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Efficiency Long Island and Renewable Energy Portfolios

2015 Annual Evaluation Report
(Volume II – Program Guidance Document)

FINAL

Prepared for:

PSEG LONG ISLAND
We make things work for you.

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With Subcontractors:

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1. Introduction

Volume II of the 2015 Annual Evaluation Report—the Program Guidance Document—provides a program-by-program review of gross and net impacts of the Efficiency Long Island and Renewable Energy portfolios, as well as a description of the methods employed in our analyses to obtain the impacts. Opinion Dynamics created this document for use by PSEG Long Island and Lockheed Martin program staff to provide data-driven planning actions moving forward and full transparency for the methods used to calculate savings. The Efficiency Long Island and Renewable Energy portfolios were administered by the Long Island Power Authority (LIPA) through 2013. Effective January 1, 2014, PSEG Long Island began its 12-year contract, with LIPA assuming day-to-day management and operations of the electric system, including administration, design, budget, and implementation of the Efficiency Long Island Portfolio and Renewable Energy Portfolio. In March of 2015, PSEG Long Island transitioned the implementation of the Efficiency Long Island Portfolio to its subcontractor, Lockheed Martin. PSEG Long Island continues to implement the Renewable Energy Portfolio. This evaluation covers the period from January 1, 2015 to December 31, 2015.

This section includes a comparison of the estimated demand and energy impacts determined through our evaluation (ex post impacts) to the expected impacts used for program tracking (ex ante impacts). The Evaluation Team used the most detailed measure-level data available from program-tracking systems as the basis for our estimation of ex post impacts and measure-level ex ante estimates. We provide two specific comparisons. The first is between the ex ante net savings and the evaluated net savings calculated by the Evaluation Team using detailed measure-level tracking information; the ratio of these two numbers is defined as the realization rate. (This information matches the data shown in Volume I and is compared for the goal attainment purposes.) The second comparison is between the same ex ante net savings and the ex post net savings; the ratio of these two numbers is defined as the cost-effectiveness realization rate.

The remainder of this document is organized as follows:

- Sections 2 through 8 provide a program-by-program review of energy and demand savings. For each program, there is a calculation of energy and demand savings accrued during the 2015 implementation year. We have also included any measure-specific recommendations for updating the gross energy and demand savings calculations.
- Section 9 provides a summary of the study methodology, including information on the primary and secondary data collection, as well as the analytical methods used to derive savings estimates.
- Appendix A presents the ex ante and ex post net-to-gross values by program and measure.

1.1 Key Definitions

Below we provide definitions for key terms used throughout the document:

- Gross Impacts: The change in energy consumption and/or demand at the generator that results directly from program-related actions taken by participants, regardless of why they participated. These impacts include line losses, coincident factors for demand, and waste-heat factors and installation rate for lighting. Gross impacts are the demand and energy that power plants do not generate due to program-related actions taken by participants.[1]

[1] While this evaluation includes line losses, coincidence factors, and installations rates when estimating gross impacts, PSEG Long Island does not include these in its gross impact estimates.

- **Net Impacts:** The change in energy consumption and/or demand at the generator that results directly from program-related actions taken by customers that would not have occurred absent the program. The only difference between the gross and net impacts is the application of the net-to-gross ratio (NTGR).
- **Net-to-Gross Ratio (Free-Ridership and Spillover):** The factor that, when multiplied by the gross impact, provides the net impacts for a program. The NTGR is defined as the savings that can be attributed to programmatic activity and comprised of free-ridership (FR) and spillover (SO). Free-ridership (FR) reduces the ratio to account for those customers who would have installed an energy-efficient measure without the program. The FR component of the NTGR can be viewed as a measure of naturally occurring energy efficiency, which may include efficiency gains associated with market transformation resulting from ongoing program efforts. Spillover (SO) increases the NTGR to account for those customers who install energy-efficient measures outside of the program (i.e., without an incentive), but due to the actions of the program. The NTGR is generally expressed as a decimal and quantified through the following algorithm:

$$NTGR = 1 - FR + SO$$

- **Ex Ante Net Impacts:** The energy and demand savings expected by the program as found in the program-tracking database. The ex ante net impacts include program-planning NTGR values.
- **Evaluated Net Savings:** The net savings attributed to the program for purposes of comparison to program savings goals. Evaluated net savings are determined by applying program planning assumptions for NTGR to the gross impact estimates determined by the Evaluation Team.
- **Ex Post Net Savings:** The savings realized by the program after independent evaluation determined gross impacts and applied ex post NTGR values. Ex post NTGR values have been determined through primary research by the Evaluation Team. The Evaluation Team uses the ex post net impacts in the cost-effectiveness calculation to reflect the current best industry practices.
- **Line Loss Factors:** Line losses of 6.4% on energy consumption (resulting in a multiple of 1.0684 = (1 ÷ (1 − 0.064)) and of 9.1% on peak demand (resulting in a multiple of 1.1001 = (1 ÷ (1 − 0.091)) have been applied to the reported numbers.

Within the economic analysis, three terms are used:

- **Direct Impacts:** Direct impacts are equal to the localized portion of direct spending of the PSEG Long Island programs. For example, direct impacts include money (and associated increases in employment) supplied to contractors to install energy efficiency measures in homes and businesses, such as weatherization contractors installing insulation in homes for the Home Performance with ENERGY STAR® (HPwES) program.
- **Indirect Impacts:** Indirect impacts are determined by the amount of the direct impacts spent within Long Island on supplies, services, labor, and taxes. For example, indirect impacts include money (and associated employment) transferred to local businesses by contractors for supplies needed to install energy efficiency measures, such as if a local wholesaler of HVAC equipment increases sales and adds additional workers to help meet the growing demand for the company's products.
- **Induced Impacts:** Induced impacts are associated with the effects of the direct and indirect impacts on household and business proprietors' income. For example, money expended on Long Island by households or business proprietors benefiting from energy efficiency savings and direct and indirect program spending, such as if an employee of a weatherization contractor uses his or her income (increased by work through the HPwES program) to purchase a car, which stimulates business at the local car dealership.

1.2 Summary of Gross and Net Impact Methods

Below we provide a summary of the methods used to determine evaluated and ex post net savings. Section 1 contains a more detailed discussion of methods.

Gross Impact Methods

We conducted multiple analyses to assess the evaluated gross energy and demand savings associated with PSEG Long Island's programs. The majority of our evaluated gross impacts come from engineering analysis using algorithms and inputs derived from the program-tracking databases. We also performed billing analyses for the HPwES program, the Home Performance Direct (HPD) program, and the Residential Energy Affordability Partnership (REAP) program. For the Commercial Efficiency Programs (CEP), in the summer of 2012, the Evaluation Team performed onsite measurement and verification (M&V) on custom projects, which resulted in a gross realization rate, which we applied to the 2015 custom projects.

Net Impact Methods

The Evaluation Team used net impact estimates as inputs to three separate analyses required by PSEG Long Island: the determination of annual demand and energy savings toward goal attainment, the benefit/cost assessment, and the economic impact assessment. Based on the specific requirements of each assessment, we developed the two separate net savings estimates described below.

Evaluated Net Savings

An important catalyst in LIPA's decision to invest in the Efficiency Long Island and Renewable Energy portfolios was the desire to offset the need to develop approximately 520 MW of generating capacity on Long Island required to satisfy forecasted energy demand. As such, performance relative to the annual capacity savings goals is a critically important performance metric for PSEG Long Island's programs. PSEG Long Island derived its annual savings goals from planning assumptions regarding key inputs to the estimation of expected gross and net savings. To allow for consistency and direct comparison between evaluated program performance and established savings goals, the Evaluation Team developed "evaluated net savings" estimates for each Efficiency Long Island and Renewable Energy program for the purposes of assessing goal attainment. This approach is consistent with the approach applied by utilities in nearly half of all states with energy efficiency program offerings. We calculated evaluated net savings by applying PSEG Long Island's planning assumptions for NTGR to the gross demand and energy savings estimates determined through our evaluation.

Ex Post Net Savings

Among other inputs, the benefit/cost and economic impact assessments require an estimate of net program savings. The best practice approach for both assessments dictates that the net savings used to develop the benefit/cost ratio, or to quantify economic benefits, reflect current levels of FR and SO to provide an accurate estimate of the benefits associated with the current year's investment in the programs. As such, the Evaluation Team used ex post net savings in both assessments. We calculated ex post net savings by applying ex post NTGRs to evaluated gross impact estimates. For 2015, we had no new primary data collection or activities to update previous NTGR values. As such, all ex post NTGRs are identical to 2014 values. Both the planning NTGR values (applied within the evaluated savings) and ex post NTGR values (applied within the cost-effectiveness savings) are in Appendix A.

1.3 Summary of Evaluated Demand and Energy Net Impacts

Overall, our evaluation found that evaluated net savings were closely aligned with program-tracking estimates. The realization rates in Table 1-1 provide a comparison of evaluated net savings to ex ante savings. We discuss reasons why the evaluated values differ from the ex ante values in Sections 2 through 8.

Table 1-1. Portfolio Evaluated Impacts (Used for Comparison to Goals)

Program	Ex Ante Net Savings		Evaluated Net Savings		Realization Rate	
	MW	MWh	MW	MWh	MW	MWh
Efficiency Long Island Portfolio						
Commercial Efficiency Programs	24.1	112,443	23.0	107,654	96%	96%
Residential Programs						
Energy Efficient Products (EEP)	23.3	184,741	24.4	177,356	105%	96%
Cool Homes	4.3	3,564	4.6	4,084	106%	115%
REAP	0.6	2,093	0.4	1,052	69%	50%
HPD	1.9	4,090	1.0	2,086	53%	51%
HPwES	0.9	668	0.4	340	50%	51%
Subtotal Residential	30.9	195,156	30.8	184,918	100%	95%
Total Efficiency Long Island Portfolio (Commercial Efficiency and Residential)	55.0	307,599	53.8	292,572	98%	95%
Renewable Energy Portfolio	30.3	72,362	29.0	69,530	96%	96%
Total Efficiency Long Island and Renewable Energy Portfolios	85.3	379,960	82.9	362,102	97%	95%

1.4 Summary of Cost-Effectiveness Results

Based on an analysis of program- and portfolio-level impacts and costs, the savings generated by the Efficiency Long Island Portfolio are cost-effective. The Evaluation Team used two separate tests to establish a benefit/cost ratio for each program: the Program Administrator Cost (PAC) test and the Total Resource Cost (TRC) test. The tests are similar in most respects, but consider slightly different benefits and costs in determining a benefit/cost ratio. The PAC test measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the program administrator (PA), including all program costs and any rebate and incentive costs, but excludes costs incurred by the participant. The TRC test considers costs to the participant, but excludes rebate and incentive costs, as these are viewed as transfers at the societal level. The TRC test also includes the benefits of non-electric (i.e., gas and fuel oil) energy savings where applicable, resulting in different benefit totals than the PAC test. To allow for direct comparison with all supply-side options, we applied the PAC test as the primary method of determining cost-effectiveness and used assumptions similar to those used by PSEG Long Island's resource planning team.

Table 1-2 presents the benefit/cost ratios for both PAC and TRC tests for each program and for each portfolio separately. The PAC test benefit/cost ratio is 3.3 for the Efficiency Long Island Portfolio and 9.0 for the Renewable Energy Portfolio, indicating that portfolio benefits exceed PA costs in both cases (a benefit/cost ratio greater than 1 indicates that portfolio benefits outweigh costs). The portfolio-level TRC values are 2.2 and 0.7 for the Efficiency Long Island and Renewable Energy portfolios, respectively.

The PAC test was less than 1 for three programs in 2015: REAP, HPwES, and HPD. The cost-effectiveness of the HPwES and HPD programs decreased from 1.3 and 1.1 in 2014 to 0.9 and 0.6 in 2015, respectively. This change resulted from increased program costs coupled with lower program savings. While the REAP program PAC test of 0.5 is below the cost-effectiveness threshold of 1, this ratio is similar to recent years. Cost ineffectiveness is not unusual for low-income programs, which typically are not required to be cost-effective.

Table 1-2. Cost-Effectiveness for the Efficiency Long Island and Renewable Energy Portfolios

	Program Administrator Cost Test			Total Resource Cost Test		
Program	NPV Benefits	Costs	Benefit/ Cost Ratio	Net Present Value (NPV) Benefits	Costs	Benefit/ Cost Ratio
Efficiency Long Island Portfolio						
Commercial Efficiency Programs	$106,743,659	$35,369,001	3.0	$106,743,659	$47,649,791	2.2
Residential Programs						
EEP	$103,935,790	$17,995,475	5.8	$103,935,790	$25,674,033	4.0
Cool Homes	$14,418,224	$7,289,501	2.0	$14,418,224	$21,760,272	0.7
REAP	$1,250,572	$2,653,759	0.5	$1,250,572	$2,699,969	0.5
HPD	$2,830,632	$4,507,609	0.6	$2,865,718	$4,510,563	0.6
HPwES	$1,696,724	$1,965,775	0.9	$2,025,484	$3,950,970	0.5
Subtotal Residential	$124,131,943	$34,412,118	3.6	$124,495,788	$58,595,807	2.1
Total Efficiency Long Island Portfolio	$230,875,602	$69,781,119	3.3	$231,239,448	$106,245,598	2.2
Renewable Energy Portfolio	$197,347,567	$21,917,179	9.0	$197,347,567	$293,678,292	0.7
Total Efficiency Long Island and Renewable Energy Portfolios	$428,223,169	$91,698,298	4.7	$428,587,015	$399,923,890	1.1

A levelized cost analysis is a way to quickly compare the cost of energy efficiency programs with energy or demand savings from other sources. Levelized costs are expressed as $/kW-yr or $/kWh, meaning that the result can readily be compared to the cost of alternative supply additions or the cost of generating electricity. However, this is different from how power is typically purchased, where capacity is purchased first and then the additional cost of energy is added. The levelized costs here are either/or values. That is, the total costs are included in the calculation for levelized costs for kWh, and then the same costs are included in the kW value. Regardless, if the cost of the efficiency investment is less than the cost of capacity additions or generated electricity, efficiency is considered a wise investment.

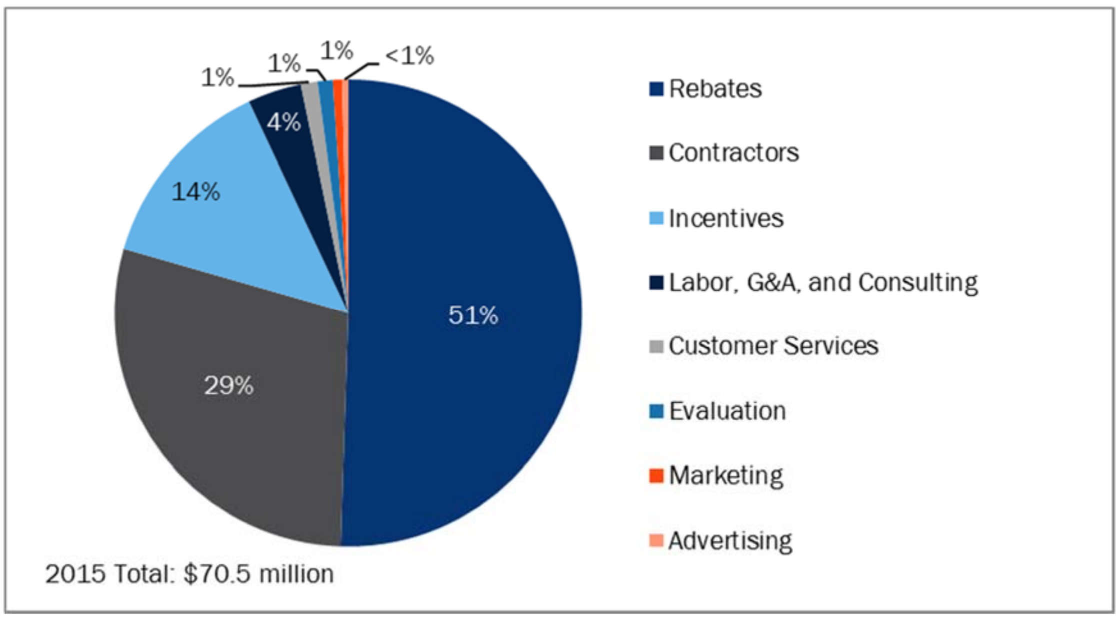
Table 1-3 provides the levelized costs for each program and for each portfolio separately based on the PAC test. The levelized costs of capacity and energy for the Efficiency Long Island Portfolio savings is $182.94/kW-yr and $0.039/kWh—less than the comparable costs of alternative supply-side resources. Likewise, the levelized costs of capacity and energy associated with PSEG Long Island's investment in the Renewable Energy Portfolio is $56.41/kW-yr and $0.024/kWh, which compares favorably to the cost of alternative supply.

Table 1-3. Levelized Costs for the Efficiency Long Island and Renewable Energy Portfolios

Program	Total Program Costs	PAC Levelized Costs	
		$/kWh	$/kW-yr
Efficiency Long Island Portfolio			
Commercial Efficiency Programs	$35,369,001	0.047	200.46
Residential Programs			
EEP	$17,995,475	0.018	114.74
Cool Homes	$7,289,501	0.239	205.64
REAP	$2,653,759	0.405	1,013.36
HPD	$4,507,609	0.341	714.91
HPwES	$1,965,775	0.602	475.58
Subtotal Residential Programs	$34,412,118	0.033	167.87
Subtotal Efficiency Long Island Portfolio	$69,781,119	0.039	182.94
Renewable Energy Portfolio	$21,917,179	0.024	56.41
Total	$91,698,298	0.034	119.36

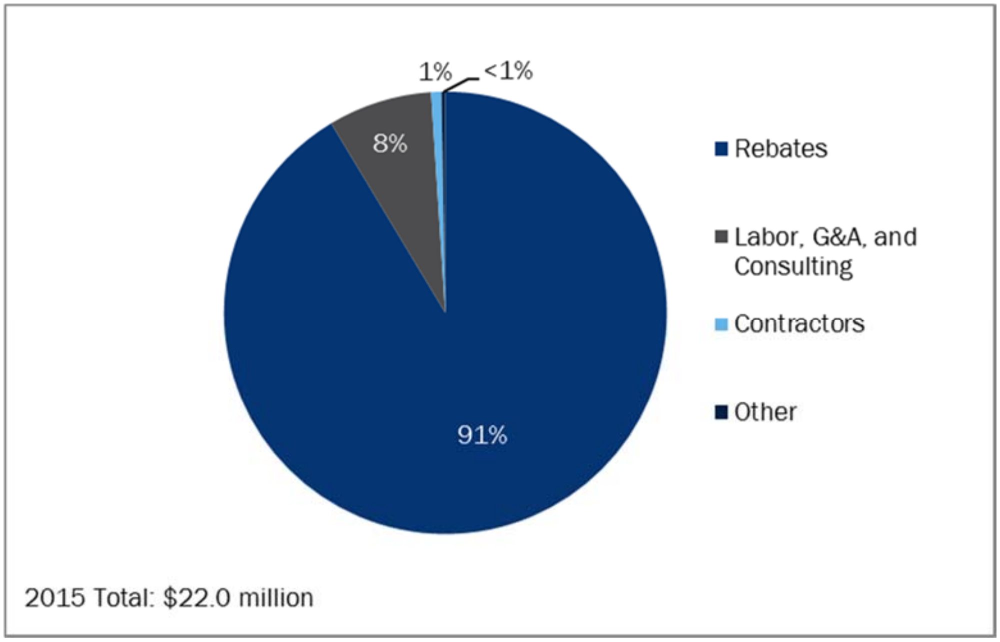
PSEG Long Island's expenditures varied for each program. Figure 1-1 and Figure 1-2 show the respective breakouts of spending related to the Efficiency Long Island and Renewable Energy portfolios by type of expenditure.

Figure 1-1. 2015 PSEG Long Island Expenditures for the Efficiency Long Island Portfolio



"Rebates" consists of payments made to participating customers. "Incentives" consists of payments made to participating contractors (e.g., HVAC installers). "Customer Services" consists of payments made to program implementers for direct installation (e.g., Lime Energy for SBDI).

Figure 1-2. 2015 PSEG Long Island Expenditures for the Renewable Energy Portfolio



Note: Rebate expenditures includes $20.1 million in NYSERDA funding. "Other" expenditures include marketing, advertising, evaluation, and administrative expenses.

1.5 Summary of Economic Benefits Results

The Evaluation Team estimated the expected changes to Long Island's overall economic output and employment resulting from PSEG Long Island's 2015 Efficiency Long Island and Renewable Energy portfolios over the next 10 years. Table 1-4 and Table 1-5 present the direct impacts and the combined indirect and induced impacts for 2015 and for the 10-year period of 2015 to 2024. To account for expected inflation and the assumed increasing cost of electricity, the tables show the results as NPV using the discount rate of 5.50% used in PSEG Long Island's supply-side planning and the cost-effectiveness analysis.

Over 10 years, the 2015 investments in the Efficiency Long Island Portfolio are expected to return $178.1 million in total economic benefits to the regional economy (in 2015 dollars), with an employment benefit of 1,362 new full-time equivalent employees (FTEs)[2] over that time period.

[2] Full-time equivalents represent the number of total hours worked divided by the number of compensable hours in a full-time schedule. This unit allows for comparison of workloads across various contexts. An FTE of 1.0 means that the workload is equivalent to a full-time employee for 1 year, but could be done, for example, by one person working full-time for a year, two people both working half-time for the year, or two people each working full-time for 6 months.

Table 1-4. Economic Impact of 2015 Efficiency Long Island Portfolio Investments

2015 Efficiency Long Island Portfolio Investments	2015 Economic Impact	2015–2024 Economic Impact (NPV[a])
Economic Impact		
Total Economic Output (millions)	$77.5	$178.1
Direct Effect	$70.4	$70.4
Indirect and Induced Effect	$7.1	$107.7
Employment (FTE)	582	1,362
Impact per $1M Investment		
2015 Program Investment (millions)	$70.5	$70.5
Total Economic Output in M per $1M Investment	$1.1	$2.5
Employment (FTE) per $1M Investment	8.3	19.3

[a] Using nominal discount rate of 5.50%, based on PSEG Long Island energy-supply cost assumptions.

The investments in the Efficiency Long Island Portfolio resulted in a slightly larger total economic output in 2015 ($77.5 million) than in 2014 ($73.9 million), despite program expenditures remaining essentially constant as compared to 2014. Several factors contributed to this difference, including:

- Changes to the mix of investments in commercial and residential programs and their related energy and demand savings
- Changes to the implementation of programs in the Efficiency Long Island portfolio, including rebate and incentive levels
- Changes to the Long Island economy and how economic impacts diffuse through different sectors

Over 10 years, the 2015 investments related to the Renewable Energy Portfolio (i.e., program spending plus NY-Sun Initiative funding through the New York State Energy Research and Development Authority [NYSERDA]) are expected to return $159.9 million in total economic benefits to the regional economy (in 2015 dollars), with an employment benefit of 1,083 new FTEs over that time period. Note that the indirect and induced effect of the portfolio was negative for 2015 and for the following 10-year period, but these effects will eventually become positive as the benefits of the installed systems continue through their 20- to 25-year expected life.

Table 1-5. Economic Impact of 2015 Renewable Energy Portfolio Investments

2015 Renewable Energy Portfolio Investments	2015 Economic Impact	2015–2024 Economic Impact (NPV[a])
Economic Impact		
Total Economic Output (millions)	$83.2	$159.9
Direct Effect	$170.0	$170.0
Indirect & Induced Effect	−$86.8	−$10.1
Employment (FTE)	457	1,083
Impact per $1M Investment		
2015 Program Investment (millions)[b]	$1.9	$1.9
Total Economic Output in M per $1M Investment	$43.4	$83.4
Employment (FTE) per $1M Investment	10.5	565.1

[a] Using nominal discount rate of 5.50%, based on PSEG Long Island energy-supply cost assumptions.
[b] Program investment does not include $20,048,651 in solar funding from NYSERDA NY-Sun. Economic impacts, however, do include the benefits of these projects.

Similar to the 2014 results, 2015 spending on PSEG Long Island's Renewable Energy Portfolio resulted in much greater benefits to the Long Island economy than in some previous program years. This difference is driven primarily by two factors: the substantial increase in the number of solar PV systems installed and $20 million in funding through NYSERDA's NY-Sun Initiative. The effect of NYSERDA's funding was especially pronounced because it positively contributed to the direct impact of the program, but did not incur a corresponding renewables charge to PSEG Long Island ratepayers. Additionally, the portfolio continued to benefit from the falling price of PV modules.

2. The Commercial Efficiency Programs

PSEG Long Island's CEP caters to a wide range of business customers in PSEG Long Island's service territory. As part of the programs, PSEG Long Island offers incentives for a variety of energy-efficient equipment options and provides other types of support, such as energy audits and technical assistance studies. In 2015, PSEG Long Island continued delivering the CEP through the following avenues:

- **Prescriptive:** Includes predefined new construction replacement measures. Incentives amounts are fixed for the qualifying measures.
- **Existing Retrofit:** Includes retrofit measures and relies on a predefined menu of measures installed at the existing site to determine savings. Incentives amounts are fixed for the qualifying measures.
- **Custom/Whole Building Design:** Includes incentives for more-complex and less-common energy-efficient equipment and for new construction projects that integrate energy-efficient building shell and operating systems that result in a building that exceeds standard practice. Custom projects offer a certain degree of flexibility in terms of equipment choices and incentive amounts, thus allowing PSEG Long Island to better meet customer needs and engage customers with the program.

In addition to these core components, PSEG Long Island offered a Small Business Direct Install (SBDI) program as part of the CEP in the first quarter of 2015. The program offered energy-efficient lighting solutions to small business customers in constrained circuits. PSEG Long Island discontinued the SBDI program offering in March 2015. There are currently no plans to offer an SBDI program solution moving forward.

PSEG Long Island's 2015 CEP portfolio also included no-cost energy assessments, cost-shared technical assistance studies, building commissioning co-funding, Leadership in Energy and Environmental Design (LEED) certification incentives, and ENERGY STAR Benchmarking certification.

At the beginning in 2015, Lockheed Martin oversaw the design and implementation of all CEP components except SBDI. Lime Energy implemented the SBDI program until the program's termination in early 2015.

PSEG Long Island's CEP portfolio achieved 80% of the peak demand goal and 97% of the energy savings goal in 2015. Table 2-1 provides a summary of the CEP ex ante performance against goals.

Table 2-1. CEP Ex Ante Program Performance against Goals

Metric	MW	MWh
Goal	30.0	116,071
Ex Ante Net Savings	24.1	112,443
% of Goal	80%	97%

Existing Retrofit projects and lighting measures continued to be the primary source of energy and demand savings. As can be seen in Table 2-2, Existing Retrofit projects accounted for 82% of ex ante net demand savings and 72% of ex ante net energy savings. Lighting measure installations across all program components accounted for 85% of the ex ante net demand savings and 78% of ex ante net energy savings.[3]

[3] Note that these measures include lighting controls and refrigerated case lighting products.

Table 2-2. CEP Savings from Lighting and Non-Lighting Measures

Program Component	End-Use	Ex Ante Net Savings	
		% MW	% MWH
Prescriptive	Lighting	4%	4%
	Non-Lighting	4%	6%
Existing Retrofit	Lighting	77%	71%
	Non-Lighting	5%	1%
Custom	Lighting	1%	1%
	Non-Lighting	6%	15%
SBDI	Lighting	3%	2%

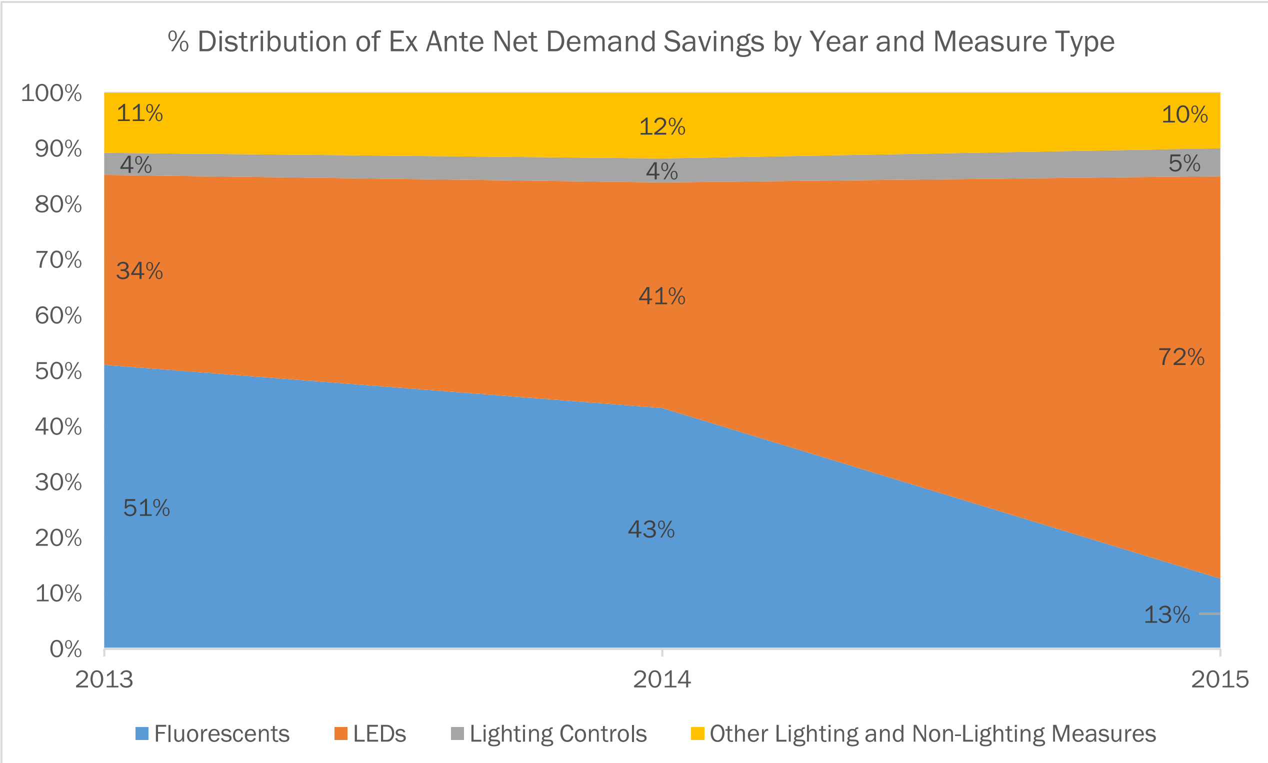
CEP measure offerings and incentive levels remained largely unchanged in 2015 as compared to 2014. Noticeable changes included the following:

- Addition of several linear ambient lighting luminaire offerings
- Rebates per qualified LEED point within the Technical Assistance program reduced from $1,000 to $500, and cap of rebates allowed for energy modeling and electric-related commissioning reduced from 90% to 70%

LED lighting continued to increase in prominence in 2015. LEDs grew to account from 34% of the Prescriptive, Existing Retrofit, and SBDI ex ante net demand savings in 2013 to 72% in 2015.[4]

[4] Due to lack of measure detail for Custom projects, we excluded this program component from the analysis.

