Evaluation of 2023 Energy Efficiency and Beneficial Electrification Portfolio – Volume II Program Guidance Document

Prepared for PSEG Long Island

By Demand Side Analytics
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1 PREFACE

GLOSSARY OF TERMS

Key Term	Definition
MWh Beneficial Electrification (MWh_{be})	The increase in weather-normalized annual electric energy consumption attributable to beneficial electrification measures.
MWh Energy Efficiency (MWh_{ee})	The reduction in weather-normalized annual electric energy consumption attributable to energy efficiency programs or measures.
Delta MWh	The total change in annual electric energy consumption. Equal to $MWh_{ee} – MWh_{be}$. Energy Efficiency measures, MWh_{ee}, typically result in a reduction in a customer's annual electric consumption and are reported as positive impacts. Beneficial Electrification measures, MWh_{be}, result in an increase in the customer's annual electric consumption. A negative value of Delta MWh indicates the measure or program increases electric consumption on the PSEG Long Island system as a whole. A positive value of Delta MWh indicates the measure or program reduces electric consumption on the PSEG Long Island system.
Discount Rate	The time value of money 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.

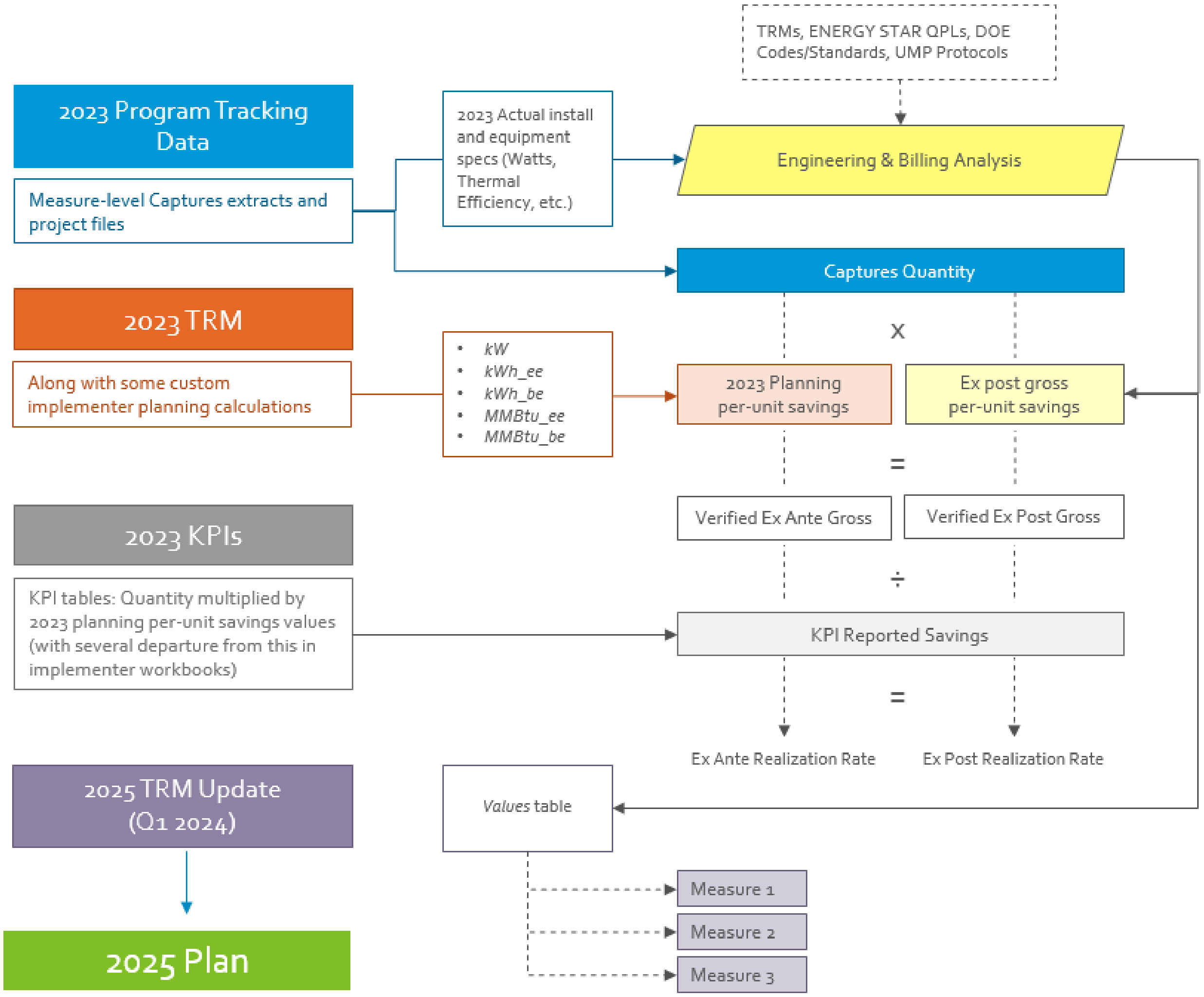
ANNUAL EVALUATION TASKS AND CYCLE TIMELINE

Figure 1-1 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 B.

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.

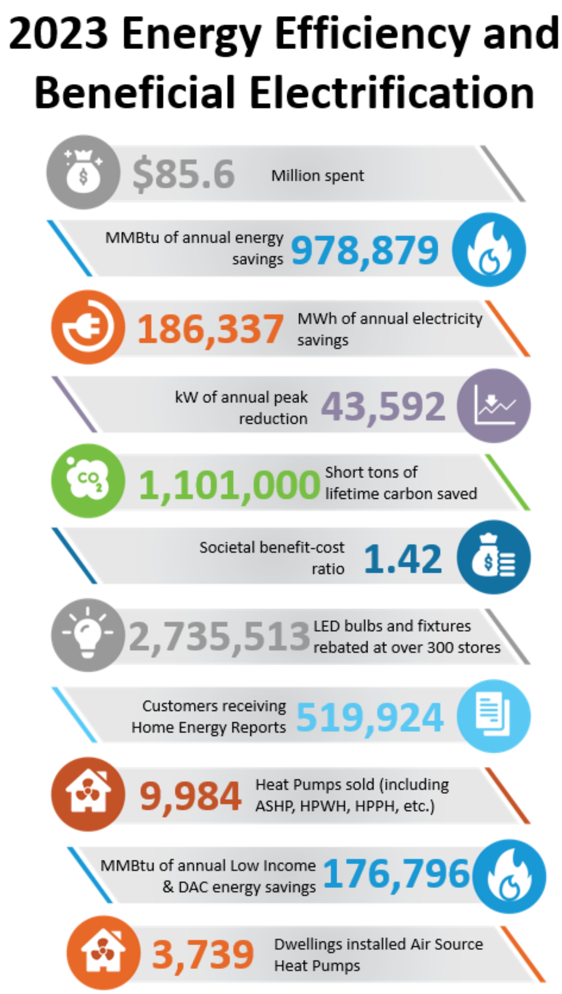
It is important to note that the feedback loop is a two-year cycle. PSEG Long Island has already established 2024 goals and planning assumptions, therefore findings and recommendations from the 2023 ex-post evaluation will not be reflected in the 2024 program claimed savings methodology. The findings 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 1-1: Annual Evaluation Data Flow



2 INTRODUCTION

PSEG Long Island's Energy Efficiency and Beneficial Electrification programs offer an array of incentives and rebates 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 Program Guidance Document (Volume II) presents detailed program-by-program impact analysis results. The 2023 Annual Evaluation Report (Volume I), provides an overview of the portfolio-level evaluation findings.

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 CO2 emissions – the equivalent of removing approximately 214,000 combustion engine cars for a year.[1] PSEG Long Island's efforts led to $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 New York investor-owned utilities (IOUs), progress toward this target should exclude fossil fuel heating penalties for lighting measures. 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 the 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 C.

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 2-1 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 2-1: Energy Efficiency Cycle, Objectives, and Key Terms

	Planning	Implementation	Audit & Verification	Evaluation	Cost-Effectiveness
Objective	Set goals for future years and set rules for how savings will be calculated for settlement with implementer	Recruit participants, maximize energy savings, and track activities	Determine if the Implementer used the assumptions and calculations pre-approved by PSEG Long Island	Produce the best after-the-fact estimate of savings delivered using the best methods and data available	Assess if the portfolio of energy efficiency activities was cost-effective from a (New York) societal perspective using Ex-Post Net savings
Timeline	• **Spring 2022**: Planning for 2023 using draft 2023 TRM assumptions	• **2023**: Portfolio Programs implemented	• **January 2024**: Verified Ex-Ante Savings Calculated using planning assumptions from 2022	• **Spring 2024**: Ex-Post evaluation of 2022 portfolio using most up-to-date methods (including PSEG Long Island TRMs 2024-2025, NYS TRMs v10 and v11)	• **Spring 2024**: Using Ex-Post Net evaluation values
Key terms	• Planned Savings • Technical Resource Manual (TRM)	• Gross Ex-ante Savings (Claimed Savings)	• Verified Ex-Ante Savings	• Ex-post Gross Savings • Ex-Post Net Savings • Realization Rate • Net-to-Gross Ratio (NTGR)	• Societal Cost Test (SCT) • Utility Cost Test (UCT) • Levelized Cost of Energy • Levelized Cost of Capacity

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 the energy efficiency and beneficial electrification portfolio implementers. Despite any potential disruptions to program delivery, PSEG Long Island showed strong performance compared to goals.

In 2023, PSEG Long Island administered eight programs. These programs are described in Table 2-1.

Table 2-1: 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.

Program	Description
Multi-Family	The Multifamily program was launched in October 2020. At launch, the Multifamily program targeted New Construction Multifamily developments. In 2021, the Multifamily Program expanded to include Existing Building Multifamily properties. The Multifamily program offers rebates for Common Area Lighting (Indoor and Outdoor), Common Area Heating and Cooling, Common Area Pool Equipment, Common Area VFDs, In-Unit Heating and Cooling, and In-Unit Appliances.
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.

Program	Description
Residential Energy Affordability Partnership	The program is designed for income-eligible customers and aims to save energy, provide education, help participants reduce electric bills, and make their homes healthier and safer. This program encourages whole-house improvements to existing homes by promoting home energy surveys and comprehensive home assessment services identifying potential efficiency improvements at no cost to the customer.
All Electric Homes	The All Electric Homes program is an extension of New York state policy goals to reduce reliance on fossil fuel combustion appliances in homes. This program offers incentives and rebates to developers who build single-family all-electric homes or convert existing single-family homes from fossil fuel heating and appliances to all-electric.

2.1 PORTFOLIO ENERGY SAVINGS AND PERFORMANCE

Table 2-2 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 B.

Table 2-2: 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**	**784,516**
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 2-2 and Figure 2-3 visualize 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 2-2: Portfolio MMBtu Savings

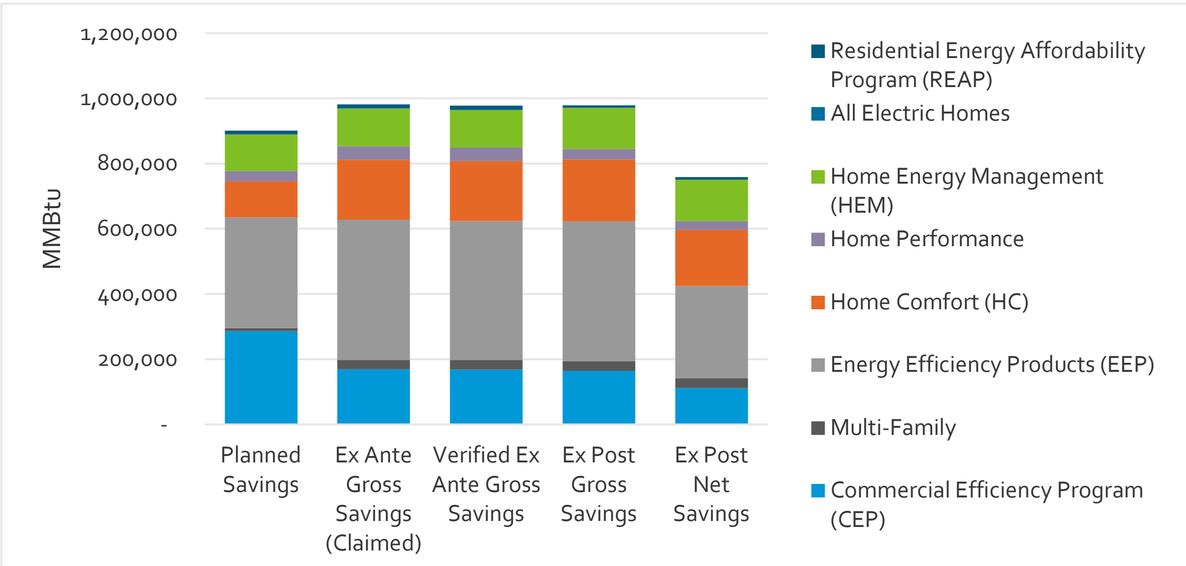
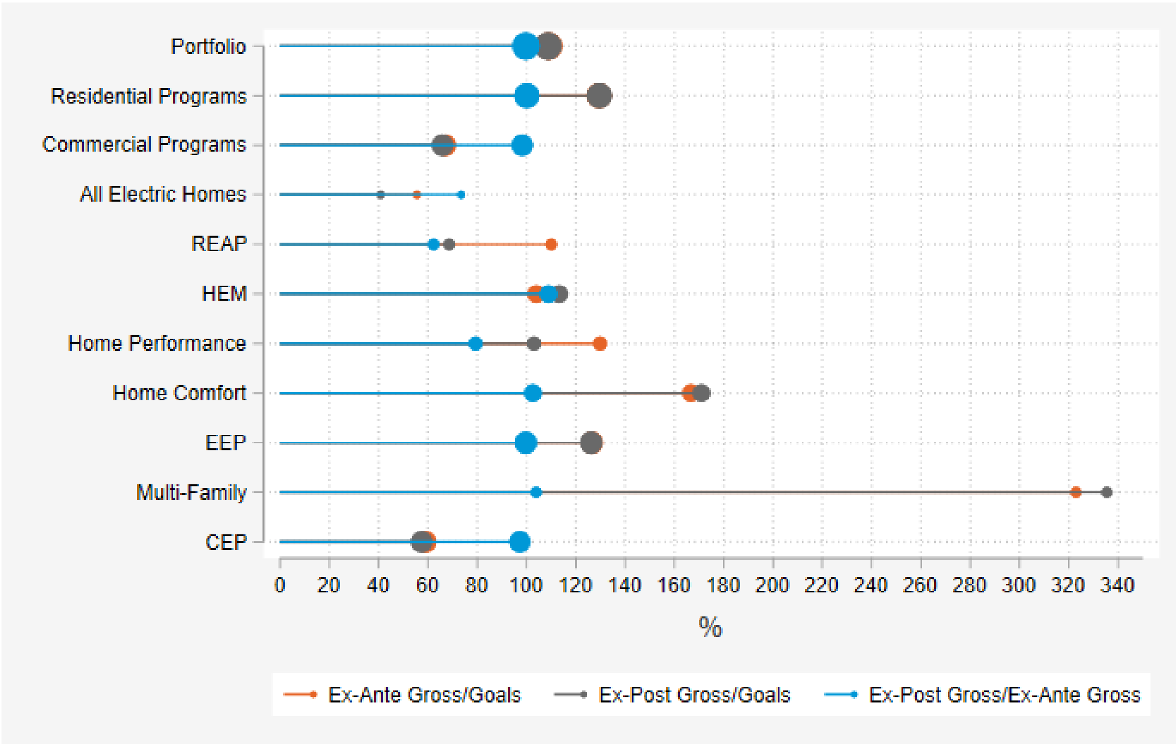


Figure 2-3 visualizes how evaluated savings compare to claimed savings (the Realization Rate, blue bars), how evaluated savings compare to planned savings (grey bars), and how claimed savings compare to planned savings (orange bars). The size of the circle in the plots is scaled based on the goals for 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 2-3: Portfolio Performance Metrics



As Figure 2-3 shows, for 2023 program year most programs had realization rates very close to 100% when comparing claimed and ex-post gross savings.

Table 2-3 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 2-3: Summary of Differences between Ex-Post and Ex-Ante

Portfolio Component	Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings	Summary of Savings Difference
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 Appendix A 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 values varied slightly from planning assumptions resulting in 101% realization rate 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.

2.1.1 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 2-4 shows the impacts per program split into four segments: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) 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 as 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. Specific methodologies for identifying DAC and Low Income customers for each program can be found in the "Overview of Impacts by Disadvantaged Community and Low Income" section of each program chapter in this report. 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 2-4: Portfolio Impacts by DAC, Low Income, and Market Rate Customers

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%.

2.2 COST-EFFECTIVENESS RESULTS

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 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.

Table 2-5 presents the benefit-cost results for the portfolio and for each program using the primary Societal Cost Test perspective. The portfolio-level SCT values are 1.19 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.

[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.

Table 2-5: Societal Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio

Sector	Program	NPV Benefits ($1,000)	Costs ($1,000)	B/C Ratio
Commercial	Commercial Efficiency Program	$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

The portfolio was cost effective with an SCT ratio of 1.42. In 2023 Cost Effectiveness, 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 1.0. The reasons for the change in SCT ratios 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 tests discussed in detail in Volume I.
- **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 delivered 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 Volume I, we discuss additional non-energy impacts that can potentially be incorporated into cost effectiveness analysis 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 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 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 Volume I.
- **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 ratio 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 2-4 shows SCT ratios for each program. Note that the size of markers is proportional to the ex-post MMBtu savings for each program.

Figure 2-4: Societal Cost Test Ratios by Program

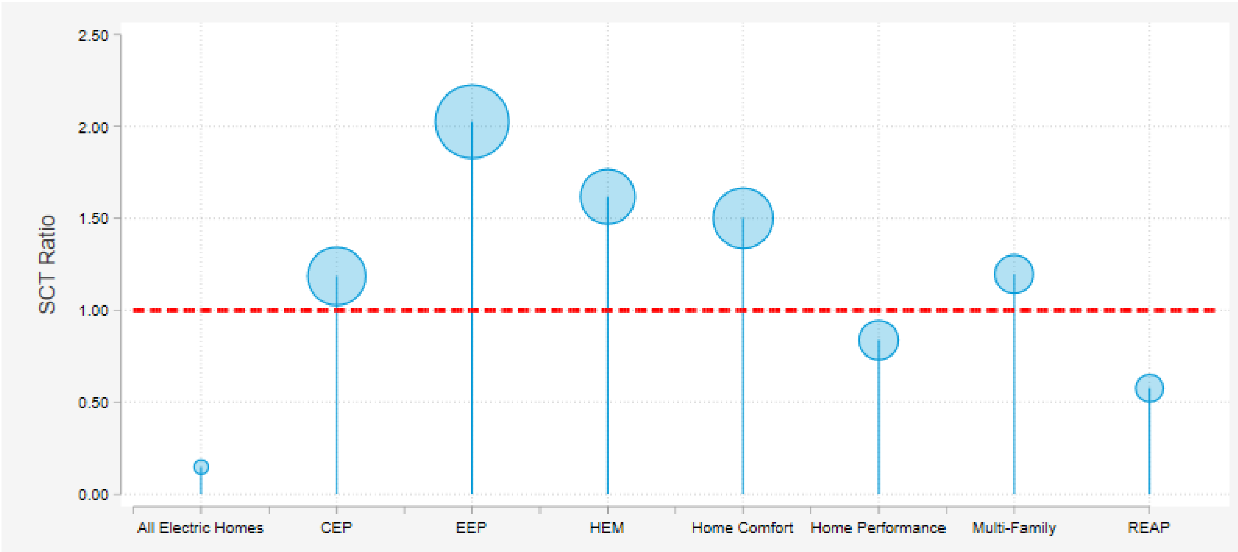
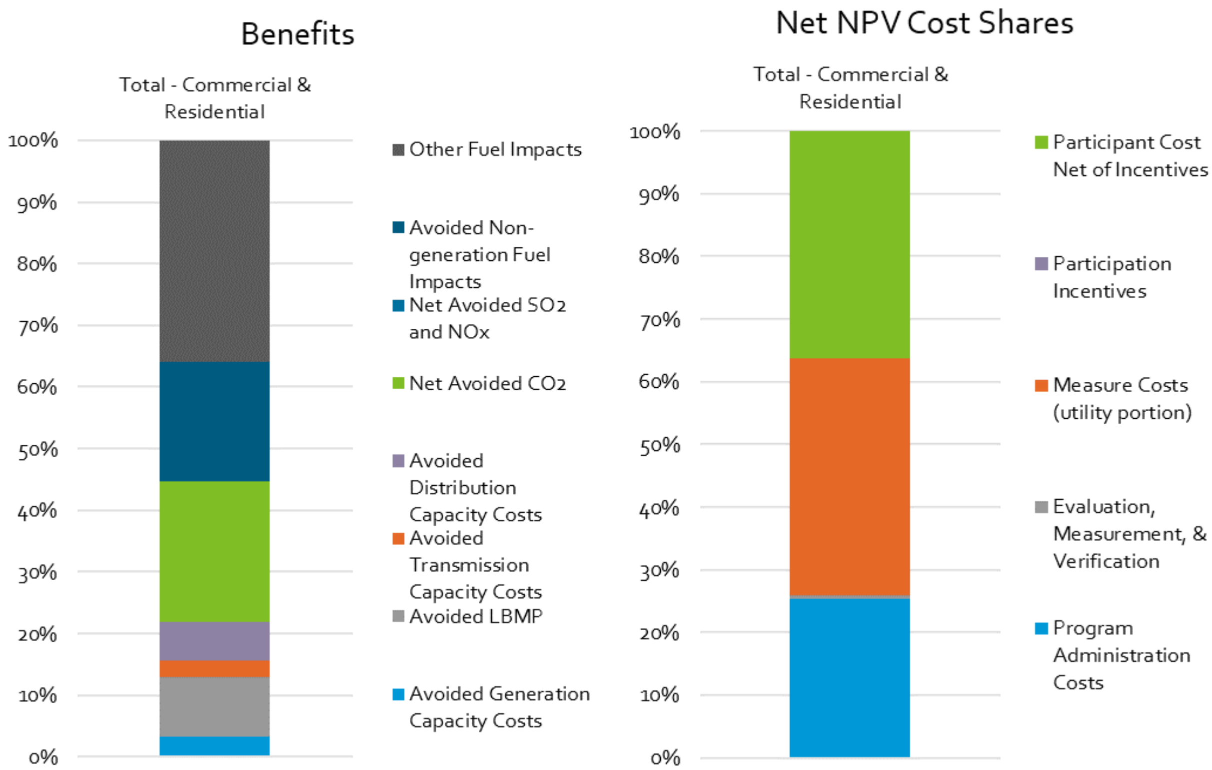


Figure 2-5 summarizes the benefit and cost categories analyzed and the share each contributed to the SCT. The primary two benefits for the SCT are other fuel impacts at 38% and avoided CO2 emissions at 23% of benefits. The combined benefits for capacity (generation, transmission, distribution) together 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 program measures over baseline measures. Program administration costs, including utility labor, advertising, and implementation vendor fees, comprise about 26% of societal costs.

