Opinion Dynamics

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451

Energy Efficiency and Renewable Energy Portfolios

2016 Annual Evaluation Report
(Volume I - Executive Summary)

Prepared for:

PSEG LONG ISLAND
We make things work for you.

Prepared by:

OPINION DYNAMICS CORPORATION

May 30, 2017

With Subcontractors:

Opinion Dynamics

Table of Contents

Opinion Dynamics

Table of Tables

Table of Figures

1. Introduction to the Annual Evaluation Report

This report presents the program evaluation results of PSEG Long Island's 2016 Energy Efficiency Portfolio and Renewable Energy Portfolio conducted by the Opinion Dynamics evaluation team. The Efficiency Long Island and Renewable Energy portfolios were administered by the Long Island Power Authority (LIPA) from inception through 2013. Effective January 1, 2014, PSEG Long Island began its 12-year contract assuming all day-to-day management and operations of the electric system, including planning, administration, design, and implementation of the Energy Efficiency Portfolio and the Renewable Energy Portfolio. In March of 2015, PSEG Long Island transitioned the implementation of the Energy Efficiency Portfolio to its subcontractor, Lockheed Martin. PSEG Long Island continues to implement the Renewable Energy Portfolio. This assessment covers the period from January 1, 2016 to December 31, 2016.

The evaluation team produced two volumes that together comprise the entire Annual Evaluation Report. This document, the *2016 Annual Evaluation Report (Volume I)*, provides an overview of evaluation findings, including impact and process results for 2016. The *2016 Program Guidance Document (Volume II)* provides detailed program-by-program impact analysis results, process evaluation findings, and a discussion of data collection and analytic methods. The evaluation team developed the *Program Guidance Document* with the needs of PSEG Long Island's and Lockheed Martin's program planners and managers in mind, as the programs in the Energy Efficiency Portfolio and the Renewable Energy Portfolio continue to be important and cost-effective resources.

1.1 Key Definitions

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

- **Gross Impacts:** The change in energy consumption and/or demand at the generator that results directly from program-related actions taken by participants, regardless of why they participated. These impacts include line losses, coincident factors for demand, and waste-heat factors and installation rate for lighting. Gross impacts are the demand and energy that power plants do not generate due to program-related actions taken by participants.[1]
- **Net Impacts:** The change in energy consumption and/or demand at the generator that results directly from program-related actions taken by customers that would not have occurred absent the program. The only difference between the gross and net impacts is the application of the net-to-gross ratio (NTGR).
- **Net-to-Gross Ratio (Free-Ridership and Spillover):** The factor that, when multiplied by the gross impact, provides the net impacts for a program. The NTGR is defined as the savings that can be attributed to programmatic activity and is composed of free-ridership (FR) and spillover (SO). FR reduces the ratio to account for those customers who would have installed an energy-efficient measure without the program. The FR component of the NTGR can be viewed as a measure of naturally occurring energy efficiency, which may include efficiency gains associated with market transformation resulting from ongoing program efforts. SO increases the NTGR to account for those customers who install energy-efficient measures outside of the program (i.e., without an incentive), but due to the actions of the program. The NTGR is generally expressed as a decimal and quantified through the following algorithm:

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

$$NTGR = 1 - FR + SO$$

- **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.
- **kW (Demand or Capacity):** The average level of power used over an hour. Peak demand is the average power used across a 4-hour period when there is high use. For Long Island, peak demand takes place from 2:00 to 6:00 p.m., Monday through Friday (non-holiday), from June to August. System coincident demand is the level of demand at the hour of the day when there is the maximum demand on the system grid. Demand savings values in this report are system coincident demand impacts between 4:00 p.m. and 5:00 p.m. on non-holiday weekdays in from June to August.
- **kWh (Energy Consumption):** The total power consumed over an hour. Energy impacts are based on annual consumption.
- **Utility Cost Test (UCT):** A test that measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the Program Administrator (including incentive costs) and excluding any net costs incurred by the participant. To allow for direct comparison with PSEG Long Island's assessment of all supply-side options, and consistent with previous evaluation reports, we applied the UCT as the primary method of determining cost-effectiveness and used assumptions similar to those used by PSEG Long Island's resource planning team.
- **Societal Cost Test (SCT):** A test that measures the net costs of an energy efficiency program as a resource option based on the total costs of the program, including both the participants' and the Program Administrator's costs. Rebate costs are not included in this test as they are assumed to be a societal transfer.
- **Discount Rate:** The interest rate used to calculate the present value of future payments (i.e., the avoided costs from energy and demand savings). PSEG Long Island uses a weighted average cost of capital (WACC) supplied by LIPA that represents the cost of borrowing to build additional capacity to meet the future supply needs of the service territory. Based on these factors, we used a nominal discount rate of 4.17% in the 2016 evaluation.
- **Levelized Cost of Capacity:** The equivalent cost of capacity (kW) to be incurred each year over the life of the equipment that would yield the same present value of total costs, using a nominal discount rate of 4.17% to be consistent with base load generation supply-side resources in the Long Island service territory. The levelized cost of capacity is a measure of the costs of the program to the administrator in a form that can be compared to the cost of supply additions.
- **Levelized Cost of Energy:** The equivalent cost of energy (kWh) over the life of the equipment that would yield the same present value of costs, using a nominal discount rate of 4.17%. The levelized cost of energy is a measure of the costs of the program to the administrator in a form that can be compared to the cost of supply additions.

2. Executive Summary

In 2016, PSEG Long Island continued to cost-effectively increase the savings realized from the Energy Efficiency and Renewable Energy portfolios. PSEG Long Island spent approximately $74.9 million of the annual budget on these portfolios in 2016, and received an additional $10.8 million in funding from the New York State Energy Research and Development Authority (NYSERDA) through the NY-Sun Initiative. The total spending of $85.7 million is slightly lower than was spent in 2015. The evaluated demand savings increased in 2016 to 84.27 MW, compared with 82.85 MW in 2015. Evaluated energy savings also increased in 2016, to 369,843 MWh compared with 362,102 MWh in 2015. The 2016 evaluated demand and energy savings from these portfolios exceeded the established goals by 9% and 16%, respectively. Two key factors drove 2016 program performance, as described below.

Continued Strength in Residential Solar Installations. In 2016, PSEG Long Island continued to experience high levels of solar photovoltaic (PV) installations through its Solar Photovoltaic program. Installations were driven by decreases in system prices, demand for leased residential solar systems, the availability of $10.8 million in rebates from NYSERDA's NY-Sun Initiative, and a strong PV market infrastructure on Long Island. While projects and generation decreased slightly from 2015, the residential initiative continued to exceed expectations, reaching more than 140% of its goals for both kWh and kW generation. Despite the NY-Sun Initiative funds for residential projects running out in April 2016, residential solar installations still accounted for 98% of the program's projects and 90% of kWh and kW generation.

Increase in Sales of Efficient Lighting Products within the Energy Efficiency Portfolio: In 2016, the Energy Efficient Products (EEP) program substantially exceeded its savings goals, which it has done for each of the last 4 years. The EEP program exceeded its demand and energy goals in 2016 by 30% and 33%, respectively, more than making up for shortfalls in other commercial and residential efficiency programs. Also, as has been the case in prior years, savings from lighting measures, which make up the vast majority of EEP program savings, primarily drove the program's, and the portfolio's, performance.