Figure 2-1. CEP Savings from Lighting and Non-Lighting Measures



Program marketing efforts in 2015 remained largely consistent with 2014 and relied on a wide range of marketing strategies and tactics to broaden customer and trade ally awareness of the program and its benefits, including continued reliance on trade allies, energy efficiency conferences, testimonials, webinars, web advertising, and electronic newsletters to promote the CEP. There were 475 participating trade allies and 11 energy consultants who supported direct outreach to customers in 2015. Biweekly Open House meetings continued to be another source of customer and trade ally engagement. During those meetings, PSEG Long Island energy consultants were available to answer trade ally questions, review application forms, provide project pre-approval, and address any other issues. Program staff we interviewed expressed satisfaction with the level of marketing and outreach; however, they anticipate an increased marketing effort in 2016 due to a larger marketing budget.

Based on the interviews with the program staff, the CEP generally ran smoothly in 2015 with few bottlenecks or issues. The CEP's performance benefits from: a proven implementation structure; a solid foundation of rigorous data capture, transfer, and tracking; and a procedure-driven delivery process with thorough quality assurance/quality control (QA/QC). The transition of the CEP to Lockheed Martin caused substantial changes in staffing and processes and required intensive training and onboarding efforts. However, according to the program staff, all customer-facing interactions transitioned seamlessly.

Program QA/QC processes remained identical to 2014, with all Prescriptive and Existing Retrofit projects requiring pre-approval and pre-inspection and all Prescriptive New Construction projects and projects over $10,000 in incentives requiring post-inspection. A dedicated team of Senior Territory Managers (STMs) performed pre- and post-inspections during the first part of 2015. Lockheed Martin energy consultants took over that role in the latter part of the program year and also hired inspectors in December 2015.

In 2015, the program continued to rely on Siebel as the core data entry and tracking system, while preparing for transition to Lockheed Martin's LM Capture database. Well-established data entry and tracking processes resulted in few inconsistencies and errors with project classification or savings assignment. We discuss the inconsistencies found during our desk reviews in the gross impact section of this report.

Over the course of 2015, CEP staff implemented several technological improvements and are contemplating more in 2016. To support accurate and efficient data capture, the program developed and deployed a new interactive energy assessment tool. The program is planning to shift all of its application forms into an online format that will allow for seamless, accurate, and efficient data capture and transfer into the LM Capture database. The program is also planning to further relax pre- and post-inspection requirements for Prescriptive and Existing Retrofit lighting projects with hopes of shifting the time savings to more-complex projects, such as thermal storage solutions.

With the SBDI program discontinued, to better cater to the needs of small business customers, PSEG Long Island introduced a Fast Track LED program. The program launched in 2016 and offers rebates on LED lighting products without requiring pre-approval or pre-inspection. Large customers (rate 285) are not eligible to participate in this program. The program sets a limit on the number of products for which customers can receive rebates in order to limit participation by larger customers.

Additional program changes implemented in 2016 include incentives for thermal storage systems capable of shifting the power associated with conventional chilled water systems from the peak period to the off-peak period. This includes chillers, pumps, fans, cooling towers, and other associated equipment typically in use during the peak period for conventional cooling. Program incentives for LED measures and lighting controls in 2016 decreased further due to rapidly dropping market prices for that equipment.

Looking ahead, there are several potential challenges that could hinder the CEP's goal achievement in 2016 and beyond. With the termination of the SBDI program, PSEG Long Island lost not only a considerable source of savings, but also a program design that provided access and helped with engagement of small business customers. While the Fast Track LED program is designed to at least partially fill this gap, it may ultimately lack the appeal and the ease of participation of a turnkey offering. Based on the results of the Small Business Profiling study that Opinion Dynamics recently completed for PSEG Long Island, small business customers represent 82% of accounts, yet their historical participation rate is only a third of the participation rate of non-small business customers (5% vs. 15%). With such a wide gap in participation, and in the absence of a turnkey program, PSEG Long Island may have a difficult time engaging small business customers, who are often constrained by financial barriers and a lack of resources to dedicate to investigating and implementing energy efficiency improvements. Such differences in participation rates between small business customers and non-small business customers have been observed in several other jurisdictions, among them Midwest and California.

As PSEG Long Island moves from the Siebel data-tracking system to Lockheed Martin's LM Capture system[5], challenges with data capture, transfer, and processing may arise, resulting in implementation bottlenecks. Deploying a staggered transition to LM Capture, providing thorough training on the new system, carefully documenting the data entry and processing steps, and developing QA protocols will help eliminate possible issues and make the transition to LM Capture seamless to customers.

[5] Transition to LM Capture began in October 2015.

Overall Impacts for Commercial Efficiency Programs

Table 2-3 provides a comparison of evaluated net savings to ex ante net savings for the CEP by program component and associated realization rates. Evaluated realization rates are calculated by dividing evaluated net savings values by ex ante net savings values. Overall at the program level, the CEP achieved 96% of its ex ante net energy and demand savings. Evaluated realization rates for demand savings ranged from 80% for the Custom program component to 99% for the SBDI program component. Evaluated realization rates for energy savings ranged from 95% for the Prescriptive and Custom program components to 102% for the SBDI program component.

Table 2-3. CEP Net Impacts for Goal Comparison

	Ex Ante Net Savings		Evaluated Net Savings		Evaluated Net Realization Rate	
CEP Component	kW	kWh	kW	kWh	kW	kWh
Prescriptive	1,875	10,913,399	1,742	10,372,101	93%	95%
Custom	1,795	18,141,836	1,436	17,234,744	80%	95%
Existing Retrofit	19,764	81,188,039	19,190	77,809,814	97%	96%
SBDI	659	2,199,454	654	2,237,378	99%	102%
CEP Total	**24,092**	**112,442,728**	**23,022**	**107,654,038**	**96%**	**96%**

Ex post net savings differ from evaluated net savings in that ex post savings are developed using ex post NTGRs, while evaluated net savings are based on program planning NTGR values. Program-planning NTGRs differed from evaluated values by program component. The Evaluation Team did not perform new NTGR research this year and, therefore, used NTGRs established through previous evaluations. The derivation of ex post NTGRs is described in detail below and in Section 1.2 of this report.

Table 2-4 provides a comparison of ex ante and ex post net savings by program component and associated realization rates. The Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments. Ex post net realization rates were calculated by dividing ex post net savings by ex ante net savings. Overall, the CEP achieved an ex post net realization rate of 75% for both energy and demand savings. Ex post realization rates for demand savings ranged from 64% for the Custom program component to 86% for the SBDI component. Ex post realization rates for energy savings ranged from 74% for the Existing Retrofit program component to 89% for the SBDI program component.

Table 2-4. CEP Net Impacts for Cost-Effectiveness

	Ex Ante Net Savings		Ex Post Net Savings		Ex Post Net Realization Rate	
CEP Component	kW	kWh	kW	kWh	kW	kWh
Prescriptive	1,875	10,913,399	1,346	8,378,261	72%	77%
Custom	1,795	18,141,836	1,147	13,701,622	64%	76%
Existing Retrofit	19,764	81,188,039	14,902	60,378,419	75%	74%
SBDI	659	2,199,454	569	1,952,560	86%	89%
CEP Total	**24,092**	**112,442,728**	**17,964**	**84,410,862**	**75%**	**75%**

Estimation of both evaluated and ex post savings relied on a series of engineering analyses. Sections below provide detailed analysis results by program component.

Engineering Analysis Results – Prescriptive Program Component

This section provides the results of the Evaluation Team's analysis of energy and demand savings associated with prescriptive measures installed through the CEP. Different engineering approaches were used for the prescriptive non-lighting measures and prescriptive lighting measures, as described below.

Engineering analysis of the prescriptive non-lighting measures included all 2015 projects and consisted of a review of the Siebel data extract and application of engineering algorithms. For the purposes of the engineering analysis, we grouped prescriptive non-lighting measures into six end-use categories: HVAC, commercial kitchen equipment, compressed air, refrigeration, motors and variable-frequency drives (VFDs), and building envelope (i.e., Cool Roofs). As part of the engineering analysis, the Evaluation Team leveraged measure-level detail provided as part of the program-data tracking extract to tailor the analysis of energy savings to reflect the efficiency standards set by the program over the course of the program year. For example, for HVAC measures, equipment size (in tons) and efficiency (in SEER/EER) were available, and we used these inputs to ensure an "apples to apples" comparison with the ex ante estimates in the program-tracking database. The Evaluation Team used available measure data to estimate evaluated and ex post impacts.

PSEG Long Island did not track lighting measure characteristics in the database at the same level of detail as it did non-lighting measures. As such, the Evaluation Team conducted desk reviews of a sample of projects (n=10) within the lighting and performance lighting measure groups. This approach is consistent with the approaches used in previous evaluations (see Section 9.3 for details on the sampling methodology). The engineering desk review of a sample of projects as opposed to of the entire population was necessitated by our inability to automatically extract project-specific information for the population of prescriptive lighting projects.

Table 2-5 presents evaluated net energy and demand savings associated with the Prescriptive program component by end-use category. As both ex ante and evaluated net savings values are calculated using program-planning NTGRs, the differences expressed through the realization rates represent differences in the ex ante and evaluated gross savings.

Table 2-5. Prescriptive Program Component: Comparison of Ex Ante and Evaluated Net Savings

Category	Number of Units	Ex Ante Net Savings		Evaluated Net Savings		Evaluated Net Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	19,991	883	4,608,882	929	4,023,279	105%	87%
Non-Lighting							
HVAC	364	417	621,284	379	562,409	91%	91%
Commercial Kitchen Equipment	4	2	10,528	2	11,248	100%	107%
Compressed Air	44	203	1,424,803	75	1,034,028	37%	73%
Refrigeration	2,500	178	2,983,689	178	2,983,689	100%	100%
Motors and VFDs	130	84	1,080,298	71	1,573,533	84%	146%
Building Envelope	34	108	183,915	108	183,915	100%	100%
Total	23,067	1,875	10,913,399	1,742	10,372,101	93%	95%

Below we describe analysis specifics and reasons for discrepancies in savings.

Reasons for Differences in Impacts

- For ***Lighting*** measures (both prescriptive and performance lighting), the engineering desk reviews yielded the evaluated net realization rate of 105% for demand savings and 87% for energy savings with the relative precision of 6.8% and 15.2% at 90% confidence, respectively. Desk reviews revealed discrepancies with 1 of the 10 projects in our sample:
  - One project consisted of LED refrigerated case lighting in a supermarket. Ex ante savings assumptions did not include an application of the waste-heat factor to demand savings. The ex ante savings calculation also assumed 24/7 operation (8,760 hours per year). For the ex post savings calculation, we applied a waste-heat factor of 1.4 when calculating demand savings, which is consistent with the New York Technical Manual (NYTM) for LED refrigerated case lighting. We also confirmed lower operating hours and adjusted the hours to be consistent with a grocery/supermarket building type. These changes resulted in higher demand saving but lower energy savings for this project, which in turn affected the overall prescriptive lighting realization rate due to the size of this project.
- For ***HVAC*** measures, the engineering analysis resulted in the evaluated net realization rate of 91% for both energy and demand savings. The discrepancy between the ex ante and evaluated savings is due to the changes in measure mix from the previous years. Ex ante per-ton savings appear to be based on deemed savings calculated for a historical measure mix in terms of efficiency and cooling capacity. The Evaluation Team estimated savings using the 2015 program measure mix, which takes into account 2015 measure-specific characteristics. The database did not contain cooling capacity information for some measures. The Evaluation Team estimated these values using available data for similar measures. For new construction and end-of-useful-life replacement installations, we determined evaluated savings by comparing the installed equipment to a code-standard baseline. For early replacement installations, sufficient pre-existing equipment data were available to characterize the full project savings. Our analysis applied normalized savings (i.e., kW/ton or kWh/ton) values across the different types of HVAC measures and incorporated similar algorithms and assumptions to those used by the CEP. We multiplied these normalized values by the installed cooling capacity in tons for each measure type to arrive at our estimated savings.
- For ***Commercial Kitchen Equipment***, the analysis resulted in the evaluated net realization rate of 100% for the demand savings and 107% for energy savings. This category consists of only four insulated holding cabinets, and we determined evaluated savings using the Hot-Food Holding Cabinet Life-Cycle Cost Calculator developed by the Food Service Technology Center. We do not have exact reasons for the small discrepancy in energy savings.
- For ***Compressed Air*** measures, the resulting evaluated net realization rates are 37% for demand savings and 73% for energy savings. The air receiver measures are the major contributors to the lower evaluated savings for compressed air measures. These measures accounted for a high percentage of demand and energy savings in 2015 and a much higher percentage than in 2014 (73% vs. 58% for demand savings and 44% vs. 28% for energy savings). The Evaluation Team's analysis of the compressed air measures leveraged the savings calculation methods and assumptions similar to what is recommended by programs in the northeast. Those calculations take into account project-specific characteristics. The CEP assumes a savings percentage. We do not know the specifics of how the CEP calculated the assumed savings percentage, therefore we cannot explain the sources of discrepancies. Going forward, we recommend

using savings algorithms for these measures based on the Technical Reference Manual (TRM) provided by the Evaluation Team.

- For ***Refrigeration*** measures, the program-tracking data lacked detail on the installed measure information (such as kW rating) behind kW savings. Given the lack of data, the Evaluation Team assigned a realization rate of 100% for these measures. The Evaluation Team's previous review of program algorithms and assumptions gives us confidence that the program is characterizing this measure category's savings appropriately. The Evaluation Team recommends that the program update its data collection and tracking procedures for this measure to ensure that all data required for evaluation are accurately recorded and available to the Evaluation Team.

- For ***Motors and VFDs*** measures, the engineering analysis resulted in the evaluated net realization rate of 84% for demand savings and 146% for energy savings. Program-tracking data contained extensive per-installation information that enabled the Evaluation Team to conduct engineering analysis by facility and motor type. The analysis used normalized savings values (i.e., kW/hp or kWh/hp) that the NYTM recommends based on different building types and VFD application. We multiplied these values by the installed horsepower for each measure provided by PSEG Long Island to arrive at the evaluated savings. It appears that ex ante savings in 2015 more closely reflect the NYTM assumptions, but the Evaluation Team could not replicate the ex ante savings and therefore has no insight into the remaining discrepancies.

- For ***Building Envelope*** measures, the Evaluation Team used measure-specific information when available to most accurately characterize the incentivized equipment. Building envelope measures have been assigned a realization rate of 100% for this year's analysis, as there was insufficient information to complete a thorough analysis.

Net impacts indicate the savings to the grid due to program intervention. The ex ante NTGR values varied from the ex post NTGR by end-use as shown in Table 2-6. We applied the same ex post NTGR as in the previous evaluations. The Evaluation Team developed an updated NTGR for the CEP in 2011 and performed primary research in 2012 to specifically look for participant SO. SO added approximately 0.021 to the previous NTGR of 0.70. We calculated ex post net savings by applying the NTGR of 0.72 to the evaluated gross savings. In contrast, the program calculates ex ante net savings by assigning multiple deemed NTGRs based on measure type. These deemed NTGRs range from 0.64 to 1.00.

Table 2-6. Prescriptive Program Component NTGRs

End-Use	Ex Ante NTGR[a]	Ex Post NTGR[b]
General Lighting	0.92	0.72
Performance Lighting	0.92	0.72
HVAC	0.90	0.72
Commercial Kitchen Equipment	0.75	0.72
Compressed Air	0.91	0.72
Refrigeration	1.00	0.72
Motors and VFDs	0.64	0.72
Building Envelope	1.00	0.72

[a] Ex ante NTGR values are from measure-specific information received from PSEG Long Island staff.
[b] Ex post FR is 30% for both kW and kWh. The specific SO value varies between demand and energy savings. The demand SO is 1.87%, while the energy SO is 1.55%.

Table 2-7 shows a comparison of ex ante and ex post net energy and demand savings associated with the Prescriptive program component by end-use category. As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments.

Table 2-7. Prescriptive Program Component: Comparison of Ex Ante and Ex Post Net Savings

Category	Number of Units	Ex Ante Net Savings		Ex Post Net Savings		Ex Post Net Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	19,991	883	4,608,882	686	3,073,998	78%	67%
Non-Lighting							
HVAC	364	417	621,284	298	444,779	72%	72%
Commercial Kitchen Equipment	4	2	10,528	2	10,045	96%	95%
Compressed Air	44	203	1,424,803	62	823,849	31%	58%
Refrigeration	2,500	178	2,983,689	128	2,134,829	72%	72%
Motors and VFDs	130	84	1,080,298	92	1,759,171	109%	163%
Building Envelope	34	108	183,915	78	131,591	72%	72%
Total	23,067	1,875	10,913,399	1,346	8,378,261	72%	77%

Engineering Analysis Results – Existing Retrofit Program Component

The engineering analysis of the Existing Retrofit program component relied on a series of desk reviews for a representative sample of projects. The Evaluation Team drew two independent samples of projects, one for the lighting end-use (n=22) and one for the HVAC end-use (n=10).[6] Desk reviews yielded overall evaluated net realization rates of 97% for demand savings and 96% for energy savings with relative precision of 3.2% and 5.4% at 90% confidence, respectively.

Table 2-8 presents evaluated net energy and demand savings associated with the Existing Retrofit program component by end-use category. As both sets of net savings values were calculated using the same program-planning NTGRs, the differences expressed through the realization rates represent differences in the ex ante and evaluated gross savings.

Table 2-8. Existing Retrofit Program Component: Comparison of Ex Ante and Evaluated Net Savings

End-Use	Units	Ex Ante Net Savings		Evaluated Net Savings		Evaluated Net Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	588,342	18,604	79,480,644	18,029	76,106,495	97%	96%
HVAC	477	1,160	1,707,395	1,160	1,703,319	100%	100%
Total	588,819	19,764	81,188,039	19,190	77,809,814	97%	96%

Below we describe the specific reasons for discrepancies in savings.

[6] Four of the original 10 HVAC projects were misclassified and therefore removed from the sample and replaced with backup projects.

Reasons for Differences in Impacts

For the *Lighting* projects, our analysis of 22 projects found five primary reasons for differences in the evaluated net realization rates:

- For measure type L742 (linear LED replacement lamps), delta watts were overestimated due to multiplying the number of lamps per fixture by the total fixture wattage. This affected 2 of the 22 sampled projects.
- Ex ante savings for lighting controls varied depending on the control type due to the application of different savings factors (savings factors ranged from 13% to 50%, depending on the control type). The Evaluation Team applied a 30% savings factor across all control types, as prescribed by the NYTM. These adjustments affected 4 of the 22 projects in the sample.
- When estimating evaluated net savings for exit signs, the Evaluation Team applied a coincidence factor of 1.0 and 8,760 hours of operation. Although the program typically assumes continuous operation of exit signs, three of the sampled projects showed ex ante savings calculations that applied a coincidence factor of 0.75 and hours of use based on building type. While ex ante savings values assume partial operation over the course of the year, exit signs normally operate throughout the year.
- Ex ante savings assumptions for refrigerated case lighting included a waste-heat factor of 1.45 for demand savings and 1.46 for energy savings. The Evaluation Team applied slightly lower waste-heat factors consistent with the NYTM for these measures (1.40 for demand and 1.41 for energy). These adjustments affected 3 of the 22 projects in the sample.
- The Evaluation Team increased energy and demand savings for 1 of the 22 projects due to additional occupancy sensors per the invoice that were not included in ex ante savings estimates.

The analysis of the savings assumptions for a sample of Existing Retrofit HVAC projects revealed accurate and consistent savings calculations. The current method for calculating savings for Existing Retrofit projects assumes the baseline equipment has remaining useful life. During our desk review, however, we found pre-inspection pictures and email communication with the customers indicating that this may not have been the case for all of the projects. The program may want to consider collecting the age of the existing equipment to be consistent with Appendix M[7] of the NYTM, which allows using the existing equipment as baseline only if useful life remains on the equipment.

Table 2-9 shows a comparison of ex ante and ex post net energy and demand savings associated with the Existing Retrofit program component by end-use category. As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments. Similar to the Prescriptive program component, we did not perform new net-to-gross analysis this year. The Evaluation Team developed an updated NTGR for the CEP and Solutions Provider program elements in 2011 and performed primary research in 2012 to specifically look for participant SO. SO added approximately 0.02[8] to the previous NTGR of 0.70. The planning NTGRs are 0.92 for lighting and 0.90 for HVAC. The evaluated NTGR is 0.72 for ex post net savings values.

[7] Appendix M – Guidelines for Early Replacement Conditions. http://www3.dps.ny.gov/.

[8] The specific SO value varies between demand and energy. The demand SO is 1.87%, while the energy SO is 1.55%. When considered at the single level, both are 2%. We applied the specific values shown here in our analysis.

Table 2-9. Existing Retrofit Program Component: Comparison of Ex Ante and Ex Post Net Savings

End-Use	Units	Ex Ante Net Savings		Ex Post Net Savings		Ex Post Net Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	588,342	18,604	79,480,644	13,975	59,024,280	75%	74%
HVAC	477	1,160	1,707,395	927	1,354,139	80%	79%
Total	588,819	19,764	81,188,039	14,902	60,378,419	75%	74%

ENGINEERING ANALYSIS RESULTS – SMALL BUSINESS DIRECT INSTALL PROGRAM COMPONENT

PSEG Long Island discontinued its SBDI program in early 2015. Given program termination, low contribution of the program savings to the overall CEP savings, and consistent realization rates developed as part of the previous evaluations, the Evaluation Team did not perform an engineering analysis of the SBDI savings but rather applied realization rates from the 2014 evaluation.

Table 2-10 shows ex ante and evaluated net energy and demand savings associated with the SBDI program component. Both net savings values are calculated using program-planning NTGRs, meaning the differences expressed through the realization rates represent differences in the ex ante and evaluated gross savings.

Table 2-10. SBDI Program Component: Comparison of Ex Ante and Evaluated Net Savings

	Ex Ante Net Savings		Evaluated Net Savings		Evaluated Net Realization Rate	
	kW	kWh	kW	kWh	kW	kWh
Total	659	2,199,454	654	2,237,378	99%	102%

Table 2-11 presents ex ante and ex post net energy and demand savings associated with the SBDI program component. The Evaluation Team estimated a single NTGR for the SBDI component of the CEP last year and applied the same value this year, with the addition of a negligible level of SO.[9] This NTGR value of 0.87 was lower than the program-planning value of 1.0, reducing all values in Table 2-11. As noted previously, the Evaluation Team develops ex post net impact estimates for use in the benefit/cost and economic impact assessments.

Table 2-11. SBDI Program Component: Comparison of Ex Ante and Ex Post Net Savings

	Ex Ante Net Savings		Ex Post Net Savings		Ex Post Net Realization Rate	
	kW	kWh	kW	kWh	kW	kWh
Total	659	2,199,454	569	1,952,560	86%	89%

ENGINEERING ANALYSIS RESULTS - CUSTOM PROGRAM

We based evaluated and ex post energy and demand savings from the Custom program on the evaluation of 29 sites via engineering M&V during the 2012 impact evaluation. We applied the same realization rates (0.80 for demand savings and 0.95 for energy savings) from this past analysis to the 2015 Custom projects. Table 2-12 shows ex ante and evaluated net energy and demand savings associated with the Custom program

[9] Our analysis of participant SO for the SBDI set of customers indicated very little SO. We found SO of 0.27% for energy and 0.01% for demand. These were included in the total savings in our analysis.

component. Both net savings values are calculated using program-planning NTGRs, meaning the differences expressed through the realization rates represent differences in the ex ante and evaluated gross savings.

Table 2-12. Custom Program Component: Comparison of Ex Ante and Evaluated Net Savings

	Ex Ante Net Savings		Evaluated Net Savings		Evaluated Net Realization Rate	
	kW	kWh	kW	kWh	kW	kWh
Total	1,795	18,141,836	1,436	17,234,744	80%	95%

Table 2-13 presents ex ante and ex post net energy and demand savings associated with the Custom program component. As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments. Similar to the Prescriptive and Existing Retrofit program components, we performed no NTGR research this year. The Evaluation Team developed an updated NTGR for the CEP and Solutions Provider/Large Business program elements in 2011 and performed primary research in 2012 to specifically look for participant SO. SO added approximately 0.02[10] to the previous NTGR of 0.70. We calculated ex post net savings by applying the NTGR of 0.72 to evaluated gross savings. In contrast, the program calculated ex ante net savings using a deemed value of 0.90 for custom projects.

Table 2-13. Custom Program Component: Comparison of Ex Ante and Ex Post Net Savings

	Ex Ante Net Savings		Ex Post Net Savings		Ex Post Net Realization Rate	
	kW	kWh	kW	kWh	kW	kWh
Total	1,795	18,141,836	1,147	13,701,622	64%	76%

Net-to-Gross Ratio Estimation

Free-Ridership and Participant Spillover

PSEG Long Island uses deemed NTGRs for the CEP that range from 0.64 to 1.00 depending on the measure for the CEP, and uses an NTGR of 0.90 for the Custom program. The 2011 program evaluation found a 0.70 NTGR for the CEP.

In 2012, the Evaluation Team performed primary research to estimate participant SO. The resulting SO adds approximately 0.02 to the previous NTGR of 0.70. The resulting total NTGR for Custom projects increased to 0.72.

We did not revisit NTGR assessment as part of the 2015 evaluation, but rather relied on the FR estimate developed during the 2011 evaluation and the SO estimate developed as part of the 2012 evaluation.

[10] The specific SO value varies between demand and energy. The demand SO is 1.87%, while the energy SO is 1.55%. When considered at the single level, both are 2%. We applied the specific values shown here in our analysis.

3. The Energy Efficient Products Program

The objective of the EEP program is to increase the purchase and use of energy-efficient appliances and lighting among PSEG Long Island residential customers. In 2015, the program provided rebates or discounts on a range of ENERGY STAR products: CFL bulbs and solid state lighting (LED) bulbs and fixtures, advanced power strips, refrigerators, clothes dryers, clothes washers, air purifiers, and pool pumps. The program also included an appliance recycling component in which the program paid residents to recycle older working refrigerators, freezers, room air conditioners, and dehumidifiers.

The EEP program's longer-term goal is to transform the market so that consumers regularly choose energy-efficient appliances and lighting over less-efficient alternatives. In addition to offering financial incentives, the program educates customers about the benefits of using energy-efficient products in their homes through the PSEG Long Island website and program marketing materials. The EEP program coordinates its product requirements with ENERGY STAR, the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE), and updates efficiency requirements when any of these organizations changes its standards.

Overall, 2015 was a successful year for the program. The program reached its internal goals (achieving savings within budget) by early September, approximately 3 months ahead of schedule. As such, PSEG Long Island assigned more budget to the program and extended savings goals for the year.

During 2015, the program expanded several of its product offerings. First, the program expanded the number of efficient clothes dryers eligible for rebate through the program. To pair with the rebates for high-efficiency clothes dryers, the program also reinstated ENERGY STAR clothes washer rebates for "most efficient" models. Additionally, PSEG Long Island brought several new ENERGY STAR two-speed and variable-speed pumps into the pool pumps program.

The program also modified several product incentives in 2015.

