVIOUS RESPONSE] solution? Percentages may not add up to 100% due to rounding.
Note: (1) Refused and Do Not Know responses have been excluded (2) Lighting Discount, Energy Efficiency Homes Program, Gas efficiency, Gas conversion, and Free CFL Bulb Solutions were removed due to lack of responses.
(3) Responses include only Whole Home Solution customers.
Source: Navigant analysis

- **Finding**: Of respondents (n=72), 97% indicated that the Whole Home Solution energy advisor explained the results of the audit extremely well. Additionally, 92% of all respondents (n=122) found the report useful. They found recommendations to save energy most useful (48%), followed by understanding how recommendations saved energy (17%) and estimates of where their homes used energy (11%).
- However, only 67% of in-home Assessment respondents (n=107) indicated that an energy advisor followed up with them to explain results of the home visit. Conversely, when asked recalling whether a major measure was recommended in an audit report or by an energy advisor, none of the rebated major measure respondent participants also reported having an in-home assessment that recommended the major measure. Together, this indicates the Solution may be able to leverage the goodwill earned by through the in-home assessment into a major measure installation.
- **Finding:** Respondents indicated reducing energy costs and using less energy were the primary reasons for participating in the Whole Home Solution. Almost 30% responded Other when asked "What reason or reasons did you have for participating in the program?" Verbatim responses indicated those participants were curious about energy usage, valued a third-party review of their home, and the home visit cost was a low barrier (Figure D-7).

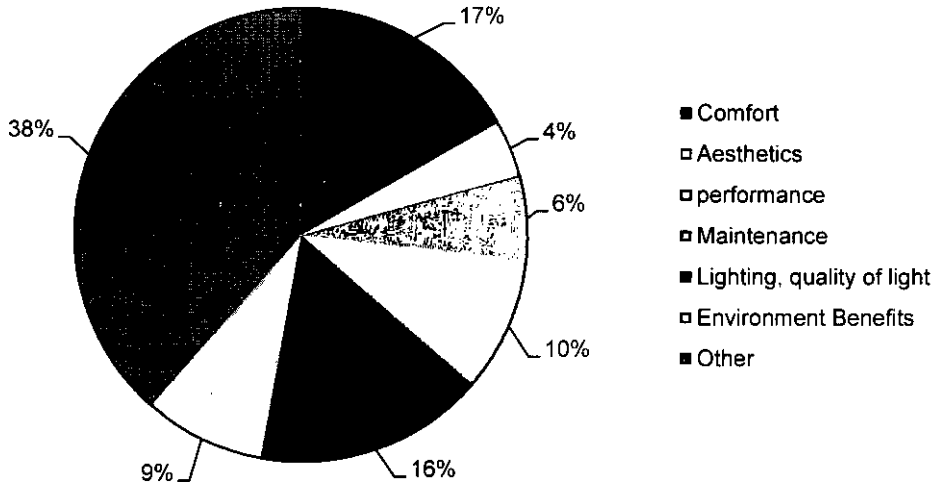
Figure D-7. Participant Reasons for Participation, n=144



Question: What reason or reasons, did you have for participating in the program? Multiple responses allowed.
Note: Refused and Do No Know responses have been excluded.
Source: Navigant analysis

- **Finding:** Besides receiving energy and cost savings from the program, 17% of respondents indicated that comfort was an additional benefit, while 16% expressed the quality of lighting was another advantage (Figure D-8). Navigant also analyzed verbatim responses from the Other category, which revealed a wide range of benefits. Respondents indicated that participating in the program was an invaluable learning experience where they received more information about energy savings strategies such as installing insulation. One respondent also indicated that it allowed them to "teach [their] kids how to save energy." Overall, these responses reflect that the program has many benefits to customers beyond reducing their energy bill.

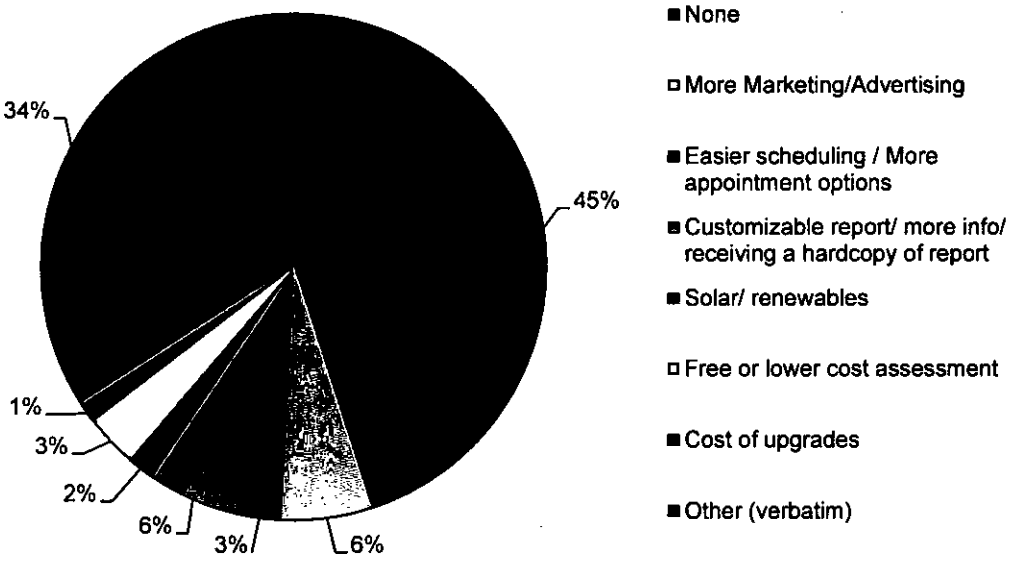
Figure D-8. Non-Energy Benefits Experienced by Whole Home Participants, n=41



Question: What other benefits did you experience?
Note: Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

- **Finding:** When asked how PECO can improve the Whole Home Solution, respondents provided valuable recommendations, which were analyzed to identify common themes. Navigant discovered 45% of respondents indicated that they did not have any suggestions, while other respondents expressed numerous ideas for improvement (Figure D-9).

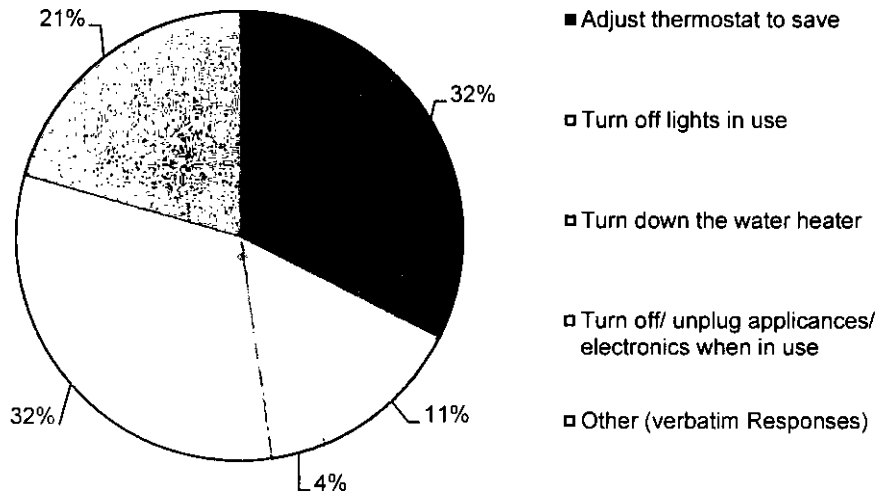
Figure D-9. Suggested Improvement to the Whole Home Solution, n=127



Question: What suggestions, if any, do you have for improving the PECO [Solution]?
Note: Navigant recoded question to identify common themes from survey responses. Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

- **Finding:** When participants were asked if there are any recommendations from the program that they do not intend to implement, 29% of respondents (n=49) indicated they do not plan to pursue installing measures such as installing insulation, replacing household doors, and replacing water heaters. Of those who responded, 28% indicated that they do not believe sufficient cost savings would be generated from implementing those recommendations and 37% expressed that the cost of the recommendation was the primary barrier for pursuing the suggestion.
- **Finding:** When participants were asked about their energy-saving habits, 32% indicated they adjust their thermostat to save energy, while 32% turn off or unplug appliances and electronics when they are not in use (Figure D-10). A wide range of energy savings habits were also expressed in the Other category where participants indicated they installed insulation, smart thermostats, LED light bulbs, and power strips to save energy.

Figure D-10. Energy Saving Actions from Whole Home Solution Participants, n=88



Question: What energy saving actions have you taken?
Note: Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

D.4 New Construction Solution

PECO's New Home Rebates Program intends to accelerate the adoption of energy efficiency in the design, construction, and operation of new single-family and multifamily homes by leveraging the US Environmental Protection Agency's (EPA's) ENERGY STAR Homes certification. Builders who are building new single-family or multifamily homes can take advantage of PECO's New Home Rebate Program to incorporate energy efficiency. The program also offers incentives for Code Plus homes. A Code Plus home achieves savings of 30% above a code-level home and provides builders an additional incentive tier below the ENERGY STAR-certified home level.

Performance Systems Development (PSD) is the CSP for this solution. A participant is a new home.

D.4.1 Gross Impact Evaluation Methodology

The PY9 New Construction solution impact evaluation consisted of reviewing project REM/Rate™ files and building simulation modeling.

Engineering File Reviews

Navigant reviewed each project's REM/Rate model and all prescriptive measure calculations for compliance with the appropriate PA TRM. The evaluation team reviewed project tracking data, ex ante

measure savings calculations, and REM/Rate model files submitted by raters for compliance with the program requirements.

Building Simulation Modeling

Navigant verified energy and demand savings by independently recalculating all claimed savings reported from the REM/Rate building simulation models. The team conducted building simulation modeling for a sample of projects completed in PY9. Each REM/Rate file was run using a batch process against the User-Defined Reference Home (UDRH) based on TRM specifications. The evaluation team calculated the annual energy and demand savings associated with the program homes as the difference between the baseline (UDRH) and as-built simulation results. The resulting energy and demand savings were compared to the claimed savings to determine an RR.

The PY9 sampling strategy used a random sample of projects from the population of program participants in the PY9 tracking database. The evaluation team selected sampled projects based on builder volume to ensure the sample reflected the participant population. Navigant initially intended to complete a census review of projects, but data acquisition hurdles prevented that approach. Therefore, the team developed a sample as shown in Table 3-3 in Section 3.1.2.

D.4.2 Net Impact Evaluation Methodology and Results

Net savings represents the percentage of the gross program impacts that can reliably be attributed to the program. Navigant estimated net savings by applying a calculated NTG ratio to the verified gross savings. The NTG ratio is calculated as the sum of free ridership and spillover rates. The evaluation team estimated free ridership and spillover rates based on data collected during participating builder telephone surveys. The team asked survey respondents a series of questions designed to identify the program's influence on building practices.

The NTG sampling strategy attempted to reach a census of program builders, and the evaluation team completed 12 interviews.

The NTG ratio calculated for the Residential New Construction Solution in PY9 is 0.87. This is down slightly from the values calculated in the previous investigation that occurred in PY7 (0.94) due to the lack of quantifiable spillover in PY9. Only two builders reported completing projects without an incentive, but neither provided enough detail on these projects to quantify spillover savings.

D.4.3 Process Evaluation

Navigant completed a process evaluation for the New Construction Solution in PY9. The process evaluation consisted of in-depth interviews with PECO program staff and CSP implementation staff and participating builder phone surveys.

The evaluation team used in-depth interviews with key PECO and CSP staff instrumental to understand the New Construction Solution implementation in PY9. The interviews focused on implementation strategies, data tracking, program management, and areas for program improvement. There were no significant changes to the program processes in PY9. Marketing activities primarily focused on direct outreach to recruit new builders through in-person meetings and builder events. Navigant found that

builders were very satisfied with most elements of the program, though opportunities exist to improve builder satisfaction and engagement.

The team also conducted online and phone surveys with participating builders to better understand their perceptions of the program and to measure free ridership and spillover. Table D-6 provides a summary of the PY9 sampling strategy.

Table D-6. New Construction Builder Survey Sample Design for PY940

Target Group	Population Size	Target Sample Size	Achieved Sample Size
Participating Builders	**20**	**10**	**12**

Source: Navigant analysis

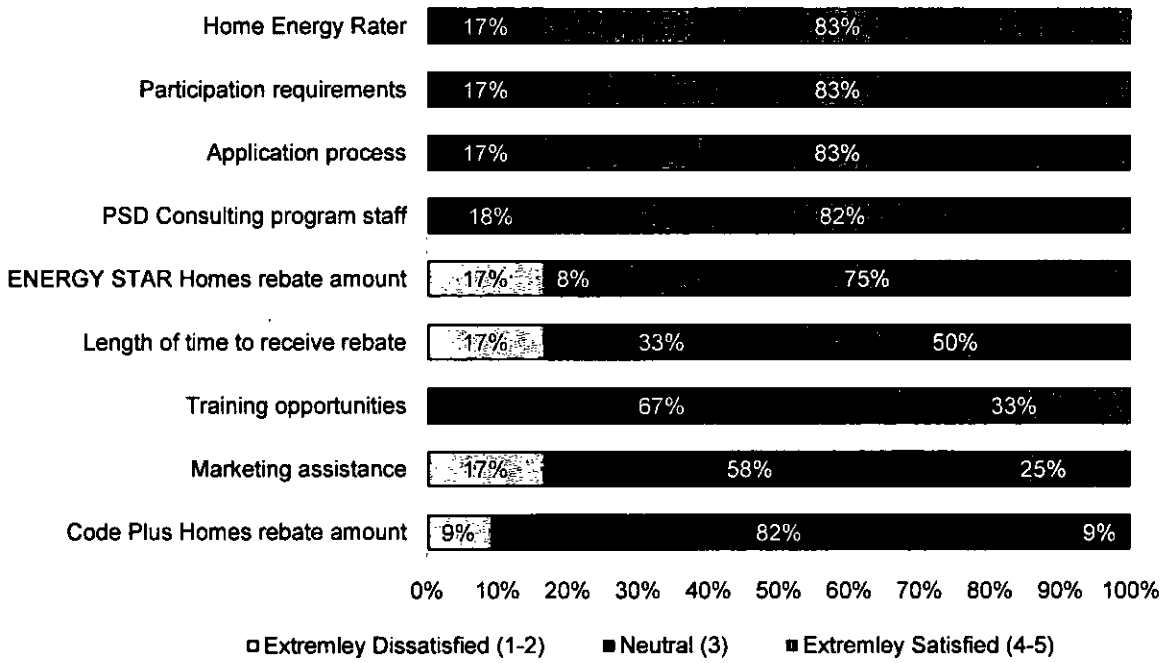
D.4.4 Findings and Recommendations

The following provides a summary of Navigant's findings resulting from the PY9 evaluation of the New Construction Solution.