Taken together, residential and commercial lighting measures account for more than two-thirds of all Energy Efficiency demand savings and 86% of energy savings. As such, the overall performance of the current Energy Efficiency Portfolio depends heavily on PSEG Long Island's ability to continue to promote efficient lighting within a shifting market being driven by rapid changes in technologies, prices, and efficiency standards.

Recent increases in the sale of program LED lighting products have driven EEP program performance. CFLs had traditionally been the dominant source of lighting product sales and savings within the EEP program. However, beginning in 2015, evaluated savings from LED products exceeded those realized from CFLs. Program sales of LED bulbs increased from less than 1% sold through the program in 2010 to 70% in 2016. In total volume, the program sold more than 1.8 million LED bulbs and fixtures in 2016, accounting for 85% of all evaluated demand savings from EEP program lighting measures.

Our evaluation found a similar trend in the share of savings associated with the installation of LED fixtures incentivized through the Commercial Efficiency Programs (CEP), as acceptance of LED lighting in the commercial market continued to increase. LEDs grew from 34% of the CEP evaluated demand savings in 2013 to 89% in 2016.[2]

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

2.1 Summary of Portfolio Performance

The 2016 annual demand and energy savings goals were 77.0 MW and 317,905 MWh for the combined Energy Efficiency and Renewable Energy portfolios, as shown in Table 2-1. Combined evaluated net savings are 109% of the goal for demand and 116% of the goal for energy. PSEG Long Island exceeded the demand and energy goals at a total cost of approximately $85.6 million, including the $10.8 million that was provided directly by NYSERDA for solar incentives.

Table 2-1. Net Impacts: Energy Efficiency and Renewable Energy Portfolios Evaluated Impacts versus Goals

Program	PSEG Long Island Annual Energy Efficiency and Renewable Energy Budget	Energy Efficiency and Renewable Energy Actual Cost	Coincident Demand Savings (MW)		Energy Savings (MWh)	
			Goal	Evaluated	Goal	Evaluated
Energy Efficiency Portfolio						
Commercial Efficiency Programs	**$43,472,843**	**$36,796,488**	**28.00**	**25.32**	**110,580**	**105,456**
Residential Programs						
EEP	$16,899,422	$17,220,137	19.23	25.07	143,805	191,172
Cool Homes	$6,880,436	$6,534,917	4.29	3.17	4,002	2,611
Residential Energy Affordability Partnership (REAP)	$2,987,916	$2,949,269	0.56	0.59	2,114	1,493
Home Performance Direct (HPD)	$4,568,270	$4,300,482	1.95	1.48	4,224	2,459
Home Performance with ENERGY STAR® (HPwES)	$4,204,366	$3,829,709	1.00	0.25	666	267
Subtotal Residential Programs	**$35,540,410**	**$34,834,514**	**27.03**	**30.56**	**154,811**	**198,003**
Total Energy Efficiency Portfolio (Commercial and Residential Programs)	**$79,013,253**	**$71,631,002**	**55.03**	**55.88**	**265,391**	**303,459**
Renewable Energy Portfolio (including NYSERDA Funds in Actual Cost)	**$2,397,702**	**$14,018,419**	**22.00**	**28.39**	**52,514**	**66,384**
Total Energy Efficiency and Renewable Energy Portfolios	**$81,410,955**	**$85,649,421**	**77.03**	**84.27**	**317,905**	**369,843**

Notes:

1. Costs and Budget figures do not include LIPAEdge, REV, or Utility 2.0.
2. Actual costs are the expenditures necessary to obtain the energy and demand savings as reported in the Siebel and LM Captures systems, and do not reflect PSEG Long Island accrual accounting.
3. Solar PV benefits and costs (which are included in the Renewable Energy Portfolio) include $10.8 million in rebates from the NYSERDA's NY-Sun Initiative.
4. Solar PV impacts are expressed in terms of generation.

In 2016, PSEG Long Island spent just over $74.8 million on Energy Efficiency and Renewables of its annual operating budget of $81.4 million for these programs. The program also spent $10.8 million in solar incentives from NYSERDA's NY-Sun Initiative for a total of $85.6 million in 2016 expenditures. Based on our analysis of portfolio impacts and costs, the savings generated by the portfolios are cost-effective. As shown Table 2-2:

- Based on the UCT, the overall benefit/cost ratio is 5.1 for the combined portfolio savings (a UCT value greater than 1 indicates that portfolio benefits outweigh costs), and the levelized costs of the combined portfolio savings are $109.67/kW-yr and $0.033/kWh.[3]
- Based on the SCT, the overall benefit/cost ratio is 1.2 for the combined portfolio savings and the levelized costs are $471.98/kW-yr and $0.143/kWh.

PSEG Long Island will begin to apply updated avoided energy supply costs in 2017 in response to the guidance provided in the 2016 New York State Benefit Cost Analysis Handbook. The new avoided costs are lower than those used in 2016 and will, therefore, lower the benefit/cost ratios at the program- and portfolio-levels. The likely impacts of these new avoided costs on the energy efficiency and renewable energy portfolios in 2017 are discussed in Section 02.6.

[3] A levelized cost analysis is a way to quickly compare the cost of energy efficiency programs with energy or demand savings from other sources. Because levelized costs are expressed as $/kW-yr and/or $/kWh, they can be readily compared to the cost of alternative supply additions or the cost of generating electricity.

Table 2-2. Energy Efficiency and Renewable Energy Portfolios Benefit/Cost Ratio and Levelized Costs

Program	Benefit/Cost Ratio		UCT Levelized Costs		SCT Levelized Costs	
	UCT	SCT	$/kW-yr	$/kWh	$/kW-yr	$/kWh
Energy Efficiency Portfolio						
Commercial Efficiency Programs	**3.7**	**2.7**	**$167.80**	**$0.040**	**$226.49**	**$0.054**
Residential Programs						
EEP	4.4	1.9	$153.42	$0.027	$338.56	$0.059
Cool Homes	0.90	0.60	$428.28	$0.598	$630.08	$0.880
REAP	0.62	0.62	$784.48	$0.308	$784.48	$0.308
HPD	0.96	0.97	$452.70	$0.272	$452.70	$0.272
HPwES	0.30	0.06	$1,433.09	$1.360	$8,023.36	$7.611
Subtotal Residential Programs	**2.5**	**1.1**	**$242.86**	**$0.051**	**$532.00**	**$0.112**
Total Energy Efficiency Portfolio (Commercial and Residential Programs)	**3.1**	**1.7**	**$197.48**	**$0.045**	**$347.30**	**$0.079**
Renewable Energy Portfolio	**15.5**	**0.89**	**$33.52**	**$0.014**	**$580.10**	**$0.248**
Total Energy Efficiency and Renewable Energy Portfolios	**5.1**	**1.2**	**$109.67**	**$0.033**	**$471.98**	**$0.143**

Notes:

1. Benefit/cost ratio from Utility Cost perspective using comparison to base load marginal supply costs. If ratio is greater than 1.0, program is cost-effective.
2. All levelized cost calculations use a discount rate of 4.17% to be consistent with supply-side alternatives.
3. Solar PV benefits and costs (which are included in the Renewable Energy Portfolio) include $10.8 million in rebates from NYSERDA's NY-Sun Initiative.