- Within the lighting program, the program adapted its LED incentives over the course of the year, in response to fluctuating demand for LED bulbs. Incentives started at about $6 per bulb in January 2015, peaked at about $7 per bulb in May, and finished the year at about $3 per bulb for a select MOUs that had received additional funding in September.
- In the efficient pool pumps program, PSEG Long Island reduced the incentive amounts for variable-speed ENERGY STAR pool pumps. The 2015 variable-speed incentives included a $350 participant rebate and a $100 dealer incentive, both of which were $100 less than 2014 incentives ($450 participant rebate and a $200 dealer incentive). In 2015, PSEG Long Island eliminated rebates and incentives for non-ENERGY STAR two-speed pumps, while ENERGY STAR two-speed pump incentives and rebates remained the same.
- The program ran two $500 sweepstakes to boost participation in the appliance recycling program.
- The program offered a $75 incentive for clothes washers, constituting no more than 50% of the total sales price of the unit. The program offered a $150 incentive for ENERGY STAR dryers. In 2014, the program announced the $250 rebate being available for heat pump dryers, but began offering a $300 in January 2015.
- The program made relatively small changes to the rebate amounts for air purifiers in 2015, offering $25 for some models and $50 for others. The rebate was capped at 50% of the cost of the air purifier.

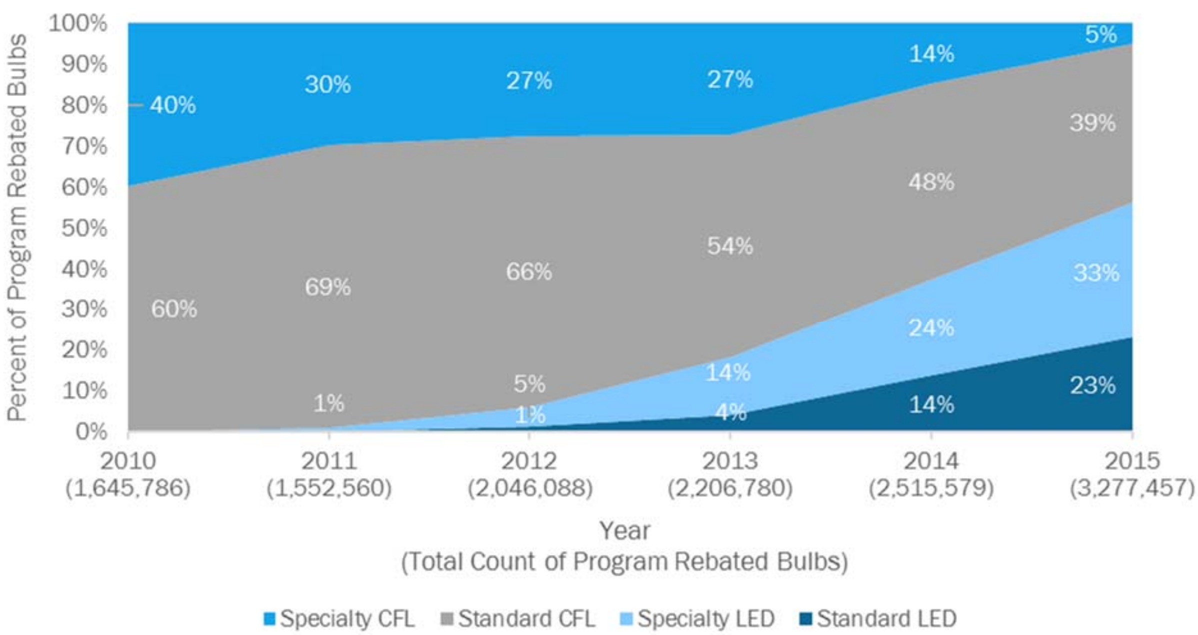
The Evaluation Team observed several notable trends within the various EEP measure categories. Below, we provide a more detailed study of these program participation and savings trends.

LIGHTING

A substantial increase in the number of rebated bulbs sold in 2015 (up 30% from 2014) accounted for the majority of the EEP program's success in exceeding it savings goals. Much of this increase is from the sale of LEDs and, in particular, specialty LEDs. In 2015, the program sold more LEDs than CFLs—the historically leading product—and specialty LED bulbs alone accounted for a third of total 2015 program bulb sales. Since 2012, the program's specialty LED bulb sales have nearly doubled every year.

Overall, customers purchase more efficient rebated bulbs each year, but CFLs represent a diminishing share of these sales. Figure 3-1 shows the evolution of the EEP lighting program's product mix over time.[11] Notably, while the share of specialty CFL sales is declining, the share of specialty LED sales is increasing, indicating that customers treat specialty CFLs and specialty LEDs as substitute products. In addition, although standard CFL sales remain steady (1,208,290 bulbs in 2014 and 1,274,056 bulbs in 2015), their proportional contribution to total program sales is shrinking (from a high of 69% in 2011 to 39% in 2015).

Figure 3-1. Percent of Total Program Bulbs Rebated by Type: 2010–2015



Source: EEP program tracking data, 2010–2015.

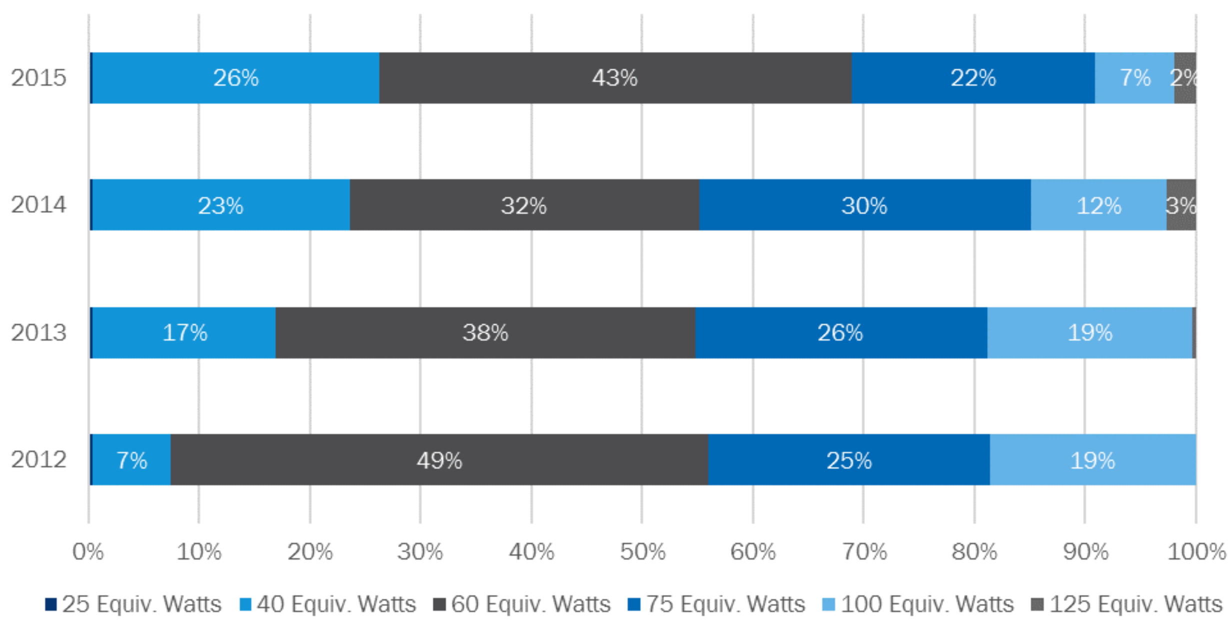
The substantial growth in the importance of LEDs to the program is being driven by a mix of both market forces (e.g., growing number of products, declining prices, and increasing quality) and programmatic decisions. LEDs have become increasingly cost-competitive relative to CFLs; thus, as LED prices fall, customers interested in purchasing efficient lighting may be moving straight from inefficient lighting to LEDs. Retailer stocking practices also play a role in the trends. For example, program managers observed that stores are continuing to stock fewer specialty CFL products than in past years. In turn, the program's 2015 sales of specialty CFLs (159,001 products) were only 44% of 2014 sales (364,111 products).

[11] The Evaluation Team segmented specialty LED vs. standard LED bulbs based on bulb descriptions listed in the PSEG Long Island program data.

The market for standard CFLs is also changing rapidly, and PSEG Long Island should assess the relative effectiveness of continuing to invest in CFL rebates. While standard CFLs are becoming a smaller share of the overall mix of bulbs rebated, with 1.2 million bulbs rebated in 2015, their absolute numbers continue to remain high and have remained steady in recent years. Recent research conducted by Opinion Dynamics in other comparable markets has shown that very high rates of free-ridership are now common for rebated CFLs, resulting in much lower real net energy and demand savings Opinion Dynamics recommends, therefore, either the discontinuation of CFLs in the EEP program offering, or research to assess the current net-to-gross ratio for program CFLs.

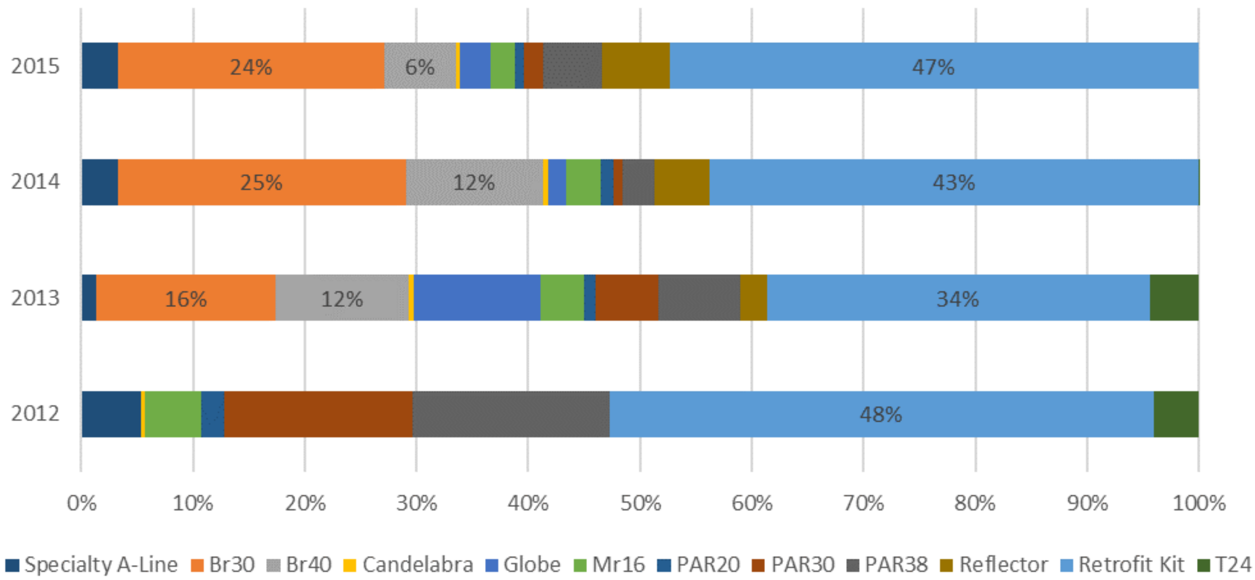
While the number of program LEDs increased in 2015, the average savings per bulb decreased, and the program achieved fewer savings from specialty LEDs than it had expected. In large part, it seems that the program is not realizing 100% of ex ante savings because the program is using ex ante savings assumptions based upon a mix of rebated products that includes a higher proportion of higher equivalent wattage bulbs, when in fact, the proportion of lower equivalent wattage bulbs has increased. Figure 3-2 and Figure 3-3 show the changing specialty LED product mix over time, in terms of equivalent wattage and bulb shape.

Figure 3-2. Percent of Specialty LED Sales by Equivalent Incandescent Wattage



Source: 2015 EEP upstream rebate program-tracking data. Excludes bulk rebates and online store tracking data.

Figure 3-3. Percent of Specialty LED Sales by Bulb Shape.



Source: 2015 EEP upstream rebate program-tracking data. Excludes bulk rebates and online store tracking data.

Three factors affected the changing mix of lighting measures and their associated savings: a change in the types of specialty LED products that customers purchased, the increasing efficiency of individual products over time, and updates to the ENERGY STAR mapping scheme that the program and the Evaluation Team use to determine equivalent baseline wattages of the inefficient lighting that would have been purchased absent the program. Several examples help clarify the second two factors. First, manufacturers are improving the efficiency of some LED products over time. For example, a 625-lumen specialty LED downlight bulb may have used 13 watts in 2014, but only 12.5 watts in 2015. All else being equal, this product would be compared to the same wattage baseline in each year, and energy savings for that product would increase. However, the ENERGY STAR-recommended methods for comparing equivalent baseline bulbs is based on wattages, not lumens. In reducing its wattage from 13 to 12.5 watts, the ENERGY STAR baseline for the 625-lumen LED downlight bulb goes from 75 watts to 60 watts.

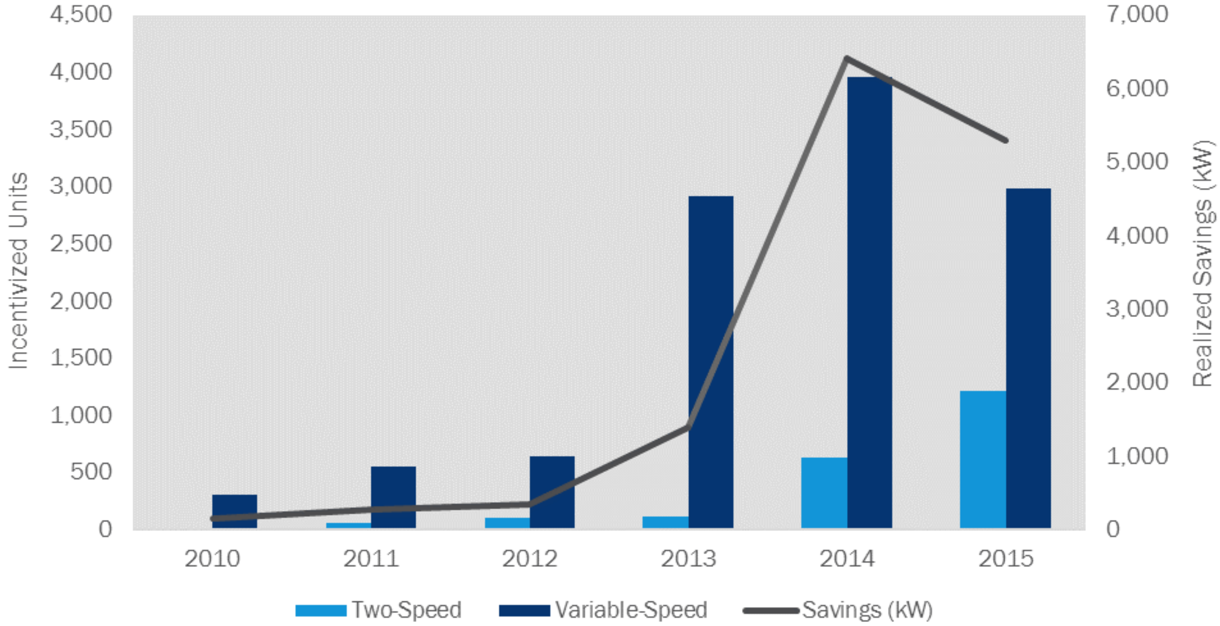
ENERGY STAR does periodically revise the average wattages of efficient bulbs for a given lumen output. When this happens—as it did in 2015—the program is evaluated using a different set of assumptions than were used in program planning. For example, the baseline for a 9-watt specialty LED was a 40-watt bulb in 2014, but with the updated ENERGY STAR wattage mapping (February 2015), the baseline for a 9-watt specialty LED changed to a 60-watt bulb in 2015. In summary, changing measure mixes and baseline equivalencies per watt may make it challenging to project savings based on prior year outcomes.

Pool Pumps

Breaking from the overall trend of the last 5 years, demand savings from pool pumps declined in 2015 (from 6,416 kW in 2014 to 5,302 kW in 2015), as shown in Figure 3-4. The decrease results from an overall reduction in the number of pool pumps (−9%) and a significant reduction in the proportion of the more-efficient variable-speed pumps rebated in 2015 compared to 2014. Despite the overall reduction in total program sales, two-speed pumps nearly doubled between 2014 and 2015 (from 636 units in 2014 to 1,215 units in

2015). Several factors appear to be driving this increase: the higher rebate amounts in 2015 for two-speed pumps, the availability of more models of eligible two-speed pumps, and falling prices.

Figure 3-4. Pool Pumps Rebated by Type: 2010–2015



Source: EEP program tracking data, 2010–2015.

Program-tracking data illuminate two marketplace trends pertinent to program planning. First, examining 2015 rebate data in context of the estimated 10,000 single-speed pool pumps needing replacement each year on Long Island[12] suggests that the EEP program captured about 40% of Long Island's single-speed pool pump replacement market this year (up from about 8% in 2012). Second, rebate application data show that participants install two-speed pumps and variable-speed pumps in mutually-exclusive settings. Program participants report installing almost all two-speed pumps (98%) in above-ground pools, while they install almost all variable-speed pumps (99%) in in-ground pools. To develop a better understanding of the factors influencing energy and demand savings potential from efficient pool pumps, the Evaluation Team recommends collecting baseline data on the Long Island pool pump market, including characteristics of existing pool pumps (e.g., types, capacities, ages, and operating schedules), the number of new pool installations and pool pump use in other applications, and the drivers and barriers for contractors and distributors promoting efficient pool pumps.

[12] This figure is based on the estimated 100,000 single speed pumps on Long Island from the 2013 In-Home Study, and the effective useful life of a pool pump (10 years), resulting in 10,000 single-speed pumps being replaced each year. The study used survey and site visits to estimate the percent of customers with pools and pump types. This estimate is likely a minimum size for the market as it assumes a single pump per pool and does not include pool pumps for new pools and those used in other applications, such as for hot tubs, spas, or landscaping water features.

Clothes Washers and Dryers

In 2015, the EEP program reinstated rebates for ENERGY STAR super-efficient clothes washers, and the program expanded the number of ENERGY STAR clothes dryer models available for rebate. Though the clothes washer and dryer segment is currently relatively small (about 1% of program energy and demand savings), there appears to be room for further growth in the future. The effective useful life of a clothes washer has been estimated to be 11 years.[13] With an estimated 560,000 owner-occupied homes with clothes washers on Long Island, the market replacement rate of washers is about 50,000 washers per year.[14] In the first year of reinstating rebates for ENERGY STAR super-efficient clothes washers, the 2015 program captured about 6% of this estimated annual homeowner clothes washer replacement market. Given the relatively small captured share of the overall clothes washer replacement market and the measure's better-than-expected first-year performance, sales of program-rebated most-efficient clothes washers are likely to increase next year.

The EEP program manager indicated that one reason for the return of super-efficient clothes washers was to capture customers who were simultaneously purchasing a clothes dryer. We examined 2015 program data to explore marketing advantages of offering complementary products. About one-quarter of customers participating in the clothes washer and/or dryer rebate programs did buy both a washer and a dryer (24%). Even though clothes washer rebates are newer offerings than clothes dryer rebates, more participants purchased rebated clothes washers (58%) than rebated clothes dryers (42%). The addition of clothes washers to the list of rebated measures may not achieve the purpose of selling significantly more washers and dryers as a pair, yet both products generated higher-than-expected savings for the program in 2015.

Appliance Recycling

Program staff noted that the appliance recycling program continues to have lower participation than desired, despite implementing a sweepstakes program in 2014 and 2015 to drive higher participation. To evaluate whether any market characteristics could help explain the low participation, we considered appliance recycling services that customers might have outside of the EEP program. The Evaluation Team confirmed that the largest refrigerator retailers on Long Island, upon delivery of a new refrigerator, also recycle their customers' old refrigerator at no cost. While the retailers do not offer a participant rebate along with their recycling service, it may be that many customers are recycling their older units before they have the opportunity to become operating secondary units. The program may be experiencing low participation because the program's market is limited to refrigerator recycling outside of the routine appliance replacement cycle. While customers interested in disposing of a working secondary refrigerator have always been the primary target of the program, it is likely that this is a smaller market than the program predicted. In addition, during in-home research conducted by the Evaluation Team in 2013, we interviewed homeowners with secondary refrigerators about their willingness to participate in the appliance recycling program. Few of the respondents expressed interest, as they perceived higher value in having the use of the secondary refrigerator than the program incentive.

Impacts for Goal Comparison

Table 3-1 provides a program-level comparison of evaluated net savings to ex ante savings by measure category.

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[13] Effective useful life estimate is based on the 2014 Massachusetts TRM.

[14] The estimated percent of homes with clothes washers is based on the U.S. Census 2013 American Housing Survey. Estimated percent of homeowners on Long Island is based on 2013 American Community Survey Census Block Group estimates.

Table 3-1. Energy Efficient Products Program Net Impacts for Goal Comparison

Category	Ex Ante[a]			Evaluated			Realization Rate	
	N	kW	kWh	N	kW	kWh	kW	kWh
Lighting	3,278,363	19,601	176,847,916	3,278,363	18,338	165,445,174	94%	94%
Pool Pumps	4,197	2,718	3,808,052	4,197	5,302	8,152,581	195%	214%
Appliance Recycling	5,153	615	3,177,306	5,153	442	2,854,875	72%	90%
Most-Efficient Clothes Washers	3,263	117	432,975	3,263	117	432,975	100%	100%
Refrigerators	1,992	43	231,180	1,992	27	226,293	62%	98%
Air Purifiers	370	24	131,378	370	23	131,378	93%	100%
Clothes Dryers	2,351	136	80,206	2,351	136	80,206	100%	100%
Power Strips	382	6	32,241	382	6	32,241	100%	100%
Totals	3,296,071	23,261	184,741,254	3,296,071	24,391	177,355,722	105%	96%

[a] Source: Evaluation Team analysis of program-tracking data.

Reasons for Differences in Impacts

Lighting: Lighting accounted for approximately 75% of the evaluated demand savings and 93% of the evaluated energy savings across the EEP program in 2015. The Evaluation Team determined a realization rate of 94% for both evaluated demand and energy savings. The lower realization rates for lighting are mainly due to the following:

- **Specialty LED delta watts:** The program assumed a wattage mix based on 2013 data, whereas the Evaluation Team used actual 2015 data. The average installed wattage in 2013 was 12.8 watts, but it was 11.0 watts in 2015. Mapping the baseline watts to these two installed wattages results in ex post savings that, relative to ex ante savings, are based on lower baseline watts and lower overall delta watts.
- **Standard LED delta watts:** Similar to specialty LEDs, standard LED program assumptions relied on a measure mix from 2013 data, whereas the Evaluation Team used actual 2015 data. The average installed watts in 2013 was 10.9 watts, whereas it was 9.7 watts in 2015. Mapping the baseline watts to these installed wattages results in lower baseline watts in 2015 than in 2013 and lower overall delta watts for ex ante savings.
- **CFL In-Storage:** The program's ex ante savings estimates for in-storage bulbs from 2014 relied on goals rather than actual installation counts from 2014 (actual installation counts are not available at the time of 2015 EEP planning). Also, for CFL specialty lamps, program assumptions for savings in 2013 and 2014 were approximately 20%–25% higher than evaluated recommendations.

Pool Pumps: The realization rates for two-speed and variable-speed pool pumps was 195% for demand savings and 214% for energy savings. It appears that ex ante calculations relied on assumptions from the Consortium for Energy Efficiency (CEE) Residential Swimming Pool Initiative. Because the EEP program bases its pool pump efficiency requirements upon the ENERGY STAR standards, the Evaluation Team estimated savings using ENERGY STAR savings calculations with New York default runtime hours (hours per day). The Evaluation Team does, however, recommend augmenting these savings calculations with Long Island-specific data on actual hours of use and pump settings for both efficient and baseline equipment.

Appliance Recycling: The overall realization rates for all recycled appliances were 72% and 90% for demand and energy, respectively, as shown in Table 3-1. The 2015 tracking data provided the Evaluation Team with detailed information on recycled refrigerators and freezers, including size, configuration, and vintage. With this information, the Evaluation Team was able to accurately assess the average savings per recycled refrigerator and freezer using ENERGY STAR savings calculation methods. This led to a combined realization rate for recycled refrigerators and freezers of 69% and 90% for demand and energy savings, respectively. For dehumidifier recycling, the Evaluation Team estimated savings using ENERGY STAR savings calculations, resulting in realization rates of 97% for both demand and energy savings. For recycled room air conditioners, the ex ante demand and energy savings values were found to be higher than the evaluated savings (realization rates of 75% and 74%, respectively). The evaluated savings relied on the savings calculations recommended by ENERGY STAR.

Refrigerators: Realization rates for ENERGY STAR-rated refrigerators were 62% for demand savings and 98% for energy savings. Since detailed information on sizes of 2015 refrigerators were not available in the tracking data, evaluators used 2012 refrigerator size information to calculate gross savings. Though program assumptions for energy savings for prescriptive and most-efficient models were in line with ENERGY STAR recommendations, the claimed (ex ante) peak demand savings are higher than evaluated savings (ex post) because the program appears to have used lower annual operating hours than the Evaluation Team did. To ensure that accurate savings can be calculated for each installation, we recommend that the program begins collecting information on refrigerator size.

Air Purifiers: Realization rates for ENERGY STAR air purifiers were 93% for demand savings and 100% for energy savings. The ex ante energy savings were revised in 2015 to more closely align with the Evaluation Team's use of ENERGY STAR savings recommendations and assumptions. The difference in demand savings may be due to the use of different coincidence factors. Coincidence factor data on air purifiers is limited, and since ENERGY STAR does not assess peak performance of appliances, the Evaluation Team assumed a coincidence factor of 0.9316, which is consistent with residential dehumidifiers. Both appliances feature similar operating profiles, cycling continuously throughout the day; therefore, we believe the 0.9316 value is a reasonable estimate of peak hour operation.

Impacts for Cost-Effectiveness

With one exception (appliance recycling), the ex post NTGR and the ex ante NTGR assumptions were consistent for all program measures. Table 3-2 shows the ex ante and ex post NTGRs by measure.

Table 3-2. NTGRs for Energy Efficient Products Program

Program Measures	Ex Ante			Ex Post		
	Free-Rider	Spillover	NTGR	Free-Rider	Spillover	NTGR
CFLs – Standard	30%	4%	0.74	30%	4%	0.74
CFLs – Specialty	25%	20%	0.95	25%	20%	0.95
ENERGY STAR solid state lighting	5%	25%	1.20	5%	25%	1.20
Fixtures	1.7%	3.2%	1.02	1.7%	3.2%	1.02
Refrigerators and freezers	20%	10%	0.90	20%	10%	0.90
Appliance recycling	43%	0%	0.57	52%	0%	0.48
Pool pumps	20%	10%	0.90	20%	10%	0.90
Smart strips	0%	0%	1.00	0%	0%	1.00
Super-efficient dryers and most efficient clothes washers	20%	10%	0.90	20%	10%	0.90
Air purifiers	30%	15%	0.85	30%	15%	0.85

Applying the NTGRs in Table 3-2 to evaluated gross savings provides ex post net savings. Table 3-3 provides a category-by-category comparison of ex ante to ex post net savings. As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments.

Table 3-3. Energy Efficient Products Program Net Impacts for Cost-Effectiveness

Category	Ex Ante[a]			Ex Post			Cost-Effectiveness Realization Rate	
	N	kW	kWh	N	kW	kWh	kW	kWh
Lighting	3,278,363	19,601	176,847,916	3,278,363	18,338	165,445,174	94%	94%
Pool Pumps	4,197	2,718	3,808,052	4,197	5,302	8,152,581	195%	214%
Appliance Recycling	5,153	615	3,177,306	5,153	372	2,404,105	61%	76%
Most-Efficient Clothes Washers	3,263	117	432,975	3,263	117	432,975	100%	100%
Clothes Dryers	2,351	136	80,206	2,351	136	80,206	100%	100%
Refrigerators	1,992	43	231,180	1,992	27	226,293	62%	98%
Power Strips	382	6	32,241	382	6	32,241	100%	100%
Air Purifiers	370	24	131,378	370	23	131,378	93%	100%
Totals	**3,296,071**	**23,261**	**184,741,254**	**3,296,071**	**24,321**	**176,904,953**	**105%**	**96%**

[a] Source: Evaluation team analysis of program-tracking data.

4. The Cool Homes Program

The Cool Homes program seeks to improve the energy efficiency of residential HVAC systems throughout Long Island. Through the assistance of a program-approved contractor, residential account holders can apply for rebates for the quality installation (QI) of higher-efficiency HVAC equipment, including split central air conditioners (traditional CACs), geothermal and air-source heat pumps, and ductless mini-split systems. QI means that the contractor performs Manual J calculations to install an energy-efficient unit that is appropriately sized for the space and to ensure that the refrigerant charge and airflow are checked using prescribed tests. Participating Cool Homes contractors receive incentives for each rebated QI. In the 2015 program, PSEG Long Island also introduced an equipment-only rebate option that allows the customer to choose any licensed air conditioning (A/C) contractor to install qualifying split CACs, geothermal and air-source heat pumps, and ductless mini-splits rather than having the work performed only by Cool Homes program contractors. With the equipment-only rebate, customers receive lower rebate amounts for qualifying equipment and contractors are not eligible for QI incentives.

In 2015, the Cool Homes program set a demand goal of 4.29 MW and achieved evaluated demand savings of 4.57 MW, achieving its demand goals for the third year in a row. More than three-quarters of the 6,448 measures rebated (79%) were split CACs. The remaining rebated measures were ductless mini-split systems (14%), air-source heat pumps (ASHPs) (4%), and geothermal heat pumps (GTHPs) (3%), as seen in Table 4-1.

Table 4-1. Number of Cool Home Program Systems by Measure

Measure	Quantity	Percent
Split CAC	5,114	79%
Ductless Mini-Split	894	14%
ASHP	249	4%
GTHP	166	3%
Total	6,448[a]	100%

[a] Includes rebates for 1 energy-efficient furnace fan and 24 ductwork replacements, which were not officially offered during the 2015 program year.

