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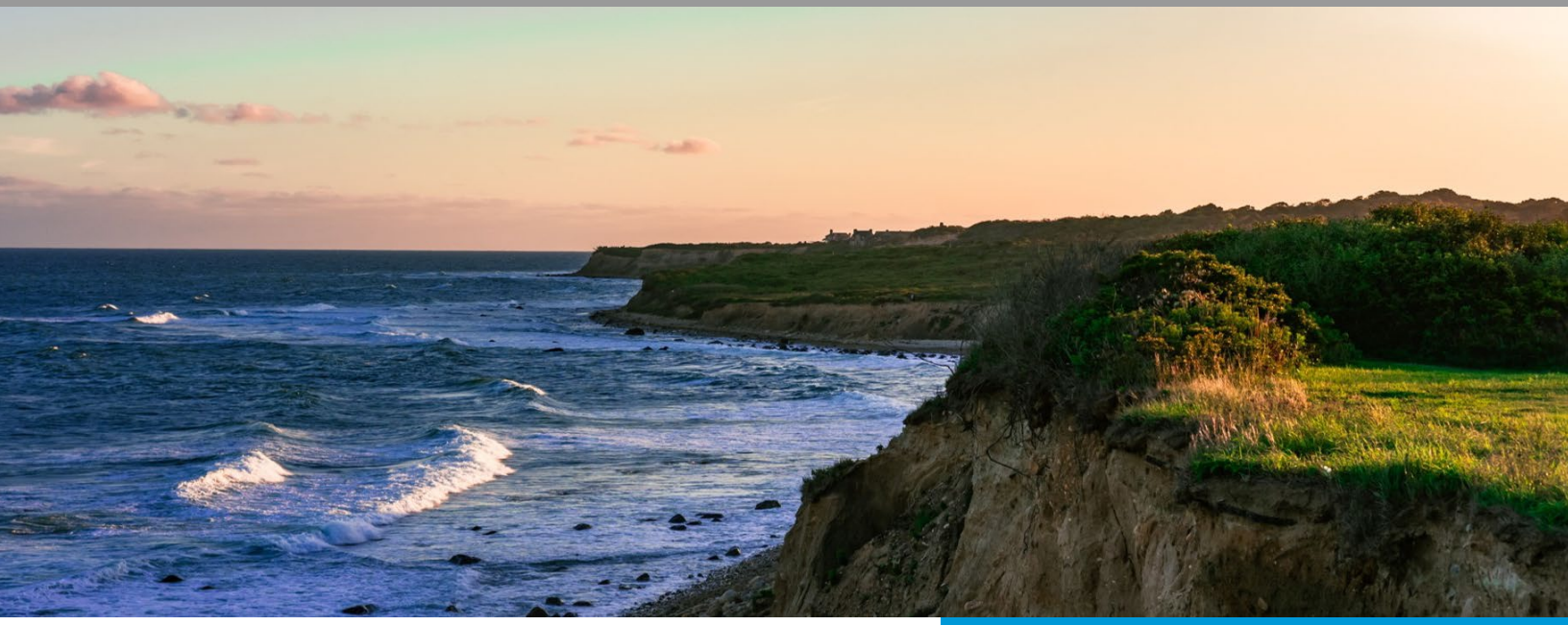
2023 Annual Evaluation Report – Volume I Executive Summary



Prepared for PSEG Long Island

By Demand Side Analytics

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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. 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 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 2023 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.

Key Term	Definition
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, 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.
Ratepayer Impact Test (RIM)	A test that estimates the impact of conservation programs on rates due to changes in utility revenue as result of program activities. The RIM considers the cost-effectiveness from the perspective of a non-participating ratepayer. Energy efficiency programs will typically not pass the RIM test because measures lead to a reduction in utility revenue. Conversely, BE programs often pass the RIM test because the increased consumption allows the utility to spread its fixed costs across more units of energy.
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.

Key Term	Definition
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.
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.

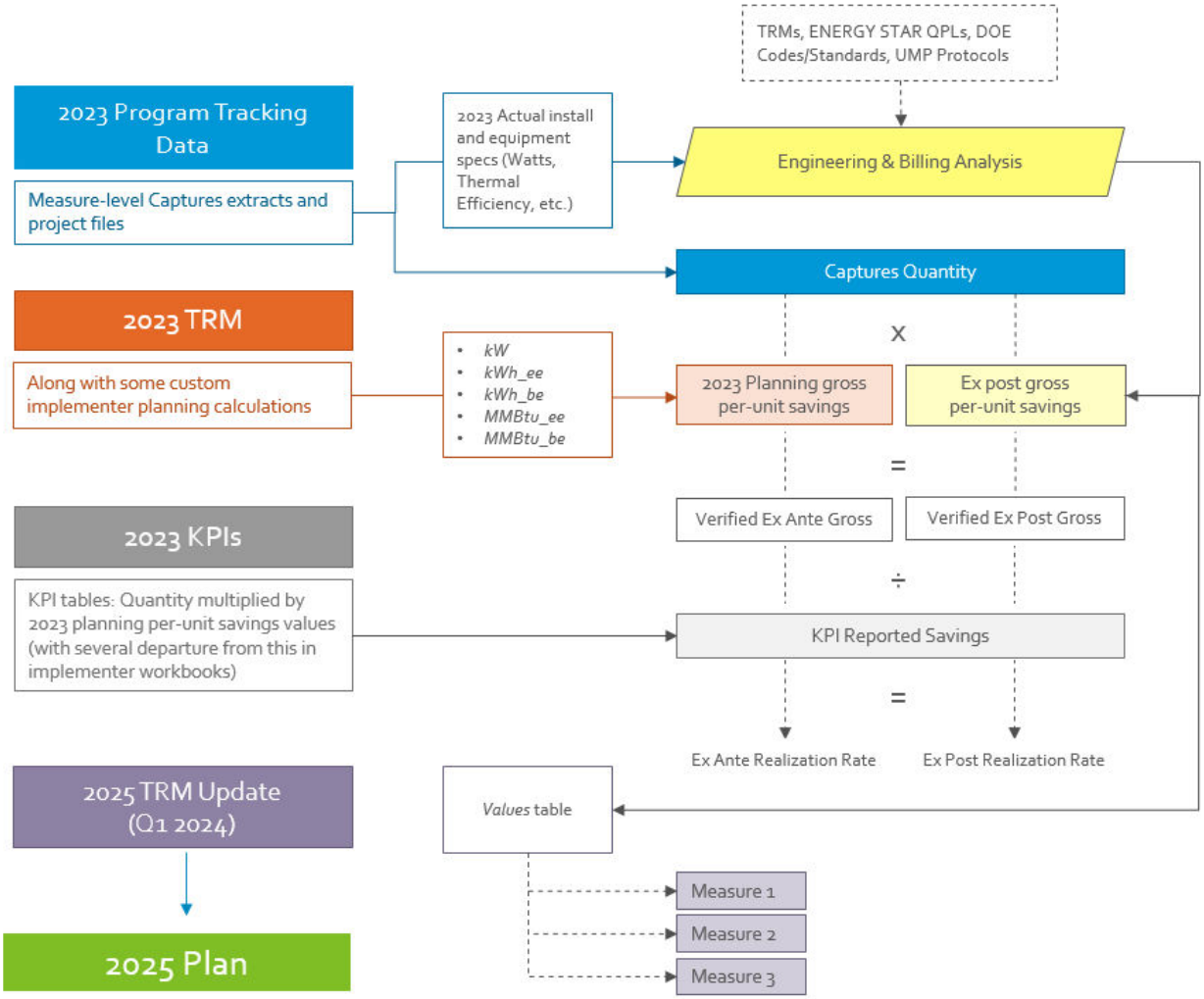
ANNUAL EVALUATION TASKS AND CYCLE TIMELINE

Figure 0-1 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 computed consistently with the calculations and assumptions approved by PSEG Long Island. 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 Memo, Appendix C.

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, Federal Codes and Standards, and actual equipment specifications are utilized in this portion of the evaluation. The output informs recommendations for future planning cycles.

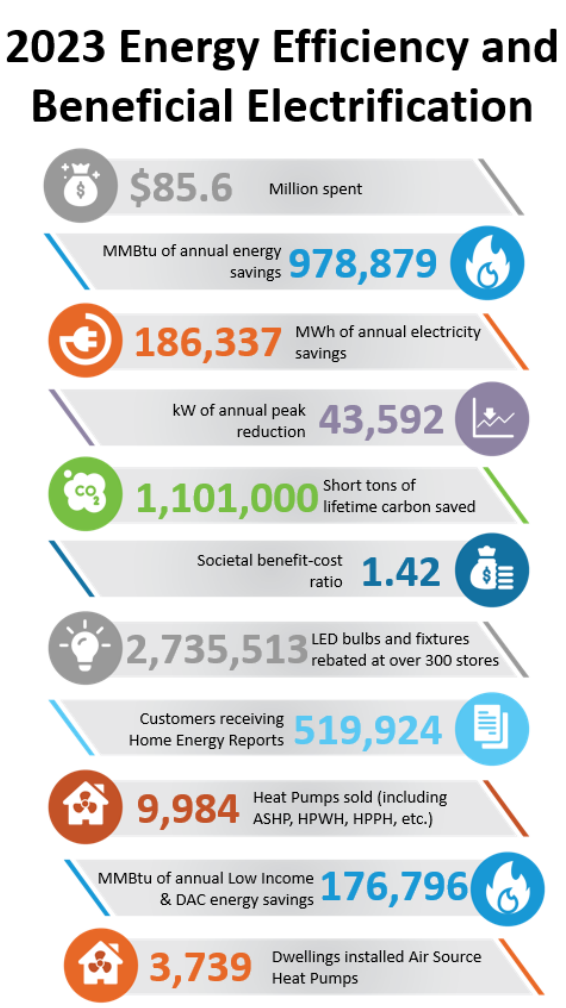
It is important to note that the feedback loop is a two-year cycle. PSEG Long Island has already established 2024 goals and planning assumptions, therefore findings and recommendations from the 2023 ex-post evaluation will not be reflected in the 2024 program claimed savings methodology. The findings and recommendations of this 2023 impact evaluation will be reflected in 2025 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 2022 evaluation were expected to persist in the 2023 evaluation results.

Figure 0-1: Annual Evaluation Data Flow



1 INTRODUCTION

PSEG Long Island's Energy Efficiency and Beneficial Electrification programs offer an array of incentive and rebate opportunities 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 avoiding 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 was administered by Uplight for the 2023 Program Year. This report presents the 2023 Energy Efficiency and Beneficial Electrification Portfolio program evaluation ex-post gross results and covers the period from January 1, 2023 to December 31, 2023.



The Demand Side Analytics evaluation team produced two volumes that together compose the entire Annual Evaluation Report. This document, the 2023 Annual Evaluation Report (Volume I), provides an overview of the portfolio-level evaluation findings. The 2023 Program Guidance Document (Volume II) provides detailed program-by-program impact analysis results.

In 2023, PSEG Long Island spent $85.6 million implementing the Energy Efficiency and Beneficial Electrification Portfolio. The investment led to 978,879 of total MMBtu savings and avoided 1.1 million short tons of CO_2 emissions – the equivalent of removing approximately 214,000 combustion engine cars for one year.[1] PSEG Long Island's efforts led to over $170 million in net societal benefits, with a societal benefit cost ratio of 1.42.

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% by 2030. In 2018, New Efficiency: New York set a statewide

[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

energy efficiency target of 185 TBtu in energy savings by 2025. 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:

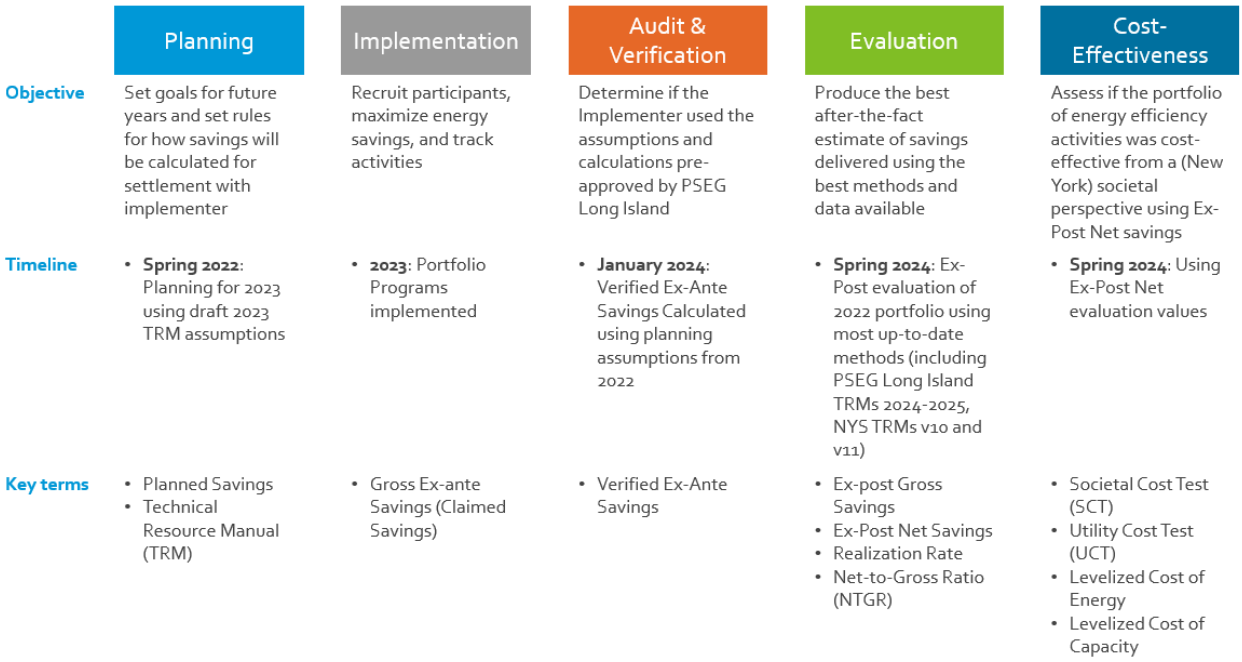
- **Changed its primary performance metric from electric energy (kWh) and peak demand (kW) to MMBtu.** The switch allows PSEG Long Island to pursue beneficial electrification measures like heat pumps that increase electric consumption but lower overall energy consumption and emissions. The MMBtu performance 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 continues to expand 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.
- **Adopted a 7.85 TBtu by 2025 target, their portion of the overarching 185 TBtu goal.** PSEG Long Island is responsible for reporting their progress towards 7.85 TBtu of energy savings by 2025. For consistency with investor-owned utilities (IOUs), the impacts to be counted towards this target should be calculated excluding fossil fuel heating penalties. PSEG Long Island includes fossil fuel penalties in their ex post evaluation of MMBtu impacts. However, when impacts are calculated without fossil fuel heating penalties, as other New York IOUs do, an additional 0.806 TBtu of impacts can be counted towards PSEG Long Islands total contribution since 2020. Further details on this process can be found in Appendix E .