An important catalyst in LIPA's initial decision to invest in the Energy Efficiency and Renewable Energy portfolios was the need to offset approximately 520 MW of generating capacity on Long Island required to satisfy energy demand forecasted at that time. As such, performance relative to the annual capacity savings goals has been the primary performance metric for these programs since 2009. However, with the launch of New York's Reforming the Energy Vision (REV), the role of energy efficiency and renewable energy within New York's comprehensive energy strategy is changing. PSEG Long Island's strategies and goals for energy efficiency will begin to more closely align with REV principles. Beginning in 2017, the primary goal will be focused on electric energy savings, with demand savings and greenhouse gas reductions also measured, but not as a primary goal. The evaluation team is working with PSEG Long Island to scope studies that will identify and quantify the future energy savings opportunities and inform the development of revised savings goals.

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 program within the Energy Efficiency Portfolio and the Renewable Energy Portfolio, as shown in Table 2-1 and presented throughout this report, for purposes of assessing goal attainment. We calculated evaluated net savings by applying PSEG Long Island's planning assumptions for the net-to-gross factor to the gross demand and energy savings estimates determined through our evaluation.

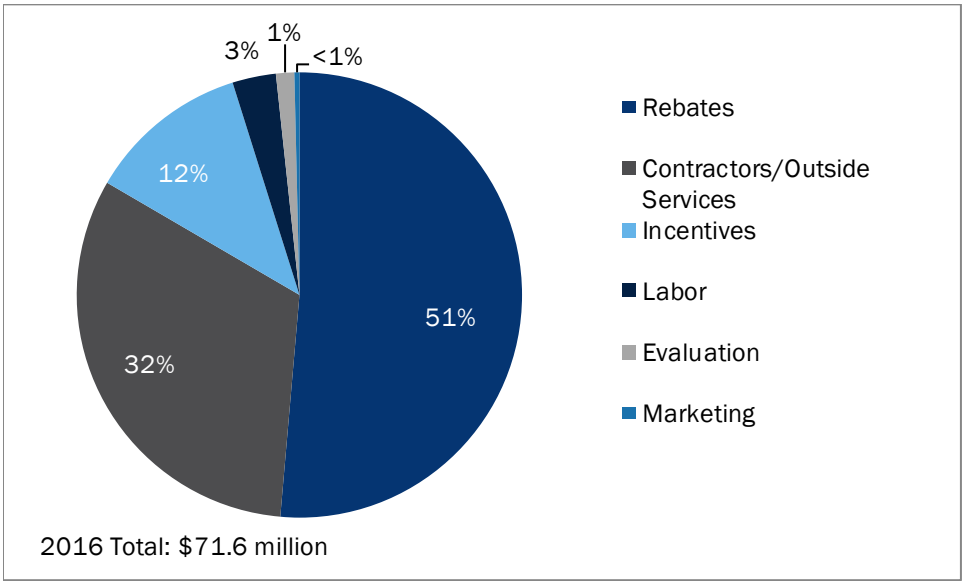
Among other inputs, the benefit/cost assessment requires an estimate of ex post net program savings. The best-practice approach to this assessment dictates that the net savings used to develop the benefit/cost ratio reflect current levels of naturally occurring energy efficiency, FR, and SO to provide an estimate of the benefits associated with the current year's investment in the programs. As such, the evaluation team used net-to-gross

factors derived from primary data collection with customers to develop the net energy savings estimates included in the benefit/cost ratio calculation and for lifetime levelized costs.

Including the NYSERDA funding, PSEG Long Island spent just under $85.7 million on the Energy Efficiency and Renewable Energy portfolios in 2016, slightly lower than in 2015. However, PSEG Long Island realized a 2% increase in evaluated demand savings and a 2% increase in evaluated energy savings compared to 2015. Figure 1 presents a summary of the $71.6 million spending related to implementation, management, and evaluation of energy efficiency programs in the Energy Efficiency Portfolio by type of expenditure.

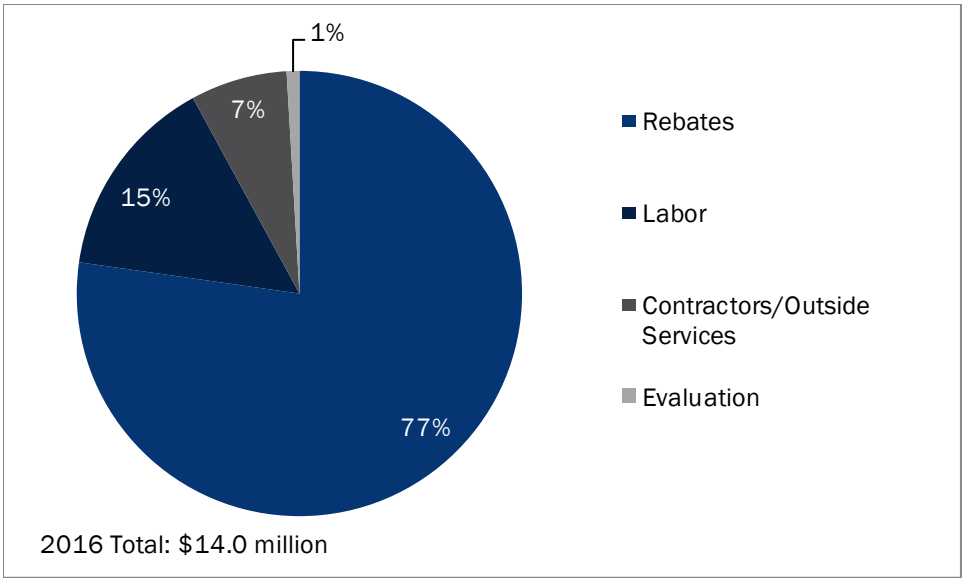
Figure 2 provides the detail for the $14.0 million investment of PSEG Long Island and NYSERDA funds in the 2016 Renewable Energy Portfolio.

Figure 1. 2016 PSEG Long Island Expenditures for the Energy Efficiency Portfolio



"Rebates" consists of payments made to participating customers. "Incentives" consists of payments made to participating contractors (e.g., HVAC installers).

Figure 2. 2016 PSEG Long Island and NYSERDA Expenditures for the Renewable Energy Portfolio



