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Efficiency Long Island and Renewable Energy Portfolios

2014 Annual Evaluation Report (Volume II – Program Guidance Document)

FINAL

Prepared for:

PSEG LONG ISLAND

We make things work for you.

Prepared by:

OPINION DYNAMICS CORPORATION

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With Subcontractors:

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1. Introduction

Volume II of the PSEG Long Island Efficiency Long Island and Renewable Energy Portfolios 2014 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 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 through 2013. Effective January 1, 2014, PSEG Long Island began its 12-year contract with Long Island Power Authority 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.

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 1) the ex ante net savings calculated by the Evaluation Team using detailed measure-level tracking information and 2) the evaluated savings; 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 1) the same ex ante net savings and 2) the ex post 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 10 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 2014 implementation year. We have also included any measure-specific recommendations for updating the gross energy and demand savings calculations.
- Section 11 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, waste-heat factors, and installation rate for lighting. Gross impacts are the demand and energy that the power plants do not generate due to program-related actions taken by participants.
- Net Impacts: The change in energy consumption and/or demand at the generator that results directly from program-related actions taken by participants, and 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. Free-ridership reduces the ratio to account for those customers who would have installed an energy-efficient measure without the program. The free-ridership 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 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.
- **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 would 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 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 had 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. For example, if the employee of a weatherization contractor used 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 11 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 database. 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), the Evaluation Team performed onsite measurement and verification (M&V) in the summer of 2012 on custom projects that resulted in a gross realization rate, which we applied to the 2014 custom projects.

Net Impact Methods

The Evaluation Team used net impact estimates as inputs to three separate analyses required by PSEG Long Island: 1) the determination of annual demand and energy savings toward goal attainment; 2) the benefit/cost assessment; and 3) the economic impact assessment. Based on the specific requirements of each assessment, we developed two separate net savings estimates as described below.

Evaluated Net Savings

An important catalyst in the Long Island Power Authority'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 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 free-ridership and spillover 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 2014, we had no new primary data collection or activities to update previous NTGR values. As such, all ex post NTGRs are identical to 2013 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 Gross and 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 10.

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

Program	Ex Ante		Evaluated		Realization Rate	
	MW	MWh	MW	MWh	MW	MWh
CEP Mid-Market	7.0	27,334	6.95	27,142	99%	99%
Solutions Provider/Large Business	16.8	77,824	15.97	74,084	95%	95%
Direct Install	4.3	16,637	4.27	16,924	99%	102%
Total Commercial	**28.1**	**121,795**	**27.18**	**118,150**	**97%**	**97%**
Energy-Efficient Products (EEP)	18.25	136,861	20.97	135,583	115%	99%
Cool Homes	5.07	4,078	5.52	5,064	109%	124%
REAP	0.38	2,369	0.14	995	37%	42%
HPwES	0.76	567	0.45	352	59%	62%
HPD	1.85	4,550	1.23	2,821	66%	62%
ENERGY STAR® Labeled Homes (ESLH)	0.05	147	0.05	147	100%	100%
Total Residential	**26.37**	**148,572**	**28.36**	**144,962**	**108%**	**98%**
Efficiency Long Island Total	**54.45**	**270,367**	**55.55**	**263,112**	**102%**	**97%**
Solar Photovoltaic (PV)	15.14	38,602	14.50	35,088	96%	91%
Backyard Wind	0.00	5	0.00	11	100%	233%
Renewable Energy Total	**15.14**	**38,607**	**14.50**	**35,099**	**96%**	**91%**
Total Portfolio	**69.59**	**308,974**	**70.04**	**298,210**	**101%**	**97%**

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 PAC, 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 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 3.4 for the Efficiency Long Island Portfolio and 4.4 for the

Renewable Energy Portfolio, indicating that portfolio benefits exceed PAC costs in both cases (a benefit/cost ratio greater than 1 indicates that portfolio benefits outweigh costs). The portfolio-level TRC values are 2.1 and 0.7 for the Efficiency Long Island and Renewable Energy Portfolios, respectively.

The PAC test was less than 1 for two programs in 2014: ESLH and REAP. The ESLH program was winding down in 2014 and, as a result, did not achieve the level of savings in relation to PAC costs as would be expected in a typical program year. The REAP program was redesigned in 2014 to offer a new set of measures with the aim of improving savings and cost effectiveness. PSEG Long Island assumed the new program savings and costs into its program planning and goal setting processes. However, program implementation did not conform to the new program design until late in 2014, which was reflected in the lower program savings and cost effectiveness. While the REAP program PAC test of 0.2 is somewhat lower than in prior years, the program has not been cost effective in 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

	Total Resource Cost			Program Administrator Cost		
Program	NPV* Benefits	Costs	Benefit/ Cost Ratio	NPV Benefits	Costs	Benefit/ Cost Ratio
Subtotal Commercial Efficiency Program	**$133,158,661**	**$54,481,799**	**2.4**	**$133,158,661**	**$41,787,796**	**3.2**
EEP	$82,765,627	$27,229,812	3.0	$82,765,627	$13,818,296	6.0
Cool Homes	$14,342,552	$17,150,424	0.8	$14,342,552	$6,861,698	2.1
REAP	$601,449	$2,692,384	0.2	$601,322	$2,692,384	0.2
HPwES	$1,977,142	$3,361,534	0.6	$1,770,996	$1,468,946	1.2
HPD	$3,533,561	$3,283,598	1.1	$3,500,538	$3,283,598	1.1
Existing Homes Subtotal	*$20,454,704*	*$26,487,940*	*0.8*	*$20,215,407*	*$14,306,625*	*1.4*
ESLH	$265,132	$350,646	0.8	$265,132	$396,097	0.7
Subtotal Residential	**$103,485,463**	**$54,068,397**	**1.9**	**$103,246,167**	**$28,521,018**	**3.7**
Subtotal Efficiency Long Island	**$236,644,125**	**$110,550,197**	**2.1**	**$236,404,828**	**$70,308,815**	**3.4**
Solar PV	$97,470,373	$143,119,658	0.7	$97,470,373	$21,933,614	4.5
NY-Sun Funding	N/A	N/A	N/A	N/A	$(10,433,509)	N/A
Backyard Wind	$8,501	$80,921	0.1	$8,501	$181,249	0.0
Subtotal Renewable Energy	**$97,478,874**	**$143,200,579**	**0.7**	**$97,478,874**	**$22,114,863**	**4.4**
Total	**$334,122,999**	**$253,750,776**	**1.3**	**$333,883,702**	**$92,423,678**	**3.6**

* Net present value.

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. The levelized costs of capacity and energy for the Efficiency Long Island Portfolio savings is $172.05/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 $113.73/kW-yr and $0.047/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	Levelized Costs	
		$/kWh	$/kW-yr
Commercial Efficiency Program	**$41,787,796**	**0.043**	**184.09**
EEP	$13,818,296	0.018	112.19
Cool Homes	$6,861,698	0.203	157.80
REAP	$2,692,384	0.427	3,027.06
HPwES	$1,468,946	0.416	324.63
HPD	$3,283,598	0.184	421.33
Existing Homes Subtotal	*$14,306,625*	*0.195*	*246.81*
ESLH	$396,097	0.269	746.71
Subtotal Residential	**$28,521,018**	**0.035**	**157.00**
Subtotal Efficiency Long Island	**$70,308,815**	**0.039**	**172.05**
Solar PV	$21,933,614	0.047	112.80
Backyard Wind	$181,249	1.271	0.00
Subtotal Renewable Energy	**$22,114,863**	**0.047**	**113.73**
Total	**$92,423,678**	**0.041**	**153.24**

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.[1]

[1] Rebates consist of payments made to participating customers. Incentives consist of payments made to participating contractors (e.g., HVAC installers). Customer Services consist of payments made to program implementers involved with direct installation (e.g., Lime Energy for Small Business Direct Install [SBDI]).

Figure 1-1. 2014 PSEG Long Island Expenditures for the Efficiency Long Island Portfolio

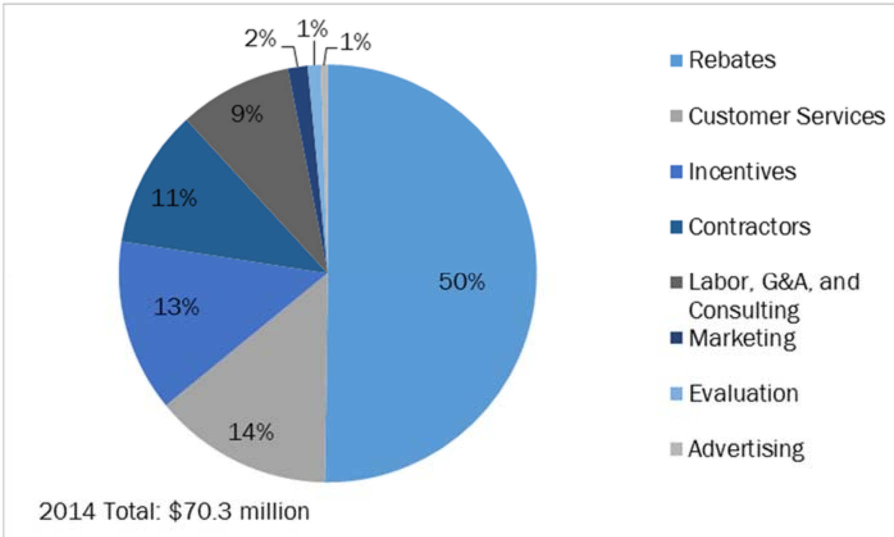
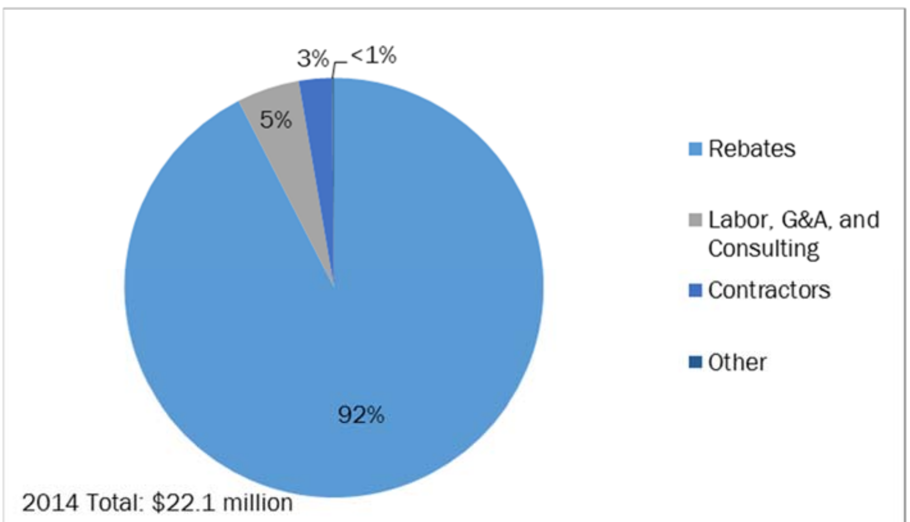


Figure 1-2. 2014 PSEG Long Island Expenditures for the Renewable Energy Portfolio



Note: "Other" includes 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 2014 Efficiency Long Island and Renewable Energy Portfolios over the next 10 years. Table 1-4 and Table 1-5 below present the direct impacts and the combined indirect and induced impacts for 2014 and for the 10-year period of 2014 to 2023. To account for expected inflation and the assumed increasing cost of electricity, the tables show the results as net present value using the discount rate of 5.5% used in PSEG Long Island's supply-side planning and the cost-effectiveness analysis.

Over 10 years, the 2014 investments in the Efficiency Long Island program are expected to return $160.9 million in total economic benefits to the regional economy (in 2014 dollars), with an employment benefit of 1,166 new full-time equivalent employees (FTEs)[2] over that time period.

Table 1-4. Economic Impact of 2014 Efficiency Long Island Program Investments

2014 Efficiency Long Island Program Investments	2014 Economic Impact	2014-2023 Economic Impact (NPV[3])
Economic Impact		
Total Economic Output (millions)	$73.9	$160.9
Direct Effect	$65.7	$65.7
Indirect & Induced Effect	$8.2	$95.2
Employment (FTE)	473	1,166
Impact per $1M Investment		
2014 Program Investment (millions)	$70.3	$70.3
Total Economic Output in M per $1M Investment	$1.0	$2.3
Employment (FTE) per $1M Investment	6.7	16.6

Over 10 years, the 2014 investments in the Renewable Energy Portfolio are expected to return $95.9 million in total economic benefits to the regional economy (in 2014 dollars), with an employment benefit of 705 new FTEs 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 one year, but could be done by one person working full-time for a year, two people working part-time for the year, or two people each working full-time for six months.

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

Table 1-5. Economic Impact of 2014 Renewable Energy Program Investments

PY2014 Renewable Energy Program Investments	2014 Economic Impact	2014-2023 Economic Impact (NPV[4])
Economic Impact		
Total Economic Output (millions)	$60.5	$95.9
Direct Effect	$86.1	$86.1
Indirect & Induced Effect	($25.5)	$9.8
Employment (FTE)	411	705
Impact per $1M Investment		
2014 Program Investment (millions)[5]	$11.7	$11.7
Total Economic Output in M per $1M Investment	$5.2	$8.2
Employment (FTE) per $1M Investment	35.2	60.3

The investments in the Efficiency Long Island Portfolio resulted in a smaller total economic output in 2014 ($73.5 million) than in 2013 ($85.0 million). This decrease is consistent with decreased program expenditures – the total economic output created per $1 million of investment in 2014 is similar to results from 2013. Similarly, employment created per $1 million of investment remained constant compared to 2013.

Spending on PSEG Long Island's Renewable Energy Portfolio resulted in much greater benefits to the Long Island economy in the 2014 program year than in 2013. This difference is primarily driven by two factors: 1) the substantial increase in the number of solar PV systems installed through the Solar Pioneer program, and 2) $10.4 million in funding through NYSERDA's NY-Sun Initiative. This funding 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.

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

[5] Program investment does not include $10,433,509 in solar funding from NYSERDA NY-Sun. Economic impacts, however, do include the benefits of these projects.

2. The Commercial Efficiency Program

PSEG Long Island's CEP is multifaceted and comprehensive. The CEP caters to all business customers in PSEG Long Island's service territory, including small business customers and not-for-profit entities. As part of the program, 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 2014, PSEG Long Island continued delivering the CEP through the following four avenues:

- **Prescriptive:** Includes predefined new construction, as well as replacement and retrofit measures. Incentives amounts are fixed for the qualifying measures.
- **Existing Retrofit:** Includes retrofit measures using the predefined menu of measures installed in the existing site as the determination of savings. Incentives amounts are fixed for the qualifying measures.
- **Small Business Direct Install (SBDI):** Includes lighting measures to small business customers in load-constrained pockets in Long Island. Features turnkey delivery approach and fixed incentive levels.
- **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 customers' needs and engage customers with the program.

In addition to these core components, as part of the CEP, PSEG Long Island also offered no-cost energy assessments, cost-shared technical assistance studies, building commissioning co-funding, and Leadership in Energy and Environmental Design (LEED) certification incentives in 2014.

In January 2014, similar to the other programs in the PSEG Long Island's energy efficiency portfolio, PSEG Long Island assumed oversight of the CEP administration and implementation from National Grid.

One of three implementation entities serviced CEP program participants in 2014: PSEG Long Island implemented the program among small and medium accounts (CEP Mid-Market), TRC or Solutions Provider implemented the program among managed and large, unmanaged accounts for most of the year (Solutions Provider), and Lime Energy implemented the SBDI program component among small business customers in constrained circuits. In September 2014, PSEG Long Island terminated the contract with TRC and assumed the implementation of the CEP among managed and large, unmanaged accounts (CEP Large Business).

In 2014, PSEG Long Island's CEP portfolio achieved 87% of the gross energy demand savings goal and 91% of energy savings goal, as seen in Table 2-1. The overall CEP portfolio's inability to meet its goals is in part due to lower-than-expected performance of the SBDI program and a mid-year reduction in spending on Mid-Market and Large Business projects to meet corporate budget restrictions. Despite the reduction in program spending and associated energy savings, the levelized costs of these programs were lower in 2014 ($184.09) than in 2013 ($200.93). The Mid-Market program component achieved 99% of the demand savings goal and the Solution Provider/Large Business component achieved 86% of the goal.

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

Program Component	Goal		Ex Ante Net Savings		% of Goal	
	MW	MWh	MW	MWh	MW	MWh
Mid-Market	7.0	28,454	7.0	27,334	99%	95%
Solutions Provider/Large Business	18.5	75,107	16.8	77,824	86%	99%
SBDI	5.5	25,762	4.3	16,637	77%	66%
Total	31.1	129,323	28.1	121,795	87%	91%

The CEP continued to rely primarily on lighting measures for savings. As can be seen in Table 2-2, 84% of the ex ante net demand savings came from lighting measures.[6]

Table 2-2. Commercial Efficiency Program Savings from Lighting and Non-Lighting Measures

Program Component	Ex Ante Net Savings	
	% MW	% MWH
Lighting	84%	84%
Non-Lighting	16%	16%

LED lighting became a more prominent portion of the CEP. In 2014, the CEP expanded its offering of LED equipment to include LED retrofit kits and LED tube replacements. LED lighting was a part of 59% of projects and accounted for 37% of 2014 ex ante net demand savings across all projects. Of all Prescriptive and Existing Retrofit lighting projects, LED lighting was a part of 79% of projects and accounted for 52% of demand savings. In comparison, LED lighting accounted for 42% of CEP Prescriptive and Existing Retrofit demand savings in 2013 and 30% in 2012. LED prominence increased despite a reduction in program incentives from 2013 on. For example, PSEG Long Island reduced incentives for screw-in LEDs by half, and incentives for 1X4 LED panels were reduced by 30%. This reduction in incentives was likely in response to the rapidly decreasing prices for LEDs.

In addition to reducing incentives for LEDs, PSEG Long Island reduced program incentives for other lighting measures. According to program staff, reductions in incentives were a preemptive response to a potential budget deficit. Program staff do not envision major changes to program measures or incentive levels in 2015.

In 2014, PSEG Long Island took over the implementation of the Energy Assessment program component from TRC. PSEG Long Island reconfigured and expanded this program component and, to more effectively implement the program, developed an interactive Excel-based assessment tool that demonstrates savings and recommendations to customers.[7] In early 2014, PSEG Long Island removed the mandatory post-inspection requirement for smaller Prescriptive and Existing Retrofit projects (incentives under $5,000). Instead, a random 10% of these projects have been post-inspected.

PSEG Long Island stopped accepting 2014 projects and transitioned to 2015 applications as of December 2014. According to program staff, this transition is designed to avoid the influx of projects at the end of the year to contribute to a smoother program year close.

According to program staff interviews, promotion of the program through trade ally outreach continued to be the main vehicle for marketing the Mid-Market and the Solutions Provider program components in 2014. The program had two dedicated staff members to market its offerings to trade allies and continued to offer trade

[6] Note that these measures include lighting controls and refrigeration lighting.

[7] In previous program years, the Energy Assessment component was limited to certain accounts.

ally open house meetings every Friday to answer any program-related questions from trade allies. In addition, PSEG Long Island introduced quarterly roundtable discussions with the most active 12–14 trade allies (known as the Trade Ally Council), in an effort to elicit feedback on trade ally experiences with the program.

