Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

MONDRE ENERGY, INC.

DNV

brightline GROUP

2022 Annual Evaluation Report – Volume I Portfolio Summary

Prepared for PSEG-LI

By Demand Side Analytics Evaluation Team

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PREFACE

GLOSSARY OF TERMS

Key Term	Definition
MWh Beneficial Electrification (MWh_{be})	The increase in weather-normalized annual electric energy consumption attributable to beneficial electrification measures.
MWh Energy Efficiency (MWh_{ee})	The reduction in weather-normalized annual electric energy consumption attributable to energy efficiency programs or measures.
Delta MWh	The total change in annual electric energy consumption. Equal to $MWh_{ee} - MWh_{be}$. Energy Efficiency measures, MWh_{ee}, typically result in a reduction in a customer's annual electric consumption and are reported as positive impacts. Beneficial Electrification measures, MWh_{be}, result in an increase in the customer's annual electric consumption. A negative value of Delta MWh indicates the measure or program increases electric consumption on the PSEG Long Island system as a whole. A positive value of Delta MWh indicates the measure or program reduces electric consumption on the PSEG Long Island system.
Discount Rate	The time value of money is used to calculate the present value of future benefits and costs. PSEG Long Island uses a weighted average cost of capital supplied by LIPA that represents the cost of borrowing to build additional capacity to meet the service territory's future supply needs. Based on these factors, we used a nominal discount rate of 5.66% in the 2022 evaluation.
Ex-Ante Gross Savings	The energy and demand savings recorded by the implementation contractor in the program tracking database. Ex-ante gross savings are sometimes referred to as claimed savings. These savings are calculated using planning assumptions and algorithms.
Ex-Post Gross Savings	The energy and demand savings estimated by the evaluation team, using the best methods and data available at the time of the evaluation.
Ex-Post Net Savings	The savings realized by the program after independent evaluation determines ex-post gross savings and applies NTGRs and line losses. The evaluation team uses the ex-post net impacts in the cost-effectiveness calculation to reflect the current best industry practices.
Gross Impacts	The change in energy consumption or demand directly due to the participants' program-related actions, regardless of why they participated. These impacts include coincidence factors (CFs) for demand, waste-heat factors, and installation rates. Gross impacts presented in this report do not include line losses and,

Key Term	Definition
	therefore, represent the energy and demand savings as would be measured at the customers' meters.
kW Impacts (Demand or Capacity)	The reduction in demand coincident with system peaking conditions due to energy efficiency measures. For Long Island, system peaking conditions typically occur on non-holiday summer weekdays. This report's peak demand savings values are based on system coincident demand impacts between 4 pm and 5 pm on non-holiday weekdays from June to August.
Levelized Cost of Capacity	To operate the electric grid, the system operator needs installed, operable capacity to meet peak demand conditions. The levelized cost of capacity is a metric that allows planners to compare the costs of different resources to meet (or lower) peak demand. The metric is typically expressed in terms of $kW/year.
Levelized Cost of Energy	The equivalent cost of energy (kWh) over the life of the equipment that yields the same present value of costs, using a nominal discount rate of 6.16%. The levelized cost of energy is a measure of the program administrator's program costs in a form that planners can compare to the cost of supply additions.
Line Loss Factor	The evaluation team applies line losses of 5.67% on energy consumption (resulting in a multiplier of 1.0601 = [1 ÷ (1 – 0.0567)]) and of 7.19% on peak demand (resulting in a multiplier of 1.0775 = [1 ÷ (1 – 0.0719)]) to estimate energy and demand savings at the power plant.
MMBtu Beneficial Electrification ($MMBtu_{be}$)	For fuel-switching measures, the reduction in site-level fossil fuel consumption minus the site level increase in the electric consumption (MWh_{be}) converted to MMBtu at 3.412 MMBtu per MWh.
MMBtu Energy Efficiency ($MMBtu_{ee}$)	The reduction in site-level energy consumption due to energy efficiency expressed on a common MMBtu basis. $MMBtu_{ee}$ impacts are calculated by multiplying the MWh_{ee} impacts by a static 3.412 MMBtu per MWh conversion factor and adding any fossil fuel conservation attributable to the measure. Secondary fossil fuel impacts, such as the waste heat penalty associated with LED lighting, are also deducted from the $MMBtu_{ee}$ estimates.
Net Impacts	The change in energy consumption or demand that results directly from program-related actions taken by customers (both program participants and non-participants) that would not have occurred absent the program. The difference between the gross and net impacts is the application of the net-to-gross ratio (NTGR) and line losses. Net impacts presented in this report also include line losses and, therefore, represent the energy and demand savings as would be measured at the generator. Net impacts are used for cost-effectiveness analysis.

Key Term	Definition
Net-to-Gross Ratio (Free-Ridership and Spillover)	The factor that, when multiplied by the gross impacts, provides the net impacts for a program before any adjustments for line losses. The NTGR is defined as the savings attributable to programmatic activity after accounting for free-ridership (FR) and spillover (SO). Free-ridership reduces the ratio to account for those customers who would have installed an energy-efficient measure without a program. The free-ridership component of the NTGR can be viewed as a measure of naturally occurring energy efficiency. Spillover increases the NTGR to account for non-participants who install energy-efficient measures or reduce energy use due to the actions of the program. The NTGR is generally expressed as a decimal and quantified through the following equation: NTGR = 1 – FR + SO
Realization Rate	The ratio of ex-post gross to ex-ante gross impacts. This metric expresses the evaluation savings as a percentage of ex-ante savings claimed by PSEG Long Island or the implementation contractor. The Home Energy Management program is implemented by Uplight on behalf of PSEG Long Island. TRC and its subcontractors implement the remainder of the portfolio.
Societal Cost Test (SCT)	A test that measures a program's net costs as a resource option based on benefits and costs to New York. Rebate costs are not included in this test because they are assumed to be a societal transfer. To maintain consistency with the most current version of the New York Benefit-Cost Analysis Handbook, we applied the SCT as a primary method of determining cost-effectiveness using the same assumptions as those used by PSEG Long Island's resource planning team.
Technical Reference Manual (TRM)	A collection of algorithms and assumptions used to calculate resource impacts of PSEG Long Island's Energy Efficiency Portfolio. The PSEG Long Island TRM aligns with the New York State TRM in many respects but includes Long Island specific parameters and assumptions where available from saturation studies or prior evaluation research.
Total MMBtu Impact	The primary performance metric since program year 2020. Equal to the sum of $MMBtu_{be}$ and $MMBtu_{ee}$. This metric represents the change in site-level fuel consumption attributable to the measure or program. This metric does not consider the amount of MMBtu required to generate a kWh of electricity – only the embedded energy in the delivered electricity.
Utility Cost Test (UCT)	A test that measures the net costs of a program as a resource option, based on the costs that the program administrator incurs (including incentive costs) and excluding any costs incurred by the participant beyond what is subsidized by the program. To allow for direct comparison with PSEG Long Island's assessment of all supply-side options and consistent with previous evaluation reports, we continue to show the UCT as a secondary method of determining cost-effectiveness.

Key Term	Definition
Verified Ex-Ante Gross Savings	A key question is if the ex-ante gross energy impacts claimed by the implementation contractors were calculated consistently using the calculations and assumptions approved by PSEG Long Island and LIPA and used to develop annual savings goals. To verify claimed savings, the evaluation team independently calculates the saving using the calculations and assumptions pre-approved by PSEG Long Island. These savings estimates are used to determine if PSEG Long Island achieves its annual scorecard goals.

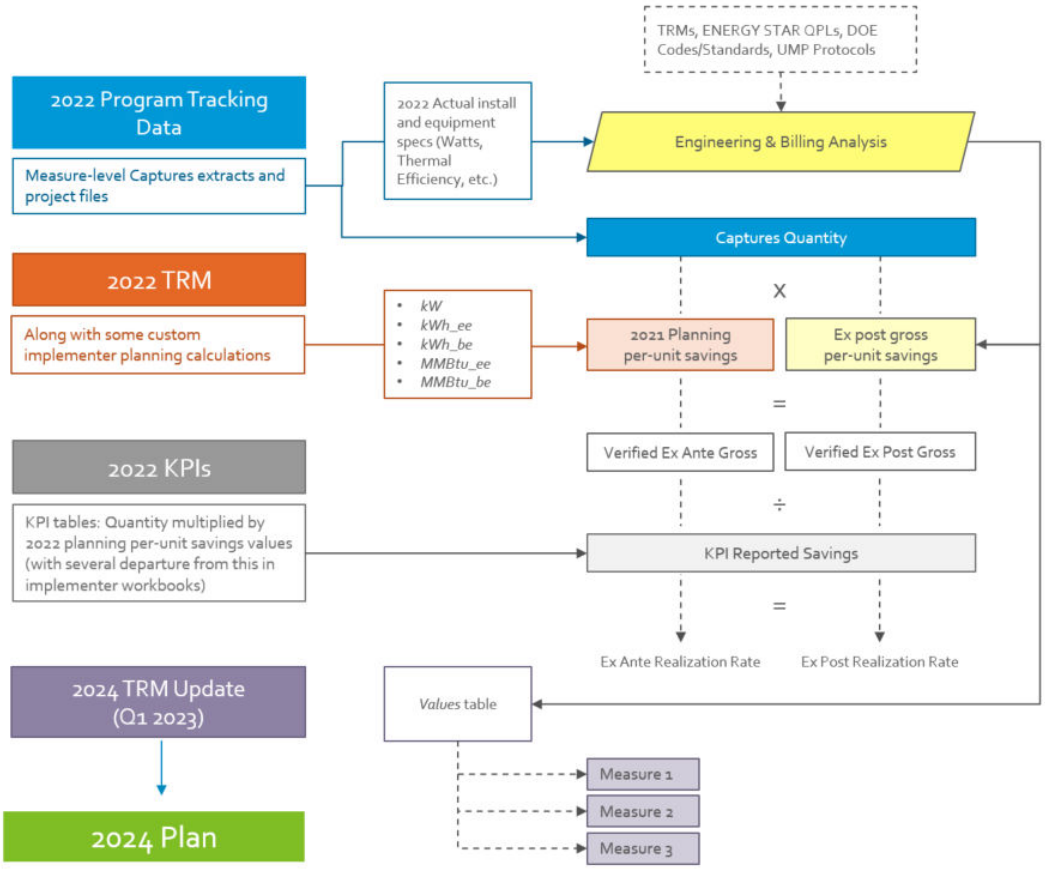
ANNUAL EVALUATION TASKS AND CYCLE TIMELINE

Figure 1 outlines annual energy efficiency and beneficial electrification programming timeline for planning, verified ex-ante, and verified ex-post and the resources that inform assumptions for each deliverable. The verified ex-ante audit asks if the ex-ante gross energy impacts claimed by the implementation contractors were calculated consistently with the calculations and assumptions approved by PSEG Long Island and LIPA. To verify claimed savings, the evaluation team independently calculates the savings using the calculations and assumptions pre-approved by PSEG Long Island. These savings estimates are used to determine if PSEG Long Island achieves its annual scorecard goals, and results are submitted in the Verified Ex-Ante, Appendix D.

Volumes I and II of this report outline the results from the ex-post evaluation. The ex-post evaluation estimates energy and summer peak demand savings for the portfolio using the most current methods and data available at the time of the evaluation. Assumptions and algorithms from the most up to date TRMs, DOE Codes and Standards, and actual equipment specifications are utilized in this portion of the evaluation. The output informs recommendations for future planning cycles.

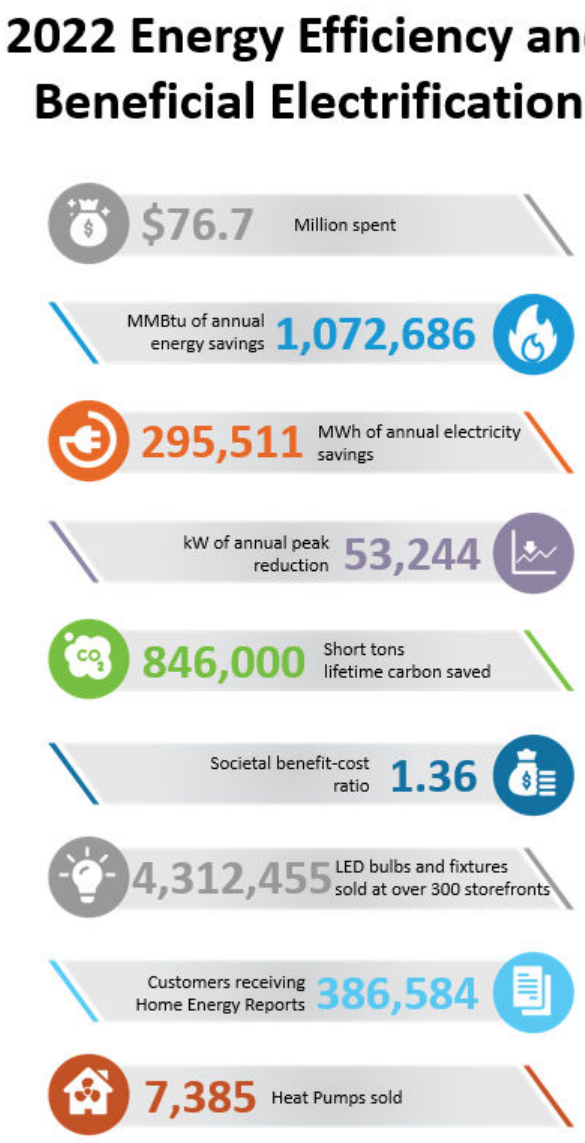
It is important to note that the feedback loop is nearly a two-year cycle. PSEG Long Island has already established 2023 goals and planning assumptions, therefore findings and recommendations from the 2022 ex-post evaluation will not be reflected in the 2023 program claimed savings methodology. The findings and recommendations of this 2022 impact evaluation will be reflected in 2024 planning assumptions, goal setting, and ex-ante savings values. Additionally, any major drivers in differences between ex-post and claimed ex-ante savings discovered in the 2021 evaluation were expected to persist in the 2022 evaluation results.

Figure 1: Annual Evaluation Data Flow



1 INTRODUCTION

PSEG Long Island's Energy Efficiency and Beneficial Electrification programs offer a wide array of incentives, rebates, and programs to PSEG Long Island residential and commercial customers to assist them in either reducing their energy usage through energy efficiency, thereby lowering their energy bills, or in electrifying their homes and avoid fossil fuel-based costs through beneficial electrification. The Energy Efficiency and Beneficial Electrification Portfolio is administered by PSEG Long Island and its subcontractor, TRC, on behalf of the Long Island Power Authority (LIPA). The sole exception is the residential behavioral program, Home Energy Management (HEM), which is administered by Uplight. This report presents the 2022 Energy Efficiency and Beneficial Electrification Portfolio program evaluation ex-post gross results and covers the period from January 1, 2022 to December 31, 2022.



The Demand Side Analytics evaluation team produced two volumes that together compose the entire Annual Evaluation Report. This document, the 2022 Annual Evaluation Report (Volume I), provides an overview of the portfolio-level evaluation findings. The 2022 Program Guidance Document (Volume II) detailed program-by-program impact analysis results.

In 2022, PSEG Long Island spent $76.7 million implementing the Energy Efficiency and Beneficial Electrification Portfolio. The investment led to 1,072,686 of total MMBtu savings and avoided 846,000 short tons of CO_2 emissions – the equivalent of removing over 164,272 combustion engine cars for a year.[1] PSEG Long Island's efforts led to $150 million in net societal benefits, with a societal benefit cost ratio of 1.36.