2.2 Energy Efficiency Portfolio Evaluated Impacts

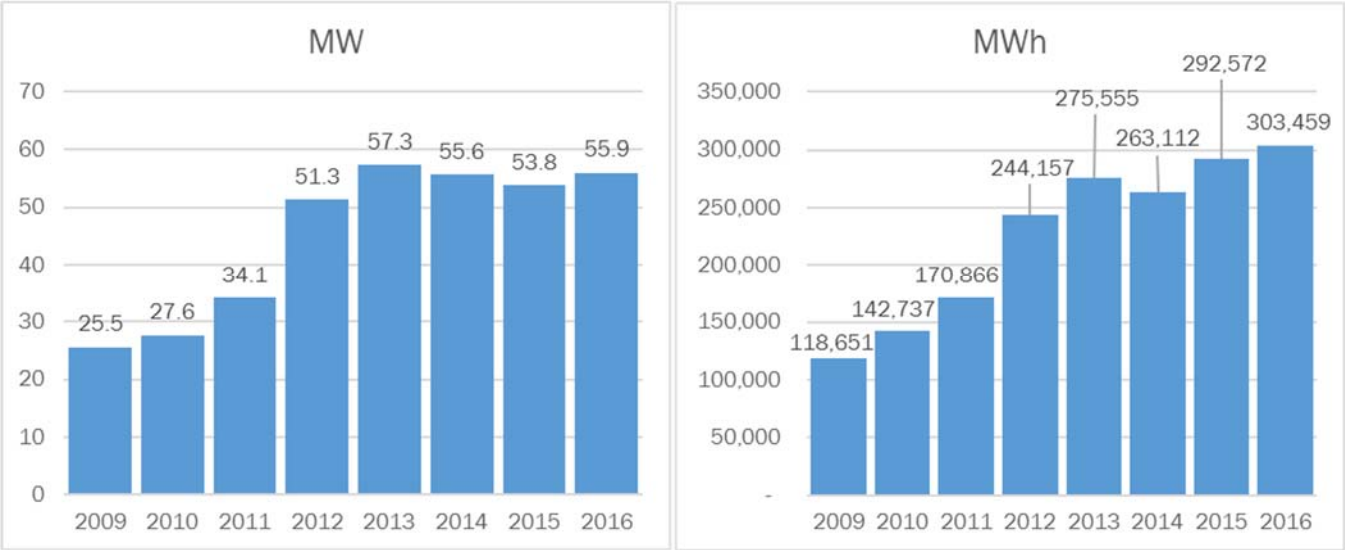
Overall, evaluated net savings from the Energy Efficiency Portfolio included 55.9 MW of demand savings and approximately 303,459 MWh of energy savings. These energy savings resulted in the annual displacement of more than 182,731 tons of CO_2 equivalents,[4] 68 tons of SO_2, and 136 tons of NOx. These greenhouse gas reductions are equivalent to removing more than 35,016 cars from the road and a fuel savings of more than 383,794 barrels of oil.[5]

In 2016, the Energy Efficiency Portfolio exceeded its demand and energy savings goals by 1% and 14%, respectively. Figure 3 presents the evaluated savings from the energy efficiency programs spanning the 8 years since the Energy Efficiency Portfolio's inception.

[4] CO_2 equivalents includes carbon dioxide, methane, and nitrous oxide.

[5] Displacement savings values calculated using 2014 Long Island sub-regional emissions rates of the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID 2014 v2), released February 27, 2017. Equivalent savings values are based on the U.S. EPA's Greenhouse Gas Equivalencies Calculator (updated May 2016).

Figure 3. 2016 Energy Efficiency Portfolio Evaluated Net MW and MWh Savings



Similar to previous years, there were variances between evaluated results and the established savings goals across programs. While the residential programs exceeded their demand savings goals by 3.5 MW, the CEP fell short of its demand goal by 2.7 MW. In terms of evaluated energy savings, the residential programs are substantially higher than the goal (28%), more than offsetting a shortfall in energy savings from the CEP. The evaluated net demand savings for the CEP increased by about 10% from 2015 and realized 90% of the 2016 demand savings goal and 95% of the energy savings goal.

The EEP program accounts for the largest share of demand and energy savings among the residential programs, and its performance largely drives the overall performance of the residential portfolio. In 2016, the EEP program surpassed its annual savings goals, with evaluated net demand and energy savings equal to 130% and 133% of its goals, respectively.

Based on an analysis of portfolio impacts and costs, the savings generated by the Energy Efficiency Portfolio are cost-effective. As shown in Table 2-3, the benefit/cost ratio, as calculated using the UCT, is 3.1. The benefit cost/ratio using the SCT is 1.7. In addition, the 2016 UCT levelized costs for Energy Efficiency Portfolio savings are $197.48/kW-yr or $0.045/kWh—less than the comparable marginal costs of supply-side alternatives.

Table 2-3. Summary of 2016 Energy Efficiency UCT, SCT, and Levelized Costs

Cost-Effectiveness Test	Benefit/Cost Ratio	Levelized Cost ($/kW-yr)	Levelized Cost ($/kWh)
UCT	3.1	$197.48	$0.045
SCT	1.7	$347.30	$0.079

2.3 Energy Efficiency Portfolio Economic Impacts

As part of the annual evaluation, the evaluation team assessed the economic impacts of the Energy Efficiency Portfolio investments on the economy of Long Island. Beginning in 2011, we developed an input-output (I-O) model of the Long Island regional economy using IMPLAN modeling software to estimate these impacts. Central to the I-O model approach is the development of a static model for the effects of program spending

based on a matrix of relationships among economic sectors, including industries, households, government, and foreign trade. The model requires inputs on spending, avoided costs, electric rates, and other parameters from PSEG Long Island, and draws on the net savings information included in the benefit/cost assessment. The evaluation team updated this model and its inputs for this 2016 evaluation.

As in previous years, we estimated 1-year and 10-year economic impacts associated with the 2016 Energy Efficiency Portfolio investment, where the 10-year economic impacts accrue from measures installed in 2016 over their remaining measure life. We then add these 1-year and 10-year economic impacts to the 2010–2015 estimates to develop a portfolio-to-date estimate (adjusted to 2016 dollars).[6]

As shown in Table 2-4, our analysis of economic benefits found that PSEG Long Island's $71.6 million investment in the Energy Efficiency Portfolio in 2016 returned $90.4 million in total economic benefits to the Long Island regional economy in 2016, including an additional 642 full-time equivalent (FTE) employees.[7] Over 10 years, these 2016 investments are expected to return $170.6 million in total economic benefits to the regional economy (in 2016 dollars[8]), with an employment benefit of 1,225 new FTEs over the time period.

Extrapolating these results over the 8-year life of the portfolio, the $473.0 million invested to date in Energy Efficiency ($534.1 million in 2016 dollars) produced approximately $619.7 million[9] in cumulative annual economic benefits, with an employment benefit of 3,850 FTE employees. Over the 10 years following each program year investment, these 8-years of investments are expected to return $1.31 billion[10] to the Long Island regional economy, and result in 8,580 additional FTEs between 2009 and 2025.

Table 2-4. Economic Impact of 2009–2016 Energy Efficiency Portfolio Investments

Effect	Impact of 2016 Program Investment		Impact of 2009–2016 Program Investment	
	First-Year Impact	Impact over 10 years[a]	First-Year Impact	Impact over 10 years[a]
Total Economic Output[b] (2016 $1M)	$90.4	$170.6	$619.7	$1,314.4
FTE Employees	642	1,225	3,850	8,580

[a] Includes the 10-year impacts for each program year beginning in that year.

[b] Total economic output is the value of industry production. In IMPLAN, these are annual production estimates in producer prices.

2.4 Progress toward Long-Range Energy Efficiency Portfolio Goals

In 2009, LIPA established aggressive annual and cumulative demand savings goals for the Energy Efficiency Portfolio. These goals, established for the Efficiency Long Island Portfolio, called for a cumulative reduction of 520 MW in system coincident peak demand by 2018, as shown in Figure 4. The evaluation team notes that

[6] We estimated the economic impact of the portfolio for the first 2 years of Energy Efficiency Portfolio implementation by extrapolating the economic impacts from 2011 (assuming similar multipliers of economic impact) to arrive at a portfolio-to-date estimate.