The CEP also relied on a dedicated team of Senior Territory Managers (STMs) who promoted the program to customers, as well as to chambers of commerce and economic development groups. Marketing to customers in 2014 also included the annual Energy Efficiency Conference for Long Island Businesses held in October 2014, testimonials, web advertising, and an electronic newsletter. Overall, program staff we interviewed were satisfied with the level of marketing and outreach efforts.

The Siebel system continued to be the core data entry and tracking system for the CEP. 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 QA/QC. Nevertheless, despite multiple QA/QC steps undertaken throughout project implementation and rigorous data tracking and verification processes, as part of the impact analysis we found a few inconsistencies with the tracking data. We discuss these inconsistencies further in the Impacts section below.

Based on the interviews with program staff, the program generally ran smoothly in 2014, with few bottlenecks or issues. According to program staff, while the transition of the Solutions Provider program component from TRC to PSEG Long Island caused a few bottlenecks associated with the tracking database access on the back end, all customer-facing interactions transitioned seamlessly.

The program will be undergoing significant changes. Beginning in 2015, the design and implementation of the CEP was transitioned to Lockheed Martin. In addition, the SBDI program was discontinued at the end of March 2015. Furthermore, Lockheed Martin will replace the Siebel program tracking system with their proprietary LM Capture database in 2015. Despite these changes, the program staff believes the CEP is well positioned to meet its 2015 goals.

Looking ahead, there are several potential challenges that could hinder the achievement of CEP's goal in 2015 and beyond. The core challenge is the program's heavy reliance on lighting measures. As previously mentioned, over 80% of the program's energy and demand savings were from lighting measures. Federal regulations phasing out T12s in 2012 will affect the savings that PSEG Long Island can claim as part of lighting retrofits due to lower delta watts. Increasing prominence, customer interest, and rapid reduction in LED prices is likely to contribute to the increased naturally occurring adoption of the LED technology in the commercial sector. Understanding the state of the market and market dynamics and strategically adjusting the portfolio's offerings will be critical for the program's continued success. In addition, to accurately reflect net program savings, particularly given the steady increase in savings from LED lighting, it will be necessary to update the planning assumptions and evaluated net-to-gross factors for the CEP program such that they stay abreast with these changes.

With the elimination of the SBDI program, PSEG Long Island loses a significant amount of energy and demand savings. The SBDI program accounted for 16% of the CEP demand savings and 8% of the ELI Portfolio demand savings in 2014. These savings will presumably need to be taken up by other programs. With the understanding that small businesses make up a significant and unique portion of the commercial market on Long Island, the Evaluation Team conducted a market traction study for the SBDI program in 2012. This study showed that SBDI-eligible customers have very different characteristics from other commercial customers. Small business customers have a unique set of barriers to participation, namely, lack of time and resources to dedicate to investigation and implementation of energy-efficient improvements, and having a turnkey program for this customer group is beneficial. At present, the degree to which the CEP Mid-Market program can absorb the SBDI program participants is not clear. In addition, through effective targeting of program resources, the SBDI model has the benefit of addressing capacity-constrained areas, a stated priority for PSEG Long Island.

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

Overall Impacts for Commercial Efficiency Program

Table 2-3 provides a comparison of evaluated net savings to ex ante savings for the CEP impacts by implementation entity.

Table 2-3. Commercial Efficiency Program Impacts for Goal Comparison

Program Component	Category	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Mid-Market	Prescriptive	449	2,045,510	410	1,864,078	91%	91%
	Custom	69	205,663	55	195,380	80%	95%
	Existing Retrofit	6,508	25,082,579	6,480	25,082,579	100%	100%
	Mid-Market Subtotal	*7,026*	*27,333,752*	*6,946*	*27,142,037*	*99%*	*99%*
Solutions Provider/ Large Business	Prescriptive	1,890	9,167,753	1,723	9,295,717	91%	101%
	Custom	2,634	13,939,113	2,107	13,242,157	80%	95%
	Existing Retrofit	12,236	54,717,519	12,139	51,546,305	99%	94%
	Solutions Provider/ Large Business Subtotal	*16,760*	*77,824,385*	*15,969*	*74,084,179*	*95%*	*95%*
SBDI		4,294	16,636,795	4,267	16,923,658	99%	102%
Commercial Program Total		28,080	121,794,932	27,183	118,149,875	97%	97%

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 NTGRs. Program-planning NTGRs differed from evaluated values by program component. The Evaluation Team did not perform new 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 11 of this report.

Table 2-4 provides a comparison of ex ante and ex post savings by the CEP implementation entity and project category. The Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments.

Table 2-4. Commercial Efficiency Program Impacts for Cost-Effectiveness

Program Component	Category	Ex Ante		Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Mid-Market	Prescriptive	449	2,045,510	324	1,484,633	72%	73%
	Custom	69	205,663	44	155,327	64%	76%
	Existing Retrofit	6,508	25,082,579	5,068	18,609,409	78%	74%
	Mid-Market Subtotal	**7,026**	**27,333,752**	**5,436**	**20,249,369**	***77%***	***74%***
Solutions Provider/ Large Business	Prescriptive	1,890	9,167,753	1,386	7,785,907	72%	73%
	Custom	2,634	13,939,113	1,682	10,527,515	64%	76%
	Existing Retrofit	12,236	54,717,519	9,500	40,111,333	78%	73%
	Solutions Provider/ Large Business Subtotal	**16,760**	**77,824,385**	**12,568**	**58,424,755**	***75%***	***75%***
SBDI		4,294	16,636,795	3,713	14,769,276	86%	89%
Commercial Program Total		28,080	121,794,932	21,717	93,443,400	77%	77%

In the following sections, we present the measure-level impacts for each program component.

Prescriptive Component of Commercial Efficiency Program

This section provides the results of the Evaluation Team's analysis of energy and demand savings associated with prescriptive measures installed through the CEP by the CEP Mid-Market and Solutions Provider/Large Business implementation entities. We analyzed the impacts by program component (Prescriptive, Custom, and Existing Retrofit) and not by implementation entity. As such, we aggregated our results for prescriptive measures across implementation entities within our analysis and used the same realization rate for both. For the purposes of engineering analysis, we grouped prescriptive non-lighting measures into six end-use categories: HVAC, compressed air, refrigeration, motors and variable-frequency drives (VFDs), building envelope (i.e., Cool Roofs), and vending machines. We analyzed the general lighting and performance lighting together through a separate analysis, and then incorporated it back into the prescriptive measure savings totals.

The evaluation of the six non-lighting prescriptive measures noted above consisted of several phases. First, the Evaluation Team analyzed the program's tracking database, which contained an ex ante savings estimate for each individual measure incentivized in 2014. The database also contained information regarding measure characteristics, allowing the Evaluation Team to tailor the analysis of energy savings to reflect the efficiency standards set by the program over the past year. For example, for HVAC measures, equipment size (in tons) and efficiency (in SEER/EER) were available, and we applied these characteristics to evaluation savings calculations to ensure an "apples to apples" comparison with ex ante estimates presented in the program-tracking database. The Evaluation Team used the measure type and characteristic information from the database to derive the impacts, as described in Section 11.3. PSEG Long Island did not track lighting measure characteristics at the same level of detail as for non-lighting measures. As such, the Evaluation Team selected a sample of projects within the lighting and performance lighting measure groups for desk reviews. This approach is consistent with the approaches used in previous evaluations.

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. See the definitions in Section 1.1 for a discussion of the difference between the ex ante and evaluated values.

Table 2-5. Prescriptive Component of CEP: Net Savings for Goal Comparison

Category	Number of Units	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	14,881	1,206	5,369,129	1,154	4,636,882	96%	86%
Non-Lighting							
HVAC	337	594	1,179,581	572	1,296,597	96%	110%
Compressed Air	78	278	2,420,784	129	2,085,009	46%	86%
Building Envelope	35	126	235,648	126	235,648	100%	100%
Motors and VFDs	173	63	966,212	82	1,859,973	129%	193%
Refrigeration	1,383	72	1,032,157	72	1,032,157	100%	100%
Vending Machine Controls	9	0	9,752	0	13,530	100%	139%
Total	16,896	2,339	11,213,263	2,134	11,159,796	91%	100%

The Evaluation Team identified a number of reasons for discrepancies in gross savings by category as described below.

Reasons for Differences in Impacts

- For *Lighting* measures (both general lighting and performance lighting), the Evaluation Team completed a thorough project-specific analysis of the installed lighting systems. This allowed the Evaluation Team to calculate energy and demand savings for a sample of projects based on project parameters such as fixture type, occupancy sensor type, and installed number of components. Using the coefficient of variation found in our previous year's analyses, we determined the number of projects we needed to review for an expected 10% precision from sampling error. We compiled data from a sample of 10 projects, of which 2 were misclassified and consequently subsequently removed from the sample. As a result of the analysis, we developed a realization rate of 96% for demand savings and 86% for energy savings. To develop realization rates, we divided the evaluated savings by deemed savings. Through the review, we identified discrepancies with four out of eight projects. They are discussed below:
  - One project did not list hours of use in the program-tracking data. Since the project was refrigerated case lights, we assumed the hours of use for a grocery/supermarket. This resulted in realization rates of 92% for demand and 34% for energy savings. Assuming 24/7 hours of operation would increase the energy savings realization rate to 54%. We applied the deemed values from PSEG Long Island for this project, so it is not clear what is causing the remaining discrepancy for demand and energy savings. This project was the largest in terms of energy savings in the sample and is the leading contributor to the realization rates for prescriptive lighting measures.
  - For two projects, the post-inspection forms showed more fixtures than recorded in the program-tracking data. The Evaluation Team revised measure quantities to account for these fixtures. Both projects were parking garages incorporating waste heat and coincidence factors. We removed waste heat factors and coincidence factors and assumed the lights operate 24/7. For one of the parking garage projects, the energy and demand savings were based on lower hours of use, while the other already assumed 24/7 operation. For both projects, the ex ante gross and net savings

were equivalent in the program-tracking database, so we believe there may be other issues with the ex ante numbers for these projects, as we did not expect the gross and net to be equal.

  - Based on discussions with PSEG Long Island, we removed coincidence factors for one refrigerated case lighting project as it is not supposed to be included in the deemed savings value. However, the realization rates are still 91% and 92% for demand and energy, respectively, with no other explanation for the discrepancy since we are using deemed savings values from PSEG Long Island.

- For *HVAC* measures, the Evaluation Team applied a similar analysis strategy as in past evaluations. Measure-specific characteristics, such as cooling capacity and efficiency, were available for most projects in the program database and were used to characterize the efficient operation of installed equipment. Cooling capacity was missing for some measures in the program-tracking data. The Evaluation Team imputed 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 preexisting equipment data were available to characterize the full project savings. Our analysis used normalized savings values (i.e., kW/ton or kWh/ton) 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 to arrive at our estimated savings. The Evaluation Team could not replicate the ex ante savings and therefore has no insight into the reasons for discrepancies.
- For *Motor and VFD* measures, the database featured extensive per-installation information. With this information, the Evaluation Team conducted an analysis by facility and motor type, leading to realization rates of 129% for demand savings and 193% for energy savings. Our analysis used the normalized savings values (i.e., kW/hp or kWh/hp) that the New York Technical Manual (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 our evaluated savings. The Evaluation Team could not replicate the ex ante savings and therefore has no insight into the reasons for discrepancies.
- For *Refrigeration* measures, the program-tracking data lacked information on installed kW. These measures have thus been assigned a realization rate of 100% for this year, similar to previous years. 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 *Compressed Air* measures, the tracking database contained measure-specific information, allowing the Evaluation Team to estimate savings. The resulting realization rates are 46% for demand and 86% for energy savings. The air receiver measures are the major contributors to the lower ex post savings. This measure category accounted for about two-thirds of the demand savings and one-quarter of energy savings from the compressed air projects. The Evaluation Team's analysis of compressed air measures relied on the savings calculation methods and assumptions similar to what is recommended by programs in the Northeast, while the ex ante savings were calculated using an unknown savings percentage. We do not know the specifics around how the CEP calculated the savings percentage, so we therefore cannot explain the sources of discrepancies. Going forward, we recommend using savings algorithms for these measures based on Technical Reference Manuals (TRMs) provided by the Evaluation Team.

- For ***Building Envelope*** and ***Vending Machine Control*** measures, the Evaluation Team used measure-specific information when available to most accurately characterize the incentivized equipment. Building envelope and vending machine control 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 off 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.

Table 2-6. NTGRs for Prescriptive Components of the Commercial Efficiency Program

End-Use	Ex Ante NTGR*	Ex Post NTGR**
General Lighting	0.92	0.72
Performance Lighting	0.92	0.72
Motors and VFDs	0.64	0.72
Compressed Air	0.91	0.72
HVAC	0.90	0.72
Building Envelope	1.00	0.72
Vending Machine Controls	0.99	0.72

* Ex ante NTGR values are from measure-specific information received from PSEG Long Island staff.

** Ex post free-ridership is 30% for both kW and kWh. The specific spillover value varies between demand and energy. The demand spillover is 1.87% while the energy spillover 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. (See the definitions in Section 1.1 for a discussion of the difference between the ex ante and ex post values.) 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 Component of Commercial Efficiency Program for Cost-Effectiveness

Category	Number of Units	Ex Ante		Ex Post		Cost-Effectiveness Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	14,881	1,206	5,369,129	901	3,606,183	75%	67%
Non-Lighting							
HVAC	337	594	1,179,581	452	1,028,677	76%	87%
Vending Machine Controls	9	0	9,752	0	9,778	100%	100%
Compressed Air	78	278	2,420,784	107	1,639,378	38%	68%
Refrigeration	1,383	72	1,032,157	51	738,508	72%	72%
Motors and VFDs	173	63	966,212	108	2,079,409	171%	215%
Building Envelope	35	126	235,648	90	168,606	72%	72%
Total	16,896	2,339	11,213,263	1,709	9,270,540	73%	83%

REASONS FOR DIFFERENCES IN NET IMPACTS

We applied the same ex post NTGR as last year's evaluation. 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 spillover. Spillover added approximately 0.02[8] 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 vary from 0.64 to 1.10.

EXISTING RETROFIT COMPONENT OF COMMERCIAL EFFICIENCY PROGRAM

Table 2-8 presents evaluated net energy and demand savings associated with the Existing Retrofit program component by end-use category. As both net savings values were 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 2-8. Existing Retrofit Component of the Commercial Efficiency Program for Goal Comparison

Program Component	Category	End Use	Ex Ante			Evaluated		Realization Rate	
			Units	kW	kWh	kW	kWh	kW	kWh
Existing Retrofit	Mid-Market	Lighting	94,937	6,187	24,531,471	6,166	23,420,204	100%	95%
		HVAC	228	321	551,108	314	496,993	98%	90%
	Solutions Provider	Lighting	207,743	9,705	45,953,190	9,672	43,871,527	100%	95%
		HVAC	282	989	1,467,718	967	1,323,597	98%	90%
	Large Business	Lighting	30,310	1,542	7,296,611	1,500	6,351,180	97%	87%
Total			333,500	18,745	79,800,098	18,619	75,463,502	99%	95%

REASONS FOR DIFFERENCES IN IMPACTS

We drew two independent samples of projects for this program component, one for the lighting end-use (n=16) and one for the HVAC end-use (n=15), and found gross impact realization rates of 99% and 95% for lighting demand and energy savings, respectively, and 98% and 90% for HVAC end-use demand and energy savings, respectively. The lighting sample initially included just CEP and Solutions Provider projects. It was later supplemented with an additional sample (n=10) of Large Business projects. One of 15 HVAC projects was misclassified and was therefore removed from the sample and analysis.

For the ***Lighting*** projects, our analysis of 26 projects found four primary reasons for differences in the realization rates:

- Fixture counts varied for 8 of the 26 sampled projects. We used the fixture counts listed on the post-inspection forms.

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

- We found discrepancies in assumed hours of use for 4 of the 26 sampled projects and corrected the hours of use based on the building type for the project.
- Ex ante calculations for lighting control measures apply different control savings based on the control type codes (range from 13% to 50%). The Evaluation Team applied a 30% savings factor across all control types, as prescribed by the NYTM. These adjustments affected 6 of the 26 projects in the sample that contained lighting controls, with a negligible difference in savings.
- One project claimed greater net ex ante savings than gross savings in the program-tracking database. We believe there is an issue with the underlying data for this project.

To support the analysis of ***HVAC*** project savings, the evaluation used unlocked implementer workbooks. Desk reviews of the savings assumptions identified discrepancies in savings for 6 of the 14 sampled projects. More specifically:

- One project was double-counting ex ante savings.
- For two projects, the energy and demand savings were based on SEER rather than EER, which was inconsistent with how savings were calculated for other projects. We believe EER, which is the efficiency of the unit at full load, is the most appropriate, as we are multiplying by full load cooling hours.
- One project had inconsistent measure quantities when compared to the post-inspection form. The Evaluation Team used measure quantities listed in the post-inspection form, thus increasing the realization rate above 100%.
- Baseline efficiencies were not available for two projects; therefore, we used the baseline based on IECC 2009.

The current method for calculating savings for Existing Retrofit projects assumes the baseline equipment has remaining useful life. The program may want to consider collecting the age of the existing equipment to be consistent with Appendix M[9] 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 to ex post net energy and demand savings associated with the Existing Retrofit program component by end-use category. (See the definitions in Section 1.1 for a discussion of the difference between the ex ante and ex post values.) As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments.

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

Table 2-9. Existing Retrofit Component of Commercial Efficiency Program for Cost-Effectiveness

Program Component	Category	End Use	Ex Ante			Ex-Post		Cost-Effectiveness Realization Rate	
			Units	kW	kWh	kW	kWh	kW	Units
Existing Retrofit	Mid-Market	Lighting	94,937	6,187	24,531,471	4,817	18,214,300	78%	74%
		HVAC	228	321	551,108	251	395,109	78%	72%
	Solutions Provider	Lighting	207,743	9,705	45,953,190	7,556	34,119,650	78%	74%
		HVAC	282	989	1,467,718	772	1,052,260	78%	72%
	Large Business	Lighting	30,310	1,542	7,296,611	1,172	4,939,423	76%	68%
Total			333,500	18,745	79,800,098	14,568	58,720,742	78%	74%

REASONS FOR DIFFERENCES IN NET IMPACTS

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 spillover. Spillover added approximately 0.02[10] 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.

SMALL BUSINESS DIRECT INSTALL COMPONENT OF COMMERCIAL EFFICIENCY PROGRAM

Table 2-10 shows net energy and demand savings associated with the SBDI program component. As we calculated both 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 2-10. SBDI Component of Commercial Efficiency Program Impacts for Goal Comparison

CEP	Ex Ante		Evaluated		Realization Rate	
	kW	kWh	kW	kWh	kW	kWh
All Measures	4,294	16,636,795	4,267	16,923,658	99%	102%

REASONS FOR DIFFERENCES IN IMPACTS

We based our analysis on a desk review of 20 sampled projects. Our analysis resulted in a near 100% realization rate for demand savings and a realization rate of 102% for energy savings. While the realization rate for energy was near 100%, we made changes to hours of use on 8 of the sampled 20 projects. The changes resulted in increased savings for some projects and decreased savings for others, effectively canceling each other out when totaled together. We made no other changes to the projects and, aside from the changes to hours of use, evaluated calculations would have matched ex ante exactly.

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

Table 2-11 presents net ex post 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 spillover.[11] This NTGR value, 0.87, was lower than the program-planning value of 1.0, reducing all values in Table 2-11. (See the definitions in Section 1.1 for the difference between the ex ante and ex post values.) As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments.