Source: 2015 Cool Homes program tracking data. A small number of rebates were provided for furnace fans (1) and ductwork (24), which were offered in 2013, but not officially offered in 2014 or 2015. These 2015 measures were likely the result of a lag in rebate processing.

The program provided rebates to more systems in 2015 than it did in 2014 (as seen in Table 4-2) and, in meeting its goals, came in more than $400,000 under budget. The largest year-over-year increase occurred in ductless mini-split systems, followed by traditional split CAC systems. GTHPs remained at about the same levels as 2014, while the number of ASHPs decreased significantly.

Table 4-2. Difference in Number of Cool Home Program Measures Installed, 2014–2015

Measure	2014	2015	Percent Difference
Split CAC	3,881	5,114	32%
Ductless Mini-Split	562	894	59%
ASHP	320	249	−22%
GTHP	162	166	2%
Total	**5,319**	**6,423[a]**	**21%**

[a] Does not include rebates for 1 energy-efficient furnace fan and 24 ductwork replacements, which were not officially offered during the 2015 program year.

Source: Cool Homes program tracking data, 2014 and 2015.

In 2015, PSEG Long Island introduced an equipment-only rebate option, which allows a participant to select any contractor, not just a participating contractor, to install his or her equipment. This new option is only being adopted gradually by customers and contractors as awareness grows. In 2015, it represented a small, but growing, portion of the total rebated installations, as shown in Table 4-3, which shows the number of equipment-only and installations by Cool Homes Contractors in 2015. The vast majority of Cool Homes projects in 2015 followed the traditional QI pathway and were conducted by participating contractors. Equipment-only installations in 2015 consisted of 316 CAC installations and 160 ductless systems.

Table 4-3. Equipment-Only Installations by Month in 2015[a]

	Equipment-Only Installations		Installations by Cool Homes Contractors			
Month	CAC Systems	Ductless Systems	CAC Systems (QI Required)	ASHP Systems (QI Required)	Ductless Mini-Split Systems	GTHP Systems
January	0	0	414	50	94	8
February	0	0	364	36	53	10
March	0	0	227	45	43	25
April	0	0	249	28	41	8
May	1	0	185	6	42	9
June	13	5	312	17	46	1
July	14	25	317	3	55	1
August	21	18	694	27	98	5
September	44	49	613	9	85	9
October	23	22	487	11	59	10
November	13	8	382	5	66	26
December	187	33	554	12	52	54
Totals	316	160	4,798	249	734	166

[a] Does not include rebates for 1 energy-efficient furnace fan and 24 ductwork replacements, which were not officially offered during the 2015 program year.

Source: Cool Homes program tracking data, 2015.

In addition to adding the equipment-only option, PSEG Long Island eliminated the early retirement option in 2015. Even though the early retirement component of the program was not offered in 2015, there were 974 early retirement-rebated projects paid in 2015, primarily in the first four months of the year. Most of these equipment installations were completed in 2014, but the rebates were paid in 2015 due to normal delays in application submittals and processing. The number of early retirement projects completed by month are shown in Table 4-4.

Table 4-4. Early Retirement Projects by Month in 2015

Month	Early Retirement Installations
January	316
February	260
March	176
April	132
May	34
June	6
July	4
August	22
September	16
October	4
November	1
December	3
Totals	974

IMPACTS FOR GOAL COMPARISON

Table 4-5 provides a program-level comparison of evaluated net savings to ex ante savings by measure category. As both ex ante and evaluated net savings values are calculated using program-planning NTGRs, the differences expressed through the realization rates represent differences in the ex ante and evaluated gross savings. (See the definitions in Section 1.1 for a discussion of the difference between the ex ante and evaluated values.)

Table 4-5. Cool Homes Program Net Impacts for Goal Comparison

Category	Installs	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Split CAC	5,114	3,609	2,379,579	3,850	2,777,947	107%	117%
Ductless Mini-Split	894	209	253,055	287	340,485	137%	135%
ASHP	249	202	326,649	220	416,687	109%	128%
GTHP	166	295	600,931	203	543,689	69%	90%
Duct Replacement	24	5	3,912	8	4,615	150%	118%
Totals	6,447	4,319	3,564,126	4,567	4,083,779	106%	115%

REASONS FOR DIFFERENCES IN IMPACTS

To estimate energy and demand savings, the Evaluation Team used algorithms incorporating average installed size and efficiency for each measure, as determined through examination of the program's 2015 tracking data. We multiplied normalized savings-per-ton values by the total installed capacity to calculate total evaluated savings by measure. Most measure-specific discrepancies between ex ante and evaluated savings are due to differences in assumptions of efficiencies and other efficient equipment characteristics used to calculate savings. Because the program design includes making predictions about future installations during the planning process, this could lead to discrepancies in ex ante and evaluated savings. For end-of-life replacement and new construction measures, the Evaluation Team relied on the 2015 tracking data for installed efficiency and the NYTM for baseline efficiencies. For early retirement measures, the Evaluation Team relied on the 2015 program-tracking database for both the installed and pre-existing efficiencies. The program and the Evaluation Team used the same coincidence factors and effective full load cooling hours (EFLCH).

To ensure valid comparisons of the evaluated savings to the ex ante savings, the Evaluation Team first “backs out” the NTGR embedded in the ex ante values for each measure. Ex ante gross savings do not contain coincidence factors, line losses, or NTGRs, but do contain QI factors. The Evaluation Team found that the “backed-out” NTGRs and the program’s established planning NTGRs did not always match. Inconsistencies in tracking data arose during the program’s transition to the Siebel tracking database in 2014, and these inconsistencies may continue to cause some of the NTGR discrepancies identified in 2015. As the evaluation team does not recommend deviating from the planning NTGRs at this point, we applied the actual NTGRs for all measures rather than the “backed-out” NTGRs when determining evaluated net savings.

The Evaluation Team has the following comments on the measure-specific savings calculations summarized in Table 4-5:

- Split CAC: Evaluated savings for CACs were higher than ex ante savings for both demand (107%) and energy (117%) savings. The Evaluation Team believes these discrepancies are primarily due to differences in baseline efficiency for early retirement CACs for which the Evaluation Team was able to use the actual reported efficiency for each piece of equipment removed in 2015.
- Ductless Mini-Split Systems: Ductless mini-split systems achieved higher evaluated savings for both demand (137%) and energy (135%). The Evaluation Team relied on 2015 tracking data for pre-existing equipment efficiency and size to characterize the baseline for early retirement projects. As consistent with the Cool Homes TRM methodology, the Evaluation Team applied a code baseline efficiency for end-of-life replacements or new construction projects. The Evaluation Team also observed discrepancies between the “backed-out” NTGR and the planning value for ductless mini-split systems. Our “backed-out” NTGR ranged from 0.90 to 1.05, while the planning value is 0.92 for demand and 0.98 for energy. These discrepancies also contribute to the higher realization rate.
- Air-Source Heat Pumps: ASHPs achieved realization rates of 109% (demand) and 128% (energy) primarily due to differences in baseline efficiency assumptions for early retirement systems. The evaluation analysis incorporated the actual efficiencies of removed equipment, as noted in program-tracking data. Assumptions for the coincidence factor and annual cooling and heating hours are identical between evaluation and program calculations.
- Geothermal Heat Pumps: GTHPs yielded lower evaluated savings for both demand (69%) and energy (90%). Ex ante per-ton savings are 60%–70% higher in 2015 than they were in 2014, while the weighted average efficiencies (EER and Heating Seasonal Performance Factor [HSPF]) have remained relatively unchanged between the two years. It is not clear what caused the dramatic increase in ex ante savings for GTHPs, but that increase led to the realization rates of less than 100%. In addition, there continue to be some underlying issues with ex ante data, as we calculated a “backed-out” NTGR of 1.25 rather than the expected actual value of 0.92 for demand and 0.98 for energy.
- Duct Replacement: Evaluated savings for ductwork were higher than ex ante savings for demand (150%) and energy (118%). Similar to other measures within the Cool Homes program, we observed discrepancies between “backed-out” NTGRs and actual NTGRs. Our “backed-out” NTGR was 0.83 for demand and 0.85 for energy, while the actual NTGR is 1.0 for both demand and energy. Similar to the other measures above, we believe the discrepancy is due to these differences and potential issues with the underlying ex ante data.

Impacts for Cost-Effectiveness Calculations

The cost-effectiveness calculations are based on ex post net savings estimates. As discussed previously, ex post net savings are calculated using NTGRs developed by the Evaluation Team. The ex post NTGR for split CACs was derived from extensive research in 2011 with participating and non-participating customers, as well as HVAC market actors, including contractors and equipment distributors (see the 2011 report for details). Table 4-6 shows a categorical breakdown of ex post savings compared with tracked program savings (ex ante).

Table 4-6. Cool Homes Program Net Impacts for Cost-Effectiveness

Category	Installs	Ex Ante		Ex Post		Cost-Effectiveness Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Split CAC	5,114	3,609	2,379,579	3,387	1,902,742	94%	80%
Ductless Mini-Split	894	209	253,055	287	340,485	137%	135%
ASHP	249	202	326,649	220	416,687	109%	128%
GTHP	166	295	600,931	203	543,689	69%	90%
Duct Replacement	24	5	3,912	8	4,615	150%	118%
Totals	6,447	4,319	3,564,126	4,105	3,208,574	95%	90%

The program applies planning, or ex ante, NTGR values of between 0.92 and 1.0 for each program measure category.[15] Additionally, the program NTGR differs for energy and demand for some measures. The Evaluation Team developed an updated NTGR for split CAC installations in 2011, including separate factors for savings associated with QI practices and equipment efficiency, and used those same values this year. We applied the program-planning values for all other measures. The evaluated NTGR for CAC installations included participant FR and program SO. Table 4-7 shows the NTGR values for the Cool Homes program.

[15] PSEG Long Island assigns different levels of FR based on the efficiency tier of the equipment. These FR values range from 0.20 for the lowest tier to 0.10 for the highest tier. The program measure category NTGRs are a weighted average of all tiers for each measure category.

Table 4-7. Cool Homes Program NTGRs

Measure	Ex Ante NTGR		Ex Post NTGR	
	kW[a]	kWh[a]	kW	kWh
CAC Equipment	0.92	0.98	0.52	0.52
CAC QI	0.92[b]	0.98[b]	1.49	1.41
CAC Total	0.92	0.98	0.84	0.65
GTHP	0.92	0.98	0.92	0.98
ASHP	0.92	0.98	0.92	0.98
ASHP QI	1.00[b]	1.00[b]	1.00	1.00
Ductless Mini-Split	0.92	0.98	0.92	0.98
Ductwork	1.00	1.00	1.00	1.00

[a] The Evaluation Team "backed-out" NTGRs based on the information included in the program-tracking data. The "backed-out" values are different than the program-planning assumptions listed in this table for some measures.
[b] Ex ante savings for QI are included in the overall ex ante savings for split CAC and ASHP systems, and the program applies the NTGR to the overall measure-level savings. Ex post savings were calculated using a separate NTGR for equipment and QI.

Standard Market Baseline Analysis for CAC Measures

In 2013, the Evaluation Team conducted a market assessment on central A/C equipment in PSEG Long Island's territory. We conducted site visits to gather nameplate data to determine the efficiency of CAC systems installed on Long Island outside of the Cool Homes program. Additionally, we conducted primary research among program participants and customers who recently installed CAC systems outside of the Cool Homes program (non-participants) to assess the size of the CAC market on Long Island and to identify differences and/or similarities between these populations. Our research concluded that Cool Homes program participants install CAC systems that are more efficient and smaller (more likely to be properly sized) compared to customers who install CACs outside of the program. Specifically, the 2013 research found the average SEER and cooling capacity of CAC Cool Homes program installations to be 16.2 SEER and 3.5 tons, respectively, compared to the market baseline of 14.3 SEER and 3.9 tons.

For the 2015 evaluation of the Cool Homes program, the Evaluation Team further explored the differences in average SEER and cooling capacity determined through the 2013 research. For end-of-life replacements, evaluated savings currently apply a baseline efficiency based on the NYTM (the federal standard) and assume a consistent cooling capacity between the baseline and efficient units. We considered an alternative approach that assumed a market baseline efficiency and capacity from the 2013 market research. To estimate the market baseline efficiency, we calculated a ratio between the installed efficiency (16.2 SEER) and market baseline efficiency (14.3 SEER) determined through the 2013 market baseline study and applied this ratio to the individual measure efficiencies installed in 2015. We calculated a similar ratio for capacity, using the installed capacity and market capacity from the 2013 market baseline study and applied this ratio to the installed capacities in the 2015 tracking data. We performed this analysis for both the end-of-life and early retirement measures.

The Evaluation Team concluded that using the market baseline approach results in slightly higher evaluated demand savings and lower energy savings compared to the current approach based on a federal standard baseline. Specifically, Table 4-8 presents the comparison between the current evaluated method and the market baseline method. The market baseline method results in a 109% demand realization rate and 90% energy realization rate, which are 2% higher and 27% lower than the current method, respectively.

Table 4-8. Evaluated Savings for Split CAC: Current Method vs. Market Baseline Method

Category	Ex Ante		Evaluated (Current Method)		Evaluated (Market Baseline Method)	
	kW	kWh	kW	kWh	kW	kWh
Split CAC	3,609	2,379,579	3,850	2,777,947	3,936	2,138,768
Realization Rate (Evaluated/Ex Ante)	N/A	N/A	107%	117%	109%	90%

Summary of Findings and Next Steps

Based on interviews with program staff, program data, and an assessment of PSEG Long Island's long-term goals, the Evaluation Team makes the following recommendations.

- Geothermal systems have stayed relatively constant in terms of installations, rising only 1% from 2014 to 2015, despite increased focus and research on promoting this area of the program. We recommend additional research investigating barriers to installing geothermal systems and the most-effective incentive structures.
- The program should investigate the mismatches in backed-out and program-theoretical NTGRs. If rounding errors in the tracking database are the major cause, consider adding more decimal places to ensure that savings are being tracked accurately.

5. The Residential Energy Affordability Partnership Program

The REAP program assists low-income households with energy efficiency improvements. The program helps low-income customers save energy, improves the overall residential energy efficiency on Long Island, and, with the reduction in utility bills through energy efficiency, and lowers PSEG Long Island's financial risk associated with bill collection. To participate in the REAP program, household income must be no more than 70% of the median income, adjusted for household size.

The REAP program includes a free home energy audit, in addition to free energy-saving measures. In 2014, the program included refrigerators, CFL light bulbs, pipe insulation, attic insulation, hot water tank wraps, and low-flow shower heads. As part of the redesign of the REAP program for 2015, room air conditioners and dehumidifiers were added to the program, with the aim of increasing savings and cost-effectiveness. In June 2015, the REAP program discontinued its refrigerator offerings in favor of the new measures.

Program implementation processes changed slightly in 2015. REAP program direct installations, made during the initial visit, continue to be tracked in the Siebel data-tracking system. Follow-up visits and measure installations are performed under the HPD program and tracked via Real Home Analyzer (RHA). Data from those installations are collected monthly by REAP program staff.

Impacts for Comparison to Goals and Cost-Effectiveness

As in previous evaluations, the Evaluation Team used two approaches to estimate savings for the REAP program in 2015: an engineering analysis and a billing analysis. Because the billing analysis uses actual customer electric usage to estimate savings, and is therefore more robust than engineering estimates, we based the savings from the program on the results of the billing analysis. Our billing analysis uses 2014 participants as the treatment group, since the method requires post-installation electricity usage data for approximately 1 year after participation. With the addition of room A/C units and dehumidifiers at the start of 2015, the billing analysis captures the savings for participants who did not install those measures. For the participants who had those measures installed, the measure-level savings calculated in the engineering analysis are added to the savings shown by the billing analysis. The results, presented in Table 5-1, show an energy savings realization rate of 48% for all measures excluding dehumidifiers and room A/C units, for which realization rates of 58% and 100%, respectively, are used to calculate overall savings for the program. The overall program realization rates for demand and energy savings are 69% and 50%, respectively.

Table 5-1. REAP Program Net Impacts for Comparison to Goals and Cost-Effectiveness

Measure Category	N[a]	Ex Ante		Evaluated/Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
CFL Bulbs	1,962	145.8	1,320,669	70.3	633,921	48%	48%
Domestic Hot Water (DHW)	115	8.0	141,970	8.0	68,146	100%	48%
Refrigerator	286	53.0	352,454	20.0	169,178	38%	48%
Duct Sealing	264	194.0	112,991	93.1	54,236	48%	48%
Duct Insulation	60	3.2	1,856	1.6	891	48%	48%
Air Sealing	269	7.0	15,022	3.3	7,211	48%	48%
Dehumidifier	277	41.7	70,653	24.1	40,999	58%	58%
Room A/C	661	160.2	77,787	200.2	77,787	125%	100%
Total	**2,166[a]**	**612.9**	**2,093,401**	**420.6**	**1,052,367**	**69%**	**50%**

[a]* Number of REAP program projects with measures in 2015.

Reasons for Differences in Impacts

The billing analysis model uses monthly billing data, among other inputs, to quantify post-participation changes in energy use. Because monthly observations of coincident peak demand are not available for participating customers, the billing analysis does not produce estimates of demand savings. To estimate demand savings, we calculated a ratio between the engineering-based estimates of evaluated demand and energy savings and applied this ratio to the energy savings estimates derived from the billing analysis.

With recent changes to available measures, the billing analysis is not able to capture the full spectrum of savings that is likely to have occurred in 2015. Since the billing analysis utilizes 2014 participants as the treatment group—participants who did not receive dehumidifiers and room A/C units—we are able to capture savings associated only with behavioral changes and measures installed as part of the previous base program structure. To account for savings attributable to new measures, we looked to the engineering analysis for this evaluation cycle. In the next evaluation, we will be able to include those measures and once again capture savings for the entire program with the billing analysis.

The combined billing and engineering analysis found that the REAP program generated approximately 1,052 MWh in energy savings in 2015, or about 50% of the expected net energy savings. Applying the ratio of evaluated demand to energy savings from the engineering analysis to the 934 MWh[16] in energy savings results in 196.3 kW in demand savings, or 47% of the expected peak demand savings. The billing and engineering analyses are described in more detail below.

Billing Analysis

The Evaluation Team conducted the billing analysis with the goal of determining the overall evaluated net energy savings for the REAP program. Our billing analysis uses 2014 participants as the treatment group, since the method requires post-installation electricity usage data for approximately 1 year after participation.[17] We also included a comparison group consisting of households that participated in 2015. The comparison group helps us assess the counterfactual or baseline for the treatment group (2014 participants) in the post-period.

Program participants were fairly similar across program years, with no significant differences in the share of those measures accounting for the highest portion of program savings in 2014 and 2015 (Table 5-2). In both years, lighting contributed the highest percentage of ex ante program savings, although we see that savings are slightly more spread out between other measures, with air and duct sealing taking up a larger portion of installations in 2015 than prior years. Refrigerators contributed a significant share of savings, but with the discontinuation of the measure midway through 2015, their share has decreased. Despite some program changes and changes in the measure mix for the less-common measures, the overall measure composition between the two years is sufficiently comparable.

[16] 934 MWh excludes the dehumidifier and window AC measures which received engineering analysis only and were not included in the billing analysis.

[17] Note that participants who initiated participation in 2014 and continued participating in 2015 (i.e., through the REAP program) are considered 2014 participants for the purpose of the billing analysis.

Table 5-2. REAP Program Installations by Program Year for Billing Analysis Groups

Measure Installed	Billing Analysis Treatment Group (2014 Participants) (n=957)		Billing Analysis Comparison Group (2015 Participants) (n=974)	
	Participants	Percentage of Gross kWh	Participants	Percentage of Gross kWh
Air Sealing	4.7%	0.19%	15.4%	9.38%
CFLs	93.3%	72.47%	95.9%	58.61%
DHW Insulation	3.1%	1.43%	1.5%	0.12%
DHW Temperature Turn-Down	2.1%	2.15%	3.8%	2.04%
Duct Insulation	0.9%	0.13%	3.1%	2.95%
Duct Sealing	4.7%	1.25%	15.1%	7.39%
Faucet Aerator	3.7%	0.46%	5.7%	1.99%
Refrigerator	22.0%	21.18%	14.8%	13.75%
Low-Flow Shower Head	3.0%	0.73%	4.1%	3.77%

The billing analysis model is a linear fixed effects regression (LFER) conditional demand analysis (CDA) model, which utilizes individual “dummy” variables to indicate the presence of any major measure installation. The model also allows all household factors that do not vary over time to be absorbed by (and therefore controlled for) the individual constant terms in the equation. This would include such things as square footage, appliance stock, habitual behaviors, household size, and many other factors. To improve our estimate of the counterfactual (what 2014 participants would have done during the post-period absent the program), we added dummy variables for each month of the evaluation period. The monthly dummy variables provide information on time trends not related to the comparison group per se. This method “allows” the comparison group to represent something closer to the counterfactual. We also entered weather terms in the model, as well as interaction terms between weather and the post-period for the treatment group, to account for differences in weather across years.

We used the billing analysis to determine the overall program realization rate. We did not attempt to calculate measure-level realization rates due to the considerable number of participants who installed multiple measures. Given the overlap in measure installations, it is impossible to accurately estimate individual effects, since parameters in the model are highly collinear, thus greatly increasing uncertainty around the estimates. As such, we report the results only for the overall program effect.

Table 5-3 presents the overall net program savings for 2015 REAP program participants. As shown below, the 2015 REAP program realized 48% of its expected net savings. These results reflect savings attributable to the program and the types of measures installed prior to the 2015 changes, which we refer to here as the “core” program. Additional savings from the installation of room A/Cs and dehumidifiers were estimated using the engineering analysis.

Table 5-3. Savings from the REAP Program Billing Analysis Compared to Ex Ante Savings Estimates for “Core” Program[a]

End-Use	N (Participants in Billing Analysis)	Observed Savings		Program-Planning Savings[b]		Realization Rate
		Household Daily Savings	Household Annual Savings	Household Daily Savings	Household Annual Savings	
Core Program	2,642	1.40	510	2.89	1,055	48%

[a] “Core” program does not include room air conditioner and dehumidifier savings.
[b] The line loss factor is not applied to the program-planning savings.

Engineering Analysis

The Evaluation Team also performed a measure-level engineering analysis of ex ante savings to estimate evaluated impacts. Specifically, the Evaluation Team used program-tracking data and applied either deemed savings estimates or calculated savings based on various parameters described in additional detail below. We used the engineering analysis to determine a ratio between energy and demand savings that we then applied to the billing analysis energy savings to estimate billing demand savings.

Given that the REAP program is a direct installation program serving low-income customers, the Evaluation Team assumed that this customer segment would not invest in energy efficiency without assistance, as they have limited financial resources and many other competing needs. Therefore, we used a NTGR of 1.0, which is typical for low-income programs. Table 5-4 provides a review of impacts for the program in 2015 by category based on an engineering estimate of savings.

Table 5-4. REAP Program Measure-Specific Net Impacts: Engineering Approach

Measure Category	N[a]	Net Ex Ante		Net Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
CFL Bulbs	1,962	145.8	1,320,669	162.4	1,465,037	111%	111%
DHW	115	8.0	141,970	12.7	108,547	159%	76%
Refrigerator	286	53.0	352,454	21.5	181,153	40%	51%
Duct Sealing	264	194.0	112,991	194.0	112,988	100%	100%
Duct Insulation	60	3.2	1,856	3.2	1,856	100%	100%
Air Sealing	269	7.0	15,022	7.0	15,022	100%	100%
Dehumidifier	277	41.7	70,653	24.1	40,999	58%	58%
Room A/C	661	160.2	77,787	200.2	77,787	125%	100%
Total	2,166[a]	612.9	2,093,401	625.0	2,003,389	102%	96%

[a] Number of REAP program projects with measures in 2014.

We highlight some of the discrepancies observed during the engineering analysis below:

- **Lighting:** In 2015, removed lighting wattages were not included in the REAP program Direct Install data collection spreadsheets, unlike in 2014. The Evaluation Team estimated an average installed wattage based on program-tracking data and applied an assumed multiplier to estimate baseline wattage based on the correlation between installed and removed bulbs found in 2014 REAP program tracking data. We hypothesized that discrepancies between ex ante and evaluated net savings may be caused by differences in the assumed baseline and installed wattages and/or coincidence factors and assumed hours of use.
- **Domestic Hot Water:** Shower heads, faucet aerators, pipe insulation, tank wraps, and temperature turndown account for the DHW savings attributable to the REAP program. The program-tracking data lacked several key assumptions to determine and/or validate impacts. These assumptions and the savings calculation methodology are described below:
  - The pre-existing shower head and faucet aerator flow rates in gallons per minute (gpm) were included in the program-tracking spreadsheet, allowing comparison between removed and installed shower head and aerator flow rates.
  - The evaluated savings for pipe insulation were calculated using DOE 3E Plus software, while the savings for tank wrap measures were calculated using engineering assumptions on boiler surface losses. It is not clear how the program savings were determined.

  - The temperature turndown measure reflects reduced skin losses from maintaining the hot water at a lower temperature (120°F assumed) during standby mode.
  - When estimating peak demand savings, the Evaluation Team used a coincidence factor of 0.23, adopted from a study of electric hot water heaters.[18] Based on a higher demand realization rate from previous years, the program also appears to have more closely adopted the evaluators' CF recommendation of 0.23 for DHW peak demand savings calculations.
- Refrigerator: For refrigerator measures, the evaluated net savings reflect the weighted average ENERGY STAR-recommended savings based on 2015 installed refrigerator sizes and configurations. The baseline refrigerator energy consumption represents a weighted average energy consumption based on year of pre-existing refrigerator, per ENERGY STAR, as obtained from the 2014 program-tracking database, since this information was not available in the 2015 program-tracking database.
- Dehumidifier: For dehumidifiers, the Evaluation Team used savings referenced from ENERGY STAR algorithms and unit consumptions for federal standard and ENERGY STAR-qualified units. The program appears to use a similar algorithm, but applied a multiplier of 0.9 to the baseline dehumidifier energy factor, resulting in a discrepancy between ex ante and evaluated savings.
- Room A/C: For room A/C measures, the Evaluation Team used a methodology consistent with the program that reflects ENERGY STAR guidelines for federal standard and efficient nameplate EER. The discrepancies between ex ante and evaluated net savings are caused by differences in the assumed installed equipment capacities. The program uses maximum capacity defined by tier. The 2015 REAP program tracking spreadsheet did not contain information on the actual installed equipment capacities. The Evaluation Team therefore referenced 2014 EEP program data for actual installed room A/C capacities, since there were no EEP program room A/C installs in 2015.

[18] Minnesota Municipal Utilities Association. "Water Heating Load Control." http://www.mmua.org/html/CIP/CIPdocs/pt_loadcontrol95.doc.

6. The Home Performance Direct Program

The HPD and HPwES programs work in concert to provide homeowners with free and low-cost measures and information to encourage greater energy savings. Together, the programs consist of a full-home audit; a Home Energy Score; and possible incentives for new, efficient equipment.

The HPD program conducts free, full-home energy audits by a certified Building Performance Institute (BPI) contractor for homes with central air conditioning. During the audit, the contractor checks for moisture problems, assesses insulation and building envelope sealing, and evaluates heating and cooling efficiency.[19] The BPI contractor also provides participants with free air- and duct-sealing measures, up to 20 free CFLs, and, for customers with electric hot water, faucet and shower aerators. Upon completion of the audit, participants are provided with an assessment report that includes an energy efficiency score for the home and suggested improvements, along with estimated energy savings (in dollars).

The HPD program implementation remained mostly consistent between 2014 and 2015. Prior changes in program eligibility (and targeting) in 2013 shifted the composition of the participant base to a lower proportion of electric space-heated (ESH) homes since that time. This remained consistent in 2015, which again saw a very low proportion of ESH participant households.

Impacts for Comparison to Goals and Cost-Effectiveness

As in the 2014 evaluation, the Evaluation Team used two approaches to estimate ex post savings for the HPD program in 2015: an engineering analysis and a billing analysis. Because the billing analysis used actual customer electric usage to estimate savings, and is therefore more robust than engineering estimates, we based the savings from the program on the results of the billing analysis. Table 6-1 provides a review of impacts for the program in 2015 by measure category. The results of the billing analysis are applied for the purposes of goal comparison and cost-effectiveness analysis for all measure categories. The engineering analysis provides a comparison to the billing analysis and a way to estimate demand savings, an output that is unavailable within a monthly billing analysis.

Table 6-1. HPD Program Net Impacts for Goal Comparison and Cost-Effectiveness

Measure Category	N[a]	Ex Ante		Evaluated/Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Air Sealing	2,145	58	107,562	30	54,857	51%	51%
CFL Bulbs	2,236	242	3,057,636	173	1,559,394	71%	51%
Duct Sealing	2,112	1,504	842,883	767	429,871	51%	51%
Heating and Hot Water	1,016	71	81,637	27	41,635	38%	51%
Total	3,057[a]	1,874	4,089,719	996	2,085,757	53%	51%

[a] Number of HPD program projects with measures in 2015.

[19] The type and extent of HPD program measure installation depends on which measures will have the greatest savings impact, as determined by household attributes and program software. Air- and duct-sealing work is limited by the amount of time contractors can spend installing measures during their HPD program visit.

Reasons for Differences in Impacts

The billing analysis found that the HPD and HPwES programs realized 51% of its expected net energy savings. To estimate demand savings, we calculated a ratio between energy and demand using the engineering analysis, and applied this ratio to the billing analysis energy savings. Applying the ratio resulted in the HPD program achieving 53% of its expected peak demand savings. We describe the billing and engineering analyses in more detail below.