Figure 2-5: Portfolio Net Present Value Benefit and Cost Shares by Category



3 COMMERCIAL EFFICIENCY PROGRAM

3.1 COMMERCIAL EFFICIENCY PROGRAM DESCRIPTION

PSEG Long Island's Commercial Efficiency Program (CEP) helps non-residential customers save energy by offering rebates and incentives for the installation of energy conservation measures. In addition to rebates for energy savings measures, Technical Assistance rebates are available under CEP to offset the cost of engineering and design services for qualifying projects. CEP sponsors a broad array of measures among a variety of business types through the program components identified in Table 3-1.

Table 3-1: Summary of CEP Measure Catalog

Category and Measure		Description
Lighting	Comprehensive Lighting	CEP continued to offer the performance-based interior lighting program that incentivizes customers and contractors to install the most energy efficient equipment available. Rebates are paid to customers on a $/kWh basis.
	Fast-Track Lighting	The prescriptive alternative to Comprehensive Lighting allows business customers and their Prime Efficiency Partners (PEPs) to submit streamlined applications for lighting upgrades associated with fixed rebates.
Multifamily		The Multifamily program was launched in October 2020. At launch, the Multifamily program targeted New Construction Multifamily developments. In 2021, the Multifamily Program expanded to include Existing Building Multifamily properties. The Multifamily program offers rebates for Common Area Lighting (Indoor and Outdoor), Common Area Heating and Cooling, Common Area Pool Equipment, Common Area VFDs, In-Unit Heating and Cooling, and In-Unit Appliances.
HVAC		CEP's HVAC offerings have expanded over time and now include high-efficiency unitary and split-system air conditioners, air-source heat pumps, and geothermal heat pumps.
Custom		The Custom program sponsors projects that are not conducive to the prescriptive path, providing business customers with support for complex, interactive, or unique efficiency measures. Variable refrigerant flow (VRF) heat pumps were tacked as Custom measures in 2023.
Standard Measures		The Standard category includes commercial measures that do not fall into the above categories and includes compressed air, variable frequency drives (VFDs), battery-operated lawn equipment, non-road electric vehicles, refrigeration, and pool equipment.

3.1.1 PROGRAM DESIGN AND IMPLEMENTATION

CEP participation is driven through partnerships with installation contractors, or Lead Partners, through whom customers may apply directly without an installation contractor. Engaging the implementation contractors to deliver the program has improved program performance and market impacts. As such, Lead Partner relationship management is an integral part of the program. The program recognizes, and promotes, the importance of open communication between the contractors and the program.

The introduction of the Prime Efficiency Partner network in 2017 has enabled the program to touch more small business customers and has led to an increase in project submittals. Contractors wishing to participate in the Fast Track program and be designated "Prime" must meet specific business criteria, complete trainings, and meet the strict program requirements. The launch of the Prime Efficiency Partner program has also played a crucial role in maintaining customer satisfaction. Program administrators offer weekly trainings and Quality Control Evaluation procedures to ensure continued quality installations for commercial customers.

3.1.2 Program Participation and Performance

PSEG Long Island's Commercial programs (CEP and Multi-Family) achieved 67% of the 2023 program MMBtu goals, saving 197,504 MMBtu on a verified ex-ante basis, as shown in Table 3-2. In recent program years, CEP typically had one extremely large project that accounts for a large portion of the overall program impacts. This was not the case for the 2023 program year, and as a result the program claimed fewer savings. Additionally, the actual CEP spend in 2023 was 65% of the planned spend.

Table 3-2: 2023 CEP and Multi-Family Verified Ex-Ante Gross Program Performance vs. Goals

Metric	MMBtu
Goal	295,236
Verified Ex-Ante Gross Savings	197,504
% of Goal	67%

Comprehensive Lighting projects accounted for the largest share of CEP ex-ante gross energy savings in 2023. As shown in Table 3-3, Comprehensive Lighting projects accounted for 57% of ex-ante gross MMBtu savings, outpacing Fast Track (5%) and Refrigerated Lighting (1%) measure groups within the lighting category. Custom Measures, which included variable refrigerant flow (VRF) heat pumps and other cooling and refrigeration measures, represented 17% of CEP ex-ante MMBTU savings. Refrigeration, Motors & VFDs, Compressed Air, Other Commercial Equipment, and HVAC collectively accounted for 6% of CEP ex-ante gross MMBtu savings.

Table 3-3. 2023 CEP Percent of Total Ex-Ante Gross Savings by Program Component

Category	Program Component	Ex-Ante Gross Savings		
		% MMBtu	% MWh	% kW
Lighting	Comprehensive Lighting	56.9%	75.7%	52.4%
	Fast Track Lighting	5.1%	7.0%	6.4%
	Refrigerated Case Lighting	0.8%	0.9%	0.5%
	Lighting Subtotal	**62.7%**	**83.6%**	**59.3%**
Multi-Family	Multi-Family	14.6%	3.8%	0.3%
Standard	Refrigeration	1.3%	1.5%	35.1%
	Motors & VFDs	0.3%	0.4%	0.1%
	Compressed Air	1.0%	1.1%	1.0%
	Other Commercial Equipment	1.5%	0.2%	0.1%
	Standard Subtotal	**4.2%**	**3.1%**	**36.3%**
Custom	Custom	16.8%	8.4%	3.2%
HVAC	HVAC	1.5%	0.9%	0.8%

3.2 COMMERCIAL EFFICIENCY PROGRAM IMPACTS

3.2.1 Overview of Impacts by Resource Type

Table 3-4, Table 3-5, and Table 3-6 compare ex-post gross savings to ex-ante gross savings and show the associated realization rates by program component for MMBtu, MWh, and kW, respectively. Realization rates were calculated by dividing ex-post gross savings values by ex-ante gross claimed savings values. Overall, CEP realized 98% of its ex-ante gross MMBtu energy savings claims, 97% of MWh savings claims, and 71% of kW savings claims. Opportunities to refine MMBtu savings claims are further addressed in Table 3-8.

Table 3-4: 2023 CEP Ex-Post Gross MMBtu Impacts by Program Component

Category	Program Component	N	Ex-Ante Gross Savings (Claimed) MMBtu	Ex-Post Gross Savings MMBtu	Realization Rate %
Lighting	Comprehensive Lighting	1,270	112,488	108,293	96%
	Fast Track Lighting	331	10,001	9,482	95%
	Refrigerated Case Lighting	20	1,582	1,474	93%
	Lighting Subtotal	**1,621**	**124,072**	**119,248**	**96%**
Standard	Refrigeration	74	2,638	2,630	100%
	Motors & VFDs	42	634	634	100%
	Compressed Air	19	2,076	2,554	123%
	Nonroad Vehicle Electrification	9	2,372	2,372	100%
	Other Comm. Equipment	13	570	570	100%
	Standard Subtotal	**157**	**8,290**	**8,760**	**106%**
Custom	Custom	169	33,336	33,181	100%
HVAC	HVAC	97	2,873	2,783	97%
Multi-Family	Multi-Family	38	28,828	29,944	104%
Adjustments	Project Adjustments	3	446	446	100%
Total		**2,085**	**197,845**	**194,363**	**98%**

Table 3-5: 2023 CEP Ex-Post Gross MWh Impacts by Program Component

Category	Program Component	N	Ex-Ante Gross Savings (Claimed) MWh[1]	Ex-Post Gross Savings MWh	Realization Rate %
Lighting	Comprehensive Lighting	1,270	40,115	38,551	96%
	Fast Track Lighting	331	3,720	3,531	95%
	Refrigerated Case Lighting	20	464	432	93%
	Lighting Subtotal	**1,621**	**44,300**	**42,514**	**96%**
Standard	Refrigeration	74	773	914	118%
	Motors & VFDs	42	186	186	100%
	Compressed Air	19	609	749	123%
	Nonroad Vehicle Electrification	9	(206)	(206)	100%
	Other Comm. Equipment	13	98	98	100%
	Standard Subtotal	**157**	**1,459**	**1,740**	**119%**
Custom	Custom	169	594	612	103%
HVAC	HVAC	97	382	446	117%
Multi-Family	Multi-Family	38	-303	-374	123%
Adjustments	Project Adjustments	3	131	131	100%
Total		**2,085**	**46,562**	**45,069**	**97%**

[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 Beneficial Electrification, while KPI scorecard reports Energy Efficiency Savings only.

Table 3-6: 2022 CEP Ex-Post Gross kW Impacts by Program Component

Category	Program Component	N	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings	Realization Rate
			kW	kW	%
Lighting	Comprehensive Lighting	1,270	7,923	8,915	113%
	Fast Track Lighting	331	968	947	98%
	Refrigerated Case Lighting	20	74	103	139%
	Lighting Subtotal	**1,621**	**8,965**	**9,965**	**111%**
Standard	Refrigeration	74	5,305	90	2%
	Motors & VFDs	42	21	21	100%
	Compressed Air	19	150	149	100%
	Nonroad Vehicle Electrification	9	(3)	(3)	100%
	Other Comm. Equipment	13	16	16	100%
	Standard Subtotal	**157**	**1,459**	**1,740**	**5%**
Custom	Custom	169	489	68	14%
HVAC	HVAC	97	114	266	233%
Multi-Family	Multi-Family	38	53	137	260%
Total		**2,082**	**15,108**	**10,709**	**71%**

Table 3-7 shows the breakdown of Energy Efficiency (EE) and Beneficial Electrification (BE) components of MMBtu and kWh savings for measures where BE components exist.

Table 3-7: Breakdown of Ex-Post Gross Impacts by EE and BE Components

Category	Measure	MWh_{ee}	MWh_{be}	MWh Total (EE - BE)	$MMBtu_{ee}$	$MMBtu_{be}$	MMBtu Total (EE + BE)
Lighting	Comprehensive Lighting	38,551	0	38,551	108,293	0	108,293
	Fast Track Lighting	3,531	0	3,531	9,482	0	9,482
	Refrigerated Case Lighting	432	0	432	1,474	0	1,474
	Lighting Subtotal	**42,514**	**0**	**42,514**	**119,248**	**0**	**119,248**
Standard	Refrigeration	914	0	914	2,630	0	2,630
	Motors & VFDs	186	0	186	634	0	634
	Compressed Air	749	0	749	2,554	0	2,554
	Nonroad Vehicle Electrification	0	206	(206)	0	2,372	2,372
	Other Comm. Equipment	102	4	98	357	212	570
	Standard Subtotal	**1,951**	**210**	**1,741**	**6,175**	**2,584**	**8,760**
Custom	Custom	4,384	3,771	612	15,011	18,170	33,181
HVAC	HVAC	515	110	405	1,756	1,026	2,782.24
Multi-Family	Multi-Family	1,987	2,361	-374	7,391	22,553	29,944
Total		**51,351**	**6,452**	**44,898**	**149,582**	**44,333**	**193,915**

We estimate that heat pumps in HVAC, Custom, and Multifamily categories contribute to 6,452 MWh/year of additional electrical sales by displacing preexisting fossil fuel fired systems (Beneficial Electrification impacts). The program encouraged customers and contractors to install high-efficiency lighting and other equipment that, when compared with code-compliant or pre-existing electric equipment, led to 51,351 MWh/year of energy savings (Energy Efficiency Impacts). The overall electric consumption therefore decreased by 44,898 MWh. However, accounting for the consumption of displaced fossil fuels in the $MMBtu_{be}$ column, led to 193,915 MMBtu of annual energy savings.

3.2.2 Key Drivers for Differences in Impacts

Table 3-8 summarizes the major differences that contributed to the MMBtu realization rates, along with the evaluation team's recommendations to improve savings claims moving forward.

Table 3-8: Key Contributors to CEP MMBtu RR and Proposed Solutions

Component	Summary of Savings Difference	Recommendation
Comprehensive and Fast Track Lighting	▪ In some of the analyzed building types, operating hours differed from values specified in the PSEG-LI TRM. While the PSEG LI TRM has adopted lighting operating hours values from the NYS TRM for more than four years, TRC's commercial lighting savings calculation tools have not been consistently updated to align with the NYS TRM across all building types.	▪ Align savings assumptions with PSEG-LI TRM.
Multifamily Appliances	▪ TRC did not claim electric savings (kW and kWh) resulting from ENERGY STAR appliance installations under two multifamily projects. This included 385 clothes washers, 385 dishwashers and 270 refrigerators. MMBtu savings were claimed appropriately from these measures.	▪ Ensure workbook-calculated savings are accurately claimed within Captures database for all measures.
Multifamily Custom Heat Pumps	▪ Custom heat pump savings were estimated by TRC using the statewide clean heat tool[3]. We have seen an increased usage of the tool for projects within Multifamily. Since the workbook is password protected, we couldn't perform a comprehensive review of calculations and assumptions, but independently calculated impacts from a sample of incented heat pumps.	▪ Consider obtaining an unlocked version of the statewide clean heat tool, and review heat pump savings assumptions and calculations for alignment with PSEG-LI TRM.
Custom Measures	▪ Ex-ante savings for variable refrigerant flow heat pumps were calculated using the statewide clean heat tool. The tool was password protected and could not be accessed to perform ex-post analysis. Ex-post savings were approximated using TRM baseline efficiencies and assuming that all other clean heat tool inputs held constant.	▪ Consider obtaining an unlocked version of the statewide clean heat tool, and review heat pump savings assumptions and calculations for alignment with PSEG-LI TRM.

[3] https://cleanheat.ny.gov/assets/other/Statewide%20CHP%20Custom%20Calculator%20v3%20Mar-1-2024.xlsx

3.2.3 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 3-9 shows the commercial program (CEP and Multi-Family Combined) ex-post impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in the Introduction, Section 2.1.1. For commercial programs, only DAC impacts were claimed. Overall, 28% of commercial project MMBtu impacts from the CEP and Multi-Family programs count towards the DAC and Low Income standards.

Table 3-9: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	139,589	72%
DAC Only	54,774	28%
Low Income Only	0	0%
DAC & Low Income	0	0%
Total	**194,363**	**100%**

3.3 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this evaluation, our key findings and recommendations for the Commercial Efficiency Program are presented in Table 3-10. In most cases, our recommendations apply to the 2025 program year. Planning for the 2024 program year was finalized a year ago, and program delivery is almost half complete. These types of changes are often most efficient to implement at the beginning of a new program year. Most of our recommendations are also reflected in the recently completed 2025 PSEG Long Island TRM.

Table 3-10: Commercial Efficiency Findings and Recommendations

Finding	Recommendation
▪ CEP's non-lighting measures have become increasingly prominent, while lighting's share of savings has gradually decreased year to year. Lighting in 2023 accounted for 63% of ex-post gross MMBtu savings.	▪ We identified in 2023 that the program prioritized the expansion of heat pump offerings within the HVAC segment, and this technology is rapidly gaining traction in the commercial sector. PSEG Long Island should continue to expand its program offerings beyond lighting to offset the declining share of program savings attributed to lighting. This could be achieved by focusing on non-lighting segments, such as refrigeration and HVAC, as well as lighting controls, for which the market is rapidly evolving.
▪ For select measures such as lighting, critical project-level details are excluded from Captures tracking data. As a result, we could not conduct measure-level engineering analysis of the population of projects but rather relied on desk reviews among a sample of comprehensive lighting measures.	▪ CEP administrators should start collecting and tracking relevant measure- and project-specific data in measure records. This would allow evaluators to extract data that informs savings for all projects rather than refer to project workbooks one by one. Most notably for the following data field: ➢ Existing fixture quantity (Comprehensive Lighting program component), which was added for the 2024 program year.

4 ENERGY EFFICIENCY PRODUCTS PROGRAM

4.1 ENERGY EFFICIENCY PRODUCTS PROGRAM DESCRIPTION

The following sections detail the program design, implementation strategies, and PY2023 participation and performance for the Energy Efficiency Products (EEP) program.

4.1.1 PROGRAM DESIGN AND IMPLEMENTATION

The objective of EEP 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, online, and downstream promotions. These products meet the energy efficiency standards set by the Environmental Protection Agency (EPA) and the Department of Energy (DOE). Key measures in the EEP program for 2023 include LED lighting, thermostats, heat pump pool heaters (HPPH), and ENERGY STAR appliances such as dehumidifiers and air purifiers. Smaller measures include heat pump water heaters (HPWH) and battery-operated lawn equipment.

TRC is responsible for the overall delivery of EEP and manages the rebated components of the program. Subcontractor ARCA managed the appliance recycling component of EEP until mid-year when they ceased business operations and PSEG Long Island discontinued the appliance recycling component. Subcontractor EFI manages the retail and online marketplace components of EEP. Additionally, TRC subcontracts CLEAResult to aid in lighting rebate promotions.

4.1.2 PROGRAM PARTICIPATION AND PERFORMANCE

The EEP program achieved 125% of 2023 program MMBtu goals, saving 426,082 MMBtu on a verified ex-ante basis. Ninety-four percent of EEP verified ex-ante savings are attributable to three measure categories: LED lighting (61%), thermostats (24%), and heat pump pool heaters (10%). Table 4-1 shows 2023 EEP program performance compared to goals.

Table 4-1: EEP Verified Ex-Ante Gross Program Performance vs. Goals

Metric	MMBtu
Goal	339,857
Verified Ex-Ante Gross Savings	426,082
% of Goal	125%

In 2023, the EEP program incentivized more than 2.7 million energy efficient products to PSEG Long Island residential customers. PSEG Long Island rebated 16,669 smart thermostats, 11,592 dehumidifiers, 3,782 washers and dryers, 4,145 air purifiers, and 1,393 heat pump pool heaters through EEP in 2023.

The biggest contributor to EEP program savings is LED Lighting (61% of ex-post MMBtu). In 2023, EEP Lighting measures provided point-of-sale discounts on over 2.4 million LED lamps and fixtures at Long Island retailers and online, before ceasing altogether at mid-year as EISA baselines took effect.

Table 4-2 summarizes participation for each program measure compared to the planning goal.