New York has established many statewide energy efficiency and emission reduction targets. The Climate Leadership and Community Protection Act (CLCPA) set the overall goal of reducing GHG emissions by 40%

[1] The EPA estimates 4.6 metric tons of carbon per vehicle-year, the equivalent of 5.15 short tons per vehicle-year. See: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

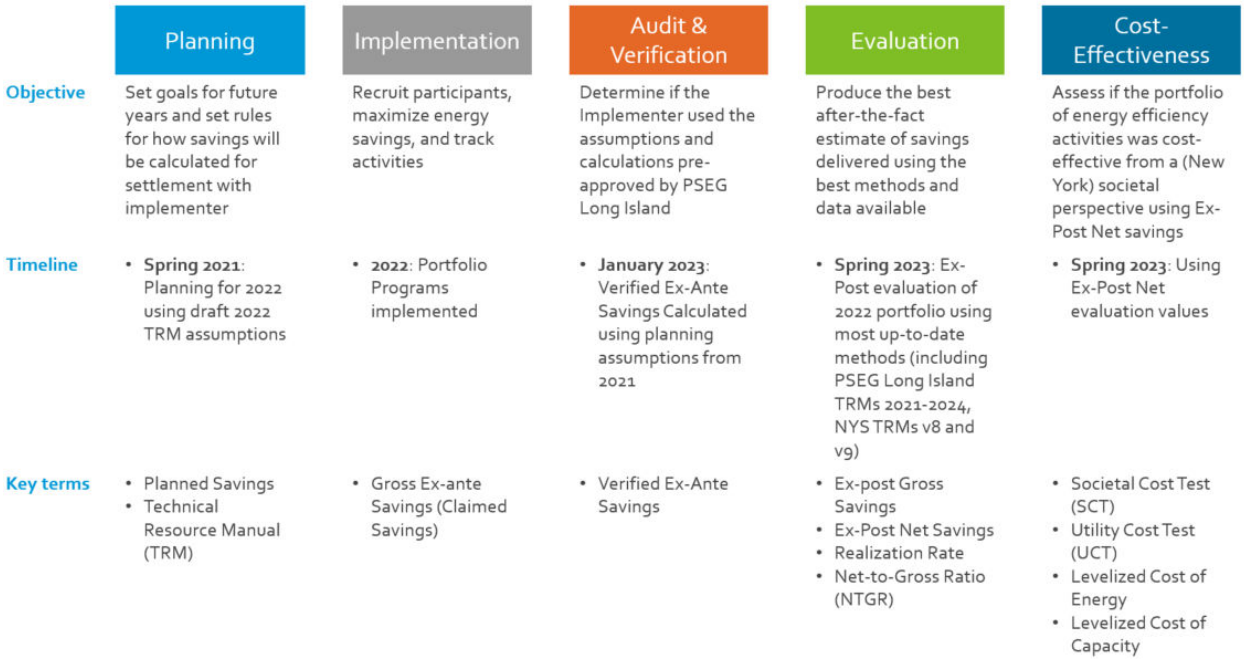
by 2030. In 2018, New Efficiency: New York set a statewide energy efficiency target of 185 TBtu in energy savings by 2025. These New York goals establish savings targets on an energy (Btu) basis for the State of New York. By laying out these targets, New York established fuel-neutral metrics to incorporate beneficial electrification in the building and transportation sectors, which is necessary to achieve the State's carbon reduction goals. In response, PSEG Long Island:

- **Changed its primary performance metric from electric energy (kWh) and peak demand (kW) to MMBtu.** The switch allows PSEG Long Island to pursue beneficial electrification measures like heat pumps that increase electric consumption but lower overall energy consumption and emissions. The MMBtu performance metric is "MMBtu at the site" meaning saved or increased kWh is converted to MMBtu using a static factor of 3.412 MMBtu per MWh - the thermal efficiency of the electric power generation fleet does not affect the calculations.
- **Incorporated and expanded beneficial electrification measures in its offerings**. PSEG Long Island has continued to pioneer efforts to expand their energy efficiency programs to include rebates and incentives for customers to install measures that supply beneficial electrification to the grid, such as heat pumps, and allow customers to save on their fossil fuel-based costs. Adopting fuel-neutral savings targets allows PSEG Long Island to aggregate efficiency achievements across electricity, natural gas, and delivered fuels such as oil and propane, which in turn shifts investment towards more non-lighting opportunities.

Energy efficiency programs undergo a yearly cycle including planning, implementation, audit and verifications, evaluation, and cost-effectiveness. At each stage, the term "energy savings" is used, leading to the need to be precise about the type of savings. Because energy efficiency has a unique lexicon, we include a comprehensive Glossary of Terms with definitions and encourage readers who are less familiar with the key terms to review them.

Figure 2 below shows the energy efficiency program cycle, the main objectives at each step, and the key terms. The feedback loop is nearly a two-year cycle. The planning activities for 2022 were conducted in 2021 and set the goals, rules, and algorithms for calculating energy savings. The 2021 energy efficiency and beneficial electrification measures were not evaluated until the spring of 2022, meaning 2022 programs were already being implemented before performance metrics were available from the 2021 evaluation. Considering this lag, we expected any major drivers in differences between claimed savings and ex-post impacts that were discussed in the 2021 evaluation to persist into 2022. Additionally, most of the findings and recommendations of this 2022 impact evaluation will be reflected in 2024, not 2023, planning assumptions, goal setting, and ex-ante savings values since PSEG Long Island has already established 2023 goals and planning assumptions.

Figure 2: Energy Efficiency Cycle, Objectives, and Key Terms



While the COVID-19 pandemic has largely subsided, there were residual effects in many implementation practices across the energy efficiency and beneficial electrification portfolio. Additionally, with remote work or hybrid work models becoming more permanent, fundamental shifts in customer behaviors should be taken into consideration. With a strong housing market, customers continuing to work from home, a renewed appetite for home improvements might prove a beneficial target for the energy efficiency and beneficial electrification portfolio implementers. Despite any potential disruptions to program delivery, PSEG Long Island showed strong performance compared to goals.

In 2022, PSEG Long Island administered nine programs, described in Table 1.

Table 1: Energy Efficiency and Beneficial Electrification Program Descriptions

Program	Description
Commercial Efficiency Program	The program assists non-residential customers in saving energy by offering customers rebates and incentives to install energy conservation measures as well as beneficial electrification measures. In addition, Technical Assistance rebates are available under the CEP to offset the cost of engineering and design services for qualifying projects.
Multi-Family	The Multifamily program was launched in October 2020. At launch, the Multifamily program targeted New Construction Multifamily developments. In 2021, the Multifamily Program expanded to include Existing Building Multifamily properties. The Multifamily program offers rebates for Common Area Lighting (Indoor and Outdoor), Common Area Heating and Cooling, Common Area Pool Equipment, Common Area VFDs, In-Unit Heating and Cooling, and In-Unit Appliances.

Program	Description
Energy Efficient Products	The program's objective is to increase the purchase and use of energy-efficient appliances and lighting among PSEG Long Island residential customers. The program provides rebates or incentives for ENERGY STAR® certified lighting and appliances through upstream and downstream promotions. This program also supported Beneficial Electrification measures such as heat pumps. The program supports the stocking, sale, and promotion of efficient residential products at retail locations.
Home Energy Management	Home energy reports are behavioral interventions designed to encourage energy conservation by leveraging behavioral psychology and social norms. The paper or electronic reports compare a customer's energy consumption to similar neighboring households and provide targeted tips on reducing energy use.
Home Comfort	The Residential "Home Comfort" HVAC program, formerly the Cool Homes Program, aims to reduce the energy usage of residential customers with heat pumps. The program seeks to influence PSEG Long Island customers to make high-efficiency choices when purchasing and installing ENERGY STAR ducted air-source heat pumps (ASHP), ductless mini split heat pumps, and ground source heat pumps (GSHP). Using a single application for all measures (heat pumps and weatherization), the Program seeks to promote Whole House solutions to both market and income eligible customers. The program has established strong business partnerships with heating and cooling contractors, manufacturers, and program support contractors.
Home Performance	The program serves residential customers and has two main branches: Home Performance with ENERGY STAR® and Home Performance Direct Install. The goal of the Home Performance with ENERGY STAR® Program (HPwES) is to reduce the carbon footprint of both market and income eligible customers who utilize gas, oil, or propane as a primary heat source. The Home Performance Direct Install targets customers with electric heating and includes an energy assessment and select free efficiency upgrades. After the free direct install measures are delivered, customers receive a free home energy assessment and are eligible for HPwES rebates.
Residential Energy Affordability Partnership	The program is designed for income-eligible customers and aims to save energy, provide education, help participants reduce electric bills, and make their homes healthier and safer. This program encourages whole-house improvements to existing homes by promoting home energy surveys and comprehensive home assessment services identifying potential efficiency improvements at no cost to the customer.
All Electric Homes	The All Electric Homes program is an extension of New York state policy goals to reduce reliance on fossil fuel combustion appliances in homes. This program offers incentives and rebates to developers who build single-family all-electric homes or convert existing single-family homes from fossil fuel heating and appliances to all-electric.

Program	Description
Pay for Performance	In 2022, PSEG Long Island moved to incorporate pay for performance approaches to their energy efficiency and beneficial electrification portfolio. This is designed as an alternative incentive approach that utilizes PSEG Long Island's extensive AMI technology and rewards energy savings performance at the meter. This program is currently in the RFP and piloting phases. The ultimate goal is to align payments with actual energy savings and encourage expanding EE investments across the service territory.

The remainder of the portfolio report presents the results and key findings. Section 2 summarizes the energy savings and performance. Section 3 presents the portfolio cost-effectiveness. Section 4 outlines economic impacts. Finally, Section 5 discusses trends and upcoming changes in beneficial electrification and energy efficiency planning considerations.

2 ENERGY SAVINGS AND PERFORMANCE

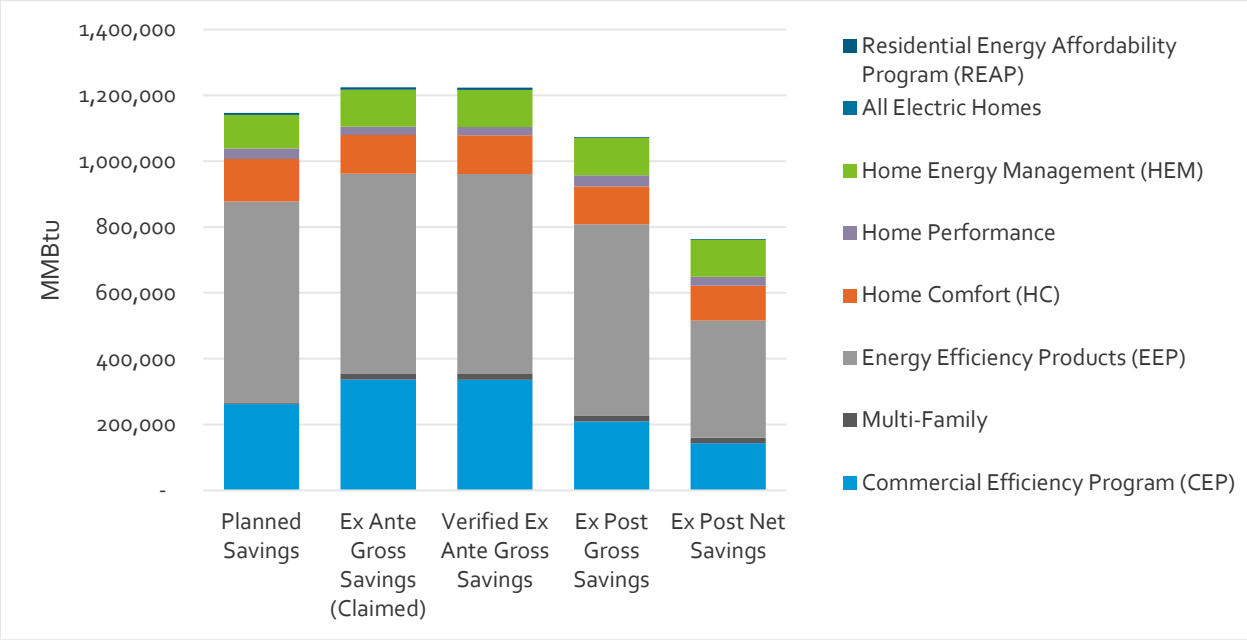
Table 2 below compares planned, claimed, verified, and ex-post gross and net savings under the primary performance metric, MMBtu. At the portfolio level, the claimed and verified ex-ante values exceeded planning targets. Implementation contractor performance is to be judged using the verified ex-ante metric. For the verified ex-ante metric, the evaluation team independently verified that the main contractor, TRC, calculated the savings consistently with the algorithms and assumptions used for planning. Results of the Verified Ex-Ante Memo can be reviewed in Appendix D.

Table 2: Summary of 2022 Energy Program Performance

Sector	Program	Planned Savings (Goals)	Ex-Ante Gross Savings (Claimed)	Verified Ex-Ante Gross Savings	Ex-Post Gross Savings (Evaluated)
		MMBtu	MMBtu	MMBtu	MMBtu
Commercial	Commercial Efficiency Program (CEP)	262,559	337,103	336,381	209,304
	Multi-Family	2,423	18,763	18,763	16,778
Residential	Energy Efficiency Products (EEP)	612,027	605,812	605,943	582,358
	Home Comfort (HC)	129,673	117,818	117,803	114,784
	Home Performance	31,917	25,113	24,783	34,049
	Home Energy Management (HEM)	101,952	113,362	113,362	113,219
	Residential Energy Affordability Program (REAP)	5,953	6,008	5,967	2,108
	All Electric Homes	560	80	79	85
Subtotal Commercial:		**264,982**	**355,867**	**355,144**	**226,082**
Subtotal Residential:		**882,082**	**868,192**	**867,938**	**846,604**
Total Portfolio:		**1,147,064**	**1,224,059**	**1,223,083**	**1,072,686**

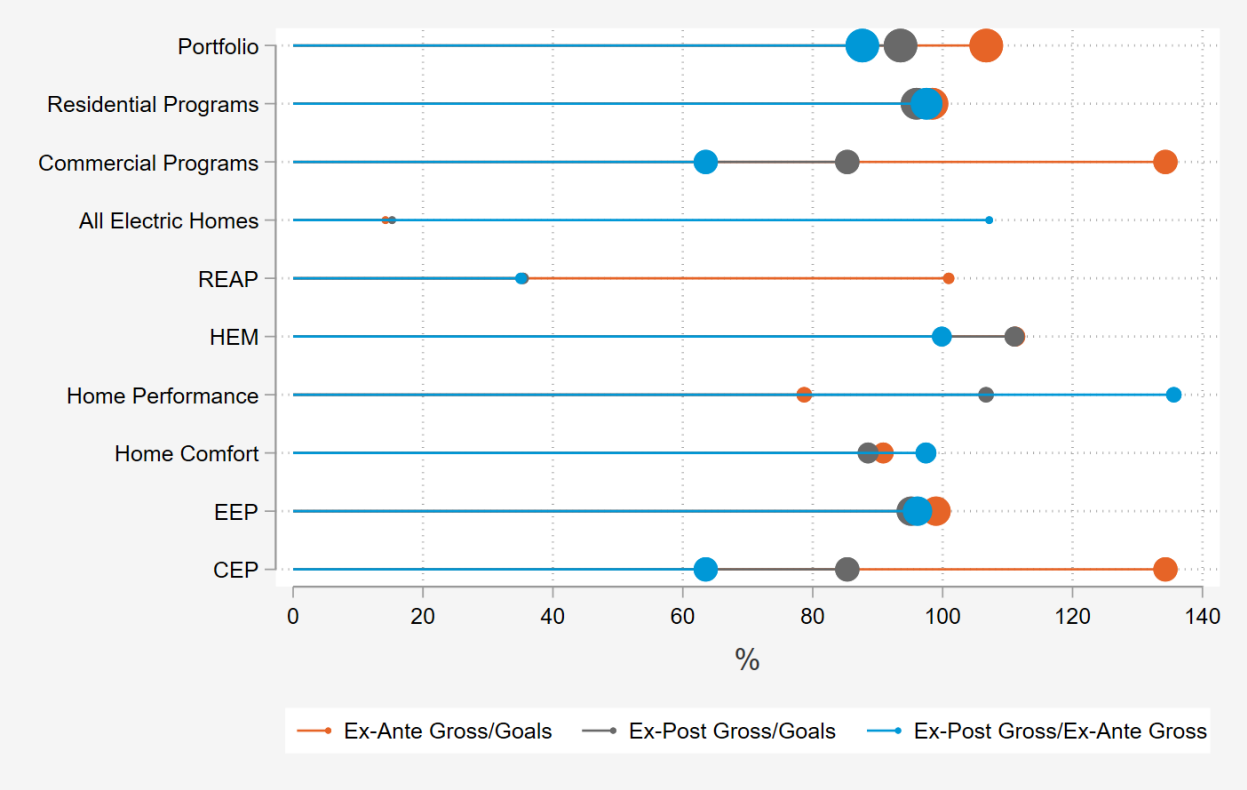
Figure 3 and Figure 4 visualize the program performance. Because the goals are based on MMBtu gross savings, the appropriate comparisons are between MMBtu planned, claimed, and ex-post gross savings. Each program section provides the energy (MWh) and peak demand (kW) savings to facilitate comparison with prior years. We caution that measures that reduce fossil fuel use, such as heat pumps and heat pump water heaters, can increase overall electricity consumption and peak demand metrics.