Energy efficiency and beneficial electrification 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 1-1 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 2023 were conducted in 2022 and set the goals, rules, and algorithms for calculating energy savings. The 2022 energy efficiency and beneficial electrification measures were not evaluated until the spring of 2023, meaning 2023 programs were already being implemented before performance metrics were available from the 2022 evaluation. Considering this lag, we expected any major drivers in differences between claimed savings and ex-post impacts that were discussed in the 2022 evaluation to persist into 2023.

Additionally, most of the findings and recommendations of this 2023 impact evaluation will be reflected in 2025, not 2024, planning assumptions, goal setting, and ex-ante savings values since PSEG Long Island has already established 2024 goals and planning assumptions.

Figure 1-1: 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 and customers continuing to work from home, a renewed appetite for home improvements might prove a beneficial target for energy efficiency and beneficial electrification portfolio implementers. Despite any potential disruptions to program delivery, PSEG Long Island showed strong performance compared to goals.

In 2023, PSEG Long Island administered eight programs, described in Table 1-1.

Table 1-1: 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.

Program	Description
	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.
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 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. In 2023 PSEG Long Island also claimed electric savings from coordinated programming with National Grid's natural gas weatherization program on Long Island.
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.

Program	Description
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.

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 2-1 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 2-1: Summary of 2023 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)	286,309	169,017	168,677	164,419
	Multi-Family	8,928	28,828	28,828	29,944
Residential	Energy Efficiency Products (EEP)	339,857	429,962	426,082	428,794
	Home Comfort (HC)	110,518	184,211	184,223	188,908
	Home Performance*	31,426	40,802	40,668	32,372
	Home Energy Management (HEM)	111,770	116,214	116,214	126,552
	Residential Energy Affordability Program (REAP)	10,884	11,977	11,983	7,466
	All Electric Homes	1,038	577	519	424
Subtotal Commercial		**295,236**	**197,845**	**197,504**	**194,363**
Subtotal Residential		**605,493**	**783,743**	**779,689**	**784,518**
Total Portfolio		**900,730**	**981,587**	**977,194**	**978,879**

* Home Performance values include 5,596 MMBtu of ex-ante savings, 5,596 MMBtu of verified ex-ante savings, and 5,281 MMBtu of ex-post gross savings from weatherization coordination with National Grid.

Figure 2-1 and Figure 2-2 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 2-1: Portfolio MMBtu Savings

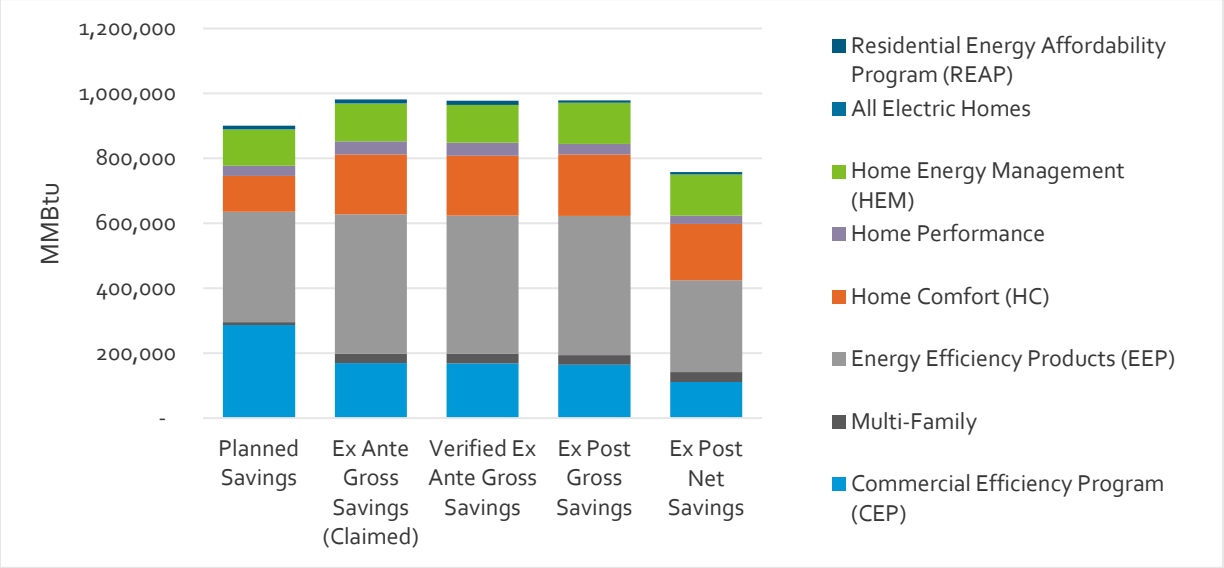
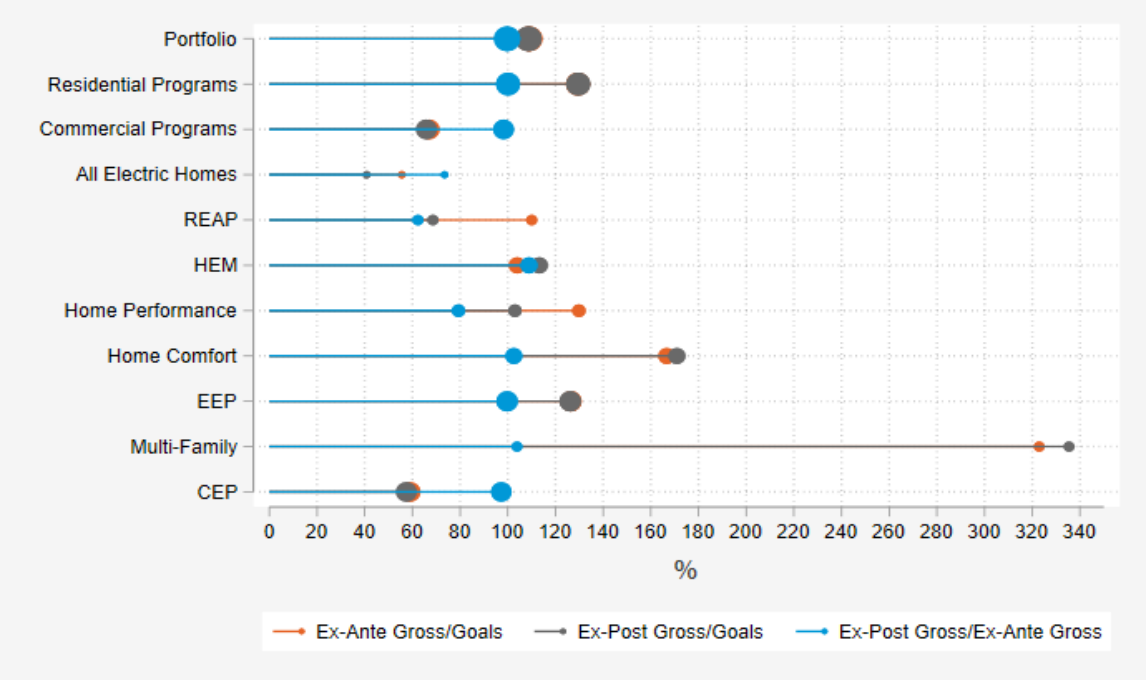


Figure 2-2 visualizes how evaluated savings compare to claimed savings (the Realization Rate, blue bars), how evaluated savings compare to planned savings (grey bars), and how claimed savings compare to planned savings (orange bars). The size of the circle in the plots is scaled based on the goals for the program. At the portfolio level, the ex-post gross savings were 109% of planned savings. For residential programs, the ex-post gross savings was 130% of planned savings while ex-post gross savings for commercial programs was 66% of planned savings.

Figure 2-2: Portfolio Performance Metrics



As Figure 2-2 shows, most programs had realization rates very close to 100% when comparing claimed and ex-post gross savings.

Table 2-2 summarizes the primary reasons as to why portfolio ex-post gross (evaluated) savings departed from the planned and claimed savings. The overall Portfolio realization rate is 99.87% with a total difference of -2,708 MMBtu between claimed ex-ante and verified ex-post impacts. This indicates that in aggregate, the verified savings are closely aligned with claimed savings for the 2023 program year. However, there is more variation between the claimed ex-ante and verified ex-post MMBtu impacts by program and/or certain measure groups. For the 2023 program year, it's important to note the high impact contribution of Home Energy Reports, contributing to 13% of the portfolio savings, and the increasing nuances in consumption analysis results for Home Performance and REAP programs. Additionally, minor reporting errors in Captures led to under-reporting of EEP LED savings while updated efficiency metrics led to higher savings for Home Comfort Heat Pumps.

Table 2-2: 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
Home Energy Reports	▪ Difference of 10,388 MMBtu savings for an overall realization rate of 108%.	▪ Two additional Home Energy Report Cohorts were rolled out in 2023, increasing participation to over 500,000 customers. ▪ The consumption analysis found slightly higher impacts on a per customer basis compared to 2022 leading to a realization rate of 108%. ▪ The program represents 13% of the overall portfolio impacts.
Home Performance and REAP Consumption Analyses	▪ The consumption analyses for both REAP and Home Performance resulted in low realization rates. ▪ 58% Home Performance Realization Rate ▪ 62% REAP Realization Rate	▪ The Consumption analyses relies on modeling techniques that compare electric consumption changes amongst participating homes following program services to a comparison group of homes with no intervention. ▪ The combination of transitioning to MMBtu as the primary reporting metric and increasing influence of Beneficial Electrification measures calls into question the suitability of consumption analysis for evaluation for these programs. ▪ See section 5.2 for more detail.
EEP LED Savings	▪ Difference of -6,041 MMBtu for an overall lighting realization rate of 98%.	▪ Actual 2023 product wattages and baseline wattage varied slightly from planning assumptions resulting in 101% realization rate

Portfolio Component	Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings	Summary of Savings Difference
		for LED Standard and 94% realization rate for LED Specialty. ▪ Claimed per-unit savings were misreported due to a data entry error in Captures resulting in a difference of 4,000 MMBtu.
Home Comfort Heat Pumps	▪ Difference of 4,683 MMBtu in heat pump categories for a realization rate of 103%.	▪ Changes in efficiency metrics (HSPF->HSPF2, SEER->SEER2) led to modest differences in heat pump impact results. ▪ We used the new DOE efficiency metrics EER2/SEER2/HSPF2, whereas TRC used historic metrics of EER/SEER/HSPF in their calculations. TRC transitioned to EER2/SEER2/HSPF2 for 2024.

Table 2-3 shows the impacts per program split into four segments: 1) Non-Disadvantaged Community & Non-Low Income, 2) Disadvantaged Community (DAC) Only, 3) Low Income Only, and 4) DAC & Low-Income. Under the CLCPA, New York Utilities are required to direct 35-40% of their portfolio benefits to Low Income or DAC identified customers. The effort to identify DAC and Low Income impacts aligns with PSEG Long Islands efforts to track progress towards these requirements. The method used to identify DAC and Low Income impacts align with the definitions of the two categories outlined by the Climate Justice Working Group (CJWG). DACs are identified geographically by census block groups that meet criteria outlined by the CJWG. Any impacts counted towards DACs represent projects that are located within the list of DAC Census Block Groups produced by NYSERDA and the CJWG. Additionally, Low Income is an income-qualified identifier. Any participant with an income that falls at or below 60% of the state-median income counts towards this segment. In the 2023 program year, 26% of the portfolio MMBtu savings were allocated to either Low Income customers or customers who lived in Disadvantaged Communities.

Table 2-3: Portfolio Impacts by DAC, Low Income, and Market Rate Customers

Energy Efficiency Program	Ex-Post Gross MMBtu				% DAC/ Low Income
	Non-DAC & Non-Low Income	DAC Only	Low Income Only	DAC & Low Income	
Commercial Efficiency Program (CEP)	128,284	36,135	0	0	22%
Multi-Family	11,305	18,639	0	0	62%
Energy Efficiency Products (EEP)	328,313	67,083	33,397*	0	23%
Home Comfort (HC)	129,821	8,665	44,057	6,365	31%
Home Performance	14,088	1,821	12,124	4,340	56%
Home Energy Management (HEM)	112,758	13,794	0	0	11%
Residential Energy Affordability Program (REAP)	2,413	601	3,358	1,095	68%
All Electric Homes	134	290	0	0	68%
Subtotal Commercial	**139,589**	**54,774**	**0**	**0**	**28%**
Subtotal Residential	**587,526**	**92,254**	**92,937**	**11,800**	**25%**
Total Portfolio	**727,115**	**147,028**	**92,937**	**11,800**	**26%**

*EEP Low Income MMBtus come from LED light bulbs dispersed through Long Island Food Banks. If these light bulbs don't count towards Low Income, the updated Portfolio % impacts towards DAC/Low Income is 22%, and the updated EEP % impacts towards DAC/Low Income is 16%.