Table 4-2. 2023 EEP Program Participation vs. Goals, by Measure

Measure	Number of Units (Actual)	Planned Units (Goal)	Percentage of Goal Achieved
EEP ES Room Air Purifiers (<150)	2,314	1,250	185%
EEP ES Room Air Purifiers (>150)	1,831	750	244%
EEP Advanced Power Strip Tier 1	1,596	5,000	32%
EEP Advanced Power Strip Tier 2	75	500	15%
EEP Clothes Dryer - Electric Resistance	1,872	2,500	75%
EEP Clothes Dryer - Most Efficient	64	100	64%
EEP ME Clothes Washer	1,846	3,000	62%
EEP ES Dehumidifier	11,592	5,000	232%
EEP Heat Pump Water Heater - Small	121	150	81%
EEP Heat Pump Water Heater - Large	101	75	135%
EEP Tankless Water Heater < 12 kW	-	90	-
EEP Tankless Water Heater >=12 kW	13	45	29%
EEP Heat Pump Pool Heater	1,393	1,000	139%
Solar Pool Covers	45	200	23%
EEP Refrigerator Recycle- Pre 2001	140	2,000	7%
EEP Refrigerator Recycle- Post 2001 & Pre 2014	1,334	800	167%
EEP Dehumidifier Recycle	69	150	46%
LED Standard	1,261,607	750,000	168%
LED Specialty	1,232,350	1,200,000	103%
EEP Redeemed Recycling Voucher	17		-
EEP Connected Thermostats	10,456	8,000	131%
EEP Learning Thermostats	6,213	6,000	104%
EEP Electric Weed Trimmer	14	-	-
EEP Electric Leaf Blower	45	-	-
EEP Electric Lawn Mower (All Sizes)	13	-	-
ES Linear Fixture	63,660	16,000	398%
LED In Storage (Standard)	50,741	50,741	100%
LED In Storage (Specialty)	58,405	58,405	100%
Bundle: LED Standard (5 lamp), LED Specialty (5 lamp)	757	n/a	-
Bundle: LED Specialty (5 lamp), APS Tier 1	127	n/a	-
Bundle: LED Specialty (5 lamp), Air Purifier (<150 CADR)	505	n/a	-
Bundle: LED Specialty (5 lamp), Connected Thermostat	739	n/a	-
Bundle: LED Standard (10 lamp)	801	n/a	-
Bundle: LED Specialty (10 lamp)	378	n/a	-
Total	**2,711,234**	**2,111,756**	**128%**

Table 4-3 compares quantities for 2022-2023 by measure category. The quantity of lighting rebates fell by 41% as lighting was phased out of EEP in mid-year 2023. The number of smart thermostat rebates grew by 30% relative to 2022, heat pump pool heaters by 14%, and water heaters by 10%.

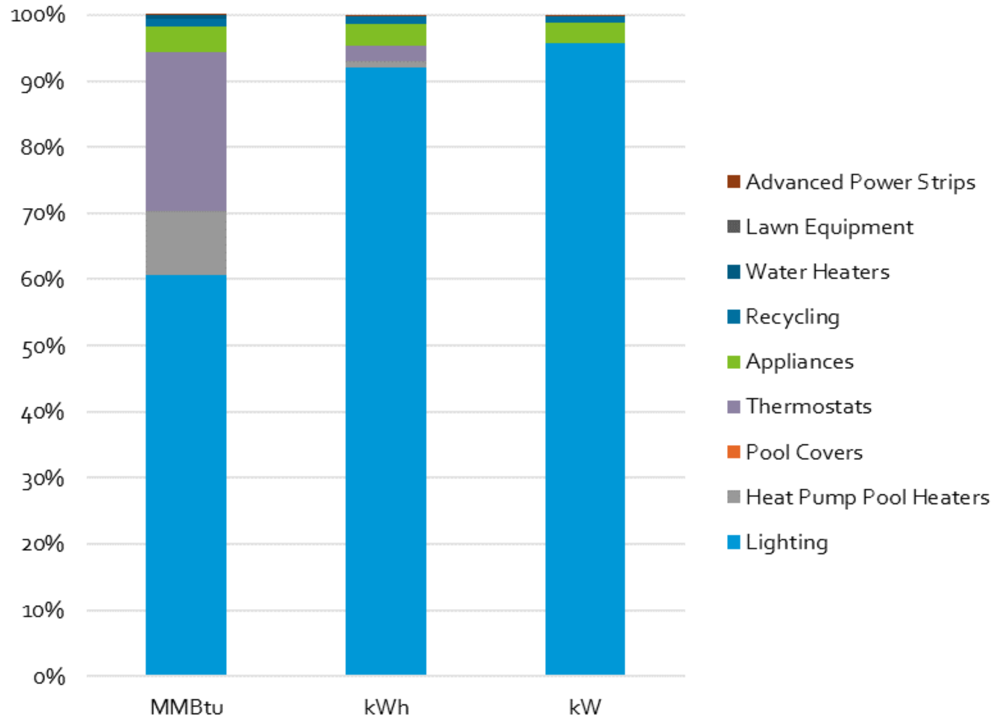
Table 4-3: 2022-2023 Quantity Comparison, by Measure Category

Measure Category	2022 Units	2023 Units*	Percentage Change
Lighting	4,584,487	2,692,978	-41%
Heat Pump Pool Heaters	1,217	1,393	14%
Pool Covers	31	45	45%
Pool Pumps	15	-	-100%
Thermostats	13,375	17,408	30%
Appliances	19,834	20,024	1%
Recycling	2,832	1,560	-45%
Water Heaters	213	235	10%
Lawn Equipment	2,464	72	-97%
Advanced Power Strips	1,457	1,798	23%
Total	**4,625,925**	**2,735,513**	**-41%**

*Includes units included in bundles, which is why total doesn't align with Table 4-2

Figure 4-1 shows the distribution of ex-ante gross energy and demand savings across the EEP program. Lighting measures (LED Standard/Specialty, Linear LEDs, and In-storage LEDs) account for most of the ex-ante gross savings across all resources. Smart thermostats, heat pump pool heaters, and air purifiers are the other top measures. Along with LED lighting, these measures account for 98% of ex-ante gross MMBtu savings. For a comparison of MMBtu savings between 2022 and 2023, see Figure 4-3.

Figure 4-1: 2023 EEP Program Ex-Ante Gross Savings by Resource and Measure Category



4.2 ENERGY EFFICIENT PRODUCTS PROGRAM IMPACTS

The following sections provide the results of the impact analysis for the EEP program.

4.2.1 OVERVIEW OF IMPACTS BY RESOURCE TYPE

Table 4-4 shows ex-ante and ex-post gross MMBtu impacts and realization rates by measure category. Table 4-5 and Table 4-6 show the equivalent impacts for MWh and kW.

Table 4-4: 2023 EEP MMBtu Impacts by Measure Category

Measure Category	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings	Realization Rate
	MMBtu	MMBtu	%
Lighting	266,258	260,217	98%
Heat Pump Pool Heaters	41,175	41,371	100%
Pool Covers	139	139	100%
Thermostats	95,489	103,302	108%
Appliances	19,174	16,131	84%
Recycling	5,096	4,986	98%
Water Heaters	2,206	2,256	102%
Lawn Equipment	12	14	120%
Advanced Power Strips	414	379	92%
Total	**429,962**	**428,794**	**100%**

Table 4-5: 2023 EEP MWh Impacts by Measure Category

Measure Category	Ex-Ante Gross Savings (Claimed[1])	Ex-Post Gross Savings	Realization Rate
	MWh	MWh	%
Lighting	116,606	115,760	99%
Heat Pump Pool Heaters	1,834	1,137	62%
Pool Covers	41	41	100%
Thermostats	3,425	3,051	89%
Appliances	4,942	4,053	82%
Recycling	1,494	1,461	98%
Water Heaters	(132)	(138)	105%
Lawn Equipment	(1)	(0)	27%
Advanced Power Strips	121	111	92%
Total	**128,330**	**125,476**	**98%**

[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 Beneficial Electrification, while KPI scorecard reports Energy Efficiency Savings only.

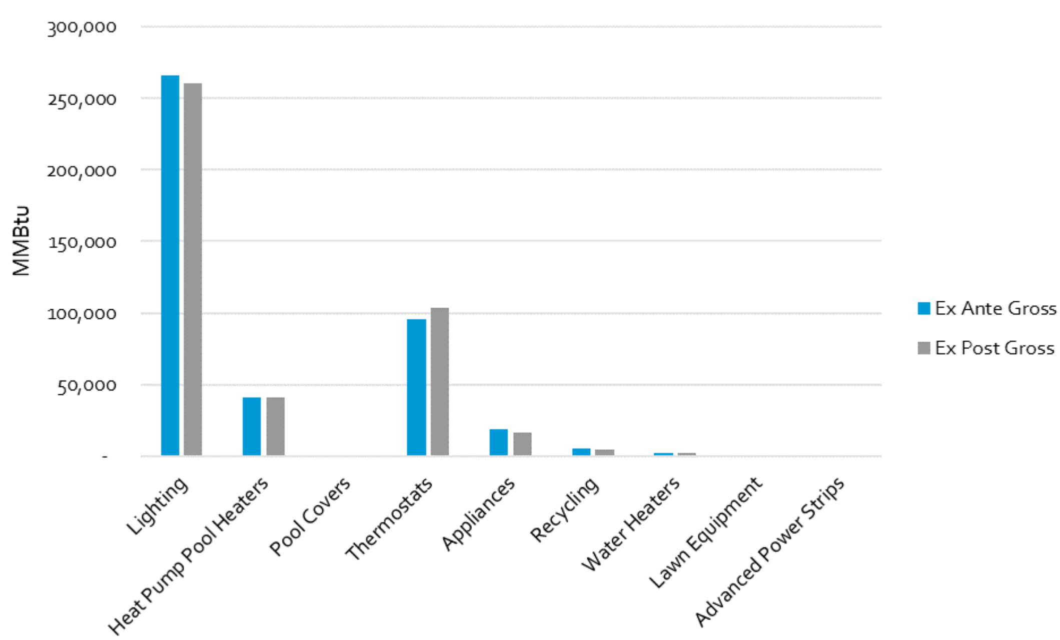
Table 4-6: 2023 EEP kW Impacts by Measure Category

Measure Category	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings	Realization Rate
	kW	kW	%
Lighting	16,996	20,686	122%
Heat Pump Pool Heaters	-	-	
Pool Covers	-	-	
Thermostats	-	-	
Appliances	908	656	72%
Recycling	214	221	103%
Water Heaters	(13)	(15)	112%
Lawn Equipment	-	-	
Advanced Power Strips	13	12	92%
Total	**18,117**	**21,560**	**119%**

4.2.1.1 Ex-Post Findings

The overall EEP program MMBtu realization rate, calculated as the ratio of ex-post gross savings to ex-ante gross savings, is 99.7%. While the overall program level variance between the claimed and ex-post gross MMBtu (the MMBtu variance) nets out to only 1,168 MMBtu less than reported, there are seven measures with measure-level variance greater than +/- 500 MMBtu. Lighting measures, Smart Thermostats, and Dehumidifiers account for most of the MMBtu variance. More detail on the cause of variance for each measure is included in the following section. The EEP program achieved 126% of the 2023 MMBtu goal on an ex-post gross basis. Figure 4-2 compares ex-ante gross and ex-post gross MMBtu savings by measure category.

Figure 4-2 EEP Ex-Ante Gross and Ex-Post Gross MMBtu Savings by Measure Category

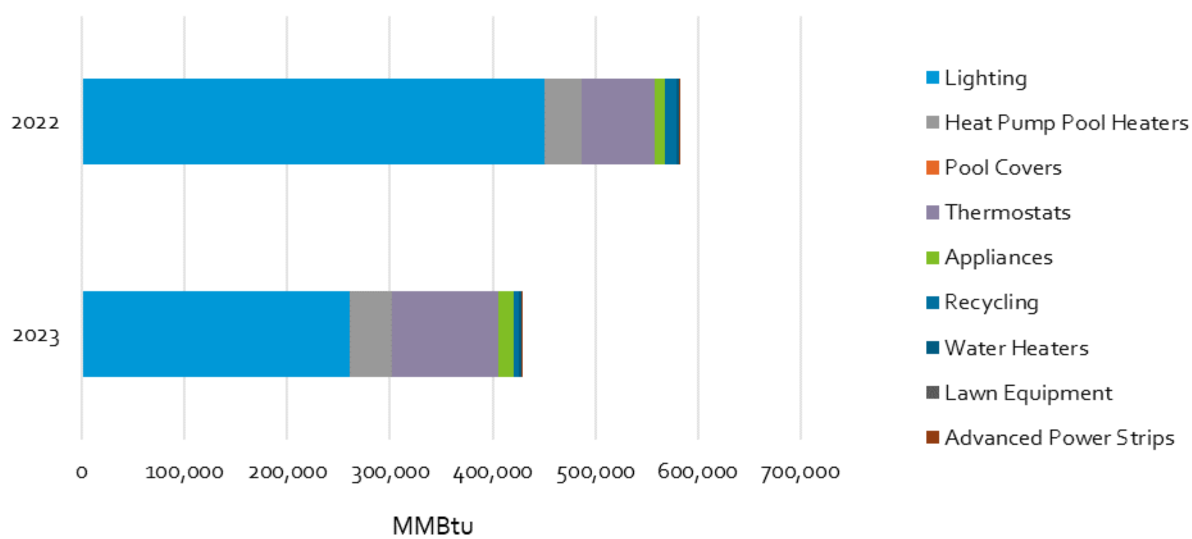


Overall, 16 out of 33 EEP measures have MMBtu realization rates of greater than or equal to 100%, and 17 measures have realization rates of less than 100%. The highest measure-level realization rate in EEP is for Linear Fixtures (167%), and the lowest is for Dehumidifiers (51%). The biggest positive ex-post gross MMBtu variance is for Connected Thermostats, which exceeds ex-ante values by 4,813 MMBtu. The biggest negative ex-post gross variance is in LED Specialty, where ex-post savings came up short of ex-ante by 8,850 MMBtu.

4.2.1.2 Comparison to 2022

EEP MMBtu savings decreased by 36% from 2022 to 2023. Lighting savings decreased by 42 percent. The biggest increase is in thermostats (44%), following 68% growth in thermostat MMBtu from 2021-2022. Figure 4-3 shows how EEP MMBtu savings changed from 2022 to 2023.

Figure 4-3: EEP MMBtu Impacts by Measure Category, 2022 and 2023 (ex-post gross)



4.2.1.3 Beneficial Electrification Impacts

Table 4-7 shows the breakdown of Energy Efficiency (EE) and Beneficial Electrification (BE) MMBtu and kWh for measures where a BE component exists. The clothes dryer, water heater, and heat pump pool heater measures include a mixture of electric efficiency and beneficial electrification impacts. Lawn equipment measures assume a purely gasoline-powered baseline.

Table 4-7: Breakdown of Ex-Post Gross MMBtu Per-Unit Impacts by EE and BE Components

Measure	$MMBtu_{ee}$	$MMBtu_{be}$	$MMBtu_{total}$	kWh_{ee}	kWh_{be}	ΔkWh
EEP-300 EEP Clothes Dryer - Electric Resistance	0.08	0.15	0.23	24.56	200.84	(176.28)
EEP-310 EEP Clothes Dryer - Most Efficient	0.52	0.21	0.73	152.82	53.28	99.54

Measure	$MMBtu_{ee}$	$MMBtu_{be}$	$MMBtu_{total}$	kWh_{ee}	kWh_{be}	ΔkWh
EEP-600 EEP Heat Pump Water Heater - Small	1.14	11.14	12.28	335.05	695.97	(360.92)
EEP-610 EEP Heat Pump Water Heater - Large	0.30	7.16	7.47	89.23	680.61	(591.38)
EEP-655 EEP Tankless Water Heater >=12 kW	(0.78)	1.97	1.19	(229.72)	2,454.46	(2,684.18)
EEP-720 EEP Heat Pump Pool Heater	6.53	23.17	29.70	1,913.08	1,096.88	816.20
EEP-1950 EEP Electric Lawn Mower (All Sizes)	-	0.44	0.44	-	4.40	(4.40)
EEP-1920 EEP Electric Weed Trimmer	-	0.11	0.11	-	1.61	(1.61)
EEP-1930 EEP Electric Leaf Blower	-	0.16	0.16	-	3.68	(3.68)

4.2.2 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 4-8 shows the EEP program ex-post impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in the Introduction, Section 2.1.1. Overall, 23% of EEP MMBtu impacts count towards the DAC and Low Income standards. A large portion of EEP impacts come from retail point-of-sale discounts on LED lighting products. We use the location of the storefront to assign DAC status for upstream measures and conservatively assign no low income savings to retail lighting since the income of the purchaser is unknown. Presumably some share of the nearly 3 million LEDs product discounted in 2023 were purchased by low income households, so it is likely that the estimates shown in Table 4-8 slightly under-represent the actual Low Income impacts of the EEP program.

Table 4-8: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	328,313	76.6%
DAC Only	67,083	15.6%
Low Income Only*	33,397*	7.8%
DAC & Low Income	0	0.0%
Total	**428,794**	**100%**

*EEP Low Income MMBtus come from light bulbs dispersed through Food Banks. If these light bulbs don't count towards Low Income then the updated EEP % impacts towards DAC/Low Income is 16%.

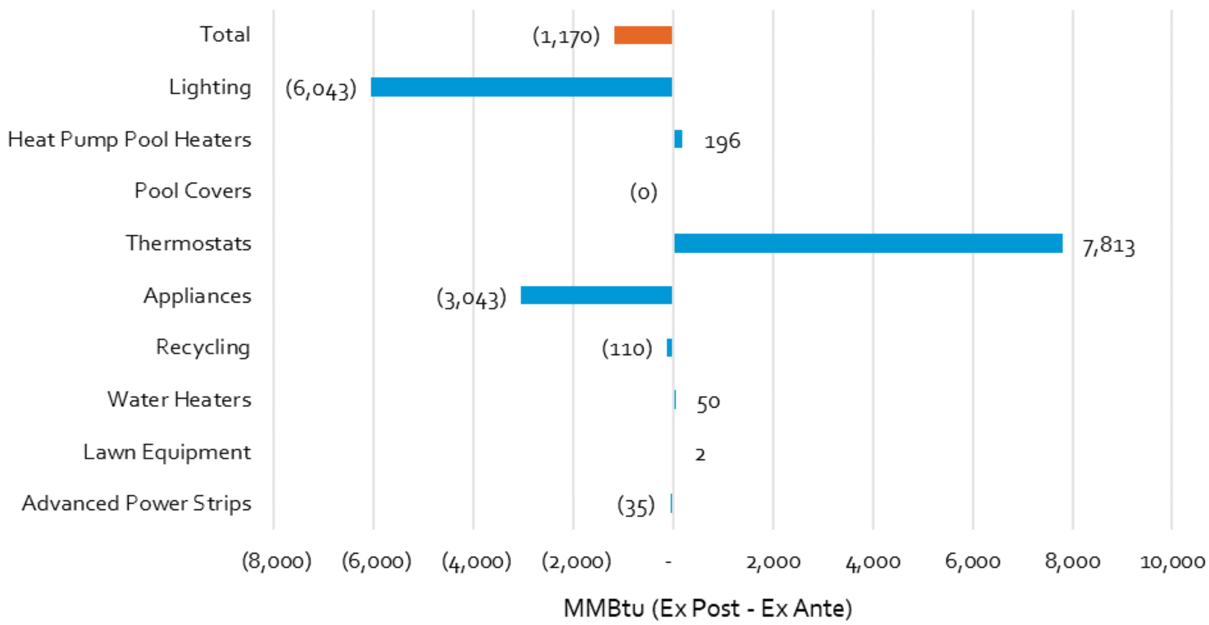
4.2.3 KEY DRIVERS FOR DIFFERENCES IN IMPACTS

This section describes key drivers of the overall gross realization rates, with an emphasis on MMBtu savings. Most variance between ex-ante gross and ex-post gross savings is due to one or more of the following evaluation activities:

- **Use of equipment characteristics from units installed during 2023 to inform and refine per-unit savings assumptions.** For example, by cross-referencing model numbers from more than 11,000 of the Dehumidifiers rebated in PY2023 with the ENERGY STAR qualified product list, we were able to use actual efficiency and capacity specifications, which showed that the average new dehumidifier is both less efficient and smaller than assumed for planning. The delta between base and efficient liters-per-kWh ratings was 45% less than planned and capacity was about 15% less than the TRM estimate, resulting in an MMBtu realization rate of 51 percent. In cases like this, the 2023 actuals will lead to input parameter changes in the PSEG LI TRM, in this case for 2025 TRM. This type of adjustment was also impactful for Lighting, where small differences in wattage deltas between planning assumptions and verified units (1-2 Watts per unit) were enough to lead to realization rates of 101% (LED Standard) and 94% (LED Specialty).
- **Reporting errors.** Claimed per-unit savings values for the two largest measures by quantity and savings, Standard and Specialty LED Lighting, were misreported as the result of a data entry error in the Captures import. The reported per-unit savings values only exceeded the planning assumptions by about 0.002 MMBtu per unit, and both Standard and Specialty LED Lighting had verified ex-ante realization rates of greater than 98%, but the sheer volume of bulbs rebated—more than 2.5 million during 2023—adds up to a reporting discrepancy of nearly 4,000 MMBtu. In another case, a row was repeated in the KPI Scorecard worksheet, resulting in double counting of claimed savings for 33% of Tier 2 Advanced Power Strips (a very small measure overall).
- **Refinement to other algorithm inputs based on an improved source or revised assumption.** For instance, the baseline fraction of fuel-fired heat pump pool heaters was updated based on a more recent end use consumption survey than the prior source.
- **2022 carryover planning assumptions.** Carryover was less of a driver in PY2023 than in PY2022, when many of the EEP measures underwent significant revisions to planning assumptions between 2021 and 2022. For PY2023, five measures included carryover projects from 2022, and only about 4% of the units within those measures used 2022 planning values.