Figure 3: Portfolio MMBtu Savings



The ex-post results are driven by a couple of measures in the two most prominent programs, Commercial Efficiency Program (CEP) and Energy Efficient Products (EEP). Figure 4 visualizes how evaluated savings compare to claimed savings (the Realization Rate, blue bars), how evaluated savings compare to planned savings (grey bars), and how claimed savings compare to planned savings (orange bars). The size of the circle in the plots is scaled based on the goals for the program. At the portfolio level, the ex-post gross savings were 94% of planned savings. For residential programs, the ex-post gross savings was 96% of planned savings while ex-post gross savings for commercial programs was 85% of planned savings. Please note, for HEM the ratio for both the Ex-Post Gross/Goals and Ex-Post Gross/Ex-Ante Gross was 100%, so they overlap perfectly in the chart below.

Figure 4: Portfolio Performance Metrics



As Figure 4 shows, the biggest drivers of the gap between claimed and ex-post gross savings are the results for CEP and EEP. For EEP, the main driver for differences between claimed and ex-post evaluated results are LED lighting and heat pump pool heaters, a carryover issue first identified as part of the 2020 Evaluation. For CEP, the gap between claimed and ex-post gross (evaluated) savings is almost entirely driven by Golf Carts under Nonroad Electric Vehicles. In fact, differences between ex-ante and ex-post values for golf carts were the largest driver of overall portfolio Realization Rate.

Table 3 summarizes the primary reasons as to why portfolio ex-post gross (evaluated) savings departed from the planned and claimed savings. These four items led to a 143,772 MMBtu decrease between ex-ante gross and ex-post gross savings. The portfolio level difference between ex-ante gross and ex-post gross was 151,374 MMBtu. The change in the primary performance metric from electric energy (kWh) and peak demand (kW) to MMBtu required significant modifications to PSEG Long Island's planning, tracking, and reporting infrastructure. Additionally, PSEG Long Island's focus on expanding Beneficial Electrification measures has come with certain growing pains. Beneficial Electrification is new to the industry, and as a pioneer of Beneficial Electrification measures in New York, PSEG Long Island did not have the luxury of established TRMs to base measure characterizations on when developing their BE offerings. It is not unexpected that some BE measures, such as Golf Carts and Heat Pump Pool Heaters, have become the largest drivers in the overall portfolio realization rate.

Table 3: Summary of Differences between Ex-Post and Ex-Ante

Portfolio Component	Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings	Summary of Savings Difference
CEP Nonroad Electric Vehicles	▪ Ex-Post Gross < Ex-Ante Gross ▪ 108,668 MMBtu difference ▪ 12% Measure Realization Rate	▪ Electric Golf carts were the single largest driver of the overall 2022 Portfolio realization rate. ▪ The TRM methodology used for planning savings for this category dates back to 2019 but had received little scrutiny due to limited participation. TRC correctly applied the 2022 PSEG Long Island TRM methodology to 2022 projects, resulting in a VEA realization rate of 100%. During the summer 2022 as part of a continuous TRM improvement process, PSEG LI requested a review of the methodology and savings assumptions. DSA reviewed the golf cart and forklift savings algorithms and assumptions and made some changes to the methodology and parameters, including: ▪ Reduction in estimated baseline annual gasoline consumption from 799 gallons (96 MMBtu equivalent) to 120 gallons (15 MMBtu) ▪ The resulting assumption is 3,300 miles traveled annually for the gasoline and electric unit, revised from about 22,000 miles for the gasoline unit. ▪ Broader methodology update that changes the algorithm to a common miles-traveled-per-year basis with MPG and miles-per-kWh assumptions for the baseline and electric golf carts.
CEP Lighting	▪ Ex-Post Gross < Ex-Ante Gross ▪ 16,601 MMBtu difference ▪ 89% Measure Realization Rate	▪ In some of the analyzed building types, operating hours used to calculate ex-ante savings differed from values specified in the PSEG LI TRM. While the PSEG LI TRM has adopted lighting operating hours values from the NYS TRM for more than three years, TRC's commercial lighting savings calculation tools have not been consistently updated to align with the NYS TRM across all building types including: auto related, food stores, office, parking garages, and retail.

Portfolio Component	Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings	Summary of Savings Difference
EEP Lighting – Standard and Specialty LEDs	▪ Ex-Post Gross < Ex-Ante Gross ▪ 12,447 MMBtu difference ▪ 97% Measure Realization Rate	▪ Within the specialty lighting measure category, integrated fixtures and downlights were the most common product type. Evaluated savings use the actual wattage and baseline of each program supported product instead of a weighted average value based on an assumed mix. Additionally, the evaluation team uses a 50:50 blend of halogen and incandescent efficacy values to determine the baseline for integrated fixtures. This drove the overall lighting realization rate down. ▪ In the 2022 program year, much of the product claimed as Linear LEDs were non-linear integrated specialty fixtures. The distinction between the specialty LED and linear LED product category becomes incredibly important in 2023. Beginning August 1, 2023, specialty LEDs are no longer eligible to claim savings in the PSEG Long Island TRM due to changes in federal standards. Linear LEDs remain an eligible measure for all of 2023 and beyond. If PSEG Long misclassifies LED fixtures and rebates them after August 1st, this could have significant impacts on 2023 realization rates and cost-effectiveness.
EEP Heat Pump Pool Heaters	▪ Ex-Post Gross < Ex-Ante Gross ▪ 6,056 MMBtu difference ▪ 86% Measure Realization Rate	▪ In the 2020 program year evaluation, heat pump pool heaters went through much of the same scrutiny that golf carts are going through in this year's evaluation. The heat pump pool heater issues were addressed for 2022, and the observed differences come entirely from 2021 carryover projects (124 out of 1,216 HPPH projects closed in 2022).

Table 4 shows that in 2022, PSEG Long Island spent 91% of their planned budget. For Multi-Family, Home Comfort, and REAP the actual spend exceeded the planned budget, while CEP, EEP, Home Performance, HEM, and AEH had lower costs than planned. The Multi-Family program planned to complete 10 projects in the 2022 program year but completed 70 projects leading to 647% more program spending than planned.

Table 4: Energy Efficiency Portfolio Costs (Planned vs. Actual)

Sector	Program	Planned Budget	Actual Spend	Actual/Planned
Commercial	Commercial Efficiency Program (CEP)	$32,925,236	$26,751,421	81%
	Multi-Family	$250,807	$1,623,199	647%
Residential	Energy Efficiency Products (EEP)	$25,087,845	$25,139,687	100%
	Home Comfort (HC)	$12,112,950	$12,651,692	104%
	Home Performance	$4,676,225	$3,739,846	80%
	Home Energy Management (HEM)	$2,976,339	$2,072,527	70%
	Residential Energy Affordability Program (REAP)	$1,458,692	$1,495,134	102%
	All Electric Homes	$49,944	$18,943	38%
Subtotal Commercial:		$33,176,043	$28,374,620	86%
Subtotal Residential:		$46,361,994	$45,117,829	97%
Total Energy Efficiency Portfolio:		**$79,538,038**	**$73,492,449**	**92%**

3 COST-EFFECTIVENESS

Cost-effectiveness analysis is a widely applied tool designed to allow for direct comparison across resource options and to provide a basis for prioritizing investments. The main goal is to facilitate a more efficient allocation of resources by using a common metric – net benefits or the benefit-cost ratio – to compare alternative options. Decision-makers typically apply cost-effectiveness analysis on a forward-looking basis to investments with significant upfront costs but with benefits that accrue over multiple years. It also requires a pre-specified perspective (e.g., societal, utility, program participant, non-participating ratepayer) since different parties can view the same outcome differently.

In this report, however, cost-effectiveness is applied retrospectively to answer the following questions:

- Were the 2022 energy efficiency and beneficial electrification activities and investments cost-effective in retrospect?
- How did cost-effectiveness vary by program?
- How sensitive are cost-effectiveness results to key inputs?

Typically, cost-effectiveness analysis focuses on whether specific policies or programs lead to overall improvements in welfare for society – whether benefits outweigh costs. When benefits outweigh costs, all relevant stakeholders could be made better off through appropriate redistribution. However, policies and programs often produce winners and losers. What counts as a benefit and as a cost often depends on the test perspective. For example, lower prices are typically favorable from a customer's perspective but can mean reduced profit margins from a producer's perspective. A widely accepted industry practice is to assess energy efficiency and demand response programs from multiple perspectives. Depending on the perspective, certain benefits do or do not accrue, and costs under one viewpoint can be viewed as transfers from another.

In New York, the primary metric for screening portfolios for cost-effectiveness is the Societal Cost Test (SCT), which includes benefits accrued to New York as a whole. The perspective enables New York to factor in the avoided costs of energy production and delivery and carbon impacts. It also enables the inclusion of beneficial electrification technologies that increase electricity use but lead to overall lower energy consumption or reduced carbon impacts by shifting energy use from fossil fuels (fuel oil, propane, and natural gas) to electricity. Finally, the SCT considers the full incremental measure costs.[2]

Consistent with PSEG Long Island's Benefit-Cost Analysis (BCA) Handbook, we applied the SCT test as the primary method of determining cost-effectiveness. We also ensured that key assumptions including avoided costs, discount rates, and line losses match those used for PSEG Long Island's latest Utility 2.0 filing.

[2] Incremental costs are defined as the efficient measure cost (including labor) minus the equipment and labor costs of any baseline measure(s) that would otherwise have been installed. In the few cases where incentives surpass incremental costs, the incentive cost is included in the Societal Cost Test rather than the incremental measure cost.

In addition, all calculated benefits and cost benefit ratios reflect net impacts. Net impacts are the change in energy consumption or demand that results directly from program-related actions taken by customers (both program participants and non-participants) that would not have occurred absent the program. The difference between the gross and net impacts is the application of the net-to-gross ratio (NTGR). Net impacts presented in this report also include line losses and, therefore, represent the energy and demand savings as would be measured at the generator.

The critical driver of portfolio SCT ratio and net benefit changes in 2022 compared to prior years was:

- **Change in Lighting EUL from 20 years to 15 years:** The estimated useful life of lighting was decreased from 20 years to 5 years in the NYS TRM and PSEG Long Islands TRM to accommodate the updated EISA standards which made LED lighting the baseline starting July 2023. The decrease in lighting EULs decreased the SCT for EEP and REAP programs, which both had a large lighting component in 2022. If the lighting EUL had stayed at 20 years, the portfolio SCT ratio would be 1.93.

3.1 COST-EFFECTIVENESS RESULTS

Table 5 presents the benefit-cost results for the portfolio and for each program using the primary Societal Cost Test perspective. The portfolio-level SCT values are 1.22 and 2.13 for Commercial and Residential Energy Efficiency programs, respectively. The full energy efficiency portfolio SCT value is 1.71. From a societal perspective the Energy Efficiency and Beneficial Electrification Portfolio is cost-effective. The Commercial subtotal is close to 1.0 and the Residential program subtotal is well over 1.0 (a benefit/cost ratio greater than 1 indicates that portfolio benefits outweigh costs).

Table 5: Societal Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$39,280	$35,032	1.12
	Multi-Family	$4,383	$3,202	1.37
Total Commercial Portfolio:		$43,663	$38,234	1.14
Residential	Energy Efficient Products	$53,866	$36,345	1.48
	Home Comfort	$41,108	$22,747	1.81
	Residential Energy Affordability Partnership	$329	$1,495	0.22
	Home Performance	$7,666	$7,507	1.02
	All Electric Homes	$39	$38	1.02
	Home Energy Management	$3,324	$2,073	1.60
Total Residential Portfolio:		$106,333	$70,204	1.51
Total Portfolio[1]:		**$149,996**	**$110,311**	**1.36**

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

Figure 5 shows SCT ratios for each program. Note that the size of markers are proportional to the planned MMBtu savings for each program. The SCT ratio was less than 1.0 for only the REAP program, though the reasons for the change in SCT relative to prior years vary by program. Some key observations are:

- **CEP**: The SCT ratio for CEP is 1.12 in 2022 compared to 1.22 in 2021. Because it is close to 1.0, all inputs have the potential to tip the outcome. SCT results for the CEP are driven substantially by incremental costs which are largely a function of project costs. However, the project costs are high relative to energy savings compared to the rest of the portfolio. These higher costs lead to a lower SCT ratio for CEP compared to other programs. Relative to 2021, the levelized costs for energy for the measures in the CEP portfolio increased dropping the SCT ratio to 1.12.
- **Multi-Family:** The SCE ratio for Multi-Family is 1.37.
- **EEP:** The SCT ratio for EEP is 1.48 in 2022, a large decrease over the 3.43 ratio from in 2021. Despite this drop, EEP was one of the most cost-effective program in the portfolio for 2022. The reason for this drop lies primarily with lighting EULs. In 2021, the lighting EUL was 20 years, and this dropped to 5 years in 2022 as a result of the EISA LED standards. This matches the 2022 PSEG Long Island TRM. As a whole, the role of lighting is expected to diminish as LEDs are required under changing federal standards.
- **Home Comfort**: The SCT ratio for Home Comfort is 1.81 in 2022 compared to 1.66 in 2021. In 2022 the avoided costs of natural gas and fuel were updated resulting in higher values associated with these fuels. This could lead to an increase in SCT.

- **REAP**: The SCT ratio for REAP is 0.22 in 2022 compared to 0.74 in 2021. Like EEP, the lighting EUL dropped from 20 years to 5 years. Lighting is 42% of the REAP program's impacts. Cost-ineffectiveness is not unusual for income-qualified programs, which typically are not required to be cost-effective. In section 5.7, we discuss additional non-utility impacts that can potentially be incorporated into cost effectiveness as low-income benefits.
- **Home Performance**: The SCT for Home Performance is 1.02 in 2022. The ratio has been close to 1 since 2020. These are long term, capital intensive investments in the home, and as a result, so a SCT ratio around 1 is expected.
- **All Electric Homes:** The SCE for AEH is 1.02. 2022 is the first year that the All Electric homes was evaluated.
- **HEM**: The SCT is 1.6 in 2022 compared to 1.07 in 2021. The cost effectiveness increased relative to 2021 due to a relative increase in per customer MMBtu impact. Additionally, program costs decreased substantially, while savings and benefits increased.