Table 2-4 shows that in 2023, PSEG Long Island spent 103% of their planned program-specific budget. For Multi-Family, EEP, Home Comfort, HEM, AEH, and REAP, the actual spending exceeded the planned budget. CEP and Home Performance had lower costs than planned. For Multi-Family, EEP, and Home Comfort, the additional spending correlates to an increase in impacts over planned impacts. Alternatively, REAP and All Electric Homes had lower impacts than planned, but more budget was spent than planned. This indicates a relatively higher implementation cost than what was planned for these programs.

Table 2-4: Energy Efficiency Portfolio Costs (Planned vs. Actual)

Sector	Program	Planned Budget	Actual Spending	Actual/Planned
Commercial	Commercial Efficiency Program (CEP)	$35,420,889	$22,898,674	65%
	Multi-Family	$793,440	$3,369,735	425%
Residential	Energy Efficiency Products (EEP)	$17,450,595	$19,546,663	112%
	Home Comfort (HC)	$14,595,782	$24,352,650	167%
	Home Performance	$7,595,513	$7,066,285	93%
	Home Energy Management (HEM)	$2,242,341	$2,266,903	101%
	Residential Energy Affordability Program (REAP)	$2,029,600	$2,504,349	123%
	All Electric Homes	$148,881	$849,958	571%
Subtotal Commercial		$36,214,329	$26,268,410	73%
Subtotal Residential		$44,062,712	$56,586,809	128%
Total Energy Efficiency Portfolio		$80,277,041	$82,855,218	103%

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 often 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, cost-effectiveness is applied retrospectively to answer the following questions:

- Were the 2023 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 greenhouse gas 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

[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.

avoided costs, discount rates, and line losses match those used for PSEG Long Island's latest Utility 2.0 filing.

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.

3.1 COST-EFFECTIVENESS RESULTS

Table 3-1 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 1.19 and 1.56 for Commercial and Residential Energy Efficiency and Beneficial Electrification programs, respectively. The full energy efficiency and beneficial electrification portfolio SCT value is 1.42. A benefit/cost ratio greater than 1.0 indicates that portfolio benefits outweigh costs, and from a societal perspective the Energy Efficiency and Beneficial Electrification Portfolio is cost-effective.

Table 3-1: 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	$35,545	$29,974	1.19
	Multi-Family	$7,084	$5,919	1.20
Total Commercial Portfolio		**$42,629**	**$35,893**	**1.19**
Residential	Energy Efficient Products	$53,916	$26,611	2.03
	Home Comfort	$60,832	$40,522	1.50
	Residential Energy Affordability Partnership	$1,388	$2,409	0.58
	Home Performance	$7,862	$9,382	0.84
	All Electric Homes	$138	$932	0.15
	Home Energy Management	$3,902	$2,411	1.62
Total Residential Portfolio		**$128,037**	**$82,266**	**1.56**
Total Portfolio[1]		***$170,667***	***$120,068***	***1.42***

[1] Portfolio costs include $1.9M of advertising that was not allocated to individual programs

In the 2023 cost-effectiveness analysis, the marginal emissions rate (tons per MWh) was updated to align with the EPA eGRID Report, increasing the value slightly. Holding all else constant, a higher marginal emissions rate improves cost effectiveness for energy efficiency and decreases cost effectiveness for beneficial electrification. The SCT ratio varies by program, falling below 1.0 for the

REAP, Home Performance, and All Electric Homes programs while CEP, Multi-Family, EEP, Home Comfort, and HEM all had SCT ratios above 1. 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 1.19 in 2023 compared to 1.12 in 2022. 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. There is much more beneficial electrification implementation and less lighting relative to the 2022 program year. As CEP continues the trend away from lighting and towards beneficial electrification, it will be important to watch its influence on the SCT ratio.
- **Multi-Family:** The SCT ratio for Multi-Family is 1.20 in 2023 compared to 1.37 in 2022. Like CEP, the Multi-Family program saw an increase in beneficial electrification measures in 2023 compared to 2022. For beneficial electrification measures, it is useful to also consider results of the RIM test discussed further both in Section 3.1.1 and Appendix C.
- **EEP:** EEP continues to be one of the most cost-effective programs in the portfolio with a SCT ratio of 2.03 in 2023 compared to 1.48 in 2022. There was a mix of changes in the EEP program that could have contributed to the increased cost effectiveness. Relative administrative costs decreased from 2022 to 2023. Additionally, the EUL for heat pump pool heaters increased from 8 to 15 years to align with the NYS TRM, improving the cost effectiveness for that measure and the EEP program. Additionally, two marginal measure categories, electric lawn equipment and appliance recycling measures, were sunset in the 2023 program year.
- **Home Comfort:** The SCT ratio for Home Comfort is 1.50 in 2023 compared to 1.81 in 2022. In 2023 the avoided costs of natural gas and fuel were updated resulting in lower values associated with these fuels. This, along with the higher marginal emission rate, place downward pressure on the SCT for a program dominated by heat pumps. Additionally, the Home Comfort program saw a higher percentage of whole home installations for ASHP Mini-Splits, which have a higher incremental cost per unit of savings than partial home installations.
- **REAP:** The SCT ratio for REAP is 0.58 in 2023 compared to 0.22 in 2022. Cost-ineffectiveness is not unusual for income-qualified programs, which typically are not required to be cost-effective. In section 5.1.3, we discuss additional non-energy impacts that can potentially be incorporated into cost effectiveness as low-income benefits. Additionally, the realization rate for REAP was much higher for the 2023 program year which increases the SCT benefits and improves cost effectiveness.
- **Home Performance:** The SCT for Home Performance is 0.84 in 2023 compared to 1.02 in 2022. The ratio has been close to 1.0 since 2020 but dipped below 1.0 in 2023. The types of measures implemented in Home Performance are long-term, capital-intensive investments

in the home, so an SCT ratio around 1.0 is expected. This includes an increase in heat pump adoption through the program. Additionally, an increased focus on weatherization measures such as building envelope and duct and air sealing has potential to drive down SCT cost effectiveness as these are traditionally high-cost, lower-impact measures. The Home Performance realization rate was lower in 2023 compared to 2022. This lowers the resource savings and SCT benefits, driving cost effectiveness down. For beneficial electrification measures, it is useful to also consider results of the RIM test. For energy efficiency it is useful to consider the results of the UCT tests. Both are discussed further in Section 3.1.1 and Appendix C.

- **All Electric Homes:** The SCT ratio for AEH is 0.15 in 2023 compared to 1.02 in 2022. The cost of the three projects increased greatly over the first program year. In 2022, the AEH program spent a total of $18,874 for two projects (about $9,437/project), while in 2023 $849,958 was spent on three projects (about $283,319/project). Most of the cost increase comes from the $818,474 of contractor fees allocated to the All Electric Homes program.
- **HEM:** The SCT is 1.62 in 2023, a slight increase compared to 1.60 in 2022. The cost effectiveness increased relative to 2022 due to a relative increase in per-customer energy savings.

Figure 3-1 shows SCT ratios for each program. Note that the size of markers is proportional to the ex-post MMBtu savings for each program.

Figure 3-1: Societal Cost Test Ratios by Program

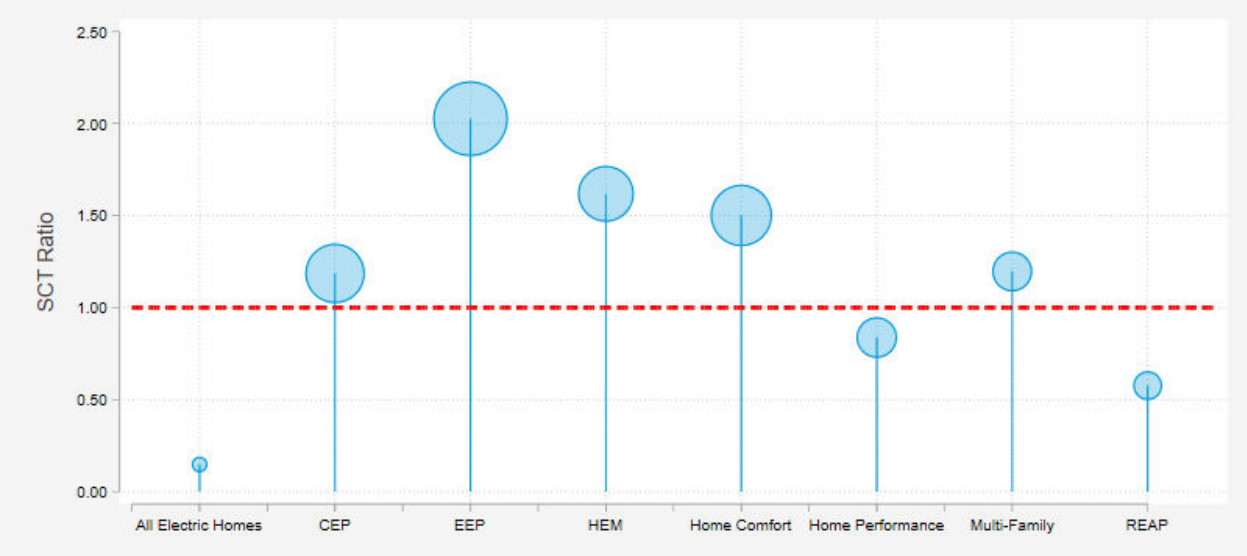


Figure 3-2 summarizes the benefit and cost categories analyzed and the share each contributed to the SCT. The primary two benefits for the SCT are other fuel impacts at 38% and avoided carbon emissions at 23% of benefits. The combined benefits for capacity (generation, transmission, distribution) together comprise about 11% 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. Incremental measure costs paid by participants net of incentives account for 36% of the Net NPV Cost Shares and portion paid by the utility accounts for 37% of the 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 26% of societal costs.

Figure 3-2: Portfolio Net Present Value Benefit and Cost Shares by Category

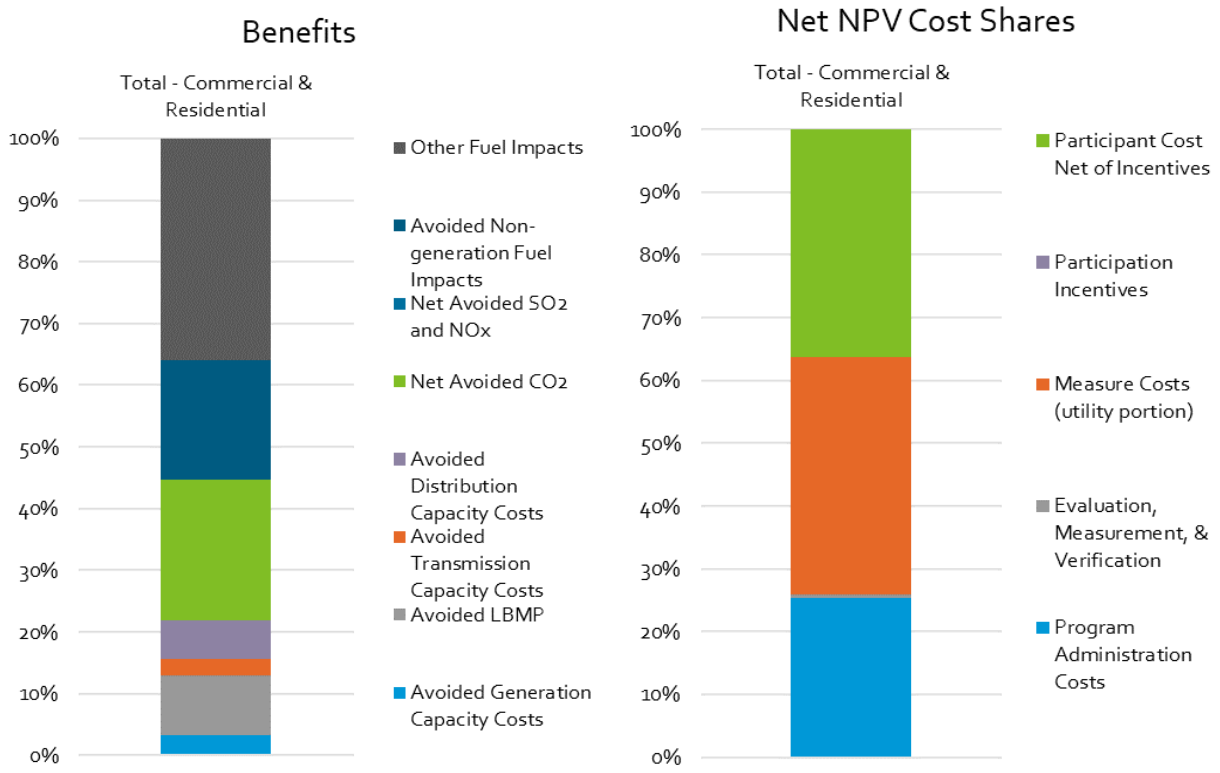


Table 3-2 shows the distribution of SCT benefits for beneficial electrification measures, Table 3-3 shows the distribution of SCT benefits for energy efficiency measures, and Table 3-4 shows the distribution of SCT benefits for the portfolio as a whole. The cells highlighted in orange are the top three benefit categories for each group. These tables show that most of the benefits fall into fuel categories such as avoided natural gas and delivered fuel impacts. As the porfilio shifts towards more beneficial electrification, we can expect to see this trend continue. While PSEG Long Island is an electric utility and the cost its programs are funded through electric rates, most of the portfolio benefits come from fossil fuel savings and avoided greenhouse gas emissions.