Table 2-11. SBDI Component of Commercial Efficiency Program Impacts for Cost-Effectiveness

Category	Ex Ante		Ex Post		Cost-Effectiveness Realization Rate	
	kW	kWh	kW	kWh	kW	kWh
All Measures	4,294	16,636,795	3,713	14,769,276	86%	89%

Custom Program

We based energy impacts 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 and 0.95 for energy) from this past analysis to the 2014 Custom projects, as seen in Table 2-12. The Evaluation Team is completing a desk review analysis of custom projects in 2015 that may result in an update of the realization rates for this program component. The results of this analysis are forthcoming and the Evaluation Team will provide this update to PSEG Long Island in a separate memo when the analysis is complete.

Table 2-12. Custom Program Component for Goal Comparison

Program Component	Category	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Custom	Mid-Market	69	205,663	55	195,380	0.80	0.95
	Solutions Provider/Large Business	2,634	13,939,113	2,107	13,242,157	0.80	0.95
Total		**2,703**	**14,144,776**	**2,162**	**13,437,537**	**0.80**	**0.95**

Table 2-13 presents net ex post energy and demand savings associated with the Custom program component. (See the definitions in Section 1.1 for the difference between the ex ante and ex post values.) As noted previously, the Evaluation Team developed ex post net impact estimates for use in the benefit/cost and economic impact assessments.

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

Table 2-13. Custom Program Component for Cost-Effectiveness

Program Component	Category	Ex Ante		Ex Post		Cost-Effectiveness Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Custom	Mid-Market	69	205,663	44	155,327	0.64	0.76
	Solutions Provider/Large Business	2,634	13,939,113	1,682	10,527,515	0.64	0.76
Total		**2,703**	**14,144,776**	**1,727**	**10,682,842**	**0.64**	**0.76**

REASONS FOR DIFFERENCES IN NET IMPACTS

Similar to the Prescriptive program component, 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 spillover. Spillover added approximately 0.02[12] to the previous NTGR of 0.70. We calculated ex post net savings by applying the updated NTGR, 0.72, to evaluated gross savings. In contrast, the program calculates ex ante net savings using a deemed value that varied by end-use, but averaged 0.965 overall for the CEP.

NET-TO-GROSS RATIO ESTIMATION

FREE-RIDERSHIP AND PARTICIPANT SPILLOVER

Net savings are the savings that can be attributed to programmatic activity. The NTGR is a value that, when multiplied with the gross impacts, provides a savings value that accounts for naturally occurring efficiency that would have happened even if the program did not exist (free-ridership), as well as projects that were influenced by the program but did not receive direct assistance (spillover). The NTGR is generally expressed as a decimal and quantified through the following algorithm:

$$NTGR = 1 - \text{Free-Ridership} + \text{Spillover}$$

PSEG Long Island uses deemed NTGRs for the CEP that vary from 0.41 to 0.95, depending on the measure for the CEP, and uses an NTGR of 1 for the SBDI program. The 2011 program evaluation found a 0.70 NTGR for the CEP and a 0.87 for SBDI.

In 2012, the Evaluation Team performed primary research to estimate participant spillover. The resulting spillover adds another approximately 0.02[13] to the previous NTGR of 0.70 and a negligible amount to the previous 0.87 NTGR for SBDI. The resulting total NTGR for SBDI, consequently, remained at 0.87 and the remaining program components increased to 0.72.

We did not revisit NTGR assessment as part of the 2014 evaluation, but rather relied on the free-ridership estimate developed during the 2011 evaluation and spillover estimate developed as part of the 2012 evaluation.

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

[13] See previous footnote.

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 2014, the program provided rebates or discounts on ENERGY STAR® CFLs, fixtures, solid state lighting (LEDs), advanced power strips, refrigerators, super-efficient dryers, 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 overall goal of the EEP program 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 Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE), and updates efficiency requirements when any of these organizations changes its standards.

In 2014, there were few changes to the EEP-incentivized product mix. The program began a pilot offering rebates on ENERGY STAR® air purifiers and went forward with adding high-efficiency dryers after beginning a pilot in 2013. PSEG Long Island also authorized several new ENERGY STAR® two-speed and variable speed pool pumps for installer incentives and rebates.

PSEG Long Island modified several EEP program incentive structures for 2014. Participants in the appliance recycling component of the program were given larger gift certificates for the online efficient lighting catalog when recycling air conditioners and dehumidifiers in addition to their refrigerator. Recycled air conditioners and dehumidifiers received certificates for $30. This is an incentive increase of $10 over that offered in 2013. Due to fluctuations in demand for LED bulbs, incentives changed throughout the year, ranging from $3 to $7.50. For ENERGY STAR® pool pumps, customers were limited to purchasing a single unit in 2014, but incentives and rebates were unchanged.

For several individual EEP measures, we have observed significant changes in program participation in recent years that warrant some recognition and further examination. Below we have summarized program participation and savings for pool pumps and lighting products from the past 5 years.

Pool Pumps

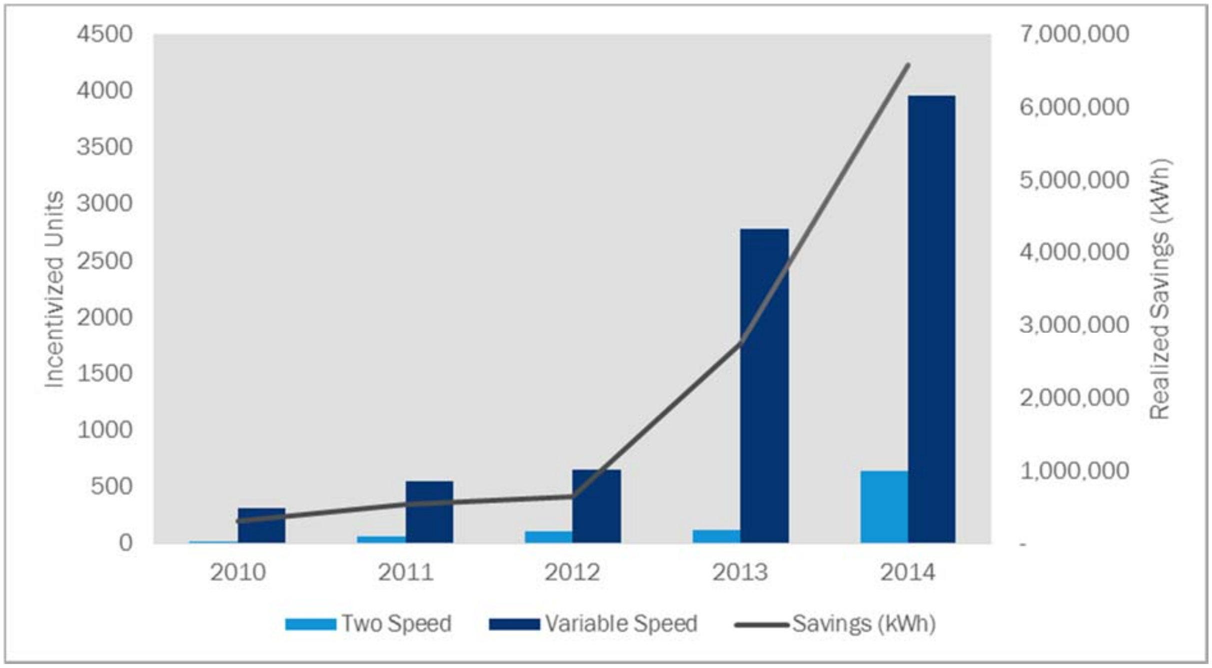
The EEP program has realized significant increases in the number of energy-efficient pool pumps rebated over the last 5 years, from 316 units in 2010 to 4,596 units in 2014, as shown in Figure 3-1. Program managers primarily attribute the expansion to increased marketing and outreach efforts aimed at contractors and distributors. With an estimated 100,000 pools on Long Island, and an effective useful life of 10 years, the market replacement rate of pumps is about 10,000 pumps per year.[14] Based on these estimates, the program now captures about 45% of the annual pool pump replacement market on Long Island.

Though the vast majority of rebated units were variable speed pumps, there was a 534% year-to-year increase in the number of two-speed pool pumps rebated from 2013 to 2014. This increase was most likely caused by

[14] Estimate from 2013 PSEG Long Island in-home study conducted by Opinion Dynamics, which used survey and site visits to estimate the percent of customers with pools. These estimates do not include pool pumps used in other applications, such as for hot tubs, spas, and landscaping water features.

the inclusion of several lower-priced pumps in the list of pool pumps approved for rebates. With the addition of these pumps, the average cost of a rebated two-speed pump in 2014 was about half the average cost of an incentivized two-speed pump in 2013.[15]

Figure 3-1. Pool Pumps Rebated by Type: 2010–2014



Source: EEP program-tracking data, 2010–2014.

This large increase over the years is a positive trend. However, the Evaluation Team knows that pool pumps may not provide the savings estimated in engineering analysis as homeowners often override the controls. As such, if pool pumps continue to be a large part of the EEPs portfolio, we recommend a study that uses site monitoring of pumps to estimate peak demand savings in the field.

LIGHTING

Traditionally, CFLs have accounted for the vast majority of savings for the EEP program. However, LED bulbs are increasingly accounting for a larger share of program bulbs and savings. Since 2010, the number of incentivized LED bulbs has more than doubled every year. The number of LED products available on the market and continuing price reductions helped LED bulbs account for 45% of savings from EEP lighting products in 2014.

As shown in Figure 3-2, though program standard CFL bulb purchases peaked in 2012, they have declined and leveled off over the last 2 years. Further, program specialty CFLs have declined in the past year. Conversely, the numbers of rebated standard and specialty LED bulbs have increased significantly since 2012.[16]

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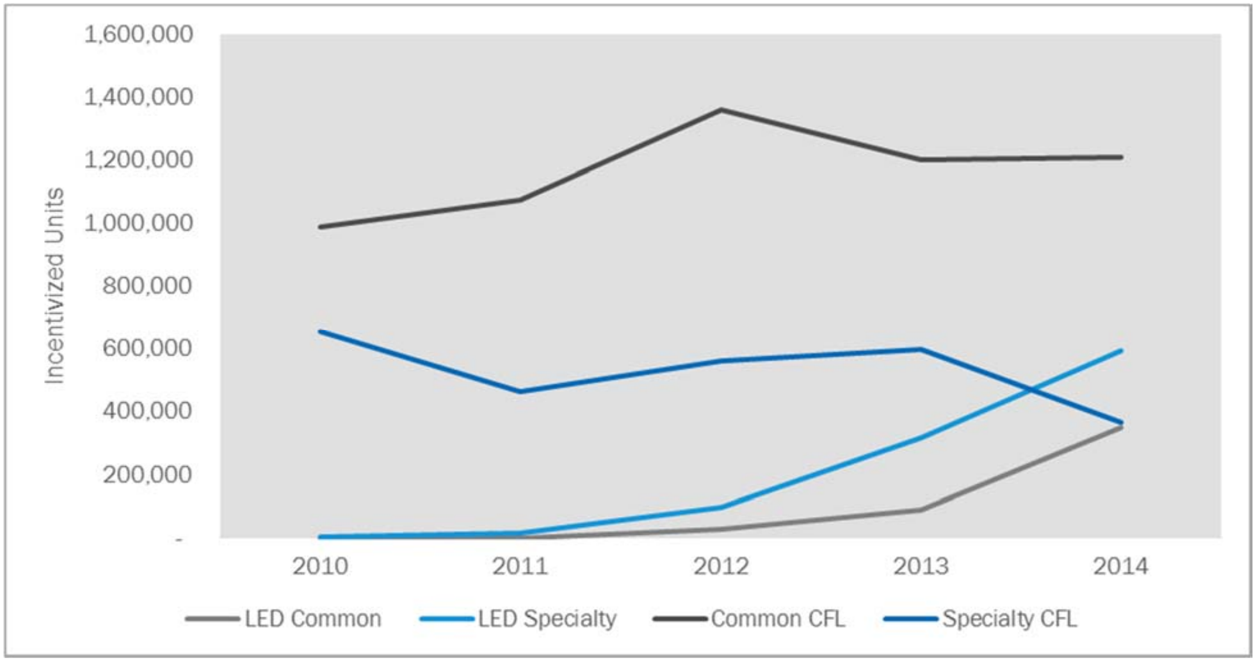
[15] Estimate is based on “amount tendered” field in the PSEG Long Island Program-Tracking Data.

[16] Segmentation of specialty LED versus standard LED based on descriptions of bulbs from PSEG Long Island program-tracking data.

Figure 3-2. Bulbs Rebated by Type: 2010–2014



Source: EEP program-tracking data, 2010–2014.

Room Air Conditioners

Research conducted by the Evaluation Team on Long Island in 2013 revealed that the market for room air conditioners and dehumidifiers has essentially transformed such that the vast majority of units for sale are ENERGY STAR® qualified. Based on this research, PSEG Long Island discontinued its rebates for these products for the 2014 program year.

As of June 1, 2014, all types of room air conditioners sold in the U.S. are required to have combined energy efficiency ratio (CEER) ratings almost a full point higher than required in previous regulations. These new standards are equal to, and in some cases exceed, the current ENERGY STAR® specification for room air conditioners. In response to these changes, the EPA is rolling out new ENERGY STAR® version 4.0 specifications for room air conditioners, which will take effect for products manufactured on or after October 26, 2015. ENERGY STAR® version 4.0 increases the accepted CEER base rating across all room air conditioners by at least one half of one point and will likely result in fewer room air conditioner products on the market that meet the ENERGY STAR® criteria. As such, PSEG Long Island should monitor market trends moving forward and consider reinstating rebates for these higher energy-efficient products as they come into the marketplace.

Impacts for Goal Comparison

Table 3-1 provides a program-level comparison of evaluated net savings to ex ante savings by measure category. (See the definitions in Section 1.1 for a discussion of the difference between the ex ante and evaluated values.)

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

Category	Ex Ante			Evaluated			Realization Rate	
	N*	kW	kWh	N*	kW	kWh	kW	kWh
Lighting	2,519,617	14,030	126,576,184	2,516,691	13,744	123,987,663	98%	98%
Pool pumps	4,596	3,035	4,246,538	4,596	6,416	6,580,004	211%	155%
Appliance recycling	6,540	791	4,345,878	6,576	523	3,512,266	66%	81%
Refrigerators	12,970	302	1,468,469	12,973	155	1,306,049	51%	89%
Room air conditioners	753	11	5,416	753	43	21,081	389%	389%
Dehumidifiers	342	26	43,890	342	42	71,186	162%	162%
Super-efficient dryers	240	27	36,923	240	27	36,923	100%	100%
Air purifiers	340	21	120,571	340	21	50,328	98%	42%
Power strips	204	3	17,218	94	3	17,218	100%	100%
Total	2,545,602	18,246	136,861,088	2,542,605	20,973	135,582,717	115%	99%

* Ex post impacts reflect only those measures identified in the program tracking data, which included 2,926 fewer lighting units, 3 additional refrigerators, 36 additional recycled appliances, and 110 fewer smart power strips than used to calculate ex ante savings.

Reasons for Differences in Impacts

Lighting: We found a realization rate of 98% for demand and energy for lighting sold through the program in 2014. The lower realization rates are due to differences in program-assumed delta watts. The Evaluation Team used the program-tracking database to categorize each of the program bulbs by wattage category and to assign an assumed pre-program wattage for each category based on lumen equivalency. These assumptions follow the ENERGY STAR® recommended values. The average incentivized CFL bulb was 15.7 watts, and the Evaluation Team assumed a pre-program wattage of 62.9 watts, for an assumed per-unit weighted savings of 47.3 watts. For LEDs, the average incentivized bulb was 10.8 watts, and the Evaluation Team assumed a pre-program wattage of 59.7 watts, for an assumed per-unit weighted savings of 48.9 watts.

Pool Pumps: The realization rates for two-speed and variable-speed pool pumps was 211% for demand impact (kW) and 155% for energy savings (kWh). These realization rates have increased from previous years due to changes in the savings calculation approach recommended by ENERGY STAR®. The Evaluation Team revised the measure savings algorithms to reflect the latest ENERGY STAR® recommendations, which increased savings significantly.

Refrigerators: Realization rates for ENERGY STAR®-rated refrigerators were 51% for kW and 89% for kWh. Detailed information on the sizes of refrigerators installed in 2014 was not available in the tracking data. Therefore, the Evaluation Team used 2012 refrigerator size install 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 peak demand savings are higher due to lower annual operating hours reflected in program kW savings. We recommend that the program track the data it collects on installed refrigerator size to ensure that accurate savings can be calculated for each installation.

Room Air Conditioners: Realization rates increased dramatically for room air conditioners in 2014, as ex ante per unit savings decreased by 70%–80% on average between 2013 and 2014, while the evaluated per unit values remained the same. Based upon the Evaluation Team's research in 2013 that showed very few non-ENERGY STAR® room air conditioners available for purchase on Long Island, the program used the ENERGY STAR® minimum EER values as its baseline in 2014. The EEP program discontinued providing rebates for ENERGY STAR® room air conditioners in 2014, and the relatively few units that were rebated in 2014 account for a very small portion of program savings. The Evaluation Team, therefore, continued to use the ENERGY STAR® criteria and savings calculation assumptions.

Dehumidifiers: Realization rates for ENERGY STAR® dehumidifiers were 162% for both kW and kWh. The 2014 program-tracking data provided the Evaluation Team with more detailed information on dehumidifier purchases, including the unit size in pints per day. This information allowed for a more accurate assessment of savings per installation using the ENERGY STAR® savings calculator. It is not apparent which of the specific ex ante savings assumptions are resulting in the higher realization rate.

Appliance Recycling: The 2014 tracking data provided the Evaluation Team with more detailed information, including the size, configuration, and vintage of recycled refrigerators and freezers. With this information, the Evaluation Team was able to more accurately assess the average savings per refrigerator or freezer recycled. These more-accurate savings values led to realization rates of 66% and 81% for kW and kWh, respectively. For dehumidifiers, the Evaluation Team confirmed that the program's gross savings estimates are appropriate; however, we observed about 7% more units recycled than claimed by the program. For recycled room air conditioners, the ex ante energy savings value was found to be higher than the evaluated savings, which relied on the savings recommended by ENERGY STAR®.

Air Purifiers: Realization rates for ENERGY STAR® air purifiers were 98% for kW and 42% for kWh. The Evaluation Team analyzed this new measure by referencing savings recommendations in the ENERGY STAR® savings calculator.

Moving forward, we recommend that PSEG Long Island regularly update EEP measure savings to reflect the most current ENERGY STAR® savings recommendations and assumptions. Ex ante savings assumptions for pool pumps, room air conditioners, dehumidifiers, recycled refrigerators, recycled room air conditioners, and air purifiers were inconsistent with the ENERGY STAR® calculator assumptions. Additionally, we repeat our earlier recommendation for M&V on pool pumps.

Impacts for Cost-Effectiveness

The ex post NTGR differed from the ex ante NTGR assumption to varying degrees across program measures. Table 3-2 shows the ex ante and ex post NTGRs by measure.