Figure 5: Societal Cost Test Ratios by Program

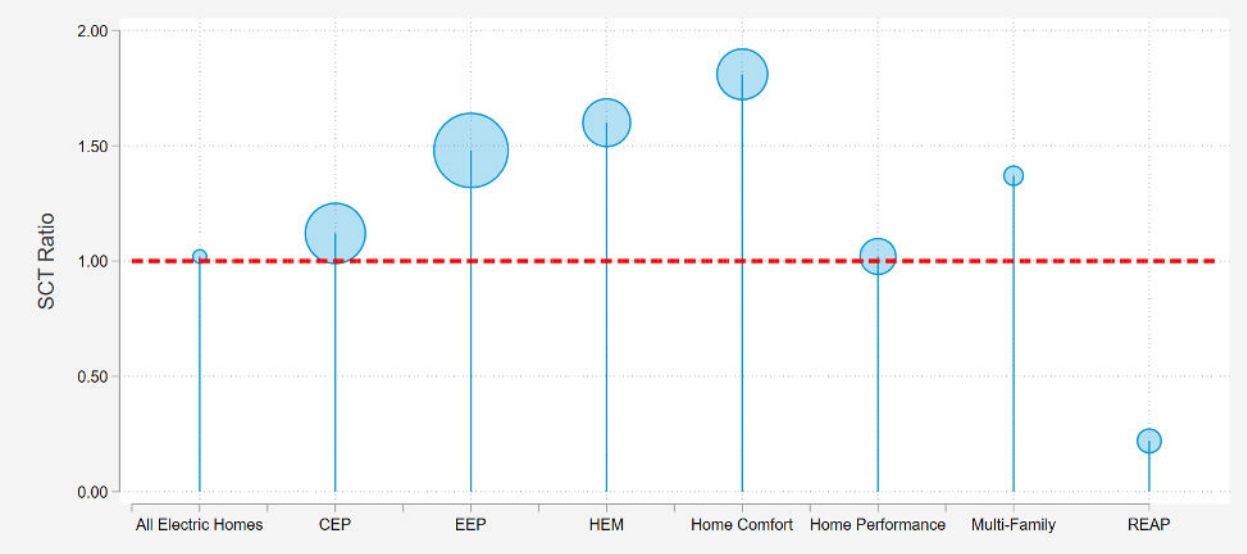
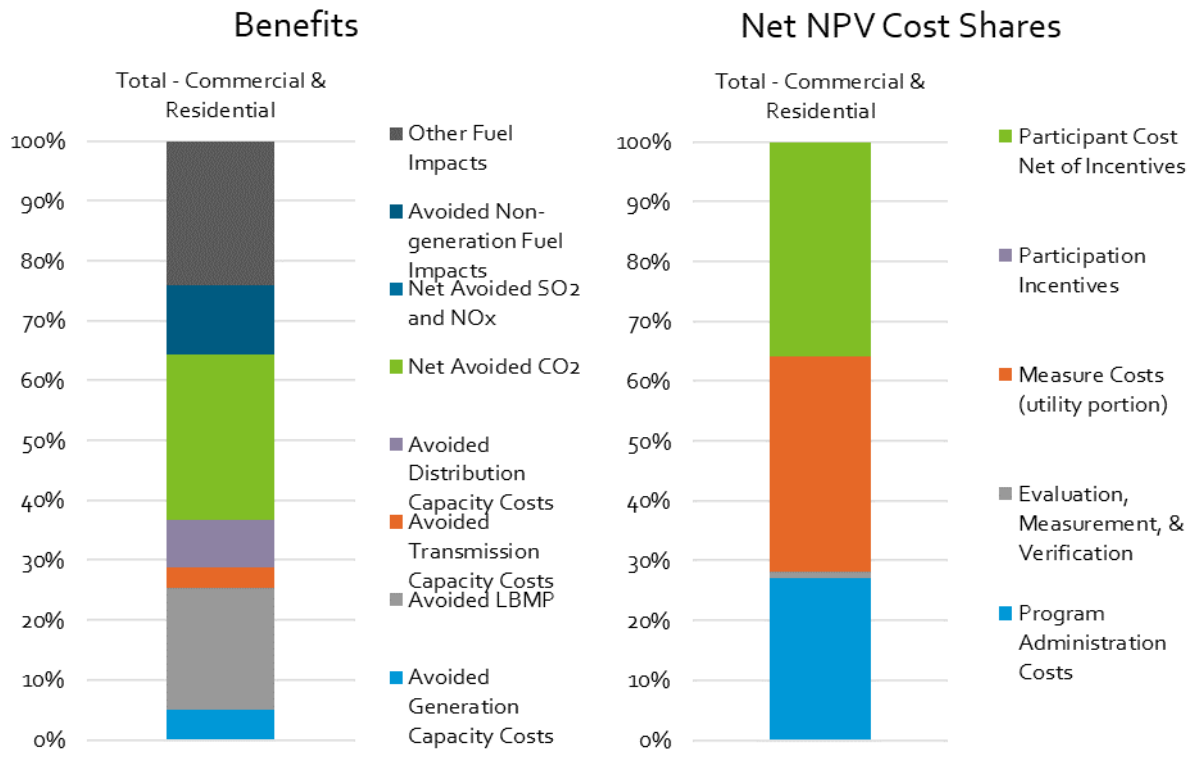


Figure 6 summarizes the benefit and cost categories analyzed and the share each contributed to the SCT. The primary two benefits for the SCT are avoided carbon emissions at 28% of benefits[3,4], and other fuel impacts at 24% of benefits. The combined benefits for capacity (generation, transmission, distribution) together comprise about 16% of societal benefits. From a societal perspective, the largest two cost categories are the measure costs borne by participants and the measure costs borne by the utility in the form of customer rebates and contractor incentives. Both account for 36% of the Net NPV

[3] Carbon emission rate for electricity based on DPS "Order Adopting a Clean Energy Standard". http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=15-e-0302
[4] Carbon and particulate emission rates for fuels based on EPA AP-42 Quantification. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

Cost Shares. Together these two categories comprise the full incremental cost of efficiency measures over baseline measures. Program administration costs, including utility labor, advertising, and implementation vendor fees, comprise about 27% of societal costs.

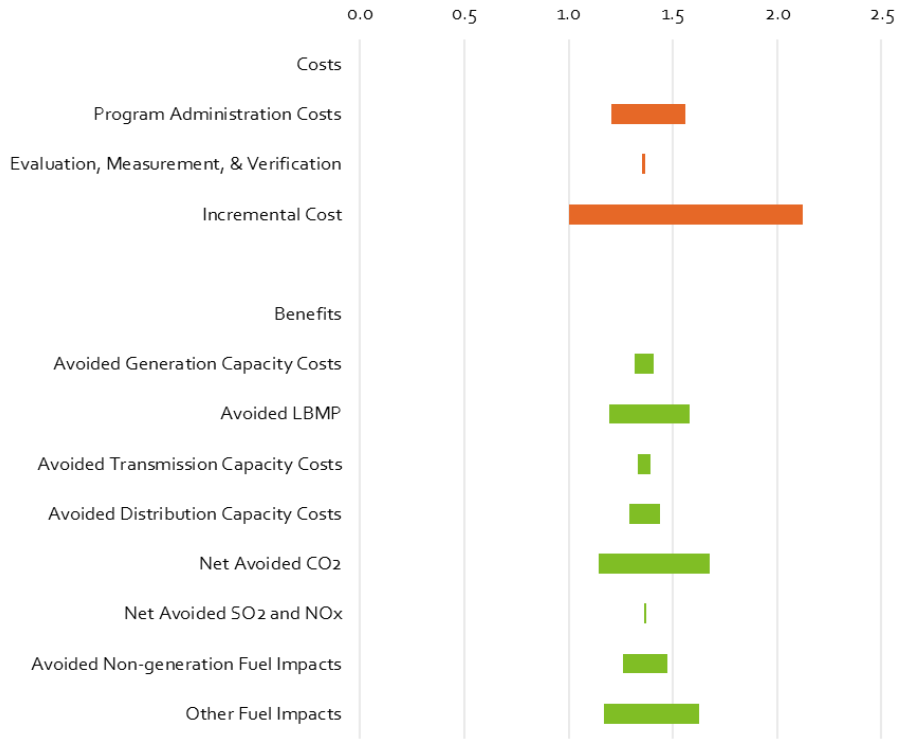
Figure 6: Portfolio Net Present Value Benefit and Cost Shares by Category



3.2 SENSITIVITY ANALYSIS

When considering the prospective implications of a cost-effectiveness analysis, it is important to assess how sensitive results may be to assumptions about cost and benefit inputs. Figure 7 shows the range of portfolio SCT ratios when each cost and benefit category is independently varied up and down by 50%. For example, if incremental costs were 50% higher the portfolio SCT would be about 1.00, but if incremental costs are 50% lower, the portfolio SCT ratio would be about 2.12. Similarly, if the avoided cost of carbon was 50% lower, the portfolio SCT would be 1.14, but if avoided carbon costs were 50% higher, the portfolio SCT ratio would be 1.68. The sensitivity analysis demonstrates that cost-effectiveness results are primarily driven by incremental cost assumptions, followed by administrative costs, other fuel impacts, and avoided carbon costs. The finding is logical given that these components comprise the largest shares of costs and benefits, respectively.

Figure 7: Efficiency Portfolio SCT Ratio Sensitivity to +/-50% Changes in Costs & Benefits



In addition to varying cost and benefit inputs up and down, an additional sensitivity analysis was conducted to explore the effects of declining carbon intensity of the power supply. As the electric generation mix decarbonizes, every MWh saved produces fewer avoided tons of CO_2. This means that it will be somewhat less cost-effective to save the same unit of electricity, holding all else constant. Conversely, every additional MWh consumed results in less CO_2 emitted than would have been the case at a higher emissions rate. This means that it will be somewhat more cost-effective to deploy beneficial electrification measures which result in increased electricity consumption.

The marginal carbon emissions rate is constant over time in the base scenario analysis. To explore sensitivity to declining emissions, marginal emissions were decreased annually to reach the carbon emissions rate implied by reaching the 70% renewables by 2030 goal of the Climate Leadership and Community Protection Act.[5] Table 6 shows the program and portfolio societal cost test results for this sensitivity scenario. The SCT ratio dropped from 1.36 to 1.29. On a relative basis, this drop is much smaller compared to last year. This is expected as beneficial electrification measures become more prevalent in the portfolio and the assumed marginal carbon emissions decrease. For example, programs relying primarily on energy savings show modestly lower SCT ratios. In contrast, the Home Comfort program and All Electric Homes program, which relies primarily on beneficial electrification, shows a modest increase in the SCT.

[5] https://climate.ny.gov/Our-Progress

Table 6: Societal Cost Test Results for Declining Emissions Sensitivity

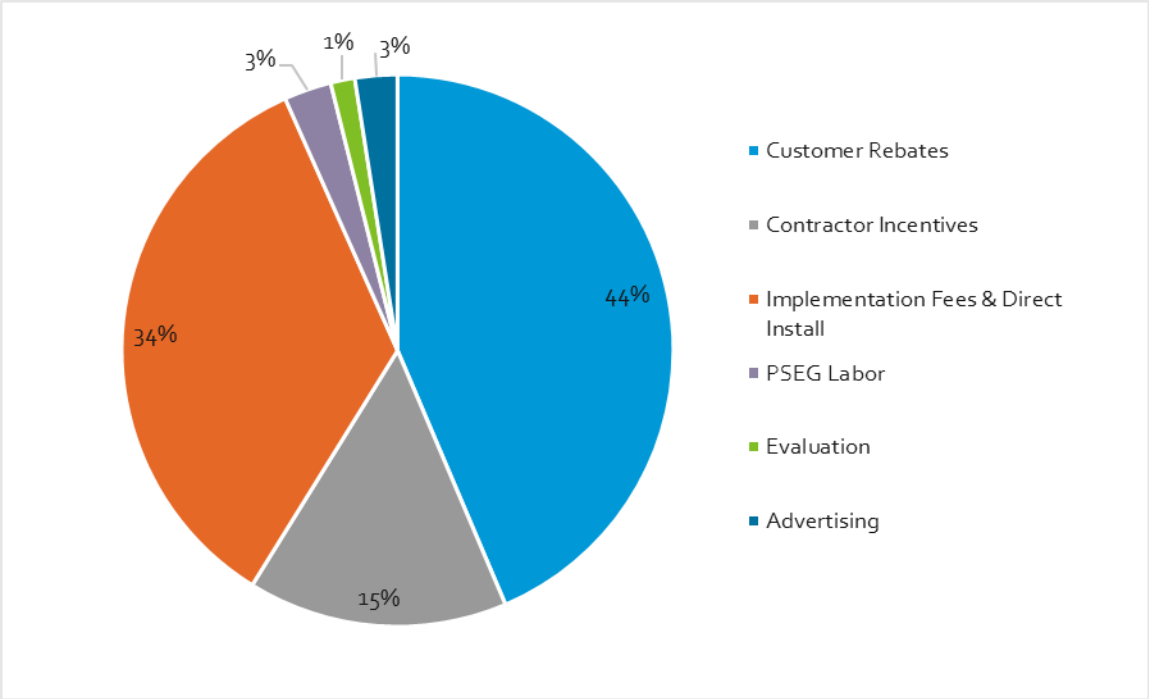
Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$33,552	$35,032	0.96
	Multi-Family	$4,249	$3,202	1.33
Total Commercial Portfolio:		**$37,801**	**$38,234**	**0.99**
Residential	Energy Efficient Products	$50,584	$36,345	1.39
	Home Comfort	$42,570	$22,747	1.87
	Residential Energy Affordability Partnership	$296	$1,495	0.20
	Home Performance	$7,392	$7,507	0.98
	All Electric Homes	$40	$38	1.04
	Home Energy Management	$3,324	$2,073	1.60
Total Residential Portfolio:		**$104,206**	**$70,204**	**1.48**
Total Portfolio[1]:		***$142,007***	***$110,311***	***1.29***

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

3.3 2022 EXPENDITURE SUMMARY

PSEG Long Island spent $75.37 million on the Energy Efficiency and Beneficial Electrification Portfolio in 2022, compared to $74.96 million in 2021. Figure 8 summarizes the $75.36 million in spending related to implementation, management, and evaluation of energy efficiency programs in the 2022 Energy Efficiency and Beneficial Electrification Portfolio by type of expenditure. Customer "Rebates" consists of payments made to participating customers. Contractor "Incentives" consists of payments made to participating contractors (e.g., heating, ventilation, and air conditioning (HVAC) installers).

Figure 8: 2022 PSEG Long Island Expenditures for the Energy Efficiency and Beneficial Electrification Portfolio



4 ECONOMIC IMPACT MODELING

Table 7 summarizes the estimated changes to Long Island's overall economic output and employment resulting from PSEG Long Island's 2022 Energy Efficiency Energy portfolio investments. Over 25 years, the 2022 investments in the Energy Efficiency Portfolio are expected to return $535.9 million in total economic benefits to the regional economy (in 2022 dollars), with an employment benefit of 973 full-time equivalent employees (FTEs)[6] over that time period.

Table 7: Economic Impact of 2022 Energy Efficiency and Beneficial Electrification Portfolio Investments

2022 Portfolio Investments		2022 Economic Impact	2022-2047 Economic Impact NPV[a]
Economic Impact	Total Economic Output	$168.8	$535.9
	Direct Effects	$159.2	$159.2
	Indirect & Induced Effects	$9.5	$376.6
	Employment FTE	478	973
Impact per $1M Investment	2022 Program Investment (Millions)	$75.4	$75.4
	Total Economic Output in Dollars per $1M Investment	$2.24	$7.11
	Employment (FTE) per $1M Investment	6.3	12.9

[a] Using nominal discount rate of 5.66%, based on PSEG Long Island Utility 2.0 filing assumptions.

Employment benefits are positively correlated to Program investment and to increased disposable income from participant energy cost savings. Program Year 2022 projected employment of 478 FTEs is comparable to 466 FTEs in Program Year 2021 and in line with the 0.58% increase in Program investment. Program Year 2022 participant energy cost savings over 25 years are projected to create 495 FTEs in addition to the 478 FTEs from Program investment, totaling 973 FTEs as shown in Table 3.