Table 3-2: Beneficial Electrification Detailed Benefits Breakout

	Avoided LBMP	Avoided Generation Capacity Costs	Avoided Transmission Capacity Costs	Avoided Distribution Capacity Costs	Avoided GHG	Avoided Natural Gas Impacts	Delivered Fuel Impacts
Commercial	$512	$1	$1	$3	$1,746	$6,226	$3,719
Residential	$7,038	$284	$168	$409	$6,706	$20,560	$57,094
Portfolio	**$7,550**	**$285**	**$169**	**$411**	**$8,453**	**$26,786**	**$60,814**

Table 3-3: Energy Efficiency Detailed Benefits Breakout

	Avoided LBMP	Avoided Generation Capacity Costs	Avoided Transmission Capacity Costs	Avoided Distribution Capacity Costs	Avoided GHG	Avoided Natural Gas Impacts	Delivered Fuel Impacts
Commercial	$9,934	$2,345	$2,050	$4,952	$13,405	$269	$971
Residential	$13,532	$2,699	$1,807	$4,293	$17,099	$5,955	$4,469
Portfolio	**$23,466**	**$5,043**	**$3,857**	**$9,244**	**$30,504**	**$5,686**	**$3,498**

Table 3-4: Total Portfolio (EE and BE) Detailed Benefits Breakout

	Avoided LBMP	Avoided Generation Capacity Costs	Avoided Transmission Capacity Costs	Avoided Distribution Capacity Costs	Avoided GHG	Avoided Natural Gas Impacts	Delivered Fuel Impacts
Commercial	$9,422	$2,346	$2,051	$4,954	$15,151	$5,957	$2,748
Residential	$6,494	$2,982	$1,975	$4,702	$23,806	$26,515	$61,564
Portfolio	**$15,915**	**$5,328**	**$4,026**	**$9,656**	**$38,957**	**$32,472**	**$64,312**

3.1.1 Cost Effectiveness Tests: Resource of Interest and Best Test to Measure Cost Effectiveness

While the SCT is the primary cost test for the Energy Efficiency and Beneficial Electrification portfolio, it is worth exploring the information provided by both the Utility Cost Test (UCT) and Ratepayer Impact Test (RIM). The UCT is a good secondary test for Energy Efficiency measures, whereas the RIM is a useful secondary test for the Beneficial Electrification measures. The RIM Test views cost-effectiveness from the perspective of non-participating ratepayers and assesses whether the change in electric rates due to program activity outweighs costs of operating the programs.

At the portfolio level, the UCT ratio is 0.41, however when evaluated only for Energy Efficiency impacts the UCT ratio increases to 0.94. Specifically, programs with higher concentration of energy efficiency measures, such as EEP, see higher cost effectiveness ratios under the UCT compared to programs consisting of mostly beneficial electrification measures. Alternatively, the RIM ratio is 0.40 at the portfolio level, but when evaluated for Beneficial Electrification measures, the RIM ratio increases to

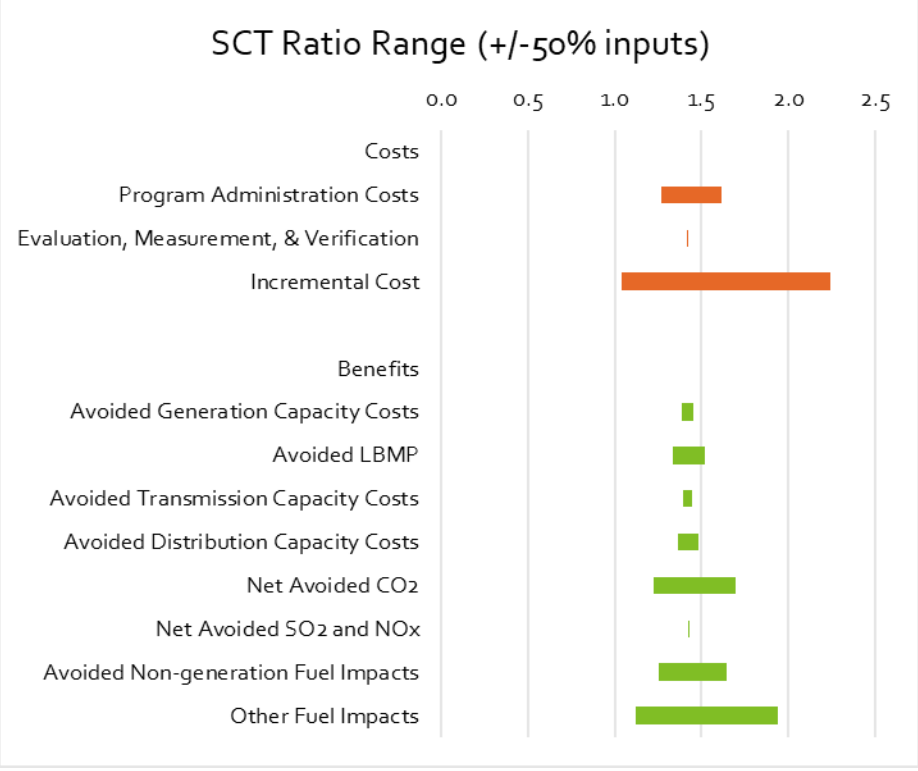
1.35. Programs consisting of mostly beneficial electrification, such as Home Comfort, have highly cost-effective RIM results. This indicated that the beneficial electrification measures are cost effective from the non-participating ratepayer perspective.

Appendix C provides additional detail on the UCT and RIM results.

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 3-3 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 1.04. If incremental costs are 50% lower, the portfolio SCT ratio would be about 2.25. Similarly, if the avoided cost of carbon was 50% lower, the portfolio SCT would be 1.22, but if avoided carbon costs were 50% higher, the portfolio SCT ratio would be 1.70. The sensitivity analysis demonstrates that the SCT cost-effectiveness results are primarily driven by incremental cost assumptions, followed by administrative costs, other fuel impacts, and avoided carbon costs. This finding is logical given that these components comprise the largest shares of costs and benefits, respectively.

Figure 3-3: Portfolio SCT Ratio Sensitivity to +/-50% Changes in Costs & Benefits



In addition to varying cost and benefit inputs up and down, we conducted a sensitivity analysis 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 as the carbon intensity of the power supply decreases, 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.[3] Table 3-5 shows the program and portfolio SCT results for this sensitivity scenario. The SCT ratio dropped from 1.42 to 1.39. On a relative basis, this drop is 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, which relies primarily on beneficial electrification, shows a modest increase in the SCT.

Table 3-5: Societal Cost Test Results for Declining Emissions Sensitivity

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	SCT Ratio (Sensitivity)	SCT Ratio (Base)
Commercial	CEP	$30,534	$29,976	1.02	1.19
	Multi-Family	$7,190	$5,920	1.21	1.20
Total Commercial Portfolio		**$37,725**	**$35,896**	**1.05**	**1.19**
Residential	Energy Efficient Products	$51,062	$26,611	1.92	2.03
	Home Comfort	$64,597	$40,522	1.59	1.50
	REAP	$1,353	$2,409	0.56	0.58
	Home Performance	$8,086	$9,382	0.86	0.84
	All Electric Homes	$144	$932	0.15	0.15
	Home Energy Management	$3,902	$2,411	1.62	1.62
Total Residential Portfolio		**$129,143**	**$82,266**	**1.57**	**1.56**
Total Portfolio [1]		**$166,868**	**$120,068**	**1.39**	**1.42**

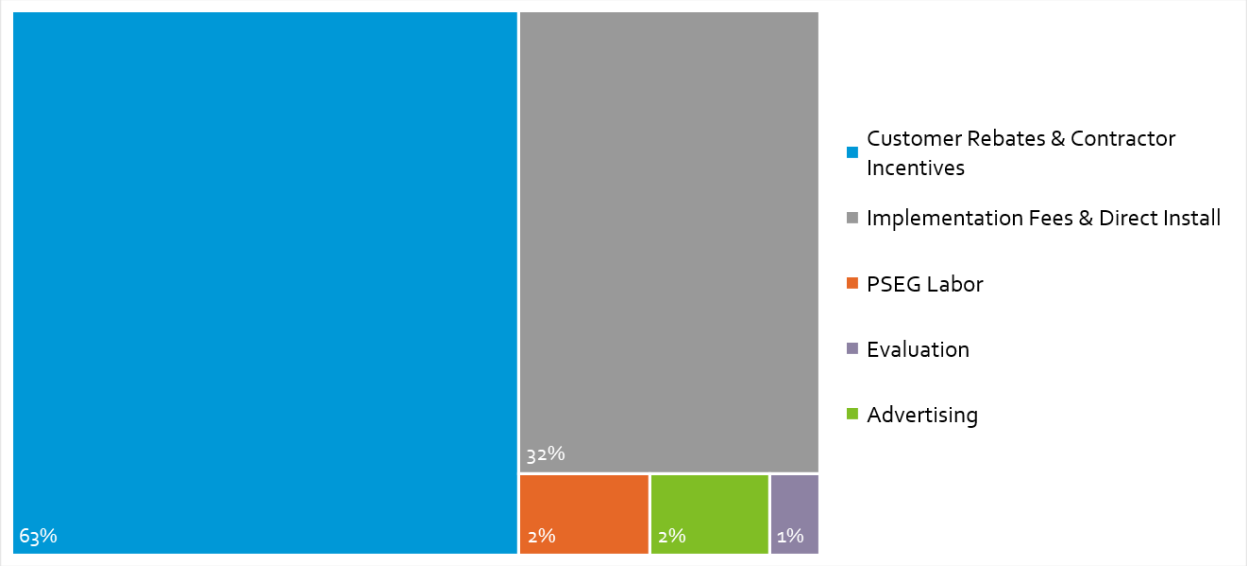
[1] Portfolio costs include $1.9M of advertising that was not allocated to individual programs

3.3 2023 EXPENDITURE SUMMARY

PSEG Long Island spent $85.55 million on the Energy Efficiency and Beneficial Electrification Portfolio in 2023, compared to $75.37 million in 2022. Figure 3-4 summarizes spending related to implementation, management, and evaluation of programs in the 2023 Portfolio by type of expenditure. Customer "Rebates" consist of payments made to participating customers, and Contractor "Incentives" consist of payments made to participating contractors (e.g., heating, ventilation, and air conditioning (HVAC) installers).

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

Figure 3-4: 2023 PSEG Long Island Expenditures for the EE and BE Portfolio



4 ECONOMIC IMPACT MODELING

Table 4-1 summarizes the estimated changes to Long Island's overall economic output and employment resulting from PSEG Long Island's 2023 Energy Efficiency Energy portfolio investments. Over 25 years, the 2023 investments in the Energy Efficiency Portfolio are expected to return $533.0 million in total economic benefits to the regional economy (in 2023 dollars), with an employment benefit of 1,512 direct and indirect full-time equivalent employees (FTEs)[4] over that period. Of these 1,512 FTEs, 1,073 are considered direct jobs and 439 are indirect jobs with an average wage of $45.68/hour.

Table 4-1: Economic Impact of 2023 Portfolio Investments

2023 Portfolio Investments		2023 Economic Impact	2023-2047 Economic Impact NPV[a]
Economic Impact	Total Economic Output	$304.6	$533.0
	Direct Effects	$254.7	$254.7
	Indirect & Induced Effects	$49.9	$278.2
	Employment, Total FTE	1,095	1,512
	Employment, Direct FTE	784	1,073
	Employment, Indirect FTE	311	439
Impact per $1M Investment	2023 Program Investment (Millions)	$85.6	$85.6
	Total Economic Output in Dollars per $1M Investment	$3.56	$6.23
	Employment (FTE) per $1M Investment	12.8	17.7

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

Employment is positively correlated with Program investment and with increased disposable income from participant energy cost savings. Program Year 2023 investment was $85.6 million, representing an increase of $10.2 million over Program Year 2022. This increase was largely due to higher rebate costs associated with the expansion of the Home Comfort program to Low-to-Moderate Income customers. Program Year 2023 projected employment increased to 784 direct FTEs from 478 direct FTEs in Program Year 2022, commensurate with higher Program investment. Program Year 2023 participant energy cost savings over 25 years are projected to create 439 direct and indirect FTEs in addition to the 1,095 FTEs from Program investment, totaling 1,512 FTEs as shown in the table above.

The net present value (NPV) of economic output of $533 million equals the present value of participant energy costs savings over 25 years of $228.4 million plus the 2023 economic impact of $304.6 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.

[4] 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.

5 TRENDS IN ENERGY EFFICIENCY AND BENEFICIAL ELECTRIFICATION

New York has several sweeping and ambitious statewide clean energy goals. In 2018, the New Efficiency: New York (NE:NY) white paper was published. In 2019, building on the initiatives set in NE:NY, 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 two million climate-friendly, 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 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 and low income communities.

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
Achieve a minimum of 1 million electrified homes and up to 1 million electrification-ready homes by 2030
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.

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 cold climate 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 DISCUSSION ON THE NE:NY ORDER AND THE CLCPA

5.1.1 A Shift in Traditional Energy Efficiency Programs to Heat Pumps and Weatherization

Federal and state regulators are pushing for fundamental changes in how the energy system operates. As a result of Governor Cuomo's directive to establish a Statewide energy efficiency initiative, in April 2018, the New Efficiency: New York (NE:NY) white paper was published. This white paper set a statewide target of 185 TBtu in energy efficiency savings from 2019-2025. For PSEG Long Island, this translates to 7.85 TBtu of total savings by 2025.