Table 3-2. NTGRs for Energy Efficient Products

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
Dehumidifiers	30%	15%	0.85	67%	0%	0.33
Refrigerators	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
Room air conditioners	30%	25%	0.95	30%	25%	0.95
Super-efficient dryers	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. (See the definitions in Section 1.1 for a discussion of the difference between the ex ante and ex post values.) 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 Net Impacts for Cost-Effectiveness

Category	Ex Ante			Ex Post			Cost-Effectiveness Realization Rate	
	N*	kW	kWh	N	kW	kWh	kW	kWh
Lighting	2,519,617	14,030	126,576,184	2,516,691	13,744	123,987,663	98%	98%
Pool pumps	4,596	3,035	4,246,538	4,596	6,416	6,580,004	211%	155%
Appliance recycling	12,970	302	1,468,469	6,576	440	2,957,697	56%	68%
Refrigerators	753	11	5,416	12,973	155	1,306,049	51%	89%
Room air conditioners	6,540	791	4,345,878	753	43	21,081	389%	389%
Dehumidifiers	342	26	43,890	342	16	27,637	63%	63%
Super-efficient dryers	240	27	36,923	240	27	36,923	100%	100%
Air purifiers	204	3	17,218	340	21	50,328	98%	42%
Power strips	340	21	120,571	94	3	17,218	100%	100%
Totals	**2,545,602**	**18,246**	**136,861,088**	**2,542,605**	**20,865**	**134,984,600**	**114%**	**99%**

* Ex post impacts reflect 2,926 fewer lighting units, 3 additional refrigerators, 36 additional recycled appliances, and 110 fewer smart power strips.

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 of higher-efficiency HVAC equipment, including traditional split system central air conditioners (traditional CACs), geothermal and air-source heat pumps (ASHPs), ductless mini-split systems, furnace fans, and ductwork. Quality Installation means that the contractor performs Manual J calculations to install the energy efficient unit that is appropriately sized as well as check the refrigerant charge and airflow using prescribed tests. Participating contractors also receive incentives for each rebated quality installation.

In 2014, the Cool Homes program met its demand goals for the second year in a row, providing rebates for 5,319 measures. Nearly three-quarters of these measures (73%) were traditional CACs sold through Cool Homes contractors. PSEG Long Island incentivized an additional 203 (4%) traditional CAC systems sold through an upstream pilot program with HVAC distributors. The remaining rebated measures were ductless mini-split systems (11%), ASHPs (6%), geothermal heat pumps (GTHPs) (3%), furnace fans (3%), and ductwork (1%), as seen in Table 4-1.

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

Measure	Quantity	Percent
Traditional CAC	3,881	73%
Ductless Mini-Split	562	11%
ASHP	320	6%
Upstream (Traditional CAC)*	203	4%
GTHP	162	3%
Furnace Fan*	130	2%
Ductwork*	61	1%
Total	**5,319**	**100%**

Source: 2014 Cool Homes program-tracking data.
* The upstream program was initiated in 2013, but the rebates were not paid to distributors until 2014 and savings were not accounted for until 2014. Rebates for energy-efficient furnace fans and ductwork replacement were not officially offered during the 2014 program year.

The program provided rebates to fewer systems in 2014 than it did in 2013 (as seen in Table 4-2) though the program still met its goals and came in $2 million under budget. Declines were seen in every measure in 2014 except ASHPs. Not surprisingly, the greatest declines were seen in furnace fans and ductwork, which were offered in 2013, but not officially offered in 2014. PSEG Long Island provided a limited number of rebates for these measures in 2014 as a result of a lag in paperwork processing or a legacy from contractors or customers familiar with the 2013 program, who the implementer offered the prior year's rebate as a courtesy.

Table 4-2. Difference in Number of Cool Home Program Measures Installed, 2013–2014

Measure	2013	2014	Percent Difference
Traditional CAC	4,421	3,881	−13%
Ductless Mini-Split	716	562	−22%
ASHP	279	320	+15%
Upstream (Traditional CAC)*		203	
GTHP	195	162	−17%
Furnace Fan*	375	130	−65%
Ductwork*	178	61	−66%
Total	**6,164**	**5,319**	**−14%**

Source: Cool Homes program-tracking data, 2013 and 2014.
* The upstream program was offered in 2013, but the savings are accounted for in 2014. Rebates for energy-efficient furnace fans and ductwork replacement were not officially offered during the 2014 program year.

Upstream Pilot

In 2013, the Cool Homes program ran an upstream pilot program to encourage the sale of high-efficiency traditional CAC systems by distributors. The savings from this pilot program were not claimed in 2013 because incentives were based upon the difference between 2012 and 2013 sales. Therefore, PSEG Long Island could not pay incentives or claim savings until after 2013. Only two Long Island HVAC distributors participated in the program. PSEG Long Island established a baseline for each distributor based on 2012 sales of efficient systems to estimate the number of qualifying systems that the distributors would sell without the presence of the pilot program. To encourage sales of these systems, the pilot offered distributors $200 for each qualifying high-efficiency CAC system sold in 2013 above the baseline numbers. Both distributors exceeded their 2012 baseline sales, but fell short of expected sales. The pilot ended at the end of 2013, because of the relatively low participation by local distributors, and there are no plans to continue it in the future.

Application Process

Both program participants and implementers have reported that the Cool Homes program's application process is burdensome and poses a barrier to participation. Therefore, program staff has been exploring options for reducing the number of steps and automating the application process. Program implementers and contractors reported that two parts of the application process in 2014 were particularly burdensome: the customer's physical signature and the pre-approval. The requirement to gather a physical signature from the customer on the completed application often meant that the contractor must make an additional trip to the residence. In 2015, the program eliminated the pre-approval application requirement, which has significantly reduced the burden on contractors. In addition, with the introduction of the Equipment Only component, non-participating contractors are able to submit a one-page rebate application which further reduces the burden on contractors.

Program staff have also attempted to ease the burden of submitting an application by hosting weekly open houses for contractors who need assistance with the application process or any other program requirements. According to program staff, this open house is typically well attended, with Cool Homes contractors present nearly every week. To further reduce the burden, the Evaluation Team recommends accepting electronic signatures from customers and contractors and replacing the Excel-based application system with a more streamlined web-based data entry system. Some systems would allow PSEG Long Island to download the data directly from these platforms into an Excel worksheet or upload it directly into the program-tracking system.

The program may also benefit from mobile-friendly data entry, which would allow contractors with smartphones to fill out key information while still at the job site.

Implementer Access to Data

In 2014, the program implementer, Conservation Services Group, reported having limited access to program data while using the Seibel system. As a result, the implementer was unable to aid contractors who had questions about their application and where it was in the process. They also were unable to view the number and types of applications submitted in real time, which posed a challenge to their effective implementation of the program. The Evaluation Team recommends that, as the program transitions to the new Lockheed Martin data-tracking system, the implementer be able to view the types and number of systems that have been rebated, as well as contractor information.

In addition, program staff indicated that the current data system often contains multiple entries for the same participating contractor, but with different names (e.g., Joe Smith and Sons, Smith & Sons, Joe Smith). This makes any analysis of contractor participation difficult and reduces the implementer's ability to track applications through the payment process. Further, program staff cannot accurately identify which contractors are not actively participating in the program, which is a condition of being an approved Cool Homes contractor. The Evaluation Team recommends establishing a unique identifier for each participating contractor and recording this identifier on each application.

Geothermal Heat Pumps

Geothermal systems represent a significant opportunity for energy savings, and PSEG Long Island is making efforts to increase the installation of these systems on Long Island. Some jurisdictions on Long Island have restrictions and codes that can make the installation of GTHPs difficult, and PSEG Long Island is working with these jurisdictions to ease the process for its customers. As a result, the program expects to see more GTHPs installed through the program in the coming years. However, PSEG Long Island has conducted no research on the free-ridership rate and baseline for these systems in PSEG Long Island territory, nor is there research on effective incentive levels. The Evaluation Team recommends that PSEG Long Island conduct research that will aid in long-term planning of the GTHP component of the Cool Homes program. More specifically, such research would examine:

- Baseline: In 2014 and prior years, the Evaluation Team used ASHPs as the baseline for GTHPs. However, PSEG Long Island has conducted no research to ascertain what customers are replacing or would have installed absent the program incentive. Research should be conducted with program participants who installed geothermal to gather the type of system (as well as SEER and EER levels) that the customer would have installed absent the program, and the baseline should be adjusted accordingly.
- Free-Ridership: Similarly, no research has been conducted on free-ridership of GTHPs in the Cool Homes program. Given the difference in cost and incentives, free-ridership of GTHPs may differ substantially from that of traditional CACs. The free-ridership should be assessed to aid in program planning and to more accurately estimate program savings.
- Optimal Incentive Levels: Incentives for customers installing geothermal systems vary widely across the country. A 17 EER geothermal system would receive a rebate of $375 in SCE&G territory, but up to $1,500 in Connecticut (UI and Connecticut Light and Power), and would not qualify for Cool Homes, which does not offer rebates for systems below 19 EER. The Evaluation Team has done little research to establish the most effective incentive levels. Given that geothermal installations are significantly

more expensive than ASHPs and traditional CAC systems, an effective incentive level may be a key element to growing the geothermal component of the Cool Homes program.

IMPACTS FOR GOAL COMPARISON

Table 4-3 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 4-3. Cool Homes Net Impacts for Goal Comparison

		Ex Ante		Evaluated		Realization Rate	
Category	Installs	kW	kWh	kW	kWh	kW	kWh
Traditional CAC	3,881	4,290	2,828,095	4,591	3,356,780	107%	119%
ASHP	320	299	476,438	350	661,042	117%	139%
GTHP	162	222	517,113	244	673,144	110%	130%
Ductless Mini-Split	562	165	178,839	201	236,514	122%	132%
Upstream (Traditional CAC)	203	47	0	95	79,160	200%	–
Furnace Fan	130	38	67,437	17	46,252	44%	69%
Ductwork	61	13	9,617	20	11,538	153%	120%
Total	5,319	5,074	4,077,539	5,516	5,064,431	109%	124%

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 2014 tracking database. 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 regarding the efficiency level of the removed system in the early retirement component of the program. The program and the Evaluation Team use the same coincidence factors and effective full load cooling hours (EFLCH).

As part of the evaluation process, the Evaluation Team “backed out” the NTGR for all measure categories at all tiers. Ex ante savings do not contain coincidence factors, line losses, or NTGR, but do contain quality install factors. The Evaluation Team found that the “backed-out” NTGRs and the program’s actual NTGRs did not always match, particularly for furnace fan and GTHP measures, where “backed-out” NTGRs were 1.25. Inconsistencies in tracking data arose during the program’s transition to the Siebel tracking database. Namely, certain project savings were marked as “gross” but actually reflected net savings. Further details on these erroneous entries were not available. The Evaluation Team believes this issue is the main contributor to the difference between ex ante and evaluated net savings. We applied the actual NTGRs for all measures rather than the “backed-out” NTGRs when determining evaluated savings.

The Evaluation Team has the following comments on the measure-specific savings calculations summarized in Table 4-3:

- **Traditional CACs:** Evaluated savings for traditional CACs were slightly higher than ex ante savings for both demand (107%) and energy (119%) savings. These differences are due to slight differences in baseline efficiency for early retirement CACs for which the Evaluation Team was able to use estimates for efficiency for each piece of equipment removed.
- **ASHPs:** ASHPs achieved realization rates of 117% (demand) and 139% (energy) 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 evaluator and program calculations.
- **GTHPs:** GTHPs yielded higher evaluated savings for both demand (110%) and energy (130%) savings due to differences in baseline efficiency assumptions. The Evaluation Team referenced the same baseline efficiencies as recommended by the NYTM for ASHPs; however, we could not determine program baseline assumptions from the files provided. In addition, we believe that there may 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 0.9 for both demand and energy.
- **Ductless Mini-Splits Systems:** Ductless mini-split systems achieved higher evaluated savings for both demand (122%) and energy (132%). The elevated realization rates are attributable to differences in baseline efficiency values for early retirement projects. The Evaluation Team relied on tracking data for preexisting 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. Similar to GTHPs, we also observed discrepancies between the “backed-out” NTGR and the theoretical value for ductless mini-split systems. Our “backed-out” NTGR ranged from 0.85 to 0.98, while the actual value is 0.92 for demand and 0.98 for energy. These discrepancies also contribute to the higher realization rate.
- **Upstream pilot:** Since these savings were associated with a pilot project that will not be continuing, and they represent a relatively small portion of total program savings, the Evaluation Team assigned a realization rate of 100% to all claimed upstream pilot savings. The program did not claim any energy savings for the upstream pilot in 2014, but did claim demand savings. The Evaluation Team believes that there would be energy savings associated with the upstream pilot program, and applied a 100% realization rate to the estimated energy savings from the additional program-tracking data spreadsheets. The program assumed a 50% free-ridership to the claimed demand savings, but we believe that the estimated savings are already net because they came from units above the forecasted sales numbers, and therefore a free-ridership value is not applicable. We therefore removed the 50% free-ridership, leading to a 200% realization rate for demand savings. We cannot calculate a realization rate for energy savings as the ex ante savings were 0, but we applied the same methodology to energy savings.
- **Furnace fans:** Evaluated savings for furnace fans were lower than ex ante savings for demand (44%) and energy (69%). These differences are due to differences in baseline fan efficiency and assumed operating hours. Additionally, similar to GTHPs and ductless mini-split systems, we observed discrepancies between the “backed-out” NTGR and the actual value for furnace fans. Our “backed-out” NTGR was 1.25 for demand and 0.99 for energy, while the actual value is 0.84 for demand and 0.90 for energy. These discrepancies also contribute to the low realization rates.
- **Duct Replacement:** Evaluated savings for ductwork were higher than ex ante savings for demand (153%) and energy (120%). Similar to other measures within the Cool Homes program, we observed discrepancies between “backed-out” NTGRs and actual NTGRs. Our “backed-out” NTGR was 0.82 for demand and 0.83 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 traditional 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 4-4 shows a categorical breakdown of ex post savings compared with tracked program savings (ex ante). (See the definitions in Section 1.1 for the difference between the ex ante and ex post values.)

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

		Ex Ante		Ex Post		Cost-Effectiveness Realization Rate	
Category	Installs	kW	kWh	kW	kWh	kW	kWh
Traditional CAC	3,881	4,290	2,828,095	3,631	2,194,101	85%	78%
ASHP	320	299	476,438	350	661,042	117%	139%
GTHP	162	222	517,113	244	673,144	110%	130%
Ductless Mini-Split	562	165	178,839	201	236,514	122%	132%
Upstream (Traditional CAC)	203	47	0	95	79,160	200%	–
Ductwork	61	13	9,617	20	11,538	153%	120%
Furnace Fan	130	38	67,437	17	46,252	44%	69%
Total	**5,319**	**5,074**	**4,077,539**	**4,556**	**3,901,751**	**90%**	**96%**

The program applies planning NTGR values of between 0.5 and 0.98 for each program measure category.[17] Additionally, the program NTGR differs for energy and demand for some measures. The Evaluation Team developed an updated NTGR for traditional CAC installations in 2011, including separate factors for savings associated with quality installation 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 free-ridership and program spillover. Table 4-5 below shows the NTGR values for the Cool Homes program.

[17] PSEG Long Island assigns different levels of free-ridership based on the efficiency tier of the equipment. These free-ridership 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 4-5. Cool Homes NTGRs

Measure	Ex Ante kW*	Ex Ante kWh*	Ex Post kW	Ex Post kWh
Traditional CAC Equipment	0.92	0.98	0.52	0.52
Traditional CAC Installation	0.92**	0.98**	1.49	1.41
Air Source Heat Pump Equipment	0.92	0.98	0.92	0.98
Air Source Heat Pump Quality Installation	0.92**	0.98**	1.00	1.00
Ductless Mini-Split	0.92	0.98	0.92	0.98
Ductwork	1.00	1.00	1.00	1.00
Geothermal Heat Pump	0.92	0.98	0.92	0.98
Furnace Fan	0.84	0.90	0.84	0.90
Upstream (Traditional CAC)	0.50	0.50	1.00	1.00

* 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.

** Ex ante savings for quality installation are included in the overall ex ante savings for traditional 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 quality installation.

Summary of Findings and Next Steps

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

- **Continue to streamline the Cool Homes application process:** Consider converting to a web-based application, and accepting electronic signatures from contractors and customers.
- **Implementer Access to Data:** PSEG Long Island should house the data from Cool Homes applications in a way that allows the program implementer access to the most recent data. This will allow the program implementers to provide better assistance to contractors.
- **Research on Geothermal:** Geothermal systems are likely to increase in the coming years as regulatory barriers are reduced and customers become more aware of their benefits. The Evaluation Team recommends conducting additional research to determine the accuracy of the baselines and free-ridership estimates. Additional research should also be performed to determine the most effective incentive structures.
- **Review the Application of Factors:** The Evaluation Team observed several discrepancies in the "backed-out" NTGRs and the actual ex post NTGRs for some measures. We recommend reviewing the application of all factors, including NTGRs, throughout the program to ensure that they are accurate and consistent with the actual value assumed for each measure.

5. 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 CAC. During the audit, the contractor checks for moisture problems, assesses insulation and envelope sealing, and evaluates heating and cooling efficiency.[18] 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).

HPD program implementation remained mostly consistent between 2013 and 2014. Prior changes in program eligibility (and targeting) for 2013 shifted the composition of the participant base to a lower proportion of electric space heated (ESH) homes. This remained consistent in 2014, which again saw a very low proportion of ESH participant households. In addition, in 2013 HPD implemented a Duct Insulation Pilot for participating households with unconditioned attics. In 2014, HPD added an incentive for this measure.

Impacts for Comparison to Goal and Cost-Effectiveness

As in the 2013 evaluation, the Evaluation Team used two approaches to estimate ex post savings for the HPD program in 2014: 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 5-1 provides a review of impacts for the program in 2014 by measure category. (See the definitions in Section 1.1 for the difference between the ex ante and evaluated values.) 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 5-1. HPD Net Impacts for Goal Comparison and Cost-Effectiveness

Measure Category	N (Number of Projects)*	Ex Ante		Evaluated/Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Air Sealing	2,126	58	96,275	36	59,691	62%	62%
Lighting	2,252	244	3,438,251	236	2,131,715	97%	62%
Duct Sealing	2,118	1,429	830,668	886	515,014	62%	62%
Hot Water	133	121	184,909	72	114,643	59%	62%
Total	**2,313**	**1,852**	**4,550,103**	**1,230**	**2,821,064**	**66%**	**62%**

* Number of HPD projects with measure in 2014.

[18] The type and extent of HPD 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 visit.

REASONS FOR DIFFERENCES IN IMPACTS

The billing analysis found that the Home Performance programs realized 62% 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 program achieving 66% 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 HPD and HPwES. Given the overlap in 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 increases both the precision and robustness of our results. Estimating separate models for HPD and HPwES 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 HPD and HPwES follow a similar program design and exhibit overlap in participants, we think a single model approach yields the most accurate estimates of program savings.

Our billing analysis used 2013 participants as the treatment group since the method requires post-installation electricity usage data for approximately 1 year after participation.[19] We also included a comparison group consisting of households that participated in 2014. The comparison group helps us assess the counterfactual or baseline for the treatment group (2013 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 2013 and 2014 program years (as shown in Table 5-2) and no substantive change in program design across the 2 years. In both years, lighting contributed around 70% of ex ante program savings, with duct sealing also contributing a significant share (21% in 2013 and 22% in 2014). Overall, the analysis of the measure composition shows that the 2 program years are comparable and that it was appropriate to use 2014 as a comparison group.

[19] Note that participants who initiated participation in 2013 and continued participating in 2014 (i.e., through HPwES) are considered 2013 participants for the purpose of this analysis and are included in the billing analysis.