- **Finding:** Participating builders were generally very satisfied with the program overall, with 83% of respondents rating it 4 or above on a scale from 1 to 5. When asked about satisfaction with specific aspects of the program, builders reported the highest satisfaction with working with the home energy rater and with CSP program staff, the rebate amounts for ENERGY STAR homes, the rebate application process, and the requirements of the program, as shown in Figure D-11. Participants reported relatively lower satisfaction with marketing assistance for the program, training opportunities, the rebate amounts for Code Plus homes, and the time it takes to receive a rebate. These satisfaction ratings are similar to results in PY7, where builders also expressed high satisfaction working with their rater and CSP staff. In PY7 builders similarly reported lower satisfaction for marketing assistance, training opportunities, and the time it takes to receive a rebate through the program.

[40] Navigant designed survey samples to achieve 15% relative precision at the 85% confidence level at the solution level for NTG ratios and satisfaction ratings.

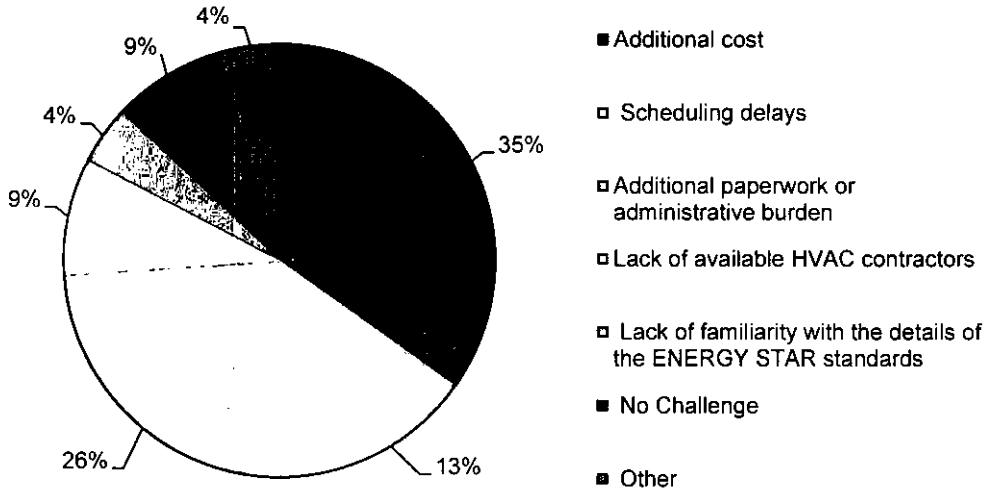
Figure D-11. Builder Forecast for PY9 Program Activity (n=12)



Question: On a scale of 1 to 5, where 5 is Extremely Satisfied and 1 is Extremely Dissatisfied, how would you rate your satisfaction with the following aspects of the PECO New Home Rebates program?
Source: Navigant analysis

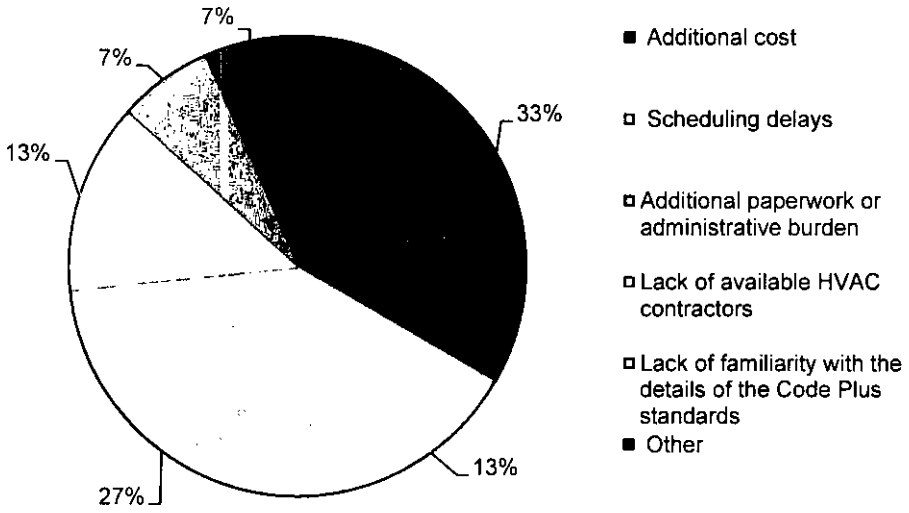
- **Finding:** Some survey responses indicted that participants are less satisfied with marketing assistance and training opportunities because they are unaware that these services are offered through the program.
    - **Recommendation:** PECO should consider more direct outreach with builders to inform them about marketing and training opportunities through the program.
- **Finding:** The evaluation team analyzed open-ended responses describing participants' lower satisfaction rating for the time it takes to receive a rebate. Over 33% of builders indicated that it takes about 3 to 6 months to receive a rebate.
    - **Recommendation:** PECO should continue to monitor incentive processing time to identify and minimize bottlenecks and ensure that builders are promptly receiving rebates. Should the average rebate delivery time lag beyond the 60-day goal, PECO and Navigant should identify and propose solutions to the reasons for the delay.
- **Finding:** When asked to identify the greatest challenge regarding building homes to ENERGY STAR standards (Figure D-12), builders stated that the primary barriers are the additional costs and administrative work, which impact their ability to construct homes to the appropriate standards. Builder challenges are similar for meeting Code Plus standards, as shown in Figure D-13.

Figure D-12. Greatest Challenge in Meeting ENERGY STAR Standards (n=12)



Question: What are the challenges that your company faces when building homes to ENERGY STAR standards? Multiple responses allowed.
Source: Navigant analysis

Figure D-13. Greatest Challenge in Meeting Code Plus Standards (n=12)

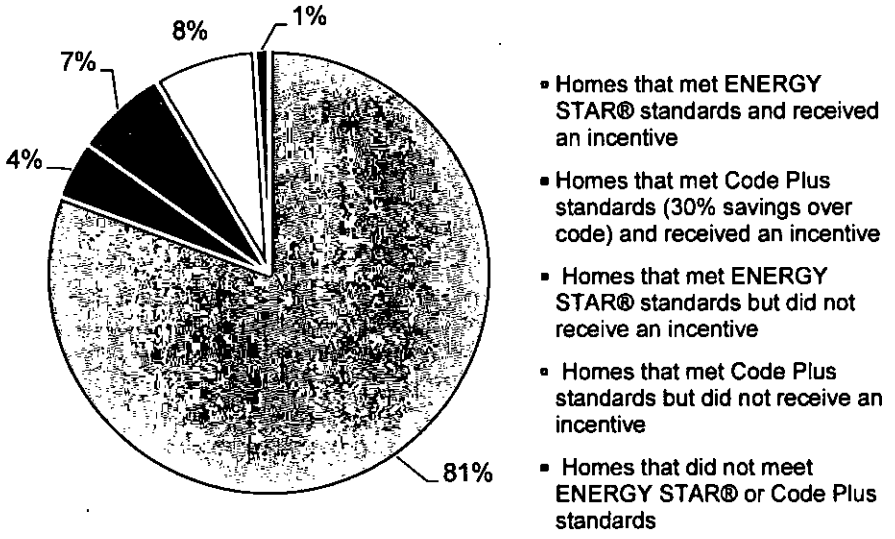


Question: What are the challenges that your company faces when building homes to Code Plus standards? Multiple responses allowed.
Source: Navigant analysis

- **Finding:** The evaluation team asked builders to report several statistics related to the homes built by their company in PY9. As shown in Figure D-14, 81% of all homes built by respondents met ENERGY STAR Standards and received a rebate through the New Home Rebates program. In addition, 4% of homes were constructed to Code Plus standards and received a rebate. In total,

85% of homes built by respondents received a rebate from the New Homes Rebate Program. Of the 14% of homes that did not receive a rebate, verbatim responses indicated that the builders were either not aware of the program at the time of home construction or they did not believe that homes would qualify for a rebate. 1% of homes did not meet ENERGY STAR or CODE Plus standards.

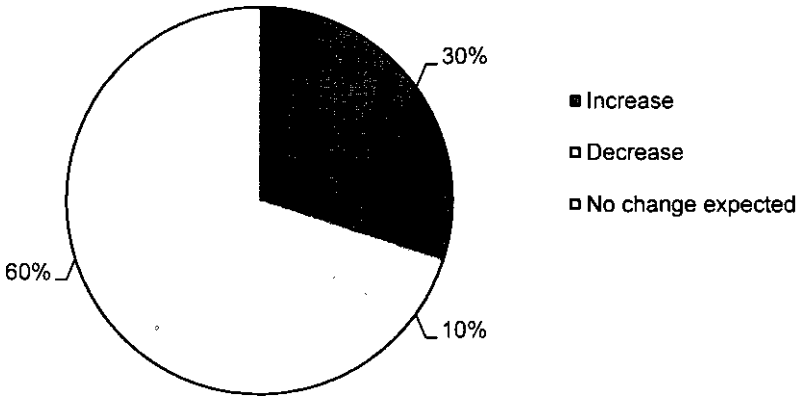
Figure D-14. Portion of Respondents' Homes Participating in PY9 (n=12)



Question: Of all the homes your company built between June 2017- May 2018 in PECO's service area, roughly what percent of these homes were: Homes that met ENERGY STAR® standards and received an incentive. Homes that met Code Plus standards (30% savings over code) and received an incentive, Homes that met ENERGY STAR® standards but did not receive an incentive, Homes that met Code Plus standards but did not receive an incentive, Homes that did not meet ENERGY STAR® or Code Plus standards?
Source: Navigant analysis

- **Finding:** Looking ahead to PY10, 60% of builder respondents believe that their program activity will remain the same, 30% estimate that activity will increase, and 10% estimate that activity will decrease, as shown in Figure D-15. Navigant's analysis of PY9 survey verbatim responses indicates that builders expect to increase their participation because of the potential for market growth within PECO territory. One builder also indicated that the availability of incentives for new homes is driving an increase in program participation.

Figure D-15. Builder Forecast for PY10 Program Activity (n=10)

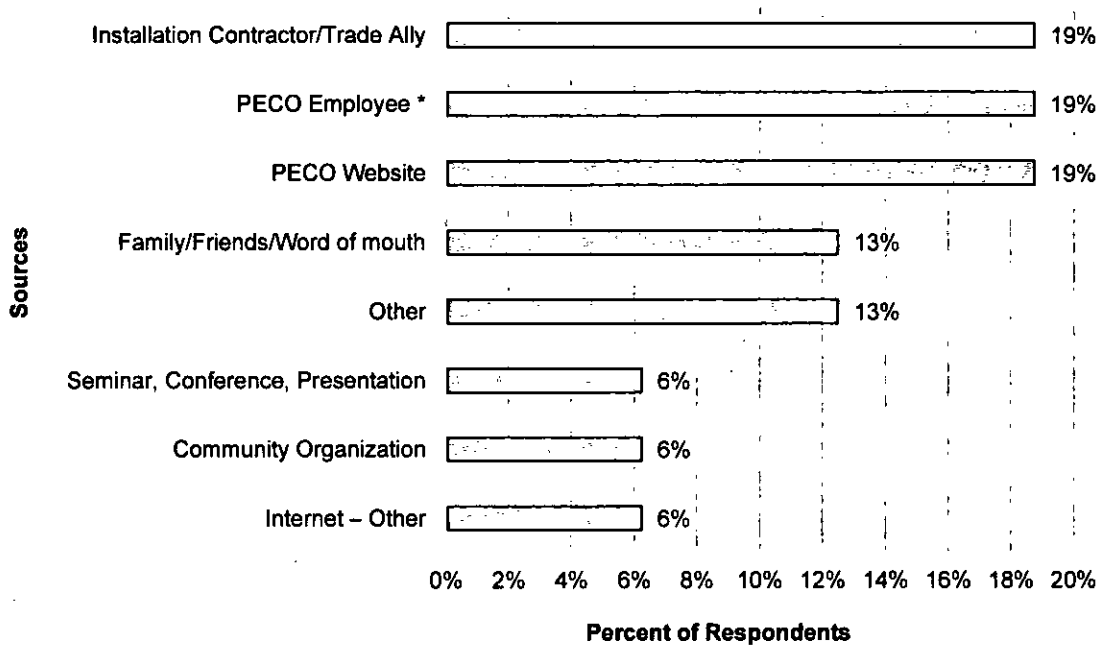


Question: In PY10 (June 2018-May 2019), do you expect the number of homes you enroll in PECO's New Home Rebates program to increase, decrease, or stay about the same compared to last year?

Source: Navigant analysis

- **Finding:** Survey participant builders were asked to identify how they learned about the New Home Rebates Program. Many builders learned about the program through the PECO website (19%), a PECO representative (19%), or a trade ally (19%), as shown in Figure D-16. Builders also learned about the program through word of mouth from family and friends (13%).