These goals were established to fast-track progress towards New York's greater 40 by 30 climate goal, set forth in Governor Cuomo's 'Reforming the Energy Vision' (REV) initiative. The progress of these efforts culminated in signing into law the Climate Leadership and Community Protection Act (CLCPA) on July 18, 2019. This new law reinforced the NE:NY and REV targets by formalizing the goals set by both into law through the legislation.

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.

In July 2023, the New York Public Service Commission published an Order[5] with directions for the Energy Efficiency and Building Electrification portfolios of NYS Utilities as they pertained to the New Efficiency: New York (NE:NY) and Clean Energy Fund Portfolios. Within this order, the Commission acknowledged that while historically, portfolios were encouraged to pursue the lowest-cost, highest savings measures, it was now time to shift focus towards measures that implement building electrification, building envelope, and HVAC controls. These measures are typically higher cost, lower savings.

As a result, while LIPA is not ordered to follow any of these requirements, PSEG Long Island's energy efficiency programs are undergoing a necessary shift in focus to align with the changes the NY IOUs are making. As traditional low-cost, high-yield energy efficiency measures like LED lighting become required by federal standards and phase out of program offerings, higher-cost and more deep-cutting measures, such as HVAC and building envelope, will come into focus. Additionally, much more emphasis has been put on beneficial electrification measures, specifically heat pumps.

5.1.2 Introducing a Strategic Framework

In the most recent NE:NY order, issued July 2023, a Strategic Framework was established categorizing Energy Efficiency and Beneficial Electrification measures under three categories: 1) Strategic, 2) Neutral, and 3) Non-Strategic. At a high level, the plan encourages utilities to expand measures that fall under the strategic category and phase out non-strategic measures. Figure 5-1 outlines the definitions for each category as written in the order.

[5] Link to July 2023 Order: https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={E0F27489-0000-CF14-9DBB-3BE183AC4793}

Figure 5-1: Strategic Framework Definitions

Strategic Measures and Programs	1. "permanently reduce and/or eliminate electricity or natural gas usage on an annual basis, which would not occur absent the program's intervention; 2. permanently reduce and/or eliminate electricity or natural gas usage on a peak-hour or peak-day basis, respectively (in areas of current or anticipated near-term supply constraints), which would not occur absent the program's intervention; 3. improve the building envelope resulting in near-term reduction in electricity or fossil fuel usage that will also serve to mitigate future winter peaking on the electric grid in the event the buildings heating system is electrified; or, 4. permanently reduce and/or eliminate on-site combustion of fossil fuel usage on an annual basis, through the installation of efficient space heating or hot water electrification, which would not occur absent the program's intervention."
Non-Strategic Measures and Programs	1. "jeopardize the advancement of Strategic energy efficiency and/or building electrification programs or measures; 2. increase the use of fossil fuels; 3. have an Effective Useful Life of six years or less; 4. do not promote conservation behaviors and result in use of more energy through increased operation of a measure; or 5. are naturally occurring energy efficiency that results from codes and standards, or through routine market adoption which typically occurs without targeted financing options, rebates, or incentives."
Neutral Measures and Program:	1. "neither advance nor jeopardize Strategic programs or measures, but produce overall reductions in annual energy consumption and do not have any characteristics considered Non-Strategic."

The guidelines established around this strategic framework require that 85% of budget in 2026 is to be put towards strategic measures, none will be applied to non-strategic measures, and up to 15% towards neutral measures. Measures falling under the non-strategic category, and therefore not allowed after the 2025 program year, include:

- **Natural gas-fired equipment:** Equipment such as residential natural gas space heating, domestic hot water, natural gas fireplace, and other natural gas equipment.
- **Lighting:** Lighting controls are allowed in commercial buildings when installed with other strategic measures.
- **Appliances:** Electric plug-in appliances such as refrigerators, freezers, clothes washers, or any other residential or commercial equipment not permanently connected to the building.
- **Home energy reports:** HERs cannot be supported with EE/BE budgets.
- **Marketplaces:** Program administrators who plan to operate an online marketplace post-2025 would need to provide justification for the continued support of the marketplace.

Assuming LIPA wishes to align its conservation programming with the New York utilities subject to the order, PSEG Long Island's EE and BE portfolio will have to undergo a major shift between the 2025 and 2026 program years. With the sunset of highly cost-effective program measures such as appliances, lighting, and home energy reports, and increased emphasis on measures and with historically lower cost effectiveness such as beneficial electrification measures and weatherization, it will become much more expensive to yield the same level of impacts as prior program years. The residential Energy Efficient Products Program (EEP), which has consistently been the highest saving and most cost-effective program in the portfolio, is currently composed almost entirely of non-strategic measures. In 2025, EEP will undergo a major shift by phasing out these measures and focusing on battery operated lawn equipment, ad hoc weatherization measures, and heat pump water heaters. Alternatively, Home Performance and Home Comfort programs will both grow with Home Performance traditionally focusing on weatherization measures and Home Comfort focusing on heat pump installations.

Non-residential programs will be similarly affected by the loss of LED lighting measures. In 2023, LED lighting accounted for over 60% of ex-post gross MMBtu savings across the CEP and Multi-Family programs. The strategic measures of interest for 2026 will require more program investment per MMBtu than lighting according to every planning study our team has reviewed.

5.1.3 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 voted on and approved the final criteria for identifying Disadvantaged Communities (DACs) in March 2023. The 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 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, 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 or who live in DAC communities, and by targeting households 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-energy system impacts and benefits that low-income programs bring to the community. Non-energy 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.[6] 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,
- Increased home productivity, and
- Reduced home fires.

The National Standard Practice Manual for Benefit-Cost Analysis (NSPM)[7] 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. However, 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.[8] 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 benefits-based LMI requirements.

Historically, PSEG Long Island's REAP program focused on electric 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,

[6] 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

[7] NSPM for Benefit-Cost Analysis of Distributed Energy Resources: https://www.nationalenergyscreeningproject.org/wp-content/uploads/2020/08/NSPM-DERs_08-24-2020.pdf

[8] 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

PSEG Long Island is expanding REAP offerings to target fossil fuel savings in addition to electricity savings.

5.1.4 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.

5.1.4.1 Cost of Natural Gas

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 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. As the electric generation mix decarbonizes, the marginal cost of electricity should become increasingly decoupled from the avoided cost of fossil fuel.

5.1.4.2 Value of Avoided CO2 Emissions

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 2023, avoided CO_2 emissions was the second largest benefits category, representing 23% of all SCT benefits.

- The current social cost of carbon assumed in the PSEG Long Island Cost Effectiveness evaluation is $61.40 per metric ton, or $55.70 per short ton, and the portfolio SCT is 1.42.
- In neighboring Pennsylvania, the 2021 Act 129 Total Resource Cost Test Order[9] 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 1.27.
- In November 2023, the EPA Interagency Working Group published guidance[10] that established a central cost of carbon of $120/metric ton in 2020 dollars. If our avoided cost of carbon was updated to match this guidance, the portfolio benefit cost ratio would be 1.57.

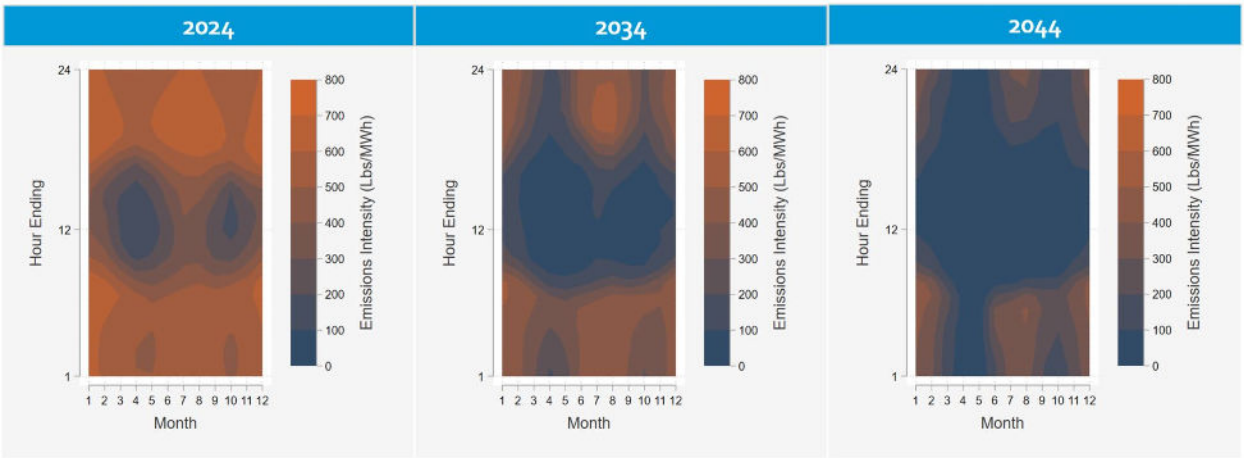
The social cost of carbon is not a technical metric, it's a policy decision. As an evaluator we cannot determine which value is correct, but we would recommend PSEG Long Island review this key assumption with LIPA. It's an important driver of cost-effectiveness results for both energy efficiency and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

[9] https://www.puc.pa.gov/pcdocs/1648126.docx
[10] https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf: Table ES.1

5.1.4.3 Marginal Emissions Rate

As described in Section 3, current modeling practices in New York use a marginal emissions 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 5-2 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.

Figure 5-2: Example Emissions Profiles in a Highly Decarbonized Grid (Maryland)



5.1.5 Expanding Heat Pump Deployment

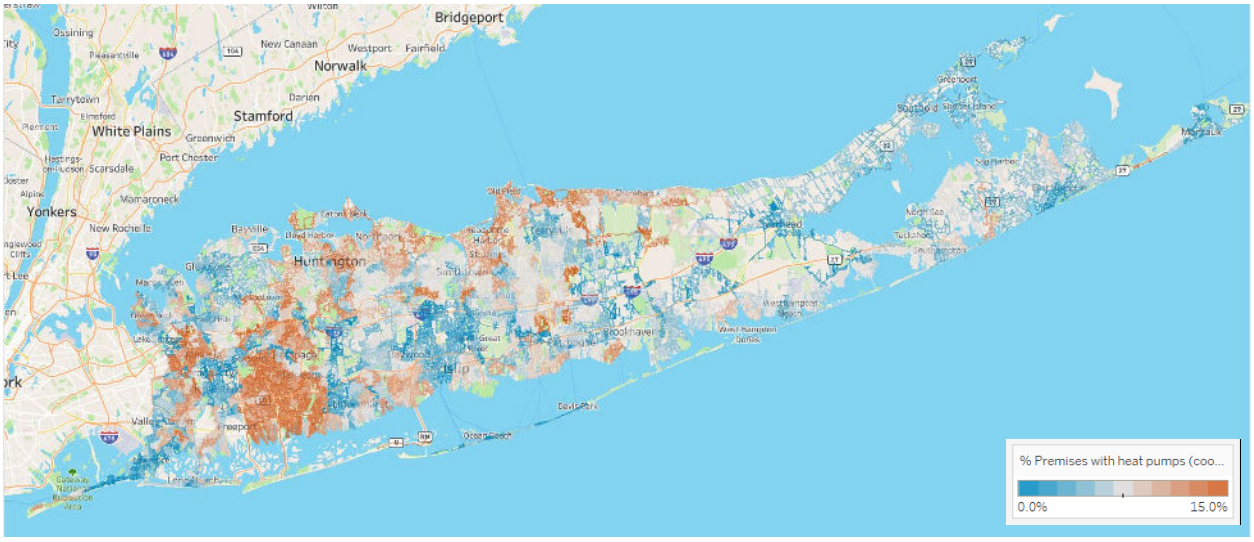
Heat pumps are a critical technology for electrification efforts. This umbrella term includes heat pumps for space heating and cooling, heat pump pool heaters, and heat pump water heaters. Heat pumps use electricity to move heat in buildings and can replace technologies like furnaces or boilers that 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 2025, 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 67,000 dwellings with whole house heat pumps between 2023 and 2030. There is a notable pivot point in 2026 when new codes and standards are enacted for New Construction. These new codes will require new buildings to

install heat pumps. This will push the Beneficial Electrification Program to focus only on retrofit projects as new construction will no longer be available for heat pump programs. Due to the increased importance of heat pumps and the sunset of new construction options under beneficial electrification programs, we recommend that PSEG Long Island run sensitivity analyses to estimate the effect of contractor and customer incentives on heat pump adoption.

Figure 5-3 shows the distribution of heat-pumps as of May 2024, highlighting the percent of homes on the feeder with a program-supported heat pump. Deeper orange pockets represent areas with higher heat pump penetration. From this figure, we can see that PSEG Long Island's efforts to install heat pumps are working, but 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 patterns on feeders and transformers.

Figure 5-3: Distribution of Cumulative Heat Pump Installations through May 2024



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 ASHP 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 specifically targeted customers who would benefit and are more likely to install heat pumps.

The heat pump application process is complex for contractors with requirements for Manual J load calculations. To alleviate some of the burden on the contractor, TRC streamlined the application workbook. The NEEP List is now integrated in the workbook, so the contractor just needs to enter the

AHRI number and Manual J data. For the existing equipment, contractors still must collect the equipment type, but the application workbook assigns existing equipment efficiencies based on the PSEG LI TRM. In 2023 and 2024, TRC increased contractor engagement by sending out monthly newsletters for program updates and training, updating training videos on YouTube, and increasing the number of QIV training centers. TRC also promotes contractors via Case Studies on the Home Comfort Website. Contractors can also apply for more "Smart Tools" reimbursements and marketing cost share.