The sub-sections below summarize the key drivers in order of measure contribution to the overall EEP MMBtu realization rates. The measure categories detailed in this section (Lighting, Thermostats, and Appliances) account for nearly all the overall EEP MMBtu variance.

Figure 4-4 MMBtu Variance by Measure Category (Ex-Post Gross Minus Ex-Ante Gross)



4.2.3.1 Lighting

As shown in Table 4-9, the gross realization rates (ratio of Ex-Post Gross to Claimed savings) for lighting measures combined are 98% for MMBtu savings, 113% for kWh savings, and 122% for kW.

Table 4-9: EEP Lighting Realization Rates by Measure

Measure	N	MMBtu RR	kWh RR	kW RR
EEP-1200 LED Standard	1,273,402	101%	102%	102%
EEP-1250 LED Specialty	1,246,770	93%	95%	95%
EEP-2200 ES Linear Fixture	63,660	167%	167%	167%
LED-S In-storage LEDs	109,146	100%	100%	625%
Total (Weighted Average)	**2,692,978**	**98%**	**113%**	**122%**

Table 4-10 lists the key drivers of differences between ex-ante gross and ex-post gross impacts for EEP lighting measures.

In July 2023, screw-based lighting was phased out of the EEP program. In April 2022, the US Department of Energy released its final rulemaking regarding the Energy Independence and Security Act (EISA) backstop provision. This standard established a baseline efficiency requirement of 45 lumens per Watt for most categories of general service light bulbs (A-lamps, reflectors, globes, candelabra) and effectively prohibits the sale of non-LED lamps.

Table 4-10: Key Contributors to Lighting RR Variance and Recommendations

Component	Summary of Contributing Factors	Recommendations
Standard, Specialty, and Linear LEDs, including In-storage	▪ **Wattage:** Actual 2023 product wattages, baseline wattage, and the resulting deltas varied slightly from planning assumptions. The delta wattage for Standard is nearly 1W greater than the planning value, and Specialty was about 2W less than the planning value. For Linear fixtures, higher actual baseline wattage and lower actual efficient wattage resulted in a delta that is about 170% of the assumed value. ▪ **Reporting Issues:** Claimed per-unit savings values for both Standard and Specialty LED Lighting were misreported as the result of a data entry error in the Captures import. For In-storage lighting, the coincidence factor was doubly applied to reported kW.	▪ No recommendations for lighting

4.2.3.2 Thermostats

Smart Thermostats provided 24% of EEP ex-post gross MMBtu savings in 2023. Realization rates are 108% for MMBtu and 89% for kWh. Zero kW are claimed. Table 4-11 shows key contributors to Thermostat variance.

Table 4-11: Key Contributors to RR Variance and Recommendations: Thermostats

Component	Summary of Contributing Factors	Recommendations
Smart Thermostats	▪ **Heating and Cooling Energy Savings Factors:** Updated to align with the NYS TRM v11 (slight decrease from v10). ▪ **Output Heating Capacity for Heat Pumps:** Updated to align with the average capacity from 2023 Home Comfort installations. ▪ **Hours:** Both heating and cooling hours slightly decreased with NYS TRM v11.	▪ Continue to use the most recent PSEG LI TRM savings assumptions for thermostat planning values.

4.2.3.3 Heat Pump Pool Heaters

Heat Pump Pool Heaters accounted for 10% of EEP ex-post gross MMBtu savings in 2023. HPPH realization rates are 100% for MMBtu and 65% for MWh (PY2022 was 86% and 46% respectively).

Demand (kW) savings are assumed to be zero because we assume limited pool heating is required on the system peak day.

Realization rate variance for heat pump pool heaters is primarily due to slightly lower actual heat pump coefficient of performance (COP) than the planning assumption, and an update to the fractions of fuel-fired and electric baseline heaters since 2023 planning because of the Residential End Use Consumption Survey (RECS) update. More baseline heaters (74%) are fuel fired than previously assumed (69%). Reported MMBtu was zero for seven units.

Table 4-12 Key Contributors to RR Variance and Recommendations: Heat Pump Pool Heaters

Component	Summary of Contributing Factors	Recommendations
Heat Pump Pool Heaters	▪ **Coefficient of Performance (COP) actual:** Actual efficient COP is 99% of assumed planning value. ▪ **Fuel-fired and electric baseline heater fractions:** Updated to reflect RECS 2020 for Northeast residences with heated pools (2023 TRM used RECS 2015 assumption).	▪ Continue to use the most recent PSEG LI TRM savings assumptions for HPPH planning values. ▪ Consider collecting data on the baseline fuel-fired heater fraction.

4.2.3.4 Appliances

Combined Appliance realization rates are 84% for MMBtu, 82% for kWh and 72% for kW. In 2023, air purifiers were the largest contributor to Appliance savings, accounting for 70% of verified MMBtu.

Dehumidifiers, which contributed about 0.5% of EEP savings and 15% of appliance category savings, have an MMBtu realization rate of 51% for PY2023, compared to 104% for PY2022. In prior evaluation cycles, the TRM assumptions were based on the LM Captures records, as the EFI records did not include model info. This year, 96% of the EFI records include model info, and there are no LM measures. Using the model numbers to look up actual equipment specifications, the average efficient unit is revealed to be about 6% less efficient than the TRM estimate. This is a 45% decrease in the efficiency delta between baseline and efficient compared to the TRM. Capacity (pints/day) is also about 15% less than the TRM estimate, with a smaller but still negative impact on verified savings. The new and more complete picture of the average model specifications in the tracking data will lead to an update in the 2025 TRM.

Table 4-13 includes savings and realization rates by Appliance type.

Table 4-13: Appliance Category Savings by Appliance Type

Appliance Type	Ex Ante MMBtu	Ex Post	MMBtu RR	% of Appliance MMBtu
Air Purifier	11,643	10,899	94%	71%
Clothes Dryer	434	477	110%	3%
Clothes Washer	1,612	1,608	100%	10%
Dehumidifier	4,707	2,379	51%	15%
Total	**18,397**	**15,364**	**84%**	**100%**

Table 4-14: Key Contributors to RR Variance and Recommendations: Appliances

<table>
<tr><th>Component</th><th>Summary of Contributing Factors</th><th>Recommendations</th></tr>
<tr><td>Air Purifier</td><td>▪ 2023 Actuals: Efficient unit specs (standby power, cfm/W, and CADR) were updated based on actual installs.</td><td rowspan="4">▪ Require model numbers or ENERGY STAR ID in reporting for all units. Despite a marked improvement for dehumidifiers compared to prior years, 454 units (4%) reported no model numbers.
▪ Continue to revise planning assumptions on an ongoing basis to align with the PSEG LI TRM.
▪ Anchor program eligibility requirements in current codes and standards. Continue to align eligibility with the most current ENERGY STAR qualified product lists and have clear business rules around changes to codes and standards. After a “sell-through” period to address known changes, make sure to only rebate units that comply with current ENERGY STAR standards.</td></tr>
<tr><td>Clothes Dryer</td><td>▪ 2023 Actuals: 2023 installs exhibited different baseline and efficient actual CEFs than the 2023 TRM/Planning values. For EEP-310, the average load size decreased due to a shift toward smaller units.</td></tr>
<tr><td>Clothes Washer</td><td>▪ 2023 Actuals: Very slight revisions to washer equipment specs based on actual installs and the small/large capacity split.</td></tr>
<tr><td>Dehumidifier</td><td>▪ 2023 Actuals: Base and efficient energy factors and pints/day were informed by actual installs.</td></tr>
</table>

4.2.3.5 Other EEP Measures

Table 4-15 presents a summary for other EEP program components where ex-post gross savings differed materially from ex-ante gross savings. Our recommendations for appliance recycling are contingent on PSEG Long Island finding a new implementation contractor and restarting the program component.

Table 4-15 Key Contributors to RR Variance and Recommendations: Other EEP Measures

<table>
<tr><th>Component</th><th>Summary of Contributing Factors</th><th>Recommendations</th></tr>
<tr><td rowspan="2">Recycling</td><td colspan="2">Combined realization rates for recycling measures (refrigerators and dehumidifiers) are 98% for MMBtu, 98% for kWh, and 103% for kW. Recycling measures combine for 1% of EEP savings in 2023.</td></tr>
<tr><td>▪ Actual refrigerator attributes vary from planning assumptions. Pre-2001 (EEP-900) are higher per-kWh savings; post-2001 (EEP-910) units are lower.
▪ Recycled dehumidifiers during 2023 are almost entirely smaller units (66 of 69 total units are <= 25 pints/day) relative to 2023 planning assumptions which used a nearly 50/50 split between small/med capacity tiers, based on 2023 install data. Actual average capacity of recycled units is higher than assumed for both tiers</td><td>▪ If the component is part of future program plans, revisit the refrigerator recycling application/data-gathering component. Recycled equipment attributes including refrigerator volume and age are critical for calculating savings. In 2023, PSEG LI claimed more kWh per refrigerator than the NY IOUs, largely due to the prevalence of older units (20+ years).
▪ Use the PSEG LI TRM for dehumidifier recycling planning values, which will be updated to reflect the prevalence of smaller units.</td></tr>
<tr><td rowspan="2">Water Heaters</td><td colspan="2">Combined Water Heater realization rates across Heat Pump and Instantaneous measures are 102% for MMBtu, 112% for kWh, and 112% for kW. Water heaters combine for 1% of EEP savings in 2023. Install data informed uniform energy factor (UEF) averages for baseline and efficient cases based on model numbers and ENERGY STAR standards for tank capacity.</td></tr>
<tr><td>▪ Slight updates to base efficiency weighting using actual counts, slightly lower UEF for actual installs than planning assumption</td><td>▪ Continue to use the latest version of the PSEG-LI TRM for planning values.</td></tr>
<tr><td rowspan="2">Pool Covers</td><td colspan="2">Pool Cover realization rates are 100% for MMBtu and 107% for kWh. Demand savings are zero.</td></tr>
<tr><td>▪ Slight update to weather data impacting ambient temperature and supply water temperature</td><td>▪ Continue to use the latest version of the PSEG-LI TRM for planning values.</td></tr>
</table>

Component	Summary of Contributing Factors	Recommendations
Lawn Equipment	Lawn equipment realization rates are 120% for MMbtu and 28% for kWh. Demand savings are zero.	
	▪ **Update to TRM algorithm:** starting with the 2024 TRM, savings are estimated using run time and tank capacity instead of BSFC factor.	▪ **Report kWh EE, kWh BE, and delta kWh independently** for all measures in EFI and LMC KPI Scorecard data.
Advanced Power Strips	Advance Power Strip realization rates are 92% for MMBtu, kWh, and kW.	
	▪ **Revised deemed savings estimates:** kWh savings estimates were updated with v10 of the NYS TRM, affecting MMBtu and kWh accordingly.	▪ **Continue to use the latest version of the PSEG-LI TRM for planning values.**

5 HOME COMFORT PROGRAM

PSEG Long Island's Home Comfort Residential Heating and Cooling Program provides residential customers rebates for the purchase and installation of efficient and clean heat pumps. The primary objective of the program is to influence PSEG Long Island customers to make high efficiency choices when purchasing and installing ENERGY STAR® ducted split air-source heat pumps (ASHP), ductless mini split and multi split heat pumps (DMHP), and ground source heat pumps (GSHP). Each year the Home Comfort program has evolved to align more closely with New York State's aggressive greenhouse gas reduction goals. The Climate Leadership and Community Protection Act (CLCPA), a significant achievement of New York State, along with the Governor's commitment to electrify 2 million homes by 2030, has motivated state officials to reinforce and expand their efforts to install heat pumps across their territory. The Long Island Power Authority (LIPA) is leading the way in the implementation of New York State's policy goals. Home Comfort program administered by PSEG Long Island specifically displaces fossil fuels for heating and decarbonizes buildings by promoting and installing heat pump technologies. In 2023, the Home Comfort Program installed 6,176 heat pumps, 6,024 air source heat pumps, 152 geothermal heat pumps, and 120 heat pump water heaters.

5.1 HOME COMFORT PROGRAM DESIGN AND PARTICIPATION

The following sections detail the program design, implementation strategies, and PY2023's participation and performance for the Home Comfort program.

5.1.1 Program Design and Implementation

The Home Comfort program offers customer rebates to both market rate and income eligible customers and contractor incentives for heating and cooling system upgrades. Weatherization measures are promoted with heat pump installations but are processed and claimed through the Home Performance program in order to better provide holistic whole home solutions. Program participation is primarily driven through partnerships with installation contractors, also called Home Comfort Participating Contractors.

Engaging the installation contractors to deliver the program has improved program performance and market impacts by ensuring the Quality Installation Verification of HVAC equipment, which includes right-sizing of the equipment, refrigerant charge correction, and airflow testing. All whole-house heat pumps[4] in 2023 required a Quality Installation Verification installation. PSEG Long Island eliminated the Partial House offering in September 2023 to focus program efforts on whole home solutions.

[4] A whole-house heat pump system is sized and installed to provide between 90% and 120% of the design heating load per Manual J calculations.

5.1.2 Program Participation and Performance

Based on verified ex-ante estimates, the Home Comfort program reached 167% of its energy savings goal in 2023. Table 5-1 presents 2023 Home Comfort programs verified ex-ante gross MMBtu savings compared to goal.

Table 5-1: Home Comfort Program Verified Ex-Ante Gross MMBtu Savings versus Goals

Metric	MMBtu
Goal	110,518
Verified Ex-Ante Gross Savings	184,223
% of Goal	167%

Table 5-2 presents Home Comfort measure installations from 2020 through 2023. The installation of ductless & ducted ASHPs through the Home Comfort program continued to be a high contributor to the overall Home Comfort portfolio in 2023, consistent with PSEG Long Island MMBtu-based savings goals and New York State Clean Heat initiatives. The program started incentivizing heat pump water heater (HPWH) installations in 2021, and had a sharp rise in installations in 2023 from previous years.

Table 5-2: Comparison of Home Comfort Program Measures Installed – 2020 to 2023

Measure	2020	2021	2022	2023	Percent Difference 2022 to 2023
Split CAC	1,304	0	0	0	0%
Smart Thermostats	227	68	84	60	-28%
Ducted ASHPs	822	985	1,192	2,171	-2%
Ductless ASHPs	2,837	2,917	2,564	3,853	+50%
GSHP	132	146	201	152	-24%
HPWH	0	11	65	121	+86%
Total	**5,322**	**4,127**	**4,106**	**6,357**	**+54%**

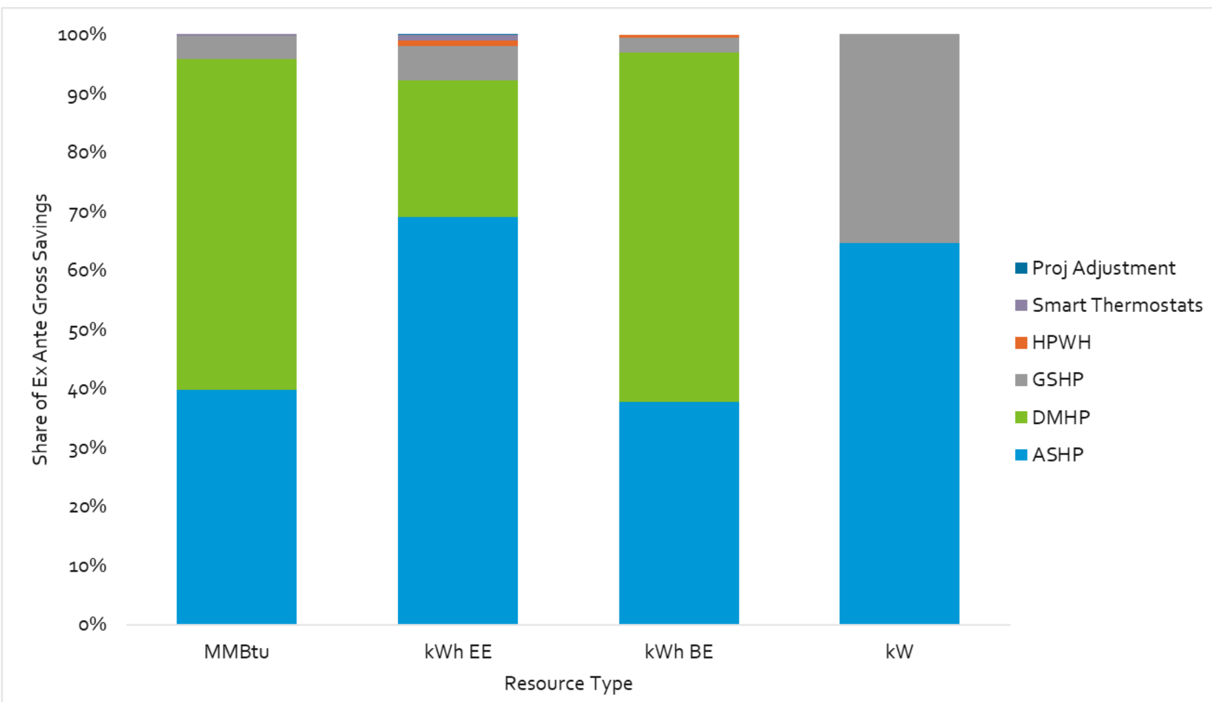
Figure 5-1 shows the distribution of ex-ante gross energy and demand savings across the Home Comfort program. Ducted and ductless mini/multi split heat pumps accounted for a combined 96% of the ex-ante gross MMBtu savings in 2023. These installations also resulted in beneficial electrification impacts for which a baseline heating load supplied by a fossil fuel source was displaced by the incented heat pump. When planning for the 2023 program year, program implementers identified the cooling and heating baseline scenarios for heat pump installations shown in Table 5-3. Evaluators reviewed and agreed with these baseline assumptions during the program planning phase and have therefore incorporated them in the calculation of ex-post impacts.

Table 5-3: Cooling and Heating Baseline Scenarios for Heat Pump Installations

#	Scenario	Preexisting Cooling Equipment	Preexisting Heating Equipment	Cooling Baseline	Heating Baseline
1	New Construction	N/A	N/A	Code Compliant HP	Code compliant fossil fuel furnace
2	Retrofit	AC or Heat Pump	Fossil Fuel	Preexisting AC or HP	Preexisting fossil fuel furnace/boiler
3	Retrofit	AC or Heat Pump	Electric Resistance or Heat Pump	Preexisting AC or HP	Preexisting electric heating system

Beneficial electrification measures increase electricity consumption, resulting in negative kWh impacts, but reduce total energy consumption (MMBtu) and emissions from the displacement of fossil fuels. Scenarios 1 and 2 above result in beneficial electrification impacts, shown as kWh BE in Figure 5-1. The electric savings resulting from the installation of efficient heating and cooling equipment is shown as kWh EE.

Figure 5-1: Home Comfort Program Ex-ante Gross Impacts by Resource and Measure Category



Evaluators identified that the kW impacts in DMHP systems were very low and driven by lower installed EER ratings compared to the baseline EER specified in the 2023 New York State TRM and PSEG Long Island TRM for a majority of the cold-climate ductless mini- and multi-split heat pumps installed in 2023.

5.2 HOME COMFORT IMPACTS

The following sections provide the results of the impact analysis for the Home Comfort program.

5.2.1 Overview of Impacts by Resource Type

Table 4-4 shows ex-post gross MMBtu impacts by measure category. Table 4-5 and Table 4-6 show the ex-post MWh and kW impacts, respectively. Realization rates are calculated by dividing ex-post gross savings values by ex-ante gross savings values. Overall, the Home Comfort program realized 103% of its ex-ante gross MMBtu energy savings claims, 153% of MWh impacts claims, and 141% of kW savings claims. Note that the overall gross MWh impacts are negative for the Home Comfort program due to significant increase in site-level electric consumption from beneficial electrification measures (e.g., heat pumps). We expand on the impacts of beneficial electrification for Home Comfort measures in Section 4.2.1.1.

Table 5-4: 2023 Home Comfort Program Ex-Post Gross MMBtu Impacts

Measure	N	Ex-Ante Gross Savings (Claimed) MMBtu	Ex-Post Gross Savings MMBtu	Realization Rate %
Ducted ASHPs	2,171	73,403	85,177	116%
Ductless Mini- and Multi-split heat pumps	3,853	103,268	96,641	94%
GSHP	152	6,988	6,577	94%
Smart Thermostats	60	96	98	102%
Heat Pump Water Heaters (HPWH)	121	1,244	1,202	97%
Project Adjustments	2	-787	-787	100%
Totals	**6,359**	**184,211**	**188,908**	**103%**

Note: Totals may not sum due to rounding.