Figure D-16. Builder Source of Information (n=12)



*PECO Employee includes a PECO account representative and a customer service representative
Question: How did you learn about the [SOLUTION] program? Multiple responses allowed; sum of percentages will not add up to 100%.
Other includes: HERS rater and LEED certification energy auditor
Source: Navigant analysis

- **Finding:** The evaluation team asked builders what they believe prevents other builders from joining the New Home Rebates Program. Roughly 30% of respondents indicated that lack of awareness of the program may impact other builders from joining the program.

D.5 Behavioral Solution

A major objective of the Residential EE Program is to provide education, awareness, and motivation to customers that want easy entry into the energy efficiency (EE) market and want to benefit from energy efficient products. To achieve these ends, the Behavioral Solution partners with Oracle to implement a randomized control trial (RCT) that provides a select set of residential customers with home energy reports (HERs). The reports provide participants with helpful information about the ways they use energy. HERs also use social norms to compare the customer's energy use to the average energy use of other households like theirs, so customers have a better sense of whether their energy use patterns fall above or below the norm. Finally, these reports provide targeted recommendations or tips to customers that suggest actions that customers can take to reduce consumption. The combination of HER content serves to enhance a customer's understanding of their energy use, encourage them to reduce their consumption using targeted tips and social norms, and enhance customer engagement and satisfaction. The reports are sent to a targeted subset of customers on an opt-out basis. Currently, the reports are being provided to more than 380,000 PECO customers.

In addition to the RCT, the Behavioral Solution provides HERs to households enrolled in PECO's AC Saver Program. The AC Saver Program is a residential demand response (DR) initiative that primarily seeks to reduce the peak demands of participants. The HERs sent to these participants are intended to maintain customer satisfaction while enhancing customer education and awareness related to EE benefits.

- Oracle is the CSP for this solution.
- One participant is counted as a utility account included in the program's treatment group, including those accounts associated with the AC Saver program.

Table D-7 summarizes the numbers of participating treatment group homes by cohort and month for those households included within the PY9 scope of evaluation activities.

Table D-7. Behavioral Solution Treatment Group Counts by Cohort

Month	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5 – Electric	Wave 5 – Dual Fuel	AC Saver	Total
Jun 2017	28,596	35,147	60,596	200,897	31,695	17,607	38,392	**412,930**
Jul 2017	28,354	34,909	60,225	199,181	31,258	17,448	38,131	**409,506**
Aug 2017	28,106	34,685	59,842	197,442	30,619	17,246	37,880	**405,820**
Sep 2017	27,878	34,471	59,511	195,830	29,967	17,061	37,667	**402,385**
Oct 2017	27,725	34,299	59,220	194,511	29,526	16,920	37,476	**399,677**
Nov 2017	27,532	34,149	58,963	193,411	29,157	16,803	37,305	**397,320**
Dec 2017	27,387	34,041	58,715	192,369	28,825	16,707	37,144	**395,188**
Jan 2018	27,246	33,909	58,494	191,388	28,566	16,598	36,971	**393,172**
Feb 2018	27,127	33,820	58,316	190,619	28,333	16,511	36,861	**391,587**
Mar 2018	27,043	33,740	58,163	189,984	28,129	16,448	36,742	**390,249**
Apr 2018	26,904	33,630	57,959	189,109	27,887	16,370	36,592	**388,451**
May 2018	26,758	33,504	57,739	188,212	27,629	16,279	36,441	**386,562**

Source: Navigant analysis

D.5.1 Impact Evaluation Methodology

Navigant followed the impact evaluation methodology outlined in Section 6.1.1 of the Phase III Evaluation Framework. The evaluation team estimated savings using a monthly lagged dependent variable (LDV) model. For details on this model, please refer to Section 6.1.1.5 of the Evaluation Framework.

D.5.2 Summary Statistics and Results

Table D-8 through Table D-11 summarize the regression outputs and summary statistics by cohort within both the RCT and AC Saver groups. The summaries also include the absolute precision results for each wave. The Phase III Evaluation Framework document (at Section 6.1.1.1.1) requires the solution-level verification achieve an absolute precision of ±0.5% at the 95% confidence level (two-tailed); individual waves may have a wider margin of error. Given that Behavioral Solution analysis examines the solution's

entire population, a census evaluation, the precisions reported in Table D-8 reflect the error of the regression analysis estimate rather than a sampling uncertainty. The reader should also note that this uncertainty is reflected within the Behavioral analysis only. That is, the regression analysis estimation error is not reflected within the Residential EE Program or the PY9 portfolio total savings uncertainty. Those rolled up uncertainties only reflect sampling uncertainties that may be associated with other solutions.

Table D-8. Behavioral Solution Cohort Regression Details – Waves 1-4

Month	Wave 1		Wave 2		Wave 3		Wave 4	
	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error
Jun 2017	-0.56	0.10	-1.27	0.18	-0.87	0.11	-0.53	0.07
Jul 2017	-0.78	0.11	-1.47	0.20	-1.15	0.13	-0.63	0.09
Aug 2017	-0.65	0.11	-1.45	0.18	-1.05	0.12	-0.58	0.08
Sep 2017	-0.57	0.10	-1.28	0.17	-0.96	0.10	-0.50	0.07
Oct 2017	-0.58	0.09	-1.11	0.15	-0.78	0.09	-0.47	0.06
Nov 2017	-0.85	0.13	-1.01	0.17	-0.68	0.10	-0.34	0.07
Dec 2017	-1.21	0.21	-1.21	0.26	-0.82	0.15	-0.40	0.10
Jan 2018	-1.25	0.22	-1.54	0.27	-0.74	0.15	-0.37	0.10
Feb 2018	-0.96	0.18	-1.39	0.23	-0.70	0.13	-0.24	0.08
Mar 2018	-1.05	0.17	-1.14	0.21	-0.78	0.12	-0.23	0.08
Apr 2018	-0.73	0.13	-1.22	0.17	-0.77	0.11	-0.27	0.07
May 2018	-0.51	0.10	-1.26	0.18	-0.82	0.10	-0.50	0.06

Source: Navigant analysis

Table D-9. Behavioral Solution Cohort Regression Details – Waves 5 and AC Saver

Month	Wave 5 – Electric		Wave 5 – Dual Fuel		AC Saver	
	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error
Jun 2017	-0.03	0.10	0.04	0.12	-0.23	0.06
Jul 2017	-0.17	0.11	-0.29	0.14	0.13	0.07
Aug 2017	-0.35	0.10	-0.45	0.13	-0.49	0.06
Sep 2017	-0.45	0.09	-0.52	0.11	-0.78	0.05
Oct 2017	-0.38	0.09	-0.42	0.10	-0.32	0.05
Nov 2017	-0.30	0.12	-0.15	0.10	-0.30	0.05
Dec 2017	-0.39	0.17	-0.16	0.13	-0.39	0.06
Jan 2018	-0.69	0.19	-0.20	0.14	-0.33	0.06

Month	Wave 5 – Electric		Wave 5 – Dual Fuel		AC Saver	
	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error
Feb 2018	-0.60	0.15	-0.29	0.12	-0.47	0.05
Mar 2018	-0.47	0.14	-0.31	0.12	-0.43	0.06
Apr 2018	-0.45	0.12	-0.20	0.11	-0.56	0.05
May 2018	-0.40	0.09	-0.45	0.12	-0.49	0.05

Source: Navigant analysis

Table D-10. Behavioral Solution Cohort Percent Savings – Waves 1-4

Month	Wave 1		Wave 2		Wave 3		Wave 4	
	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error
Jun 2017	1.61%	0.56%	1.86%	0.53%	1.70%	0.43%	1.44%	0.39%
Jul 2017	2.02%	0.56%	1.92%	0.52%	1.92%	0.42%	1.43%	0.38%
Aug 2017	1.88%	0.62%	2.14%	0.53%	2.03%	0.44%	1.55%	0.40%
Sep 2017	1.88%	0.63%	2.19%	0.57%	2.20%	0.47%	1.61%	0.42%
Oct 2017	1.89%	0.60%	2.12%	0.57%	2.06%	0.48%	1.74%	0.43%
Nov 2017	1.84%	0.55%	1.62%	0.54%	1.72%	0.51%	1.24%	0.49%
Dec 2017	1.65%	0.56%	1.38%	0.57%	1.65%	0.57%	1.18%	0.59%
Jan 2018	1.56%	0.55%	1.65%	0.57%	1.45%	0.58%	1.06%	0.57%
Feb 2018	1.57%	0.56%	1.85%	0.60%	1.59%	0.58%	0.81%	0.55%
Mar 2018	1.84%	0.58%	1.64%	0.60%	1.87%	0.59%	0.81%	0.58%
Apr 2018	1.71%	0.59%	2.10%	0.59%	2.06%	0.55%	1.07%	0.52%
May 2018	1.67%	0.63%	2.29%	0.64%	2.09%	0.49%	1.83%	0.46%

Source: Navigant analysis

Table D-11. Behavioral Solution Cohort Percent Savings – Waves 5 & AC Saver

Month	Wave 5 – Electric		Wave 5 – Dual Fuel		AC Saver	
	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error
Jun 2017	0.07%	0.55%	-0.12%	0.64%	0.81%	0.40%
Jul 2017	0.41%	0.53%	0.65%	0.59%	-0.38%	0.40%
Aug 2017	0.96%	0.56%	1.18%	0.65%	1.69%	0.41%
Sep 2017	1.48%	0.59%	1.64%	0.69%	3.25%	0.44%

Month	Wave 5 – Electric		Wave 5 – Dual Fuel		AC Saver	
	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error	Treatment Coefficient	Cluster Robust Standard Error
Oct 2017	1.38%	0.61%	1.58%	0.71%	1.60%	0.44%
Nov 2017	0.94%	0.71%	0.62%	0.82%	1.48%	0.47%
Dec 2017	0.90%	0.75%	0.53%	0.89%	1.62%	0.53%
Jan 2018	1.47%	0.78%	0.66%	0.91%	1.36%	0.52%
Feb 2018	1.55%	0.75%	1.13%	0.93%	2.25%	0.51%
Mar 2018	1.30%	0.77%	1.23%	0.99%	2.13%	0.55%
Apr 2018	1.52%	0.75%	0.87%	0.90%	3.00%	0.51%
May 2018	1.45%	0.64%	1.69%	0.85%	2.43%	0.48%

Source: Navigant analysis

Table D-12 summarizes the monthly gross savings for the Behavioral waves informed by the regression analysis activities. These results reflect the impacts before any consideration of the overlap analysis, which is described in the next section.

Table D-12. Behavioral Solution Monthly Gross Savings

Month	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5 – Electric	Wave 5 – Dual Fuel	AC Saver	Total
Jun 2017	478	1,335	1,583	3,193	25	-23	263	**6,855**
Jul 2017	686	1,593	2,148	3,903	164	158	-155	**8,498**
Aug 2017	562	1,557	1,950	3,577	329	240	573	**8,789**
Sep 2017	477	1,320	1,722	2,967	408	266	878	**8,037**
Oct 2017	502	1,183	1,438	2,845	351	219	374	**6,913**
Nov 2017	704	1,037	1,208	1,976	265	78	330	**5,598**
Dec 2017	1,023	1,279	1,500	2,384	350	81	445	**7,062**
Jan 2018	1,057	1,621	1,347	2,200	609	102	374	**7,309**
Feb 2018	732	1,312	1,136	1,297	474	136	485	**5,572**
Mar 2018	877	1,196	1,401	1,357	409	156	485	**5,880**
Apr 2018	587	1,230	1,335	1,541	381	99	610	**5,784**
May 2018	427	1,312	1,461	2,918	345	228	559	**7,249**

Source: Navigant analysis

D.5.3 Dual Participation Analysis

To the extent that the Behavioral Solution increases participation in other solutions, some savings from the regression analysis could be double counted if appropriate adjustments are not made. Double counting can be avoided for solutions that track participation at the customer level by generating estimates of the increase in participation in the solution among Behavioral Solution participants. This is also known as the dual participation savings.

To generate estimates of dual participation, Navigant followed the Phase III Evaluation Framework guidance on completing dual participation analyses. The Phase III Evaluation Framework conveys that exposure to the Behavioral Solution messaging often motivates participants to take advantage of other solution offerings that may be promoted through Behavioral Solution promotional materials. This exposure creates a situation where households in the treatment groups tend to participate in other solutions at a higher rate than households in the control groups.[41] The framework methodology calls for program-specific uplift calculations, and the SWE requests those values be reported. Given PECO's reorganization of Phase I and Phase II programs into solutions for Phase III, Navigant estimated aggregate uplift across residential programs.

Navigant's dual participation analysis also accounts for upstream EE solutions. The calculation of double counted savings from upstream solutions is complicated participation not being tracked at the customer level; therefore, the approaches described previously for specific homes are infeasible. Per Section 6.1.1.8.2 of the Phase III Evaluation Framework, the evaluation team used an assumed upstream reduction factor subtracted from the estimate of energy savings for each wave of Behavioral Solution participants after downstream double counted savings had been removed. The specific reduction factors used for the waves are shown in Table D-13.

Table D-13. Default Upstream Adjustment Factors

Years Since Cohort Inception	Default Upstream Reduction Factor	Behavior Waves
1	0.75%	W5
2	1.50%	W4, AC Saver
3	2.25%	W3
4 and beyond	3.00%	W1, W2

Source: Phase III Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs, Prepared by The Statewide Evaluation Team: NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC. Contracted Under the Pennsylvania Public Utility Commission's RFP 2015-3 for the Statewide Evaluator, October 21, 2016

Table D-14 summarizes the overlap or uplift savings associated with downstream and upstream EE solutions found for each of the Behavioral Solution waves. These savings are subtracted from the total savings previously shown in Table D-12.