Additionally, there has been a high historical uptake of heat pump pool heaters through the programs and relatively low uptake of heat pump water heaters. This indicates that there is high potential for heat pump water heater expansion in PSEG Long Island territory. PSEG Long Island plans to launch a midstream heat pump water heater offering within EEP in late 2024.

5.2 CONSUMPTION ANALYSIS IMPLICATIONS FOR A CHANGING PORTFOLIO

Regression analysis of electric meter data has been a key evaluation technique for several residential programs in PSEG Long Island's energy efficiency portfolio for many years. Evaluations of the REAP, Home Performance, and Home Energy Management programs all rely on modeling techniques that compare electric consumption changes amongst participating homes following program services to a comparison group of homes with no intervention. On one hand, this is arguably the most robust evaluation technique across the portfolio because ex-post savings come from real measurements at the revenue meter. Consumption analysis is an IPMVP[11]-adherent measurement and verification technique (IPMVP Option C) and does not require numerous assumptions like a TRM-based engineering analysis. The rollout of AMI across Long Island has allowed us to analyze more granular electricity consumption data and transition monthly models to daily or even hourly models. However, the evolution of PSEG Long Island's portfolio also creates challenges which call into question the suitability of consumption analysis for evaluation for some programs. Key issues include:

- **PSEG Long Island can only provide electric meter data.** As an electric utility, PSEG Long Island has rich electricity consumption data but no access to natural gas or delivered fuel consumption data. When program interventions primarily target electricity savings, this is of little concern. However, with the transition to MMBtu as the primary performance metric and the policy focus on weatherization in New York, PSEG Long Island's programs increasingly target fossil fuel savings. Table 5-1 shows the split of electric versus fossil fuel savings on an MMBtu basis for the three primary weatherization measures within the Home Performance with ENERGY STAR program component. Almost three-quarters of the claimed savings are from fossil fuel heating savings that are invisible to the electric meter.

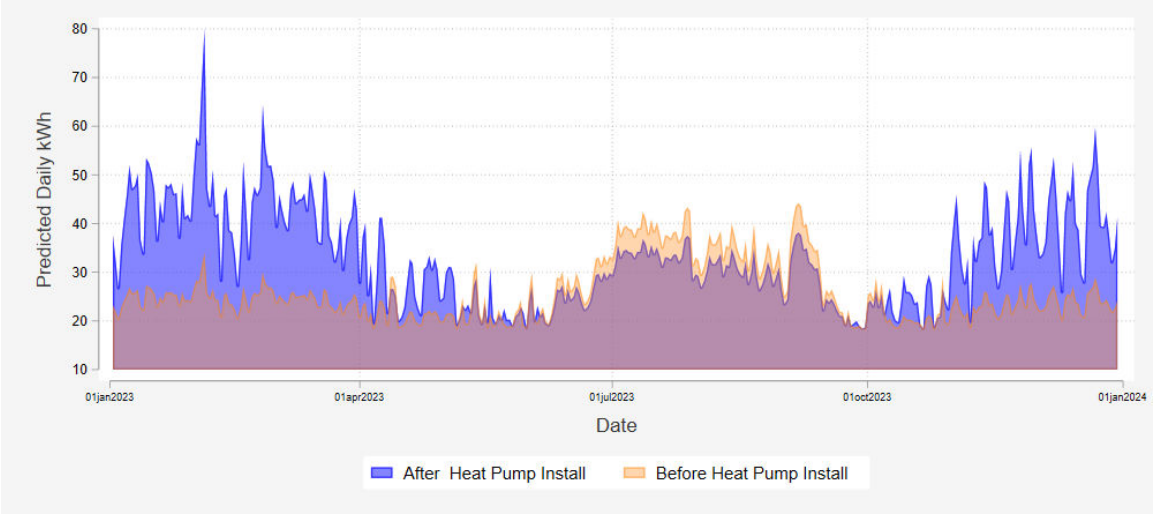
[11] International Performance Measurement and Verification Protocol. https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

Table 5-1: 2023 HPwES Ex-Ante Weatherization Savings by Fuel

HPwES Measure Type	MMBtu Total	MMBtu Electric	MMBtu Fossil Fuel
Duct Sealing	2,034	1,052	982
Air Sealing	3,421	1,114	2,308
Envelope	8,468	1,524	6,944
Weatherization Total	**13,923**	**3,690 (26.5%)**	**10,233 (73.5%)**

- **Promotion of heat pumps leads to increases in electric consumption that make it hard to detect energy efficiency.** Beneficial electrification and the promotion of heat pump technologies is a top policy priority on Long Island and across New York. Figure 5-4 shows the typical impact of a heat pump at the electric meter. Heat pumps generally save electricity in summer because they air condition more efficiently than the units they replace. But in the winter, they lead to a sharp increase in electric consumption relative to fossil fuel heat. This complicates consumption analyses due to the need for assumptions about fossil fuel displacement and introduces uncertainties that can significantly skew the accuracy of evaluations. Our current evaluation approach is to omit homes with BE measures from the consumption analysis. Some jurisdictions use increased winter electric consumption measured via consumption analysis as a proxy for fossil fuel heating savings, but this analysis requires several strong assumptions and would create significant evaluation risk for PSEG Long Island relative to the current TRM-based method used for Home Comfort and Home Performance heat pump projects.

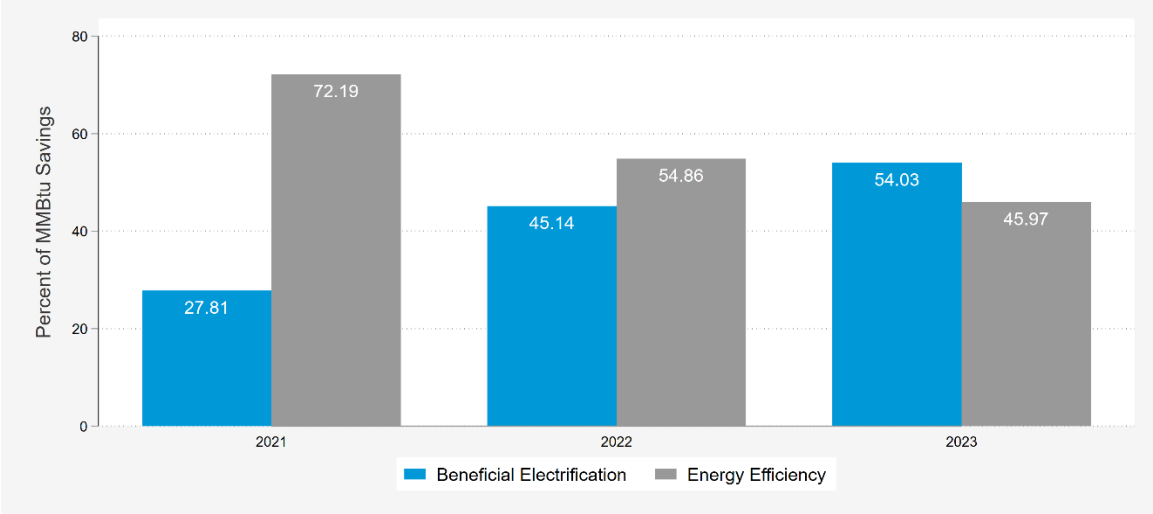
Figure 5-4: Residential Heat Pump Impact Time-Series



- **Beneficial electrification is becoming a larger component of the Home Performance program.** Figure 5-5 shows the share of MMBtu coming from EE and BE measures for the

last three years. Each year, the pool of EE-only homes shrinks, which limits the sample size of the consumption analysis – leading to noisier results.

Figure 5-5: Home Performance Ex-Ante MMBtu Savings by Year and Measure Type



- **Consumption analysis results are inherently noisy and carry more evaluation risk.** The precision of each consumption analysis is a function of the effect size and the number of homes analyzed. The HEM program has a huge estimation sample with over 500,000 treated households and 100,000 control group homes. However, the average impact per home is less than 1%, so the margin of error is ±30% or almost 40,000 MMBtu. Home Performance is also afflicted by the effect size issue. Because most participants only completed a Home Energy Assessment and received kit measures, the average ex-ante kWh savings represented just 3.2% of pre-retrofit annual billed electric consumption. If we removed HEA participants from the consumption analysis (along with BE homes), the estimation pool for Home Performance would shrink to a few hundred homes. Precision is also a concern for REAP. The 2022 evaluation estimated 264 kWh/year of electric savings per home with a 95% confidence interval ranging from 6 kWh to 523 kWh. Despite the noisy results, consumption analysis has made it clear that ex-ante gross kWh savings for REAP are too high and need to be addressed.
- **The metric used to measure goal achievement matters.** If the ex-post results are used to assess as a metric for goal achievement, the consumption analysis challenges described above become magnified. The alternative to consumption analysis is engineering analysis – where evaluators combine assumptions about equipment efficiency and operating characteristics algebraically to calculate savings. These equations and inputs are generally documented during planning and rarely change during ex-post evaluation. Consider the hours of use assumptions within the CEP Lighting program. Once these assumptions are established in the PSEG Long Island TRM and followed correctly during implementation, there is minimal risk that ex-post evaluation results will depart from ex-ante claims in a

material way. If the TRM assumes 3,463 operating hours for a Retail business, evaluators will use 3,463 hours to compute both verified ex-ante and ex-post savings. Consumption analysis is analogous to an ex-post evaluation procedure where actual lighting hours of use are measured and used to claim ex-post savings. Such an approach would clearly be more rigorous, but it would also create significantly more risk for departures between ex-post and ex-ante. Currently that risk is largely concentrated in the programs which rely on consumption analysis.

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
NE:NY	New Efficiency: New York
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 2023 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 2023 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[12] 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 also increase electricity consumption and demand. Thus, some program MWh and kW impact results show negative electricity savings.

[12] 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 B-1: 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	46,865	45,443	32,193
	Multi-Family Program	(303)	(374)	(396)
Residential	Energy Efficiency Products	128,330	125,476	75,912
	Home Comfort	(14,483)	(22,110)	(21,412)
	Home Performance	1,777	378	301
	Home Energy Management	32,758	37,090	39,320
	Residential Energy Affordability Program	2,023	448	475
	All Electric Homes	(19.5)	(13.7)	(17)
Subtotal Commercial		46,562	45,069	31,797
Subtotal Residential		150,386	141,268	94,577
Total Energy Efficiency Portfolio		**196,948**	**186,337**	**126,374**

[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 B-2: 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	15,056	10,572	7,634
	Multi-Family Program	53	137	148
Residential	Energy Efficiency Products	18,117	21,560	13,027
	Home Comfort	374	526	524
	Home Performance	2,232	2,038	1,632.61
	Home Energy Management [1]	8,697	8,697	9,370
	Residential Energy Affordability Program	267	57	61
	All Electric Homes	5	5	4
Subtotal Commercial		15,108	10,709	7,782
Subtotal Residential		29,693	32,883	24,620
Total Energy Efficiency Portfolio		**44,801**	**43,592**	**32,401**

[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

The Utility Cost Test (UCT) and the SCT are similar in most respects but consider slightly different benefits and costs in determining a benefit/cost ratio.[13] 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 delivery 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., natural gas and fuel oil) energy savings or increases, or greenhouse gas emissions. 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 C-1, the UCT ratio was 0.41 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 and Home Performance UCT ratios are negative, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, these programs raise the cost of operating the electric system. 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 C-2 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 ratio is 0.92 – much closer to 1.0. In contrast, the Home Comfort SCT ratio is 1.50 indicating that from the societal perspective, benefits do outweigh costs associated with this program comprised primarily of electrification measures.

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

Table C-1: 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	$18,759	$22,813	0.82
	Multi-Family	$14	$3,458	0.004
Total Commercial Portfolio		**$18,773**	**$26,271**	**0.71**
Residential	Energy Efficient Products	$19,435	$20,253	0.96
	Home Comfort	($5,851)	$24,444	-0.24
	Residential Energy Affordability Partnership	$153	$2,409	0.06
	Home Performance	($163)	$7,010	-0.02
	All Electric Homes	$0	$851	0.0005
	Home Energy Management	$2,578	$2,411	1.07
Total Residential Portfolio		**$16,153**	**$57,378**	**0.28**
Total Portfolio[1]		***$34,926***	***$85,554***	***0.41***

[1] Portfolio costs include $1.9M of advertising that was not allocated to individual programs

Table C-2: Utility Cost Test Results without Beneficial Electrification Measures

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$18,587	$17,467	1.06
	Multi-Family	$694	$716	0.97
Total Commercial Portfolio		**$19,281**	**$18,183**	**1.06**
Residential	Energy Efficient Products	$19,111	$17,579	1.09
	Home Comfort	$0	$0	NA
	Residential Energy Affordability Partnership	$153	$2,409	0.06
	Home Performance	$488	$2,476	0.20
	All Electric Homes	$0	$0	NA
	Home Energy Management	$2,578	$2,411	1.07
Total Residential Portfolio		**$22,330**	**$24,875**	**0.90**
Total Portfolio[1]		***$41,611***	***$44,367***	***0.94***

[1] Portfolio costs include $1.9M 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 viewed 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 the units of energy sold. The primary metric for

allocating costs across most ratepayers is consumption as measured by kWh. Because consumption is the denominator for determining rates, volumetric rates increase as total consumption decreases, and volumetric 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 C-3, the RIM ratio was 0.40 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 C-4 further reinforces this by showing the RIM ratio when energy efficiency is removed. The RIM ratio is cost effective at 1.35 for Beneficial Electrification measures only. Home Comfort, Home Performance, and Multifamily are all cost effective under this filter. For CEP, the Custom category was allocated to Beneficial Electrification because most measures in this group were heat pumps. Installation of heat pumps both saves kWh in the summer and adds kWh in the winter. There were also energy efficiency measures in the Custom category. When saved kWh and added kWh are roughly equal, as they were for CEP, neither the RIM or the UCT ratios will look favorable.