Table 5-2. Comparison of Installed measures for 2013–2014 Participants Included in Billing Analysis

	Billing Analysis Treatment Group (2013 Participants) n=1,967		Billing Analysis Control Group (2014 Participants) n=2,301	
Measure Installed	Percentage of Participants	Percentage of Gross kWh	Percentage of Participants	Percentage of Gross kWh
Lighting	78%	70%	85%	69%
Duct Sealing	80%	21%	89%	22%
Insulation	36%	4%	23%	2%
Air Sealing	93%	2%	93%	2%
Direct Hot Water	8%	2%	8%	4%
Attic Vents, etc.	26%	0%	15%	0%
HVAC Equipment	5%	0%	4%	0%
HVAC Pipes	0%	0%	0%	0%
Refrigerator	0%	0%	0%	0%
Thermostat	2%	0%	1%	0%
Windows/Doors	2%	0%	1%	0%

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 2013 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 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, 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 2013 HPD and HPwES participants. As shown below, the 2013 Home Performance programs realized 62% 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).[20]

[20] See detailed methodology section for more details.

Table 5-3. Savings from Home Performance Billing Analysis Compared to Ex Ante Savings Estimates

End-Use	N (Participants in billing analysis)	Observed Savings		Program Planning Savings*		Realization Rate
		Household Daily kWh Savings for Those with the Measure	Household Annual kWh Savings for Those with the Measure	Household Daily kWh Savings for Those with the Measure	Household Annual kWh Savings for Those with the Measure	
Overall Savings	1,967	2.49	909	4.03	1,472	62%

* 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 use 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 for each program measure category to develop the ex ante savings estimates. The Evaluation Team developed a NTGR for the program in 2011, including free-ridership and program spillover. For 2014, we developed a net realization rate using the billing analysis and, therefore, did not apply the NTGRs.

Table 5-4 provides a review of impacts for the program in 2014 by category based on an engineering estimate of savings. (See the definitions in Section 1.1 for the difference between the ex ante and ex post values.)

Table 5-4. HPD Measure-Specific Net Impacts – Engineering Approach

Measure Category	N (Number of Projects)*	Net Ex Ante		Net Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Air Sealing	2,126	58	96,275	58	96,273	100%	100%
Lighting	2,252	244	3,438,251	217	1,953,858	89%	57%
Duct Sealing	2,118	1,429	830,668	1,429	830,649	100%	100%
Heating and Hot Water	133	121	184,909	49	78,473	41%	42%
Total	**2,313**	**1,852**	**4,550,103**	**1,753**	**2,959,253**	**95%**	**65%**

* Number of HPD projects with measure in 2014.

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

- For ***Air Sealing and Duct Sealing*** measures, no information was available regarding input values for the ex ante savings algorithm. We examined the program savings algorithm 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.
- 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. Therefore, the Evaluation Team calculated an average installed wattage based on HPD tracking data and applied a multiplier to estimate baseline wattage based on correlation between installed and

removed bulbs found in REAP tracking data. We believe the REAP tracking data is representative of residential lighting baseline per our research on lumen equivalence between incandescent and CFL bulbs. We anticipate that discrepancies between ex ante and ex post may be caused by differences in baseline and/or with coincidence factors and assumed hours of use.

- For ***Domestic Hot Water*** (DHW) measures, including shower heads, faucet aerators, pipe insulation, tank wrap, and temperature turndown, 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 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 preexisting shower head and faucet aerator flow rates in gallons per minute (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.
  - 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, we used a coincidence factor of 0.23 adopted from a study of electric hot water heaters.[21] 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.

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

6. 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. HPwES 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 the New York State Energy Research and Development Authority (NYSERDA) for energy efficiency home improvements made as part of the HPwES program.

Program implementation remained fairly consistent between 2013 and 2014, with only two changes of note. First, in 2014 only participants with central air conditioning (i.e. systems with duct work, including heat pumps) were eligible to receive HPwES incentives. Homes with through-the-wall (TTW) AC or ductless mini-split air condition were no longer eligible for HPwES incentives. Secondly, the incentives for mechanical ventilation as well other supplemental incentives were removed from the program.

Impacts for Comparison to Goal and Cost-Effectiveness

As in the 2013 evaluation, the Evaluation Team used two approaches to estimate ex post savings for the HPwES program in 2014: 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 6-1 provides a review of impacts for the program in 2014 by category. (See the definitions in Section 1.1 for the difference between the ex ante and evaluated values.) As described below, we use the billing analysis results for all evaluated savings.

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

Measure Category	N (Number of Projects)*	Ex Ante		Evaluated/Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Building Envelope	716	154.3	151,703	95.7	94,056	62%	62%
HVAC	375	553.2	299,972	322.7	185,983	58%	62%
Air Sealing	712	33.2	39,429	20.6	24,446	62%	62%
Hot water	133	15.0	30,058	8.6	18,636	57%	62%
Lighting	48	6.0	41,092	2.8	25,477	47%	62%
Refrigerator	3	2.5	5,094	0.4	3,158	15%	62%
Total	727	764.4	567,348	450.8	351,756	59%	62%

* Number of HPwES projects with measure in 2014.

Note: Totals may not sum due to rounding.

Reasons for Differences in Impacts

The billing analysis found that the Home Performance programs realized 62% 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 program achieving 59% of their 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 HPD and HPwES. Given the overlap in 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 increases both the precision and robustness of our results. Estimating separate models for HPD and HPwES 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 HPD and HPwES follow a similar program design and exhibit overlap in participants, we think a single model approach yields the most accurate estimates of program savings.

Our billing analysis used 2013 participants as the treatment group since the method requires post-installation electricity usage data for approximately 1 year after participation.[22] We also included a comparison group consisting of households that participated in 2014. The comparison group helps us assess the counterfactual or baseline for the treatment group (2013 participants) in the post-period.

Program participants were fairly similar across program years, with mostly small differences in the share of measures in the 2013 and 2014 program years (as shown in Table 6-2) and no substantive change in program design across the 2 years. In both years, lighting contributed around 70% of ex ante program savings with duct sealing also contributing a significant share (21% in 2013 and 22% in 2014). Overall, the analysis of the measure composition shows that the 2 program years are comparable.

[22] Note that participants who initiated participation in 2013 and continued participating in 2014 (i.e., through HPwES) are considered 2013 participants for the purpose of this analysis and are included in the billing analysis.

Table 6-2. Comparison of Installed Measures for 2013–2014 Participants Included in Billing Analysis

Measure Installed	Billing Analysis Treatment Group (2013 Participants) n=1,967		Billing Analysis Control Group (2014 Participants) n=2,301	
	Percentage of Participants	Percentage of Gross kWh	Percentage of Participants	Percentage of Gross kWh
Lighting	78%	70%	85%	69%
Duct Sealing	80%	21%	89%	22%
Insulation	36%	4%	23%	2%
Air Sealing	93%	2%	93%	2%
Direct Hot Water	8%	2%	8%	4%
Attic Vents, etc.	26%	0%	15%	0%
HVAC Equipment	5%	0%	4%	0%
HVAC Pipes	0%	0%	0%	0%
Refrigerator	0%	0%	0%	0%
Thermostat	2%	0%	1%	0%
Windows/Doors	2%	0%	1%	0%

The billing analysis model is a LFER 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 2013 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 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, thus greatly increasing 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 2013 HPD and HPwES participants. As shown below, the 2013 Home Performance programs realized 62% 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).[23]

[23] See detailed methodology section for more details.

Table 6-3. Savings from Home Performance Billing Analysis Compared to Ex Ante Savings Estimates

End-Use	N (Participants in billing analysis)	Observed Savings		Program Planning Savings*		Realization Rate
		Household Daily kWh Savings for Those with the Measure	Household Annual kWh Savings for Those with the Measure	Household Daily kWh Savings for Those with the Measure	Household Annual kWh Savings for Those with the Measure	
Overall Savings	1,967	2.49	909	4.03	1,472	62%

* 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 apply to the billing analysis energy savings to estimate billing demand savings.

The program applies a planning NTGR of 1 for each program measure category to develop the ex ante savings estimates. For 2014, 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 2014 by category based on an engineering estimate of savings. (See the definitions in Section 1.1 for the difference between the ex ante and ex post values.)

Table 6-4. HPwES Measure-Specific Net Impacts – Engineering Approach

Measure Category	N (Number of Projects)*	Net Ex Ante		Net Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Building Envelope	716	154.3	151,703	154.3	151,700	100%	100%
HVAC	375	553.2	299,972	527.1	303,757	95%	101%
Air Sealing	712	33.2	39,429	33.2	39,428	100%	100%
Hot Water	133	15.0	30,058	15.0	32,585	100%	108%
Lighting	48	6.0	41,092	4.1	37,387	69%	91%
Refrigerator	3	2.5	5,094	0.4	3,531	16%	69%
Total	727	764.4	567,348	734.2	568,389	96%	100%

* Number of HPwES projects with measure in 2014.

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

- For ***Building Envelope*** measures, the program-tracking data did not include any information on R values of preexisting 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.

- For ***HVAC*** measures, the evaluated demand savings were 5% lower than ex ante, while evaluated energy savings were 1% higher. No reference information on program algorithms or assumptions is available for the Evaluation Team to pinpoint specific reasons for the minor discrepancy in savings. The Evaluation Team followed the same per-install calculation methodologies used for similar Cool Homes measures; however, there were measure-specific discrepancies between claimed HPwES and Cool Homes measures.
- 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.
- For ***DHW*** measures, including pipe insulation, tank wraps, 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 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, type of tank wrap insulation, pre- and post-R value of tank wrap, size of the replaced water heater, and area (sf) of tank wrap. The evaluated savings calculation methodology for these measures is as follows:
  - We calculated the evaluated savings for pipe insulation using DOE 3E Plus software.
  - We calculated tank wrap savings based on an estimated energy reduction value from DOE research.
  - When estimating peak demand savings, we used a coincidence factor of 0.23 adopted from a study of electric hot water heaters.[24]
- 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. Therefore, the Evaluation Team estimated an average installed wattage based on HPwES tracking data and applied a multiplier to estimate baseline wattage based on correlation between installed and removed bulbs found in REAP tracking data. We believe the REAP tracking data is representative of residential lighting baseline per our research on lumen equivalence between incandescent and CFL bulbs. We anticipate that discrepancies between ex ante and evaluated savings may be caused by differences in baseline and/or with coincidence factors and assumed hours of use.
- 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 tracking data. Evaluated savings for the five refrigerators installed in 2014 reflect the weighted average ENERGY STAR®-recommended savings based on 2014 installed refrigerator sizes and configurations. The baseline refrigerators represent a weighted average energy consumption based on year of preexisting refrigerator, per ENERGY STAR®. Since the 2014 HPwES tracking spreadsheet did not contain information on the age of the preexisting refrigerators, 2014 REAP data for 448 installs was referenced by the Evaluation Team when performing these weighted savings calculations.

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

7. The Residential Energy Affordability Program

The Residential Energy Affordability Program (REAP) assists low-income households with energy efficiency improvements. The logic behind this program is that a reduction in utility bills through energy efficiency would lower the PSEG Long Island's financial risk with collection and bad debt, while improving residential energy efficiency on Long Island. To participate in REAP, 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. The mix of measures offered through the program remained similar to 2013. 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 2014, room air conditioners and dehumidifiers were added to the program with the aim of increasing savings and cost effectiveness. However, due to problems integrating these measures into the application, program implementation did not conform to the new program design and planning assumptions until late in 2014. Per interviews with program staff, REAP is also discontinuing its refrigerator offering in 2015.

Program implementation processes remained similar from 2013 to 2014; however, one notable change is the transition from the Seibel data tracking system to the Real Home Analyzer (RHA), which has been used in previous years. Also of note is that program goals and budgets were reduced for 2014. As a result, there is less program marketing and outreach than in previous years. However, REAP is making an effort to channel more qualifying customers with CAC to the HPD program.

Impacts for Comparison to Goal and Cost-Effectiveness

As in the 2013 evaluation, the Evaluation Team used two approaches to estimate savings for the REAP program in 2014: 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. We show the results in Table 7-1. The results of this year's billing analysis are similar to the results of last year's billing analysis of 2012 participants. The cost-effectiveness realization rate was 37% for kW savings and 42% for kWh savings.

Table 7-1. REAP Net Impacts for Comparison to Goal and for Cost Effectiveness

Measure Category	N (Number of Projects)*	Ex Ante		Evaluated/Ex Post		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Lighting	1,913	175.5	1,714,751	79.8	720,196	45%	42%
DHW	182	66.6	133,475	7.3	56,059	11%	42%
Refrigerator	448	68.5	484,826	24.1	203,627	35%	42%
Air Sealing	100	2.7	2,272	1.2	954	42%	42%
Duct Insulation	15	2.1	1,082	0.9	454	42%	42%
Duct Sealing	100	64.5	33,007	27.1	13,863	42%	42%
Total	**2,474**	**380.0**	**2,369,413**	**140.4**	**995,153**	**37%**	**42%**

* Number of REAP projects with measure in 2014.

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.

The billing analysis found that the REAP program generated approximately 995 MWh in energy savings in 2014, or 42% of the expected net energy savings. Applying the ratio of evaluated demand to energy savings from the engineering analysis to the 995 MWh in energy savings results in 140 MW in demand savings, or 37% of the expected peak demand savings. The billing and engineering analyses are described in more detail below.

Billing Analysis

The Evaluation Team conducted a billing analysis with the goal of determining the overall evaluated net energy savings for REAP. Our billing analysis used 2013 participants as the treatment group, since the method requires post-installation electricity usage data for approximately 1 year after participation.[25] We also included a comparison group consisting of households that participated in 2014. The comparison group helps us assess the counterfactual or baseline for the treatment group (2013 participants) in the post-period.

Program participants were fairly similar across program years, with mostly small differences in the share of measures in the 2013 and 2014 program years (as shown in Table 7-2) and no substantive change in program design across the 2 years. In both years, lighting contributed the highest percentage of ex ante program savings (nearly 70% in 2013 and 76% in 2014). Refrigerators also contributed a significant share, but this decreased somewhat compared to 2013. Overall, the analysis of the measure composition shows that the 2 program years are comparable.

Table 7-2. REAP Installations by Program Year

	Billing Analysis Treatment Group (2013 Participants) n=2,642		Billing Analysis Control Group (2014 Participants) n=1,714	
Measure Installed	Percentage of Participants	Percentage of Gross kWh	Percentage of Participants	Percentage of Gross kWh
Air Sealing	3%	0%	3%	0%
Direct Hot Water	8%	6%	9%	5%
Duct Sealing	3%	1%	3%	1%
Lighting	98%	69%	98%	76%
Refrigerator	41%	24%	18%	18%

The billing analysis model is a LFER 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 2013 participants would have done during the post-period absent the program), we added dummy variables for each month of the evaluation period. The

[25] Note that participants who initiated participation in 2013 and continued participating in 2014 (i.e., through REAP) are considered 2013 participants for the purpose of this analysis and are included in the billing analysis.

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 chose not to include measure-realization rates due to a considerable number of participants who installed multiple measures. Such overlap in measure installations makes it extremely difficult to 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 7-3 presents the overall net program savings for 2013 REAP participants. As shown below, the 2013 REAP program realized 42% of its expected net savings. Not shown are the measure-level realization rates for lighting and refrigerators due to the higher degree of uncertainty around the parameter estimates. However, based on our analysis of the billing analysis model, a decrease in the share of savings for lighting appears to account for much of the decreased overall savings (compared to last year's results).

Table 7-3. Savings from REAP Billing Analysis Compared to Ex Ante Savings Estimates

End-Use	N (Participants in Billing Analysis)	Observed Savings		Program-Planning Savings		Realization Rate
		Household Daily Savings for Those with the Measure	Household Annual Savings for Those with the Measure	Household Daily Savings for Those with the Measure	Household Annual Savings for Those with the Measure	
Overall Program	2,642	1.67	610	3.93	1,435	42%

* 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. The engineering analysis was used to determine a ratio between energy and demand savings that we then apply to the billing analysis energy savings to estimate billing demand savings.

Given that REAP 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 7-4 provides a review of impacts for the program in 2014 by category based on an engineering estimate of savings. (See the definitions in Section 1.1 for the difference between the ex ante and evaluated values.)

Table 7-4. REAP Measure-Specific Net Impacts – Engineering Approach

Measure Category	N (Number of Projects)*	Net Ex Ante		Net Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
CFL Bulbs	1,913	175.5	1,714,751	175.8	1,586,380	100%	93%
DHW	182	66.6	133,475	16.7	127,895	25%	96%
Refrigerator	448	68.5	484,826	32.5	274,285	47%	57%
Air Sealing	100	2.7	2,272	2.7	2,272	100%	100%
Duct Insulation	15	2.1	1,082	2.1	1,082	100%	100%
Duct Sealing	100	64.5	33,007	64.5	33,006	100%	100%
Total	2,474	380.0	2,369,413	294.4	2,024,920	77%	85%

* Number of REAP projects with measure in 2014.

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

- **Lighting:** Due to the program's improved data collection procedures, the REAP lighting analysis now reflects the pre-install wattage for all installs. This improvement has led to realization rates closer to 100% for both energy and peak demand.
- **DHW:** 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 preexisting shower head and faucet aerator flow rates in gpm were included in the program-tracking spreadsheet for the first time, allowing comparison between removed and installed shower head and aerator flow rates.
  - The evaluated savings for pipe insulation was 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.[26] Due to the low peak demand realization rate, we believe that the program used a higher value for the coincidence factor when calculating ex ante savings, but cannot determine what factor was used from the program-tracking data extract provided to us.
- **Refrigerator:** For refrigerator measures, the evaluated savings reflect the weighted average ENERGY STAR®-recommended savings based on 2014 installed refrigerator sizes and configurations. The baseline refrigerator energy consumption represents a weighted average energy consumption based on year of preexisting refrigerator, per ENERGY STAR®, as obtained from the 2014 program-tracking database.

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

8. The ENERGY STAR® Labeled Homes Program

The PSEG Long Island ENERGY STAR® Labeled Homes (ESLH) program worked with local residential building contractors and the supporting contractor and architect infrastructure to encourage the construction of more energy-efficient, ENERGY STAR®-certified homes. The program drew on an established network of Home Energy Rating System (HERS) providers to work with builders during the design and construction of participating homes. The program also used the HERS rating to verify that ENERGY STAR® standards were met.

In 2012, the Long Island Power Authority made a long-term commitment to offer program incentives to the Wyandanch Rising housing project. PSEG Long Island fulfilled that commitment in 2014. With the completion of the Wyandanch Rising project, PSEG Long Island decided that 2014 would be the final year for the ESLH program. The cost per kilowatt of savings from the ESLH program was relatively high, and PSEG Long Island determined that energy savings could be found more cost-effectively in other program areas.

In 2012, PSEG Long Island revised the structure to offer incentives to homes that are not ENERGY STAR®-qualified but that have reached a HERS Index score below 70 (referred to as HERS Index homes), along with other program requirements. As the program ramped down in 2014, the number of incentivized HERS Index homes dropped significantly from the number in 2013—from 305 to 13.

Impacts for Comparison to Goal and Cost-Effectiveness

Table 8-1 shows the net evaluated savings compared with net tracked (ex ante) program savings. (See Section 1.1 for the definitions of ex ante and evaluated impacts.) Savings are broken out by homes that met all program requirements (ENERGY STAR® homes) and homes that the Evaluation Team categorized as program spillover (HERS Index homes).