[41] Pennsylvania PUC. "Section 6.1.1.8. Dual Participation Analysis." *Phase III Evaluation Framework.* http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

Table D-14. Downstream and Upstream Savings Adjustments

Behavior Waves	Downstream Dual Participation Savings (MWh/yr)	Upstream Dual Participation Savings (MWh/yr)	Total Dual Participation (MWh/yr)
1	585	226	**811**
2	1,195	443	**1,638**
3	770	393	**1,163**
4	440	446	**886**
5 - Electric	23	31	**53**
5 - Dual Fuel	0	13	**13**
AC Saver	517	71	**587**

Source: Navigant analysis

D.5.4 Behavioral Program Impacts

Finally, by combining the results of the regression analysis and the overlap analysis, Navigant created a final set of estimates of the PY9 Behavioral Solution impacts, detailed in Table D-15. These energy savings reflect the net impacts for each of the five waves of RCT participants. Navigant uses a NTG ratio of 1.00.

Table D-15. Behavioral Solution Net Impacts

Behavior Waves	Gross Savings (MWh/yr)	Downstream Dual Participation Savings (MWh/yr)	Upstream Dual Participation Savings (MWh/yr)	Net Savings (MWh/yr)	Demand Savings (MW)[42]
1	8,115	585	226	7,303	0.8
2	15,975	1,195	443	14,337	1.6
3	18,228	770	393	17,065	1.9
4	30,158	440	446	29,273	3.3
5 - Electric	4,108	23	31	4,055	0.5
5 - Dual Fuel	1,741	0	13	1,728	0.2
AC Saver	5,222	517	71	4,635	0.5
Total	**83,548**	**3,529**	**1,622**	**78,396**	**8.9**

Source: Navigant analysis

Total verified savings are 78,396 MWh/yr. Solution-reported savings by PECO are 81,934 MWh/yr, resulting in a RR of 0.96.

[42] PECO will claim the verified demand savings, but the implementer (Oracle) does not evaluate these savings as part of their standard reporting. Therefore, there is no RR for demand savings.

D.5.5 Findings and Recommendations

Beyond the energy and demand impacts evaluated during PY9, Navigant has no additional findings or recommendations for the Behavioral Solution. Navigant notes that it completed an extensive process evaluation for the solution in PY8.

APPENDIX E. RESIDENTIAL LOW-INCOME EE PROGRAM

The following appendix subsections provide additional detail on the evaluation sample design, methods, and activities deployed in PY9 for select Residential Low-Income EE solutions. The reader should refer to the body of the report for evaluation findings, results, and conclusions. Additional and select details are provided here to give readers more context and background about the research efforts undertaken for PY9.

- Whole Home Solution
- Lighting Solution (discontinued in PY9)

E.1 Whole Home Solution

PECO's Low-Income Whole Home Solution offers income-eligible customers multiple pathways to engage with PECO to improve the energy performance of their entire home. These pathways include the following:

- Free home energy check-ups, providing site visits, education, and direct installation of energy efficient products.
- Collaboration with property owners to deliver services to income-eligible customers living in multifamily buildings, consistent with the home energy check-up. This effort includes large private property owners and the city's public housing authority.
- Collaboration with complementary income-eligible programs (such as the Philadelphia Gas Works and Weatherization Agencies) to identify income-eligible customers and serve them through a single outreach effort.
- Workshops delivered to income-eligible multifamily buildings providing energy education and energy kits.
- Collaboration with the Low-Income Usage Reduction Program (LIURP), providing complementary efficient products to increase the LIURP service offering's comprehensiveness.
- LED lighting giveaways through community events in collaboration with community partner organizations. In PY9, PECO expanded distribution to include food banks serving income-eligible customers.
- Direct customer referrals to the Appliance Recycling Solution.

E.1.1 Impact Evaluation

The impact evaluation focused on verifying reported savings and determining the degree to which reported and verified savings are consistent with planned savings.

Navigant used site visits to confirm measure installation. Multifamily projects and large, medium, and small sized single-family projects were sampled for onsite verifications. The team did not sample very small projects (<342 kWh); instead, the small project strata realization rates (RRs) were applied to the very small project strata.

The Low-Income Whole Home Solution serves income-eligible multifamily properties. Projects are implemented and reported based on meter configuration: projects are reported individually at the apartment level on individually metered buildings. Conversely, projects are reported at the building level for master-metered buildings. The evaluation team worked with the CSP to identify groups of single-family projects that belonged to a larger multifamily building. By sampling multifamily buildings in their own strata, the team accounted for program implementation differences occurring when tenants rather than property owners are making residential project decisions. All multifamily measures were residential-/product-based in nature (such as light bulbs, water conservation devices, or smart strips). The program did not install common area measures in PY9.

The impact evaluation sampling strategy used a random sample of projects from the population of program participants in the PY9 tracking database. Navigant selected sampled projects based on project size to ensure the sample reflected the participant population. The sampling strategy is discussed in Section 3.2.

Navigant calculated verified savings for projects with onsite verification. The analysis used installed product data collected onsite (including equipment size, wattage, flow rate, location, etc.) applied to TRM algorithms. Differences between reported and verified savings were due to the following reasons:

- Difference between reported and verified measures
    a. **Lighting:** Of the 76 measures sampled, 23 measures had fewer verified products than reported, while four measures were identified with more products installed than reported. (The evaluation team identified additional measures based on product similarities and conversations with customers while onsite.)
    b. **Domestic hot water:** Three water conservation measures in the sample of 23 measures were not verified. Additionally, one 50-gallon heat pump domestic hot water was not confirmed installed through the onsite verification.
    c. **Smart strips:** Of the 28 sampled smart strip measures, four customers with two reported smart strips stated they only received one. Additionally, two products had been removed due to either malfunction or dissatisfaction.
    d. **Building shell:** One building shell insulation measure was not confirmed installed through the onsite verification.
- Onsite conditions:
    a. **Lighting:** The team calculated verified savings based on verified conditions including verified wattage to one-tenth of a watt and locational-specific hours of use (HOU).
    b. **Heat pump water heater:** Reported savings were not calculated based on TRM algorithms. The TRM algorithm resulted in verified savings of just 35% of reported savings. Larger tanks use EFbase and EFee constant values, which result in negative savings. The evaluation team suggests reviewing this measure in more detail to confirm the TRM defaults and assess the overall measure for use in the program.
    c. **Water conservation:** Verified savings for low-flow devices were based on default TRM savings values per verified installed location.
    d. **Smart strips:** Verified savings were calculated based on the number of plugs and products controlled (entertainment system or other).

E.1.2 Process Evaluation

The PY9 Whole Home Solution process evaluation was narrow in scope, following more extensive PY8 activities. The evaluation team conducted in-depth interviews with PECO program and CSP and maintained regular dialogue about the program and program activities with PECO staff.

E.1.3 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Low-Income Whole Home Solution.

- **Finding**: There is room for improvement in how the CSP calculates savings for reported heat pump water heaters. The TRM algorithm uses EFbase and EFee constant values, which resulted in negative savings for larger size tanks.
    - **Recommendation**: Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.
- **Finding:** Low-income-qualified multifamily buildings are not identified in the tracking database. Specifically, individual residential apartment projects within a multifamily building are not identified as part of a common multifamily building.
    - **Recommendation**: PECO and the CSP should assign a multifamily building ID for projects that are in the same multifamily building.
- **Finding**: Tenants in Low Income MF buildings are receiving direct install measures; however, there are no common area measures indicated as installed.
    - **Recommendation**: If needed to meet Phase III Low-Income targets, consider developing onsite staff training, skills, and tracking mechanisms to identify and implement common area opportunities.

E.2 Lighting Solution

The Low-Income Lighting Solution was discontinued during PY9; however, savings persisted through calendar year 2017, and these savings are credited as low-income. Low-Income Lighting Solution savings were allocated to the Low-Income carveout based on results of the PY8 evaluation.

The PY8 geographic information system (GIS) analysis assessed retail customer income levels and resulted in a 70% reduction in the savings allocated to the low-income carveout. The reduction is due to analysis of retailer locations and the income levels in neighboring areas as described in the PY8 Annual Report. The analysis found that 30% of residents near retailer locations were income-eligible; savings are allocated accordingly to the low income carveout goals in PY9.

The evaluation activities for the Low-Income Lighting Solution mirror those performed for the Residential EE Program Lighting Solution, as outlined in Appendix D.1. Navigant did not undertake additional evaluation activities specific to Low-Income Lighting in PY9.

APPENDIX F. SMALL AND LARGE C&I EE PROGRAMS

The following appendix subsections provide additional detail on the evaluation sample design, methods, and activities deployed in PY9 for select Small and Large C&I EE Program solutions. The reader should refer to the body of the report for evaluation findings, results, and conclusions. Additional and select details are provided here to give readers more context and background about the research efforts undertaken for PY9.

- Equipment and Systems Solution
- New Construction Solution
- Whole Building Solution
- Data Centers Targeted Market Segment

F.1 Equipment and Systems Solution

The Equipment and Systems Solution offers incentives for existing building retrofit projects with either deemed, partially deemed, or custom measures. Typical measures include lighting, variable frequency drives (VFDs), HVAC systems, and controls. 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. In addition, a single customer is permitted to participate in multiple projects with unique project numbers. PECO's C&I or G/E/NP customers that own or rent their space are eligible to participate in this solution. Participating customers must first identify EE projects at their facility, including deemed, partially deemed, or custom measures. Next, the customer must submit a pre-application to ICF—the CSP—before completing the project. Once approved, each project is implemented by the customer's own contractor, and either the customer or the contractor submits the rebate paperwork to the implementer.

F.1.1 Impact Evaluation

Phone Verification

Navigant conducted desk reviews for all projects in the evaluation sample. Most of the small stratum and approximately half of the medium stratum projects received phone verification via live interviews with knowledgeable site contacts. The desk reviews made use of project applications, project-specific analysis files and associated calculation sheets, measure invoices, measure specification sheets, construction plans, and other construction documents provided by PECO. Documentation included scanned files of hard copy forms, as well as electronic files of CSP inspection reports, photos of installed measures, important emails, and memoranda. In the case of whole building projects and some new construction projects, executable modeling files and related model output files were also provided, as applicable. The team supplemented the desk reviews with phone verification, consisting of interviews with customers about their projects. Common points of discussion included information about the quantities and type of each measure installed, the operating status of the measures, equipment nameplate data, operating schedules, a careful description of site conditions, and overall verification of the information contained in the project files.

Onsite Verification

Navigant conducted onsite verification for all sampled projects in the large stratum, approximately half of the sampled projects in the medium stratum, and a small number of projects in the small stratum. The team visited medium and small stratum projects with complexity or variability in ex ante energy or demand savings documentation. Navigant also applied the desk review process outlined in the Phone Verification section to any projects receiving onsite verification. The primary objective of the site visits was to collect the data identified in the Phase III Evaluation Framework[43], including verification of the quantities and type of each measure, equipment nameplate data, operating schedules, and a careful description of site conditions. Navigant achieved the verification through visual inspection of the measures and by interviewing the customers.

Onsite Verification with Metering

For projects that surpassed the expected kWh savings thresholds set in Table 1-2 of the 2016 PA TRM, the team—in addition to performing all of the tasks outlined in the Onsite M&V section—collected site-specific information for open variables used in the calculation of energy and demand savings. Site-specific information included end-use metered data and trend data from building management systems (BMSs).

Summary of Sampling Methodology

Using tracking data from PY9, Navigant obtained the total number of projects and the total amount of energy savings in the population. With this project data on hand, Navigant created four strata of sampled projects.

All projects above 3 million kWh per year of annual savings make up a census stratum (Stratum 1 – Very Large Projects). In the Small C&I Program, there were no projects that fit this description. Navigant then excluded all projects making up the lowest 2% of total solution energy savings, sorted the projects by size, and divided the population into three strata: those projects making up the top third, the middle third, and the lowest third of the total energy savings.

Small Equipment and Systems

- **Stratum 1:** Very high impact and/or very high uncertainty measures. Projects over 3 million kWh/year energy savings.
- **Stratum 2:** High impact and/or high uncertainty measures. Projects between 175,000 kWh/year and 3 million kWh/year energy savings.
- **Stratum 3:** Medium impact and/or medium uncertainty measures. Projects between 70,000 kWh/year and 175,000 kWh/year energy savings.
- **Stratum 4:** Low impact measures. Projects less than 70,000 kWh/year energy savings.

[43] Phase III Evaluation Framework. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

Large Equipment and Systems:

- **Stratum 1:** Very high impact and/or very high uncertainty measures. Projects over 3 million kWh/year energy savings.
- **Stratum 2:** High impact and/or high uncertainty measures. Projects between 750,000 kWh/year and 3 million kWh/year energy savings.
- **Stratum 3:** Medium impact and/or medium uncertainty measures. Projects between 200,000 kWh/year and 750,000 kWh/year energy savings.
- **Stratum 4:** Low impact measures. Projects less than 200,000 kWh/year energy savings.

In Small C&I Equipment and Systems, Navigant evaluated a sample of 41 projects, almost all of which involved retrofitting lighting equipment or installing lighting controls. Of the 41 projects, 40 fell into this category, with the only other project consisting of a hotel HVAC and occupancy control retrofit. This random sample is comparable to the entire population of small Equipment and Systems, where 2,131 out of 2,177 total implemented measures (97.8%) were lighting-related.

The SWE conducted detailed desk reviews on three of these projects.

For Large C&I Equipment and Systems, the sampled project mix was more varied. Of the 35 projects evaluated:

- 22 involved lighting and/or lighting control retrofits
- Six involved variable frequency drive (VFD) retrofits
- Three were classified as HVAC measures
- Four were classified as fully custom (including some large chiller plant measures) or involved a combination of the above measures

Details of the impact sample, by stratum, can be seen in Tables Table 3-23 and Table 3-35. The SWE conducted site visits for two of the projects and desk reviews on an additional six projects.

F.1.2 Process Evaluation

Navigant completed a targeted process evaluation for the Small and Large Equipment Systems Solutions in PY9. The evaluation team conducted in-depth interviews with PECO and CSP staff and conducted surveys with participant customers.