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

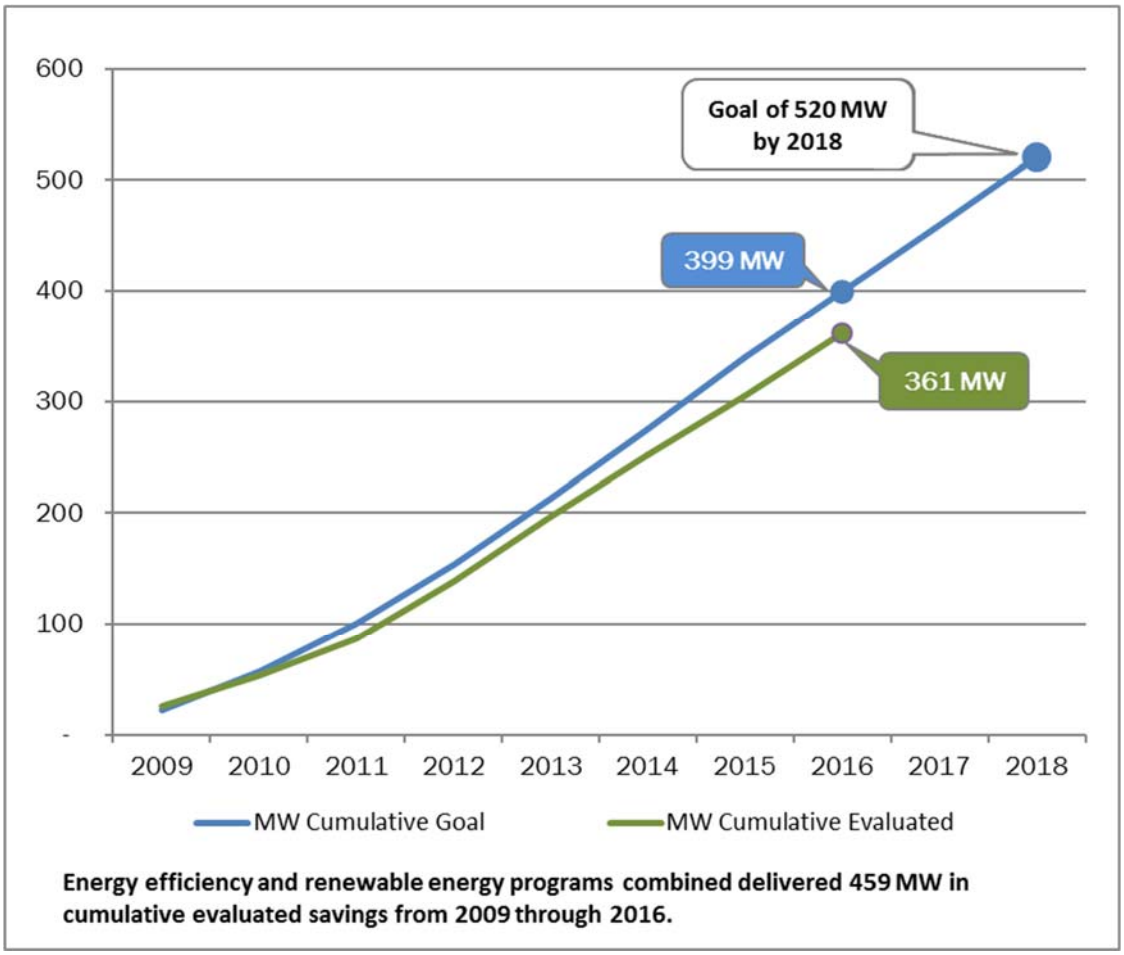
[8] Using the energy supply discount rate assumption of 4.17%.

[9] In 2016 dollars.

[10] In 2016 dollars.

long-term goals will change moving forward, but have included this discussion for the purposes of recounting the Portfolio's cumulative performance over the past eight years.

Figure 4. Energy Efficiency Portfolio Progress toward Demand Goal (MW)



Since establishing these goals, the Energy Efficiency Portfolio investments continue to result in progress toward the long-range goal. The Energy Efficiency Portfolio has achieved 90% of the cumulative demand savings goal as of 2016, the same percentage achieved through 2015.[11] (It should be noted that LIPA's Electric Resource Plan used an expected value set conservatively to 79% of the long-range goal for the Energy Efficiency Portfolio in its capacity planning models to account for the possibility of falling short of the goal.) In 2016, based on our evaluated savings results, the Energy Efficiency Portfolio realized 102% of its annual energy demand savings goals and spent approximately 91% of its budget. Moving forward, we can expect a greater emphasis on energy savings to help the State of New York meet its goal of 40% greenhouse gas reductions by 2030. For example, the 2017 goal for energy efficiency is 243,000 MWh of energy savings, rather than focusing on peak demand reduction.

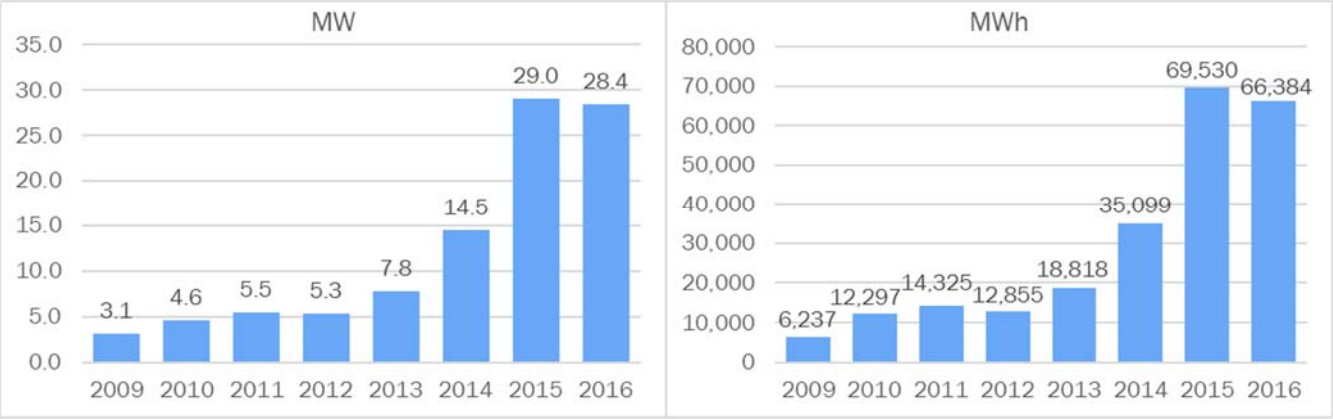
[11] When the cumulative evaluated demand savings associated with the Renewable Energy programs since 2009 are added to Efficiency Long Island Portfolio savings, the total cumulative evaluated demand savings increases to 459 MW.

2.5 Renewable Energy Portfolio Evaluated Impacts

PSEG Long Island spent $3.2 million of its operating budget on the Renewable Energy Portfolio in 2016, with NYSERDA providing $10.8 million in rebate costs through the NY-Sun Initiative.[12] Overall, our evaluation showed that the portfolio generated 28.4 MW of coincident demand and 66,384 MWh of energy. The Renewable Energy Portfolio resulted in an annual displacement of approximately 39,974 tons of CO_2 equivalents,[13] 15 tons of SO_2, and 30 tons of NOx. These greenhouse gas reductions are equivalent to removing approximately 7,660 cars from the road and a fuel savings of more than 83,958 barrels of oil.[14]

The Renewable Energy Portfolio greatly exceeded its goals in 2016, achieving 129% of its net demand goal and 126% of its energy goal. Demand and energy savings from the Renewable Energy Portfolio each dropped off slightly compared to 2015, as did program spending.