Table C-3: 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	$19,105	$109,571	0.17
	Multi-Family	$6,495	$8,523	0.76
Total Commercial Portfolio		**$25,600**	**$118,094**	**0.22**
Residential	Energy Efficient Products	$20,744	$114,331	0.18
	Home Comfort	$59,892	$31,200	1.92
	Residential Energy Affordability Partnership	$153	$3,274	0.05
	Home Performance	$6,573	$9,711	0.68
	All Electric Homes	$88	$870	0.10
	Home Energy Management	$2,578	$11,657	0.22
Total Residential Portfolio		**$90,027**	**$171,044**	**0.53**
Total Portfolio[1]		***$115,628***	***$291,044***	***0.40***

[1] Portfolio costs include $1.9M of advertising that was not allocated to individual programs

Table C-4: Ratepayer Impact Test Results without Energy Efficiency Measures

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$518	$6,685	0.08
	Multi-Family	$5,607	$3,422	1.64
Total Commercial Portfolio		**$6,125**	**$10,107**	**0.61**
Residential	Energy Efficient Products	$578	$5,897	0.10
	Home Comfort	$59,892	$31,200	1.92
	Residential Energy Affordability Partnership	$0	$0	NA
	Home Performance	$6,085	$5,222	1.17
	All Electric Homes	$88	$870	0.10
	Home Energy Management	$0	$0	NA
Total Residential Portfolio		**$66,643**	**$43,189**	**1.54**
Total Portfolio[1]		***$72,768***	***$53,893***	***1.35***

[1] Portfolio costs include $1.9M 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 C-5 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 and Home Performance are negative. Additionally, the first-year cost per kWh for the All Electric Homes and Multi-Family program is also negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table C-5: First Year Costs for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	2023 Ex-Post Gross UCT First-Year Acquisition Cost			2023 Ex-Post Gross SCT First-Year Acquisition Cost		
		$/MMBtu	$/kW-year	$/kWh	$/MMBtu	$/kW-year	$/kWh
Commercial	Commercial Efficiency Program	$203	$2,988	$0.71	$266	$3,926	$0.93
	Multi-Family Program	$115	$23,429	($8.73)	$198	$40,106	($14.94)
Subtotal Commercial Portfolio		**$184**	**$3,376**	**$0.82**	**$252**	**$4,612**	**$1.12**
Residential	Energy Efficient Products	$72	$1,555	$0.27	$94	$2,043	$0.35
	Home Comfort	$141	$46,350	($1.14)	$235	$76,835	($1.89)
	Residential Energy Affordability Partnership	$323	$39,177	$5.08	$323	$39,177	$5.08
	Home Performance	$294	$32,397	($4.31)	$393	$43,360	($5.76)
	All Electric Homes	$2,263	$218,172	($48.87)	$2,477	$238,805	($53.49)
	Home Energy Management	$19	$257	$0.06	$19	$257	$0.06
Subtotal Residential Portfolio		**$93**	**$2,472**	**$0.62**	**$134**	**$3,545**	**$0.89**
Total Portfolio		***$118***	***$2,774***	***$0.68***	***$165***	***$3,893***	***$0.96***

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 C-6 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 first-year cost per kWh for the Home Comfort program and Home Performance are negative. Additionally, the first-year cost per kWh for the All Electric Homes and Multi-Family program are also negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table C-6: Levelized Costs for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	2023 Ex-Post Net UCT Levelized Costs			2023 Ex-Post Net SCT Levelized Costs		
		$/MMBtu	$/kW-year	$/kWh	$/MMBtu	$/kW-year	$/kWh
Commercial	Commercial Efficiency Program	$19.05	$297	$0.07	$25.03	$390	$0.09
	Multi-Family Program	$11.27	$2,425	($0.67)	$19.29	$4,150	($1.14)
Subtotal Commercial Portfolio		**$17.46**	**$336**	**$0.08**	**$23.86**	**$459**	**$0.11**
Residential	Energy Efficient Products	$10.74	$357	$0.06	$14.12	$469	$0.08
	Home Comfort	$50.12	$8,218	($0.37)	$83.09	$13,623	($0.61)
	Residential Energy Affordability Partnership	$43.69	$5,371	$0.70	$43.69	$5,371	$0.70
	Home Performance	$48.21	$3,276	($2.59)	$64.52	$4,384	($3.47)
	All Electric Homes	$196.18	$18,470	($3.38)	$214.74	$20,217	($3.70)
	Home Energy Management	$17.97	$257	$0.06	$17.97	$257	$0.06
Subtotal Residential Portfolio		**$21.16**	**$800**	**$0.18**	**$30.34**	**$1,147**	**$0.26**
Total Portfolio		***$21.89***	***$576***	***$0.13***	***$30.71***	***$809***	***$0.19***

APPENDIX D VERIFIED EX-ANTE MEMO

Memorandum 2023 VERIFIED EX-ANTE SAVINGS

Date: January 31, 2024

To: Dan Zaweski, Mike Voltz, Ronan Murphy, and Gabrielle Scibelli (PSEG Long Island)

From: 2023 Evaluation Team (Demand Side Analytics, DNV, Mondre Energy, and BrightLine Group)

Re: 2023 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 and peak demand savings as part of its evaluation of PSEG Long Island's 2023 energy efficiency and beneficial electrification programs. This memorandum defines "verified ex-ante" (VEA) savings and presents the 2023 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 assumption used for planning. 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 2023 projects were completed using 2022 application workbooks with 2022 savings assumptions. For the purposes of VEA, we consider these "carryover" projects verified as long as 2022 algorithms and assumptions were correctly implemented.

The verified ex-ante savings are the first milestone of the 2023 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 2023 verified ex-ante savings for MMBtu. The verified ex-ante savings were 99.6% 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. Any calculations and assumptions that deviated from approved values are documented in Appendix B: Supplemental Detail.

Consistent with 2023 planning, the MMBtu savings in Table 1 incorporate fossil fuel heating penalties for lighting measures. LED lighting emits less heat as a byproduct compared to inefficient lighting technologies and this creates real HVAC interactive effects in participating homes and businesses. However, New York's investor-owned utilities (IOUs) operate fuel-specific energy efficiency programs where electric programs only report electric impacts and natural gas programs only report natural gas impacts. Since lighting falls within electric programs, the IOUs do not account for fossil fuel heating penalties when reporting the impacts of their lighting programs. For comparison, the evaluation team separately calculated portfolio energy savings without fossil fuel heating penalties for lighting measures in Table 5 of this memo.

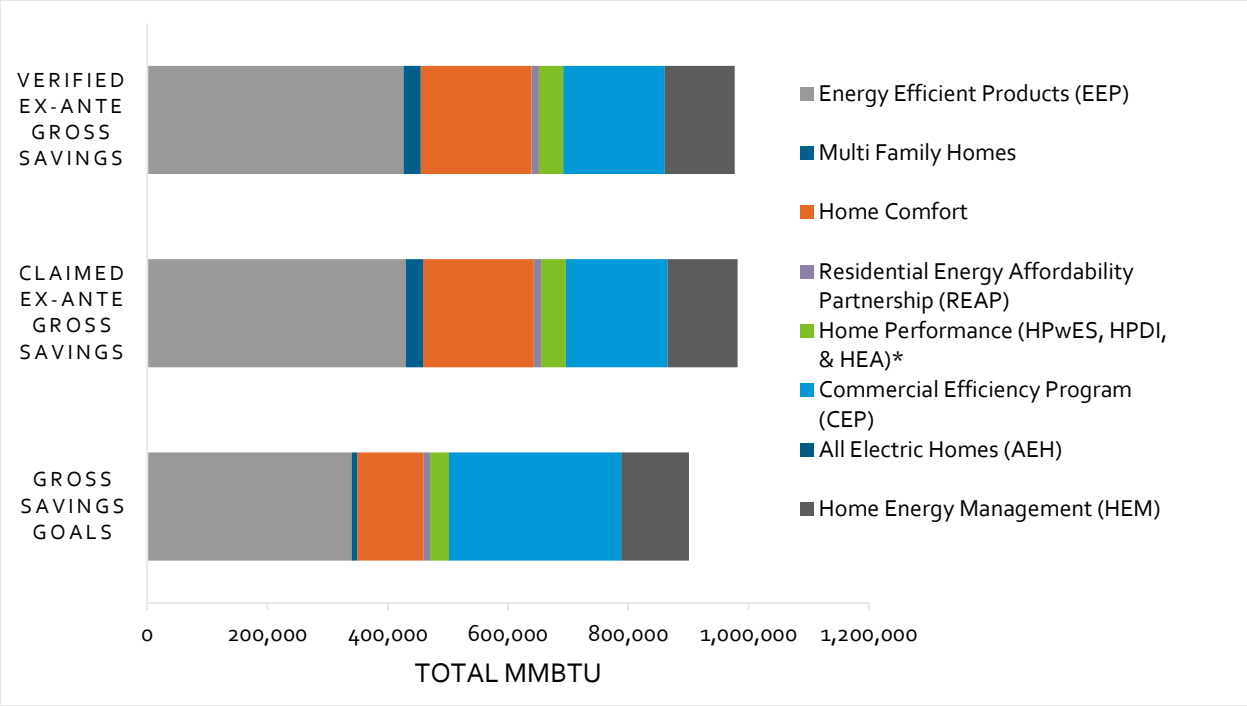
TABLE 1: SUMMARY OF 2023 VERIFIED EX-ANTE MMBTU SAVINGS AND GOALS

Program		2023 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)	286,309	169,017	168,677	99.8%	59%
	Multi-Family Homes Rebate	8,928	28,828	28,828	100.0%	323%
Residential	Energy Efficient Products (EEP)	339,857	429,963	426,082	99.1%	125%
	Home Comfort	110,518	184,211	184,223	100.0%	167%
	Residential Energy Affordability Partnership (REAP)	10,884	11,977	11,983	100.1%	110%
	Home Performance (HPwES, HPDI, & HEA)*	31,426	40,802	40,668	99.7%	129%
	All Electric Homes (AEH)	1,038	577	519	90.0%	50%
	Home Energy Management (HEM)	111,770	116,214	116,214	100.0%	104%
Total Commercial:		**295,236**	**197,845**	**197,504**	**99.8%**	**67%**
Total Residential:		**605,493**	**783,744**	**779,689**	**99.5%**	**129%**
Total Energy Efficiency:		**900,730**	**981,588**	**977,194**	**99.6%**	**108%**

*Claimed and Verified Ex Ante Savings for Home Performance include additional 5,596 MMBtu PSEG Long Island claims through their partnership with the National Grid Weatherization Program.

Figure 1 below shows that the Energy Efficiency Program, Commercial Efficiency Program, and Home Comfort programs were the top three contributing programs, together comprising 80% of verified ex-ante savings in 2023.

FIGURE 1: MMBTU CONTRIBUTIONS BY PROGRAM



Additionally, we developed a metric comparing verified ex-ante savings with the established annual savings goals. The portfolio verified ex-ante gross savings were 108.5% of the 2023 savings goals, exceeding PSEG Long Island's goals by 76,464 MMBtu. Residential programs exceeded their 2023 goal by 174,196 MMBtu, while the Commercial Programs fell short of goal by 97,732 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 2023 program year, goals were specifically set for total number of heat pumps installed, total number of unique housing units that received heat pumps, and number of distinct buildings enrolled in the Multi-Family Homes Rebate Program. Table 2 below shows the verified values for these metrics compared to the goal and claimed. The PSEG Long Island goal of 7,000 heat pump installations is based on the number of outdoor condensing units installed. We found 105 more heat pumps were installed than claimed. The goal of 1,656 housing units is based on the number of homes or multi-family apartment units receiving heat pumps. We found 51 additional housing units receiving heat pumps than claimed. Finally, the goal of 50 enrolled buildings in the multi-family program is based on the unique number of buildings enrolled to be treated by the program in 2023. We found 21 additional buildings were enrolled in the program than claimed. Both claimed and verified values exceed the goals set by PSEG Long Island for all three metrics.

Further detail on what drives the differences between the claimed and verified counts and enrollments 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)	7,000	9,879	9,984
Number of Housing Units served by Air Source Heat Pumps	1,656	3,688	3,739
Number of Buildings Enrolled - Multi-Family Homes Rebate	50	238	259

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 2023 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 2023 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)	53,016	51,003	96%
	Multi-Family Homes Rebate	2,021	2,255	112%
Residential	Energy Efficient Products (EEP)	130,305	130,234	100%
	Home Comfort	2,861	2,861	100%
	Residential Energy Affordability Partnership (REAP)	2,023	2,023	100%
	Home Performance (HPwES, HPDI, & HEA)*	3,697	3,676	99%
	All Electric Homes	17.7	17.3	98%
	Home Energy Management (HEM)	32,758	34,075	104%
Total Commercial:		**55,036**	**53,258**	**97%**
Total Residential:		**170,026**	**171,246**	**101%**
Total Energy Efficiency:		**225,063**	**224,504**	**100%**

*Claimed and Verified Ex-Ante Savings for Home performance include an additional 1,640 MWh PSEG Long Island claims through their partnership with the National Grid Weatherization Program.

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 2023 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)	15.11	16.26	108%
	Multi-Family Homes Rebate	0.05	0.07	131%
Residential	Energy Efficient Products (EEP)	18.12	21.89	121%
	Home Comfort	0.37	0.37	100%
	Residential Energy Affordability Partnership (REAP)	0.27	0.27	100%
	Home Performance (HPwES, HPDI, & HEA)*	2.24	2.40	108%
	All Electric Homes	.0050	.0048	96%
	Home Energy Management (HEM)[b]	n/a	n/a	n/a
Total Commercial:		**15.16**	**16.33**	**108%**
Total Residential:		**19.26**	**23.18**	**120%**
Total Energy Efficiency:		**34.42**	**39.51**	**115%**

*Claimed and Verified Ex-Ante Savings for Home Performance include an additional 1.76 MW PSEG Long Island claims through their partnership with the National Grid Weatherization Program.