F.1.3 Process Evaluation Methodology

The evaluation team conducted in-depth interviews with PECO and CSP staff to better understand the relationships among the key program stakeholders, the project flow for participants, and to identify potential areas for improvement. Navigant's Small and Large C&I EE Program process evaluation efforts and findings, detailed in Sections 3.3.5 and 3.4.5, targeted the program and cross-solution levels. Findings and insights from that effort are intended to inform PECO about all Small and Large C&I EE Program solutions, including the Small and Large Equipment & Systems Solutions.

Navigant used in-depth interviews with PECO and CSP staff instrumental to the delivery of the Small and Large C&I Equipment & Systems Programs to collect data regarding program implementation in PY9 and to discuss research areas of interest to program staff. The interviews focused on implementation strategies, data tracking, program management, and areas for program improvement.

The evaluation team also conducted online surveys with participants to better understand their perceptions of the program and to measure free ridership and spillover. Table F-1 provides a summary of the PY9 sampling strategy for the surveys.

Table F-1. Small and Large C&I Equipment & Systems Customer Survey Sample Design for PY9

Stratum	Population Size*	Target Sample Size	Achieved Sample Size
Large	18	18	5
Medium	55	20	5
Small	189	30	16
Small Equipment & Systems Solution Total	**262**	**68**	**26**
Very Large	3	3	2
Large	15	15	5
Medium	20	20	4
Small	136	60	17
Large Equipment & Systems Solution Total	**174**	**98**	**28**
Total	**436**	**166**	**54**

*Populations represent unique decision makers
Source: Navigant analysis

F.1.4 Findings and Recommendations

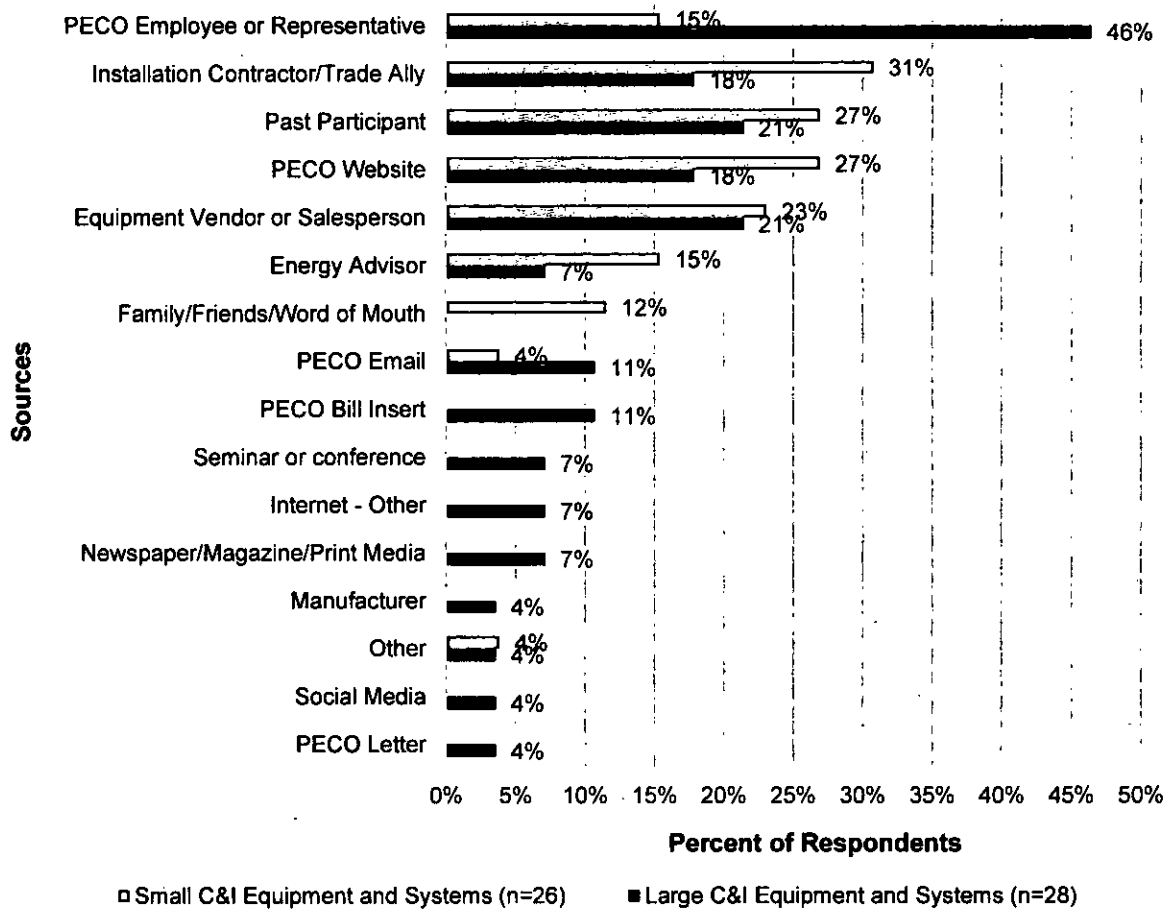
The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Small and Large C&I Equipment & Systems Solutions.

- **Finding:** Across both the Equipment and Systems and New Construction Solutions PECO has seen lower than planned participation numbers to date in both the Large and Small C&I programs. Results obtained from a C&I customer experience survey indicate that incentives are generally perceived as too low, although this is a common sentiment among utility customers in general. For Equipment and Systems, 17% of respondents, including 24% of Large Equipment and Systems respondents said that they were actively dissatisfied with the amount of the rebate received. An additional 19% of all respondents reported neutral satisfaction. When asked about specific factors limiting potential participation, several respondents explicitly mentioned the rebate amounts as related to the cost of their project and the amount of work required to complete program materials.
    - **Recommendation:** Navigant is in the process of monitoring the effects that the PY9 incentive adjustment is having on participation rates. It is still early in the process to be able to provide definitive analysis about the adjustment strategy, but Navigant and PECO should continue to monitor progress through PY10. In addition, Navigant recommends that PECO and the CSP revisit and potentially create additional tracking metrics to

document the lead generation and conversion cycle. This may help to pinpoint areas for improvement when targeting customers for program participation.

- **Finding:** Sometimes the reported HOU was based on deemed hours rather than the more accurate HOU estimates are easily obtained by interviewing the customer. This may lead to inaccurate ex ante calculations and a risk of low RRs upon verification. In addition, when such discrepancies arise during peak summer hours, the demand savings estimates are also at risk of low RRs.
    - **Recommendation:** Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.
- **Finding:** For Large C&I participants, PECO employees (46%) contributed most heavily to participants' program awareness, with Equipment Vendors (21%), Past Participants (21%), the PECO website (18%), and Installation Contractors (18%) also raising awareness. For Small C&I participants, Installation Contractors (31%) were the leading source of awareness, followed by the PECO website (27%), Past Participation (27%), Equipment Vendors (23%), Energy Advisors (15%), and PECO employees (15%). Other sources, such as social media, the internet, newspapers, and community events did not create as much awareness.

Figure F-1. Sources of Small and Large Equipment & Systems Awareness



Question: How did you learn about the [Solution] program? Multiple responses allowed; sum of percentages will not add up to 100%.

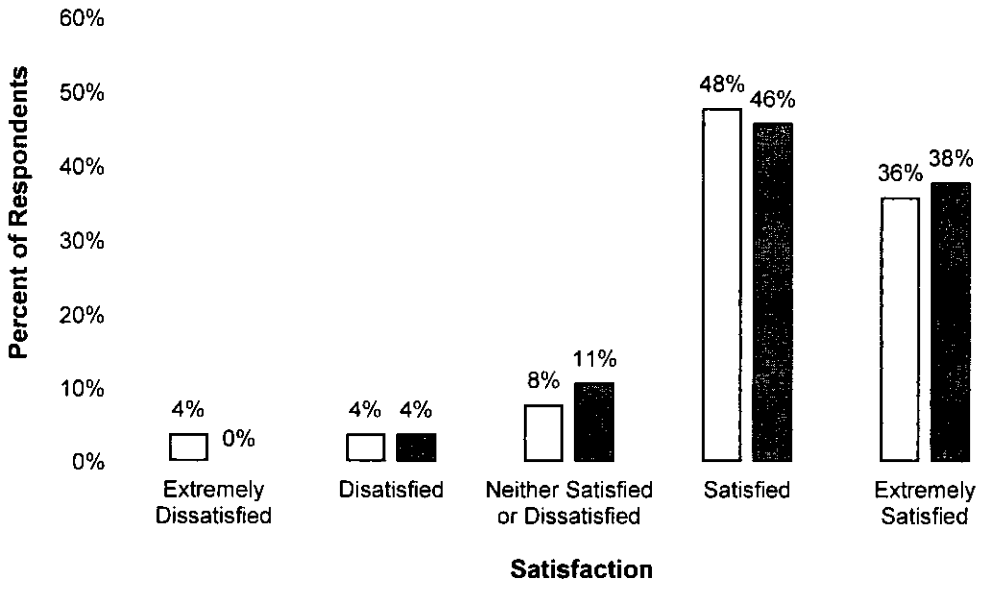
Note: Do Not Know and Refused responses have been excluded.

Source: Navigant analysis

- **Finding:** When asked what the most influential source of awareness was on a customer's decision to participate, about 27% said that outreach by PECO employees was the most influential, followed by equipment vendors and installation contractors. Of small C&I respondents, 27% said their previous participation in the solution was most influential on their decision to participate in PY9, followed by installation contractors and energy equipment vendors. Large majorities of Equipment and Systems participants relayed that they consider PECO a resource for energy efficiency information. This included nearly 70% of large program respondents and over 80% of small program respondents. The results were similar for New Construction respondents, with three out of four indicating that PECO was a resource for energy efficiency information.
- **Finding:** Both Small and Large C&I Equipment and Systems participants are satisfied with the Smart Ideas for Your Business Program, with 84% of both small and large participants reporting

that they were satisfied or extremely satisfied (Figure F-2). Key themes among respondents with lower satisfaction included low incentive values and the amount of effort required to move through the incentive process.

Figure F-2. Overall Satisfaction by Small and Large C&I Equipment and System Solutions



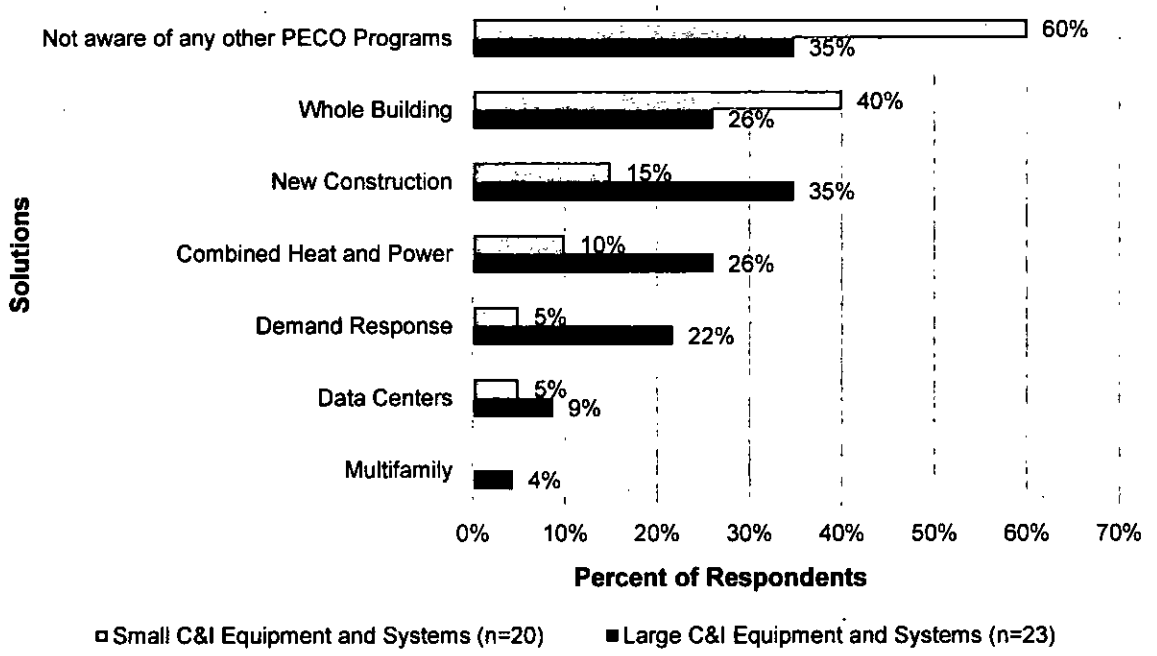
Question: Using a scale of 1 to 5, with 5 meaning extremely satisfied and 1 meaning extremely dissatisfied, how would you rate your OVERALL satisfaction with the [Solution] program?

Note: Refused and Do Not Know responses have been excluded.

Source: Navigant analysis

- **Finding:** Among Equipment and Systems participants, almost two-thirds of Small C&I respondents (60%) and over one-third of Large C&I respondents (35%) were not aware of any other PECO program. For the participants who had heard of other solutions, Small C&I participants most frequently reported hearing about Whole Building (40%), New Construction (15%), and Combined Heat and Power (10%). Large C&I respondents had most frequently heard of New Construction (35%), Whole Building (26%), and Combined Heat and Power (26%) Solutions. Of the respondents who were aware of other PECO solutions, eight had participated in another solution. Other solutions respondents participated in included:
  - C&I Whole Building (n=3)
  - C&I New Construction (n=2)
  - C&I Demand Response (n=1)
  - Multifamily Program (n=1)
  - Combined Heat and Power (n=1)

Figure F-3. Small and Large C&I Equipment & Systems Participant Awareness of Other Solutions



Question: Have you heard of any of PECO's other programs to help you save energy and money at your business?
Note: Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

F.2 New Construction Solution

The C&I New Construction Solution is designed to instill and accelerate adoption of energy efficient design and construction practices so new C&I facilities in the PECO territory are more energy efficient than the current stock. The program covers both new construction and buildings undergoing major renovation, which is defined as construction projects that involve the complete removal, redesign, and replacement of two or more major building systems. The program provides facility designers and builders with training, design assistance, and financial incentives to incorporate energy efficient systems into their building designs. Many of the projects within the C&I New Construction Solution involve efficient lighting and heating and cooling technologies and controls. The eligible customer population for the program includes all C&I and G/E/NP new construction and major renovation projects in the PECO service territory or accounts provided with electricity by PECO, including the aforementioned G/E/NP facilities. 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, and a single customer is permitted to participate in multiple projects with unique project numbers. ICF is the implementer for the New Construction Solution.