The net present value (NPV) of economic output of $535.9 equals the present value of participant energy costs savings over 25 years of $367.1 million plus the 2022 economic impact of $168.8 million from Program investments. A discount rate of 5.66% and an energy price inflation rate of 1.7% were used to calculate the NPV and participant energy cost savings and are consistent with PSEG Long Island's assumptions for supply-side planning and the cost-effectiveness analyses.

Residential lighting effective useful life (EUL) was reduced from 20 years in Program Year 2021 to 5 years in Program Year 2022. This change reduced disposable income from participant energy cost savings and the reduced the 25 year economic impact NPV from $943.6 million for Program Year 2021

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

to $535.9 for Program Year 2022. Projected employment also fell from 1,297 FTEs in Program Year 2021 to 973 FTEs in Program Year 2022 largely because of the EUL change.

5 TRENDS IN ENERGY EFFICIENCY AND BENEFICIAL ELECTRIFICATION

The Climate Leadership and Community Protection Act aims to:
Reduce Greenhouse gas emissions 40% by 2030 and 85% by 2050 below the 1990 emissions baseline.
Have 70% of energy come from renewable energy by 2030.
Achieve an energy efficiency target of 185 TBtu of cumulative site energy savings statewide.
Have 2 million climate friendly homes: 1 million electric and efficient & 1 million electrification ready.
Deploy 6 GW of Energy Storage capacity and 10 GW of solar by 2030.
Provide 35-40% of benefits of spending on clean energy and energy efficiency programs to disadvantaged communities.

New York has several sweeping and ambitious statewide clean energy goals. In 2019, the Climate Leadership and Community Protection Act (CLCPA) was signed into law. Through the CLCPA, New York is doubling down on its efforts to create a clean, resilient, and equitable energy grid. In 2022, Governor Hochul announced a plan for 2 million electrified or electrification ready homes by 2030. Meanwhile, the US Department of Energy is proposing more stringent codes and standards under the Biden administration. Changing baselines will reduce the traditional energy efficiency opportunities available to programs. This will require program administrators to be nimble regarding eligible products to ensure the PSEG Long Island portfolio continues to push market transformation. As a result, PSEG Long Island is focused on expanding renewable energy resources, further electrifying and decarbonizing their system, reducing greenhouse gas emissions, and escalating programs in disadvantaged communities.

PSEG Long Island was the first utility in the state to shift its primary performance metric to MMBtu to align with these New York targets. This new performance metric created opportunities to pursue Beneficial Electrification measures, which PSEG Long Island first introduced in their 2020 Portfolio with technology offerings like air source heat pumps, heat pump water heaters, and heat pump pool heaters. Since then, PSEG Long Island has continued to be a leader in expanding beneficial electrification measures in their service area.

The following sections walk through the implications of these statewide clean energy goals on PSEG Long Island's Energy Efficiency and Beneficial Electrification Portfolio.

5.1 A SHIFT IN TRADITIONAL ENERGY EFFICIENCY PROGRAMS

Federal and state regulators are pushing for fundamental changes in how the energy system operates. Through the CLCPA, New York has set a target of reducing greenhouse gas emissions 85% by 2050 from 1990 levels. To achieve this, utilities will be focusing on 1) increasing renewables and clean energy sources on the grid, and 2) decoupling homes and commercial buildings from fossil fuel consumption. Currently, PSEG Long Island's Energy Efficiency and Beneficial Electrification program can have the

most impact on item 2, decoupling buildings from fossil fuels. As a result, PSEG Long Island's energy efficiency programs are undergoing a necessary shift in focus. As traditional low-cost, high-impact energy efficiency measures like LED lighting become required by federal standards and phase out of program offerings, potentially higher-cost and more deep-cutting measures, such as HVAC and building envelope, will come into focus. Additionally, more emphasis will be put on beneficial electrification measures, specifically heat pumps.

5.2 ECONOMICS OF ELECTRIFICATION AND REDUCED CARBON EMISSIONS

The economics of electrification are complex, and it will be important to track the impacts of decarbonizing the grid both at the source and at site. Currently, natural gas generation is the predominant marginal generation source in downstate New York. This means that when a natural gas furnace is replaced by an electric heat pump, the primary shift is from fossil fuel combustion in the home to fossil fuel combustion at a power plant. From an emissions standpoint, this is useful because heat pumps are quite efficient at converting electricity to heat. However, as the electric generation mix includes more renewable resources on the margin, the differential in CO_2 emissions will grow considerably. In the SCT results shown in Section 3, the CO_2 emissions associated with an avoided (or added) kWh are based on the current electricity supply mix. Given aggressive climate policy goals in New York like the Climate Leadership and Community Protection Act, we expect the emissions rate of the grid to drop considerably over the next decade. As discussed in Section 3.2, a declining marginal emissions rate lowers the cost-effectiveness of energy efficiency but increases the cost-effectiveness of beneficial electrification programs.

In today's electric power system, the marginal cost of electricity is highly correlated with the cost of natural gas because natural gas is the dominant fuel source for power generation. This means global issues such as the Ukraine-Russia war affect both sides of the ledger for electrification measures because the avoided fossil fuel is more valuable, but the added electric costs are also higher. As the electric generation mix decarbonizes, the marginal cost of electricity should become increasingly decoupled from the avoided cost of fossil fuel.

The other key element in the economics of electrification is the value of avoided CO_2 emissions. The social cost of carbon is ultimately a policy decision. In 2022, avoided CO_2 emissions was the single largest benefits category, representing 28% of all SCT benefits.

- The current social cost of carbon assumed in the PSEG Long Island Cost Effectiveness evaluation is $61.78 per metric ton, or $56.05 per short ton, and the portfolio SCT is 1.36.
- In neighboring Pennsylvania, the 2021 Act 129 Total Resource Cost Test Order[7] directs utilities to set the value at $0. If PSEG Long Island used an avoided cost of carbon of zero, the portfolio SCT would decrease to 0.98.

[7] https://www.puc.pa.gov/pcdocs/1648126.docx

- Meanwhile, the Avoided Energy Supply Cost Study Group for New England recommended $128 per short ton in their 2021 Avoided Energy Supply Component (AESC[8]) report.
    - In October 2021, that study was amended[9] to recommend a social cost of carbon of $393 per short ton. Massachusetts program administrators have adopted the $393 per short ton assumption in their 2022-2024 plan for energy efficiency and demand resources.
    - At $393 per short ton, the SCT ratio for PSEG Long Island's 2022 portfolio would be 3.39.
    - At $128 per short ton, the SCT ratio for PSEG Long Island's 2022 portfolio would be 1.76.
- In December 2020, New York State's Department of Environmental Conservation (DEC) published guidance that established a central cost of carbon of $125/metric ton, roughly $113/short ton. If the avoided cost of carbon was doubled to match this guidance, the portfolio benefit cost ratio would be 1.67.

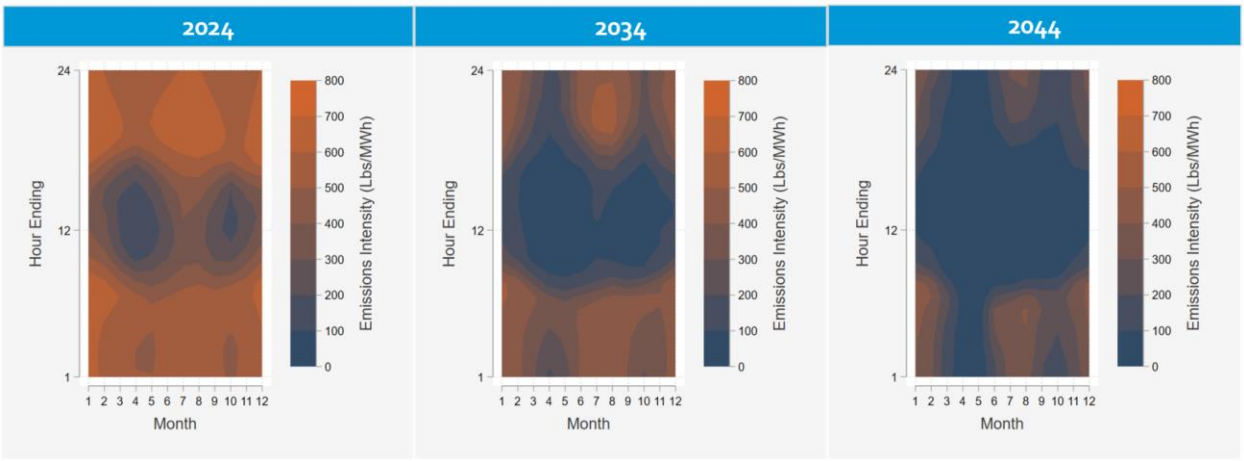
The social cost of carbon is not a technical metric, it's a policy decision. As an evaluator we cannot determine which value is correct, but we would recommend PSEG Long Island review this key assumption with LIPA. It's an important driver of cost-effectiveness results for both energy efficiency and beneficial electrification.

As described in Section 3.2, current modeling practices in New York use a marginal emission rate that is static over time. As New York completes aggressive energy transition projects the overall emissions rate of the grid will drop sharply and the differences across the year will become more pronounced. Figure 9 shows 8760 modeled emissions in a highly decarbonized future grid. As large amounts of solar generation come online, the emissions rate of the grid drops to zero in the middle of the day. The transition happens first in the shoulder months and then expands as the penetration of renewable generation and storage increases. Even in the highly decarbonized grid of 2044, there are pockets of thermal generation required in the summer and winter when loads are high relative to daily renewable generation. As New York's aggressive decarbonization efforts start to materialize, PSEG Long Island may want to consider time-differentiating its marginal emissions rate assumptions to make sure energy efficiency and beneficial programming targets offerings that will maximize emissions reductions in highly decarbonized electric grid.

[8] Avoided Energy Supply Component/Cost (AESC) report PDFs can be found here: https://www.synapse-energy.com/project/avoided-energy-supply-costs-new-england-aesc

[9] https://www.synapse-energy.com/sites/default/files/AESC_2021_Supplemental_Study-Update_to_Social%20Cost_of_Carbon_Recommendation.pdf

Figure 9: Example Emissions Profiles in a Highly Decarbonized Grid (Maryland)



5.3 INTRODUCTION OF TOU RATES

Not only will the marginal emissions rates become more time-varying, but the basic cost of electricity in PSEG Long Island's territory will soon also be time-varying. In 2022-2023, PSEG Long Island rolled out four voluntary time-of-use rates and recruited customers who were identified as structural winners – customers who benefit on time-of-use rates even if they do not change their behaviors – to enroll in one of the four TOU rates. By November 2022, PSEG Long Island enrolled over 12,000 customers. Roughly 45% were also enrolled in balanced billing plans which make monthly payments more predictable and less volatile. Thus, the voluntary enrollments help address four key questions shown in Table 8.

Table 8: Key Time-of-use Research Questions and Findings

Research Question	Finding
▪ Do customers in Long Island modify electricity use patterns in response to time-of-use rates?	▪ Customers reduced demand during higher-priced hours and increased night usage.
▪ Do structural winners modify their electricity use patterns?	▪ Yes. Structural winners changed their behavior for the opt-in evaluation. Impacts will likely be smaller for structural winners who are defaulted.
▪ Do customers on balanced billing modify their electricity use patterns?	▪ Yes. Balanced billing customers responded to incentives.
▪ Do customers with electric vehicles modify their electricity use patterns?	▪ A disproportionate share of electric vehicle owners enrolled, indicating time-of-use rates with lower overnight prices were particularly attractive to electric vehicle owners. ▪ The customer shifted use from on-peak hours to off-peak hours. Electric vehicle owners saw an average 0.94 kWh shift from on peak (4-7pm) to off-peak hours, representing a 10-12% shift.

	○ Please note, while these values are a share of home load, the patterns correspond with EVs.

The LIPA board has decided to implement default time-of-day rates for residential and commercial customers. Time-of-day rates will become the default for most Long Island residential customers in 2024. Commercial customers will default on to time-of-day rates in 2025. The default will start with structural winners and progressively roll out to the full population of eligible customers. Over 800,000 of the approximately 1 million Long Island residential customers are scheduled to be defaulted onto time-of-use rates. These rates will define higher peak prices in the mid-to-late afternoon, and discount energy prices in the off-peak hours. Once on these rates, customers will have the opportunity to save not only by reducing consumption but also by shifting when they use electricity.

Introducing default time-of-day rates creates opportunities for energy efficiency and beneficial electrification that can aid customers with the transition. Customers might have increased interest in technologies such as smart thermostats and other appliance controls which will help manage household consumption during peak pricing hours. Marketing these technologies to customers as a way to save on the new rate structure could help expand the uptake of these measures.

The introduction of time-of-use rates are expected to contribute to:

- Change the customer payback period for energy efficiency and electrification equipment. A new rate structure can change the bill savings from energy efficient or electrification equipment. This could lead to shorter payback periods for measures that reduce consumption during peak hours and longer payback periods for any electrification equipment that run during peak hours.
- It also leads to changes in customer equipment choices. While most of the focus is on short-term, behavioral price response, changes in rates can influence customer decisions regarding equipment adoption. This is often referred to as long-term price elasticity. For example, when the price of gasoline spikes, customers can only modify their driving behavior slightly in the near term, but the higher gas prices correlate with a higher share of fuel-efficient new vehicles. How electricity is priced can fundamentally alter customer's purchase decisions about energy efficiency equipment, heat pump technology, and vehicles. Recent studies conclude that the effect of electricity prices on equipment choices (long-term price elasticity) is much higher than the initial behavioral response (short-term price elasticity). A recent study from the UC Berkeley Energy Institute[10] estimated TOU long-term price elasticity to be up to 6-7 times higher than short-term price elasticity.

[10] https://haas.berkeley.edu/wp-content/uploads/WP331.pdf

- It opens opportunities for technology that enable homes to shift or modify loads. This includes smart appliances such as thermostats, water heaters, and EV chargers. All of which can be programmed to control device consumption on a time schedule.
- The change in rates will likely have a substantial effect on flexible loads, such an electric vehicles, which are expect to grow substantially. Considering the large peak to off peak pricing ratio, customers with electric vehicles have a strong incentive to charge during times of lower grid stress and, thus, lower their electricity bill.

5.4 LEADERSHIP IN NEW & EXPANDING BENEFICIAL ELECTRIFICATION MEASURES

Beneficial Electrification measures are new in the industry, and PSEG Long Island has been at the forefront of Beneficial Electrification program delivery. Being the leader comes with certain growing pains. Since beneficial electrification is new, there are few established Technical Resource Manuals (TRMs) to rely on when characterizing BE offerings. Additionally, these are more complex measure characterizations due to different units, standards, and efficiency metrics. In the evaluation of both the 2021 and 2022 program year portfolios we saw evidence of these growing pains in the heat pump pool heater and golf cart measures. The measure characterization for both had the same issue. The avoided fossil fuel consumption and increased electric consumption assumptions were not tied to a common assumption about the amount of work done annually. In this context, work can be defined as gallons of water warmed a specific number of degrees for pool heaters, miles driven for golf carts, amount of time spent mowing or blowing for lawn mowers and snow blowers. In the characterization of both golf carts and pool pumps, the fossil fuel reductions assumed more work done by the replaced fossil fuel unit than the electric replacement. We would recommend a review of all BE measures. In this review, we'd recommend focusing on assumptions regarding the amount of work needed. Then calculate the amount of energy required to do that work by an electric and fossil fuel unit and compute the difference. This could help avoid issues with this specific BE measure characterization as these technology offerings expand.

5.5 EXPANDING HEAT PUMP DEPLOYMENT

Heat pumps are a critical technology for electrification efforts. This includes heat pumps for space heating and cooling, heat pump pool heaters, and heat pump water heaters. Heat pumps use electricity to move heat in buildings and can replace technologies like furnaces or boilers that burn fossil fuel to produce heat. With advancements in heat pump technologies, homes in cold climate regions, like Long Island, can rely on the heating capabilities of heat pumps through freezing temperatures in the winter.