Table 8-1. ESLH Net Impacts for Comparison to Goal and Cost-Effectiveness

Home Type	Ex Ante Impacts			Evaluated Impacts			Realization Rate	
	N	kW	kWh	N	kW	kWh	kW	kWh
ENERGY STAR® homes	110	45.8	130,359	110	45.8	130,356	100%	100%
HERS Index homes	13	7.0	16,219	13	7.0	16,218	100%	100%
Total	123	52.8	146,578	123	52.8	146,575	100%	100%

The Evaluation Team examined the per-install assumptions in accordance with the HERS Indices and ESLH characteristics. As in previous evaluation cycles, these per-install assumptions were sound. Therefore, the Evaluation Team assigned a realization rate of 100% to each new residential home, leading to realization rates of 100% for both coincident demand and energy usage.

9. The Solar Photovoltaic Program

In 2014, PSEG Long Island offered rebates to customers for solar photovoltaic (PV) installations through two successive programs. For the majority of the year, PSEG Long Island's Solar PV program operated similarly to previous years, providing rebates to approved residential and nonresidential customers through the Solar Pioneer and Solar Entrepreneur programs, respectively. In August 2014, PSEG Long Island began to administer the NY-Sun Initiative on Long Island on behalf of NYSERDA. At that time, NYSERDA also absorbed responsibility for paying rebates to all Solar Pioneer and Solar Entrepreneur projects in progress, which are expected to close out by the third quarter of 2015. The NY-Sun program is similar to the Solar Pioneer and Solar Entrepreneur programs in that each program is designed to encourage customer-sited electric generation, which, in addition to reducing customers' monthly cost and providing them more control over electric bills, offsets PSEG Long Island's energy and capacity requirements.

Prior to the start of the NY-Sun program, PSEG Long Island made only one substantial change to the Solar Pioneer and Solar Entrepreneur programs in 2014. The application was streamlined to reduce the burden on the contractors responsible for their submission. Contractors can submit applications on paper or using the Siebel CRM online application tool. The online tool allows contractors to input customer information directly into the program database, model the energy generation of the installation, and calculate the rebate for the customer while onsite.

While similar in most aspects, the NY-Sun Initiative differs from the Solar Pioneer and Solar Entrepreneur programs in several ways. First, the NY-Sun program uses a different application and introduced an online submission tool called PowerClerk, which replaced Siebel. The application itself varies slightly in design and required information due in part to the NY-Sun Initiative's funding structure and because the Initiative is standardized to include other jurisdictions in New York.

The programs also differ in their methodology for calculating energy savings attributable to installations. In 2013, PSEG Long Island's program had transitioned from rated capacity-based to installed performance-based rebates. The system's expected output, given its size, type of equipment, panel orientation, and shading are calculated using the program's production calculator. Under the NY-Sun Initiative, while the production calculator is still used to estimate actual system output, rebate amounts reverted back to a rated capacity-based calculation constructed around the total rated output of the PV panels. In addition, the NY-Sun Initiative introduced on-bill recovery and smart energy loans as optional mechanisms for receiving rebates and defraying upfront costs.

The NY-Sun program also brought increases in project size limits accompanied by a new structure for management and allocation of funds. The PSEG Long Island program provided rebates for residential systems up to 10 kW and commercial systems up to 50 kW. The NY-Sun program boosted these cutoffs to 25 kW and 200 kW, respectively, and introduced the megawatt block structure. This structure appropriates funds into tiered incentive rates such that rebate amounts depreciate as program incentive funds are depleted to reflect the maturation of the solar industry on Long Island and related changes to market penetration, demand, and payback. Block 1 is administered first, with the other blocks being allocated successively as the previous block's MW quotient is reached until all the funds are allocated. Table 9-1 outlines the megawatt block structure.

Table 9-1. NY-Sun Megawatt Block Structure

	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	66	$0.45	$0.43
Block 3	20	$0.30	7	$0.40	$0.36
Block 4	50	$0.20	9	$0.35	$0.30
Block 5			15	$0.25	$0.23
Block 6			14	$0.15	$0.15

Program managers at PSEG Long Island reported that they have not focused on any customer-facing outreach or advertising efforts, opting instead to allow contractors to drive demand for the program. According to program managers, a substantial number of residential projects are likely attributable to lease-providers' practice of working in conjunction with contractors and canvassing entire neighborhoods. Leasing and power purchase agreements continued to drive residential participation, accounting for approximately two-thirds (66%) of residential solar PV systems rebated by the program.

In 2014, PSEG Long Island installed 3,408 solar PV systems, showing a continuing rapid increase from 975 in 2012 and 1,625 in 2013. As in the previous program year, residential systems accounted for the vast majority of installations (97%), demand savings (80%), and energy savings (77%). The program achieved 232% and 227% of initial goals for peak demand reduction and energy production, respectively.

The production estimates for 2014 far exceeded the planned goals for several reasons. First, the massive mid-year injection of funds from NYSERDA allowed PSEG Long Island to continue to accept applications at a high rate throughout the year and not to slow or suspend the program due to budget constraints as in previous years. The high growth in the number of installations was also driven by residential leased systems. With the authorization of residential solar leasing in late 2012, leased systems accounted for 66% of the residential systems installed in 2014, up from 33% in 2013. In addition to providing more favorable terms for some participants, the influx of leasing companies into the market likely increased customers' exposure to renewable energy and the PSEG Long Island program. Some leasing companies market their services by having their sales people canvass neighborhoods and going door to door. Finally, the cost of installing PV systems continued to decrease in 2014, further lowering financial barriers to customers.

Impacts for Goal Comparison

Values in Table 9-2 show the savings by program. (See the definitions in Section 1.1 for the difference between the ex ante and evaluated values.)

Table 9-2. Solar PV Residential and Nonresidential Net Impacts for Goal Comparison

		Ex Ante		Evaluated		Realization Rate	
Program	N	kW	kWh	kW	kWh	kW	kWh
Solar PV	3,107	14,212	35,905,804	13,605	32,636,885	96%	91%
NY-Sun	301	931	2,696,734	891	2,451,219	96%	91%
Total	**3,408**	**15,143**	**38,602,538**	**14,496**	**35,088,104**	**96%**	**91%**

For the 2014 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 versus performance, the Long Island Power Authority performed an in-house analysis of energy output as related to installed DC capacity using actual metered data from 98 customer installations. We used this information in our analysis to assess actual output from contractor information on the program's 3,408 installations in 2014.[27]

To determine long-term PV output over the life of the panels, we normalized solar kWh production from 2014 to 30-year typical meteorological year (TMY) weather for Islip, NY. The data indicate that the typical insolation patterns over the last 30 years are slightly higher than those observed in 2014.

The evaluated peak demand analysis used average 14-year peak day/hour information, 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 2000 to 2013, as outlined in Table 9-3.

Table 9-3. 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). A summary of the primary and secondary research conducted to estimate the effect of PSEG Long Island incentives on PV installations on Long Island can be found in the Program Guidance Document for 2011.

Values in Table 9-4 show the savings by program for the cost-effectiveness calculations. Since the NTGRs for both the ex ante and evaluated are the same value, this table is identical to Table 9-2 above. (See the definitions in Section 1.1 for the difference between the ex ante and evaluated values.)

[27] Notably, 301 of the 3,408 systems installed in 2014 went through the NY-Sun program and were not held to the same installation requirements, such as orientation, as systems installed as part of the Solar Pioneer and Solar Entrepreneur programs. Therefore, these systems may not be comparable to the sample of 2012 program year projects used to estimate actual output. However, because the NY-Sun projects account for only 7% of output in 2014, any difference would not substantially affect the program results. Additional research on the actual performance of NY-Sun systems is warranted going forward.

Table 9-4. Solar PV Residential and Nonresidential Net Impacts for Cost-Effectiveness

Program	N	Ex Ante		Evaluated		Realization Rate	
		kW	kWh	kW	kWh	kW	kWh
Solar PV	3,107	14,212	35,905,804	13,605	32,636,885	96%	91%
NY-Sun	301	931	2,696,734	891	2,451,219	96%	91%
Total	**3,408**	**15,143**	**38,602,538**	**14,496**	**35,088,104**	**96%**	**91%**

Reasons for Differences in Impacts

The program currently uses a coincidence factor of 0.51, whereas evaluator analysis determined a coincidence factor of 0.50 using the average 14-year peak hour weighting in Table 9-3. This difference is the primary contributor to slightly lower ex ante peak demand savings as compared with evaluated savings. In 2013, the program assumed a coincidence factor of 0.41; the program's coincidence factor has been revised to more closely match the evaluation recommendation.

10. The Backyard Wind Program

The Backyard Wind Program aims to promote the development of wind energy infrastructure by helping customers overcome financial barriers to purchasing systems and raising consumer awareness and demand for small wind systems. The program offers rebates with the intention of incentivizing the installation of new turbines, building partnerships with equipment distributors, working with town government officials to modify zoning regulations where appropriate, and training market actors. The program awards these rebates in two phases such that customers receive 65% of the rebate upfront and the remaining 35% prorated as necessary depending on actual production over the following year.

Although 2014 yielded no turbine installations, the program claimed residual energy savings for two municipal projects that remained in the program's queue under performance review. The program featured one installation in 2013, for which 35% of total project claimed energy savings were reported in 2014. Additionally, the program delayed the 35% residual energy savings claim for a 2012 install due to complications from Hurricane Sandy. These savings were claimed in 2014. No peak demand savings were claimed by the program in 2014 for either project because the savings were already claimed in prior years.

The program did not achieve the targeted number of systems in any of the past 5 years, suggesting that the potential penetration of small wind systems on Long Island is limited. As a result of the low participation rate, PSEG Long Island does not plan to offer the Backyard Wind Program in future years.

Impacts for Goal Comparison and Cost-Effectiveness

Table 10-1 shows the impacts from this program used for both comparison to goal and our cost-effectiveness analysis. We assessed the gross impact, but not the net impact. As such, we applied the program-planning NTGR of 1.0, meaning the impacts for comparison to goal and our evaluated impacts are identical. See the definitions in Section 1.1 for the difference between the ex ante and evaluated values.

Table 10-1. Backyard Wind – Net Impacts for Goal Comparison and Cost-Effectiveness

Program Component	Number of Units		Ex Ante		Evaluated/Ex Post		Realization Rate	
	2012/2013*	2014**	kW	kWh	kW	kWh	kW	kWh
Residential	0	0	–	–	–	–	N/A	N/A
Commercial	0	0	–	–	–	–	N/A	N/A
Municipal	2	0	–	4,573	–	10,633	N/A	233%
Total	**2**	**0**	**–**	**4,573**	**–**	**74,637**	**N/A**	**233%**

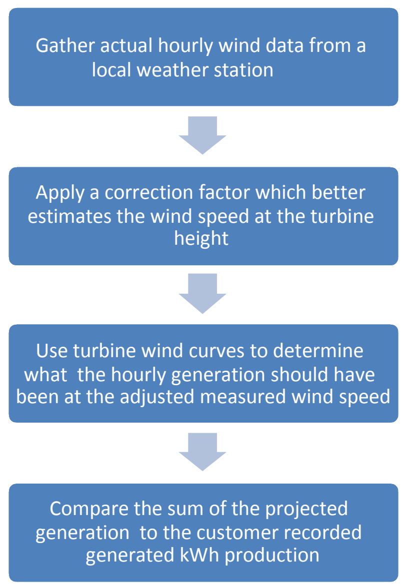
* The program claimed a 35% carryover of energy savings from 2013 projects. The program delayed the 35% carryover for a 2012 project due to complications from Hurricane Sandy.
** The program claimed 65% of energy savings from 2013 projects.

Estimation of Savings

To determine evaluated and/or ex post gross energy, the Evaluation Team conducted a review of performance data for wind turbines incentivized through the PSEG Long Island's Backyard Wind program. The system performance data consisted of monthly interval data collected from meters on the installed turbines' inverters. The program provided monthly meter-read data for a full year for each project, allowing evaluators to compare actual performance to the residual 35% claim, which reflects theoretical performance. Since anomalies in wind speed may have occurred over the 2013–2014 time frame, the evaluators normalized the actual kWh production to typical kWh production by comparing NOAA average monthly wind speeds and TMY average monthly wind speeds for Westhampton Airport. This normalization resulted in performance greater than the program's original claim for each project, leading to a high energy realization rate for the program.

We normalized the reported annual savings to a typical wind speed year so that impacts reflect the efficiency of the wind turbine at capturing wind energy, and not necessarily the particular annual fluctuation in any single year. Figure 10-1 below illustrates the steps in the normalization process.

Figure 10-1. Wind Energy Savings Normalization Steps



The Evaluation Team started by acquiring both the hourly typical wind speed (TMY weather data) and actual hourly wind speed from the nearest weather station (Westhampton Airport). Next, we converted the ratio of the annual average wind speed at the airport to the hub-height annual average wind speed. AWS Wind Navigator was the source of the wind speed as a function of height. We applied this ratio as an adjustment factor to scale the weather station wind speeds to reflect those at the sites at hub-height.

We acquired the turbine power curves for each turbine installed and used these to calculate the predicted generation for each hour, based on actual wind conditions. The turbine efficiency is the sum of the actual production of the turbine recorded by the owner divided by the sum of the predicted performance for every hour in the period.

The evaluated gross energy savings for any one project is the product of the generation projected using TMY wind data (this is equal to the ex ante savings estimates) and the turbine efficiency.[28]

[28] These calculations essentially replicate the methodology used by PSEG Long Island's software to predict performance using actual wind speed rather than typical wind speed.

11. Detailed Methods

11.1 Overview of Data Collection

Our 2014 evaluation of PSEG Long Island's Efficiency Long Island and Renewable Energy Portfolios relies primarily on reviewing and analyzing program-tracking data, customer billing data, and secondary data sources to assess program impacts. Primary data collection in 2014 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.

11.2 Overview of Analytical Methods

Table 11-1 provides an overview of the main analytical methods used in the evaluation of each of the PSEG Long Island programs in 2014. 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 11-1. Primary Analytical Methods Used in 2014 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		X	
HPwES/HPD	X		X	X	
REAP	X		X	X	
ESLH	X			X	
Solar PV	X			X	
Backyard Wind	X			X	

11.3 Commercial Efficiency Program

We performed two specific data collection activities within the CEP:

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

Next we describe each effort in greater detail.

Program Staff Interviews

As part of the 2014 CEP evaluation, we conducted in-depth interviews in February 2015, with four program staff members at PSEG Long Island responsible for the implementation of the CEP. We designed the interviews to understand programmatic changes made in 2014, as well as planned changes for 2015, and to gather program staff perspective on program performance, program process effectiveness, and any challenges that the program experienced in 2014.

Engineering Desk Reviews

In 2014, the Evaluation Team performed two types of desk reviews: 1) a review of Siebel data and calculation of savings using engineering algorithms, and 2) 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 evaluated savings for the following CEP components: 1) SBDI, 2) Existing Retrofit Lighting, 3) Existing Retrofit Non-Lighting, and 4) Prescriptive Lighting and Performance 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.[29]

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.[30] 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 Lighting, and Existing Retrofit Non-Lighting projects. In the case of the SBDI program component, we used a simple random sample. In all other cases, we relied on the Dalenius-Hodges technique to determine an appropriate stratum for each sample frame and the Neyman allocation method to obtain optimal samples by stratum. We detail this process below. Following that, 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 observations, 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[31] is to multiply the frequency f(y) by the

[29] 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 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.

[30] 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).

[31] Kish, L. (1995). *Survey Sampling*. Wiley Classics Library Edition.

width 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 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.[32]

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

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 optimum sample size for a given stratum (n_h) in some stratum that is larger than the total number of observations in the stratum (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 are others. If the original allocation gives, for example, a 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 design 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.

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

Engineering Review Sample Design

As previously mentioned, we used a simple random sample design to draw a sample of the SBDI projects. Given the similarity (and therefore limited variance) of the SBDI projects in terms of savings, we did not see a need to employ the Dalenius-Hodges technique. Table 11-2 provides detail on the total population and sample size for the SBDI component of the CEP.

Table 11-2. Commercial Efficiency Program SBDI Engineering Review Sample Design

	Projects in Population	Total Ex Ante Savings (kW)	Projects in Sample
Total	1,571	37	20

The sample design for the Prescriptive Lighting and Performance Lighting projects, Existing Retrofit Lighting, and Existing Retrofit Non-Lighting components are shown in Table 11-3. We used a stratified random sample design, split by kW demand savings, to draw the samples for these four components. The initial sample frame for the Existing Retrofit Lighting program component inadvertently excluded projects implemented by PSEG Long Island starting in September 2014. We later included those projects as a separate sample frame and drew an additional sample, to ensure comprehensive inclusion of all projects in the sampling process. Several Existing Retrofit Lighting projects were misclassified as Prescriptive Lighting projects in Siebel. As a result, we created a new sample frame and sample for those projects. In addition, one Prescriptive Lighting project was misclassified as an Existing Retrofit Non-Lighting project. Consequently, we shifted this project into the Prescriptive Lighting sample frame.

Table 11-3. Commercial Efficiency Program Prescriptive Lighting, and Existing Retrofit Lighting and Non-Lighting Custom Engineering Review Sample Design

Stratum	Boundaries (kW)	Total Ex Ante Savings (kW)	Projects in Population	Projects in Sample
Prescriptive Lighting				
1	0–30	259	66	3
2	31–152	953	12	5
Total Prescriptive Lighting		1,212	78	8
Existing Retrofit Non-Lighting Projects				
1	0–5	336	133	3
2	6–50	974	57	10
Certainty	51–149	149	1	1
Total Existing Retrofit Non-Lighting Projects		1,459	191	14
Existing Retrofit Lighting Projects				
Small Medium (Full Year) and Solutions Provider				
1	0–7	3,553	1,217	5
2	8–30	6,162	386	5
3	31–156	6,088	108	6
Total Existing Retrofit Lighting Projects		15,804	1,711	16
Large Business				
1	0–9	260	78	4
2	10–30	606	33	3
3	31–78	676	13	3
Total Large Business		1,542	124	10
Projects Misclassified as Prescriptive Lighting				
1	0–45	89	6	2
Total Projects Misclassified as Prescriptive Lighting		89	6	2

For each desk review, we performed the following tasks:

- Checked the data for data entry errors, omissions, and/or inconsistencies by comparing project documentation, such as invoices, to the program-tracking data extract.
- Calculated 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[33] to extrapolate results for each site back to the overall 2014 component population. Figure 11-1 shows the algorithm we used to extrapolate to the population.

Figure 11-1. Ratio Adjustment Algorithm

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

where I_{EP} = the ex post population impact
I_{EA} = the ex ante population impact
I_{EPS} = the ex post impact from the sample
I_{EAS} = the 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 1 (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:

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

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

11.4 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. In addition, we researched programs in the U.S. incentivizing GTHPs to assess qualifying equipment standards and incentive amounts.

11.5 Energy Efficient Products

The Evaluation Team conducted an in-depth interview with the EEP program manager and reviewed program-tracking data. In addition, we conducted secondary research on federal equipment standards and ENERGY STAR® 4.0 criteria for dehumidifiers and room air conditioners and on trends in the pool pump market.

11.6 REAP Estimation of Savings Using Billing Analysis

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

Data Preparation and Cleaning

PSEG Long Island provided participation and measure data for all customers who participated in the REAP program from 2013 to 2014. PSEG Long Island also provided a billing history going back 50 months from January 2011 to February 2015 for both 2013 and 2014 program participants.[34] Prior to carrying out the statistical modeling, we matched, cleaned, and provided quality assurance for all data. For analysis purposes, we focused primarily on the 2013 participant cohort, but retained 2014 participants as a comparison group. We used the same data-cleaning procedures for both 2013 and 2014 participants.