Figure 5. 2016 Renewable Energy Portfolio Evaluated Net MW and MWh Savings



In August 2014, PSEG Long Island began a transition from the legacy Solar Entrepreneur and Solar Pioneer programs to the NYSERDA-funded NY-Sun Residential and Small Commercial initiatives. After August 12, 2014, PSEG Long Island accepted only NY-Sun applications, and the NY-Sun program absorbed the incentive costs for all ongoing projects. Through the initiative, NYSERDA committed $65 million in total incentives for Long Island, to support 149 MW in residential systems and 65 MW in small nonresidential systems (under 200 kW). The ultimate goal of the initiative is to promote market transformation in the state by creating a sustainable market not dependent on subsidies. To accomplish this, NYSERDA created blocks of MW targets at specific incentive levels for each region of the state based on the maturity of the region's solar PV market. When the MW target of each block is met, the block is closed and a new block with a new MW target and lower incentive level is opened until all blocks for the region are filled and the incentive is no longer offered. The final block of residential funding was exhausted in April 2016.The program has used approximately half of the 65 MW available to small nonresidential customers as of March 2017.

[12] PSEG Long Island also paid an additional $34,879 in rebates for legacy Solar Pioneer projects.

[13] CO_2 equivalents includes carbon dioxide, methane, and nitrous oxide.

[14] Displacement savings values calculated using 2014 Long Island sub-regional emissions rates of the EPA's eGRID 2014 v2, released February 27, 2017. Equivalent savings values are based on the U.S. EPA's Greenhouse Gas Equivalencies Calculator (updated May 2016).

The evaluation team also reviewed the cost-effectiveness of the Renewable Energy Portfolio. Based on an analysis of portfolio impacts and costs, the savings generated by the Renewable Energy Portfolio are cost-effective. As shown in Table 2-5, the UCT benefit/cost ratio is 15.5,[15] which is a notable improvement over the 2015 value of 9.0. This increase in the UCT benefit/cost ratio for renewables in 2016 is due mainly to the decreasing rebate costs per kW of installed solar PVs. The benefit cost/ratio using the SCT is 0.89.

The 2016 UCT levelized costs are $33.52/kW-yr and $0.01/kWh compared to $56.41/kW-yr and $0.02/kWh in 2015. It is important to note that these levelized costs do not include the lost revenue associated with net metering, which is consistent with the calculation of levelized costs for energy efficiency programs. We provide this value to allow for a direct comparison to the Energy Efficiency Portfolio.

Table 2-5. Summary of 2016 Renewable Energy UCT, SCT, and Levelized Costs

Cost-Effectiveness Test	Benefit/Cost Ratio[a]	Levelized Cost ($/kW-yr)	Levelized Cost ($/kWh)
UCT	15.5	33.52	0.014
SCT	0.89	580.10	0.248

[a] Includes $10.8 million from the NYSERDA's NY-Sun Initiative.

2.6 Renewable Energy Portfolio Economic Impacts

The 2016 evaluation also includes an assessment of the economic impact of investments in the Renewable Energy Portfolio on the economy of Long Island. The Evaluation Team developed an I-O model of the Long Island regional economy for the 2011 evaluation and updated the model inputs in each subsequent year. We estimated economic impacts associated with the PSEG Long Island's 2016 investments, and then combined those results with our assessments of the prior 7 years of implementation of the Renewable Energy Portfolio programs to arrive at a portfolio-to-date estimate.

As shown in Table 2-6, our analysis of economic benefits found that the combination of PSEG Long Island's $3.2 million budget in the Renewable Energy Portfolio in 2016, plus the additional $10.8 million in funding through NYSERDA's NY-Sun Initiative, returned $78.4 million in total economic benefits to the Long Island regional economy in 2016, including an additional 433 FTEs. Over the 10-year period, these 2016 investments are expected to return $159.0 million in total economic benefits to the regional economy (2016 dollars), with an employment benefit of 1,042 new FTEs.

Extrapolating these results over the 8-year life of the portfolio, the $147.1 million investment in Renewable Energy programs to date ($178.1 million in 2016 dollars) produced approximately $365.5 million in cumulative annual economic benefits, with an employment benefit of 2,047 FTE employees. Over the 10 years following each program year investment, these 8-year investments are expected to return approximately $642.2 million to the Long Island regional economy and result in 4,085 additional FTEs between 2009 and 2025.

[15] Includes $10.8 million from the NYSERDA's NY-Sun Initiative.

Table 2-6. Economic Impact of 2009–2016 Renewable Energy Portfolio Investments

Effect	Impact of 2016 Program Investment		Impact of 2009–2016 Program Investment	
	First-Year Impact	Impact over 10 Years[a]	First-Year Impact	Impact over 10 Years[a]
Total Economic Output[b] (2016 $1M)	$78.4	$159.0	$365.5	$642.2
FTE Employees	433	1,042	2,047	4,085

[a] Includes the 10-year impacts for each program year beginning in that year.

[b] Total economic output is the value of industry production. In IMPLAN, these are annual production estimates in producer prices.

Similar to the 2015 results, 2016 spending on PSEG Long Island's Renewable Energy Portfolio resulted in much greater benefits to the Long Island economy than in earlier program years. This difference is driven primarily by two factors: the higher number of solar PV systems installed compared to the years 2012-2014 and $10.8 million in funding through NYSERDA's NY-Sun Initiative. The effect of NYSERDA's funding was especially pronounced because it positively contributed to the direct impact of the program, but did not incur a corresponding renewables charge to PSEG Long Island ratepayers.

2.7 Key Themes for Continued Success

The Energy Efficiency and Renewable Energy portfolios continued to demonstrate strong performance in 2016, providing substantial capacity and energy savings in a cost-effective manner. Combined, the portfolios exceeded the established goals for demand and energy savings. To continue to make progress toward the long-range savings goals, to maintain overall portfolio performance, and to build on the historical success of the Energy Efficiency and Renewable Energy programs, PSEG Long Island must continue to identify and consider emerging issues and challenges during its planning, budgeting, implementation, and management decisions. Below we provide an overview of the performance of the Energy Efficiency and Renewable Energy programs for the 2016 evaluation cycle and identify challenges that warrant attention in the future.

Commercial Efficiency Programs

Overview of Performance

PSEG Long Island's CEP portfolio continued to effectively service commercial customers on Long Island through the Prescriptive, Existing Retrofit, and Custom program offerings. PSEG Long Island's 2016 CEP portfolio also included no-cost energy assessments, cost-shared technical assistance studies, building commissioning co-funding, Leadership in Energy and Environmental Design (LEED) certification incentives, and ENERGY STAR® Benchmarking certification. In addition, PSEG Long Island initiated the FastTrack program in 2016, which is aimed at small commercial customers and offers rebates for efficient lighting products and lighting controls with a streamlined application process. With the discontinuation of the SBDI program in 2015, the FastTrack program provides an alternative route to energy efficiency specifically tailored to the needs of small businesses.

PSEG Long Island's CEP performed well in 2016, achieving 90% of the peak demand goal and 95% of the energy savings goal. Beyond strong performance in terms of energy and demand savings, CEP continued customer and trade ally engagement, rigorous data tracking and QA/QC, and exploration of alternative savings sources and technological improvements to the program participation process. Highlights include:

- Deploying the Online Energy Analyzer tool to help customers identify energy savings opportunities through the program

- Facilitating direct-to-LM Captures import capabilities of the information entered into application Excel worksheets, which allowed for seamless, accurate, and efficient data capture and transfer
- Offering Thermal Energy Storage (TES) and Combined Heat and Power (CHP) measures as part of the custom program to help shift power from peak to off-peak period and introduce efficient power generation systems

The transition from the Siebel data entry and tracking system to the LM Captures database in 2016 created a learning curve with data capture and processing. The program team worked to clearly document data entry and processing steps and develop QA/QC protocols. Despite challenges in the early portion of 2016, the program staff was able to maintain high levels of accuracy and consistency in processing customer applications. The evaluation team's desk reviews of projects completed in the early portion of 2016 and the later portion of the year show little difference in terms of realization rates.