F.2.1 Impact Evaluation

Phone Verification

Navigant conducted desk reviews for all projects in the evaluation sample. Most of the small stratum and approximately half of the medium stratum projects received phone verification via live interviews with knowledgeable site contacts. The desk reviews made use of project applications, project-specific analysis files and associated calculation sheets, measure invoices, measure specification sheets, construction plans, and other construction documents provided by PECO. Documentation included scanned files of hard copy forms, as well as electronic files of CSP inspection reports, photos of installed measures, important emails, and memoranda. In the case of whole building projects and some new construction projects, executable modeling files and related model output files were also provided, as applicable. The team supplemented the desk reviews with phone verifications, consisting of interviews with customers about their projects. Common points of discussion included information about the quantities and type of each measure installed, the operating status of the measures, equipment nameplate data, operating schedules, a careful description of site conditions, and overall verification of the information contained in the project files.

Onsite Verification

Navigant conducted onsite verification for all sampled projects in the large stratum, approximately half of the sampled projects in the medium stratum, and a small number of projects in the small stratum. The team visited medium and small stratum projects with particular complexity or variability in ex ante energy or demand savings documentation. Navigant also applied the desk review process outlined in the Phone Verification section to any projects receiving onsite verification. The primary objective of the site visits was to collect the data identified in the Phase III Evaluation Framework[44], including verification of the quantities and type of each measure, equipment nameplate data, operating schedules, and a careful description of site conditions. Navigant achieved the verification through visual inspection of the measures and by interviewing the customers.

Onsite Verification with Metering

For projects that surpassed the expected kWh savings thresholds set in Table 1-2 of the 2016 PA TRM, the team—in addition to performing all of the tasks outlined in the Onsite M&V section—collected site-specific information for open variables used in the calculation of energy and demand savings. Site-specific information included end-use metered data and trend data from building management systems (BMSs).

Summary of Sampling Methodology

Using tracking data from PY9, Navigant obtained the total number of projects and the total amount of energy savings in the population. With this project data on hand, Navigant created four strata of sampled projects.

All projects above 3 million kWh per year of annual savings make up a census stratum (Stratum 1 – Very Large Projects). In the New Construction solution, there were no projects that fit this description. Navigant then excluded all projects making up the lowest 2% of total solution energy savings, sorted the projects by size, and divided the population into three strata: those projects making up the top third, the middle third, and the lowest third of the total energy savings.

[44] Phase III Evaluation Framework. http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework102616.pdf

- **Stratum 1:** Very high impact and/or very high uncertainty measures. Projects over 3 million kWh/year energy savings.
- **Stratum 2:** High impact and/or high uncertainty measures. Projects between 300,000 kWh/year and 3 million kWh/year energy savings.
- **Stratum 3:** Medium impact and/or medium uncertainty measures. Projects between 200,000 kWh/year and 300,000 kWh/year energy savings.
- **Stratum 4:** Low impact measures. Projects less than 200,000 kWh/year energy savings.
- **Stratum 5:** Very low impact measures. Projects lower than 3,500 kWh/year energy savings.

For Small C&I New Construction, Navigant verified a single HVAC project in PY9, as this sector was well sampled in PY8. The samples for large and small New Construction projects were combined across PY8 and PY9, with seven small New Construction projects were verified in PY8. In total, Navigant sampled 9 out of 64 small New Construction project for the combined two-year period.

For Large C&I New Construction, Navigant verified 11 PY9 projects, bringing to two-year sample to 22 out of 58 total projects. These projects included:

- Seven projects consisted of lighting and/or lighting controls
- Two projects involved whole building energy models
- Two projects involved custom HVAC or refrigeration measures

Details of the New Construction participation numbers and impact sample, by stratum, can be seen in Table 3-23 and Table 3-35. The SWE did not conduct site visit or desk reviews for any of the Small or Large C&I New Construction projects in PY9.

F.2.2 Process Evaluation

Navigant completed a targeted process evaluation for the Small and Large C&I New Construction Solutions in PY9. The evaluation team conducted in-depth interviews with PECO program staff and CSP implementation staff to better understand the relationships among the key program stakeholders, the project flow for participants, and to identify potential areas for improvement. The solution remained relatively unchanged from PY8, with all stakeholders having a little more familiarity with one another, and the staff having more familiarity with new infrastructure such as the data tracking system.

Navigant's Small and Large C&I EE Program process evaluation efforts and findings, detailed in Section 3.3.5 and 3.4.5, targeted the program and cross-solution levels. Findings and insights from that effort are intended to inform PECO about all Small and Large C&I EE Program solutions, including Small and Large C&I New Construction Solutions.

F.2.3 Process Evaluation Methodology

The evaluation team used in-depth interviews with key PECO and CSP staff instrumental to the delivery of the Small and Large C&I New Construction Solutions to collect data regarding program implementation in PY9 and to discuss research areas of interest to program staff. The interviews focused on implementation strategies, data tracking, program management, and areas for program improvement.

The team also conducted surveys with a sample of participants to better understand their perceptions of the program and to measure free ridership and spillover. Table F-2 provides a summary of the PY8-PY9 sampling strategy for each process evaluation activity. Navigant notes that the overall survey sample size (i.e., unique customer contacts) was somewhat smaller than initially anticipated during sample design efforts. The team tried several different methods of reaching customers for interviews using both phone attempts and an online survey link sent to email addresses, in addition to offering respondents an incentive to participate. While targets were not achieved, the response rates ranged from 6% or better and greater than 20% overall. Further, achieved samples were proportionally representative of the populations.

Table F-2. Small and Large C&I New Construction Customer Survey Sample Design for PY8-PY9

Stratum	Population Size*	Target Sample Size	Achieved Sample Size
Large	2	2	1
Medium	2	2	0
Small	25	12	4
Small New Construction Solution Total	**29**	**16**	**5**
Large	3	3	1
Medium	7	7	3
Small	16	8	1
Large New Construction Solution Total	**26**	**18**	**5**
Total	**55**	**34**	**10**

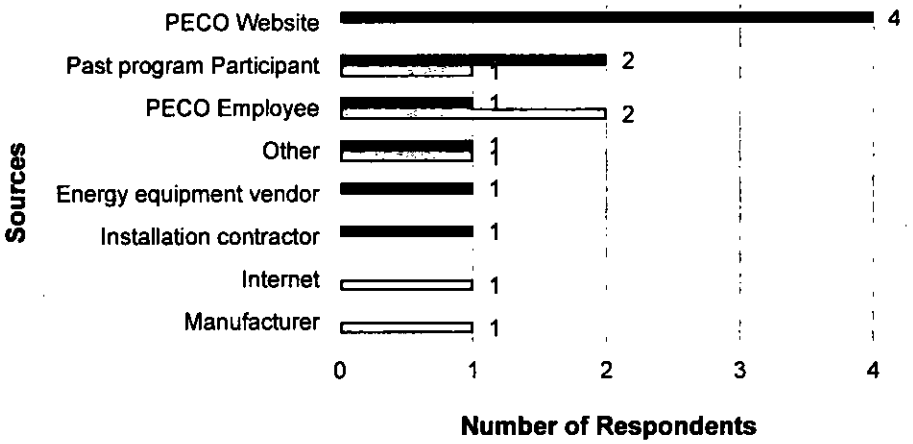
*Populations represent unique decision makers
Source: Navigant analysis

F.2.4 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Small and Large C&I New Construction Solutions.

- **Finding:** As with the Equipment and Systems solution, PECO has seen lower than planned participation numbers to date in the New Construction Solutions. Results obtained from a C&I customer experience survey indicate that incentives are generally perceived as too low, although this is a common sentiment among utility customers in general. For new construction, 25% of respondents, including 50% of Large New Construction respondents, said that they had only neutral satisfaction with the amount of the rebate received. When asked about specific factors limiting potential participation, several respondents mentioned the rebate amounts as related to the cost of their project and the amount of work required to complete program materials.
- **Finding:** The most common source of awareness was the PECO website for Small C&I respondents and a PECO employee for Large C&I respondents. Other sources of awareness for Large C&I respondents included past participation in the program, a PECO employee, energy equipment vendors, and installation contractors. Other source of awareness for Large C&I respondents included past participation in the program, internet searches and manufacturers. For Small C&I awareness, sources of awareness included past participation in the program, and manufacturers.

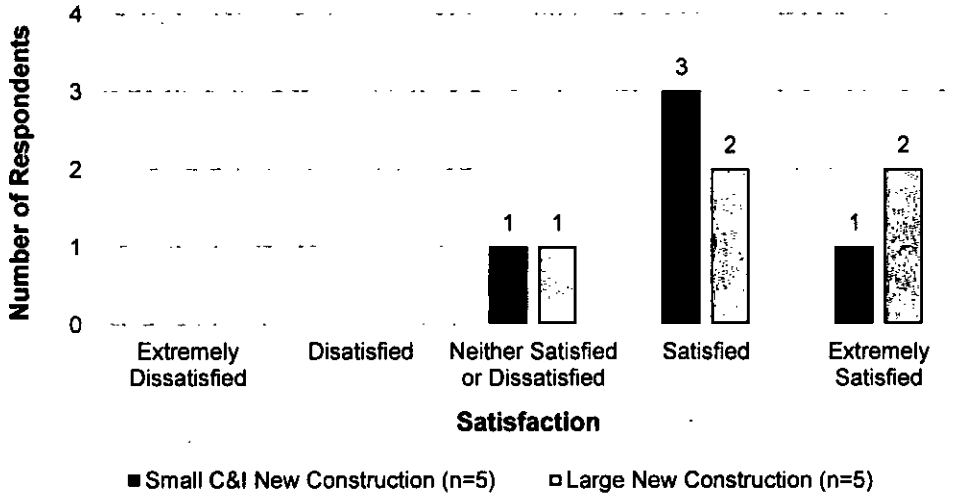
Figure F-4. Sources of Small and Large New Construction Awareness



Question: How did you learn about the [Solution] program? Multiple responses allowed
Note: Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

- **Finding:** Most of both Small and Large New Construction Solution participants were satisfied with the program. On a rating scale of 1-5, four out of five participants stated they were either satisfied or extremely satisfied with their participation in the New Construction Solution.

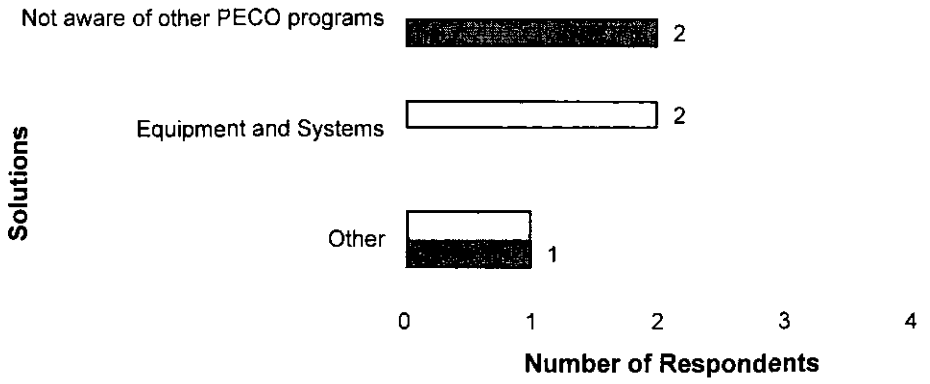
Figure F-5. Overall Satisfaction by Small and Large New Construction Solutions



Question: Using a scale of 1 to 5, with 5 meaning extremely satisfied and 1 meaning extremely dissatisfied, how would you rate your OVERALL satisfaction with the [Solution] program?
Note: Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

- **Finding:** When asked about other PECO program offerings, two Small C&I New Construction respondents had heard and participated in the Equipment and Systems program. Two Large C&I New Construction respondents were not aware of any other PECO programs (Figure F-6).

Figure F-6. Small and Large C&I New Construction Participant Awareness of Other Solutions



Question: Have you heard of any of PECO's other programs to help you save energy and money at your business?

Note: Refused and Do Not Know responses have been excluded.

Other responses included HVAC and refrigeration measures and solar panels.

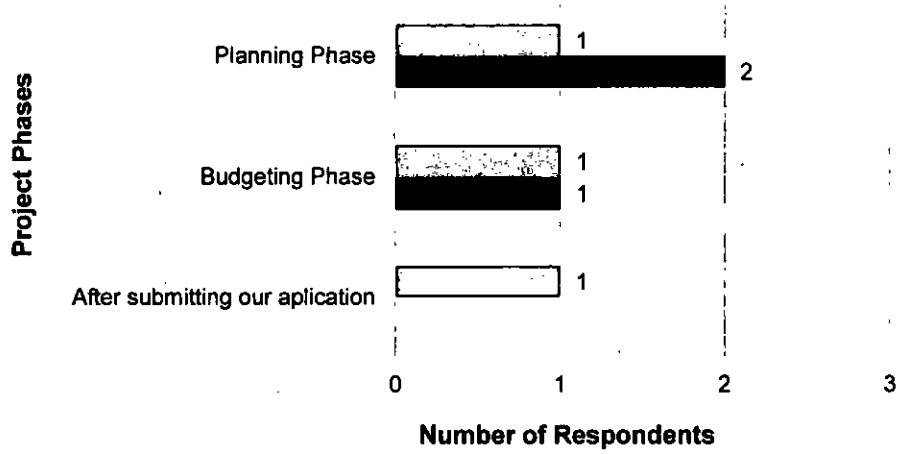
Source: Navigant analysis

- **Finding:** New Construction customers mentioned challenges in project development. New Construction projects often involve significant planning and lead time, often resulting in longer-term commitments than retrofit projects. Most of New Construction survey respondents—four out of seven—responded that their projects took more than 2 years from planning to completion.