Table 5-5: 2022 Home Comfort Program Ex-Post Gross MWh Impacts

Measure	N	Ex-Ante Gross Savings[1] (MWh)	Ex-Post Gross Savings[1] (MWh)	Realization Rate (MWh)
Ducted ASHPs	2,171	-4,564	-7,651	168%
Ductless Mini- and Multi-split heat pumps	3,853	-9,603	-13,981	146%
GSHP	152	-286	-450	157%
Smart Thermostats	60	28	29	102%
HPWH	121	-60	-59	98%
Project Adjustments	2	2	2	100%
Totals[1]	**6,359**	**-14,483**	**-22,110**	**153%**

Note: Totals may not sum due to rounding:

[1] MWh impacts include both energy efficiency (EE) and beneficial electrification (BE) components. MWh impacts are negative for heat pump and water heater measures due to the displacement of preexisting fossil fuel heating with electricity. The forthcoming section separates the EE and BE components for all measure groups and further explains the reasons for negative impacts.

Table 5-6: 2023 Home Comfort Program Ex-Post Gross kW Impacts

Measure	N	Ex-Ante Gross Savings (kW)	Ex-Post Gross Savings (kW)[1]	Realization Rate (kW)
Ducted ASHPs	2,171	240	237	99%
Ductless Mini- and Multi-split heat pumps	3,853	-2	180	-9,000%
GSHP	152	140	113	81%
Smart Thermostats	60	0	0	N/A
HPWH	121	-7	-7	101%
Project Adjustments	2	3	3	100%
Totals	**6,359**	**374**	**526**	**141%**

Note: Totals may not sum due to rounding.

[1] kW impacts include both energy efficiency (EE) and beneficial electrification (BE) components. kW impacts are negative for ductless ASHPs since EER ratings for most installed units were lower than code minimum EER from NYS TRM. kW impacts are negative for heat pump water heater measures due to the displacement of preexisting fossil fuel heating with electricity.

5.2.1.1 Beneficial Electrification Impacts

Table 4-7 shows the breakdown of Energy Efficiency (EE) and Beneficial Electrification (BE) components of MMBtu and kWh savings for measures where a BE component exists. The ductless mini splits and ducted ASHPs, GSHP, and HPWH measures include a mixture of electric energy efficiency and beneficial electrification impacts.

Table 5-7: Breakdown of Ex-Post Gross Impacts by EE and BE Components

Measure	MWh_{ee}	MWh_{be}	MWh Total (EE - BE)	$MMBtu_{ee}$	$MMBtu_{be}$	MMBtu Total (EE + BE)
Ducted ASHPs	1,950	9,601	-7,651	6,653	78,524	85,177
Ductless Mini- and Multi-split heat pumps	672	14,654	-13,981	2,294	94,347	96,641
GSHP	136	585	-450	439	6,138	6,577
HPWH	26	85	-59	90	1,112	1,202
Total	**2,784**	**24,926**	**-22,142**	**9,476**	**180,121**	**189,597**

We estimate that 2023 program-supported heat pump and water heater measures added 24,926 MWh/year of additional electrical sales by displacing preexisting fossil fuel-fired systems. The program incented customers and contractors to install high-efficiency heat pumps and water heaters that, when compared with code-compliant or pre-existing electric equipment, led to 2,784 MWh/year of energy savings. The overall electric consumption therefore increased by 22,142 MWh. However, accounting for the consumption of displaced fossil fuels in the $MMBtu_{be}$ column, Home Comfort heat pumps led to 189,597 MMBtu of annual energy savings.

5.2.2 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 5-8 shows the Home Comfort program ex-post impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in the Introduction, Section 2.1.1. Overall, 31% of Home Comfort MMBtu impacts count towards the DAC and Low Income standards. For Home Comfort, the Low Income impacts were identified by the 'LMI-ASHP' tag added to the program field in the data. DAC impacts were identified utilizing project locations and the DAC census tract list provided by NYSERDA.

Table 5-8: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	129,821	69%
DAC Only	8,665	5%
Low Income Only	44,057	23%
DAC & Low Income	6,365	3%
Total	**188,908**	**100%**

5.2.3 Key Drivers for Differences in Impacts

We conducted a measure-level savings approach to calculate the total PY2023 ex-post gross impacts for ductless ASHP, ducted ASHPs, GSHP, and Smart Thermostats. To estimate gross savings for HPWH measures, we applied the per unit ex-post gross impacts from EEP to the Home Comfort population. Most measure-specific discrepancies between ex-ante and ex-post gross savings are due to differences in program and evaluation savings algorithms and assumptions, including, but not limited to, baseline efficiencies and full load operating hours of equipment. Like 2021 and 2022, there was an increased emphasis on electrification of fossil fuel systems in 2023, for the purpose of meeting decarbonization goals. This resulted in an overall increase of electric equipment load on the grid due to the displacement of fossil fuel heating loads by heat pumps.

The U.S. Department of Energy (DOE) enacted new energy efficiency requirements for residential and commercial air conditioners and heat pumps that went into effect on January 1, 2023. These new regulations affect code compliance for mechanical equipment regardless of the state or local code edition that has been adopted because federal appliance standards preempt state and local construction codes. The minimum efficiency requirements (EER2/SEER2/HSPF2) and test procedures for residential equipment was updated and improved, and air conditioners and heat pumps manufactured after January 1, 2023 are to be rated based on new test procedures. For PY2023 Home Comfort evaluation, we utilized baseline and installed efficiencies rated in EER2, SEER2 and HSPF2, whereas the program utilized historical efficiency ratings of EER, SEER and HSPF to estimate kW, MWh and overall MMBtu impacts.

The New York State Joint Utilities made adjustments to the cooling and heating equivalent full load hours (EFLHs) in version 10 of the New York State TRM, which became effective on January 1, 2023. These adjustments were made based on a linear evaluation of the relative cooling and heating degree hours, with a base of 65°F, between the TMY3 data and the 30-year National Oceanic and Atmospheric Administration (NOAA) Climate Normals from 1991 to 2020. As a result of these updates to the NYS TRM, we updated the EFLHs in the 2024 and 2025 versions of the PSEG Long Island TRM to reflect these changes. Furthermore, these updated EFLHs have been utilized in the evaluation of Home Comfort measures in 2023. Overall, the cooling and heating degree days for the New York City region dropped slightly based on the updates resulting in lower cooling and heating EFLHs compared to the prior versions of the New York State TRM.

Overall, the evaluators calculated positive summer peak demand impacts for ductless mini- and multi-split heat pumps, while the program claimed a negative value for these units (refer figure 4-1). Baseline EER2 standards in 2023 NY TRM were overstated due to outdated conversion equations from DOE, Building America House Simulation Protocols, which was dated October 2010. For the evaluation, we updated baseline EER2 requirements by converting EER in NY TRM to EER2 based on conversion equations provided by the Pennsylvania Statewide Evaluation team's recommendations[5] to the utilities.

Below we describe the reasons for differences between gross ex-ante savings and ex-post savings for each measure. **In most cases, our recommendations apply to the 2025 program year.** Planning for the 2024 program year was finalized a year ago, and program delivery is almost half complete. These types of changes are often most efficient to implement at the beginning of a new program year. Most of our recommendations are also reflected in the recently completed 2025 PSEG Long Island TRM.

[5] The EER to EER2 conversion equations were listed in a "Codes and Standards Memo" that is not publicly available. The conversion equations will appear in the 2026 Pennsylvania TRM due for release in May 2024.

Table 5-9: Key Contributors to Home Comfort Realization Rates and Recommended Adjustments

Component	Summary of Contributing Factors	Recommendation
All heat pumps under Home Comfort	▪ We calculated the energy impacts and realization rates using the new DOE efficiency metrics EER2/SEER2/HSPF2, whereas TRC used historic metrics of EER/SEER/HSPF in their calculations. Although AHRI ratings per new DOE efficiency requirements were obtained for most 2023 installs, those ratings were converted back to EER/SEER/HSPF, before estimating claimed savings.	▪ Incorporate new DOE efficiency ratings in savings algorithms, and track these ratings as separate fields in Captures. Additionally, due to complexities in Heat pump operations at part loads, we recommend collaboration with IOUs and NYSERDA for a consistent approach to resolve this issue.
	▪ The updated NOAA climate normals for 1991-2020 have been integrated into the 2023 New York State TRM, and replacing the TMY3 climate normals with the newer data resulted in lower estimates of cooling and heating EFLHs in the TRM.	▪ **Align the full load heating and cooling hours with 2025 PSEG-LI TRM.** The 2025 PSEG-LI TRM recommendations align with values provided for residential units in 2024 NYS TRM. Since the 2024 program is already underway, the 1981-2010 climate normals will be used to calculate EFLHs in the impact calculations.
Smart Thermostats	▪ The NOAA updated climate normals for 1991-2020 have been integrated into the 2023 New York State TRM and replacing the 1981-2010 climate normals with the newer data resulted in lower estimates of cooling and heating EFLHs in the TRM.	▪ **Align the full load heating and cooling hours with 2025 PSEG-LI TRM.** The 2025 PSEG-LI TRM recommendations align with values provided for residential units in 2024 NYS TRM. Since the 2024 program is already underway, the 1981-2010 climate normals will be used to calculate EFLHs in the impact calculations.
	▪ Similar to 2022, we identified 2 instances where a home installed two smart thermostats connected to a single air-source heat pump (e.g. a zoned system). The claimed savings effectively double-count the heating and cooling capacity controlled in the home.	▪ Create an indicator for zoned systems and configure all connected thermostat calculations to account for savings from a single air-source heat pump.

6 HOME PERFORMANCE PROGRAM

PSEG Long Island's Home Performance programs have four components: Home Energy Assessments (HEAs), Home Performance Direct Install (HPDI), Home Performance with ENERGY STAR (HPwES) and National Grid Weatherization coordination (NGrid). The primary objective of the Home Performance suite of programs is to make high efficiency choices part of the decision-making process for PSEG Long Island customers when upgrading their home. The overall goal of the Home Performance with ENERGY STAR programs is to reduce the carbon footprint of customers who utilize electricity, oil, or propane as a primary heating source. To achieve this goal, the HPwES component encourages customers to consider high efficiency options when updating their home's envelope or heating systems. Home Performance Direct Install targets customers with electric heating and includes an energy assessment and certain free efficiency upgrades. Home Energy Assessments (HEAs) are free energy audits offered to certain single-family homeowners. Participants in the HEA or HPDI components may also be eligible for rebates through the HPwES program.

6.1 HOME PERFORMANCE PROGRAM DESIGN AND PARTICIPATION

6.1.1 PROGRAM DESIGN AND IMPLEMENTATION

The Home Performance portfolio offers customer rebates and contractor incentives for heating and cooling system upgrades, weatherization, and building shell upgrades like insulation, air sealing, and duct sealing. Certain minimum efficiency requirements must be met to receive Home Performance incentives and all projects must be pre-approved by the program team contractor. Home Performance offerings are available to all single-family homes in PSEG Long Island, including both market-rate and Low-Moderate Income (LMI) demographics.

As part of the HPwES Program, Home Energy Assessments (HEA) are free energy audits available to any single-family homeowner in PSEG Long Island service territory. The program is administered by TRC and involves a qualified contractor conducting a Home Energy Assessment to make the homeowner aware of energy savings opportunities. In addition to the assessment, TRC mails a "Thank You" Kit[6] that contains four 9-Watt LED bulbs to each HEA participant or a Tier 2 Smart Power strip.

In 2023, eligible customers with electric heat could participate in the Home Performance Direct Install (HPDI) program, which includes select free efficiency upgrades and an energy assessment by a certified contractor. Once the free HPDI measures are completed, customers receive their free HEA and could potentially also apply for additional rebates through HPwES. PSEG Long Island discontinued the HPDI offering for 2024.

[6] As of July 2023, TRC has updated the content of their "Thank You" Kit to include only a Tier 2 Smart Power strip in compliance with the Energy Independence and Security Act of 2007 (EISA).

6.1.2 PROGRAM PARTICIPATION AND PERFORMANCE

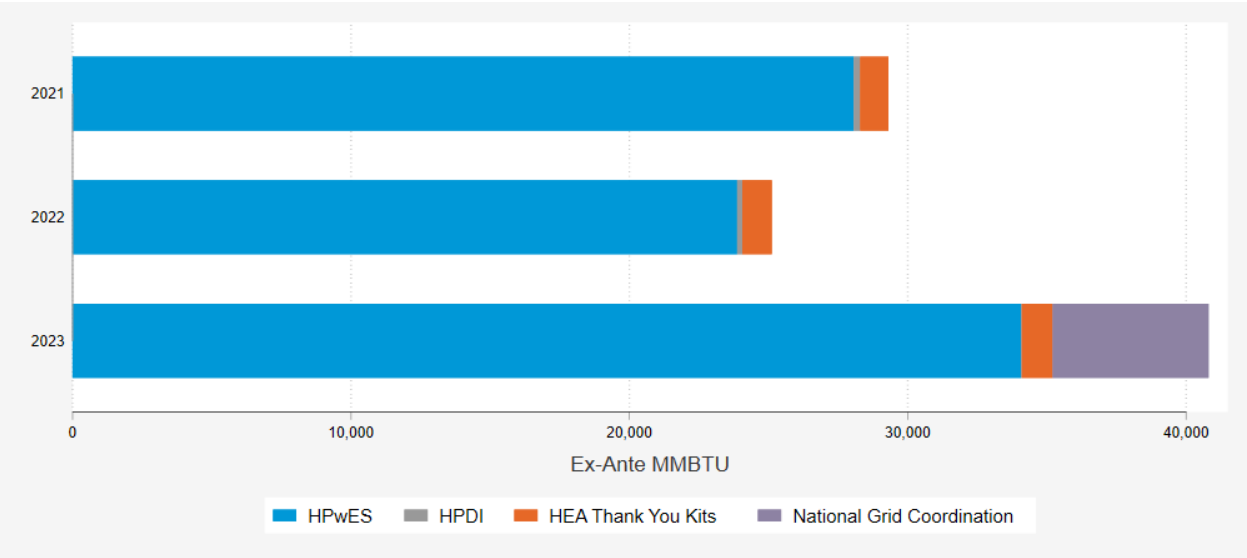
Based on verified ex-ante estimates, the Home Performance program reached 129.41% of its energy savings goal in 2023. Table 6-1 presents 2023 Home Performance programs verified ex-ante gross MMBtu savings compared to goal.

Table 6-1: Home Performance Programs Verified Ex-Ante Gross MMBtu Savings versus Goals

Metric	MMBtu
Goal	31,426
Verified Ex-Ante Gross Savings	40,668
% of Goal	129.4%

Figure 6-1 shows the claimed MMBtu savings by Home Performance program component for the last three years.

Figure 6-1: Ex-Ante MMBtu Savings by Program Component and Year



In 2023, the HPDI program completed projects with 32 customers, while the HPwES program treated 683 customers. A total of three customers participated in all three Home Performance programs. The HEA program delivered thank you kits to 3,796 customers. Of the HEA recipients, 388 customers also participated in the HPDI or HPwES programs. Overall, 4,121 unique customers were treated by the Home Performance programs in 2023. These counts include the 304 HPwES customers who installed beneficial electrification measures. Relative to 2022, the Home Performance program had fewer HPwES participants, with 683 participants in 2023 compared to 688 in 2022. The program achieved more savings per customer in 2023. Despite the decrease in HPwES participation, the increase in heat pump projects led to an increase in MMBtu savings per home, which likely helped the program exceed its goals in 2023.

6.2 HOME PERFORMANCE PROGRAMS IMPACTS

The following sections provide the results of the impact analysis for the Home Performance program.

6.2.1 OVERVIEW OF IMPACTS BY RESOURCE TYPE

For the ex-post evaluation, we used both engineering and consumption analysis to estimate savings for the Home Performance programs in 2023. To calculate ex-post gross MWh savings due to energy efficiency (EE MWh savings), we applied the consumption analysis realization rate (58%) to the ex-ante gross EE savings. To calculate the ex-post gross MWh impacts due to beneficial electrification measures, we utilized results from engineering analysis. To calculate ex-post gross demand and MMBtu savings, we used a kW/MWh and MMBtu/MWh ratio respectively developed from the engineering analysis and applied to the ex-post gross energy savings.

The combined consumption and engineering analyses found that the programs generated approximately 32,372 MMBtu in ex-post gross energy savings in 2023, or approximately 87% of the ex-ante gross MMBtu savings. Table 6-2 shows ex-ante gross impacts, ex-post gross impacts, and the realization rate by resource (MMBtu, MWh, and kW) category.

Table 6-2: 2023 Home Performance Program Ex-Post Impacts

Resource	Ex-Ante Gross Savings	Ex-Post Gross Savings	Realization Rate
MMBtu	40,802	32,372	79%
MWh	1,777	378	21%
kW	2,232	2,038	91%

6.2.2 ANALYSIS APPROACH AND DETAILED RESULTS

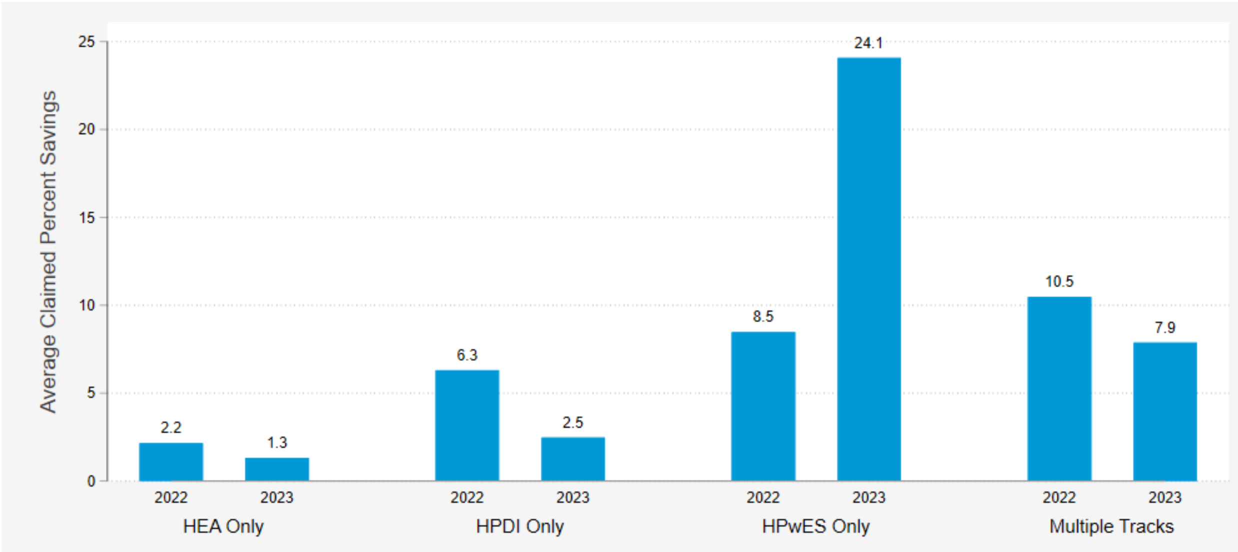
Our ex-post gross savings estimates are anchored in the analysis of daily kWh from the meter and supplemented by engineering calculations to estimate total MMBtu conservation and peak demand savings. We use engineering analysis to calculate MMBtu to kWh and kW to kWh ratios at the measure level and utilize these ratios to estimate ex-post gross MMBtu and kW impacts. In addition, because the engineering analysis provides savings at the measure level, we gain insights into the relative savings contributions of the measures offered by the programs. Finally, these measure-level savings allow us to make recommendations to the implementation team for adjusting ex-ante planning assumptions going forward.

6.2.2.1 Consumption Analysis – Approach

The Home Performance (HP) program used to rely on a consumption analysis approach that was considered very reliable in measuring electric savings resulting from residential energy efficiency interventions. However, the program's current shift in strategic focus and measurement metrics is now posing new challenges that question the suitability of the consumption analysis.