Billing Analysis

The Evaluation Team conducted a billing analysis with the goal of determining the overall ex post net program savings for the HPD and HPwES programs. Given the overlap between the two programs and the relatively small number of participants in each program, we estimated program savings using a single model. This approach allowed us to maximize the number of data points used for estimation and thus increased both the precision and robustness of our results. Estimating separate models for the HPD and HPwES programs significantly reduces the number of observations used for modeling, which typically results in poorer model fit and estimates that are unstable and susceptible to outliers. Since the HPD and HPwES programs follow a similar program design and exhibit overlap in participants, a single model approach yields the most-accurate estimates of program savings.

Our billing analysis used 2014 participants as the treatment group since the method requires post-installation electricity usage data for approximately 1 year after participation.[20] We also included a comparison group consisting of households that participated in 2015. The comparison group helps us assess the counterfactual or baseline for the treatment group (2014 participants) in the post-period. As such, results from the billing analysis are net results and application of a NTGR is inappropriate.

Program participants were fairly similar across program years, with mostly small differences in the share of measures in the 2014 and 2015 program years (as shown in Table 6-2) and no substantive change in program design across the two years. In both years, lighting contributed more than 75% of ex ante program savings, with duct sealing also contributing a significant share (17% in 2014 and 20% in 2015). Overall, the analysis of the measure composition shows that the two program years are comparable and that it was appropriate to use 2014 as a comparison group.

Table 6-2. Comparison of HPD Program Installed Measures for Participants in Billing Analysis

	Billing Analysis Treatment Group (2014 Participants) n=1,422		Billing Analysis Control Group (2015 Participants) n=1,906	
HPD Measures Installed	Percentage of Participants	Percentage of Gross kWh	Percentage of Participants	Percentage of Gross kWh
Air Sealing	89.2%	1.7%	90.1%	2.4%
Direct Hot Water	3.8%	2.9%	4.1%	1.2%
Duct Insulation	0.8%	0.0%	0.4%	0.0%
Duct Sealing	88.3%	17.2%	89.2%	20.3%
Duct Wrap	32.7%	0.5%	37.5%	0.6%
Insulation	0.1%	0.0%	0.0%	0.0%
Lighting	94.2%	77.7%	94.4%	75.4%

[20] Note that participants who initiated participation in 2014 and continued participating in 2015 (i.e., through the HPwES program) are considered 2014 participants for the purpose of the billing analysis.

The billing analysis model is a LFER CDA model, which utilizes individual indicator variables to represent the presence of any major measure installation. The model also makes individual adjustments for the energy consumption effects of household factors that do not vary over time using individual constant terms in the equation. This includes such things as square footage, appliance stock, habitual behaviors, household size, and any other factor that stays constant, with constant energy consumption over the period in the models.

To improve our estimate of the counterfactual (or baseline—what 2014 participants would have done during the post-period absent the program), we included indicator variables for each month of the evaluation period. The monthly indicator variables provide information on time trends that affect both the participant and comparison groups. The monthly indicator variables help adjust for changes in usage that are the same across all participating and comparison group customers. We also included weather terms in the model, as well as interaction terms between weather and the post-period for the treatment group, to account for differences in weather across years.

We used the billing analysis to determine the overall program realization rate for the HPD and HPwES programs combined. We chose not to include measure realization rates due to the considerable number of participants who installed *both* lighting and weatherization measures. Such overlap makes it extremely difficult to estimate individual effects, since parameters in the model are highly collinear, and including both parameters greatly increases uncertainty around the estimates. As such, we report the results only for the overall program effect.

Table 6-3 presents the overall net program savings for 2014 HPD and HPwES programs' participants. The 2014 HPD and HPwES programs realized 51% of their expected net savings. Not shown are the measure-level realization rates for lighting and weatherization due to the high degree of uncertainty around the parameter estimates. However, based on our analysis of the billing analysis model, an increase in the share of savings for weatherization appears to account for much of the increased savings (compared to last year's results).[21]

Table 6-3. Savings from HPD and HPwES Programs Billing Analysis Compared to Ex Ante Savings Estimates

End-Use	N[b]	Observed Savings		Program-Planning Savings[a]		Realization Rate
		Household Daily kWh Savings	Household Annual kWh Savings	Household Daily kWh Savings	Household Annual kWh Savings	
Overall Savings	3,746	2.42	883	4.74	1,731	51%

[a] The line loss factor is not applied to the program-planning savings.
[b] Participants in billing analysis.

Engineering Analysis

The Evaluation Team also performed a measure-level engineering analysis of ex ante savings to estimate evaluated impacts. Specifically, the Evaluation Team used program-tracking data and applied either deemed savings estimates or calculated savings based on various parameters described in additional detail below. We used the engineering analysis to determine a ratio between energy and demand savings that we then applied to the billing analysis energy savings to estimate billing demand savings.

The program applies a planning NTGR of 1.0 for each program measure category to develop the ex ante savings estimates. The Evaluation Team developed a NTGR for the program in 2011, including FR and program

[21] See detailed methodology section for more details.

SO. For 2015, we developed a net realization rate using the billing analysis and therefore did not apply the NTGRs.

Table 6-4 provides a review of impacts for the program in 2015 by category based on an engineering estimate of savings.

Table 6-4. HPD Program Measure-Specific Net Impacts: Engineering Approach

		Net ExAnte		Net Evaluated		Realization Rate	
Measure Category	N[a]	kW	kWh	kW	kWh	kW	kWh
Air Sealing	2,145	58	107,562	58	107,559	100%	100%
Lighting	2,236	242	3,057,636	217	1,962,285	90%	64%
Duct Sealing	2,112	1,504	842,883	1,504	842,865	100%	100%
Heating and Hot Water	1,016	71	81,637	49	76,698	70%	94%
Total	3,057	1,874	4,089,719	1,828	2,989,407	98%	73%

[a] Number of HPD projects with measure in 2015.

We highlight some of the discrepancies observed during the engineering analysis below:

- **Air Sealing and Duct Sealing:** For air sealing and duct sealing measures, no information was available regarding input values for the ex ante savings algorithms. We examined the program savings algorithms in prior years and determined that it was reasonable based on engineering judgment. To remain consistent with last year, we assigned a 100% realization rate for these measures.
- **Lighting:** For lighting measures, no information was available on algorithm inputs used to develop ex ante savings estimates. The Evaluation Team estimated an average installed wattage based on program-tracking data and applied an assumed multiplier to estimate baseline wattage. The multiplier was based on correlation between installed and removed bulbs found in 2014 REAP program tracking data, since 2015 REAP program tracking data lacked the necessary install information. We hypothesized that discrepancies between ex ante and ex post may be caused by differences in the assumed baseline and installed wattages and/or with coincidence factors and assumed hours of use.
- **Heating and Hot Water**: Shower heads, faucet aerators, pipe insulation, tank wrap, and temperature turndown measures account for the DHW savings attributable to the HPD program. The program's tracking data lacked sufficient detail to identify all differences between ex ante and evaluated savings. While these measures are a relatively small component of program savings, PSEG Long Island may want to consider making additions to the program's tracking database to capture additional per-install details, such as R-value and area (sf) of installed tank wrap. The evaluated savings calculation methodology for these measures is as follows:
  - The pre-existing shower head and faucet aerator flow rates in gpm were used to estimate gpm and energy savings.
  - The Evaluation Team calculated the evaluated savings for pipe insulation using DOE 3E Plus software, while the savings for tank wrap measures were calculated using engineering assumptions on boiler surface losses.
  - When estimating peak demand savings, we used a coincidence factor of 0.23 adopted from a study of electric hot water heaters.[22] Due to the low peak demand realization rates, we believe that the program used a higher value for the coincidence factor when calculating ex ante savings.

[22] Minnesota Municipal Utilities Association. "Water Heating Load Control." http://www.mmua.org/html/CIP/CIPdocs/pt_loadcontrol95.doc.

7. The Home Performance with ENERGY STAR® Program

The HPD and HPwES programs work in concert to provide homeowners with free and low-cost measures and information to encourage greater energy savings. Together, the programs consist of a full-home audit; a Home Energy Score; and possible incentives for new, efficient equipment.

The HPwES program includes a home audit by a BPI-accredited contractor to evaluate heating and cooling equipment and assess insulation levels and air leakage. The HPwES program encourages the installation of weatherization, insulation, and other building shell measures through incentives. Homeowners are eligible to receive an incentive from PSEG Long Island for 15% (up to $1,000) of eligible measures installed under the HPwES program. Customers may be eligible for additional incentives and low-interest on-bill financing from NYSERDA for energy efficiency home improvements made as part of the HPwES program. Program implementation was not changed for the 2015 program year.

Impacts for Comparison to Goals and Cost-Effectiveness

As in prior evaluations, the Evaluation Team used two approaches to estimate ex post savings for the HPwES program in 2015: an engineering analysis and a billing analysis. Because the billing analysis uses actual customer usage to estimate savings, and is therefore more robust than engineering estimates, we based the savings from the program on the results of the billing analysis. Table 7-1 provides a review of impacts for the program in 2015 by category. As described below, we use the billing analysis results for all evaluated savings.

Table 7-1. HPwES Program Net Impacts for Goal Comparison and Cost-Effectiveness

Measure Category	N[a]	Ex Ante		Evaluated/Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Building Envelope	712	191.5	186,167	97.7	94,945	51%	51%
HVAC	451	581.9	277,659	296.8	141,606	51%	51%
Air Sealing	697	41.5	55,289	21.2	28,197	51%	51%
Hot Water	143	17.3	34,602	8.8	17,647	51%	51%
Lighting	57	13.0	80,138	4.5	40,870	35%	51%
Refrigerator	14	16.8	33,675	2.0	17,174	12%	51%
Total	719	862.0	667,530	431.0	340,440	50%	51%

[a] Number of HPwES projects with measure in 2015.
Note: Totals may not sum due to rounding.

Reasons for Differences in Impacts

The billing analysis found that the HPD and HPwES programs realized 51% of their expected net energy savings. To estimate demand savings, we calculated a ratio between energy and demand using the engineering analysis, and applied this ratio to the billing analysis energy savings. Applying the ratio resulted in the HPwES program achieving 50% of its expected peak demand savings. We describe the billing and engineering analyses in more detail below.

Billing Analysis

The Evaluation Team conducted a billing analysis with the goal of determining the overall ex post net program savings for the HPD and HPwES programs. Given the overlap between the two programs and the relatively small number of participants in each program, we decided to estimate program savings using a single model. This approach allowed us to maximize the number of data points used for estimation and thus increased both the precision and robustness of our results. Estimating separate models for the HPD and HPwES programs would significantly reduce the number of observations used for modeling, which would typically result in poorer model fit and estimates that are unstable and susceptible to outliers. Since the HPD and HPwES programs follow a similar program design and exhibit overlap in participants, a single model approach yields the most-accurate estimates of program savings.

Our billing analysis used 2014 participants as the treatment group since the method requires post-installation electricity usage data for approximately 1 year after participation.[23] We also included a comparison group consisting of households that participated in 2015. The comparison group helped us assess the counterfactual or baseline for the treatment group (2014 participants) in the post-period.

Program participation was fairly similar across program years, with small differences in the share of those measures accounting for the majority of savings in 2014 and 2015 (Table 7-2). In both years, insulation, duct sealing, and duct wrap contributed more than half of ex ante program savings. Differences between 2014 and 2015 for other measures, while sometimes large, do not affect the billing analysis significantly due to the relative low overall savings contribution of these measures. Overall, the analysis of the measure composition shows that the two program years are comparable.

Table 7-2. Comparison of HPwES Program Installed Measures for Participants in Billing Analysis

	Billing Analysis Treatment Group (2014 Participants) n=485		Billing Analysis Control Group (2015 Participants) n=491	
Measures Installed	Percentage of Participants	Percentage of Gross kWh	Percentage of Participants	Percentage of Gross kWh
Air Sealing	92.7%	6.8%	89.1%	6.3%
Attic Vents, Etc.	64.4%	1.1%	63.3%	1.0%
Direct Hot Water	15.1%	1.2%	20.8%	6.5%
Duct Insulation	27.1%	6.7%	31.5%	6.4%
Duct Sealing	30.5%	15.2%	40.8%	21.3%
Duct Wrap	14.1%	27.5%	16.5%	16.2%
HVAC Equipment	14.5%	8.0%	17.9%	3.0%
Insulation	92.9%	24.5%	89.7%	20.4%
Lighting	6.7%	7.4%	8.2%	12.6%
Pipe Insulation	0.0%	0.0%	1.9%	0.0%
Refrigerator	0.4%	0.8%	2.1%	5.4%
Thermostat	5.1%	0.5%	6.4%	0.5%

We used the billing analysis to determine the overall program realization rate for the HPD and HPwES programs combined. As such, the methodologies for the billing analysis outlined in Section 6 are also applicable here.

As shown in Section 6, the 2015 HPD and HPwES programs realized 51% of their expected net savings. Not shown are the measure-level realization rates for lighting and weatherization due to the high degree of

[23] Note that participants who initiated participation in 2014 and continued participating in 2015 (i.e., through the HPwES program) are considered 2014 participants for the purpose of this analysis and are included in the billing analysis.

uncertainty around the parameter estimates. However, based on our analysis of the billing analysis model, an increase in the share of savings for weatherization appears to account for much of the increased savings (compared to last year's results).[24]

Table 7-3. Savings from HPD and HPwES Programs Billing Analysis Compared to Ex Ante Savings Estimates

End-Use	N[b]	Observed Savings: Household Daily kWh Savings	Observed Savings: Household Annual kWh Savings	Program-Planning Savings[a]: Household Daily kWh Savings	Program-Planning Savings[a]: Household Annual kWh Savings	Realization Rate
Overall Savings	3,746	2.42	883	4.74	1,731	51%

[a] The line loss factor is not applied to the program-planning savings.
[b] Participants in billing analysis.

Engineering Analysis

The Evaluation Team also performed a measure-level engineering analysis of ex ante savings to estimate evaluated impacts. Specifically, the Evaluation Team used program-tracking data and applied either deemed savings estimates or calculated savings based on various parameters described in additional detail below. We used the engineering analysis to determine a ratio between energy and demand savings that we then apply to the billing analysis energy savings to estimate billing demand savings.

The program applies a planning NTGR of 1.0 for each program measure category to develop the ex ante savings estimates. For 2015, we developed a net realization rate using the billing analysis and therefore did not apply the NTGRs.

Table 7-4 provides a review of impacts for the program in 2015 by category based on an engineering estimate of savings.

Table 7-4. HPwES Program Measure-Specific Net Impacts: Engineering Approach

Measure Category	N[a]	Net Ex Ante kW	Net Ex Ante kWh	Net Evaluated kW	Net Evaluated kWh	Realization Rate kW	Realization Rate kWh
Building Envelope	712	191.5	186,167	191.5	186,163	100%	100%
HVAC	451	581.9	277,659	581.9	277,653	100%	100%
Air Sealing	697	41.5	55,289	41.5	55,288	100%	100%
Hot Water	143	17.3	34,602	17.3	34,700	100%	100%
Lighting	57	13.0	80,138	7.1	64,481	55%	80%
Refrigerator	14	16.8	33,675	1.7	14,124	10%	42%
Total	**719**	**862.0**	**667,530**	**841.0**	**632,408**	**98%**	**95%**

[a] Number of HPwES projects with measures in 2015.

We highlight some of the discrepancies observed during the engineering analysis below:

- **Lighting**: For lighting measures, no information was available on algorithm inputs used to develop ex ante savings estimates. Information on removed lighting wattages was not available in program-tracking data. The Evaluation Team estimated an average installed wattage based on program-tracking data and applied an assumed multiplier to estimate baseline wattage based on a correlation between installed and removed bulbs found in 2014 REAP program tracking data, since 2015 REAP program data lacked install information. We believe that the REAP program tracking data are representative of residential lighting baseline per our research on lumen equivalence between incandescent and CFL bulbs. We hypothesized

[24] See detailed methodology section for more details.

that discrepancies between ex ante and ex post savings may be caused by differences in the assumed baseline and installed wattages and/or with coincidence factors and assumed hours of use.

- Non-Lighting: For non-lighting measures, the Evaluation Team performed an engineering review of the savings algorithms and deemed savings values. We highlight the primary reasons for measure-level discrepancies below:
  - Building Envelope: For building envelope measures, the program-tracking data did not include any information on R values of pre-existing or installed insulation, windows, or doors. This information was included in 2013 tracking data and provided the Evaluation Team with greater levels of detail on installed envelope measures. Due to the lack of program-tracking data, the Evaluation Team assigned a 100% realization rate for energy and peak demand savings for envelope measures. Going forward, we recommend that the program develop and use more transparent algorithms for determining ex ante savings values for building envelope measures.
  - HVAC: For HVAC measures, the Evaluation Team assigned a 100% realization rate for HVAC equipment for 2015 due to a lack of program-tracking data on the specific measures. In 2014, we had detailed install data for HVAC equipment, including size, age, and efficiency of removed equipment, which led to realization rates near 100%. While we lacked these data in 2015, we felt confident that the program calculated HVAC savings accurately based on a thorough review in previous years, which is why we applied the 100% realization rate to the HVAC measures for 2015.
  - Air Sealing: For air sealing measures, no information was available on the algorithm inputs used to develop ex ante savings estimates. We examined the program savings algorithm in prior years and determined that it was reasonable based on engineering judgment. We assigned a 100% realization rate for these measures.
  - Domestic Hot Water: For DHW measures, including pipe insulation, and water heater replacement, the program's tracking data lacked sufficient detail to identify specific differences between ex ante and evaluated savings. While these measures are a relatively small component of HPwES program savings, PSEG Long Island may want to consider making additions to the program's tracking database to capture additional per-install details, such as type of pipe insulation and size of the replaced water heater. The evaluated savings calculation methodology for these measures is as follows:
    - We applied a realization rate of 100% to the hot water heater replacement measures similar to previous years due to a lack of program-tracking data.
    - We calculated the evaluated savings for pipe insulation using DOE 3E Plus software, resulting in a realization rate of 77% for demand and 356% for energy for these measures. Due to the relatively small contribution to hot water savings, these realization rates did not affect the overall hot water realization rates.
  - Refrigerator: Ex ante refrigerator savings are significantly higher than those of other residential programs, such as EEP and REAP. The Evaluation Team cannot determine specific reasons for this discrepancy, as detailed refrigerator characteristics are not available from HPwES program tracking data. Evaluated savings for the 20 refrigerators installed in 2015 reflect the weighted average ENERGY STAR-recommended savings based on 2015 installed refrigerator sizes and configurations. The baseline refrigerators represent a weighted average energy consumption based on year of pre-existing refrigerator, per ENERGY STAR. Since the 2015 HPwES program tracking spreadsheet did not contain information on the age of the pre-existing refrigerators, 2014 REAP program data for 448 installs were referenced by the Evaluation Team when performing these weighted savings calculations.

8. The Solar Photovoltaic Program

In 2015, PSEG Long Island continued to offer rebates to residential and small commercial customers to promote the installation of solar PV systems. These rebates served to encourage customer-sited electric generation, helping customers gain more control over their electric bills and reducing their carbon footprint while also offsetting LIPA's energy and capacity requirements. In August 2014, PSEG Long Island began a transition from the legacy Solar Entrepreneur and Solar Pioneer programs to the NYSERDA-funded NY-Sun Residential and Small Commercial initiative. After August 12, 2014, PSEG Long Island accepted only NY-Sun applications and the NY-Sun program absorbed the incentive costs for all ongoing projects. Despite this shift, legacy projects with applications completed before the cutoff date continued to trickle in over the 2015 calendar year, with the last closing out in late December. Regardless of whether a project went through the NY-Sun program or the legacy Solar Pioneer and Solar Entrepreneur program, NYSERDA funded all rebates paid after August 12, 2014, including $20 million in 2015.

The NY-Sun program uses a MW block structure that allots successive tiers of incentive rates so that early adopters receive the highest rebates. The new program structure brought with it increases to the maximum rebatable project size (from 10 kW to 25 kW for residential and from 50 kW to 200 kW for commercial). Table 8-1 depicts the layout of the megawatt block structure.

Table 8-1. NY-Sun MW Block Structure for Long Island

	Residential		Nonresidential		
	MW	Incentive/Watt	MW	Incentive/Watt, first 50 kW	Incentive/Watt, up to 200 kW
Block 1	37	$0.50	7	$0.50	$0.50
Block 2	15	$0.40	6	$0.45	$0.43
Block 3	20	$0.30	7	$0.40	$0.36
Block 4	77[a]	$0.20	9	$0.35	$0.30
Block 5			15	$0.25	$0.23
Block 6			14	$0.15	$0.15

[a] Revised (initially 50 MW).

The program manager anticipated funding for the Long Island region residential rebates to run out in the second quarter of 2016. As of March 2016, funding for the first three blocks has been exhausted and only approximately 10% of the fourth block funding remains.

Compared to the legacy Solar Entrepreneur and Solar Pioneer programs, the NY-Sun program requires higher levels of certification for participating contractors. Contractors must possess North American Board of Certified Energy Practitioners (NABCEP), International Brotherhood of Electrical Workers (IBEW)-National Electrical Contractors Association (NECA), or Underwriters Laboratories (UL) certification. Contractors already participating in the Solar Entrepreneur and Solar Pioneer programs prior to the transition were temporarily grandfathered into the NY-Sun program, but were required to acquire one of the three certifications by September 2015.

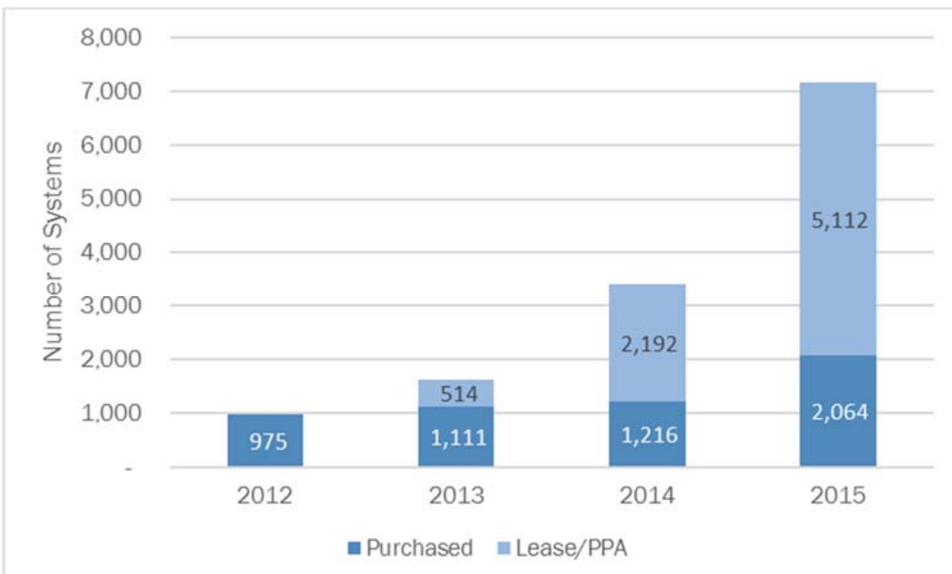
The NY-Sun program also introduced on-bill recovery and smart energy loans as optional mechanisms for receiving rebates and defraying upfront costs.

As in previous years, the program continued to take a hands-off approach to marketing and outreach, allowing contractors to communicate the program benefits to their customers. According to program staff, contractors increased their advertising in 2015, particularly some of the larger leasing companies. In past years, these companies coordinated advertising and door-to-door campaigns to recruit residential customers. Leasing and power purchase agreements continued to drive residential participation in 2015, accounting for more than two-thirds (69%) of residential solar PV systems rebated by the program.

Over the course of 2015, PSEG Long Island maintained two parallel program-tracking databases: Siebel for the legacy projects and PowerClerk for NY-Sun projects. The applications for the two programs vary slightly in design and required information due in part to the NY-Sun program's funding structure and its inclusion of other service territories.

In 2015, PSEG Long Island provided rebates for 7,176 solar PV systems, continuing the trend of roughly doubling participation for each of the past few years (975 in 2012, 1,625 in 2013, and 3,408 in 2014). As in 2014, residential systems accounted for the vast majority of installations (98%) and energy savings (88%). Figure 8-1 illustrates these changes in participation over the past four years broken out by payment method.

Figure 8-1. Number of PV Systems Installed per Year (2012–2015)



Although the commercial side of the program performed well, achieving 99% and 90% of its MWh and MW goals, respectively, it was the residential initiative that vastly exceeded expectations, reaching more than 200% of its goals for both energy and demand savings in the residential sector. PAs attribute much of this exceptional performance on the residential side to the continued efforts of companies offering leasing and power purchase agreement options to residential customers. These companies' self-motivated campaigns provided the outreach necessary to recruit more than double the anticipated number of residential participants and are expected to continue as long as funding remains available.

IMPACTS FOR GOAL COMPARISON

Table 8-2 shows the evaluated and ex ante savings for both the PSEG Long Island legacy solar program and the NY-Sun initiative.

Table 8-2. Solar PV Residential and Nonresidential Net Impacts for Goal Comparison

Program	N	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
NY-Sun	5,277	21,935	52,428,860	21,042	50,377,268	96%	96%
PSEG Long Island Solar PV	1,899	8,323	19,932,848	7,984	19,152,856	96%	96%
Total	**7,176**	**30,258**	**72,361,708**	**29,026**	**69,530,124**	**96%**	**96%**

For the 2015 evaluation, the Evaluation Team reviewed PSEG Long Island's solar PV performance analysis that uses contractor- and manufacturer-supplied hourly interval data to calculate realized energy savings from a sample of 2012 solar projects. To normalize capacity vs. performance, LIPA performed an in-house analysis of energy output as related to installed DC capacity using actual metered data from 98 customer installations. The Evaluation Team used this information to assess actual output from contractor information on the program's 7,176 installations in 2015.

The ex post peak demand analysis used average 14-year peak day/hour information provided by LIPA, along with the 2012 contractor- and manufacturer-supplied hourly output data, to determine the average demand output from installed solar panels during the typical peak hour. The typical peak hour was determined by weighting peak hours from 2002 to 2015, as outlined in Table 8-3.

Table 8-3. Solar Peak Hour Weighting Factors

Peak Hour Weighting		
Hour Starting	# Years	Weighting
2 p.m.	1	7.1%
3 p.m.	4	28.6%
4 p.m.	8	57.1%
5 p.m.	1	7.1%

Note: Percentages do not sum to 100% due to rounding.

The Evaluation Team adjusted reported results for line losses to reflect energy and demand savings at the generator.

IMPACTS FOR COST-EFFECTIVENESS

Based on research conducted in 2012 to assess the NTGR for this program, we found that the program had substantially influenced the market for solar, and the evaluated NTGR was set to 1.0 (equal to the program-planning value).[25] The values in Table 8-4 show the savings by program for the cost-effectiveness calculations. Since the NTGRs for both the evaluated and ex post savings are the same value, this table is identical to Table 8-2 above.

[25] A summary of the primary and secondary research conducted to estimate the effect of LIPA rebates on PV installations on Long Island can be found in the Program Guidance Document for 2011.

Table 8-4. Solar PV Residential and Nonresidential Net Impacts for Cost-Effectiveness

Program	N	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
NY-Sun	5,277	21,935	52,428,860	21,042	50,377,268	96%	96%
PSEG Long Island Solar PV	1,899	8,323	19,932,848	7,984	19,152,856	96%	96%
Total	**7,176**	**30,258**	**72,361,708**	**29,026**	**69,530,124**	**96%**	**96%**

Reasons for Differences in Impacts

The evaluated and ex post demand savings differed from ex ante savings for two reasons. First, we applied an average rated DC kW-to-actual AC kW factor of 0.867 based on the interval data of 124 solar PV installations on Long Island in 2012. This value differs from the modeled de-rating factor used in program planning and ex ante savings estimates. Second, the program currently uses a coincidence factor of 0.51, whereas evaluator analysis determined an ex post coincidence factor of 0.50 using the average 14-year peak hour weighting in Table 8-3.

The lower evaluated and ex post energy savings result from the application of an averaged rated DC kW-to-actual AC kWh factor of 1.071, again based on the performance of 124 solar PV projects in 2012, which is lower than the modeled value used in program planning and ex ante savings estimates.

9. Detailed Methods

9.1 Overview of Data Collection

Our 2015 evaluation of PSEG Long Island's Efficiency Long Island and Renewable Energy portfolios relied primarily on reviewing and analyzing program-tracking data, customer billing data, and secondary data sources to assess program impacts. Primary data collection in 2015 was limited mainly to in-depth interviews with program and implementation staff to provide context for our impact evaluation and to assess program processes. However, the Evaluation Team did conduct some secondary research to support limited process evaluations for several of the Efficiency Long Island programs.

9.2 Overview of Analytical Methods

Table 9-1 provides an overview of the main analytical methods used in the evaluation of each of the PSEG Long Island programs in 2015. The remainder of this section describes key analytic approaches used in our evaluation for each program and for the cost-effectiveness and economic impacts analyses in more detail.