  When listing the challenges associated with developing energy efficiency projects, four out of eight New Construction respondents mentioned lack of project funding as a key factor, while three mentioned difficulty to measure energy savings and two mentioned lack of knowledge of energy saving opportunities.

  Large majorities of New Construction respondents replied as likely or extremely likely to install bundles of energy efficiency technologies as opposed to a single technology; nearly all of those—seven out of eight respondents—indicated that they would be even more likely to do so if PECO offered higher incentives for bundling. Unsurprisingly, these customers also indicated positive preferences toward project lengths when bundling measures kept the same length or a shorter one than single measure projects, minimal business operations disruptions during installation, similar or lower operational and maintenance costs with bundled measures, and compatibility with existing equipment. PECO and Navigant will use this insight to further explore and recommend updates to solution implementation approaches in PY10. These conversations are ongoing.

Figure F-7. Most Influential Project Phase



Question: When could PECO have been most influential in your organization's design decisions (i.e. which equipment to install, timing payback) for this project?

Source: Navigant analysis

- **Finding:** Several of the larger stratum projects experienced discrepancies between reported and verified savings due to the methodology used to calculate the reported savings. In multiple instances, a regression methodology was used to extrapolate energy consumption. In another case, the reported savings were calculated by the CSP based on theoretical data rather than actual measured data gathered by the implementer. While there were discrepancies both on the high and the low ends, the net effect of these discrepancies was to lower the overall RRs.
    - **Recommendation:** Navigant is working with PECO and the implementer to identify more reliable methodologies to characterize these types of projects. The evaluation team will remain in contact with the implementer to sort out any future methodological discrepancies.
- **Finding:** Sometimes the reported HOU based on deemed hours rather than the more accurate HOU estimates are easily obtained by interviewing the customer. This may lead to inaccurate ex ante calculations and a risk of low RRs upon verification. In addition, when such discrepancies arise during peak summer hours, the demand savings estimates are also at risk of low RRs.
    - **Recommendation:** Navigant is working with PECO to identify the root cause of this issue and to confirm issue has been addressed for PY10.

F.3 Whole Building Solution

The Whole Building Solution offers the direct installation of comprehensive EE measures to customers who want to understand how to improve the overall energy performance of their small businesses. PECO and the CSP—SmartWatt—identify eligible small C&I customers using rate class descriptions and those with a demand load of less than 100 kW. The CSP conducts a comprehensive audit of the eligible customer's site and creates a proposal detailing the potential project upgrades, costs, and simple

payback estimates. On average, PECO covers between 30% and 40% of the cost of the upgrades, up to a minimum of a 1-year simple payback to the customer. PECO funds a portion of the project cost, as long as that funding does not reduce the payback to less than 1 year, as established in the rules for PY9. The CSP then works with the customer to finalize a contract and implement the agreed-upon EE upgrades. The Whole Building Solution defines participation as an activity at a customer premise with a unique project number. A project can include more than one measure, with the impact evaluation sample defined at the project level.

F.3.1 Impact Evaluation

Navigant conducted the following activities to verify the gross impacts and to review the CSP database for reporting accuracy:

- Desk reviews for all strata
  - Record-level TRM review
  - Administrative cost analysis
- Engineering file reviews with onsite and phone verification
  - Project file review of a sample of representative projects, stratified by project size[45]
  - Onsite verification of medium impact projects (≥ 30 MWh)
  - Phone verification of small impact projects (<30 MWh)

Desk Reviews

Navigant's reviews included quarterly verification of program-reported savings in the program tracking database. The evaluation team applied energy and demand savings algorithms to verify that the input parameters, as laid out in the PA TRM, used to calculate impacts were accurately reported within the program tracking data. The team completed these desk reviews for a census of projects completed by Whole Building participants. Table F-3 summarizes the results of these desk review activities.

[45] Strata designed to represent the Whole Building population with 85/15 confidence and precision using medium impact projects (≥30k kWh) and small impact projects (<30k kWh).

Table F-3. Small C&I Whole Building Summary of Desk Review Activities

Impact Activity	Finding	Description
Record-Level Savings Review	Coincident factors on demand savings (kW) estimates are not aligned with the building types defined in the TRM.	The CSP SmartWatt is applying a default coincident factor (CF) for demand (kW) savings estimates without using the building type CFs as defined in the TRM. Navigant is working with SmartWatt to approximate the level of effort required to change the process of choosing the CF in Whole Building contracts. PECO does not track to specific demand savings targets, but the demand savings estimates are used in TRC calculations and should be as accurate as possible.
Administrative Cost Review	No issues.	Navigant reviewed the administrative (direct install) costs to confirm that the amounts in the PECO tracking database match those from the CSP data. Navigant found no discrepancies.

Source: Navigant analysis

Engineering File Reviews with Onsite and Phone Verification

The Whole Building Solution conducted ex post verification activities including the creation and use of a Fulcrum app for onsite visits to organize all ex ante project documentation, site and contact information, documentation of all attempts to contact and visit customers, ex ante calculation details, and verified inputs, ex post calculations, results, and explanations. Navigant used a standardized format to enable more rigorous project QC and to minimize the errors when transferring data from the source to the point of its end use.

Navigant also conducted reviews of projects files and called customers to verify installation of the projects identified in the eTrack database. The team evaluated a sample of 34 projects, all of which involved the retrofit of lighting equipment, but also included the installation of lighting controls (six projects), electrically commutated motor (ECM) upgrades to walk-in freezers and refrigerators (nine projects), LED lighting on refrigeration case doors (three projects), and LED exit signs (one project). Details of the impact sample, by stratum, can be seen in Table 3-3 in Section 3.3.2.

The only issue Navigant found via the onsite and phone verification activity was the use of default CFs for demand savings estimates instead of using the CFs by building type as defined in the current PA TRM.

F.3.2 Process Evaluation

Navigant performed process evaluation for the Small C&I EE Program and its solutions during PY9. For the Whole Building Solution, this work included the following:

- PECO and CSP staff interviews
- Phone surveys of participants to assess how customers heard about the solution; their satisfaction with the program, solution, and PECO overall; and awareness of other PECO solutions. Navigant segmented the survey sample according to participation type

F.3.3 Process Evaluation Methodology

Interviews with PECO and CSP staff covered topics such as changes to the program design, market segments targeted by the program, and additions to the list of technologies offered by the program. The following insights were revealed via the staff and CSP interviews:

- **PECO adjusted the design of the Whole Building Solution** in PY9 to attempt to increase participation and improve customer satisfaction with the program. These adjustments included the following:
    - Increasing the maximum threshold definition of Small C&I from 100 MW to 200 MW for religious institutions and non-profits
    - Allowing certain franchise owners to participate in the program for multiple locations, provided they meet other program requirements and restrictions[46]
    - Allowing larger customers (up to 200 MW) to participate if they are installing a bundle of various technologies through the Whole Building Solution, and the percentage of savings from lighting is less than 10% of the overall project savings estimates
- **The solution is targeting new market segments** including laundromats with lighting and water heating opportunities and convenience stores with lighting and refrigeration opportunities.
- **The solution is increasing the list of technologies offered** through the solution for PY9 to include the following:
    - Automatic door closers (auto-closers)
    - Door gaskets
    - Walk-in coolers and freezers
    - Suction pipe insulation for walk-in coolers and freezers
    - Control evaporator controls
    - Evaporators or fan controls
    - Guest room occupancy sensors (small independent hotel/motels)
    - Low flow faucet and showerheads (fitness centers)
    - Variable frequency drive improvements
    - Thermostatic shower restriction valves

Navigant will continue to track these changes to the program throughout PY10.

To better understand how PECO customers feel about their experience with the Whole Building Solution, Navigant conducted a customer experience survey of 42 participants. Table F-4 shows the breakdown of surveys by stratum.

[46] Owner must meet all other program requirements other than the 100 MW threshold due to the multiple business locations; owner must also not own more than 10 franchise locations within the PECO service territory.

Table F-4. Whole Building Customer Experience Survey Sample

Solution	Stratum	Population Size	Target Sample Size	Achieved Sample Size
Whole Building	Medium Impact (≥30k kWh)	70	35	10
	Small Impact (<30k kWh)	213	40	32
	Solution Total	**283**	**75**	**42**

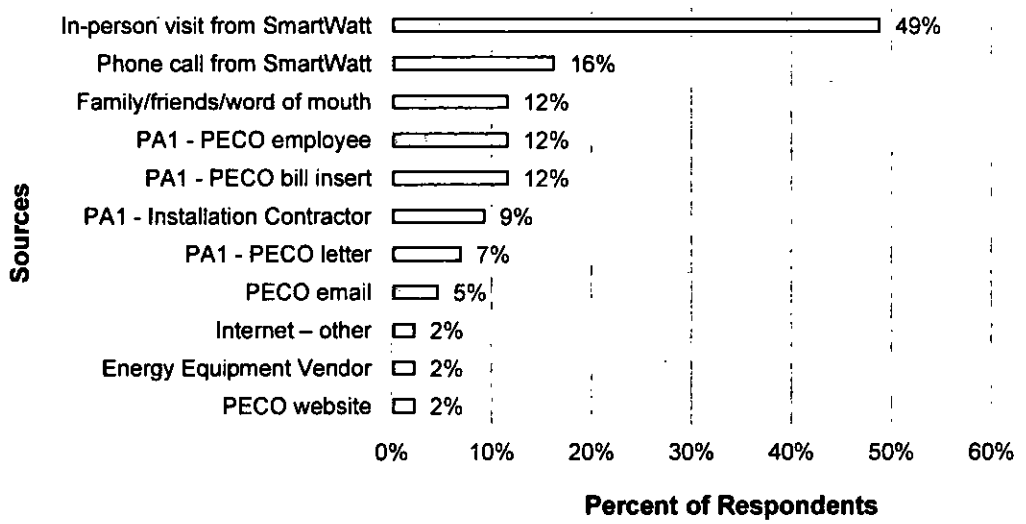
Source: Navigant analysis

F.3.4 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Small C&I Whole Building Solution.

- **Finding**: For the Small C&I Whole Building Solution, the majority (77%) of surveyed customers reported that they heard about the program directly from a program representative. This outreach came in the form of cold calls to the customer from PECO and CSP staff (16%), a visit to the customer facility by PECO and CSP staff (49%), or some other word of mouth interaction from a PECO account representative or CSP employee (12%). Another 12% of surveyed respondents said they heard of the program through word of mouth from friends, family, or other peers. These results show that direct marketing to small business customers is the most effective way to introduce them to the Whole Building Solution.

Figure F-8. Sources of Whole Building Awareness, n=56

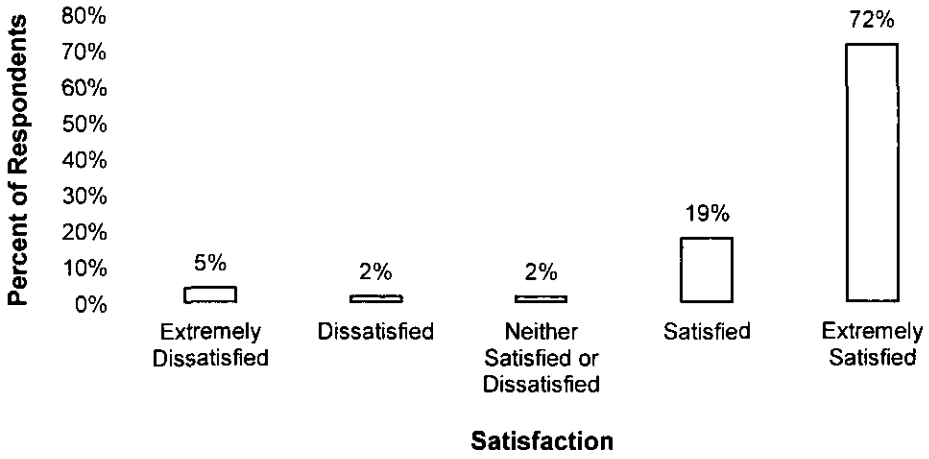


Question: How did you learn about the [Solution] program? Multiple responses allowed.
Note: Refused and Do Not Know responses have been excluded.
Source: Navigant analysis

- **Finding**: Satisfaction with the Whole Building Solution is high, with 72% of respondents rating it a 5 on a scale of 1-5, and another 19% rating it a 4. Seven percent were unhappy with the solution overall and gave it a 1 or a 2 rating. When probed further, these dissatisfied respondents cited

misinformation about the amount of savings they would achieve or with the cost they would have to cover for the project.