Existing Retrofit projects were the primary source of demand and energy savings, making up 79% and 77% of the CEP demand and energy savings, respectively. The CEP continued to rely primarily on lighting measures for savings. Lighting measure installations across all program components accounted for 93% of the ex ante net demand savings and 94% of ex ante net energy savings.[16] LED lighting increased in prominence in 2016, primarily at the expense of fluorescent lighting measures.

Potential Challenges for the Future

The CEP's heavy reliance on lighting continues to be a challenge. Looking for ways to diversify program offerings away from lighting measures will allow the program to ensure stable performance and savings sources moving forward. The LED market is experiencing dramatic changes in pricing and product availability and prominence. Program staff should continue to monitor product pricing and adjust incentives accordingly. PSEG Long Island should also continue to explore ways to diversify program offerings away from lighting measures by researching the potential energy and demand savings from other end-uses.

Transition to the new data-tracking platform (LM Captures) may bring uncertainty around the quality and completeness of the data. Continuing to develop and implement rigorous data management and QA/QC processes will ensure a high level of data quality.

Additionally, while the Fast Track program continued to increase in size, per-project savings decreased from 2015 to 2016. Year-over-year participation analysis reveals a positive 81% increase in the number of projects completed by Fast Track-eligible customers. However, our analysis also revealed a 19% reduction in per-project savings among Fast Track program-eligible customers between 2015 and 2016. One of the goals of the program is to increase participation amongst small commercial customers through a streamlined participation process, which required program staff to set a cap on the size of the project. Though the number of applications has clearly increased from 2015 to 2016, the per-project incentive cap may have a negative impact on the per-project savings. More specifically, small commercial customers who would otherwise participate in the Existing Retrofit program and complete a larger project may favor the Fast Track program's streamlined approach at the expense of the project size.

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

RESIDENTIAL EFFICIENCY PROGRAMS

OVERVIEW OF PERFORMANCE

Collectively, the residential programs provided substantial demand and energy savings in 2016 that were largely driven by the EEP program. In 2016, based on evaluated savings, the EEP program exceeded its demand and energy goals by 30% and 33%, respectively. The Cool Homes program, next largest in terms of savings, achieved only 75% of its demand goal and 68% of its energy goal. Together, the EEP and Cool Homes programs accounted for 92% of the evaluated demand savings from the residential programs in 2016.

The remaining residential programs—REAP, HPD, and HPwES—accounted for 8% of the residential programs' demand savings. The HPD and HPwES programs fell short of their demand and energy goals, while the REAP program exceeded its demand goal and fell short of its energy savings goal.

POTENTIAL CHALLENGES FOR THE FUTURE

LIGHTING

The performance of the EEP program largely drives the overall energy and demand performance of the residential portfolio. Within the EEP program, lighting products accounted for 81% of demand savings and 96% of energy savings in 2016. The EEP Lighting program reflected the changing lighting marketplace in 2016, with increased sales of (and savings from) LEDs relative to CFLs, as the program transitions away from CFLs in 2017. Substantial growth in the importance of LEDs to the program are being driven by a mix of market forces (e.g., growing number of products, declining prices, and increasing quality) and programmatic decisions. PSEG Long Island has been proactive over the years in adjusting its program offerings to accommodate these market forces. Nevertheless, two key factors are likely to create challenges to maintaining the energy and demand savings the program currently and historically has received from residential lighting measures.

Customer preferences for efficient lighting technology, particularly for LEDs, may be driving the market transformation faster than anticipated. In our 2016 Residential In-Home study, we found that energy-efficient bulbs are more than two-fifths of all bulbs in PSEG Long Island customer homes (42% are either CFL or LED). The LED penetration rate in particular has grown since 2013, from 13% of homes with at least one LED bulb to 63%, suggesting that Long Island customers are quickly adopting LEDs. The Long Island LED penetration rate is now higher than rates reported in other parts of the Northeast United States (42% in Connecticut, 30% in Upstate New York, and 51% in Massachusetts). Similarly, LED saturation on Long Island has increased in recent years (from 2% in 2013 to 17% in 2016). Energy efficiency industry groups, such as the Northeast Energy Efficiency Partnership (NEEP), have also observed these upward trends in efficient lighting penetration and saturation rates, continued LED quality improvements, and falling prices, and are monitoring national policy changes expected for 2020. As a result, NEEP recently declared that the Northeast region is in the "last stages of market transformation." However, with 47% of residential sockets on long island containing inefficient bulbs, there remain opportunities to accelerate the adoption of efficient lighting through upstream rebates over the short term, before the EISA 2020 national standards come into effect.

As was true in 2015, the baseline efficiency of light bulbs will continue to increase going forward due to code changes introduced as part of the Energy Independence and Security Act (EISA) of 2007. EISA standards for all general service bulbs are now in effect, and the U.S. Department of Energy (DOE) has proposed new standards beginning in 2020 that will further reduce maximum allowable wattages per lumen and will cover many more bulb types. These standards include provisions that affect specialty lamps (BR30), which historically have comprised a large share of EEP's specialty lighting offering. Though DOE is unable to enforce EISA requirements at this time, our research suggests that manufacturers and retailers are largely complying

with EISA provisions, and we expect this trend to continue through 2020. Considering the importance of residential lighting as a source of savings, monitoring the actual baseline lighting efficiency on Long Island will be critical to understand energy savings associated with EEP lighting and to inform future revisions in program strategy.

COOL HOMES PROGRAM PARTICIPATION

Program participation by Cool Homes participating contractors has not increased significantly in recent years, and a market characterization study conducted by the evaluation team in 2014 indicated that opportunities to capture a greater share of the market exist, The Cool Homes equipment-only offering was initiated in mid-2015 as a means of increasing the program's market share. Despite the addition of the equipment-only option and increased spending on program marketing in 2016, program-rebated installations declined in 2016 and the equipment-only offering has not realized anticipated participation levels. PSEG Long Island should conduct research into the reasons for the equipment-only offering not gaining more widespread use by Long Island HVAC contractors. In addition, program staff should continue to investigate the effectiveness of each marketing channel utilized in 2016 and should tailor future marketing efforts to prioritize the most effective channels and drive increased participation and installations of efficient cooling equipment.

RENEWABLE ENERGY PORTFOLIO

OVERVIEW OF PERFORMANCE

The Renewable Energy Portfolio greatly exceeded its goals in 2016, driven by continued decreases in system prices, the demand for leased residential solar systems, and the availability of $10.8 million from NYSERDA's NY-Sun Initiative. Past research conducted by the evaluation team found that legacy Solar Pioneer and Solar Entrepreneur programs promoted the development of a renewable energy industry on Long Island by helping increase consumer awareness of and demand for solar energy while also increasing the technology's availability. The programs have contributed to a strong PV market infrastructure on Long Island and a knowledgeable trade ally base. The program's implementation of the NY-Sun Initiative, with its $65 million allocated to the Long Island electric service territory, as well as financing offerings through the Green Jobs – Green New York initiative, also fostered growth in the market. Through these efforts, PSEG Long Island continue to foster market transformation and create a sustainable market.