Table 9-1. Primary Analytical Methods Used in 2015 Evaluation

	Qualitative Analysis of In-Depth Interviews	Secondary Data Review	Billing Analysis	Engineering Review of Algorithms	Engineering Desk Review of Projects
Program	Process/Impact	Process/Impact	Impact	Impact	Impact
CEP	X	X		X	X
EEP	X	X		X	
Cool Homes	X			X	
REAP	X		X	X	
HPD/HPwES	X		X	X	
Solar PV	X			X	

9.3 Commercial Efficiency Programs

The Evaluation Team performed two primary analytical activities as part of the CEP evaluation:

1. In-depth interviews with program staff to understand programmatic changes and record program implementation processes
2. Engineering review of algorithms and project desk reviews to assess gross impacts

Below we describe each effort in greater detail.

Program Staff Interviews

As part of the 2015 CEP evaluation, the Evaluation Team conducted in-depth interviews in December 2015 with three program staff members at Lockheed Martin who are responsible for the implementation of the CEP. The interviews were designed to understand programmatic changes made in 2015 and planned in 2016, to gather program staff perspectives on program performance and effectiveness of processes, and to understand any challenges that the program experienced in 2015.

ENGINEERING REVIEW OF ALGORITHMS AND PROJECT DESK REVIEWS

In 2015, the Evaluation Team performed two types of engineering reviews: a review of Siebel data and calculation of savings using engineering algorithms and a review of a sample of projects and calculation of savings using detailed information from each sampled project.

We reviewed Siebel data and applied engineering algorithms to evaluate savings for all prescriptive measures except for prescriptive lighting and performance lighting measures. We relied on the engineering desk reviews of a sample of projects to determine ex post savings for the following CEP program components: Prescriptive Lighting and Performance Lighting, Existing Retrofit Non-Lighting, and Existing Retrofit Lighting. The engineering desk review of a sample of projects as opposed to the population was necessitated by an inability to automatically extract project-specific information for the population of projects.[26]

We did not perform desk reviews for either SBDI or Custom projects. The discontinuation of the SBDI program in early 2015 and the small percentage of demand savings attributed to Custom projects did not warrant desk reviews. Instead, when evaluating savings, we applied 2014 realization rates for SBDI and 2012 realization rates for Custom projects, which were the most recent researched values.

All evaluations that include sampling have inherent levels of uncertainty in the estimates based solely on the fact that they are assessing only a portion of the population.[27] We can calculate this sampling error using the variability of savings seen from a probability-based sample design. In this type of design, each item in our sample frame has equal probability of being chosen for inclusion in our sample and being further assessed. However, certain sample designs require larger numbers to be included in the sample to reach the level of certainty desired. The Dalenius-Hodges technique is a statistical technique that provides optimal stratification of a population to enable reduction in sample size while maintaining statistical precision.

We used a stratified random sample design to draw samples for the Prescriptive Lighting and Performance Lighting, Existing Retrofit Non-Lighting, and Existing Retrofit Lighting projects. We relied on the Dalenius-Hodges technique to determine appropriate strata for each sample frame and the Neyman allocation method to obtain optimal samples by stratum. We detail this process below. Following, we provide information on the samples that we drew for each of the CEP components.

DETERMINATION OF STRATA BOUNDARIES

The Dalenius-Hodges method begins with the creation of numerous and narrow strata. Within each stratum, the frequency of coupons, *f(y)*, is calculated. Next, the square root of f(y), $\sqrt{f(y)}$, is calculated and the cumulative of $\sqrt{f(y)}$ is formed. The total of cumulative $\sqrt{f(y)}$ is then divided by the number of desired strata to determine the division points on the cumulative $\sqrt{f(y)}$ scale.

The above rule assumes equal widths *d* for the class intervals, and it must be modified when the class intervals have variable widths d_y. The approach recommended by Kish[28] is to multiply the *f(y)* by the width of the interval, take the square root of this value, and cumulate the values $\sqrt{d_y f(y)}$. Finally, as in the above case, the total

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[26] Detailed data that are useful for an engineering analysis are stored in Siebel as attachments, and savings are calculated outside of Siebel. The Siebel system contained a project gross and net total energy and demand savings. We used this information at the project level to pull our sample by demand savings for each component.

[27] We note that all evaluations contain levels of uncertainty, some of which can be calculated (e.g., sampling error, measurement error for engineering instruments) and some of which cannot (e.g., nonresponse in surveys).

[28] Kish, L. 1995. *Survey Sampling*. Wiley Classics Library Edition.

of cumulative $\sqrt{d_y f(y)}$ is then divided by the number of desired strata to determine the division points on the cumulative $\sqrt{d_y f(y)}$ scale.

Optimal Allocation

Once strata boundaries have been determined, an allocation scheme is used to estimate the population mean with the lowest variance for a fixed total sample size *n* under stratified random sampling. Such a scheme is the Neyman allocation as described in Cochran.[29]

$$n_h = n \frac{N_h s_h}{\sum N_h s_h} \qquad (1)$$

Where:

N_h = the total number of units in stratum *h*

n_h = the number of units in the sample of stratum *h*

n = the total number of units in the sample across all strata

s_h = the variance within stratum *h*

This formula for optimal allocation may produce an n_h in some strata that is larger than the corresponding N_h. This problem can arise in the plan for the verification of rebate program savings, since the overall sampling fraction is large and some strata are much more variable than others. If the original allocation gives, for example, an n_1 that is greater than N_1, then equation 1 is revised as follows:

$$n_h = (n - N_1) \frac{N_h s_h}{\sum_2^L N_h s_h} \qquad (2)$$

If the original allocation gives, for example, an n_1 that is greater than N_1 and an n_2 that is greater than N_2, then equation 2 is revised as follows:

$$n_h = (n - N_1 - N_2) \frac{N_h s_h}{\sum_3^L N_h s_h} \qquad (3)$$

Using the approach just described, the sample designs for all of our samples were expected to provide statistically valid impact results at least at the 90% confidence level ±10% for the projects overall based on demand.

Engineering Review Sample Design

The sample designs for the Prescriptive Lighting and Performance Lighting projects, Existing Retrofit Non-Lighting, and Existing Retrofit Lighting program components are shown in Table 9-2. We used a random sample design stratified by kW demand savings to draw the samples for these three components. Several Existing Retrofit Lighting projects were misclassified as Prescriptive Lighting, while some Prescriptive Refrigeration projects were misclassified as Existing Retrofit. The Evaluation Team corrected the misclassified projects and shifted them into the appropriate sample frames prior to drawing the samples.

[29] Cochran, W.G. 1977. *Sampling Techniques.* Hoboken: John Wiley & Sons, Inc.

Table 9-2. CEP Prescriptive Lighting, Performance Lighting, Existing Retrofit Non-Lighting, and Existing Retrofit Lighting Engineering Review Sample Design

Stratum	Boundaries (kW)	Total Ex Ante Savings (kW)	Projects in Population	Projects in Sample
Prescriptive Lighting and Performance Lighting				
1	0–13	320	129	5
2	14–100	563	18	5
Subtotal		**883**	**147**	**10**
Existing Retrofit Non-Lighting Projects				
1	0–10	566	153	5
2	11–105	594	27	5
Subtotal		**1,160**	**180**	**10**
Existing Retrofit Lighting Projects				
1	0–8	4,963	1,818	8
2	9–40	7,180	395	7
3	41–250	6,461	83	7
Subtotal		**18,604**	**2,296**	**21**

For each desk review, we performed the following tasks:

- Checked the data for data entry errors, omissions, or inconsistencies by comparing project documentation, such as invoices, to the program-tracking data extract.
- Calculated ex post gross demand and energy savings based on the detailed information in the project files and compared those savings to the program-tracking data.
- Calculated gross realization rates for each project in our sample by applying line loss, coincidence, and net-to-gross factors to the ex post gross savings values and dividing the resulting savings by ex ante net savings.
- Applied the sample design weighting factors to arrive at a gross realization rate for each program component.

For the desk reviews, we used the ratio adjustment method[30] to extrapolate results for each site back to the overall 2015 component population. Figure 9-1 shows the algorithm we used to extrapolate to the population.

[30] Lessler, Judith T. and Kalsbeek, William D. 1992. *Nonsampling Error in Surveys.* p. 269.

Figure 9-1. Ratio Adjustment Algorithm

$$I_{EP} = \frac{I_{EPS}}{I_{EAS}} * I_{EA}$$

Where:

I_{EP} = ex post population impact

I_{EA} = ex ante population impact

I_{EPS} = ex post impact from the sample

I_{EAS} = ex ante impact from the sample

$I_{EPS} \div I_{EAS}$ = realization rate

There are background algorithms that are used as part of the ratio adjustment algorithm that we describe next. To obtain the phase-specific realization rate, we use the following algorithm:

$$Realization\ Rate = \sum_{i=1}^{n} \frac{Ex\ Post\ Savings_i * W_{si}}{Ex\ Ante\ Savings_i * W_{si}}$$

Where:

W_{si} = expansion weight for stratum I (shown in tables above)

$Savings_i$ = project values for sampled projects

Once we obtain the realization rate, we calculate the standard error, error bound, and relative precision, as shown next.

$$e_i = \ Ex\ Post\ Savings_i - \ (Realization\ Rate * \ Ex\ Ante\ Savings_i)$$

$$Standard\ Error = \sqrt{\frac{W_{si}(W_{si} - 1) * \ e_i^2}{\sum_{i=1}^{n} Ex\ Ante\ Savings_i * \ W_{si}}}$$

$$Error\ Bound = 1.645 * Standard\ Error$$

$$Relative\ Precision = \frac{Error\ Bound}{Realization\ Rate}$$

To pull together the multiple samples and arrive at a single precision for the population, we use the following algorithm:

$$Relative\ Precision\ Across\ Multiple\ Samples = \frac{\sqrt{Error\ Bound_1 \ + Error\ Bound_2 \ + Error\ Bound_n}}{\sum_1^n Ex\ Post\ Savings_i}$$

9.4 Energy Efficient Products Program

The Evaluation Team conducted an in-depth interview with the EEP program manager and reviewed program-tracking data. In addition, we conducted primary research on retailer appliance recycling policies and procedures through two mystery shopper calls with two P.C. Richards and Sons retail locations on Long Island. These retailers were chosen because they had sold the most EEP program appliances in 2015. We also conducted exploratory research to learn more about the factors driving observed changes in the mix of specialty LED product purchases over time and the associated decline in program savings. This research included a detailed comparison of program-tracking datasets from multiple years to examine changes in bulbs' equivalent wattages over time; a focused comparison of changes in ENERGY STAR calculations used in 2015 and 2016; and internet research. Based on findings from these activities, we determined that three main factors are driving the changing mix of lighting measures and their associated savings: a change in the types of specialty LED products that customers purchased, the increasing efficiency of individual products over time, and updates to the ENERGY STAR mapping scheme used in the evaluation. Section 3 reports on these findings in more detail..

9.5 Cool Homes

The Evaluation Team conducted in-depth interviews with program managers and implementers and reviewed program-tracking data and program application procedures for the Cool Homes program.

9.6 Data Cleaning and Model Development for Billing Analyses for REAP, HPD, and HPwES

Data Preparation and Cleaning

PSEG Long Island provided participation and measure data for all customers who participated in the HPD/HPwES programs or the REAP program in 2014 and 2015. PSEG Long Island also provided a billing history going back 50 months to January 2012 for both 2014 and 2015 program participants.[31] Prior to carrying out the statistical modeling, we matched, cleaned, and provided QA for all data. For analysis purposes, we focused primarily on the 2014 participants, but retained 2015 participants as a comparison group. We used the same data-cleaning procedures for both 2014 and 2015 participants.

Cleaning Participation Data

We utilized records from program-tracking databases as the basis for our analysis sample, because these records had the PSEG Long Island customer account number associated with each site identifier. Our data are based on program-tracking records provided in January 2015, which included complete 2014 and 2015 participant data.

Our cleaning procedure was consistent with what was performed in prior evaluations. First, we checked to make sure that all accounts had measure data. We found no records without measure data. We then identified and removed any accounts without electric measures. We also looked for records with missing savings or zero quantities; however, no accounts had to be removed for this reason. We aggregated the remaining records

[31] Some of these data had already been provided to us in last year's evaluation and some were provided this year.

into the major end-use categories, which we then rolled up to a unique household level (defined as unique account).

After cleaning the measure data, we calculated annual expected savings for each participant based on the sum of gross deemed kWh savings for all of the measures that each participant installed within the HPD and HPwES programs. We used these expected savings as the basis for realization rates. For customers who participated in multiple program years, we used the first installation date as the cutoff for determining whether the customer would be included in the treatment or comparison group.

Matching Participant Information with PSEG Long Island Account Information

The HPD, HPwES, and REAP programs track PSEG Long Island customer account information with participant records. As a result, we used the customer account numbers provided with participation data to match billing histories to program participants.

Cleaning Billing Data

We merged 2014 and 2015 participants' billing data and then took a two-step approach to cleaning the data. This approach is consistent with the approach used in previous evaluations of the program. First, we removed individual billing periods, i.e., meter reads that were duplicative, cancelled, or had 0 billing days. Second, we cleaned the data for customer accounts with anomalous or insufficient data for billing analysis. We describe each billing data cleaning step below.

- Cleaning Individual Billing Periods: We removed billing periods with a duration of 0 days (i.e., same start and end date), periods with a missing date, and those with 0 kWh of energy usage. For participants who participated in 2015 only, we did not include billing periods occurring after their first installation date, as these 2015 participants served as the comparison group.
- Extremely High or Low Average Daily Consumption (ADC): We removed customers with entire pre- or post-periods having very high or very low usage. This is to ensure that participants spent equivalent amounts of time in their homes in the months before and after program participation. We dropped households with ADC at or below 2 kWh/day on average (across their billing history in both the pre-period and the post-period). We also dropped customers with extremely high usage (more than 300 kWh/day). These households are likely to contain odd usage patterns that we cannot easily control for and could bias our results.
- Inadequate Billing History before or after Program Participation: Many energy-savings measures in these programs are expected to generate energy savings throughout the year. To be able to assess changes in consumption due to program measures before and after installation, we required participants to have a billing history covering, at a minimum, 180 days before the first day of program participation for both the 2014 and 2015 program participants and, for 2014 participants, 180 days after participation.
- Inadequate Billing History in the Cooling Season before and after Program Participation: We also required participants to have a minimum of 60 days in the summer (cooling season), both before and after participation. This is because we expect the measure installation to be generally weather sensitive both in terms of temperature and in terms of daylight hours. By ensuring that we have enough billing data in the months of June, July, and August, we allow for more rigorous savings estimates.

Assigning Time Periods to Billing Data

The billing data were provided in billing cycle format, which means that customers have different read days and different read cycle lengths, depending on their meter read cycle. For the analysis to be comparable across customers and time periods, we needed to assign each billing period to a specific calendar month. We first assigned a month to each period based on the midpoint of the billing period, so that the month would refer to the month in which the majority of energy use occurred (e.g., if the read period started on June 20 and ended on July 19, we assigned that period to July). In cases where two shorter read periods occurred within the same billing period, we combined kWh usage for both periods and recalculated ADC across the combined period. Many billing periods in the data start and end in the middle of a month, which often causes some consecutive bills to be assigned the same month as a midpoint. In these cases, we combined the two periods.

INCORPORATING WEATHER DATA

As in previous billing analyses, weather was incorporated into the model using daily weather data from numerous weather stations across Long Island, utilizing the site closest to each account's geographic location. By using multiple sites, we could increase the accuracy of the weather data being applied to each account. We obtained these data from the National Climatic Data Center (NCDC).

The daily data are based on hourly temperatures from each day. We calculated cooling degree days (CDDs) and heating degree days (HDDs) for each day (in the analysis and historical period) based on daily temperature, using a base temperature of 65° for HDDs and 75° for CDDs.[32] Using different base temperatures may be more representative of actual heating and cooling behaviors of customers. We merged daily weather data into the billing data set so that each billing period captures the HDDs and CDDs for each day within that billing period (including start and end dates). For analysis purposes, we then calculated average daily HDDs and average daily CDDs, based on the number of days within each billing period.

MODEL DEVELOPMENT

As mentioned previously, all models included a comparison group consisting of households that participated in 2015 to construct the counterfactual baseline (what 2014 participants would have done during the post-period absent the program). Billing analysis with an appropriate comparison group provides net savings, incorporating the effects of both FR and SO. For example, the energy use patterns of the members of the comparison group during 2014–2015 (up to the point of their participation) reflect equipment installations and behavioral changes that treatment group participants (2014 participants) might have performed in the absence of the program. In addition, any measures installed during the evaluation period beyond program measures (SO) would be picked up by an increased coefficient for the participation variables.

To improve our estimate of the counterfactual baseline (what 2014 participants would have done during the post-period absent the program), we added indicator variables for each month of the evaluation period. The monthly indicator variables provide information on time trends that affect both the comparison and treatment groups. We also entered weather terms in the model, as well as interaction terms between weather and the post-period for the treatment group, to account for differences in weather across years.

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[32] The Evaluation Team diverges from the following definition to better represent the likely heating and cooling behaviors of customer. In general, a degree-day is defined as "a unit of measure for recording how hot or how cold it has been over a 24-hour period. The number of degree-days applied to any particular day of the week is determined by calculating the mean temperature for the day and then comparing the mean temperature to a base value of 65 degrees F. (The 'mean' temperature is calculated by adding together the high for the day and the low for the day, and then dividing the result by 2.) If the mean temperature for the day is, say, 5 degrees higher than 65, then there have been 5 cooling degree-days. On the other hand, if the weather has been cool, and the mean temperature is, say, 55 degrees, then there have been 10 heating degree-days (65 minus 55 equals 10)." http://www.srh.noaa.gov/ffc/?n=degdays.

Paraphrased from http://www.srh.noaa.gov/ffc/?n=degdays.

Our final model needed to fill a number of criteria. Primarily, we looked to use a model that explained as much about changes in the dependent variable as possible. The most-direct measure of this is the overall R-sq, which gives an estimate of how much the model explains. An R-sq of 1.0 would represent a model that explains 100% of the variance in the depend variable, and an R-sq of 0.5 would explain 50%. In our quasi-experiment, R-sq will appear low because of our use of fixed effects, but a higher R-sq will be a significant factor. We also compare Akaike Information Criterion (AIC) values of different model specifications. AIC is a measure of relative quality between models, based on estimated loss of information lost when a model is used to represent data. Given this, a lower value, relative to other models, indicates that the model is more robust.

In the development of our final model, we tested a series of progressively inclusive specifications. The simplest models took into account only the effect of participation and weather, in the form of total CCDs and HDDs in each period. This model does not control for changes in energy usage over time and is at a high risk of omitted variables bias.[33] Subsequent models include month-year fixed effects to control for the time at which the billing period occurred. Finally, we included interaction terms of the treatment effect with both CDDs and HDDs. Measure-specific dummy variables, indicating the installation of each measure category, were tested in the models as well. These variables take on a value of 1 during the period *after* a home received its final measure installation (i.e., excluding the month of the installation). In cases where a participant received multiple installations, the period between the first and last installation was excluded from the analysis. The installation variable(s) were set to 0 for all months before the start of program participation. Because of the overlap in measure installation, and because the program has not altered the measures provided to customers, we chose to focus on the program overall.

Some customers participated in these programs on multiple dates, so we assessed treatment to be the bill in which they participated most recently. The months between their primary participation date and their final participation date were excluded from the model. Customers with a single date of participation had only the one bill that encompassed their participation date excluded from the model. The treatment effect is the change in energy use that is caused by participating in the program and, as such, cannot overlap with time before their participation in the program.

9.7 REAP Program Estimation of Savings Using Billing Analysis

In this section, we present the statistical methods and results of a billing analysis to estimate program savings for REAP.

Final Analysis Data Set

In total, our REAP program data set includes 1,931 accounts. Approximately 47% of the total participant population was available for analysis after data preparation and cleaning. Table 9-3 presents the results of cleaning participation data, integrating clean billing data, and checking for sufficient billing data for each customer.

[33] Omitted variables bias is caused by not including important factors that affect the independent variable. The model compensates for the missing explanatory variables, resulting in misrepresentative estimates of the terms included.

Table 9-3. REAP Program Participation and Billing Data Cleaning Steps

	Total Accounts	Percent of Total
Total Unique Accounts	4,060	100.00%
Reason Account Was Dropped		
No Billing Data	145	
# of accounts remaining	3,915	96.43%
No Participant Tracking Data	2	
# of accounts remaining	3,913	96.38%
Low Overall ADC: < 2 kWh	11	
Low Overall Pre ADC: < 2 kWh	4	
High Overall Pre ADC: > 300 kWh	60	
Low Overall Post ADC: < 2 kWh (Treat)	2	
# of accounts remaining	3,896	95.96%
High Overall Post ADC: > 300 kWh (Treat)	14	
# of accounts remaining	3,822	94.14%
Less Than 60 Summer Days Pre-Period	901	
# of accounts remaining	2,921	71.95%
Less Than 60 Summer Days Post-Period (Treat)	48	
# of accounts remaining	2,873	70.76%
Less Than 6 Months in Pre-Period Days	118	
# of accounts remaining	2,755	67.86%
Less Than 6 Months in Post-Period Days (Treat)	12	
# of accounts remaining	2,743	67.56%
Cross Participation	159	
# of accounts remaining	2,584	63.65%
Room A/C Customer	535	
# of accounts remaining	2,049	50.47%
Dehumidifier Customer	118	
# of accounts remaining	1,931	47.56%
Final Number of Accounts 2014–2015	1,931	47.56%

In addition to the standard set of reasons for dropping accounts from the billing analysis, we also opted to exclude accounts that installed room A/C units or dehumidifiers. Since these measures were newly added to the program for 2015, we lacked a sufficient population of accounts in the treatment group with those measures installed. The savings provided through the billing analysis model for this evaluation relate solely to the other aspects of the REAP program and, as such, are not entirely representative of the savings realized during 2015. To bolster these savings, we added the savings calculated in our engineering analysis for room A/C units and dehumidifiers to customers who received the measure. While this reduced the size of our final data set, it was a necessary step due to the nature of our comparison group methodology, described below. Using future participants, as we do, for a comparison group delays the analysis of a given program year because we must have a year of participants, beyond the year studied, available to serve as a comparison. To avoid delaying the realization of savings caused by new measures, or other program changes, the Evaluation Team would require a full customer database and billing records for all customers. Access to these data allow for a matched comparison group to be used, where non-participants with similar energy usage patterns are matched to program participants.

ASSESSING COMPARISON GROUP EQUIVALENCY

Before performing any modeling, we assessed the comparability of our treatment and comparison groups. Using a good comparison group is important because if we can assume that the treatment and comparison groups have a similar propensity to participate, then including the comparison group allows us to calculate net savings (i.e., savings that incorporate the effects of both FR and SO). To assess the groups, we determined the overall average baseline kWh consumption for each group and the average daily kWh, CDDs, and HDDs for pre- and post-participation time periods for the treatment group. These figures provide context for the more-detailed analyses shown later in this section. Table 9-4 shows the comparison of the pre- and post-kWh and weather variables for the treatment group. It shows that consumption dropped in the post-participation period compared to the pre-participation period. This drop could reflect program impacts but may also be associated with weather. The post-participation period included a colder winter and a milder summer. Because it is unclear exactly how these two offsetting factors may have influenced energy consumption, billing analysis is necessary to isolate program-related changes from other factors, such as the separate effects of CDDs and HDDs on consumption.

Table 9-4. REAP Program Analysis: Average Values of Key Variables by Time Period for 2014 Treatment Group

Variable	Statistic	Period	
		Pre-	Post-
Daily kWh	*Mean*	23.38	20.35
	SD	21.20	16.67
CDDs	*Mean*	26.07	38.71
	SD	43.91	57.24
HDDs	*Mean*	800.96	614.91
	SD	793.68	750.50

By graphing average energy consumption during the baseline period (i.e., the pre-participation period for the treatment group and the same months of 2011 and 2012 for the comparison group), we see that the two groups have some visible difference in their usage patterns, meaning that we will need to add some corrective terms to the model to more accurately show changes due to participation in the REAP program. The gap between the treatment and control groups in the post-treatment period (right of the treatment line) is not a major concern, since they follow similar patterns through the months. In the pre-treatment period, note that the lines cross. This indicates clearly that the two groups reacted differently to changing months during that period. We also have considerably fewer bills from 2012 and 2013 in the data, accounting for approximately 20% of the bills from the 4 years included. The lack of data during that time could be a source of error. To address this potential error, we include an interaction term in the model for pre-period usage in each month. Doing this corrects for pre-period differences between the groups that occur and helps ensure that changes in energy use during the post-period are attributable to treatment as opposed to unexplained differences in the pre-period. Focusing on ADC in the time near to and after treatment, the two groups follow similar patterns of energy use over time. Figure 9-3 and Figure 9-4 show that weather for the comparison and treatment groups is nearly identical. Overall, after correcting for pre-period differences in ADC, we are confident that the 2015 REAP program participants provide a reasonable comparison to 2014 participants.

Figure 9-2. REAP Program Analysis: Baseline kWh by Sample Group in Analysis

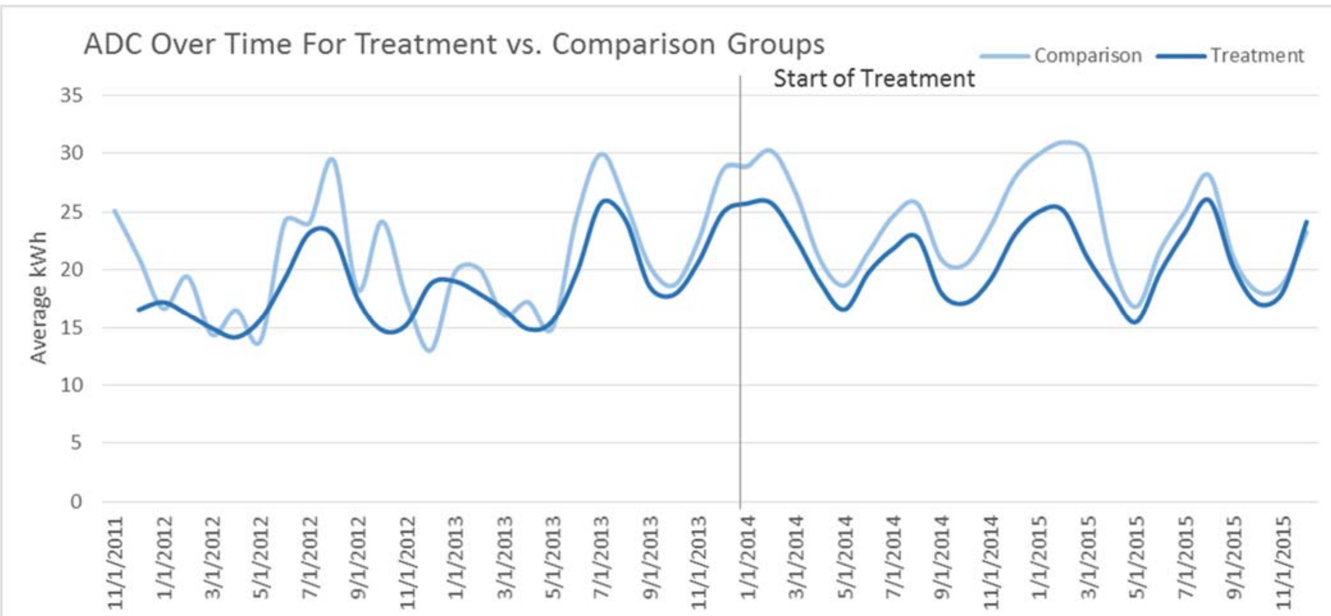


Figure 9-3. REAP Program Analysis: Heating Degree Days by Sample Group

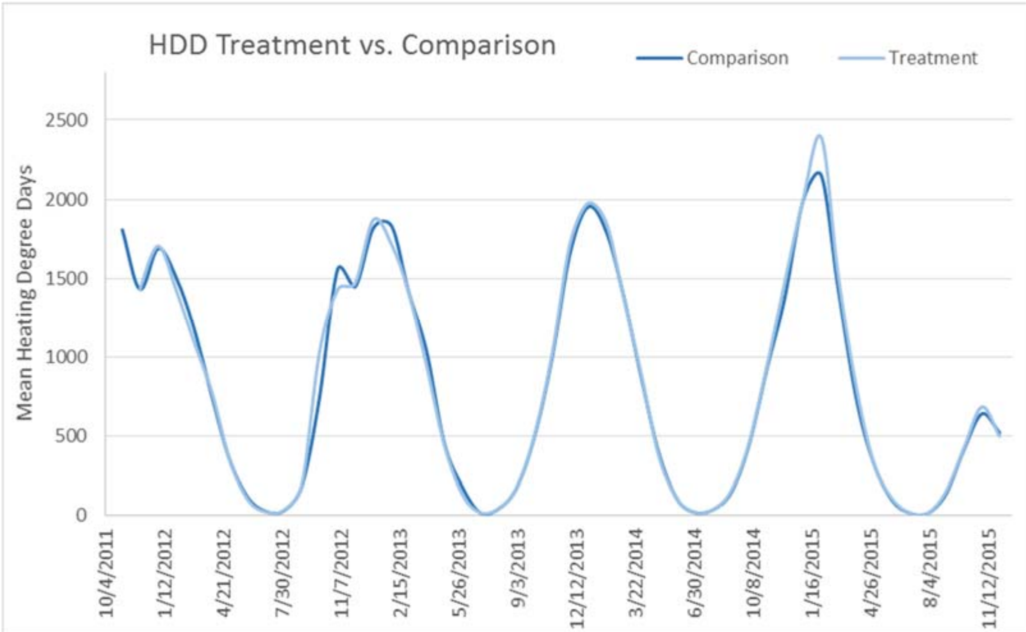
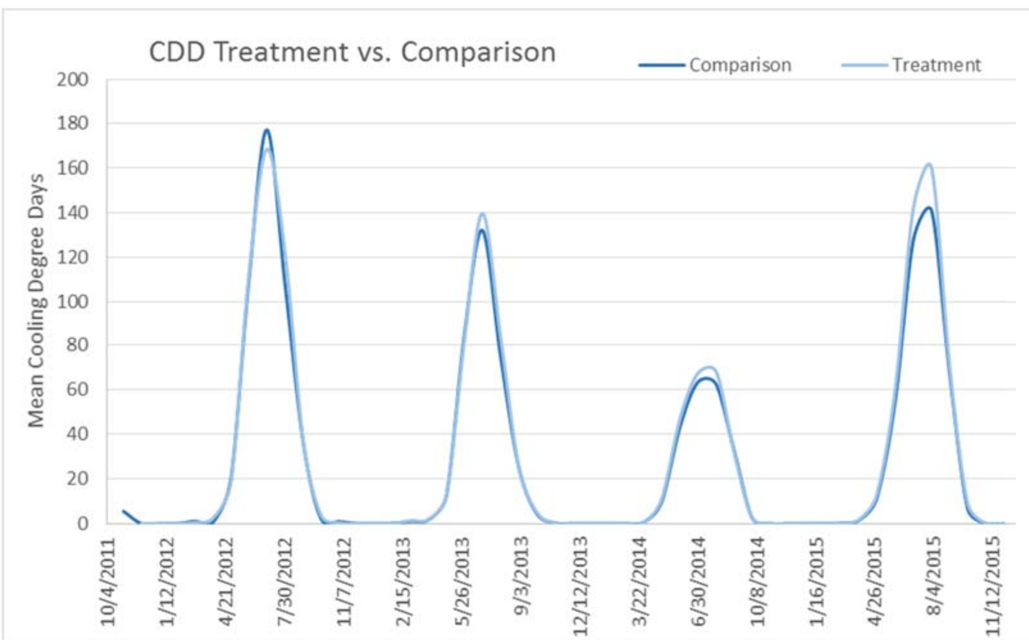


Figure 9-4. REAP Program Analysis: Cooling Degree Days by Sample Group



STATISTICAL METHOD USED

We conducted a billing analysis to determine ex post net program savings using a LFER CDA model. The final model includes terms for treatment, which is an indicator variable for participation in the program, time, and weather. The treatment effect is the change in energy use that is caused by participating in the program and, as such, cannot overlap with time before participants participate in the program. Due to a high degree of overlap between program measures, especially in the case of CFLs, we did not separate out any individual measures in the final model.[34] We did, however, remove customers who installed room A/Cs and dehumidifiers, as these were new measures to the program.