New York Clean Energy Goals established a goal of 30,000 Heat Pump installations on Long Island by 2030, correlating to about 1.15 TBtu of Beneficial Electrification. Additionally, New York has a statewide target of 1 million homes heated with electric heat pumps and an additional one million electrification-ready homes by 2030. For Long Island, this translates to a goal of about 125,000 homes

with whole house heat pumps by 2030 corresponding to an installation rate of about 15,000 heat pumps a year. Since first introducing heat pump rebates in 2020, PSEG Long Island has installed over 20,000 Heat Pumps. However, this includes heat pump pool heaters and heat pump water heaters. Since 2020, just over 15,000 HVAC Heat Pumps have been installed. This excludes heat pump pool heaters and heat pump water heaters. Figure 10 and Figure 11 show the cumulative distribution of heat-pumps from 2020 to 2023, highlighting the percent of homes on the feeder with a program-supported heat pump. The deeper the orange the higher the heat pump penetration. From these figures we can see that PSEG Long Island's efforts to install heat pumps are working, but that adoption is not evenly distributed across the system. This will create real implications for distribution planning. Winter electric consumption doubles on average after the installation of a whole home heat pump. At scale, across the service territory, this will start to shift loading patters on feeders.

Figure 10: Distribution of Cumulative Heat Pump Installations through 2020

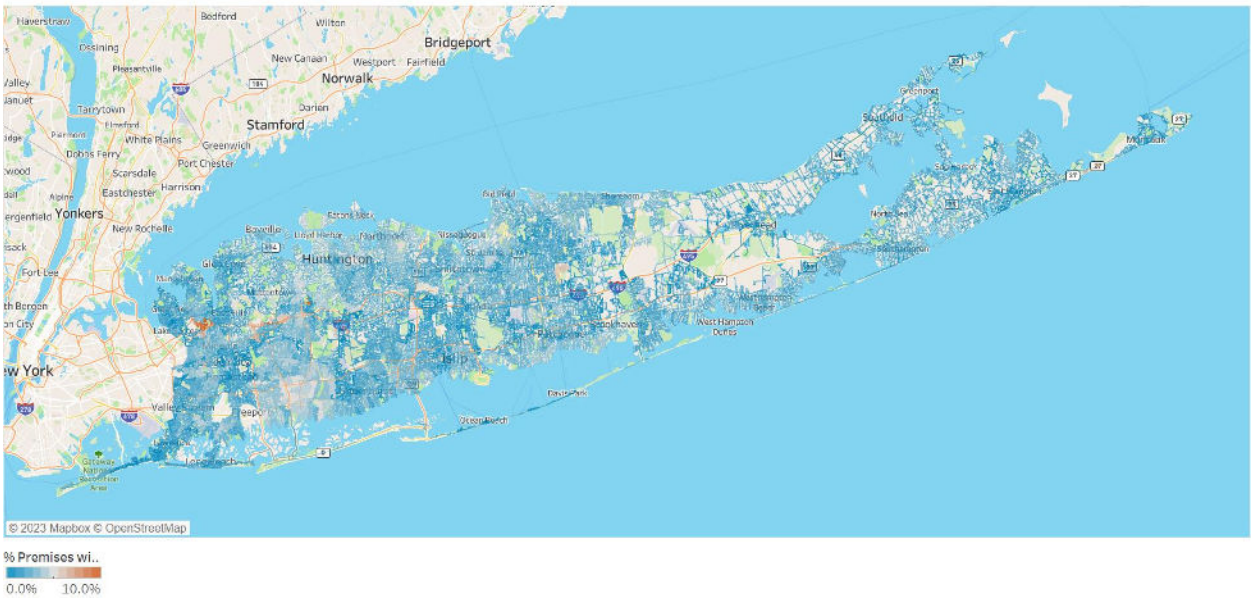
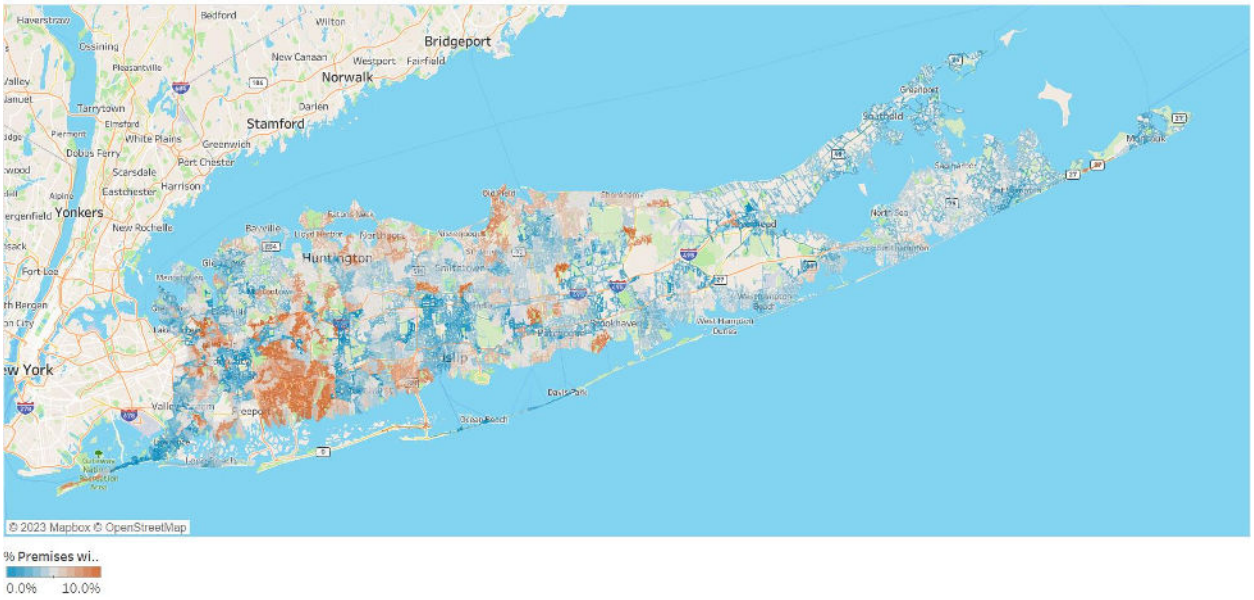


Figure 11: Distribution of Cumulative Heat Pump Installations through February 2023



There are certain barriers to overcome with the continued expansion of heat pumps. PSEG Long Island will need to work closely with contractors to improve customer awareness of whole home Air Source Heat Pumps (ASHP). Most HVAC systems will only be replaced at the end of that system's life, so it is important that HVAC contractors encourage the installation of these units when systems turn over. The need for this market availability highlights opportunities for utilities to remove perceived barriers to heat pump installations including more targeted customer marketing and education, streamlining of the financing and purchase process, and higher engagement of installation contractors.

To address these barriers for potential customers PSEG Long Island has worked on specifically targeting customers who would benefit and are more likely to install heat pumps. Additionally, they are working on developing a tool where customers may estimate the expected return on their heat pump investment. This will help expand customer familiarity and comfort with heat pump technologies. For contractors, there is an additional layer of complexity currently inherent to Heat Pumps when applying for rebates and incentives. Historically, contractors were required to conduct a Manual J load calculation as part of the install process. A Process Evaluation survey conducted by this evaluation team showed contractors found the application process to be burdensome and a major bottleneck to delivering heat pumps. A large portion of this burden falls in the Manual J calculations. Since then, PSEG Long Island added a midstream heat pump measure to its 2024 TRM. This will allow PSEG Long Island to move away from the Manual J requirement and have an impact on the heat pump market further upstream.

5.6 LIGHTING PHASE OUT

Residential LED lighting measures in the EEP contributed 450,306 MMBtu for ex-post gross energy savings in 2022. This represents 53% of all residential savings and 42% of portfolio savings. Program administrators like PSEG Long Island have had enormous success transforming the residential lighting market over the past decade and making LED products the default lighting option on most store shelves. However, the program opportunity for LED lighting measures is closing due to changes in federal standards which effectively eliminate non-LED products from the market.

In April 2022, the US Department of Energy released its final rulemaking regarding the Energy Independence and Security Act (EISA) backstop provision. This standard establishes a baseline efficiency requirement of 45 lumens per Watt for most categories of general service light bulbs (A-lamps, reflectors, globes, candelabra) and effectively prohibits the sale of non-LED lamps. In an Enforcement Policy Statement,[11] the DOE lays out the timeline shown in Figure 12. This change drastically reduces the programmatic savings available to PSEG Long Island from residential lighting within EEP.

[11] https://www.energy.gov/sites/default/files/2022-04/GSL_EnforcementPolicy_4_25_22.pdf

Figure 12: EISA Backstop Enforcement Timeline

Without the LED lighting component of EEP, the SCT ratio of the PSEG Long Island Portfolio is 1.26 (vs. 1.36). The EEP program SCT drops dramatically from 1.48 with lighting to 1.12 without lighting, but the program would remain cost effective from a societal standpoint even without lighting. Not only is LED lighting the largest contributor of savings, but it is also the lowest cost measure in terms of program expenditure per unit of energy saved. There simply is not another measure in the residential portfolio to fill the vacuum. If residential spending stays constant the expected annual savings will go down without lighting. It's unclear whether historic levels of residential savings are achievable without LED lighting, even with a large increase in budget.

CEP lighting is largely unaffected by the EISA backstop due to the retrofit nature of the program and the limited role of screw-based lighting in the commercial sector. Linear LEDs in the residential sector are also eligible after August 2023 so the distinction between the specialty LED and linear LED product category becomes incredibly important. The 2022 evaluation found that almost 90% of the 126,000 products claimed under the linear LED measure code were misclassified downlight or ceiling mount fixtures. If PSEG Long misclassifies non-linear LED fixtures and rebates them after August 2023, this could have significant impacts on 2023 realization rates and cost-effectiveness. We recommend a detailed review of product categorization prior to August to ensure program dollars are not used on ineligible lighting products.

5.7 EMPHASIS ON DISADVANTAGED COMMUNITIES

New York's Climate Leadership and Community Protection Act (CLCPA) established that utilities are to ensure that at least 35% of the benefits of spending on clean energy and energy efficiency programs go to disadvantaged communities, with an ultimate goal of 40%. This goal is proving to be a major factor in shaping future Portfolio planning efforts. Already for the 2023 program year, PSEG Long Island has more than doubled the budget of their collective LMI offerings under the Home Performance, REAP, and Home Comfort Programs increasing planned spending from about $5 million in 2022 to $12.35 million in 2023. The Climate Justice Working Group has been working on finalizing criteria for identifying Disadvantaged Communities (DACs) and low-income households for over a year. The final criteria were voted on and approved on March 27, 2023, and these guidelines have not yet been released. Previous iterations of low income definition guidelines utilized both census track indicators and income limits based on the statewide median income to define DACs and LMI households. The CLCPA set the limit at 60% of the state median income to qualify a customers as low income. Under these criteria, just 25% of Long Island households are flagged in DACs or as low-income households. Long Island may be the only region in the state with less than 35% of households qualifying under these conditions.

Historically, REAP program income standards qualified customers with income at or below 80% of the area median income. For the 2023 program year, this standard has been updated to 80% of the state median income, likely decreasing the pool of eligible REAP customers. Additionally, since the CLCPA is set at 60% of the state median income, this identified the REAP program as a low-to-moderate income program, so not all participants will be counted towards the CLCPA goals. A smaller target population presents significant challenges with meeting the standards established in the CLPCA. PSEG Long Island is already focusing on ways to effectively target these communities by specifically identifying customers who are likely low income, who live in DAC communities, or households that with higher energy use intensities. These customers will likely benefit most from EE and BE interventions. With these challenges also come opportunities to explore additional, non-utility system impacts and benefits that low income programs bring to the community. Non-utility system impacts can cover categories such as health, safety, comfort, operations and maintenance costs, energy security, and others. Massachusetts PAs explored non-utility system impacts of low-income programs in depth in a 2016 study[12]. This study applied monetary benefits to NEIs including:

- Reduced asthma symptoms,
- Reduced cold- and heat-related thermal stress,
- Fewer missed days at work,
- Reduced use of short-term, high-interest loans,
- Reduced CO poisoning,

[12] Massachusetts Special and Cross-Cutting Research Area: Low Income Single-Family Health- and Safety-Related Non-Energy Impacts Study. Prepared for Massachusetts Program Administrators by Three-Cubed and NMR Group, Inc. August 5, 2016. https://ma-eeac.org/wp-content/uploads/Low-Income-Single-Family-Health-and-Safety-Related-Non-Energy-Impacts-Study.pdf

- Increased home productivity,
- Reduced home fires.

The National Standard Practice Manual for Benefit-Cost Analysis (NSPM)[13] includes NEI consideration as part of their 5-step process. We would recommend that PSEG Long Island consider incorporating non- energy impacts into their benefit-cost analysis. There are certain challenges in both quantifying these benefits and assigning monetary values to these benefits. New Jersey has started to explore the possibility of adding NEIs to their cost tests as percent adders in an extensive review of adders included in other States' cost tests published March 2023[14]. However, given the emphasis on LMI programming in New York, we recommend PSEG Long Island and LIPA consider inclusion of some additional LMI-specific benefit streams. This would help capture a more rounded picture of the benefits realized by low-income households and improve performance towards your benefits-based LMI requirement.

Historically, PSEG Long Island's REAP program focused on energy efficiency measures such as lighting and power strips. Already, PSEG Long Island has incorporated LMI and income eligible offerings through their Home Comfort and Home Performance Programs. Through these programs, income eligible customers can receive higher incentives on measures such as heat pumps. Additionally, PSEG Long Island is looking to expand REAP offerings into beneficial electrification. Including heat pumps, heat pump water heaters, weatherization, and other more deep-cutting measures will largely increase overall costs of REAP program implementation for relatively fewer MMBtu impacts per dollar in addition to the large effort necessary to identify and engage with customers that qualify under new and more limiting income standards.

[13] NSPM for Benefit-Cost Analysis of Distributed Energy Resources: https://www.nationalenergyscreeningproject.org/wp-content/uploads/2020/08/NSPM-DERs_08-24-2020.pdf
[14] Non-Energy Benefits/ Non-Energy Impacts (NEBs/NEIs): Analysis of Alternatives for Updates for the State of New Jersey: https://www.njcleanenergy.com/files/file/BPU/2023/Energy%20Efficiency%20Triennium%202%20Non-Energy%20Benefits%20Memo%20(2023).pdf

APPENDIX A ABBREVIATIONS

ASHP	Air-source heat pump
BTU	British Thermal Unit
CEP	Commercial Efficiency Program
CF	Coincidence Factor
CHP	Combined Heat and Power
CLCPA	Climate Leadership and Community Protection Act
DER	Distributed Energy Resource
DHW	Domestic hot water
EEP	Energy Efficiency Products
EISA	Energy Independence and Security Act
EPA	U.S. Environmental Protection Agency
FR	Free Ridership
FTE	Full-Time Equivalent Employees
GSHP	Ground-source heat pump
HEM	Home Energy Management
HER	Home energy report
HPwES	Home Performance with Energy Star
kW	Kilowatt
kWh_{ee}	Kilowatt Hour Energy Efficiency
kWh_{be}	Kilowatt Hour Beneficial Electrification
kWh	Kilowatt Hour
MMBtu	Million British thermal unit
$MMBtu_{ee}$	Million British thermal unit Energy Efficiency
$MMBtu_{be}$	Million British thermal unit Beneficial Electrification
LED	Light-Emitting Diode
LIPA	Long Island Power Authority
LMI	Low- to moderate-income
NEB	Non-Energy Benefit
NTGR	Net-to-Gross Ratio
NYSERDA	New York State Energy Research and Development Authority
RIM	Ratepayer Impact Test
REAP	Residential Energy Affordability Partnership
REV	Reforming the Energy Vision
SCT	Societal Cost Test
SO	Spillover
TRM	Technical Reference Manual
UCT	Utility Cost Test
VEA	Verified Ex -Ante
VFD	Variable frequency drive

APPENDIX B ELECTRICITY ENERGY (MWH) AND DEMAND SAVINGS (KW)

Although the primary reporting metric for 2022 evaluation results is on total site-level MMBtu savings for consistency with goals, we also report fuel-specific results for several reasons.