Figure F-9. Overall Satisfaction for the Whole Building Solution, n=45



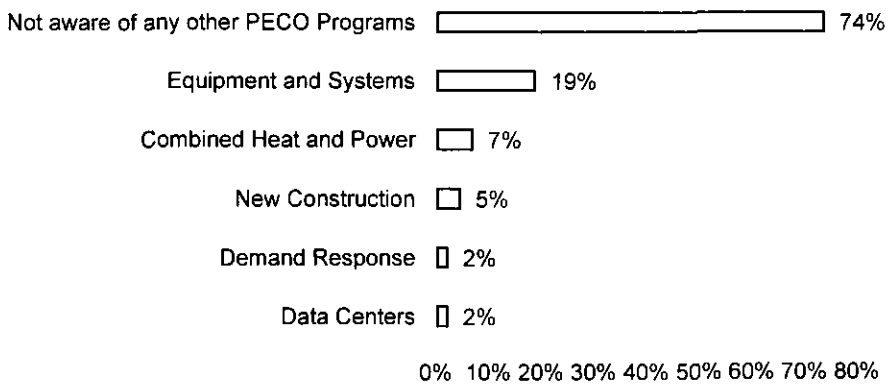
Question: Using a scale of 1 to 5, with 5 meaning extremely satisfied and 1 meaning extremely dissatisfied, how would you rate your OVERALL satisfaction with the [Solution] program?

Note: Refused and Do Not Know responses have been excluded.

Source: Navigant analysis

- **Finding**: Whole Building respondents were largely unaware of other PECO programs (74% unaware). For those who were aware, 8 respondents (19%) said they had heard of the Equipment and Systems Solution, three (6%) the CHP program, two the New Construction, and one response each for Demand Response and Data Centers. Only three of the eight respondents who had heard of the Equipment & Systems program had previously participated in it, and none of the respondents had participated in any of the other PECO programs.

Figure F-10. Whole Building Participant Awareness of Other Solutions, n=49



Question: Have you heard of any of PECO's other programs to help you save energy and money at your business?

Note: Refused and Do Not Know responses have been excluded.

- **Finding**: The Whole Building solution survey targets sectors and business types that offer the most savings for the list of energy efficient technologies offered through the program. Findings indicate business types surveyed in PY9 align closely with the segments targeted through the program outreach. For example, the retail trade sector offers lighting upgrade opportunities, small manufacturing offers motor upgrade opportunities, and the food service sector offers lighting and refrigeration upgrade opportunities. Navigant's customer survey sample represents these higher impact projects and sectors.
- **Finding:** Currently, the demand estimates use a default CF instead of the CF by building type as defined in the TRM. Navigant is currently reviewing this issue with SmartWatt to understand the implications of choosing the proper CFs by building type and the cost to train CSP staff to more accurately estimate demand savings.
- **Finding:** Discussions with PECO staff revealed changes to the program, including increasing the demand threshold for participation from 100 MW to 200 MW for religious and non-profit institutions, as well as for businesses who install a bundle of technologies where 90% of total project savings comes from technologies other than lighting. The solution will also allow franchise owners to participate with multiple locations if they meet all other program requirements other than the 100 MW threshold (due to owning multiple locations) and do not own more than 10 locations across PECO's service territory. Navigant will track the progress of these program changes in PY10 to understand how they impact participation.

F.4 Data Centers Targeted Market Segment

Projects in the Data Centers Targeted Market Segment are eligible to participate in the Equipment and Systems or C&I New Construction Solutions, depending upon the details of the project. Data centers—on account of their high energy usage profiles and specialized technologies—are given special attention from the Small and Large C&I EE programs, allowing for tailored recruitment and implementation of such projects. Much of the energy savings in this segment come from cooling technologies, although the implementation of control systems and lighting are also possible. 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. ICF is the implementer for data center projects, given their entry into either the Equipment and Systems or New Construction Solutions.

F.4.1 Impact Evaluation

Navigant evaluated all three data center projects that participated in the program in PY9. All three projects fell under the Large C&I Program. All were custom and typically involved HVAC measures. The largest data center project received a site visit with metering, as defined in the Equipment and Systems appendix. The middle data center site received a site visit with verification only, while the smallest site received a phone verification. The SWE did not conduct any site visits or desk reviews for these projects.

F.4.2 Process Evaluation

As there was no Small C&I data center participation in PY9, Navigant did not conduct in-depth process evaluation of this solution. The evaluation team is currently working with PECO to further explore the reasons behind the lack of participation.

F.4.3 Findings and Recommendations

The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Data Centers Targeted Market Segment.

- **Finding:** Most data center energy savings are derived from the load on the equipment—i.e., the greater the load, the larger the savings. This is potentially causing customers to delay program engagement until load is realized. In the Large C&I Program, there were no data center projects in PY8 and only three in PY9.
    - **Recommendation:** PECO should explore the customer decision-making process as related to data center projects to identify barriers to participation and to develop solutions to increase savings from this solution.

APPENDIX G. MULTIFAMILY TARGETED MARKET SEGMENT

The following appendix subsections provide additional detail on the evaluation sample design, methods, and activities deployed in PY9 for the Multifamily Targeted Market Segment. The reader should refer to the body of the report for evaluation results but can continue to review this appendix for qualitative findings. Additional and select details are provided here to give readers more context and background about the research efforts undertaken for PY9. The Multifamily Targeted Market Segment is unique in that it contributes savings to the Residential EE, Small C&I EE, and Large C&I EE Programs. The decision makers for the projects in this solution consist of condominium owners, small multifamily building owners, property managers of large multifamily complexes, and executives at real estate investment companies who own multiple buildings in the PECO territory.

G.1 Impact Evaluation

The complex blend of market segments and audience types requires a comprehensive sampling methodology for EM&V. Navigant submitted a revised sampling plan[47] for impact evaluation during the beginning of PY9 verification activities that sampled projects from all three programs (Residential EE, Small C&I EE, and Large C&I EE), and buildings of all sizes, and included direct-install as well as prescriptive measures. Navigant's impact evaluation included desk reviews and onsite verification of projects across all strata in PY9.

- 31 buildings making up 195 in-unit and 18 common area and exterior projects.
    - The 195 in-unit projects consisting of 36 projects with water conservation measures, one project with controls and one heat pump project, while the remaining projects had lighting measures.
    - The 18 common area projects included a mix of prescriptive lighting measures (e.g., LED troffers, surface mount fixtures, LED tube replacements, garage lights, pole mounted exterior lights)

The detailed gross impact evaluation sample design is available in Table 3-3, Table 3-23, Table 3-35.

G.1.1 Desk Reviews

Navigant's reviews included quarterly verification of program-reported savings in the program tracking database. The evaluation team applied energy and demand savings algorithms to verify that the input parameters, as laid out in the PA TRM, used to calculate impacts were accurately reported within the program tracking data. The team also compared the sampled project files and program tracking data to identify any discrepancies in measure locations, quantities, and reported savings.

[47] "PECO: PY9 Multifamily Targeted Market Segment Sample Revision" dated 04-24-2018

G.1.2 Engineering File Reviews with Onsite Verification

The Multifamily Targeted Market Segment also conducted ex post verification activities including the creation and use of a Fulcrum app for onsite visits to organize all ex ante project documentation, site and contact information, documentation of all attempts to contact and visit customers, ex ante calculation details, and verified inputs, ex post calculations, results, and explanations. Navigant used a standardized format to enable more rigorous project QC and to minimize the errors when transferring data from the source to the point of its end use.

Navigant conducted onsite verification of the sub-sampled projects at each of the sampled buildings. Over a course of a few weeks, the evaluation team was able to verify all the sampled communities except for one. The biggest factor that influenced the ability of the implementation and verification teams to schedule site visits was availability of their maintenance staff to dedicate time to the teams. The tracking of locations of the installations inside the units and common areas was not always descriptive, resulting in extra time spent in finding and verifying the installations while onsite. The detailed impact evaluation results by program are available in Sections 3.1, 3.3, and 3.4.

G.2 Process Evaluation

Interviews with PECO and CSP staff covered topics such as changes to the program design, market segments targeted by the program, improvements to their measure mix, successes and challenges faced by the CSP staff while conducting outreach, tactics used to close more prescriptive projects, and barriers to participation. Overall, PY9 being the second year of the Phase III, the CSP staff gained more traction with the decision makers as their outreach efforts came to fruition. Many leads that were pursued in PY8 for common area prescriptive projects decided to implement the projects in PY9.

Multifamily Targeted Market Segment staff and CSP interviews revealed that introducing various LEDs in the mix has increased the participation and savings achieved per project achieved per project as a wider variety of LEDs replace most of the existing inefficient bulbs compared to PY8. Staff also feel that the property managers and decision makers have started recognizing the Multifamily Targeted Market Segment as a one stop shop for their energy efficiency projects, and this has resulted in an improved measure mix. Many building owners and property managers fall short of maintenance staff to dedicate to the installation activities causing a delay in scheduling the projects. In some cases, the decision makers decide to not participate in the programs because of this reason.

G.2.1 Findings and Recommendations

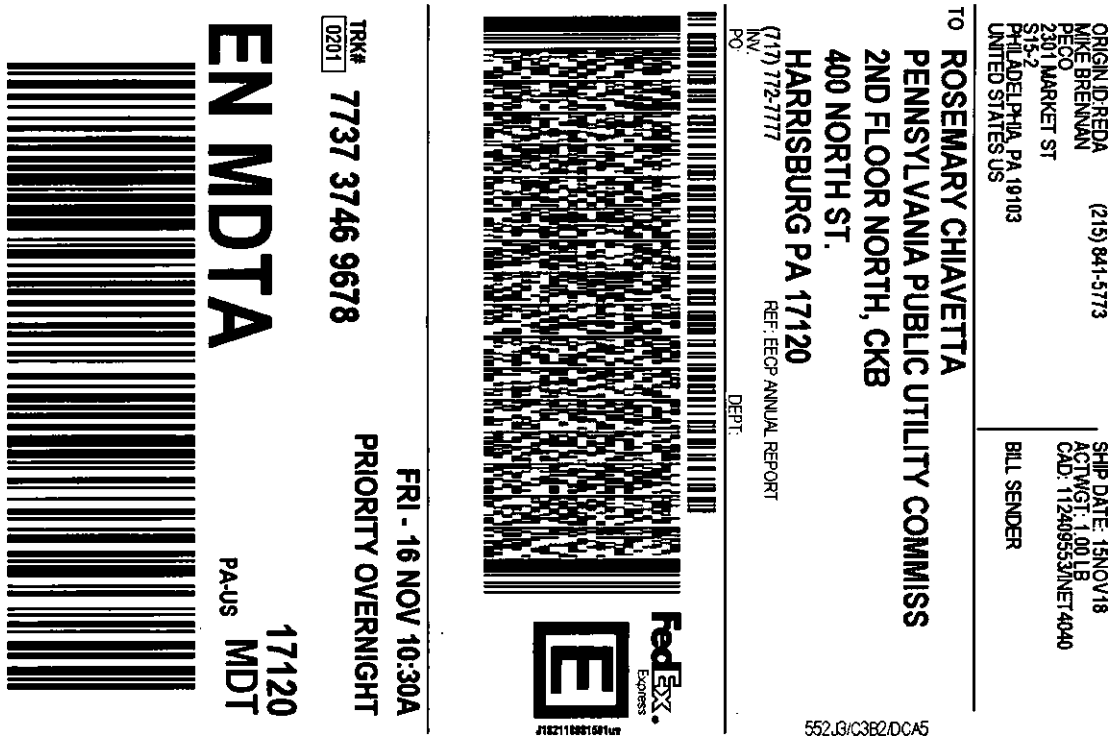
The following provides a summary of Navigant's findings and recommendations resulting from the PY9 evaluation of the Multifamily Targeted Market Segment.

- **Finding:** The CSP staff commented during the interview that introduction of a mix of LEDs such as standard, decorative, and globes made it easier for the decision makers to participate in the programs.
    - **Recommendation:** The CSP staff should keep looking out for measures that multiple property managers are looking for and introduce them in the measure mix.
- **Finding:** Based on the CSP staff interviews, building managers face an issue having adequate personnel, which delays the installation as they do not have site staff to accompany installers.

  - **Recommendation:** PECO and CSP should continue brainstorming and interviewing the property managers for possible solutions such as offering gift cards to the building maintenance staff providing temporary workers.

- **Finding:** Measures are tracked by project, but projects in the same multifamily building complex are not tracked by a unique identifier.
  - **Recommendation:** Create an ID field in eTrack that groups all the projects in a multifamily community under a unique ID.
- **Finding:** There is room for correction in the hours of use (HOU) assumption used by the CSP. In short, the CSP should use space specific deemed HOU from the TRM.
  - **Recommendation:** Navigant will work with PECO and the CSP to explore appropriate approaches for including space specific deemed HOU into the data tracking system.

Indicator	2018 Goal	2018 10+2 YTD	2019 Goal	Justification
Tier 2: Informal Volume	6200	7125	7476	There is a need to relevelize this goal. An aggressive termination strategy to address bad debt negatively impacted informal volume and has not been factored into goal setting previousl. In addition, issues with the Financial Call Center (FCC) vendor also impacted the informal volume and those issues are expected to continue as we transition to new call centers. Informal volume is typically 1-2% of 10 day notices and it is expected that the termination strategy for 2019 will be similar to 2018. Taking a 3 year average of % complaints per 10 day notices, this PI must be set higher to be reasonably achievable. 2018 informal complaints was a record low; however, it is not indicative of typical performance and should not be used to set the standard for future years.
Tier 2: Justified	129	132	145	Issues with the FCC vendor increased the number of justifieds, accounting for 75% of the total. It is expected for this number to continue to be inflated as the issues are addressed over the next year as we transition to new call centers. 2018 justifieds was a record low; however, it is not indicative of typical performance and should not be used to set the standard for future years.
Sustained Violations	48	22	45	The BCS has implemented a new training program and as a result is being much more critical on informal complaints. The number of citings has increased over the last several months, and may impact future violation numbers.
Formals	210	189	210	Formals are typically a factor of informal volume. As informal volume has increased in 2018, so has Formal volume. It is recommended to keep this PI at the same goal as 2018. 2018 formals was a record low; however, it is not indicative of typical performance and should not be used to set the standard for future years.
% of Issues Requiring Corrective Actions	98%	99%	98%	No Change
Response Time (Non-Credit)	12	13	12	No Change
Response Time (Credit)	5	3	5	No Change
Formal Response Time	20	16	20	No Change



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