To ensure that the model specifications that we chose performed at least as well as the previous evaluation, we ran the exact same model as the 2014 evaluation on this year's data. In that model, we had included specific variables for key measures, as well as an interacting between lighting and HDDs. Last year's model also did not include any post-period weather correction. The savings seen in that model were slightly smaller than those provided by this year's model, and we found this year's model to have a better fit overall. Additionally, since we were focused on overall program impacts, the new model provides a more straightforward representation of the effect of participation in the REAP program.

As for our final model specification, we fit a number of possible models and selected the one with the best overall fit based on R-sq and AIC. The following equation represents the final model:

Figure 9-5. Final Model Equation

$$ADC_{it} = B_h + B_1 Post_{it} + B_2 HDD_{it} + B_3 CDD_{it} + B_4 Post \cdot HDD_{it} + B_5 Post \cdot CDD_{it} + B_{t1} MY \cdot PreADC + \varepsilon_{it}$$

Where:

ADC_{it} = Average daily consumption (in kWh) for the billing period

$Post$ = Indicator for treatment group in post-period (coded "0" if treatment group in pre-period or comparison group in all periods)

HDD = Average daily HDDs from NOAA

CDD = Average daily CDDs from NOAA

MY = Month-year indicator for each time period in the model

$PreADC$ = Pre-period ADC

B_h= Average household-specific constant

B_1= Main program effect (change in ADC associated with being a participant in the post-period)

B_2= Increment in ADC associated with 1-unit increase in HDD

B_3= Increment in ADC associated with 1-unit increase in CDD

B_4= Increment in ADC associated with each increment increase of HDD for participants in the post-program period (the additional program effect due to HDD)

B_5= Increment in ADC associated with each increment increase of CDD for participants in the post-program period (the additional program effect due to CDD)

B_t= Coefficients for each month-year period

B_{t1}= Coefficients for each month-year period for pre-period ADC

ε_{it} = Error term

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[34] However, we did test model specifications that included dummy variables measures and we found no differences in our main results.

Electric Savings Results

Table 9-5 shows the final model results. The model is meant to show changes in electricity use after participation in the REAP program, controlling for weather, time, and the household characteristics (reflected in the constant term). The program effects term (Treatment) is negative, indicating that program participants did reduce energy consumption in the post-period (after controlling for weather). Since customers who participated in other PSEG Long Island energy efficiency programs were not included in this analysis, we can be confident that this reduced energy consumption is attributable to participation in the REAP program.

Table 9-5. REAP Program Billing Analysis: Final Model

Predictor	Coefficient	Robust Std. Err.	T	P > |t|	90% Confidence Interval	
					Lower	Upper
Treatment	−1.0847	0.404319	−2.68	0.007	−1.87767	−0.29177
HDD	−0.0067	0.000473	−13.92	0.000	−0.00761	−0.00573
CDD	0.0984	0.006715	14.66	0.000	0.085239	0.111577
Post-Period HDD	−0.0001	0.00034s	−0.34	0.733	−0.00079	0.000553
Post-Period CDD	−0.0064	0.005475	−1.17	0.241	−0.01716	0.004315
Constant	42.794	0.890003	48.08	0.000	41.04865	44.53959

Due to the weather interaction terms in the model, it is necessary to recalculate the coefficient of the treatment effect (Treatment) by combining the average value with the coefficient for each interaction term. The coefficient seen in the regression represents the reduction of daily consumption during the post-period, including any reduction caused by milder temperatures. Utilizing a simple equation that combines the coefficients of those interaction terms with the average post-period values for each, we are able to estimate the overall savings associated with the program itself.

Table 9-6. Adjusted Estimate of Daily Program Savings

ADC	Estimate	Std. Err.	T	P >|t|	90% Confidence Interval	
					Lower	Upper
(1)	−1.39774	0.2975264	−4.70	0.000	−1.887362	−0.9081174

The value of the estimate represents the kWh change in ADC given a 1-unit change in the treatment effect, i.e., treatment moving from 0 (pre-treatment) to 1 (post-treatment). These results can also be used to estimate a decrease in electricity usage overall. The savings estimated here can be extrapolated to the overall net program savings for REAP program participants who did not install room A/C units and dehumidifiers. There is a 90% probability, or confidence, that overall program savings range between 0.91 kWh and 1.89 kWh per day.

Billing Analysis Compared to Expected Savings

Table 9-7 compares the observed (ex post) savings from the billing analysis to the expected (ex ante) savings for these participants based on PSEG Long Island's program-planning estimates. The results of the comparisons are the associated realization rates. The overall realization rate for the program is 48%.

Table 9-7. Savings from REAP Program Billing Analysis Compared to Savings Expected from Program-Planning Estimates

End-Use	N[a]	Observed Savings		Program-Planning Savings[b]		Realization Rate
		Household Daily Savings	Household Annual Savings	Household Daily Savings	Household Annual Savings	
Overall Program	1,931	1.40	510	2.89	1,055	48%

[a] Number of program participants in billing analysis. There were 2,084 unique accounts from PY 2014. Of that total, 1,127 were excluded from the billing analysis for reasons outlined in Table 9-3.
[b] The line loss factor is not applied to the program-planning savings.

Participants who received the core measures from participation in the REAP program saved an estimated 510 kWh. For customers who installed new measures not included in the billing analysis we can assume that they would save more. Based on calculations from our engineering analysis, customers who installed a room A/C would likely save an additional 118 kWh on average, and those who installed a dehumidifier would save an additional 130 kWh on average.

9.8 HPD/HPwES Estimation of Savings Using Billing Analysis

In this section, we present the statistical methods and results of a billing analysis to estimate program savings for the HPD and HPwES programs.

Final Analysis Data Set

In total, our HPD/HPwES program data set includes 5,273 unique accounts. Approximately 78% of the total participant population was available for analysis after data preparation and cleaning. Table 9-8 presents the results of cleaning participation data, integrating clean billing data, and checking for sufficient billing data for each customer.

Table 9-8. HPD/HPwES Participation and Billing Data Cleaning Steps

	Total Accounts	Percent of Accounts Remaining
Total Unique Accounts	5,273	100%
Reason Account Was Dropped		
No Billing Data	165	3.1%
# of accounts remaining	5,108	96.9%
No Participant Tracking Data	4	0.1%
# of accounts remaining	5,104	96.8%
Low Overall ADC: < 2 kWh	1	0.0%
Low Overall Pre ADC: < 2 kWh	2	0.0%
# of accounts remaining	5,101	96.7%
High Overall Pre ADC: > 300 kWh	42	0.8%
High Overall Post ADC: > 300 kWh (Treat)	9	0.2%
# of accounts remaining	5,050	95.8%
Less Than 60 Summer Days Pre-Period	978	18.5%
# of accounts remaining	4,072	77.2%
Less Than 60 Summer Days Post-Period (Treat)	82	1.6%
# of accounts remaining	3,990	75.7%
Less Than 6 Months in Post-Period Days (Treat)	3	0.1%
# of accounts remaining	3,889	73.8%
Final Number of Accounts 2014–2015	3,889	73.8%

Assessing Comparison Group Equivalency

Before performing any modeling, we assessed the comparability of our treatment and comparison groups. Using a good comparison group is important because, if we can assume that the treatment and comparison groups have a similar propensity to participate, then including the comparison group allows us to calculate net savings (i.e., savings that incorporate the effects of both FR and SO). To assess the groups, we determined the overall average baseline kWh consumption of each group and the average daily kWh, CDDs, and HDDs for pre- and post-participation time periods for the treatment group. These figures provide context for the more-detailed analyses shown later in this section. Table 9-9 shows the comparison of the pre- and post-kWh and weather variables for the treatment group. It shows that consumption dropped in the post-participation period compared to the pre-participation period. This drop could reflect program impacts, but may also be associated with weather. The post-participation period included a colder winter and a milder summer. Because it is unclear exactly how these two offsetting factors may have influenced energy consumption, billing analysis is necessary to isolate program-related changes from other factors, such as the separate effects of CDDs and HDDs on consumption.

Table 9-9. HPD/HPwES Program Analysis: Average Values of Key Variables by Time Period for 2014 Treatment Group

Variable	Statistic	Period	
		Pre-	Post-
Daily kWh	*Mean*	35.45	34.04
	SD	28.79	27.96
CDDs	*Mean*	27.81	39.92
	SD	46.38	59.28
HDDs	*Mean*	808.05	576.34
	SD	811.00	727.73

Graphing average energy consumption during the baseline period (i.e., the pre-participation period for the treatment group and the same months for the comparison group) makes the assessment of energy use differences a little easier. Figure 9-6 shows the ADC for January 2011 through December 2012 (the pre-program period) to determine how similar households may be in terms of energy consumption patterns. We see strong equivalency in pre-program usage patterns between the treatment and comparison groups, demonstrating that 2014 participants serve as an effective baseline. Figure 9-7 and Figure 9-8 show that weather for the comparison and treatment groups are nearly identical. Overall, based on the similarities between weather experienced and baseline energy consumption of the two groups, we are confident that 2015 HPD/HPwES program participants provide a reliable comparison group for 2014 participants.

Figure 9-6. HPD/HPwES Program Analysis: Baseline kWh by Sample Group

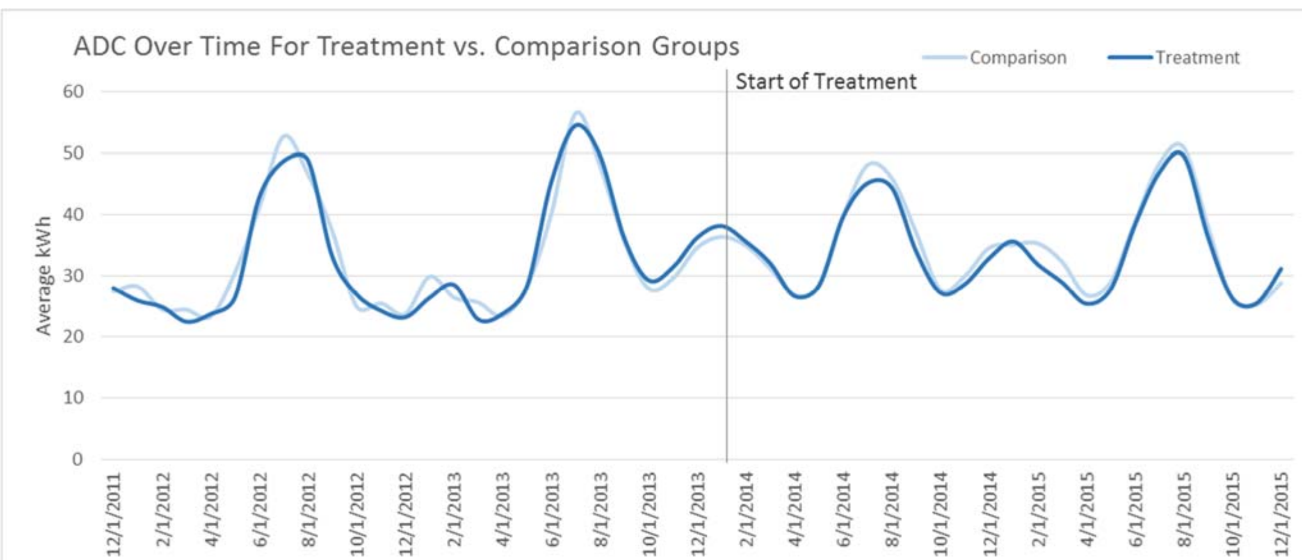


Figure 9-7. HPD/HPwES Program Analysis: Heating Degree Days by Sample Group

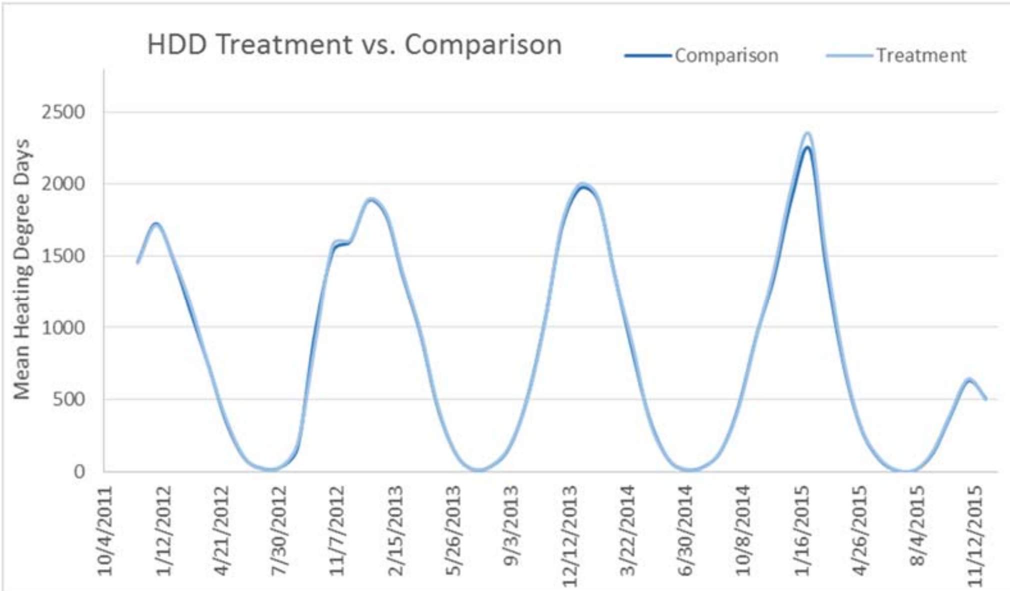
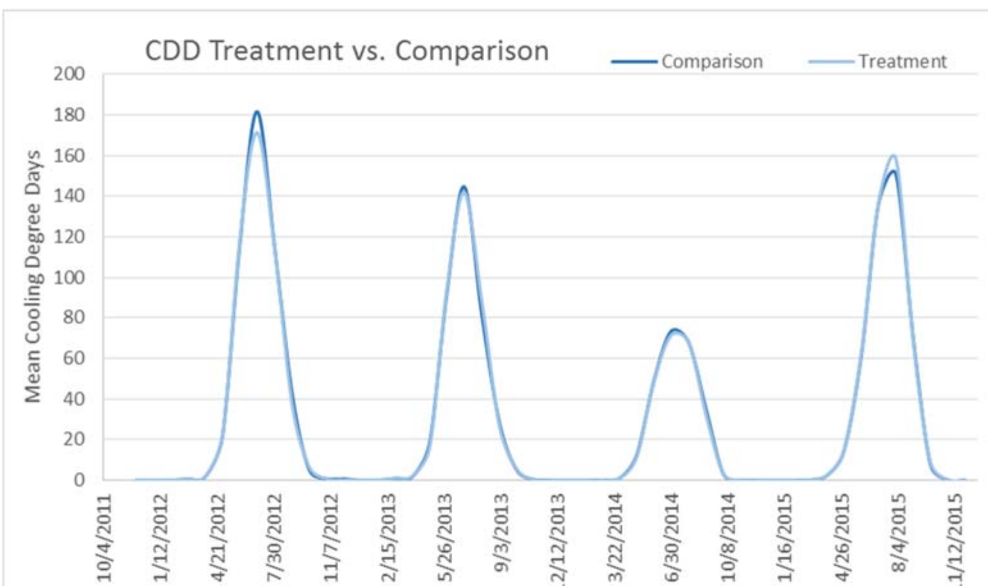


Figure 9-8. HPD/HPwES Program Analysis: Cooling Degree Days by Sample Group



STATISTICAL METHOD USED

We conducted a billing analysis to determine ex post net program savings using a LFER CDA model. The final model includes terms for treatment, which is an indicator variable indicating participation in the program, time, and weather. Due to a high degree of overlap between program measures, especially in the case of CFLs, we did not separate out any individual measures in the final model.[35] We also tested models that separated participants with electric heat. The rate of electric heat customers is small. however, and results for the larger (non-electric heat) group of customers did not change much, so we chose to leave all customers in a single model.

To ensure that the model specifications that we chose performed at least as well as the previous evaluation, we ran the exact same model as the 2014 evaluation on this year's data. In that model, we had included an interaction between specific lighting and weatherization, along with variables with weather terms, and did not include any post-period weather correction. The savings seen in that model were similar to those provided by this year's model, so we chose to continue with this year's model. Since we are focused on the program overall, the inclusion of individual measure variables overcomplicates the estimation of savings attributable to participation in program.

In deciding on our final model specification, we fit a number of possible models and selected the one with the best overall fit, based on both measures of statistical model fit (R-sq and AIC). The resulting model is more straightforward than what was used last year and provides a reliable estimation of program-level savings. The following equation represents the final model:

Figure 9-9. Final Model Equation

$$ADC_{it} = B_h + B_1 Post_{it} + B_2 HDD_{it} + B_3 CDD_{it} + B_4 Post \cdot HDD_{it} + B_5 Post \cdot CDD_{it} + B_t MY + \varepsilon_{it}$$

Where:

ADC_{it} = Average daily consumption (in kWh) for the billing period

$Post$ = Indicator for treatment group in post-period (coded "0" if treatment group in pre-period or comparison group in all periods)

HDD = Average daily HDDs from NOAA

CDD = Average daily CDDs from NOAA

MY = Month-year dummies for all time periods in the model

B_h= Average household-specific constant

B_1= Main program effect (change in ADC associated with being a participant in the post period)

B_2= Increment in ADC associated with 1-unit increase in HDD

B_3= Increment in ADC associated with 1-unit increase in CDD

B_4= Increment in ADC associated with each increment increase of HDD for participants in the post-program period (the additional program effect due to HDD)

B_5= Increment in ADC associated with each increment increase of CDD for participants in the post-program period (the additional program effect due to CDD

B_t= Coefficients for each month-year period

ε_{it} = Error term

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[35] However, we did test model specifications that included dummy variables measures and we found no differences in our main results.

ELECTRIC SAVINGS RESULTS

Table 9-10 shows the model results. The model is meant to show changes in electricity use after participation in the HPD/HpwES programs, controlling for weather and the household characteristics (reflected in the constant term). When evaluated using the means of 2014 program participation indicators, the program effects term (Treatment) is negative, indicating that program participants did reduce energy consumption in the post-period (after controlling for weather). Since customers who participated in other PSEG Long Island energy efficiency programs where not included in this analysis, we can be confident that this reduced energy consumption is attributable to participation in the HPD/HPwES programs.

Table 9-10. HPD/HPwES Program Performance Billing Analysis: Final Model

					90% Confidence Interval	
Predictor	Coefficient	Robust Std. Err.	T	P > |t|	Lower	Upper
Treatment	−3.13271	0.5746735	−5.45	0.00000	−4.259413	−2.006006
HDD	−0.00505	0.0005277	−9.56	0.00000	−0.0060818	−0.0040125
CDD	0.11707	0.007213	16.23	0.00000	0.1029306	0.1312141
Post-Period HDD	0.00082	0.00037	2.21	0.02700	0.0000922	0.0015431
Post-Period CDD	0.00447	0.0057755	0.77	0.43900	−0.0068499	0.0157969
Constant	38.1651	0.9484402	40.24	0.00000	36.3056	40.0246

Due to the weather interaction terms in the model, it was necessary to recalculate the coefficient of the treatment effect (Treatment) by combining the average value with the coefficient for each interaction term. The coefficient seen in the regression represents the reduction of daily consumption during the post-period, including any reduction caused by milder temperatures. Utilizing a simple equation that combines the coefficients of those interaction terms with the average post-period values for each, we are able to estimate the overall savings associated with the program itself.

Table 9-11. Adjusted Estimate of Daily Program Savings

					90% Confidence Interval	
ADC	Estimate	Std. Err.	T	P >|t|	Lower	Upper
(1)	−2.418414	0.38908	−6.22	0.000	−3.058552	−1.77876

The value of the estimate represents the kWh change in ADC given a 1-unit change in the treatment effect, i.e., treatment moving from 0 (pre-treatment) to 1 (post-treatment). The savings estimated here can be extrapolated to the overall net program savings for HPD/HPwES program participants.

The model results can also be used to estimate a decrease in electricity usage overall. There is a 90% probability, or confidence, that overall program savings ranged between 3.06 kWh and 1.78 kWh per day.

The Evaluation Team also compared these observed savings estimates to expected savings from the program-tracking database to determine the realization rate. The realization rate indicates what percentage of the expected savings was observed in the data. Table 9-12 shows that the 2015 HPD/HPwES programs realized 51% of their expected net savings.

Table 9-12. Savings from HPD/HPwES Program Billing Analysis Compared to Savings Expected from Program-Planning Estimates

End-Use	N[a]	Observed Savings		Program-Planning Savings[b]		Realization Rate
		Household Daily kWh Savings	Household Annual kWh Savings	Household Daily kWh Savings	Household Annual kWh Savings	
Overall Savings	3,889	2.42	883	4.74	1,731	51%

[a] Number of participants in billings analysis. There were a total of 2,773 unique accounts from PY 2014. Of that total, 1,062 program participants were excluded from the billing analysis for reasons outlined in Table 9-8.
[b] Excludes line losses.

9.9 Cost-Effectiveness Method

The Evaluation Team developed an Excel-based tool to assess cost-effectiveness at the program and portfolio levels using information derived from the PSEG Long Island 2015 Year End Expenditure Report and the evaluation results. We used three metrics to assess the cost-effectiveness of PSEG Long Island's Efficiency Long Island and Renewable Energy programs: the PAC test, the TRC test, and the levelized cost of capacity and energy. PSEG Long Island considers the Efficiency Long Island and Renewable Energy portfolios as alternative supply-side resources. To allow for direct comparison with PSEG Long Island's assessment of all supply-side options, we applied the PAC test as the primary method of determining cost-effectiveness and used assumptions similar to those used by PSEG Long Island's resource planning team. Each of the three methods is described below.

Calculation of Program Administrator Costs

The PAC test measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the PA. These costs include all program costs and any rebate and incentive costs, but exclude any measurement and evaluation costs unless those costs are necessary to administering the program. The PAC test excludes any net costs incurred by the participant, such as the actual measure cost, and includes the benefits accrued over the life of the measure, including electric energy and capacity savings for an electric utility.

The PAC test calculates a benefit/cost ratio by taking the NPV of benefits and dividing them by the first-year program costs, as shown in Equation 1. NPV discounts for the time value of money using a discount rate. In other words, savings that accrue in the future are less valuable than immediate savings. Taking a NPV normalizes for the present value of future savings. This evaluation used a nominal discount rate of 5.50%.[36]

$$PA\ Cost = \frac{NPV\ of\ Benefits\ [MCE*NRG*EUL+mAD*DR]}{2015\ Costs\ [PA]} \qquad \text{(Eq. 1)}$$

A benefit/cost ratio greater than 1 indicates a cost-effective investment of funds from a PAC perspective.

Table 9-13 presents the sources for inputs used to calculate cost-effectiveness using the PAC test.

[36] All cost-effectiveness analyses used a nominal discount rate of 5.50% to be consistent with supply-side alternatives.

Table 9-13. PAC Test Algorithm Inputs

Name	Variable	Units	Source	Input Type	Notes
MCE	Annual Marginal Utility Avoided Cost of Energy (includes costs for RGGI, NOx, and SO_2 compliance)	$/kWh	PSEG Long Island	Benefit	
NRG	Energy Reductions by Measure	kWh	Net Ex Post kWh, includes transmission losses	Benefit	First-year annual value[a]
EUL	Effective Useful Life by Measure	Year	PSEG Long Island (from AEG)	Benefit	
mAD	Marginal Utility Avoided Cost of Demand	$/kW	PSEG Long Island	Benefit	
DR	Demand Reductions by Measure	kW	Net Ex Post kWh, includes transmission losses	Benefit	First-year value – coincident peak estimate
PA	Program Administrator Cost	$ or % of incentives	PSEG Long Island (2015 Actual Expenditure report)	Cost	
DR	Discount Rate	%	PSEG Long Island (Nominal discount rate of 5.50% used in calculations of supply-side alternatives)	Discount Rate	Interest Rate

[a] For the EEP, HPwES, and HPD programs, the energy and demand savings of CFLs were discounted to account for the change in baseline efficiency levels over the life of the bulb. Beginning in 2012, higher-wattage bulbs are being phased out due to the Energy Independence and Security Act (EISA). Based on the expected installation rates, the timeline of the phase-outs, and the useful life of the CFLs, we estimate a lifetime savings of 75.3% of first-year annual value for CFLs installed in 2015.

Calculation of Total Resource Costs

The TRC test measures the total costs of a program based on both the participants' and the utility's costs. The TRC test considers the same program costs as the PA Test, with the addition of the incremental cost to the participant of purchasing the program measure. Further, the TRC test does not consider the costs of incentives and rebates, as these are viewed as transfers at the societal level. Specifically, the program administrator costs no longer include the incentive costs when used within the calculation of the TRC. A benefit/cost ratio greater than 1 indicates a cost-effective investment of funds from the perspective of the utility and its ratepayers.

Calculation of Levelized Costs

A levelized cost analysis is a way to quickly compare the cost of energy efficiency programs relative to the demand and energy saved from the programs. Levelized costs are expressed as $/kW-yr or $/kWh, meaning that the result can readily be compared to the cost of alternative supply additions or the cost of generating electricity. If the cost of the efficiency investment is less than the cost of capacity additions or generated electricity, efficiency is considered a wise investment.

The Evaluation Team determined levelized cost estimates at the program and portfolio levels. The sources for this analysis are the same as the PAC test calculations. To determine the levelized costs of the program, we determined the demand and energy savings over the life of the measure installed in a single year, discounted back to the same year of investment. The PSEG Long Island's investment (incentives and overhead) was divided by the present value of the savings to yield the lifetime levelized cost. Equation 2 shows the methodology used to calculate the levelized cost values. For a description of these costs, see Table 9-13.

$$Levelized\ Costs\ = \frac{2015\ Total\ Utility\ Expenditures}{NPV\ (Lifecycle\ kW\ or\ kWh\ Savings\ from\ 2015\ Installs)} \qquad \text{(Eq. 2)}$$

9.10 Economic Impact Method

As part of the 2015 Efficiency Long Island and Renewable Energy portfolios evaluation, the Evaluation Team conducted an economic impact analysis to quantify the benefits of PSEG Long Island's 2015 program spending on economic output and employment on Long Island. The economic impact analysis quantifies the 10-year impact of PSEG Long Island's 2015 Efficiency Long Island Portfolio and 2015 Renewable Energy Portfolio on the economies of Nassau and Suffolk counties. In particular, it quantifies each portfolio's economic impact in terms of the following impact metrics:

- Overall economic output (value-added portion of sales)
- Employment or jobs created
- Labor income/wages from these jobs

These impacts can be broken into three dimensions—direct, indirect, and induced impact—summarized as:

- Direct Impacts: Direct impacts are equal to the localized portion of direct spending of the PSEG Long Island programs. For example, direct impacts would include money (and associated increases in employment) supplied to contractors to install energy efficiency measures in homes and businesses, such as the HVAC contractor installing energy-efficient CAC systems on a project incented by the Cool Homes program.
- Indirect Impacts: Indirect impacts are determined by the amount of the direct impacts spent within Long Island on supplies, services, labor, and taxes. For example, indirect impacts would include money (and associated employment) transferred to local businesses by contractors for supplies needed to install energy efficiency measures, such as if a local wholesaler of HVAC equipment increased sales and added additional workers to help meet the growing demand for the company's products.
- Induced Impacts: Induced impacts are associated with the effects of the direct and indirect impacts on household and business proprietors' income, for example, money expended on Long Island by households or business proprietors benefiting from energy efficiency savings and direct and indirect program spending, such as if the employee of an HVAC contractor used his or her income (increased by work through the Cool Homes program) to purchase a car, which stimulates business at the local car dealership.