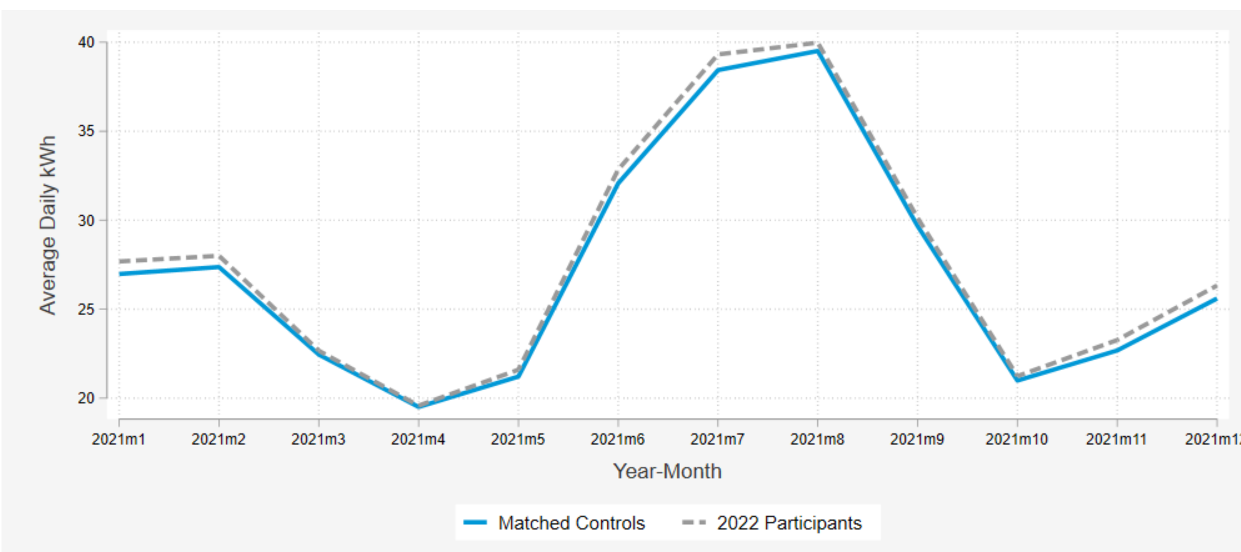
- **Shift in performance metrics.** The program's emphasis has shifted towards beneficial electrification (BE) and significant fossil fuel savings, which are not detectable through electric meter readings alone. This transition means that a substantial portion of the program's energy savings, particularly those from fossil fuels, which constitute nearly three-quarters of the total claimed savings, are not being captured in the analyses.
- **Increase adoption of heat pumps.** The increased promotion and adoption of heat pumps, which save electricity for summer months but use more electricity for winter heating, complicates consumption analysis due to the need for assumptions about fossil fuel displacement. This introduces uncertainties that can significantly skew the accuracy of evaluations.
- **We have a small signal to analyze.** Although there is many homes to analyze, with over 3,000 participating households per year in 2022 and 2023, the vast majority of participants only fall into the HEA component. As a result, the Home Performance billing analysis, while stable across model specifications and robust to idiosyncratic changes in behavior at the household level, may only be capturing a small amount of savings.
- **Changing population and Smaller Sample Size.** The growing inclusion of BE measures has reduced energy efficiency eligible sample size, leading to less precise estimates. Smaller effect sizes and broad confidence intervals further lessen the reliability of the consumption analysis.
- **The measures are retrofit rather than replace-on-burnout.** This means that the equipment installed and condition of the home prior to program participation are the appropriate baseline to use in the savings calculation.
- **Participating households tend to adopt multiple measures.** These measures can interact with one another in ways that are difficult to capture in engineering equations.
- **Savings are reasonably large on a percent basis.** On average, the ex-ante gross claimed kWh savings represented 3.2% of pre-retrofit annual billed electricity usage. As shown in Figure 6-2, ex-ante kWh savings as a percentage of weather-normalized pre-retrofit electric consumption varies by program component. Households that only participate in HEA show the smallest expected percent savings. HEA Only participants accounted for over two-thirds of all Home Performance participation in 2022 and 2023. This pulls down the average savings per household compared to the HPDI and HPwES components, which claim more kWh per participant, on average.

Figure 6-2: Average Ex-Ante kWh as a Percentage of Annual Household Consumption



Because the consumption analysis requires post-installation electricity usage data for approximately one year after treatment, we use 2022 participants as the treatment group and construct a matched comparison group from the 2023 participants. The use of future participants controls for selection effects. In other words, we know that the matched comparison group is composed of the type of homes that participate in the Home Performance programs because they participated in the following year. We further refine the comparison groups using Euclidean distance matching. Figure 6-3 compares the average monthly billing analysis of the 'treatment group' and matched control group during 2021, which is the year prior to the treated homes' participation. We employ a difference-in-differences regression model that nets out pre-period differences from the impact estimates.

Figure 6-3: Comparison of Pre-Treatment Consumption for Home Performance Consumption Analysis



The consumption analysis model uses daily electric consumption data to quantify post-participation changes in energy use. The matched controls inherit a pseudo pre-post transition date from their participant match and any records after they actually participated (in 2023) are excluded from the analysis. The transition from the pre-period to post-period is based on the project completion date, so over the course of 2023, the status the participant group in aggregate gradually shifts.

The consumption analysis model is a weather normalized linear fixed effects panel regression model. A fixed effects model absorbs time-invariant household characteristics via inclusion of separate intercept terms for each account in the treatment and comparison group. Additional details regarding the consumption analysis model, including the model specification and model parameter definitions, is presented in Appendix A, Subsection H. Several different model specifications were tested to assess the robustness of the results, and the results were indeed consistent across models.

The participant group in the consumption analysis includes homes that participated in HPwES, HEA, HPDI, as well as homes that participated in multiple program components. During 2022 and 2023 the HPwES program included a mix of electric conservation and beneficial electrification measures. We use a two-step filtering process to exclude homes with beneficial electrification measures from the consumption analysis.

1. Use the "Current Savings BE MMBtu" field in the measure-level HPwES Captures data to flag households that installed a measure with non-zero beneficial electrification savings.
2. Cross-reference the Home Performance participants with Home Comfort participation data and flag households with non-zero beneficial electrification savings.

The consumption analysis method is indifferent to the direction of the savings. However, including a mix of homes with positive and negative electric savings pulls the average towards zero and makes it more difficult to precisely estimate the impacts. Since the 2022 beneficial electrification measures were mostly heat pumps, we elected to use consumption analysis for homes that did strictly energy efficiency and analyzed beneficial electrification measures using the same engineering analysis methods as the Home Comfort program.

A key assumption with this model framework is that our estimates of 2022 performance and realization rates are applicable to 2023 measures and projects. The measure mix and ex-ante savings assumptions were generally consistent across years so we are comfortable applying the realization rate determined using 2022 participants to 2023.

6.2.2.2 Consumption Analysis – Results

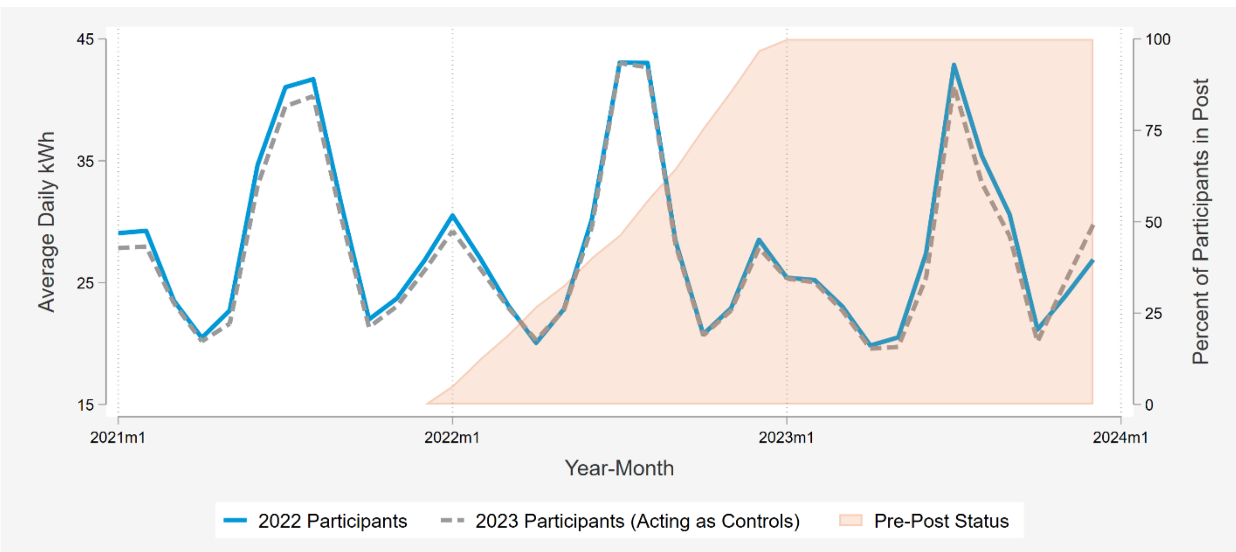
In Table 6-3 we use the results of the combined Home Performance programs model to estimate average savings for 2022 participants and compare the estimated impact to the ex-ante gross kWh savings claimed by the implementer. Across the 1,845 Long Island homes included in the regression model, the average annualized savings was 163.6 kWh. This equals 58% of the average ex-ante gross kWh savings claimed for the same homes. We applied the 58% realization rate to the ex-ante gross kWh savings claim of 2023 participants to estimate ex-post gross kWh savings for efficiency measures.

Beneficial electrification measures are evaluated using an approach that mirrors the Home Comfort program. Figure 6-4 visualizes the consumption analysis results. As more participants move into the post period, the average daily electric usage for the treatment group begins to depart from the matched control group. This departure is the effect of interest. The savings are largest during the winter and summer months, which is expected given the focus on HVAC and envelope improvement measures.

Table 6-3: Home Performance Consumption Analysis Results (n=1,845)

Parameter	Estimate	Lower Bound of 95% CI	Upper Bound of 95% CI
Daily Treatment Effect (kWh Saved)	0.45	-0.12	1.02
Daily Treatment Effect (% Savings)	1.6%	0.0%	3.2%
Annual Savings	163.62	-3.07	330.31
Ex-Ante Gross kWh		282.04	
Realization Rate	58.01%	-0.01%	117.1%

Figure 6-4: Home Performance Consumption Analysis Results Visualized



Because the consumption analysis relies on daily billing data rather than hourly AMI data, it does not produce estimates of peak demand savings. PSEG Long Island does not sell natural gas or deliver fuel, so fossil fuels consumption records are not available for analysis. To estimate MMBtu and peak demand savings for the Home Performance programs, we first calculated MMBtu to kWh and kW to kWh ratios between the engineering-based estimates for each measure. Next, we applied this ratio to the energy savings estimates derived from the consumption analysis to generate ex-post demand savings.

6.2.2.3 Engineering Analysis: HPDI

The evaluation team used program tracking data and engineering analysis to estimate gross energy and demand savings achieved by each measure installed through the 2023 HPDI program. As described above, the results of the engineering impacts analysis provide us with the demand-to-energy ratio needed to quantify demand savings from the energy consumption analysis, as well as an understanding of individual measure savings variations between consumption analysis results and planning assumptions. Table 6-4, Table 6-5, and Table 6-6 show the engineering analysis gross savings for each HPDI measure category in MMBtu, MWh, and kW, respectively.

Table 6-4: 2023 HPDI Engineering Analysis Gross MMBtu Impacts

Category	N[1]	Ex-Ante Gross Savings (MMBtu)	Engineering Analysis Ex-Post Gross Savings (MMBtu)	Engineering Analysis Realization Rate (MMBtu)
LED Bulbs	262	27.4	31.3	114%
Domestic Hot Water	5	1.3	1.3	100%
Duct Sealing	3	5.9	5.9	100%
Advanced Power Strips	10	5.4	5.4	100%
HPDI Subtotal	**280**	**40.1**	**43.9**	**110%**

[1] Count of measures installed through the HPDI program.

Table 6-5: 2023 HPDI Engineering Analysis Gross MWh Impacts

Category	N[1]	Ex-Ante Gross Savings (MWh)	Engineering Analysis Ex-Post Gross Savings (MWh)	Engineering Analysis Realization Rate (MWh)
LED Bulbs	262	8.0	9.2	114%
Domestic Hot Water	5	0.4	0.4	100%
Duct Sealing	3	1.7	1.7	100%
Advanced Power Strips	10	1.6	1.6	100%
HPDI Subtotal	**280**	**11.7**	**12.9**	**110%**

[1] Count of measures installed through the HPDI program.

Table 6-6: 2023 HPDI Engineering Analysis Gross kW Impacts

Category	N[1]	Ex-Ante Gross Savings (kW)	Engineering Analysis Gross Savings (kW)	Engineering Analysis Realization Rate (kW)
LED Bulbs	262	0.70	1.85	265%
Domestic Hot Water	5	5.00	5.00	100%
Duct Sealing	3	0.67	0.67	100%
Advanced Power Strips	10	0.20	0.16	79%
HPDI Subtotal	**280**	**6.56**	**7.68**	**117%**

[1] Count of measures installed through the HPDI program.

6.2.2.4 Reasons for Differences in Engineering Impacts: HPDI

HPDI lighting MMBtu and MWh realization rates were 110%, however there was significant variation in realization rates among lamp types as shown in Table 6-7. This variation can be attributed to differences in ex-post and ex-ante assumptions for lamp wattage and hours of use.

Ex-Post (2025 TRM) and ex-ante Baseline and LED wattage assumptions are compared in

Table 6-8 and Table 6-9. For ex-ante, lamps were categorized as Nightlight, Standard or Specialty. Baseline and LED watts were assigned to each lamp type based solely on their Category. For ex-Post, representative actual Baseline and LED watts were assigned to each lamp irrespective of Category. This resulted in the significant variation in ex-ante and ex-post savings realization rates

Ex-ante savings for Exterior 10 Watt "A" Bulb and R-40 lamps were based on 2.7 hours of use instead of 5.7 hours in the TRC Workbook for ex-ante savings and in the 2025 TRM used for ex-post savings. This resulted in kWh realization rates 256% and 159% for Exterior 10 Watt and R-40 lamps respectively.

Table 6-7: HPDI Lighting Ex-Post Realization Rates

Lamp Type	Ex-Post MMBTU Realization Rate	Ex-Post MWh Realization Rate	Ex-Post kW Realization Rate
HPD .3 Watt Nightlight	106%	106%	--
HPD 10 Watt "A"Bulb	131%	131%	281%
HPD 5 watt Globe	110%	110%	237%
HPD 6.5 Watt Candelabra BA13	90%	90%	212%
HPD 9 Watt Reflector R-30	21%	21%	247%
HPD 9 Watt Reflector R-40	102%	102%	249%
HPD Exterior 10 Watt "A"Bulb	256%	256%	--
HPD Exterior 9 Watt Reflector R-40	159%	159%	--

Table 6-8: HPDI Lighting Ex-Post and Ex-Ante Baseline Wattage Comparison

Lamp Type	2025 TRM Baseline Wattage	Ex-Ante Baseline Wattage	2025 TRM /Ex-Ante Baseline Wattage	Ex-Ante Category
HPD .3 Watt Nightlight	5.00	5.75	87%	Nightlight
HPD 10 Watt "A"Bulb	60.0	46.6	129%	Standard
HPD 5 watt Globe	47.2	46.6	101%	Standard
HPD 6.5 Watt Candelabra BA13	52.8	46.6	113%	Specialty
HPD 9 Watt Reflector R-30	62.4	54.5	114%	Specialty
HPD 9 Watt Reflector R-40	62.8	54.5	115%	Specialty
HPD Exterior 10 Watt "A"Bulb	59.8	46.6	128%	Standard
HPD Exterior 9 Watt Reflector R-40	63.1	54.5	116%	Specialty

Table 6-9: HPDI Lighting Ex-Post and Ex-Ante LED Wattage Comparison

Lamp Type	2025 TRM LED Wattage	Ex-Ante LED Wattage	2025 TRM /Ex-Ante LED Wattage	Ex-Ante Category
HPD .3 Watt Nightlight	0.3	0.3	100%	Nightlight

Lamp Type	2025 TRM LED Wattage	Ex-Ante LED Wattage	2025 TRM /Ex-Ante LED Wattage	Ex-Ante Category
HPD 10 Watt "A"Bulb	10	10	100%	Standard
HPD 5 watt Globe	5	10	50%	Standard
HPD 6.5 Watt Candelabra BA13	7	10	70%	Specialty
HPD 9 Watt Reflector R-30	9	8.39	107%	Specialty
HPD 9 Watt Reflector R-40	9	8.39	107%	Specialty
HPD Exterior 10 Watt "A"Bulb	10	10	100%	Standard
HPD Exterior 9 Watt Reflector R-40	9	8.39	107%	Specialty

Table 6-8: Key Contributors to HPDI Engineering Analysis MMBtu RR and Proposed Solutions

Component	Summary of Savings Difference	Proposed Solution
Lighting	▪ The realization rate variability among lamp types was the result of discrepancies between ex-ante and ex-post and baseline and LED lamp wattage and hours of use assumptions.	Align savings assumptions with PSEG-LI TRM. However, HPDI has been discontinued, and these measures will no longer be implemented.

6.2.2.5 Engineering Analysis: HPwES

The evaluation team used program tracking data and engineering analysis to estimate gross MMBtu, kWh, and kW demand savings achieved by each HPwES measure. Evaluators conducted this analysis for the same purpose as detailed in the HPDI engineering analysis above. Table 6-9,

Table 6-10 and

Table 6-11 compare gross engineering analysis savings to ex-ante gross savings by HPwES measure category for MMBtu, kWh, and kW savings, respectively.

Table 6-9: 2023 HPwES Engineering Analysis Gross MMBtu Impacts

Category	N[1]	Ex-Ante Gross Savings[2] (MMBtu)	Engineering Analysis Ex-Post Gross Savings (MMBtu)	Engineering Analysis Realization Rate (MMBtu)
Duct Sealing	367	2,034	2,325	114%
Air Sealing	644	3,421	2,285	67%
Envelope (Attic, wall, basement, and garage insulation)	1,128	8,468	6,886	81%
Ducted Air-source Heat Pumps	192	8,978	8,185	91%
Ductless Mini-splits	291	9,400	8,854	94%
HVAC (Non heat pumps - thermostats)	221	65	65	100%
DHW	172	1,697	1,772	104%
Measure-Level Total[3]	**3,015**	**34,064**	**30,373**	**89%**

[1] Count of measures installed through the HPwES program.
[2] Reported ex-ante gross savings include measure-level electricity savings and interactive electricity impacts from incentivized measures but exclude impacts from beneficial electrification measures.
[3] Measure-level savings are obtained through contractor reports and are used in evaluating measure category ex-ante savings to elucidate measure performance. These measure-level savings do not account for interactivity and are therefore not the official project-level savings claimed by the program administrators.

Table 6-10: 2022 HPwES Engineering Analysis Gross MWh Impacts

Category	N[1]	Ex-Ante Gross Savings[2] (MWh)	Engineering Analysis Ex-Post Gross Savings (MWh)[3]	Engineering Analysis Realization Rate (%)
Duct Sealing	367	308	356	115%
Air Sealing	644	326	201	62%
Envelope (Attic, wall, basement, and garage insulation)	1,128	447	351	79%
Ducted Air-source Heat Pumps	192	(428)	(808)	189%
Ductless Mini-splits	291	(883)	(1,162)	132%
HVAC (Non heat pumps - thermostats)	221	19	19	100%
DHW	172	(85)	(90)	105%
Measure-Level Total	**3,015**	**(296)**	**(1,133)**	**383%**

[1] Count of measures installed through the HPwES program.
[2] Reported ex-ante gross savings include measure-level electricity savings and interactive electricity impacts from incentivized measures but exclude impacts from beneficial electrification measures.
[3] Negative savings are due to beneficial electrification from displacement of fossil fuel heating systems.
[4] The Realization Rate is the ratio of Ex-Post/Ex-Ante Savings: 49/212 = 23%

Table 6-11: 2021 HPwES Engineering Analysis Gross kW Impacts

Category	N[1]	Ex-Ante Gross Savings[2] (kW)	Engineering Analysis Ex-Post Gross Savings (kW)	Engineering Analysis Realization Rate (%)
Duct Sealing	367	179	186	104%
Air Sealing	644	56	39	69%
Envelope (Attic, wall, basement, and garage insulation)	1,128	30	59	196%
Ducted Air-source Heat Pumps	192	71	14	20%
Ductless Mini-splits	291	82	22	27%
HVAC (Non heat pumps - thermostats)	221	0	0	100%
DHW	172	(10)	(10)	99%
Measure-Level Total	**3,015**	**408**	**310**	**76%**

[1] Count of measures installed through the HPwES program.
[2] Reported ex-ante gross savings include measure-level electricity savings and interactive electricity impacts from incentivized measures but exclude impacts from beneficial electrification measures.

6.2.2.6 Reasons for Differences in Engineering Impacts: HPwES

Table 6-12 identifies the key contributors to the overall engineering analysis gross MMBtu realization rate of 89%. In most cases, our recommendations apply to the 2025 program year as opposed to PY2024. Planning for the 2024 program year was finalized a year ago, and program delivery is almost half complete. These types of changes are often most efficient to implement at the beginning of a new program year. Most of our recommendations are also reflected in the recently completed 2025 PSEG Long Island TRM.