Appendix B: Supplemental Detail

The evaluation team verified the calculations and inputs for hundreds of measures. The table below includes additional detail on nuances observed in the data from Captures as well as the calculations and assumptions used that drove the realization rate away from 100%. Captures is the project tracking database used by the program implementer TRC.

Program	Sub-Component	Description	Implications
CEP	Comprehensive Lighting	▪ We calculated verified ex-ante MW savings using the building type-based coincidence factors (CF) from 2023 PSEG Long Island TRM, whereas the program used a legacy CF of 0.75 for all interior lighting projects.	▪ A 115% MW realization rate for comprehensive lighting measures.
	Refrigerated Case Lighting	▪ TRC applied PSEG 2010 assumptions for a number of projects, based on the 2010 NYS Tech Manual. Planning spreadsheet recommended an algorithm based on NYS TRM v9.	▪ Refrigerated Case Lighting constituted 1% of overall CEP lighting savings.
	Refrigeration	▪ Corrected evaporator fan motor HP input error for one measure where the recorded HP was many magnitudes higher than typical.	▪ Resulted in 88% MMBtu Realization Rate.
	Motors & VFD	▪ Corrected building type for one measure and increased kWh and kW per HP accordingly.	▪ This resulted in 101% MMBtu Realization Rate.
	HVAC	▪ Updated EFLH values for a large geothermal project to align with the building type resulting in reduced heating and cooling EFLH.	▪ Resulted in 88% MMBtu Realization Rate.
	Multi-Family Homes Rebate	▪ During the verification process, we identified that MWh and MW savings were underreported for 4 projects which included ENERGY STAR Clothes Washers, ENERGY STAR Refrigerators and ENERGY STAR Dishwashers.	▪ A 115% MWh realization rate and 131% MW realization rate for multi-family program.

Program	Sub-Component	Description	Implications
EEP	Advanced Power Strips	▪ The KPI Scorecard contains duplicate rows for the Tier 2 APS, which corresponds with a 36-unit variance in VEA compared to Reported. The quantity discrepancy explains all of the variance.	▪ 68% realization rate for EEP-210 across fuel types
	Standard and Specialty Lighting	▪ Captures data entry discrepancy (confirmed with TRC) led to slight over-reporting of per-unit savings for both Standard and Specialty bulbs.	▪ 98% MMBtu realization rate for EEP-1200, EEP-1250
	ES Linear Fixture	▪ Reported MMBtu per unit is 102% of planning value. While it's a departure from the planning assumptions, the change correctly fixes an error in the 2023 TRM used for planning.	▪ 98% MMBtu realization rate for EEP-2200
	LED Storage	▪ Coincidence Factor was applied twice to the reported kW per-unit value.	▪ 625% (1/16% CF) realization rate for kW only for LED Storage
	Bundles	▪ Lighting variances flow through to Bundles, some of which are entirely lighting, others that contain bulbs and appliances.	▪ 98-100% MMBtu realization rates for EEP-3006 through EEP-3011
	Heat Pump Pool Heater	▪ Seven units (out of nearly 1,400) reported zero MMBtu or kWh savings.	▪ 100.1% MMBtu and kWh realization rates for EEP-720
Home Performance	HPwES Insulation Measures	▪ Insulation measures tied to heat pump HVAC were reporting zero summer and winter demand savings.	▪ Incorporating demand savings for insulation drove up the realization rate for Home Performance.

Program	Sub-Component	Description	Implications
	Air Sealing	▪ Air sealing calculator was applying electric resistance savings factor for some heat pump systems (duplicate issue to 2022).	▪ Negatively impacted MMBtu, MWh, and MW VEA results.
	National Grid Weatherization Measures	▪ This program component is a joint effort with National Grid where PSEG Long Island refers customers with Natural Gas Heat to National Grid for weatherization services. In return, National Grid provides detailed measure level tracking data that allows PSEG Long Island to calculate the electric air conditioning savings from weatherization projects.	▪ Because this data is anonymized, DSA will not be able to include these homes in the home performance consumption analysis.
All Electric Homes	Appliances	▪ Workbook reference error leads to inflated savings for Refrigerators. The workbook referenced the EUL (14) rather than the per unit MMBtu savings for ENERGY STAR refrigerators (0.1605).	▪ 1.1% MMBtu realization rates for ENERGY STAR Refrigerator measure in AEH. Overall MMBtu realization rate of 90%

In addition to energy savings impacts, TRC is required to report on the number of heat pump installations, the number of Housing Units that are served by heat pumps, and the number of buildings enrolled in the multi-family program in 2023. The table below further defines each metric, and a description of what drives the differences between the reported values and our verified values.

Count Metric	Metric Definition	Description of Differences
Number of Heat Pumps Installed	▪ The PSEG Long Island goal of 7,000 heat pump installations is based on the number of outdoor heat pump units installed. For VRF, one VRF system equals one heat pump count.	▪ The EM&V team counted 105 more heat pump installs than reported by TRC. ▪ Four uncounted heat pumps were found under the CEP program, and the other 101 additional heat pumps were from Multi-Family projects. ▪ After conversations with TRC, the EM&V team determined that the gap was driven by the way heat pumps were tracked in Captures. For

Count Metric	Metric Definition	Description of Differences
		much of 2023, Multi-Family and CEP Heat Pump measures were tracked as custom projects, and project descriptions were relied on to extract all heat pump installs. However, some project descriptions did not mention the heat pump measures installed and were, therefore, inadvertently left out of the dataset feeding heat pump installation counts.
Number of Housing Units Served by Heat Pumps	▪ The PSEG Long Island Goal of 1,656 'Whole House Heat Pump Housing Units Served' is based on the total number of unique homes (single-family or apartment units) that installed a heat pump. Single Family housing units were counted by looking at the number of whole home heat pumps installed. Multi-Family housing units were counted by pulling all multi-family heat pump projects and adding up the number of apartment units served.	▪ DSA found 51 additional housing units. ▪ All these units fell under the multi-family housing sector. For non-multifamily installs, the EM&V team matches the reported housing units exactly.
Number of Buildings Enrolled in Multi-Family Program	▪ The EM&V team interprets this metric as the total number of unique buildings enrolled in the multi-family program in 2023. 'Unique Buildings' refers to the number of physical structures associated with a unique 'Parent Site'. The term 'Parent Site' refers to the company or owner of the group of buildings being treated. One parent site may have more than one unique building on the property that is being served by the project.	▪ DSA found 21 additional enrolled multi-family buildings. ▪ Currently, there is not a specific field tracking unique building enrollments in the Captures database. There are many instances where one parent site participates in multiple projects. A different mix of buildings at that parent site may participate in each project. Currently, the best way to accurately track this metric is to manually extract the supporting documentation for each project and count the unique buildings treated based on project and location descriptions.

Appendix C: Verified Impact Results without Fossil Fuel Waste Heat Factors

As part of the 2023 EM&V work, PSEG Long Island requested that the energy impacts be calculated two ways: 1) using the planned algorithms which account for fossil fuel waste heat factor penalties in the lighting measures, and 2) using algorithms implemented by other NYS utilities which do not account for fossil fuel waste heat factor penalties. This second metric allows more accurate comparison of impacts between PSEG Long Island and other utilities in New York. When fossil fuel penalties are not accounted for, there is a large increase in energy impacts for CEP, Multi-Family, EEP, REAP, and Home Performance.

TABLE 5: ENERGY IMPACTS WITH VS. WITHOUT FOSSIL FUEL HEAT PENALTY

Program		Alternate Verified Savings		
		MMBTU without Fossil Fuel Heating Penalty (A)	MMBtu with Fossil Fuel Heating Penalty (VEA) (B)	Difference (A-B)
Commercial	Commercial Efficiency Program (CEP)	197,019	168,677	28,342
	Multi Family Homes	29,798	28,828	970
Residential	Energy Efficient Products (EEP)	561,163	426,082	135,081
	Home Comfort	184,223	184,223	0
	Residential Energy Affordability Partnership (REAP)	14,016	11,983	2,033
	Home Performance (HPwES, HPDI, & HEA)*	41,022	40,668	353
	All Electric Homes (AEH)	519	519	0
	Home Energy Management (HEM)	116,214	116,214	0
Total Commercial:		**226,816**	**197,504**	**29,312**
Total Residential:		**917,157**	**779,689**	**137,468**
Total Energy Efficiency:		**1,143,973**	**977,194**	**166,780**

*Home Performance include additional 5,596 MMBtu impacts PSEG Long Island claims through the National Grid Weatherization Program.

APPENDIX E LIGHTING MMBTU SAVINGS WITHOUT HEATING PENALTY MEMO

MEMORANDUM

Date: April 12, 2024

To: Dan Zaweski, Ronan Murphy, Gabrielle Scibelli; PSEG Long Island

From: Andrea Hylant and Jesse Smith, Demand Side Analytics

Re: Lighting Waste Heat Factor Influence on Lighting Impacts

1.1 BACKGROUND & METHODS

New York's Clean Leadership and Community Protection Act sets a goal of 185 trillion Btu (TBtu) in statewide energy savings through energy efficiency efforts by 2025. Under this mandate, PSEG Long Island is dedicated to reducing their service area's energy consumption by 7.85 TBtu by 2025. Budgeting and planning activities for the 2025 program year needs to account for PSEG Long Island's ability to reach this goal. Through these efforts, PSEG Long Island, Long Island Power Authority (LIPA), and the Department of Public Service (DPS) decided to look into the TRM algorithms that informed lighting impacts. Specifically, PSEG Long Island's application of waste heat factors appeared to be more conservative than other New York State Utilities.

Figure 1 shows the algorithms used to calculate energy and peak demand savings for residential lighting measures in New York State TRM. The highlighted parameters address the interactive effects between waste heat from lighting and a home's HVAC system.

Figure 1: HVAC Interaction Factors in the NYS TRM

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_{ff}$$

LED light bulbs emit less waste heat than inefficient lighting so these factors and these terms address the amount of heat a light bulb adds to the space. During the summer, a reduction in waste heat means less work for the air conditioner and additional cooling savings. During the winter, the heating system

must work harder to make up for the reduction in waste heat from lighting. As a result, the cooling benefits capture the lower work needed by AC systems in the summer resulting in less energy consumed, while the heating penalties capture the higher amount of work needed by heating systems in the winter resulting in more energy consumed.

- The $HVAC_d$ term pertains exclusively to the cooling bonus, which are exclusively electric
- The $HVAC_{ff}$ term pertains exclusively to heating penalty in homes with fossil fuel heat
- The $HVAC_c$ term captures both the cooling bonus and the heating penalty for homes that have electric heat

New York's investor owned utilities classify their energy efficiency program as electric and natural gas and only report impacts from the target fuel. Lighting programs are electric efficiency programs so the IOUs calculate and report kWh and kW savings.[1] This means that heating penalties are ignored for homes with fossil fuel heat, which is most New York households. In the 2020 program year, in response to the CLCPA greenhouse gas emission reduction goals, PSEG Long Island changed its primary performance metric from electric energy (kWh) and peak demand (kW) to fuel agnostic 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. As a result of this change in the key performance metric, PSEG Long Island began incorporating fossil fuel waste heat penalties into their lighting impacts. This contributed in a decrease in their calculated lighting impacts overall.

To explore what PSEG Long Island's progress towards CLCPA targets would be under the IOU reporting convention, in 2023 Demand Side Analytics reviewed the lighting as reported in the Verified Ex-Ante activities. In 2024, the updated directive was to review these lighting impacts as reported in the **Evaluated Ex-Post** activities and assessing what they would have been if fossil fuel heating penalties were not included for the 2020-2023 program years.

1.2 RESULTS

Table 1 below shows the results of the waste heat factor investigation. The 'Original Ex-Post Impacts' column reflects the MMBtu savings calculated by the evaluation team using the planning assumptions for that program year. The 'Updated Ex-Post Impacts' column shows what the MMBtu savings are when heating penalties are not included in the savings calculations. Please note, HPDI is a program focused on homes with electric heat, so fossil fuel interactive effects were not applied in the ex-post evaluation. Over the 2020-2023 program years, if lighting savings algorithms did not incorporate fossil fuel heating penalties, then PSEG Long Island would have claimed and addition 0.8065 TBtu in lighting impacts.

[1] Evaluation reports may document the increased fossil fuel consumption associated with LED lighting programs, but these values are not captured in SEEP reporting or Clean Energy Dashboards.

Table 1: Lighting Impact Calculations – Original Planning vs. Re-calculated Assumptions

Program Year	Program	Original Ex Post Impacts MMBtu	Updated Ex Post Impacts MMBtu	Difference MMBtu
2020	CEP Lighting	216,142	260,140	43,998
2021		207,256	256,794	49,538
2022		137,104	166,215	29,111
2023		119,248	145,058	25,810
2020	EEP Lighting	262,903	386,731	123,828
2021		365,456	537,159	171,703
2022		450,306	678,754	228,448
2023		260,217	389,251	129,034
2020	REAP Lighting	880	1,266	386
2021		1,598	2,590	992
2022		2,031	3,583	1,552
2023		2,079	2,210	131
2020	HPDI Lighting	16	16	0.0
2021		101	101	0.0
2022		56	56	0.0
2023		24	24	0.0
2020	HEA Kits	651	1,105	454
2021		1,232	2,191	959
2022		1,052	1,588	537
2023		1,068	1,405	337
			Total Difference MMBtu	**806,480**