- PSEG Long Island is an electric utility, so the MWh and kW impacts of the Portfolio have discrete implications for a host of forecasting and system planning functions.
- Consistency with prior reports. We believe it is important for readers to have the ability to compare the results of the 2022 evaluation with prior evaluations.
- While site-level MMBtu is useful as a single metric for all conservation programming, the benefit-cost analysis requires us to keep track of resources separately. The avoided cost of one delivered MMBtu of electricity is much higher than the avoided cost of one MMBtu of fossil fuel. The emissions per MMBtu also vary by resource because generators combust 2-3 MMBtu of fossil fuel to generate power[15] to deliver one MMBtu of electricity to a Long Island home.

While the evaluation team elected to report fuel-specific results, we highlight that due to beneficial electrification, measures that reduce fossil fuel use but increase electricity consumption and demand, some program MWh and kW impact results report negative electricity savings.

[15]The marginal unit in downstate New York will typically be a combined-cycle natural gas plant or a natural gas combustion turbine. According to EIA data https://www.eia.gov/electricity/annual/html/epa_08_02.html the average heat rate of these two generator types are 7,633 Btu/kWh and 11,098 Btu/kWh respectively. This translates to a thermal efficiency of 44.7% and 30.7%.

Table 9: Total Energy Efficiency and Beneficial Electrification Program MWh Impacts

Sector	Energy Efficiency Program	Ex-Ante Gross Savings (Claimed[1])	Ex-Post Gross Savings (Evaluated)	Ex-Post Net Savings
		MWh	MWh	MWh
Commercial	Commercial Efficiency Program	66,275	59,122	42,350
	Multi-Family Program	1,449	1,042	1,105
Residential	Energy Efficiency Products	217,328	210,158	124,737
	Home Comfort	(8,059)	(9,726)	(9,438)
	Home Performance	735	1,040	829
	Home Energy Management	33,225	33,183	35,177
	Residential Energy Affordability Program	2,168	692	733
	All Electric Homes	(0.008)	2	(2)
Subtotal Commercial:		67,724	60,164	43,455
Subtotal Residential:		245,397	235,347	152,037
Total Energy Efficiency Portfolio:		**313,122**	**295,511**	**195,492**

[1] MWh Ex-Ante Gross Savings (Claimed) in table might not match KPI scorecard values. Table values include all Energy Efficiency Savings as well as negative MWh savings from Beneficial Electrification, while KPI scorecard reports Energy Efficiency Savings only.

Table 10: Total Energy Efficiency and Beneficial Electrification Program kW impacts

Sector	Energy Efficiency Program	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings (Evaluated)	Ex-Post Net Savings
		kW	kW	kW
Commercial	Commercial Efficiency Program	12,383	13,135	9,529
	Multi-Family Program	328	355	383
Residential	Energy Efficiency Products	16,257	29,568	17,779
	Home Comfort	465	400	411
	Home Performance	580	684	565.58
	Home Energy Management[1]	n/a	8,996	9,693
	Residential Energy Affordability Program	400	105	113
	All Electric Homes	2	2	1
Subtotal Commercial:		12,711	13,490	9,912
Subtotal Residential:		26,525	39,754	28,563
Total Energy Efficiency Portfolio:		**39,236**	**53,244**	**38,475**

[1] HEM kW savings are not claimed by PSEG-LI.

APPENDIX C ADDITIONAL COST-EFFECTIVENESS PERSPECTIVES AND METRICS

In New York, the primary metric for screening portfolios for cost-effectiveness is the Societal Cost Test (SCT), which includes benefits accrued to New York as a whole. The perspective enables New York to factor in the societal benefits of reduced emissions as well as the avoided costs of energy production and delivery. It also enables the inclusion of beneficial electrification technologies that increase electricity use but lead to overall lower energy consumption or reduced carbon impacts by shifting energy use from fossil fuels (fuel oil, propane, and natural gas) to electricity.

UTILITY COST TEST RESULTS

We also report the Utility Cost Test (UCT).[16] The tests are similar in most respects but consider slightly different benefits and costs in determining a benefit/cost ratio. The UCT measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the program administrator, including all program costs and any rebate and incentive costs, but excludes costs incurred by the participant. The UCT only includes benefits that accrue to the utility and therefore does not include the benefits of non-electric (i.e., gas and fuel oil) energy savings or increases, or emissions of carbon or particulates. Because both costs and benefits are different than those considered from the societal perspective, the UCT benefit-cost ratio is also different.

As shown in Table 11, the UCT was 0.73 for the Energy Efficiency and Beneficial Electrification Portfolio. This indicates that the portfolio is not cost-effective from the utility perspective. Notably, the Home Comfort UCT ratio is negative, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, the net benefits from the utility perspective are negative. While electrification produces societal benefits in the form of reduced carbon emissions and reduced non-electric fuel consumption (e.g., natural gas and fuel oil), it increases electricity consumption to serve the newly electrified end uses. From the perspective of an electric utility, such as PSEG Long Island, the increased electricity costs are not offset by fuel and carbon reductions which only accrue from the societal perspective. Table 12, displays this point further by showing what the UCT ratio is when Beneficial Electrification Measures are removed from the UCT. Without Beneficial Electrification measures, the portfolio UCT becomes cost effective at a ratio of 1.05. In contrast, the Home Comfort SCT ratio is 1.81 indicating that from the societal perspective benefits do outweigh costs associated with this program comprised primarily of electrification measures.

In addition to the influence of increasing beneficial electrification, the reduction of Lighting EULs was a major driver in the UCT ratio for 2022. The lighting EUL decreased from 20 years to 5 years for the EEP and REAP programs. If the lighting EUL remained at 20 years, the UCT ratio would be 1.37 including Beneficial Electrification which is similar to the 2021 UCT ratio of 1.43.

[16]The Utility Cost Test is also commonly known as the Program Administrator test.

Table 11: Utility Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$23,660	$26,751	0.88
	Multi-Family	$777	$1,623	0.48
Total Commercial Portfolio:		$24,437	$28,375	0.86
Residential	Energy Efficient Products	$29,014	$25,140	1.15
	Home Comfort	-$2,228	$12,652	-0.18
	Residential Energy Affordability Partnership	$215	$1,495	0.14
	Home Performance	$1,278	$3,740	0.34
	All Electric Homes	$2	$19	0.12
	Home Energy Management	$2,263	$2,073	1.09
Total Residential Portfolio:		$30,544	$45,118	0.68
Total Portfolio[1]:		**$54,981**	**$75,366**	**0.73**

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

Table 12: Utility Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio without Beneficial Electrification Measures

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$23,982	$22,859	1.05
	Multi-Family	$777	$1,623	0.48
Total Commercial Portfolio:		$24,759	$24,482	1.01
Residential	Energy Efficient Products	$28,724	$22,891	1.25
	Home Comfort	$0	$0	NA
	Residential Energy Affordability Partnership	$215	$1,495	0.14
	Home Performance	$1,035	$1,657	0.62
	All Electric Homes	$0	$0	NA
	Home Energy Management	$2,263	$2,073	1.09
Total Residential Portfolio:		$32,237	$28,115	1.15
Total Portfolio[1]:		**$56,996**	**$54,471**	**1.05**

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

RATEPAYER IMPACT TEST RESULTS

Another relevant metric in the context of electrification measures is the Ratepayer Impact test (RIM). This test considers the perspective of non-participating ratepayers and reflects the impact of programs on rates. The benefits and costs considered are like those considered from the utility perspective in that participant costs and societal benefits are not considered. The key difference is that changes in utility revenue are considered and increases in revenue are a considered as a benefit. This is the key component for assessing the impact on rates. Electricity rates are determined in part by allocating the

fixed costs of maintaining and operating the electric grid across ratepayers. The primary metric for allocating costs across most rate payers is consumption as measured by kWh. Because consumption is the denominator for determining rates average rates increase as total consumption decreases, and average rates decrease as total consumption increases. To the extent that energy efficiency results in reduced consumption, it places upward pressure on rates while electrification places downward pressure on rates by increasing total consumption.

As shown in Table 13, the RIM was 0.25 for the Energy Efficiency and Beneficial Electrification Portfolio. This indicates that the portfolio is not cost-effective from the ratepayer perspective. This is to be expected since most of the portfolio is comprised of energy efficiency measures which decrease consumption. In contrast, Home Comfort was the only program with a RIM ratio greater than 1.0, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, the net benefits for electrification from the ratepayer perspective are positive in this case, after factoring in program costs.

Table 13: Ratepayer Impact Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$26,331	$141,363	0.19
	Multi-Family	$3,207	$6,844	0.47
Total Commercial Portfolio:		$29,537	$148,206	0.20
Residential	Energy Efficient Products	$30,144	$164,280	0.18
	Home Comfort	$23,586	$12,768	1.85
	Residential Energy Affordability Partnership	$215	$2,549	0.08
	Home Performance	$1,278	$9,030	0.14
	All Electric Homes	$13	$21	0.60
	Home Energy Management	$2,263	$9,891	0.23
Total Residential Portfolio:		$57,499	$198,539	0.29
Total Portfolio[1]:		**$87,036**	**$348,619**	**0.25**

[1] Portfolio costs include $1.87M of advertising that was not allocated to individual programs

FIRST-YEAR AND LEVELIZED COSTS

In addition to benefit-cost ratios, there are two metrics which can be of value for assessing the performance of a program or portfolio. These are the first-year or acquisition cost of energy and the levelized or lifetime cost of energy. In budget planning and goal setting, the planned budget is compared to planned gross energy impacts (which do not include line losses or net to gross ratios). The actual first-year cost is comparable to this planning metric in that it compares actual spending to actual gross energy impacts. Importantly, gross impacts are considered to ensure comparability to planned budgets and energy targets. Table 14 shows the first-year cost for demand (kW), electricity (kWh), and the energy agnostic MMBtu planning metric. Both the utility and societal perspective are shown. The difference between the two is that the societal perspective includes the full incremental measure costs.

Program or portfolio acquisition costs can be compared with acquisition costs for other utility programs or portfolios. As with the UCT benefit cost ratio, the first-year cost per kWh for the Home Comfort program is negative. Additionally, the first-year cost per kWh for the All Electric Homes program is negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table 14: First Year Costs for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	2022 Ex-Post Gross UCT First-Year Acquisition Cost			2022 Ex-Post Gross SCT First-Year Acquisition Cost		
		$/MMBtu	$/kW-year	$/kWh	$/MMBtu	$/kW-year	$/kWh
Commercial	Commercial Efficiency Program	$186.90	$2,807	$0.63	$244.75	$3,676	$0.83
	Multi-Family Program	$96.75	$4,243	$1.47	$190.83	$8,368	$2.90
Subtotal Commercial Portfolio:		$177.44	$2,863	$0.65	$239.09	$3,857	$0.88
Residential	Energy Efficient Products	$70.60	$1,414	$0.20	$102.07	$2,044	$0.29
	Home Comfort	$119.92	$30,798	($1.34)	$215.61	$55,373	($2.41)
	Residential Energy Affordability Partnership	$709.27	$13,215	$2.04	$709.27	$13,215	$2.04
	Home Performance	$138.18	$6,636	$1.80	$277.36	$13,320	$3.61
	All Electric Homes	$247.64	$12,842	($10.96)	$500.38	$25,949	($22.15)
	Home Energy Management	$18.31	$216	$0.06	$18.31	$216	$0.06
Subtotal Residential Portfolio:		$74.69	$1,585	$0.29	$116.22	$2,466	$0.46
Total Portfolio:		**$100.87**	**$1,983**	**$0.39**	**$147.64**	**$2,903**	**$0.56**

Levelized cost is another useful metric which essentially divides costs by the lifetime net energy impacts (which include line losses and net to gross ratios). Net impacts are used to compare the cost of energy efficiency programs more directly with energy or capacity costs from other sources. Because levelized costs are expressed as $/kW-year and $/kWh, planners can readily compare them to the cost of alternative supply options. Table 15 shows the levelized cost for demand (kW), electricity (kWh), and the energy agnostic MMBtu planning metric. Both the utility and societal perspective are shown. The difference between the two is that the societal perspective includes the full incremental measure costs. Levelized costs can be compared with marginal costs for other resources. As with the UCT benefit cost ratio, the levelized cost per kWh for the Home Comfort program is negative. Additionally, the first-year cost per kWh for the All Electric Homes program is negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table 15: Levelized Costs for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	2022 Ex-Post Net UCT Levelized Costs			2022 Ex-Post Net SCT Levelized Costs		
		$/MMBtu	$/kW-year	$/kWh	$/MMBtu	$/kW-year	$/kWh
Commercial	Commercial Efficiency Program	$17.80	$285	$0.06	$23.31	$374	$0.08
	Multi-Family Program	$9.33	$416	$0.15	$18.40	$821	$0.30
Subtotal Commercial Portfolio:		$16.92	$290	$0.06	$22.80	$391	$0.09
Residential	Energy Efficient Products	$12.23	$304	$0.04	$17.68	$440	$0.06
	Home Comfort	$11.31	$2,513	($0.13)	$20.33	$4,519	($0.23)
	Residential Energy Affordability Partnership	$111.30	$2,213	$0.34	$111.30	$2,213	$0.34
	Home Performance	$13.57	$662	$0.18	$27.24	$1,328	$0.36
	All Electric Homes	$19.69	$1,002	($0.62)	$39.78	$2,025	($1.24)
	Home Energy Management	$17.27	$216	$0.06	$17.27	$216	$0.06
Subtotal Residential Portfolio:		$12.59	$435	$0.08	$19.59	$677	$0.13
Total Portfolio:		**$14.81**	**$382**	**$0.08**	**$21.68**	**$559**	**$0.11**

APPENDIX D VERIFIED EX-ANTE MEMO

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

MEMORANDUM 2022 VERIFIED EX-ANTE SAVINGS

Date: February 2, 2023

To: Dan Zaweski, Joseph Fritz-Mauer, Ronan Murphy, and Gabrielle Scibelli (PSEG Long Island)

From: 2022 Evaluation Team (Demand Side Analytics, DNV, Mondre Energy, and BrightLine Group)

Re: 2022 Verified Ex-Ante Savings for Energy Efficiency and Beneficial Electrification Programs

Background

PSEG Long Island asked the Demand Side Analytics evaluation team to verify ex-ante energy savings as part of its evaluation of PSEG Long Island's 2022 energy efficiency and beneficial electrification programs. This memorandum defines "verified ex-ante" (VEA) savings and presents the 2022 verified ex-ante savings for each program.

Definition of Verified Ex-Ante

The verified ex-ante calculations seek to answer the question, "were the ex-ante gross energy impacts claimed by the implementation contractors calculated consistently with approved calculations and assumptions?" To answer this question, we independently calculated program impacts using the methods and assumptions approved by PSEG Long Island and compared the results to the ex-ante gross values submitted by the implementation contractors (TRC and Uplight). The ratio of these two values is the verified ex-ante realization rate.

The details of the verified ex-ante calculations vary by program and measure. Some measures are assigned static per-unit impacts in the planning assumptions, so the verified ex-ante calculation only requires counting the number of units stored in the program tracking data and multiplying that total by the per-unit savings planning assumption. Other measures are more dynamic and require the use of algorithms and project-specific parameter values. PSEG Long Island generally uses a static set of algorithms and assumptions for a given calendar year. However, projects have varying lead times and processing lag so it is not uncommon for a project to begin in one year and complete in the following calendar year. In practice, this means a subset of 2022 projects were completed on 2021 application workbooks with 2021 savings assumptions. For the purposes of VEA, we consider these "carryover" projects verified as long as 2021 algorithms and assumptions were correctly implemented.