Cleaning Participation Data

We utilized records from the REAP program-tracking database 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 available from early February 2015, which included complete 2013 and 2014 participant data. We excluded from the analysis 18 participant records tracked in the participation data that did not have an account number associated with the site ID.

Our cleaning procedure was consistent with what was performed in the 2013 evaluation. First, we checked to make sure that all sites had measure data. We found no records without measure data. We then identified and removed any site IDs without electric measures. We also looked for records with missing savings or zero quantities; however, no accounts had to be removed for this reason. In instances with negative kWh savings, we left the household data unchanged because total savings data were not missing. We found two accounts with zero savings. Again, we retained these observations in the analysis. We aggregated the remaining records into the four 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 REAP program. We used these expected savings as the basis for realization rates. For customers who participated

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

in multiple program years, we used the first installation date as the cutoff for distinguishing whether they were 2013 or 2014 participants.[35]

Matching Participant Information with PSEG Long Island Account Information

REAP tracks 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 2013 and 2014 participants' billing data and then took a two-step approach to cleaning them. This approach is consistent with the approach used in the 2013 evaluation of the program. First, we removed individual billing periods—i.e., meter reads—that were duplicative, cancelled, or had zero 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.

- Removing Duplicate Billing Records: Some of the billing records were duplicative across the 50 months of billing records that we received. We removed these duplicates so as to not double-count the usage.
- Cleaning Individual Billing Periods: We removed billing periods with a duration of zero days (i.e., same start and end date). Usage records for these billing periods recorded either zero kWh or positive kWh; many were the first read in the available billing history or a Turn-On read. We also dropped billing periods lasting longer than 73 days, since we need to assign each billing period to a specific month for analysis purposes, and longer read periods would introduce greater error into the model. A majority of accounts had billing periods of around 60 days. To more accurately assign average daily consumption, those billing records were split. For participants who participated in 2014 only, we did not include billing periods occurring after their first installation date, as these 2014 participants served as the comparison group.
- Extremely High or Low Average Daily Consumption: 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 average daily consumption at or below 2 kWh/day on average (across their billing history in both the pre- and post-period). We also dropped customers with extremely high usage (over 300 kWh/day). These households are likely to contain odd usage patterns that we can't easily control for and could bias our results.
- Inadequate Billing History before Program Participation: The primary savings measures in the REAP program (lighting and refrigerators) 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, four billing records or 180 days before the first day of program participation for both 2013 and 2014 program participants.
- Inadequate Billing History in the Cooling Season before and after Program Participation: We also required participants to have a minimum of one billing record in the summer (cooling season). This is because we expect the measure installation to be generally weather sensitive both in terms of

[35] For customers who participated in both 2013 and 2014, we excluded billing records after their second installation date to ensure that our model was estimating only the effect of 2013 measures.

temperature and in terms of daylight hours. By ensuring that we have enough billing data in the months of May, 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 average daily consumption across the combined period. We also use this method for billing periods that covered 2 months by creating a primary midpoint to split the bill and then secondary midpoints, which were used to assign a month to the period.

Incorporating Weather Data

As in previous years' REAP billing analysis, we used 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 increased the accuracy of the weather data being applied to each account. We obtained these data from the Northeast Regional Climate Center (NRCC).

The daily data are based on hourly averages from each day. We calculated cooling degree-days (CDDs) for each day (in the analysis and historical period) based on average daily temperature and dew point using the same formula as PSEG Long Island forecasting.[36] We calculated heating degree-days (HDDs) from the average daily temperature using a balance temperature of 65 degrees. 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.

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[36] *A "degree-day" is 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).

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

FINAL ANALYSIS DATA SET

In total, our REAP data set includes 4,356 accounts. Approximately 82% of the total participant population was available for analysis after data preparation and cleaning. Table 11-4 presents the results of cleaning participation data, integrating clean billing data, and checking for sufficient billing data for each customer.

Table 11-4. REAP Participation and Billing Data Cleaning Steps

	Total Accounts	Percent of Total
Total Unique Accounts	**5,295**	**100.0%**
Reason Account Was Dropped		
Fewer than 4 Pre-Billing Periods	536	
# of accounts remaining	**4,759**	**89.9%**
Low Overall ADC < 2 kWh	4	
Low Overall Pre-ADC < 2 kWh	2	
Low Overall Post-ADC < 2 kWh	15	
# of accounts remaining	**4,738**	**89.5%**
High Overall Post-ADC > 300 kWh	201	
# of accounts remaining	**4,537**	**85.6%**
Less than 1 Summer Billing Pre-Period	100	
# of accounts remaining	**4,437**	**83.8%**
Less than 6 Months in Pre-Period Days	81	
Final Number of Accounts 2013–2014	**4,356**	**82.2%**

STATISTICAL METHOD USED

We conducted a billing analysis to determine ex post net program savings. We evaluated a number of possible models, and chose to use a LFER CDA model. The final model used “dummy” variables for each of the four measure categories: lighting, refrigerators, DHW, and weatherization. The lighting variable includes an interaction with HDDs, which is meant to capture seasonal differences in hours of lighting usage.

Our model includes a comparison group consisting of households that participated in 2014. We used a comparison group to help construct the counterfactual or baseline for the treatment group (2013 participants) in the post-period. Up until the date on which each 2014 participant entered the program, we include their billing data in the model for comparison to billing data of the 2013 participants. As soon as each customer begins participation in the program, we exclude their 2014 participant data from the analysis.

Billing analysis, through the use of an appropriate comparison group, incorporates the effects of both free-ridership and spillover, thus providing the program net savings estimates. For example, given the program targeted the same types of customers in 2013 and 2014, the energy use patterns of the members of the comparison group during 2013–2014 (up to the point of their participation) reflect equipment installations and behavioral changes that treatment group participants (2013 participants) may have performed in the absence of the program. In addition, any measures installed during the evaluation period beyond program measures (spillover) would be picked up by an increased coefficient for the participation variables.

To improve our estimate of the counterfactual (what 2013 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.

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^2 and AIC, both measures of statistical model fit. The following equation represents the final model:

$$y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + \beta_7 X_{7it} + \varepsilon_{it}$$

where y_{it} = average energy consumption per day for home *i* during month *t (ADC)*

α_i = constant term for home *i*

$\beta_{1-}\beta_7$ = coefficients for explanatory variables

X_1 = program installation of lighting measures for home *i* during month *t*

X_2 = program installation of refrigerator for home *i* during month *t*

X_3 = program installation of weatherization measures for home *i* during month *t*

X_4 = program installation of DHW measures for home *i* during month *t*

X_5 = CDDs for home *i* during month *t*

X_6 = HDDs (base 65) for home *i* during month *t*

X_7 = interaction of Lighting (LIT) dummy with HDDs

ε_{it} = error term

In this model, the end-use installation variables used in the billing analysis 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.

Assessing Comparison Group Equivalency

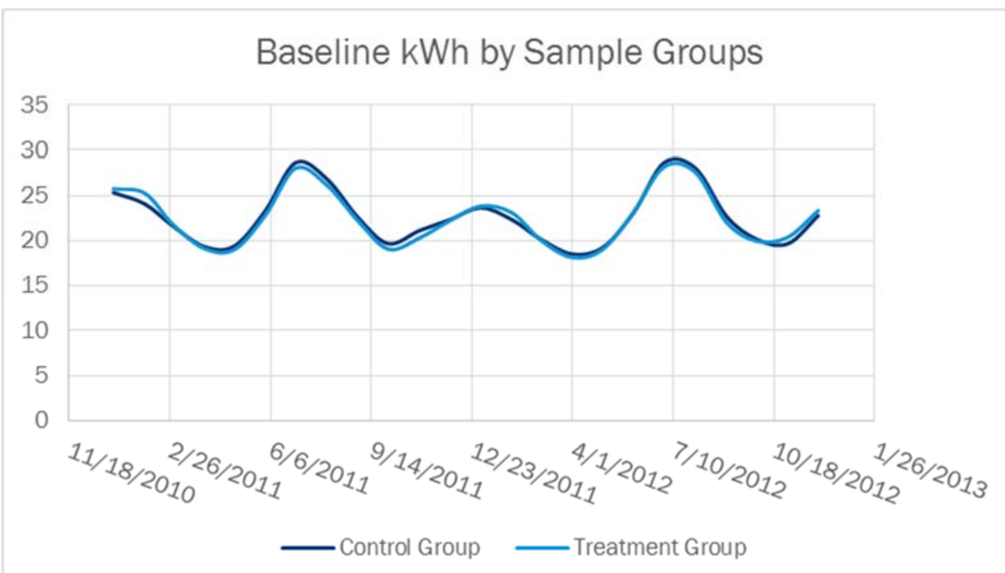
Before performing any modeling, we determined the overall average baseline kWh consumption for the treatment and comparison groups and the average daily kWh, CDDs, and HDDs for pre- and post-participation time periods for the treatment group. These figures provide context for the more detailed analyses shown later in this section. Table 11-5 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 11-5. REAP Analysis – Average Values of Key Variables by Time Period for 2013 Treatment Group

Variable	Statistic	Period	
		Pre-	Post-
Daily kWh	*Mean*	22.61	21.09
	SD	17.97	18.11
CDDs	*Mean*	69.60	60.98
	SD	116.43	99.19
HDDs	*Mean*	354.36	396.91
	SD	373.69	419.70

Also of interest is the difference in energy consumption patterns between the treatment group and the comparison group 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). Figure 11-2 shows the average daily consumption 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, thus demonstrating that 2014 participants serve as an effective baseline.

Figure 11-2. REAP Analysis – Baseline kWh by Sample Group in Analysis



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 free-ridership and spillover). We see that the two groups are very close in their usage patterns, meaning that our analysis should more accurately show changes due to external factors.

ELECTRIC SAVINGS RESULTS

Table 11-6 shows the final model results. The model shows a reduction in electricity use after program participants installed measures and after controlling for weather, time, and the household characteristics (reflected in the constant term). As shown in Table 11-6, the program effects coefficients are negative for all measures except for DHW, making it likely that each of the other end-use measures reduced consumption overall. Notably, savings from the two measures that were most commonly installed (lighting and refrigerators), as well has weatherization measures (air and duct sealing), are significant at the 0.05 alpha level. The coefficient for DHW fails to reach statistical significance, which is likely due to the very small number of participants installing these measures (i.e., small sample size). In total, these results indicate that there is a very high probability that the lighting and refrigerator measures generate most program savings.

Table 11-6. REAP Billing Analysis – Final Model

Predictor	Coefficient	Robust Std. Err.	T	P > |t|	90% Confidence Interval	
					Lower	Upper
CDDs	−0.002	0.0006	−3.93	0.000	−0.003	−0.001
HDDs	0.001	0.0002	6.87	0.000	0.0009	0.0016
Refrigerator dummy	−1.38	0.228	−6.06	0.000	−1.83	−0.935
DHW dummy	0.69	0.442	1.56	0.120	−0.178	1.55
Lighting dummy	−1.41	0.223	−6.34	0.000	−1.85	−0.975
WEA dummy	−2.36	0.708	−3.33	0.000	−3.74	−0.968
LIT x HDDs	0.001	0.0004	1.80	0.007	−0.00007	0.0016
Constant	24.26	0.257	94.54	0.000	23.75	24.75

Evaluating the model, we calculated estimated average daily electricity use and percent electricity savings. As shown Table 11-7, average daily consumption across studied participating homes dropped approximately 1.67 kWh/day after measures were installed, representing a 6.76% decrease in electricity usage overall.

Table 11-7 also shows the measure-level savings estimates for lighting and refrigeration, the major program measures. Lighting savings contributed 1.09 kWh/per day (weighted) to the overall drop of 1.67 kWh/day for the average household. Refrigerators contributed another 0.56 kWh/day (weighted) to the overall savings. Together, lighting and refrigeration account for over 90% of the program savings identified in the model.

Weighted savings and relative precision estimates are shown only for lighting and refrigeration because they are the only measures with large enough sample sizes to provide a reasonable level of confidence in the measure-level savings results. However, even for these measures, there is still a fairly high degree of uncertainty around the measure-level estimates. As such, we caution against strong interpretations of these measure-level findings.

Table 11-7. REAP Analysis – Relative Precision of Observed Savings from Billing Analysis

End-Use	Weighted Average Daily Household Savings*	90% Confidence Interval		% Savings	Relative Precision of Estimated Savings at 90% CI**
		Lower Bound	Upper Bound		
Overall	1.67	1.38	1.95	6.76%	17%
Lighting	1.09	0.78	1.39	4.42%	28%
Refrigerators	0.56	0.41	0.72	2.29%	27%

* The line loss factor is not applied to the program-planning savings
** Note that since the analysis included a population of participants, the concept of relative precision (which is associated with a sample) does not apply. However, we chose to report these measures of uncertainty to be consistent with conventional statistical reporting practices. Moreover, while sampling error does not apply here, these sampling statistics do provide some information about variability within a population for key variables.

BILLING ANALYSIS COMPARED TO EXPECTED SAVINGS

Table 11-8 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 42%. The realization rate for lighting measures is slightly low at 40%, while the realization rate for refrigeration is considerably higher at 61%.

Measure-level savings values in this table are not weighted across all households. Instead, they are presented as averages for participants who installed the particular measure. This was done to give a clear sense of what the observed savings per customer were in a manner easily comparable to the first-year savings values commonly seen in the program plan.

Table 11-8. Savings from REAP Billing Analysis Compared to Savings Expected from Program-Planning Estimates

End-Use	N (Participants in Billing Analysis)**	Observed Savings		Program-Planning Savings*		Realization Rate
		Household Daily Savings for Those with the Measure	Household Annual Savings for Those with the Measure	Household Daily Savings for Those with the Measure	Household Annual Savings for Those with the Measure	
Overall Program	2,642	1.67	610	3.93	1,435	42%
Lighting	2,591	1.11	405	2.78	1,016	40%
Refrigerators	1,086	1.38	507	2.27	830	61%

* The line loss factor is not applied to the program-planning savings.
** There was a total of 2,920 unique accounts from PY 2013. Of that total, 278 program participants were excluded from the billing analysis due to missing or incomplete measure data or insufficient billing data in the pre- or post-participation period.

11.7 Home Performance Estimation of Savings Using Billing Analysis

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

DATA PREPARATION AND CLEANING

PSEG Long Island provided participation and measure data for all customers who participated in the HPD and HPwES programs from 2013 to 2014. PSEG Long Island also provided a billing history going back 50 months from January 2011 to February 2015 for both 2013 and 2014 program participants.[37] Prior to carrying out the statistical modeling, we matched, cleaned, and provided quality assurance for all data. For analysis purposes, we focus primarily on the 2013 participants, but retained 2014 participants as a comparison group. We used the same data-cleaning procedures for both 2013 and 2014 participants.

CLEANING PARTICIPATION DATA

We utilized records from the HPD and HPwES program-tracking database 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 is based on program-tracking records available from early February 2015, which included complete 2013 and 2014 participant data.

Our cleaning procedure was consistent with what was performed in the 2013 evaluation. First, we checked to make sure that all sites had measure data. We found no records without measure data. We then identified and removed any site IDs without electric measures. We also looked for records with missing savings or zero quantities; however, no accounts had to be removed for this reason. In instances with negative kWh savings, we retained the household data because total savings was not missing.[38] We aggregated the remaining records into five main 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 REAP program. 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 distinguishing whether he or she was a 2013 or 2014 participant.[39]

MATCHING PARTICIPANT INFORMATION WITH PSEG LONG ISLAND ACCOUNT INFORMATION

HPD and HPwES 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. We dropped 130 customers (site IDs) with missing account numbers or multiple account numbers per site ID.

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

[38] Models were run with and without the accounts that had negative savings and we found no differences in results.

[39] For customers who participated in both 2013 and 2014, we excluded billing records after their second installation date to ensure that our model was only estimating the effect of 2013 measures.

Cleaning Billing Data

We merged 2013 and 2014 participants' billing data and then took a two-step approach to cleaning the data. This approach is consistent with the approach used in the 2013 evaluation of the program. First, we removed individual billing periods—i.e., meter reads—that were duplicative, cancelled, or had zero 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.

- **Removing Duplicate Billing Records:** Some of the billing records were duplicative across the 50 months of billing records that we received. We removed these duplicates so as to not double-count the usage.
- **Cleaning Individual Billing Periods:** We removed billing periods with a duration of zero days (i.e., same start and end date). Usage records for these billing periods either recorded zero kWh or positive kWh; many were the first read in the available billing history or a Turn-On read. We also dropped billing periods lasting longer than 73 days, since we need to assign each billing period to a specific month for analysis purposes, and longer read periods would introduce greater error into the model. A majority of accounts had billing periods of around 60 days. To more accurately assign average daily consumption, those billing records were split. For participants who participated in 2014 only, we did not include billing periods occurring after their first installation date, as these 2014 participants served as the comparison group.
- **Extremely High or Low Average Daily Consumption:** 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 average daily consumption at or below 2 kWh/day on average (across their billing history in both the pre- and post-period). We also dropped customers with extremely high usage (over 300 kWh/day). These households are likely to contain odd usage patterns that we can't easily control for and could bias our results.
- **Inadequate Billing History before Program Participation:** The primary savings measures in the HPD/HPwES programs (lighting and weatherization) 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, four billing records or 180 days before the first day of program participation for both the 2013 and 2014 program participants.
- **Inadequate Billing History in the Cooling Season before and after Program Participation:** We also required participants to have a minimum of one billing record in the summer (cooling season). 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 May, 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 average daily consumption across the combined period. We also use this method for billing periods that covered 2 months by creating a primary midpoint to split the bill and then secondary midpoints, which were used to assign a month to the period.

Incorporating Weather Data

As in previous years' HPD and HPwES billing analysis, we used 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 increase the accuracy of the weather data being applied to each account. We obtained these data from the NRCC.

The daily data are based on hourly averages from each day. We calculated CDDs for each day (in the analysis and historical period) based on average daily temperature and dew point using the same formula as PSEG Long Island forecasting.[40] We calculated HDDs from the average daily temperature using a balance temperature of 65 degrees. 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.

Final Analysis Data Set

In total, our Home Performance data set includes 4,268 unique accounts. Approximately 87% of the total participant population was available for analysis after data preparation and cleaning. Table 11-9 presents the results of cleaning participation data, integrating clean billing data, and checking for sufficient billing data for each customer.

[40] *A "degree-day" is 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 10 heating degree-days (65 minus 55 equals 10).

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

Table 11-9. HPD/HPwES Participation and Billing Data Cleaning Steps

	Total Accounts	Percent of Accounts Remaining
Total Unique Accounts	4,936	100%
Reason Account Was Dropped		
No Billing Data	134	
# of accounts remaining	4,802	97.3%
No Participant Tracking Data	126	
# of accounts remaining	4,676	94.7%
Fewer Than 4 Pre-Billing Periods	124	
# of accounts remaining	4,552	92.2%
Low Overall ADC < 2 kWh	4	
Low Overall Post ADC < 2 kWh	40	
# of accounts remaining	4,508	91.3%
High Overall Post ADC > 300 kWh	53	
# of accounts remaining	4,455	90.3%
Less Than 1 Summer Billing Pre-Period	129	
# of accounts remaining	4,326	87.6%
Less Than 6 Months in Pre-Period Days	58	
Final Number of Accounts 2013-2014	4,268	86.5%

Statistical Method Used

We conducted a billing analysis to determine ex post net program savings. We evaluated a number of possible models, and chose to use a LFER CDA model. The final model utilized "dummy" variables for the two primary measures of interest: lighting and weatherization. Since there were so few participants with other energy efficiency measures (refrigerators, electric water heaters, and HVAC equipment), we removed them from the analysis.[41] The other non-lighting measures were combined into a single weatherization variable to simplify the model and account for the large amount of overlap between different weatherization installations.