Table 6-12: Key Contributors to HPwES Engineering Analysis and Proposed Rectification Steps

Component	Summary of Savings Difference	Proposed Solution
Envelope (insulation), lower cooling usage	▪ Lower ex-post evaluated savings from the 2025 PSEG-LI TRM methodology are partially tied to lower cooling degree days (CDD) and equivalent full load cooling hours on residential equipment	▪ Both the ex-ante and ex-post savings are accurate to the TRM methodologies they applied. However recent updates to the PSEG-LI TRM lowered residential cooling usage across all measures leading to realization rates below 100%. Align analysis tools with PSEG-LI defined savings methodologies
Envelope, inconsistent project inputs	▪ Several projects exhibited inconsistencies in how their data was entered into the analysis tools, resulting in very high ex-ante savings. This included projects with R-value baselines set to zero resulting in artificially high savings	▪ Ensure a minimum R-value for all projects. Even if there is no existing insulation the building materials (sheetrock, OSB, vapor barriers, paint) provide some level of resistance to heat transfer
Air Sealing, HVAC system application issues	▪ Measures in homes with Electric Heat Pumps can be misclassified in the analysis workbook as AC with Electric Heat. This issue overstates electric energy and summer demand savings and results in lower realization rates. This issue was resolved in the 2022 v2 program workbook but older applications that apply older workbooks still exhibit this issue in 2023	▪ Review incoming air sealing measures that apply a Master Internal Workbook earlier than 2022 v2 and revise savings for measures tied to electric heat pumps
Air Sealing, ΔCFM_{50} approximation	▪ Ex-ante savings for most sampled projects were calculated using the blower door methodology with default pre- and post-improvement air leakage measurements even when areas of air leakage improvement range from 200 to 1,165 ft^2.	▪ Revise air sealing methodology to the ΔCFM_{50} approximation defined by the PSEG-LI and NY State TRMs that 50% of the improved area (ft^2) is equal to ΔCFM_{50} when blower door results are unavailable

Component	Summary of Savings Difference	Proposed Solution
Analysis Tool Inputs and calculations	▪ Inconsistencies with the HVAC system selected in the analysis tool and defined efficiency type are creating errors in the project savings estimates. This could be an oil boiler with efficiency set to 10.0 HSPF, or a heat pump with 80% heating efficiency. As these data points are carried through the analysis it creates issues for the savings estimate leading to missing savings or unrealistic outputs ▪ A 2023 update to the HPwES savings analysis created an issue where insulation project tied to heat pumps were calculating zero demand savings when the HVAC was operating entirely with electricity ▪ A 2022 duct sealing project, identified during billing analysis, claimed 90 MWh of energy savings due to the home area (2,200 ft^2) being entered as the unconditioned duct length.	▪ Create checks and validation within the analysis tools that ensure data entered aligns with the user defined HVAC systems align with the expected outputs for fuels used on-site and savings are feasible for the scope and scale of the completed project

6.2.2.7 Engineering Analysis: HEA Thank You Kits

For each HEA completed by PSEG Long Island in 2023, the program mailed a Thank You Kit to the customer. In previous programs years these kits contained four 9-Watt LED bulbs and this kit continued through June 2023 and was provided to 1,928 participants. Starting in July PSEG-LI discontinued savings for Standard LED bulbs and a new kit containing a single advanced power strip was delivered to 1,871 participants. Table 6-13, Table 6-14, and Table 6-15 compare ex-post savings (via engineering analysis) with ex-ante gross MMBtu, MWh, and kW savings, respectively, for the two distinct Thank You Kits.

Table 6-13: 2023 HEA Thank You Kits Gross MMBtu Impacts

Category	N	Ex-Ante Gross Savings (MMBtu)	Engineering Analysis Gross Savings (MMBtu)	Engineering Analysis Realization Rate (MMBtu)
Thank You Kits	3,799	1,103	1,080	98%

Table 6-14: 2023 HEA Thank You Kits Gross MWh Impacts

Category	N	Ex-Ante Gross Savings (MWh)	Engineering Analysis Gross Savings (MWh)	Engineering Analysis Realization Rate (%)
Thank You Kits	3,799	422	424	100%

Table 6-15: 2023 HEA Thank You Kits Gross kW Impacts

Category	N	Ex-Ante Gross Savings (kW)	Engineering Analysis Gross Savings (kW)	Engineering Analysis Realization Rate (kW)
Thank You Kits	3,799	57	58	101%

To estimate ex-ante gross savings, the TRC applied the planning assumptions for EEP standard LED bulbs using a stipulated mix of bulb types and tier 1 advanced power strips. For the ex-post evaluation, we utilize federal minimum efficiency values, by lamp type, for baseline wattages. Evaluated MMBtu, MWh, and kW savings aligned with the ex-ante assumptions resulting in 98%, 100%, 101% realization rates, respectively.

6.2.2.8 Engineering Analysis: National Grid Weatherization

In 2023 PSEG-LI coordinated with National Grid to claim electric energy and demand savings from PSEG-LI electric customers who participated in National Grid's natural gas focused weatherization program. These customers completed at least one of the following weatherization improvements with National Grid claiming all associated gas savings while electric and demand savings were claimed by PSEG-LI:

- Air Sealing
- Insulation (attic, ceiling, rim joist, wall, and floor)
- Windows

Project details shared by National Grid allowed the evaluation to estimate electric (MWh) and demand (kW) savings aligned with the 2023 PSEG-LI TRM to provide ex-ante savings. For ex-post the installed improvements were aligned with 2025 PSEG-LI TRM measures to maintain consistency with the Home Performance with ENERGY STAR Program that offers similar energy efficiency improvements. Energy savings have been converted to PSEG-LI's MMBtu efficiency metric, but this only contains electricity savings as all gas savings were captured by National Grid.

Table 6-16: 2023 National Grid Weatherization Gross MMBtu Impacts

Category	N	Ex-Ante Gross Savings (MMBtu)	Engineering Analysis Gross Savings (MMBtu)	Engineering Analysis Realization Rate (MMBtu)
National Grid Weatherization	5,386	5,596	5,281	94%

Table 6-17: 2023 National Grid Weatherization Gross MWh Impacts

Category	N	Ex-Ante Gross Savings (MWh)	Engineering Analysis Gross Savings (MWh)	Engineering Analysis Realization Rate (%)
National Grid Weatherization	5,386	1,640	1,548	94%

Table 6-18: 2023 National Grid Weatherization Gross kW Impacts

Category	N	Ex-Ante Gross Savings (kW)	Engineering Analysis Gross Savings (kW)	Engineering Analysis Realization Rate (kW)
National Grid Weatherization	5,386	1,760	1,784	101%

Ex-post results applied lower cooling degree days and equivalent full load cooling hours to all insulation measures leading to the 6% reduction in energy savings. The 1% increase in demand savings is due to an updated framing factor applied to rim joist projects.

6.2.2.9 Engineering to Billing Calibration Calculations

The 2023 consumption analysis resulted in lower ex-post gross kWh savings compared to ex-ante gross kWh savings, as shown by the 58.01% realization rate. The results were stable across multiple model specifications but have a relatively wide margin of error. The 95% confidence interval of the realization rate ranges from -0.01% to 117.1%. The wide margin of error is expected given the average savings per household. As shown in Figure 6-2, savings from homes that only receive a Home Energy Assessment are modest compared to HPDI and HPwES. Since approximately two-thirds of participants only participated in HEA, this necessarily lowers the average savings per participant.

The MMBtu and peak demand savings for Home Performance are estimated via a calibration of the electric consumption analysis and engineering calculations. For both MMBtu and kW, the ex-post gross savings was larger than the ex-ante gross savings. This result is a function of the MMBtu/kWh and kW/kWh ratios in the engineering analysis.

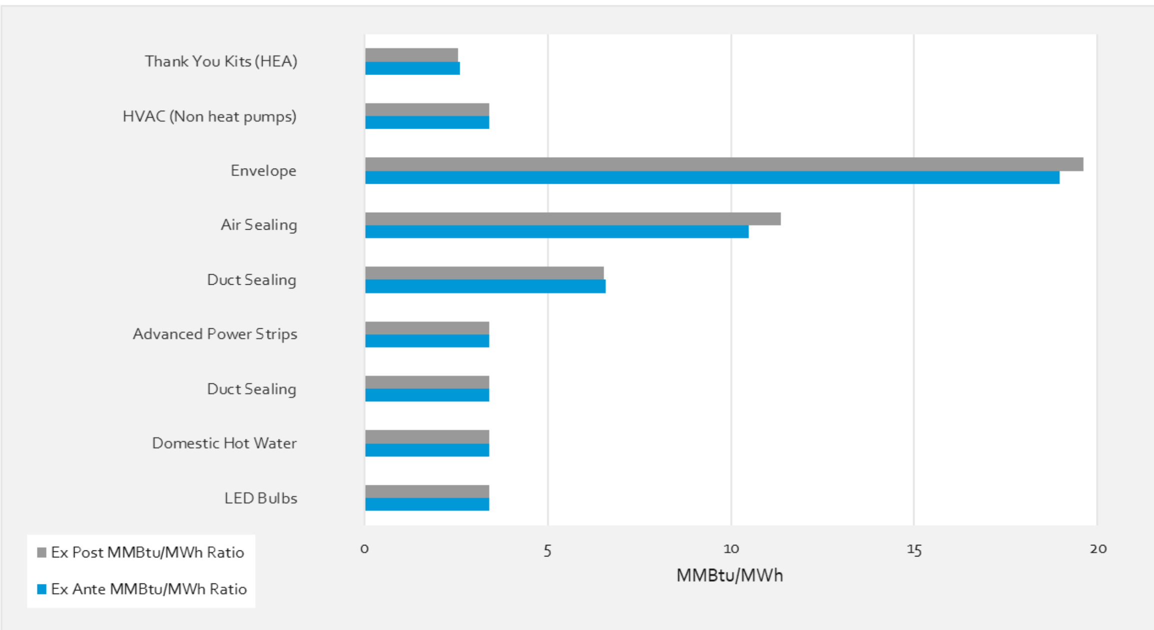
A direct conversion from MWh to MMBtu is 3.412 MMBtu/MWh.

- Measures that save only electricity will therefore have a ratio of MMBtu savings to MWh savings of 3.412. In that case, we would expect measures with relatively equal kWh and MMBtu impact estimates (or similar realization rates) to have a ratio close to 3.412.

- Measures that save fossil fuel as well as electricity with have a ratio greater than 3.412 MMBtu/MWh.
- Measures like LED lighting that save electricity, but also cause increased fossil fuel consumption due to HVAC interactive effects can have a ratio less than 3.412.

PSEG Long Island has a cold weather climate, and many of the HPwES measures primarily reduce energy consumption through a reduction in space heating. The heating fuel mix in Long Island is primarily fossil fuel, so insulating measures tend to offer more fossil fuel savings than electric savings. Figure 6-5 shows that measures like home envelope and air sealing have a much larger fossil fuel impact versus electric. For envelope measures the ratio of MMBtu to MWh was much higher in our ex-post engineering calculations than the ex-ante savings claims.

Figure 6-5: Ex-Ante Gross and Ex-Post Gross MMBtu/MWh Ratios



The billing analysis realization rate for the Home Performance program is 58.01%. Because of the variability in MMBtu per MWh across measure categories and between our engineering calculations and ex-ante assumptions, the Evaluation Team chose to calibrate MMBtu and kW savings to the billing analysis using the aggregate ratios across all measures in the engineering calculations. Table 6-19 shows the steps for MMBtu savings. The aggregate ratio of kW to MWh from our engineering calculations was 0.26.

Table 6-19: Home Performance MMBtu Billing to Engineering Calibration Calculation

Calibration Component	Calculation	Value
Billing Analysis MWh Ex-Post Impacts	MWh Ex-Ante Gross * Billing Realization Rate	1,364 MWh
MMBtu/MWh Ratio	$\frac{\text{Engineering MMBtu Ex Post}}{\text{Engineering MWh Ex Post}}$	9.30 MMBtu/MWh
Calibrated MMBtu Impacts	Billing Analysis MWh Ex-Post Impacts * MMBtu/MWh Ratio	8,280 MMBtu
Add Beneficial Electrification Impacts	Calibrated MMBtu Impacts + HPwES Heat Pumps and HPWH	32,372 MMBtu

6.2.2.10 Beneficial Electrification Impacts

In 2023, the HPwES program completed 304 [7] beneficial electrification (BE) projects that resulted in an increase in electric consumption. These measures involved displacement of fossil fuel-fired HVAC or DHW systems with high-efficiency electric systems – for example, from an oil furnace to an air-source heat pump. While BE projects increase overall electric consumption, they generate non-electric energy savings through avoided fossil fuel consumption.

To ensure that evaluated impacts accurately inform the program cost-effectiveness assessment, the evaluation team quantified both BE and energy efficiency (EE) impacts separately through engineering analysis, as shown in Table 6-20. The energy savings of the displaced fuel after electrification, and positive and negative impacts associated with energy efficiency measures, are expressed in MMBtu.

[7] There may have been more projects that involved fuel switching, but this value represents only those that resulted in negative overall project savings.

Table 6-20: Separation of EE and BE Impacts for HP Beneficial Electrification Measures

Category	Ex-Post Gross kWh_{ee}	Ex-Post Gross kWh_{be}	Ex-Post Gross ΔkWh (EE - BE)	Ex-Post Gross $MMBtu_{ee}$	Ex-Post Gross $MMBtu_{be}$	Ex-Post Gross MMBtu Total (EE + BE)
Ducted Air-source Heat Pumps	117,831	926,283	-808,452	413	7,772	8,185
Ductless Mini-splits	124,314	1,286,186	-1,161,872	423	8,431	8,854
DHW	29,431	119,062	-89,631	100	1,672	1,772
Total	271,576	2,331,531	-2,059,955	937	17,875	18,812

6.2.3 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 6-21 shows the Home Performance program ex-post Engineering impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in the Introduction, Section 2.1.1. Overall, 56% of Home Performance MMBtu impacts count towards the DAC and Low Income standards. Low Income impacts were identified using the 'LMI' tags added to Low Income project fields in the tracking data.

Table 6-21: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	14,088	44%
DAC Only	1,821	6%
Low Income Only	12,124	37%
DAC & Low Income	4,340	13%
Total	**32,373**	**100%**

6.3 CONCLUSIONS AND RECOMMENDATIONS

Our key findings and recommendations based on this evaluation are shown in Table 6-22. Based on discussions with TRC, we understand that many of the engineering analysis findings of these changes will be in place by Q3 2024.

Table 6-22: Home Performance Findings and Recommendations

Finding	Recommendation
▪ Many of the Home Performance savings methodologies differ from the recommended algorithms, inputs, and assumptions developed in the PSEG-LI TRM and Planning Documents. Realization rate inconsistencies in the engineering analysis can be minimized if the program savings are based on the same tools developed by the utility.	▪ Review the Home Performance analysis workbooks and align the savings methodologies with data provided in the PSEG-LI TRM and planning documents.
▪ Ex-ante air sealing analysis for many projects is based on a ΔCFM_{50} assumption of square footage divided by two, as provided by the NYS TRM.	▪ Move away from the air sealing assumptions and emphasize the importance of pre- and post-improvement blower door tests to develop site specific air sealing results for these projects. This will help reduce variance across sites and for the measure overall.
▪ The Home Performance program focuses on fossil fuel savings; however, PSEG Long Island does not sell gas or oil. This leads to limitations in the billing analysis since it currently relies on electric billing data. As a result, the consumption analysis only evaluates the impact of EE measures through customer billing data.	▪ Incorporating billing data from National Grid for homes that have natural gas heating would allow the billing analysis to evaluate fossil fuel savings through the Home Performance program. ▪ Explore the possibility of sourcing billing data from National Grid for homes that use natural gas for heating.

7 RESIDENTIAL ENERGY AFFORDABILITY PARTNERSHIP PROGRAM

7.1 PROGRAM DESCRIPTION

The Residential Energy Affordability Partnership (REAP) program assists low-income households with energy efficiency improvements. The program helps low-income customers save energy, improves overall residential energy efficiency on Long Island, and lowers PSEG Long Island's financial risk associated with bill collection by lowering utility bills. To be eligible to participate in the REAP program, household income must correspond with the United States Department of Housing and Urban Development low-income guidelines. Eligible customers will have an income of up to 80% of the State median income.

7.1.1 PROGRAM DESIGN AND IMPLEMENTATION

The REAP program includes a free home energy audit and free installation of energy-saving measures. In 2023, program measures included LED light bulbs (general service, globes, reflectors, candelabras, and night lights), domestic hot water (DHW) measures, thermostatic valves, exterior lighting, Tier II smart power strips, room air conditioners (RACs), dehumidifiers, refrigerators, smart thermostats, and room air purifiers. During the home energy audit, auditors provide power strips to customers with instructions on how to use the new equipment, but auditors do not install the equipment. DHW measures were only provided to homes with electric water heating in 2023.

In addition to providing program participants with energy-saving measures, the program includes a strong educational component. During the audit, the auditor works with participating customers to determine additional energy-saving actions and behavior changes that customers will commit to. These additional steps help the customers generate savings beyond those realized by the measures installed during the home audit. By educating the customers on the use and value of installed efficiency measures and helping them identify additional opportunities to save, the program can achieve its goal of helping customers who have the greatest share of their income going to energy bills. During each audit, REAP auditors also inspect the customers' heating and hot water systems for safety.

REAP program delivery transitioned back to in-person audits from remote audits in 2022 as the COVID-19 pandemic subsided on Long Island. While the measures offered were largely the same during periods of remote versus in-person audits, the installation mechanism was necessarily different and likely played some role in the evaluated impacts of the consumption analysis.

7.1.2 PROGRAM PARTICIPATION AND PERFORMANCE

Based on verified ex-ante estimates, the REAP program reached 110.0% of its energy savings goal in 2023. Table 7-1 presents verified ex-ante gross MMBtu savings compared to goals for the 2023 REAP program.

Table 7-1. 2023 REAP Program Verified Ex-ante Gross Program Performance against Goals

Metric	MMBtu
Goal	10,884
Verified Ex-ante Gross Savings	11,983
% of Goal	110.1%

Table 7-2 shows the distribution of savings by program component. For 2023 Smart Thermostats account for the largest share of gross MMBtu savings, accounting for 60.0%. Lighting continues to account for the largest share of gross REAP electric savings, accounting for 48.8% of ex-ante gross MWh savings, and 58.4% of ex-ante gross kW savings in 2023.

Table 7-2. 2023 REAP Program Component Percent of Total Ex-Ante Gross Savings

Program Component	Ex-Ante Utility Gross Savings		
	MMBtu (%)	MWh (%)	kW (%)
REAP Lighting	15.8%	48.8%	58.4%
Energy Star Refrigerators	1.0%	4.7%	4.2%
Power Strips	7.0%	12.4%	9.3%
Aerators	1.1%	0.2%	0.0%
DHW Pipe Insulation	0.4%	0.1%	0.1%
DHW Temperature Turndown	0.0%	0.0%	0.0%
Energy Star Dehumidifier	0.5%	0.9%	1.2%
Low Flow Showerhead	2.4%	0.4%	0.0%
Room Air Conditioners	1.0%	1.8%	11.1%
Thermostatic Valve	0.5%	0.1%	0.0%
Room Air Purifier	10.3%	18.0%	15.7%
Smart Thermostat	60.0%	12.7%	0.0%
Total	**100%**	**100%**	**100%**

The REAP program treated 1,976 unique participants in 2023 compared to 1,895 customers in 2022 for an increase of 4.27%. Table 7-3 shows that nearly all REAP participants received Night Lights, LED lighting, and Tier 2 Power Strips.

Table 7-3. Percent of REAP Program Participants Receiving each Measure Category

Category	Percent Receiving
Power Strips	79.9%
Night Lights	79.7%
Lighting	70.3%
Smart Thermostat	38.6%
Room AC	22.7%
Air Purifiers	16.1%
DHW - Aerators	12.4%
Dehumidifiers	10.5%
Refrigerators	7.9%
DHW - Low Flow Showerheads	7.7%
DHW - Thermostatic Shower Valve	5.4%
DHW - Pipe Insulation	3.3%
DHW - Temp Turndown	0.6%

7.2 REAP PROGRAM IMPACTS

7.2.1 OVERVIEW OF IMPACTS BY RESOURCE

As in previous years, we used both engineering and consumption analysis to estimate savings for the REAP program in 2023. Ex-post gross MMBtu savings and ex-post gross kW savings rely on both the engineering analysis and the consumption analysis, while ex-post gross MWh savings rely exclusively on the consumption analysis. To calculate ex-post gross MWh savings due to energy efficiency (EE MWh savings), we applied the consumption analysis realization rate (22.1%) to the ex-ante gross EE savings. To calculate ex-post gross summer peak demand and MMBtu savings, we used a kW/MWh and MMBtu/MWh ratio respectively developed from the engineering analysis and applied to the ex-post gross MWh savings.

We made a specific change for smart thermostats. We chose not to use the electric billing analysis results to calculate fuel savings due to the significant increase of smart thermostat installations in 2023, which resulted in a disproportionate contribution of these devices to MMBtu savings. Instead, we divided the smart thermostat MMBtu into two categories: electric and fossil fuel based on the measure characterization in the PSEG Long Island TRM. We then applied the billing analysis results to the electric MMBtu, which was 881, and the engineering review results to the fuel, which was 6,397 MMBtu. By doing so, we updated the ex-post MMBtu realization rate to 62.4%.