The verified ex-ante savings are the first milestone of the 2022 evaluation. They are a separate and distinct performance metric from the evaluated ex-post savings, which will be delivered later this spring. Both the claimed ex-ante and verified ex-ante savings are expressed on a gross basis – meaning they do not reflect adjustments for net-to-gross factors or line losses.

Results

Table 1 summarizes the 2022 verified ex-ante savings for MMBtu. The verified ex-ante savings were 99.9% of the claimed ex-ante gross savings. The evaluation team's independent measure counts were

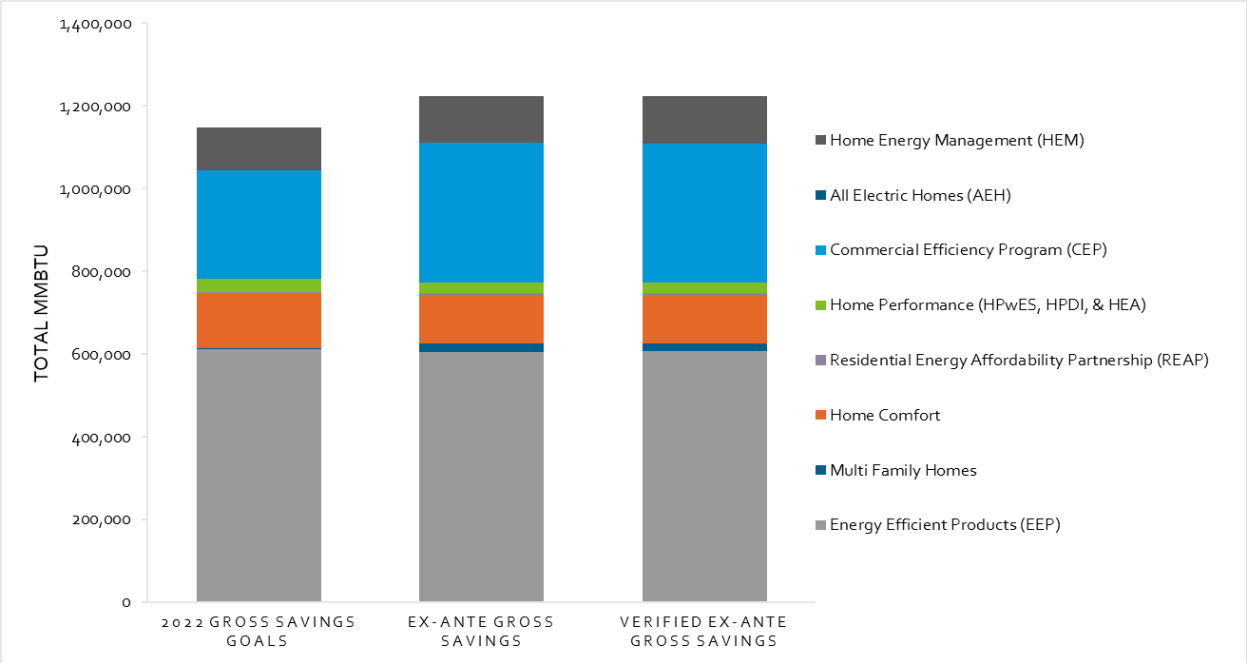
nearly identical to the claimed measure counts. Per-unit MMBtu savings calculations and assumptions matched the approved values almost perfectly for nearly all measures.

TABLE 1: SUMMARY OF 2022 VERIFIED EX-ANTE MMBTU SAVINGS AND GOALS

Program		2022 Gross Savings Goals	Ex-Ante Gross Savings	Verified Ex-Ante Gross Savings	Verified Ex-Ante Realization Rate	Verified as % of Goals
		MMBTU	MMBTU	MMBTU	%	%
Commercial	Commercial Efficiency Program (CEP)	262,559	337,244	336,381	99.7%	128%
	Multi-Family Homes Rebate	2,423	18,763	18,763	100.0%	774%
Residential	Energy Efficient Products (EEP)	612,027	605,812	605,943	100.0%	99%
	Home Comfort	129,673	117,803	117,803	100.0%	91%
	Residential Energy Affordability Partnership (REAP)	5,953	6,007	5,967	99.3%	100%
	Home Performance (HPwES, HPDI, & HEA)	31,917	25,113	24,783	98.7%	78%
	All Electric Homes (AEH)	560	80	79	99.2%	14%
	Home Energy Management (HEM)	101,952	113,362	113,362	100.0%	111%
Total Commercial:		**264,982**	**356,008**	**355,144**	**99.8%**	**134%**
Total Residential:		**882,082**	**868,177**	**867,938**	**100.0%**	**98%**
Total Energy Efficiency:		**1,147,064**	**1,224,185**	**1,223,083**	**99.9%**	**106.6%**

Figure 1 below shows that the Energy Efficiency Program, Commercial Efficiency Program, and Home Comfort programs were the top three contributing programs, together comprising 87% of verified ex-ante savings in 2022.

FIGURE 1: MMBTU CONTRIBUTIONS BY PROGRAM



Additionally, we developed a metric comparing verified ex-ante savings metric with the established annual savings goals. The portfolio verified ex-ante gross savings were 106.6% of the 2022 savings goals, exceeding PSEG Long Island's goals by 76,019 MMBtu.

In addition to energy conservation goals, PSEG Long Island set goals related to uptake of specific technologies and enrollment in new programs. In the 2022 program year, goals were specifically set for total number of heat pumps installed, total number of homes enrolled in the All Electric Homes Program, and number of distinct buildings enrolled in the Multi-Family Homes Rebate Program. Table 2 below shows that both the claimed number of heat pump installations and enrolled All Electric Homes line up with the verified counts. The verified count of enrolled buildings in the Multi-Family Homes Rebate looked at the total number of distinct buildings associated with customer accounts on all projects enrolled in 2022. The verified count of enrolled multi-family buildings was 70, far exceeding the planning goal of 10 buildings, while 109 enrolled buildings were reported. Further detail on what drives the differences between the claimed and verified MF enrollment counts can be found in Appendix B: Supplemental Detail.

TABLE 2: SUMMARY OF VERIFIED EX-ANTE COUNTS AND ENROLLMENTS

Tracked Installation and Enrollment Counts	Goal	Claimed	Verified
Heat Pump Installations (including LMI)	6,000	7,385	7,385
All Electric Homes - Enrolled Homes	20	4	4
Multi-Family Homes Rebate - Enrolled Buildings	10	109	70

Appendix A: MWh and MW VEA Results

Both the claimed ex-ante and verified ex-ante savings are expressed on a gross basis. This means they do not reflect adjustments for net-to-gross factors or line losses. The primary reporting metric for 2022 VEA is Gross MMBtu savings. Gross MMBtu is the sum of MMBtu Beneficial Electrification ($MMBtu_{be}$) savings and MMBtu Energy Efficiency ($MMBtu_{ee}$) savings.

In Table 3 below we report the claimed ex-ante and verified ex-ante MWh savings. Gross MWh savings in this context, is just the MWh Energy Efficiency (MWh_{ee}) value. Increased MWh consumption from Beneficial Electrification (MWh_{be}) are not considered in the ex-ante savings. This is different from the ex-post evaluation where we will report delta MWh impacts. Delta MWh is the difference between MWh_{ee} and MWh_{be}.

TABLE 3: SUMMARY OF 2022 VERIFIED EX-ANTE MWH SAVINGS

Program		Claimed Ex-Ante Gross Savings	Verified Ex-Ante Gross Savings	Verified Ex-Ante Realization Rate
		MWh_{ee}	MWh_{ee}	%
Commercial	Commercial Efficiency Program (CEP)	67,963	67,713	100%
	Multi-Family Homes Rebate	2,409	2,409	100%
Residential	Energy Efficient Products (EEP)	219,089	219,399	100%
	Home Comfort	2,073	2,073	100%
	Residential Energy Affordability Partnership (REAP)	2,168	2,162	100%
	Home Performance (HPwES, HPDI, & HEA)	1,794	1,718	96%
	All Electric Homes	3.5	3.3	95%
	Home Energy Management (HEM)	33,225	33,225	100%
Total Commercial:		**70,373**	**70,122**	**100%**
Total Residential:		**258,352**	**258,579**	**100%**
Total Energy Efficiency:		**328,725**	**328,701**	**100%**

Table 4 below reports claimed ex-ante and verified ex-ante peak demand (MW) values. PSEG-LI does not claim MW savings for HEM, so we did not calculate ex-ante MW savings for this program. MW savings will be provided in the ex-post evaluation. Ex-Ante MW savings are not adjusted for net-to-gross factors or line losses.

TABLE 4: SUMMARY OF 2022 VERIFIED EX-ANTE MW SAVINGS

Program		Claimed Ex-Ante Gross Savings	Verified Ex-Ante Gross Savings	Verified Ex-Ante Realization Rate
		MW	MW	%
Commercial	Commercial Efficiency Program (CEP)	12.18	11.73	96%
	Multi-Family Homes Rebate	0.33	0.40	121%
Residential	Energy Efficient Products (EEP)	16.26	16.29	100%
	Home Comfort	0.47	0.47	100%
	Residential Energy Affordability Partnership (REAP)	0.40	0.40	100%
	Home Performance (HPwES, HPDI, & HEA)	0.53	0.53	99%
	All Electric Homes	0.00	0.00	100%
	Home Energy Management (HEM)[b]	n/a	n/a	n/a
Total Commercial:		**12.51**	**12.13**	**97%**
Total Residential:		**17.66**	**17.69**	**100%**
Total Energy Efficiency:		**30.17**	**29.81**	**99%**

Appendix B: Supplemental Detail

The evaluation team verified the calculations and inputs for hundreds of measures and inputs. The below table includes additional detail on nuances observed in the Captures data as well as the calculations and assumptions used.

Program	Sub-Component	Description	Implications
Commercial Efficiency Program	Comprehensive, Fast Track and Multi-Family Lighting	▪ We calculated verified ex-ante MW savings using the building type-based coincidence factors (CF) from 2022 PSEG Long Island TRM, whereas the program used a legacy CF of 0.75 for all interior lighting projects.	▪ A 91% MW realization rate for comprehensive, 108% MW realization rate for fast track, and 131% MW realization rate for multi-family lighting measures.
	Refrigerated Case Lighting	▪ TRC applied PSEG 2010 assumptions, based on the 2010 NYS Tech Manual. Planning spreadsheet recommended an algorithm based on NYS TRM v8.	▪ Refrigerated Case Lighting constituted 2% of overall CEP lighting savings.

	Multi-Family Homes Rebate: Building Enrollment Counts	▪ Multi-Family Homes Rebate program enrollments were first tracked for the 2022 program year. An enrolled building is counted using the following criteria:
		  ▪ The building was committed to the program 2022.
		  ▪ The building is new to the Multi-Family Program. For example, if a building enrolls a lighting project in January, then enrolls an HVAC project in February, it will not be counted a second time.
		▪ During the verification process, we found that these criteria were not applied consistently month-to-month. This lead to double-counting and a misallocation of building enrollments.
		  ▪ 25 buildings were double-counted. This means that buildings involved in multiple projects, committed across different months were counted again with each new project.
			▪ Under the described criteria, the verified counts of enrolled multi-family buildings is 70, while 109 were claimed. This still far exceeds the 2022 goal of 10 buildings enrolled.
			▪ This has no impact on VEA MMBtu savings. The Realization Rate for the Multi-Family Rebate program is 100%.

Program	Sub-Component	Description	Implications
		▪ 14 buildings were misallocated to the 2022 program year. These buildings were enrolled in December 2021, but were counted towards enrollment counts for December 2022.	
Home Performance with ENERGY STAR	Air Sealing	▪ For a subset of projects, the TRC workbooks incorrectly defaults the associated HVAC system to 'AC with Electric Heat' when the system was an air source heat pump. This applied a savings factor based on electric resistance heat and overstated measure savings. TRC identified this issue in May 2022 and air sealing projects in the second half of 2022 did not have this issue.	▪ Projects closed before the adjustment claimed impacts based on incorrect assumptions. As a result, the Verified Ex Ante impacts for this measure were slightly lower than claimed resulting in an MMBtu realization rate of 92% for air sealing measures.
	Smart Thermostats	▪ For a small subset of homes, two smart thermostats were installed resulting in two types of workbook calculation errors: ▪ 1) If the thermostats controlled the same HVAC system, then the calculation double counted the HVAC capacity inflating impacts. ▪ 2) If the thermostats controlled two separate HVAC systems, the calculation tied both thermostats back to one system, sometimes applying the incorrect capacity of the heating and cooling being controlled. This pushed impacts in both directions.	▪ Adjustments were made for these measures in the Verified Ex Ante. The VEA MMBtu realization rate for Smart Thermostats was 99%.
All Electric Homes	Smart Thermostats	▪ The All Electric Homes program had one closed project in the 2022 program year. At this home, two smart thermostats were installed and controlled the same HVAC system. The workbook calculation double counted the HVAC capacity, inflating impacts.	▪ The MMBtu VEA realization rate for the All Electric Homes program was 99.2%.

Appendix C: Ex-Post Drivers

The table below outlines measures that are expected to drive differences in impacts during the Ex-Post evaluation.

Program	Sub-Component	Description	Implications
CEP	**Prescriptive: Non-Road Vehicle Electrification**	▪ PSEG Long Island had significant uptake of electric golf cart rebates in 2022. The projects delivered high MMBtu savings at very low cost, which prompted an internal review of the CEP Standard Non-road Vehicle Electrification measure in the 2022 TRM. This measure had been in the PSEG Long Island TRM for several years, but was rarely used. The mid-year review led to changes in the algorithms and assumptions in the 2023 TRM. A synopsis of the changes is below. The most impactful update being a reduction in estimated baseline annual gasoline consumption from 799 gallons (96 MMBtu equivalent) to 120 gallons (15 MMBtu). ▪ The assumed miles driven per year was reduced from 21,971 to 3,306 reducing MMBtu impact per golf cart from 93 to 10.	▪ **Verified Ex-Ante**: No Impact. We found that TRC correctly applied the 2022 TRM algorithm, and the Verified Ex-Ante results. ▪ **Verified Ex-Post**: The updated 2023 TRM method will be applied. Golf carts represented 121,029 MMBtu, 34% of the claimed MMBtu savings under CEP. The application of the updated methodology is expected to decrease the ex post realization rate for golf carts, likely decreasing the overall CEP realization rate and program performance by approximately 100,000 MMBtu.
EEP	**Linear LEDs**	▪ A mid-year adjustment was implemented in August 2022 that allowed all Indoor ENERGY STAR fixtures to be rebated under the LED Linear category in the EEP program. This adjustment was recommended in a memo from TRC and approved by PSEG Long Island. This change led to increased volume in the linear LED product category, predominantly from retrofit kits and recessed downlights. These product types are not consistent with the planning assumptions for Linear LEDs. Per-unit impacts for Linear LEDs are smaller than these ENERGY STAR LED fixtures on average so the adjustment was conservative with respect to 2022 energy savings.	▪ **Verified Ex-Ante**: No impact. The VEA EEP realization rate was 100%. ▪ **Verified Ex-Post**: DSA will reclassify each program-supported product and apply the appropriate baseline wattage assumptions. Non-linear ENERGY STAR fixtures claimed as Linear LEDs will have a realization rate greater than 100%. We expect this adjustment to add approximately 5,000 MMBtu to EEP's verified ex post savings.

Program	Sub-Component	Description	Implications
		However, this adjustment has important implications for 2023 as many of the products moved under the Linear LED category are ineligible due to new federal standards.	▪ **2023 Planning**: PSEG Long Island should limit the Linear LED product category to Linear LEDs by August 2023 to avoid a potentially significant downward evaluation result in 2023 once new federal standards are in place.