Along each dimension, we quantify economic impact in terms of economic output and employment outcomes.

Next, we describe the methodology and key assumptions used in this economic impact analysis.

Evaluated Program Effects

Program actions create effects that are the mechanisms through which PSEG Long Island programs may benefit participants and the regional economy—essentially via changes in cash flow. Based on a review of publicly available economic impact analyses of efficiency and renewable energy programs, and discussions with PSEG Long Island, we identified two main program effects (and associated costs) to quantify in the 2015 analysis. These high-priority program effects are participant bill savings and program and measure spending (on administration and management and equipment and installation), shown in the “Societal Benefits” column in Table 9-14. To determine the overall impact of net participant bill savings and program spending on the regional economy, we also quantify the monetary costs associated with these efforts, namely, incremental participant costs and the efficiency and renewable charge (that funds programs). These costs are also shown in the “Societal Costs” column of Table 9-14.

Table 9-14. Evaluated Program Effects

Category	Societal Benefits *(Realized Benefit or Avoided Cost)*	Societal Costs *(Realized Cost or Opportunity Cost)*
Participant Savings	**Program Participant Bill Savings** Increased household and business savings over 10 years, with potential increase in regional spending	**Incremental Participant Spending**[a] Participant co-payments that are incrementally higher than what they may have been in the absence of PSEG Long Island programs, due to purchase of higher-efficiency equipment
Program and Measure Spending	**Program Spending** Increased sales of goods and services and increased employment, due to PSEG Long Island’s spending on equipment, contractors, customer services, administration, and management **Incremental Participant Spending**[a] Increased spending on goods and services due to purchase of higher-efficiency equipment and contractor services	**Efficiency and Renewables Charge** Decreased disposable income for ratepayers in 2014 due to small efficiency and renewable charge(s) and riders leveraged to fund PSEG Long Island programs

[a] Incremental participant spending is measured as both a benefit and a cost to reflect the flow of funds in the local economy; while program participants experience this spending as a negative cash flow, contractors, retailers, manufacturers, and other service providers experience an equivalent positive cash flow.

Our analysis of high-priority program impacts estimates economic gains associated with portfolio-level spending and net participant savings. The impacts we estimate will be “net” in the sense that they account for the complete flow of funds associated with the benefits we are estimating: Program spending enters the model as inflows and outflows, as does incremental participant spending. Because only avoided costs are used to estimate bill savings, the total monetary value of bill savings in each year is equal to the net societal benefit of installation of high-efficiency measures in 2015. Though participant savings will be “net” and the flow of funds will be “net” in the sense that we account for both societal benefits and costs, the economic impact will be gross, as it will not “net out” what economic output, employment, and wages would have been *without* any program spending.

Model-Based Approach

The economic impact analysis is based on an input-output (I-O) model. We used IMPLAN (Impact Analysis for Planning) software to analyze the economic impact of PSEG Long Island’s programs. With information on program spending and costs, and the IMPLAN software, the Evaluation Team built a static model for the effects of program spending based on a matrix of underlying relationships among various sectors, including households, industries, and government. Assumptions about these relationships are an underlying component of the IMPLAN software, based on localized economic and employment data from such sources as the Bureau of Economic Analysis Regional Economic Accounts and the Bureau of Labor Statistics Census of Employment and Wages. These assumptions are also specific to the local economy (i.e., Nassau and Suffolk Counties), containing information on how spending is "multiplied" to multiple local sectors, as well as what portion of spending may extend beyond the local economy.[37]

To prepare the model, the Evaluation Team aggregated spending and cost data at a sector level for each year and entered this information into the software. There are 536 IMPLAN sectors, which generally correspond to NAICS codes, plus a household sector to represent residential customers. The model accounts for spending going to a specific sector (e.g., contractors), as well as expenditures from a specific sector (e.g., household spending on incremental measure costs). For example, the stream of residential *household* benefits accounts for *participant* bill savings, *participant* incremental measure cost, the efficiency and renewable charge (proportional to energy sales), and rebate payments from the program to participants, where participant bill savings persist for as long as the expected measure life of installed measures. Similarly, the stream of *commercial* benefits accounts for *participant* bill savings, *participant* incremental measure cost, and the efficiency and renewable charge (proportional to energy sales), as well as any program spending related to that sector.

Data Inputs and Assumptions

In this section, we briefly describe the data that we used as inputs in our model. The data inputs are broken into the four different spending and savings components outlined in Table 9-14.

We performed all steps for the Efficiency Long Island Portfolio and Renewable Energy Portfolio separately, though the steps were identical. Therefore, we provide a single methodology that reflects analysis steps taken for both portfolios.

Program Participant Bill Savings

To calculate the monetary value of participant bill savings over a 10-year period due to measure installation in 2015, we incorporated the following data inputs:

- **Evaluated net ex post annual kW and kWh savings for each program:** At a measure, measure-category, or program level, depending on the level used in the cost-effectiveness screening tool.
- **Effective useful measure life for each program:** To estimate savings by sector for each of the next 10 years, we applied program-level effective useful measure life value (EUL) to net savings for each program, utilizing the same assumptions as the PSEG Long Island's cost-effectiveness tests.
- **Load shapes:** We used measure-level load shapes to distribute net ex post kWh savings to load periods (e.g., summer on-peak) so that we could apply avoided energy cost per kWh values appropriately, in each year.
- **Avoided costs:** To calculate the monetary value of bill savings for the next 10 years, we used the same avoided capacity and energy cost forecast that is used for the benefit/cost screening tool. Multiplying net

[37] It is worth noting that IMPLAN makes a number of simplifying assumptions, such as fixed prices, no substitution effects, no supply constraints, and no changes in competitiveness or other demographic factors. However, such assumptions are not worrisome in assessing short-term impacts, in which the focus is on attaining a snapshot of a regional economy. In fact, this methodology is deemed to be an effective tool for the evaluation of impacts that do not shift economic equilibrium conditions and has been used successfully in economic impact evaluations of a number of different energy efficiency and renewable energy programs.

ex post savings (kW and kWh) by avoided costs (capacity and energy, respectively) gives the total monetary savings that will be realized among PSEG Long Island customers.

- Using net ex post savings, load shapes, avoided costs, and measure life assumptions, we calculated the nominal monetary value of bill savings for each program, at the program or measure-category level. We distributed all annual bill savings achieved by residential programs to the residential sector. We distributed bill savings achieved by commercial and industrial (C&I) programs to C&I participant sectors in two steps. First, we assigned participants to IMPLAN sectors based on the SIC codes of C&I participants.[38] For Efficiency Long Island programs, we then calculated the proportion of gross kWh savings by sector and by program and applied these proportions to the annual monetary bill savings values. For Renewable Energy programs, we calculated the proportion of gross kW savings by sector and by program and applied these proportions to the annual monetary bill savings values.

Program Spending

Program spending on measures and installation: PSEG Long Island provided program-level actual 2014 expenditures for three spending categories: rebates, incentives, and customer services. To assign expenditures to an IMPLAN sector, we took a slightly different approach for each category:

- **Rebates:** Spending on rebates is assigned to participating customer sectors—either the household sector or the C&I sector. For C&I, we linked participant accounts to SIC codes (available in CAS data). We then matched SIC codes to IMPLAN sectors.
- **Incentives and Customer Services:** For most programs, incentives are defined as spending that goes directly to the specialty trade contractors, and customer service expenditures are defined as spending on installation services in participant homes or businesses, which may include spending on "direct transfers" to participants (e.g., direct install). Because spending in each of these categories could be distributed to multiple sectors for a given program, we leveraged additional information, such as program budgets and discussions with program staff, to determine what comprised incentives and customer services for each program and how to distribute these expenditures (e.g., by identifying sectors in the budget and distributing actual expenditures proportional to the budget).

Program administration and management expenditures: PSEG Long Island provided actual expenditures on program delivery and administration spending, broken out by the following categories:

- **Contractors, Marketing, Advertising, and Evaluation:** These expenditures were available at a program level. We identified appropriate sectors based on detailed information in the budget and, where applicable, applied the budgetary proportions (of sector spending) to each program-level spending category. For a few expenditures, we developed sector assumptions (both sector assignment and proportion) based on discussions with PSEG Long Island program staff.
- **Professional Services, General and Administrative, Salaries:** These expenditures were available at the portfolio level. We first developed assumptions about the sectors of each expenditure line item (e.g., IT consulting) based on a breakdown of subcategories provided by PSEG Long Island, which we assigned to an IMPLAN sector. We then assigned expenditures to a portfolio (i.e., Efficiency Long Island or Renewable Energy). Though some line items were specific to one or the other portfolio, in most cases we assigned

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[38] For this analysis, we used 2015 CAS data obtained as part of the 2015 Small Business Profiling Study, which contains 2- and 4-digit SIC codes that can be mapped to IMPLAN sectors. We also supplemented this data with data purchased from Dun & Bradstreet. For participants without a SIC code or whose account number was not present in 2015 or earlier data, we assigned IMPLAN sectors in proportion to gross kWh achieved by all participants with known SIC codes.

expenditures to either the Efficiency Long Island Portfolio or the Renewable Energy Portfolio in proportion to each portfolio's staffing levels for each program, provided to us by PSEG Long Island in the form of FTEs.

Incremental Participant Spending

The Evaluation Team modeled the additional measure spending that occurs due to programs (i.e., total participant spending on measures and installation that is attributable to programs) using three sources of information:

- Incremental measure cost assumptions: We use the same per-unit incremental cost assumptions as developed by AEG for program planning and used for the 2015 benefit/cost screening tool. In some cases, we updated these costs with new assumptions based on more recent research. Incremental costs are available at a measure level (per unit) for the majority of programs.
- Ex post measure counts: Final measure counts from the 2015 evaluation, which are needed if incremental costs are per unit.
- Free-ridership and spillover rates: After estimating the total incremental measure expenditures associated with each measure (or program, if incremental costs are at the program level), we estimated the incremental spending that occurred due to PSEG Long Island's programs by using FR and SO rates using evaluated NTGRs.

To model positive cash flows of participant spending to the local economy, we assigned an IMPLAN sector to each measure in the cost-effectiveness screening tool.

To model negative cash flows of participant spending to appropriate sectors, we assigned all residential program incremental spending to the household sector. In addition, program-induced, non-labor-related cash flows to the household sector were modeled as household income change. Here, we assumed that the distribution of cash flows is proportional to the distribution of households into different income brackets.[39] For Commercial programs, we distributed spending across commercial sectors by first assigning a sector to participants based on their SIC code (using the same assignments as for participant bill savings) and then calculating the percentage of total rebate dollars each sector accounts for (with the assumption that incremental measure costs will be roughly proportional to available rebates). Program-induced non-sale-related cash flows—specifically rebates, savings, incremental cost, and Efficiency Long Island charges—were modeled as change in proprietor income.

Efficiency and Renewables Charges

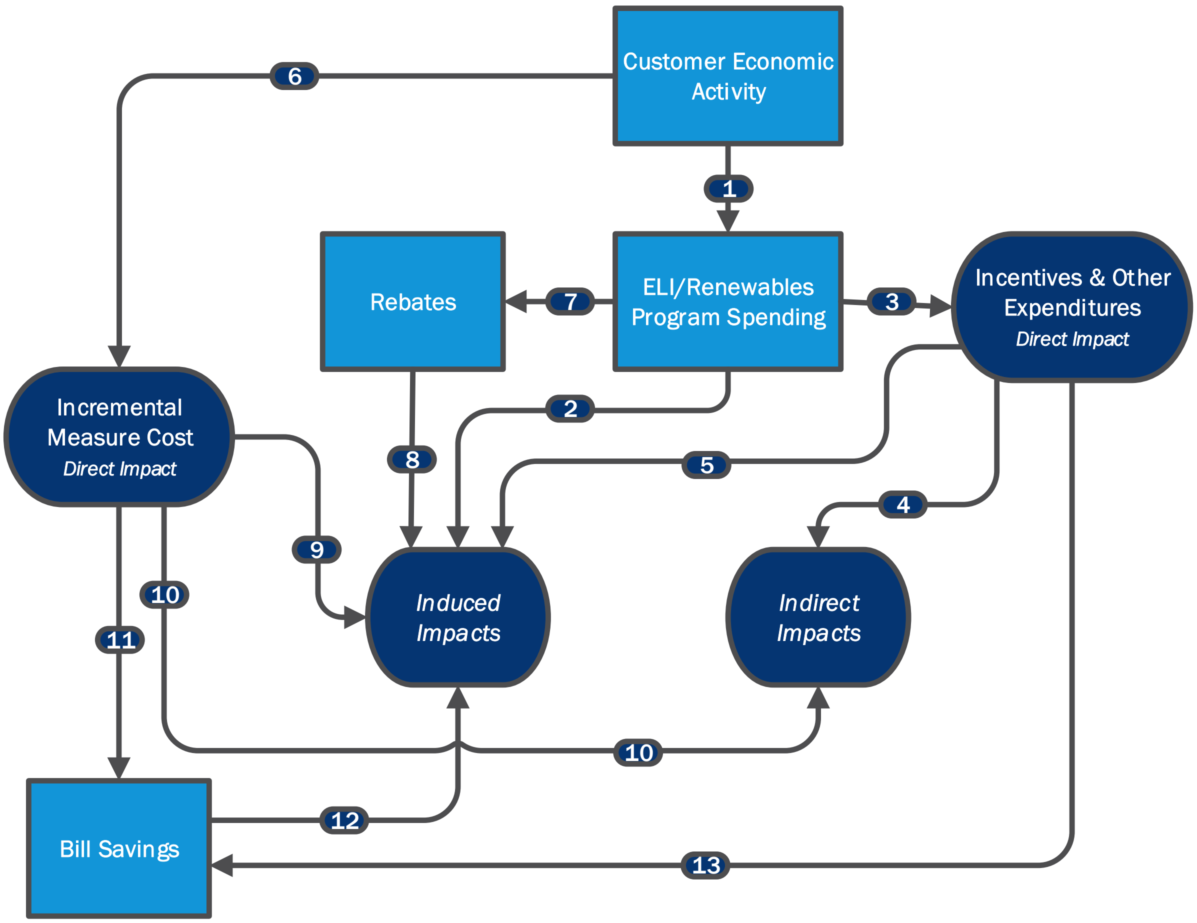
To adequately represent local cash flows resulting from offering Efficiency Long Island and Renewable Energy programs, the model includes efficiency and renewable charge revenues that were used to fund the 2015 programs. We assumed that this revenue was equivalent to total program spending. To distribute revenue across portfolios, we used the sum of program spending by portfolio, described above. To distribute revenue across sectors, PSEG Long Island provided a breakdown of 2015 sales (in MWh) for residential and C&I customers. The Evaluation Team applied these proportions to the total efficiency and renewable charge revenue estimate. The estimated proportion of charges from residential customers was applied to the household sector. We then broke down the C&I portion by IMPLAN sector based on the distribution of annual kWh by IMPLAN sector (again, based on SIC code) reflected in CAS data.

[39] Source: U.S. Census Bureau's American Community Survey. 2014.

Visual Model

A simplified visual model illustrates how the economic impact is calculated. Figure 9-10 presents the economic impacts model for PSEG Long Island's Efficiency Long Island and Renewable Energy portfolios. Note that the figure represents the portfolios as a whole, and individual programs may not contain all parts of the model due to variations in the program designs.

Figure 9-10. Visual Model of Economic Impacts of the PSEG Long Island Portfolio



Description of Model Elements

Each box in Figure 9-10 represents a dollar amount either defined as an input into the model or produced by the model as a result. Boxes with rounded corners represent impacts, while boxes with unrounded corners represent intermediate amounts. Each arrow in Figure 9-10 represents a flow of money or an effect resulting from an expenditure. It is important to note that flow numbers do not necessarily represent a sequential order of effects.

Dollar Amounts

The named boxes in Figure 9-10 represent:

- **Customer Economic Activity:** This box represents the base level of customer spending before program intervention.
- **Efficiency Long Island/Renewables Program Spending:** This box represents the total amount of program spending in 2015. The model assumes that program spending in each program year is equal to the Efficiency Long Island and Renewables Energy Charge collected in that year (see Flow #1).
- **Rebates:** This box represents the total amount of program spending in 2015 on rebates moving directly from the program to program participants.
- **Incentives & Other Expenditures:** This box represents the balance of the program spending after rebate expenditures (represented in Flow #7) and program staff salaries (represented in Flow #2). This box includes the cost of measures purchased by the program as part of direct installation program spending, as well as installation costs (Customer Services), program spending on marketing and advertising, and incentives paid directly to contractors. The portion of this spending amount (Flow #3) that occurs within Long Island is treated by the model as a *direct impact* on the Long Island economy.
- **Incremental Measure Cost:** This box represents the incremental measure cost expenditures paid by program participants toward program measures (Flow #6). The portion of this spending amount that occurs within Long Island is treated by the model as a *direct impact* on the Long Island economy. It is important to note that this dollar amount represents total incremental cost expenditures multiplied by the ex post NTGRs to account only for spending attributable to the program.
- **Bill Savings:** This box represents the bill savings resulting from installation of efficient equipment incentivized through the program.
- **Indirect Impacts:** This box represents the *indirect impacts* resulting from program activities.
- **Induced Impacts:** This box represents the *induced impacts* resulting from program activities.

Flows

The numbered flows in Figure 9-10 represent:

1. **Description:** Customers pay the Efficiency and Renewables Charge. This charge funds PSEG's Efficiency Long Island and Renewable Energy portfolios.

   Inputs: The Evaluation Team assigned the Efficiency and Renewables Charge to IMPLAN sectors for household income bracket and business sector. We distributed the charge by total usage in each sector.

2. **Description:** Customer spending levels drop due to additional spending on utility bills from the Efficiency and Renewables Charge. At the same time, PSEG Long Island pays the salaries of its program staff, increasing customer spending levels. This produces *induced impacts*.

   Inputs: We assigned PSEG Long Island's payroll figures to individual income bracket IMPLAN sectors. These sector values were entered as inputs into the IMPLAN individual spending matrices. The assigned amounts of the Efficiency and Renewables Charge (from Flow #1) were entered as inputs into IMPLAN individual spending matrices. Induced impacts are outputted from the negative effect of the charge and the positive effect of program staff salaries.

3. **Description:** PSEG Long Island spends money on the implementers, advertisers, evaluators, and other outside businesses necessary to run the programs. PSEG Long Island also spends money on measure costs for direct installation programs and on incentives going directly to contractors. The portion of this spending that occurs within Long Island is a *direct impact*.

   Inputs: PSEG Long Island program spending data by area (advertising, evaluation, incentives, etc.) is assigned to IMPLAN sectors by the Evaluation Team.

4. **Description:** The implementers, evaluators, contractors, and other outside businesses paid by PSEG Long Island spend money within Long Island on goods and services from other businesses, producing *indirect impacts*.

   Inputs: IMPLAN matrices automatically assign cascading expenditures by the initial sector to which we assigned PSEG Long Island spending (see Flow #3).

5. **Description:** The implementers, evaluators, contractors, and other outside businesses paid by PSEG Long Island pay their own internal employees. This leads to *induced impacts* when employees spend this money inside the Long Island economy.

   Inputs: IMPLAN matrices automatically assigned cascading expenditures by the initial sector to which the Evaluation Team assigned PSEG Long Island spending (see Flow #3).

6. **Description:** Participants purchase a new measure, incented by program activities and rebates. This is a *direct impact:* Participants spend their money inside the Long Island economy at a retailer/contractor, etc.

   Inputs: Based on secondary research, the Evaluation Team assigned participant incremental spending to business sectors corresponding to where spending takes place (e.g., retailers, contractors). Wherever this spending occurred inside Long Island, it is considered a *direct impact*.

7. **Description:** Participants are rebated by the program for their measure purchase.

   Inputs: PSEG Long Island program spending data were used to assign total rebate spending to participant IMPLAN sectors by income bracket or commercial segment.

8. **Description:** Flow #7 leads to *induced impacts*, as participants' spending levels elsewhere increase due to the effect of the rebate. It is important to note that, from the participant's perspective, the rebate effectively decreases the cost of the measure purchased. However, this is modeled in two separate flows in this model: first, the outflow of dollars in Flow #6 from the participant to purchase the measure and second, the flow of the rebate dollars from the program to the participant (Flow #7), which leads to *induced impacts* as mentioned above.

   Inputs: Sector values representing rebate spending assigned to income brackets and commercial segments were entered as inputs into IMPLAN individual spending matrices to output *induced impacts* from the positive effect of rebates on participant spending levels (Flow #7).

9. **Description:** Flow #6 leads to negative *induced impacts*, as participants' spending levels elsewhere decrease due to the expenditure on the measure. Flow #6 also leads to positive *induced impacts* as retailers, contractors, and others hire more staff/pay their staff more in order to respond to increased demand for their goods and services.

Inputs: Expenditures by sector produced in Flow #6 were entered as inputs into IMPLAN matrices to produce impacts. Expenditures in Flow #6 were also inputted into IMPLAN individual spending matrices as a negative effect on participant spending levels. As mentioned above in the description for Flow #8, this is the pre-rebated expenditure made by the participant.

10. **Description:** Flow #6 also leads to *indirect impacts*, as retailers and distributors from whom energy-efficient equipment is purchased order more equipment from manufacturers and distributors. The retailers and distributors from whom these items are purchased also purchase transportation services for these items, additional equipment for stores, and more items and services related to doing additional business.

    Inputs: IMPLAN matrices automatically assigned cascading expenditures by the initial sector to which we assigned PSEG Long Island spending (see Flow #6).

11. **Description:** Flow #6 also leads to bill savings as efficiency levels of energy-using appliances increases.

    Inputs: The Evaluation Team estimated bill savings as a result of program measures based on net ex post energy and demand savings multiplied by PSEG Long Island's estimates of the avoided costs of generation. These bill savings were then distributed across various income brackets and business sectors.

12. **Description:** Bill savings produce *induced impacts*, as participants' spending levels change due to their decreased expenditure on their utility bills.

    Inputs: Bill savings values from Flows #11 and #13 were inputted into IMPLAN individual spending matrices to produce impacts.

13. **Description:** Program spending on measures installed directly by programs (e.g., CFL bulbs installed through the REAP program) lead to bill savings, as increased efficiency resulting from these measures decreases energy usage and demand.

    Inputs: We estimated bill savings as a result of program measures as described in Flow #11.

Appendix A. Ex Ante and Ex Post Net-to-Gross Values by Program and Measure

Below are the ex ante and ex post values used in the results shown in this report.

Program	Measure	Ex Post – Ex Ante	Ex Post Values			Ex Ante – Calculated Program Values (all values calculated from gross and net values provided by the program)		
		NTGR Differences	FR	SO	NTGR	FR	SO	NTGR
Cool Homes	Traditional Split CAC Equipment (kW)	-40%	48%	0%	52%	*	*	92%
Cool Homes	Traditional Split CAC Equipment (kWh)	-46%	48%	0%	52%	*	*	98%
Cool Homes	Traditional Split CAC – QI (kW)	57%	0%	49%	149%	*	*	92%
Cool Homes	Traditional Split CAC – QI (kWh)	43%	0%	41%	141%	*	*	98%
Cool Homes	Traditional Split CAC – Total (kW)	-8%	*	*	84%	*	*	92%
Cool Homes	Traditional Split CAC – Total (kWh)	-33%	*	*	65%	*	*	98%
Cool Homes	Furnace Fan (kW)	0%	16%	0%	84%	16%	0%	84%
Cool Homes	Furnace Fan (kWh)	0%	10%	0%	90%	10%	0%	90%
Cool Homes	GTHP (kW)	0%	8%	0%	92%	8%	0%	92%
Cool Homes	GTHP (kWh)	0%	2%	0%	98%	2%	0%	98%
Cool Homes	ASHP – Equipment (kW)	0%	8%	0%	92%	8%	0%	92%
Cool Homes	ASHP – Equipment (kWh)	0%	2%	0%	98%	2%	0%	98%
Cool Homes	ASHP – Quality Installation	0%	0%	0%	100%	0%	0%	100%
Cool Homes	Ductless Mini-Split (kW)	0%	8%	0%	92%	8%	0%	92%
Cool Homes	Ductless Mini-Split (kWh)	0%	2%	0%	98%	2%	0%	98%
Cool Homes	Ductwork	0%	0%	0%	100%	0%	0%	100%
Cool Homes	Upstream Pilot	0%	0%	0%	100%	0%	0%	100%
HPD	All Measures (kW)	-34%	*	*	66%**	0%	0%	100%

Program	Measure	Ex Post – Ex Ante NTGR Differences	Ex Post Values FR	Ex Post Values SO	Ex Post Values NTGR	Ex Ante – Calculated Program Values (all values calculated from gross and net values provided by the program) FR	SO	NTGR
HPD	All Measures (kWh)	-38%	*	*	62%**	0%	0%	100%
HPwES	All Measures (kW)	-26%	*	*	73.9%**	0%	0%	100%
HPwES	All Measures (kWh)	-25%	*	*	74.8%**	0%	0%	100%
EEP	ENERGY STAR Refrigerator	0%	20%	10%	90%	20%	10%	90%
EEP	ENERGY STAR Dehumidifier	-52%	67%	0%	33%	30%	15%	85%
EEP	Room A/C	0%	30%	25%	95%	30%	25%	95%
EEP	ENERGY STAR Standard CFLs	0%	30%	4%	74%	30%	4%	74%
EEP	ENERGY STAR Specialty CFLs	0%	25%	20%	95%	25%	20%	95 %
EEP	Solid State Lighting	0%	5%	25%	120%	5%	25%	120%
EEP	ENERGY STAR Fixtures	0%	1.7%	3.2%	101.5%	1.7%	3.2%	101.5%
EEP	Refrigerator Recycle	-9%	52%	0%	48%	43%	0%	57%
EEP	Pool Pumps	0%	20%	10%	90%	20%	10%	90%
EEP	Smart Power Strips	0%	0%	0%	100%	0%	0%	100%
EEP	Room A/C Recycle	-9%	52%	0%	48%	43%	0%	57%
EEP	Dehumidifier Recycle	-9%	52%	0%	48%	43%	0%	57%
EEP	Ceiling Fans	0%	30%	0%	70%	30%	0%	70%
EEP	Super-Efficient Dryer	0%	20%	10%	90%	20%	10%	90%
EEP	ENERGY STAR Room Air Purifiers	0%	30%	15%	85%	30%	15%	85%
CEP Prescriptive	Lighting (kW)	-20.13%	30%	1.87%	71.87%	*	*	92%
CEP Prescriptive	Lighting (kWh)	-20.45%	30%	1.55%	71.55%	*	*	92%
CEP Prescriptive	Non-Lighting (kW)	-18.13%	30%	1.87%	71.87%	*	*	90%
CEP Prescriptive	Non-Lighting (kWh)	-18.45%	30%	1.55%	71.55%	*	*	90%

		Ex Post – Ex Ante	Ex Post Values			Ex Ante – Calculated Program Values (all values calculated from gross and net values provided by the program)		
Program	Measure	NTGR Differences	FR	SO	NTGR	FR	SO	NTGR
CEP Existing Retrofit	Lighting (kW)	-20.13%	30%	1.87%	71.87%	*	*	92%
CEP Existing Retrofit	Lighting (kWh)	-20.45%	30%	1.55%	71.55%	*	*	92%
CEP Existing Retrofit	Non-Lighting (kW)	-18.13%	30%	1.87%	71.87%	*	*	90%
CEP Existing Retrofit	Non-Lighting (kWh)	-18.45%	30%	1.55%	71.55%	*	*	90%
SBDI	All Measures (kW)	-12.99%	13%	0.01%	87.01%	0%	0%	100%
SBDI	All Measures (kWh)	-12.73%	13%	0.27%	87.27%	0%	0%	100%
REAP	All Measures (kW)	0%	*	*	100%**	0%	0%	100%
REAP	All Measures (kWh)	0%	*	*	100%**	0%	0%	100%
Solar Pioneer	All	0%	0%	0%	100%	0%	0%	100%
Solar Entrepreneur	All	0%	0%	0%	100%	0%	0%	100%
CEP Custom	(kW)	-18.13%	30%	1.87%	71.87%	*	*	90%
CEP Custom	(kWh)	-18.45%	30%	1.55%	71.55%	*	*	90%

* FR and SO are unknown or not applicable, usually because NTGR was back-calculated, calculated through billing analysis, or came from PSEG Long Island's program-planning numbers.
** These numbers are realization rates calculated through billing analysis.

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