POTENTIAL CHALLENGES FOR THE FUTURE

PSEG Long Island has implemented NYSERDA's NY-Sun Initiative since August 2014, providing many benefits to Long Island's electric customers (including the $65 million in funding provided by NYSERDA). The NY-Sun Initiative has a goal of providing long-term confidence to the marketplace and incrementally reduces rebates as more customer choices (e.g., lease, purchase, remote net metering, community aggregation) are available, the market grows, and prices decrease. The NY-Sun Incentive Program was responsible for funding all new projects and nearly all projects completed in 2016.[17]

As designed, however, the NY-Sun program is winding down on Long Island: By April 2016, PSEG Long Island had allocated 100% of the 149 MW of residential solar PV funding and, as of March 2017, 45% of the 65 MW available for small nonresidential customers had been allocated. In 2016, PSEG Long Island's Solar PV program rebated fewer projects than the previous year for the first time since 2012. In each previous year of

[17] A small share of projects were legacy Solar Pioneer projects (6 projects) or received financing through the Green Jobs – Green New York initiative (338 projects).

the program, the number of projects roughly doubled from the prior year (975 in 2012, 1,625 in 2013, 3,408 in 2014, and 7,176 in 2015).

Given the phasing out of the NY-Sun incentives and the advanced state of the solar PV market on Long Island, PSEG Long Island will need to determine the actual level of market transformation that has occurred on Long Island and in what form the program should continue. Currently, program staff expect that commercial participation will continue to increase in 2017, and anticipate the rollout of a new residential financing initiative that would work much like the current Green Jobs – Green New York initiative, but would be facilitated by the New York Green Bank. Shifting from an incentive program to a financing program will require research to update the program's assumptions about the types of participating customers, their decision-making processes, and savings attribution.

Cost Effectiveness and Avoided Costs

In 2017 PSEG Long Island's assumptions for the avoided costs of generation due to efficiency savings changed from the assumptions that were in place for 2016 and prior years. This change stems from guidance provided in the New York State Benefit Cost Analysis Handbook that was developed in 2016. Effectively, beginning in 2017, PSEG Long Island's avoided costs decreased by approximately 80%. This decrease will have significant impacts on program cost effectiveness test results for all programs in the PSEG Long Island Portfolio by making them more expensive in comparison to alternative supplies. The cost effectiveness results for the 2016 program, as presented in this report, use the old avoided costs.

To illustrate the change in the cost effectiveness results with the new avoided costs, the evaluation team conducted cost effectiveness tests on the 2016 energy efficiency and renewable energy portfolios keeping all inputs constant except the avoided costs.

Table 2-7 shows the cost effectiveness under both avoided cost scenarios for the Utility Cost Test (UCT) and the Societal Cost Test (SCT). In the UCT, the energy efficiency and renewable portfolio as a whole achieved a benefit/cost ratio of 5.1 with the existing avoided costs and 2.5 with the new avoided costs. In the SCT, the energy efficiency and renewable portfolio as a whole achieved a benefit/cost ratio of 1.2 with the existing avoided costs and 0.75 with the new avoided costs.

Table 2-7. Comparison of 2016 Cost Effectiveness Results Using Existing and New Avoided Cost Assumptions

Program/Sector	Utility Cost Test		Societal Cost Test	
	Existing Avoided Costs	New Avoided Costs	Existing Avoided Costs	New Avoided Costs
Energy Efficiency	**3.1**	**1.5**	**1.7**	**1.1**
Commercial	3.7	1.8	2.7	1.8
Residential	2.5	1.1	1.1	0.70
Renewables	**15.5**	**7.5**	**0.89**	**0.54**
Overall	**5.1**	**2.5**	**1.2**	**0.75**

These lower avoided costs will require PSEG Long Island and program implementers to remain focused on program cost effectiveness for both existing programs and any new programs to ensure that the programs provide sufficient benefits to warrant their costs.

3. Impact Results

This section presents the evaluated net energy and demand impacts for the Energy Efficiency and Renewable Energy portfolios.

3.1 Energy Efficiency Portfolio Impacts

Energy and Demand Impacts

The portfolio of Energy Efficiency programs performed well in 2016, achieving similar evaluated net savings as those of 2015, and delivering considerable energy and demand savings to electric customers on Long Island. The portfolio's evaluated net demand and energy savings came in above its stated goal for the year. Specifically, the Energy Efficiency Portfolio accounted for 55.9 MW and 303,459 MWh in total evaluated net savings for 2016. This represents approximately 104% of evaluated net demand and evaluated net energy savings compared to 2015 results, which were approximately 53.7 MW and 292,481 MWh. As shown in Table 3-1, the portfolio reached 102% of its net demand and 114% of its net energy savings goals.

Table 3-1. Net Impacts: Energy Efficiency Portfolio Evaluated Savings versus Goals

Program	2016 Net Savings Goals		2016 Evaluated Net Savings		Percent of Goal	
	MW	MWh	MW	MWh	MW	MWh
Commercial Efficiency Programs	**28.0**	**110,580**	**25.3**	**105,456**	**90%**	**95%**
Residential Programs						
EEP	19.2	143,805	25.1	191,172	130%	133%
Cool Homes	4.3	4,002	3.17	2,611	74%	65%
REAP	0.6	2,114	0.586	1,493	105%	71%
HPwES	1.0	666	0.253	267	25%	40%
HPD	2.0	4,224	1.48	2,459	76%	58%
Subtotal Residential Programs	**27.0**	**154,811**	**30.6**	**198,003**	**113%**	**128%**
Total Energy Efficiency Portfolio	**55.0**	**265,391**	**55.9**	**303,459**	**102%**	**114%**

The CEP accounted for about 45% of the Energy Efficiency Portfolio evaluated demand savings in 2016. The CEP achieved 90% of the 2016 net demand savings goal and 95% of the net energy savings goal set for the total commercial program. Driven primarily by the success of the EEP program, the residential programs performed exceptionally well, achieving 113% of their combined demand savings goals and 128% of their combined energy savings goal.

The EEP program continues to account for the largest portion of energy and demand savings within the residential programs, and performance of this program has a substantial impact on the ability of the portfolio to achieve savings goals. The continued success of the EEP program significantly contributed to the strong overall performance of the residential programs in 2016.

3.2 Renewable Energy Portfolio Impacts

Energy and Demand Impacts

Leveraging the $10.8 million in funding for rebates through NYSERDA's NY-Sun Initiative, the Renewable Energy Portfolio exceeded its net demand and energy goal, achieving 129% and 126% of these goals, respectively, as shown in Table 3-2.

Table 3-2. Net Impacts: Renewable Energy Portfolio Evaluated Savings versus Goals

Program	2016 Net Generation Goals		Evaluated Net Generation		Percent of Goal	
	MW	MWh	MW	MWh	MW	MWh
Residential Solar PV	17.6	42,011	25.5	59,548	145%	142%
Commercial Solar PV	4.4	10,503	2.9	6,836	66%	65%
Total Renewable Energy Portfolio	**22.0**	**52,514**	**28.4**	**66,384**	**129%**	**126%**

For more information, please contact:

Adam Burke
Managing Director

617 492 1400 tel
617 497 7944 fax
aburke@opiniondynamics.com

1000 Winter St
Waltham, MA 02451