The lighting variable includes an interaction with HDDs, which is meant to capture seasonal differences in hours of lighting usage. Our weatherization variable also includes an interaction with both CDDs and HDDs. In last year's billing analysis we included a variable for electric space heating, however this was unnecessary for

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

this year's model given the extremely low proportion of electric space heat households in both 2013 and 2014.[42]

Our model includes a comparison group consisting of households that participated in 2014. We used a comparison group to help construct the counterfactual or baseline for the treatment group (2013 participants) in the post-period. Up until the date on which each 2014 participant entered the program, we include their billing data in the model for comparison to billing data of the 2013 participants. As soon as each customer begins participation in the program, we exclude their 2014 data from the analysis.

Billing analysis, using an appropriate comparison group, incorporates the effects of both free-ridership and spillover, thus providing program net savings. For example, the energy use patterns of the members of the comparison group during 2013–2014 (up to the point of their participation) reflect equipment installations and behavioral changes that treatment group participants (2013 participants) might have performed in the absence of the program. In addition, any measures installed during the evaluation period beyond program measures (spillover) would be picked up by an increased coefficient for the participation variables.

To improve our estimate of the counterfactual (what 2013 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.

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^2 and AIC, both measures of statistical model fit. The following equation represents the final model:

$$y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + \beta_7 X_{7it} + \varepsilon_{it}$$

where y_{it} = average energy consumption per day for home *i* during month *t (ADC)*

α_i = constant term for home *i*

$\beta_{1-}\beta_7$ = coefficients for explanatory variables

X_1 = average daily HDDs for home *i* during month *t*

X_2 = average daily CDDs[43] for home *i* during month *t*

X_3 = lighting (LIT) measure installed dummy for home *i* during month *t*

X_4 = weatherization (WEA) measure installed dummy for home *i* during month *t*

X_5 = interaction of WEA dummy with HDDs

X_6 = interaction of WEA dummy with CDDs

X_7 = interaction of Lighting (LIT) dummy with HDDs

ε = error term

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[42] Please note that we did test model specifications with an electric space heat variable and we found no substantive differences in our results.

[43] CDDs are based on the temperature humidity index (THI), base 65 as follows:

CDDs (based on THI) = Mean Hourly THI for the day, base 65 THI;

THI = (.55 x Temp) + (.2 x Dew Point) + 17.5

CDDs = max (THI - 65, 0)

In this model, the end-use installation variables used in the billing analysis 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.

Assessing Comparison Group Equivalency

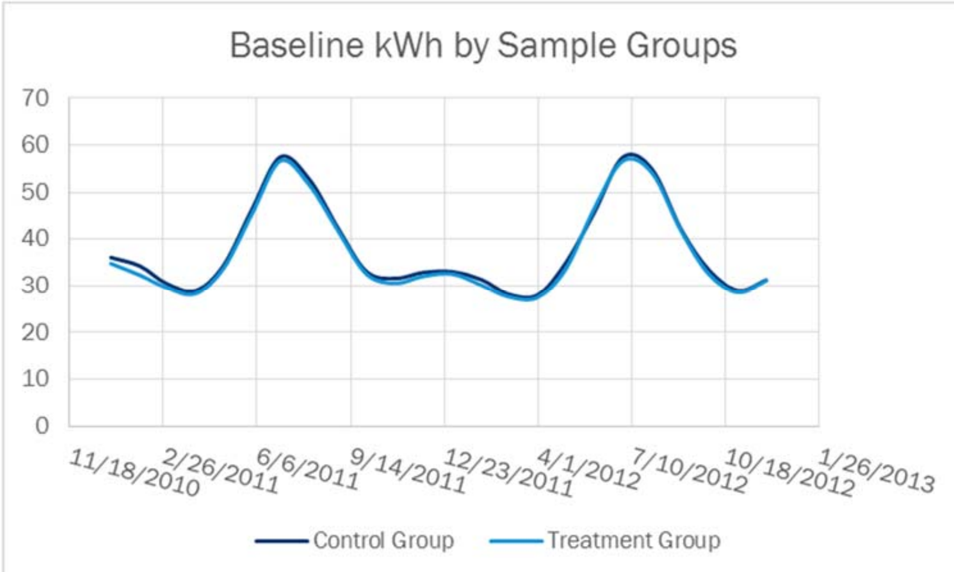
Before performing any modeling, we determined the overall average baseline kWh consumption for the treatment and comparison groups and the average daily kWh, CDDs, and HDDs for pre- and post-participation time periods for the treatment group. These figures provide context for the more detailed analyses shown later in this section. Table 11-10 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 11-10. Home Performance Analysis – Average Values of Key Variables by Time Period for 2013 Treatment Group

Variable	Statistic	Period	
		Pre	Post
Daily kWh	*Mean*	37.31	34.60
	SD	27.08	25.41
CDDs	*Mean*	68.35	59.74
	SD	115.44	97.45
HDDs	*Mean*	353.11	390.20
	SD	375.74	417.84

Also of interest is the difference in energy consumption patterns between the treatment group and the comparison group 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). Figure 11-3 shows the average daily consumption 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, thus demonstrating that 2014 participants serve as an effective baseline.

Figure 11-3. Home Performance Analysis – Baseline kWh by Sample Group in Analysis



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 free-ridership and spillover). We see that the two groups are very close in their usage patterns, meaning that our analysis should more accurately show changes due to external factors, like participation in the Home Performance programs.

Electric Savings Results

Table 11-11 below shows the model results. The model shows a reduction in electricity use after program participants installed weatherization measures, and after controlling for weather and the household characteristics (reflected in the constant term). When evaluated together using the means of 2013 program participation indicators, the program effects terms (for the post-period and measures) are jointly negative, indicating that program participants did reduce energy consumption in the post-period (after controlling for weather).

Table 11-11. Home Performance Billing Analysis – Final Model

Predictor	Coefficient	Robust Std. Err.	T	P > |t|	90% Confidence Interval	
					Lower	Upper
CDDs	0.009	0.001	8.44	0.000	0.007	0.01
HDDs	−0.001	0.0002	−4.92	0.000	−0.001	−0.0006
LIT dummy	1.29	0.545	2.37	0.018	0.22	2.36
WEA dummy	−3.22	0.492	−6.55	0.000	−4.19	−2.26
LIT x HDDs	−0.0047	0.001	−3.96	0.000	−0.007	−0.002
WEA x CDDs	−0.0042	0.002	−2.16	0.031	−0.007	−0.002
WEA x HDDs	0.0032	0.001	3.08	0.002	0.001	0.005
Constant	35.44	0.29	121.49	0.000	34.87	36.015

The model results can be used to estimate net savings for several types of customers and measures, as shown in Table 11-12. Average daily consumption across studied participating homes dropped approximately 2.49 kWh/day after measures were installed, representing a 7% decrease in electricity usage overall. There is a 90% probability, or confidence, that overall program savings range between 2.10 kWh and 2.89 kWh per day.

To calculate average measure-level annual savings estimates, the Evaluation Team ran separate single-measure models for lighting and weatherization. We chose this approach because in the overall model there were a 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, thus greatly increasing uncertainty around the estimates. Estimating single-measure models (e.g., a lighting-only model and a weatherization-only model) addresses this issue somewhat and allows for a more direct estimate of measure-specific effects. However, a major drawback with this approach is that it significantly reduces the amount of observations in the treatment group and it assumes that single-measure participants behave in the same way as other program participants.

Given these concerns, we display the findings from the single-measure models in Table 11-12; however, these results should be interpreted only as directional. In other words, these models show that weatherization measures likely account for a greater proportion of savings compared to lighting, but there is significant uncertainty (i.e., wide confidence intervals) around these point estimates.

Table 11-12. Home Performance Analysis – Relative Precision of Observed Savings from Billing Analysis*

Category	Weighted Average Household Daily Savings	90% Confidence Interval		% Savings
		Lower	Upper	
All Program Participants	2.49	2.10	2.89	7.01%
Lighting Only	*0.93*	*−0.50*	*2.37*	*2.6%*
Weatherization Only	*1.56*	*0.70*	*2.43*	*4.4%*

* These values exclude line losses.

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 11-13 below shows that the 2013 Home Performance programs realized 62% of their expected net savings.

Table 11-13. Savings from Home Performance Billing Analysis Compared to Savings Expected from Program-Planning Estimates

End-Use	N (Participants in billing analysis)**	Observed Savings		Program Planning Savings*		Realization Rate
		Household Daily KWH Savings for Those with the Measure	Household Annual KWH Savings for Those with the Measure	Household Daily KWH Savings for Those with the Measure	Household Annual KWH Savings for Those with the Measure	
Overall Savings	1,967	2.49	909	4.03	1,472	62%
Lighting Only	137	1.15	420	4.14	1,512	28%
Weatherization Only	433	1.69	617	0.99	361	171%

* Excludes line losses.
** There were a total of 2,267 unique accounts, from PY 2013. Of that total, 300 program participants were excluded from the billing analysis due to missing or incomplete measure data or insufficient billing data in the pre- or post-participation period.

A review of realization results for the individual measures may provide some explanation as to why the overall realization rate for the program was 62%. The high realization rate for weatherization measures was likely offset by a relatively low realization rate for lighting.

11.8 Cost-Effectiveness Method

The Evaluation Team developed an Excel-based tool to assess cost-effectiveness at the program and portfolio level using information derived from the PSEG Long Island 2014 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 apply 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%.[44]

$$PA\ Cost = \frac{NPV\ of\ Benefits\ [MCE*NRG*EUL+mAD*DR]}{2014\ Costs\ [PA]} \quad \text{(Eq. 1)}$$

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

Table 11-14 presents the sources for inputs used to calculate cost-effectiveness using the PAC Test.

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

Table 11-14. 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*
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
PAC	Program Administrator Cost	$ or % of incentives	PSEG Long Island (December 2014 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

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 78.529% of first year annual value for CFLs installed in 2014.

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 PAC 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 PA 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 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 11-14.

$$Levelized\ Costs\ = \frac{2014\ Total\ Utility\ Expenditures}{NPV\ (Lifecycle\ kW\ or\ kWh\ Savings\ from\ 2014\ Installs)} \quad \text{(Eq. 2)}$$

11.9 Economic Impact Method

As part of the 2014 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 2014 program spending on economic output and employment on Long Island. The economic impact analysis quantifies the 10-year impact of PSEG Long Island's 2014 Efficiency Long Island Portfolio and 2014 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 had 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 2014 analysis. These high-priority program effects are: 1) participant bill savings and 2) program and measure spending (on administration and management and equipment and installation), shown in the “Societal Benefits” column in Table 11-15. 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 shown in the “Societal Costs” column of Table 11-15.

Table 11-15. 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*** 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
w	**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** 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

* 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 will estimate 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 2014. 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.[45]

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 11-15.

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 2014, 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 cost-benefit screening tool. Multiplying net 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.

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[45] 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.

- 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 whose SIC code could be found in CAS data.[46] For Efficiency Long Island programs, we then calculated the proportion of gross kWh savings by sector, 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, 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 the 2014 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 the 2014 budget 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, 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 (e.g., Efficiency Long Island or Renewable Energy). Though some line items were specific to one or the other portfolio, in most cases we assigned expenditures to either the Efficiency Long Island or the Renewable Energy

[46] We used 2012 CAS data, which contains 2- and 4-digit SIC codes, which can be mapped to IMPLAN sectors. For participants without a SIC code or whose account number was not present in 2012 data, we assigned IMPLAN sectors in proportion to gross kWh achieved by all participants with known SIC codes.

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 2014 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 2014 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 free-ridership and spillover 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.[47] 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

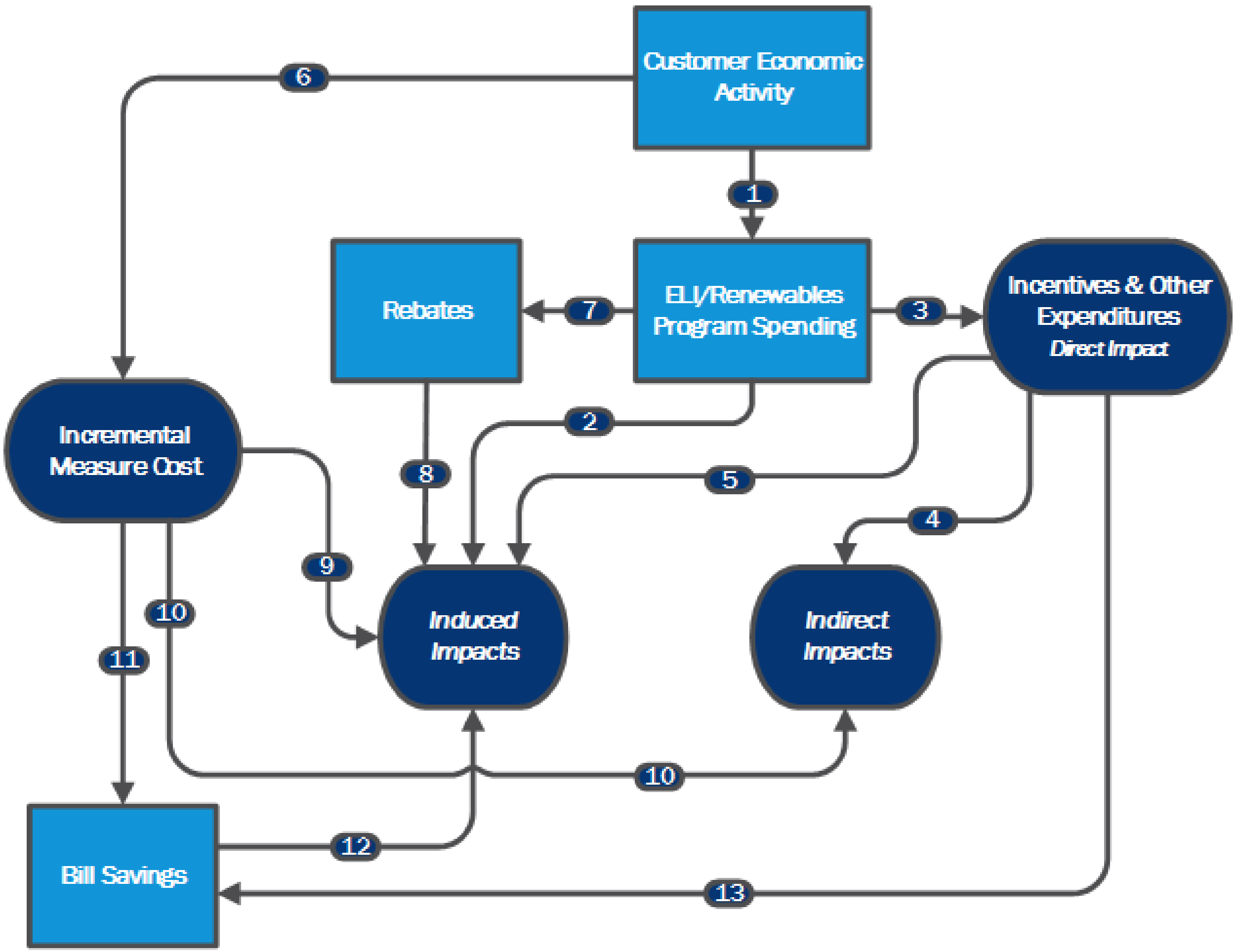
To adequately represent local cash flows resulting from offering Efficiency Long Island and Renewable Energy programs, the model includes efficiency and renewable charge revenues that were used to fund the 2014 programs. We assume that this revenue is equivalent to total program spending. To distribute 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 2014 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 2014 CAS data.

[47] Source: U.S. Census Bureau's American Community Survey (2013).

Visual Model

A simplified visual model illustrates how the economic impact is calculated. Figure 11-4 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 11-4. Visual Model of Economic Impacts of the PSEG Long Island Portfolio



Description of Model Elements

Each box in Figure 11-4 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 11-4 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 11-4 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 2014. The model assumes that program spending in each program year is equal to the Efficiency Long Island and Renewables Charge collected in that year (see Flow #1).
- **Rebates:** This box represents the total amount of program spending in 2014 on rebates moving directly from the program to program participants.
- **Incentives and Other Program 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 NTGFRs 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 11-4 represent:

1. **Description:** Customers pay the Efficiency and Renewables Charge. This charge funds PSEG Long Island's Efficiency and Renewables 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 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 *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 to the participant, 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 REAP) lead to bill savings, as increased efficiency resulting from these measures decrease 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 minus 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 –Quality Installation (kW)	57%	0%	49%	149%	*	*	92%
Cool Homes	Traditional Split CAC –Quality Installation (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%

Program	Measure	Ex Post minus 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	Furnace Fan (kW)	0%	16%	0%	84%	16%	0%	84%
Cool Homes	Furnace Fan (kWh)	0%	10%	0%	90%	10%	0%	90%
Cool Homes	Geothermal Heat Pump (kW)	0%	8%	0%	92%	8%	0%	92%
Cool Homes	Geothermal Heat Pump (kWh)	0%	2%	0%	98%	2%	0%	98%
Cool Homes	Air Source Heat Pump – Equipment (kW)	0%	8%	0%	92%	8%	0%	92%
Cool Homes	Air Source Heat Pump – Equipment (kWh)	0%	2%	0%	98%	2%	0%	98%
Cool Homes	Air Source Heat Pump - Quality Installation	0%	0%	0%	100%	0%	0%	100%
Cool Homes	Ductless Mini Split, (kW)	0%	8%	0%	92%	8%	0%	92%

Program	Measure	Ex Post minus 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	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%
HPD	All Measures (kWh)	-38%	*	*	62%**	0%	0%	100%
HPwES	All Measures (kW)	-31%	*	*	69%**	0%	0%	100%
HPwES	All Measures (kWh)	-28%	*	*	72%**	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	Soild State Lighting	0%	5%	25%	120%	5%	25%	120%

Program	Measure	Ex Post minus 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
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	Dehumidifi-er 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)	-20.13%	30%	1.87%	71.87%	*	*	90%
CEP Prescriptive	Non-Lighting (kWh)	-20.45%	30%	1.55%	71.55%	*	*	90%

Program	Measure	Ex Post minus 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
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)	-20.13%	30%	1.87%	71.87%	*	*	90%
CEP Existing Retrofit	Non-Lighting (kWh)	20.45%	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)	63%	*	*	37%**	0%	0%	100%
REAP	All Measures (kWh)	58%	*	*	42%**	0%	0%	100%
ESLH	All	0%	0%	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%
Backyard Wind	All	0%	0%	0%	100%	0%	0%	100%
Solar Hot Water	All	0%	0%	0%	100%	0%	0%	100%

Program	Measure	Ex Post minus 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
CEP Custom	(kW)	-20.13%	30%	1.87%	71.87%	*	*	90%
CEP Custom	(kWh)	-20.45%	30%	1.55%	71.55%	*	*	90%

* Free ridership and spillover is 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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