Table 7-4 below shows that the program achieved ex-post gross MMBtu savings of 7,466 MMBtu, ex-post gross MWh savings of 448 MWh, and ex-post gross kW savings of 57 kW. Individually, the engineering calculations resulted in an MMBtu realization rate of 100.7%, and the consumption analysis had an MMBtu realization rate of 62.4%. Sections 7.2.2.2 and 7.2.2.3 provide the distinct results from the consumption analysis and engineering analysis, respectively.

Table 7-4. 2023 REAP Program Impacts

Resource	Ex-Ante Gross Savings	Ex-Post Gross Savings	Realization Rate
MMBtu	11,977	7,466	62%
MWh	2,023	448	22%
kW	267	57	21%

There are a few possible explanations for the low billing analysis realization rate. One contributing factor could be the inherent decoupling of deemed savings from actual customer consumption. There are customers with savings attributed to their home that represent almost half of their annual electric consumption. Additionally, some measures such as air purifiers and dehumidifiers have the potential to add load if they are installed as new technology in the home, and there is not an existing air purifier or dehumidifier replaced. An exploration of the drivers behind the billing analysis realization rate is further detailed in section 7.2.4.2.

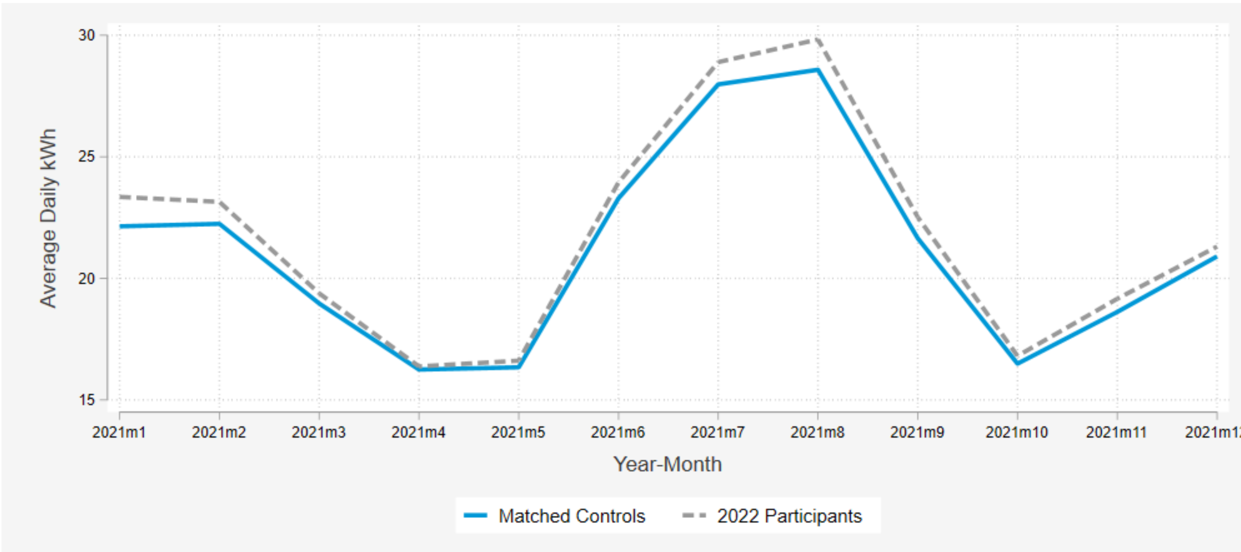
7.2.2 Analysis Approach and Detailed Results

The Evaluation Team used both engineering and consumption analysis to estimate savings for the REAP program in 2023. Consumption analyses, which use actual customer electric usage to estimate savings and account for the interactive effects of multiple measures, typically provide a more robust assessment of energy savings than engineering estimates. For this reason, we based the program ex-post kWh savings on the results of the consumption analysis. We used the engineering analysis to calculate MMBtu to kWh and kW to kWh ratios at the measure level and utilize these ratios to estimate ex-post gross MMBtu and kW impacts. In addition, because the engineering analysis provides savings at the measure level, we gain insights into the relative savings contributions of the measures offered by the REAP program. These measure-level savings allow us to make recommendations to the implementation team for adjusting ex-ante planning assumptions going forward.

7.2.2.1 Consumption Analysis – Approach

Because the consumption analysis requires post-installation electricity usage data for approximately one year after treatment, our analysis uses 2022 participants as the treatment group. We used the pre-participation period of the 2023 participants as a basis for comparison, which is consistent with prior evaluations. The energy use of the comparison group prior to their program participation acts as the counterfactual or point of comparison for the treatment group (2022 participants) in their post-installation period. In this framework, each treatment group home is matched with exactly one comparison group home based on weather-normalized annual consumption (prior to the energy upgrades) and the weather sensitivity of their consumption. Figure 7-1 compares average daily consumption between treatment group homes and their matched comparison homes. Usage between the two groups shows good alignment and the remaining differences are netted out via the modeling procedure. Another benefit to using 2023 participants as a comparison group is that this accounts for the self-selection of program participation.

Figure 7-1: Average Daily Usage of Treatment and Comparison Groups (kWh), Pre-Installation



The consumption analysis model uses daily electric consumption data to quantify post-participation changes in energy use. The matched controls inherit a pseudo pre-post transition date from their participant match and any records after they actually participated (in 2023) are excluded from the analysis. The transition from the pre-period to post-period is based on the project completion date over the course of 2022, the status the participant group in aggregate gradually shifts as projects are completed.

The consumption analysis model is a weather normalized linear fixed effects panel regression model. A fixed effects model absorbs time-invariant household characteristics via inclusion of separate intercept terms for each account in the treatment and comparison group. Additional details regarding the consumption analysis model, including the model specification and model parameter definitions, is presented in Appendix A, Subsection 0. Several different model specifications were tested to assess the robustness of the results, and the results were consistent across models.

7.2.2.2 Consumption Analysis – Results

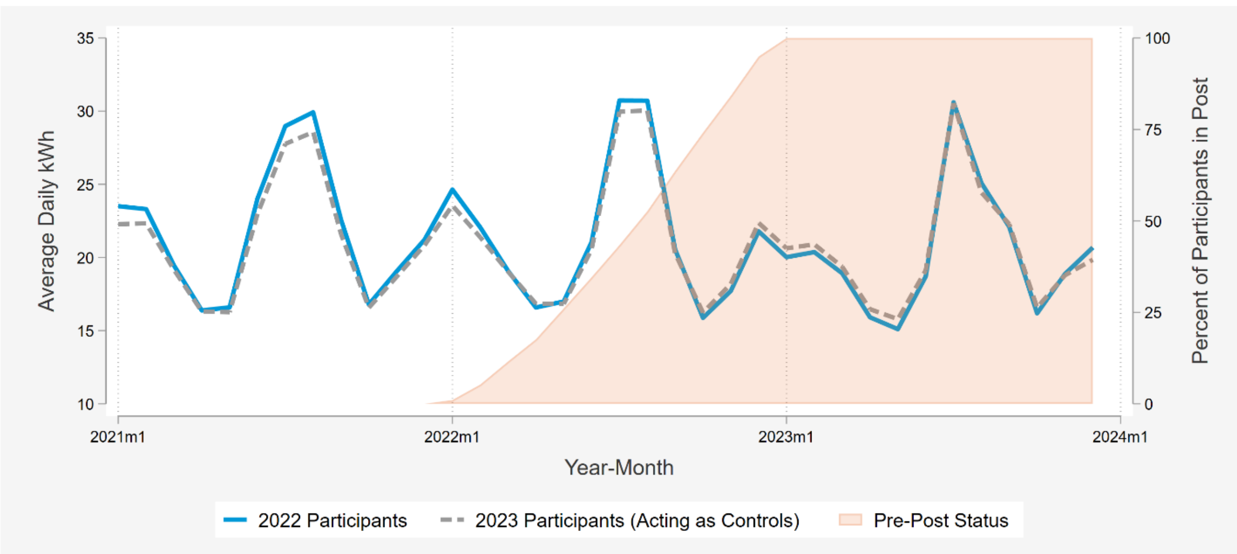
In Table 7-5, we use the results of the REAP consumption model to estimate average savings for 2022 participants and compare the estimated impact to the ex-ante gross kWh savings claimed by the implementer. There were 1,424 Long Island homes included in the regression model. There were more than 1,424 REAP participants in 2022. However, only participants with at least one year of pre-participation data and one year of post-participation data were included in the modeling. Across the homes included in the model, the average annualized savings was 274.0 kWh, which represents a 3.44% reduction in annual electric consumption. This equals 22.1% of the average ex-ante gross kWh savings claim for the same homes. We applied this 22.1% realization rate to the ex-ante gross kWh savings claim of 2023 participants to estimate ex-post gross kWh savings for REAP. Potential drivers of this realization rate are further discussed in section 7.2.4.2.

Table 7-5. REAP Consumption Analysis Results (n=1,424)

Parameter	Estimate	Lower Bound of 95% CI	Upper Bound of 95% CI
Daily Treatment Effect (kWh Saved)	0.96	0.38	1.53
Daily Treatment Effect (% Savings)	3.44%	1.43%	5.46%
Annual Savings	274.0	113.6	434.4
Ex-Ante Gross kWh		1,241.3	
Realization Rate	22.1%	9.2%	35.0%

Figure 7-2 visualizes consumption analysis results. As more participants move into the post period, the average daily electric usage for the treatment group begins to depart from the matched control group. This departure is the effect of interest.

Figure 7-2: REAP Consumption Analysis Results Visualized



7.2.2.3 Engineering Analysis – Results

Program tracking data and engineering analysis are used to estimate gross kWh and kW savings achieved by each measure installed through the 2023 REAP program. As described above, the results of the engineering impacts analysis provide us with (1) the demand to energy ratio needed to develop demand savings from the energy consumption analysis, (2) an MMBtu to kWh ratio needed to develop MMBtu savings from the energy consumption analysis, and (3) an understanding of the relative contribution of the measures offered by the program. In other words, we conduct this analysis to provide insights into the individual measure savings compared to ex-ante to enhance per-unit assumptions, as well as to understand variations between consumption analysis results and planning assumptions.

Table 7-6, Table 7-7, and Table 7-8 show the ex-post gross MMBtu, MWh, and kW savings as determined by the engineering analysis for each measure category.

Table 7-6. 2023 REAP Program Measure-Specific MMBtu Gross Impacts: Engineering Analysis

Category	N	Ex-Ante Gross Savings (Claimed)	Engineering Analysis Ex-Post Gross Savings	Engineering Analysis Realization Rate
		MMBtu	MMBtu	%
REAP Lighting	20,094	1,914	2,079	108.6%
ENERGY STAR Refrigerators	156	124	207	167.3%
Power Strips	1,578	856	856	100.0%
Aerators	403	134	88	66.0%
DHW Pipe Insulation	215	53	42	79.3%
DHW Temperature Turndown	10	2	2	121.5%
ENERGY STAR Dehumidifier	208	61	61	100.0%
Low Flow Showerhead	179	290	176	60.5%
Room Air Conditioners	667	123	123	100.0%
Thermostatic Valve	135	57	40	69.9%
Room Air Purifier	319	1,247	1,276	102.3%
Smart Thermostat	1,222	7,278	7,278	100.0%
Project Adjustments	-	-160	-160	100.0%
Total	**25,186**	**11,977**	**12,067**	**101%**

Table 7-7. 2023 REAP Program Measure-Specific MWh Gross Impacts: Engineering Analysis

Category	N	Ex-Ante Gross Savings (Claimed)	Engineering Analysis Ex-Post Gross Savings	Engineering Analysis Realization Rate
		MWh	MWh	%
REAP Lighting	20,094	989	996	100.6%
ENERGY STAR Refrigerators	156	95	109	114.1%
Power Strips	1,578	251	251	100.0%
Aerators	403	4	26	669.9%
DHW Pipe Insulation	215	2	12	675.7%
DHW Temperature Turndown	10	0	1	1035.7%
ENERGY STAR Dehumidifier	208	18	18	100.0%
Low Flow Showerhead	179	8	51	614.8%
Room Air Conditioners	667	36	36	100.0%
Thermostatic Valve	135	2	12	710.3%
Room Air Purifier	319	365	374	102.3%
Smart Thermostat	1,222	258	258	100.0%
Project Adjustments	-	-6	-6	100.0%
Total	**25,186**	**2,023**	**2,137**	**105.7%**

Table 7-8. 2023 REAP Program Measure-Specific kW Gross Impacts: Engineering Analysis

Category	N	Ex-Ante Gross Savings (Claimed)	Engineering Analysis Ex-Post Gross Savings	Engineering Analysis Realization Rate
		kW	kW	%
REAP Lighting	20,094	156.2	156.8	100.4%
ENERGY STAR Refrigerators	156	11.3	13.4	118.5%
Power Strips	1,578	24.9	24.9	100.0%
Aerators	403	0.0	0.0	--
DHW Pipe Insulation	215	0.2	1.4	675.7%
DHW Temperature Turndown	10	0.0	0.1	1035.6%
ENERGY STAR Dehumidifier	208	3.2	3.2	100.0%
Low Flow Showerhead	179	0.0	0.0	--
Room Air Conditioners	667	29.7	29.7	100.0%
Thermostatic Valve	135	0.0	0.0	--
Room Air Purifier	319	41.9	42.9	102.3%
Smart Thermostat	1,222	0.0	0.0	--
Total	**25,186**	**267**	**272**	**101.9%**

7.2.3 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 7-9 shows the REAP program ex-post Engineering impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in the Introduction, Section 2.1.1. Overall, 68% of REAP MMBtu impacts count towards the DAC and Low Income standards. Low Income Impacts were identified using the 'Income Eligibility Threshold' field tracked in the project database.

Table 7-9: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	2,413	32%
DAC Only	601	8%
Low Income Only	3,358	45%
DAC & Low Income	1,095	15%
Total	**7,466**	**100%**

7.2.4 Key Drivers for Differences in Impacts

7.2.4.1 Reasons for Differences in Engineering Impacts

Measure-level savings estimates were less than the ex-ante gross savings which resulted in realization rates of 95.8% for MMBtu, 90.0% for MWh, and 91.5% for kW as shown in Table 7-6, Table 7-7, and Table 7-8. The lighting measure category was the largest contributor to the REAP program gross savings discrepancy. Lighting comprised 55% of REAP program MWh savings. Realization rates are 108.7% for MMBtu, 90% for MWh and 100.4% for kW for this measure category.

REAP lighting MMBtu and MWH realization rates were 109% and 101% respectively. There was significant variation in realization rates among lamp types as shown in Table 7-10. Realization rates ranged from 78% for 4.7 Watt Candelabra lamps to 417% for Exterior 9-watt R-30 lamp. This variation can be attributed primarily to differences in ex-post and ex-ante assumptions for lamp wattage, hours of use, and interactive effects.

Ex-Post (2025 TRM) and ex-ante Baseline and LED wattage assumptions as compared in Table 7-11 and Table 7-12. For ex-ante, lamps were categorized as Nightlight, Standard or Specialty. Baseline and LED watts were assigned to each lamp type based solely on their Category. For ex-Post, representative actual Baseline and LED watts were assigned to each lamp irrespective of Category. This resulted in the significant variation in kWh and MMBTU realization rates among lamp types.

Ex-ante savings for Exterior 9 Watt R-30 and R-40 lamps were based on 2.7 hours of use instead of 5.7 hours in the TRC Workbook for Ex-Ante savings and the 2025 TRM used for ex-post savings. This resulted in kWh realization rates 237% and 236% for Exterior R-30 and R-40 lamps respectively.

Air conditioning and heating interactive effects were incorrectly claimed for exterior lamps in ex-ante savings. The impact on MMBtu and kWh realization rates was small (less than 2%) compared to the lamp wattage and hours of use impacts.

Table 7-10: 2023 REAP Lighting Ex-Post Realization Rates

Lighting Measure	N	Ex-Post MMBTU RR	Ex-Post kWh RR	Ex-Post kW RR
		%	%	%
REAP .3 Watt Nightlight	1,575	145%	86%	--
REAP 10 Watt "A" Bulb	10,576	94%	94%	95%
REAP 14 Watt "A" Bulb (3-way)	534	201%	201%	229%
REAP 4.7 Watt Candelabra B10	3,685	78%	78%	89%
REAP 5 watt Globe	920	79%	79%	80%
REAP 6.5 Watt Candelabra BA13	25	96%	96%	111%
REAP 9 Watt Reflector R-30	982	112%	112%	127%
REAP 9 Watt Reflector R-40	789	113%	113%	129%
REAP Exterior 10 Watt "A" Bulb	349	194%	194%	--
REAP Exterior 9 Watt Reflector R-30	88	417%	237%	--
REAP Exterior 9 Watt Reflector R-40	571	416%	236%	--
Lighting Total	**20,094**	**109%**	**101%**	**100%**

Table 7-11: 2023 REAP Lighting Ex-Post, and Ex-Ante Baseline Wattage Comparison

Lighting Measure	Ex-Post Baseline Watts	Ex-Ante Baseline Watts	Ex-Post Percentage of Ex-Ante Baseline Watts	Ex-Ante Lamp Category
REAP 0.3 Watt Night Light	5.00	5.75	87%	Nightlight
REAP 10 Watt "A"Bulb	60.00	62.84	95%	Standard
REAP 14 Watt "A" Bulb (3-way)	109.60	50.78	216%	Specialty
REAP 4.7 Watt Candelabra B10	41.80	50.78	82%	Specialty
REAP 5 Watt Globe	47.20	62.84	75%	Standard
REAP 6.5 Watt Candelabra BA13	52.80	50.78	104%	Specialty
REAP 9 Watt Reflector R-30	62.40	50.78	123%	Specialty
REAP 9 Watt Reflector R-40	62.80	50.78	124%	Specialty
REAP Exterior 10 Watt "A"Bulb	59.80	62.84	95%	Standard
REAP Exterior 9 Watt Reflector R-30	63.20	50.78	124%	Specialty
REAP Exterior 9 Watt Reflector R-40	63.10	50.78	124%	Specialty

Table 7-12: 2023 REAP Lighting Ex-Post and Ex-Ante LED Wattage Comparison

Lighting Measure	Ex-Post LED Watts	Ex-Ante LED Watts	Ex-Post Percentage of Ex-Ante LED Watts	Ex-Ante Lamp Category
REAP 0.3 Watt Night Light	0.30	0.3	100%	Nightlight
REAP 10 Watt "A"Bulb	10.00	10.25	98%	Standard
REAP 14 Watt "A" Bulb (3-way)	14.00	6.45	217%	Specialty
REAP 4.7 Watt Candelabra B10	4.70	6.45	73%	Specialty
REAP 5 Watt Globe	5.00	10.25	49%	Standard
REAP 6.5 Watt Candelabra BA13	7.00	6.45	109%	Specialty
REAP 9 Watt Reflector R-30	9.00	6.45	140%	Specialty
REAP 9 Watt Reflector R-40	9.00	6.45	140%	Specialty
REAP Exterior 10 Watt "A"Bulb	10.00	10.25	98%	Standard
REAP Exterior 9 Watt Reflector R-30	9.00	6.45	140%	Specialty
REAP Exterior 9 Watt Reflector R-40	9.00	6.45	140%	Specialty

Table 7-13: Realization Rate Drivers

Component	Summary of Contributing Factors	Recommendations
Lighting	▪ The MWH realization rate was 100%, however, there was significant variation in realization rates among lamp types ranging from 78% to 417%. This variation is the result of differences in ex-post and ex-ante assumptions for lamp wattage and hours of use. ▪ The ex-ante exterior lamp savings algorithms used 2.7 HOU for interior lamps versus the correct value of 5.7 HOU used for ex-post savings. This resulted in kWh realization rates 237% and 236% for Exterior R-30 and R-40 lamps respectively	▪ Since the program controls the exact specification of lamps installed and the roster is relatively short, rely on dedicated measure characterization for each program-supported LED product. The 2025 PSEG Long Island TRM provides separate savings values for each of the LED lighting products distributed in 2023.

Component	Summary of Contributing Factors	Recommendations
Air Purifiers	▪ Efficient unit specs (standby power, cfm/W, and CADR) were updated based on actual installs.	▪ Include an indicator in the program tracking system for "load building" measures when appliances are added to homes rather than replaced. While these installations have health benefits, they do not save energy. ▪ Update the baseline efficiency standard (CFM/Watt) to align with the New York State Appliance Standards adopted in June 2023.
Hot Water Measures	▪ Aerators, DHW Insulation, DHW Pipe Insulation, DHW Temperature Turndown, Low Flow Showerhead, and Thermostatic Valve are installed only in homes with electric water heating. Ex-Ante savings were calculated using the planning assumption that 85% of participant homes have fossil fuel water heating and 15% have electric water heating. As a result, MMBtu savings were overstated and kWh and kW savings were significantly understated. Ex-post analyses assumed electric water heating. Realization rates for kWh and kW ranged from 615% to 1035%. MMBtu realization rates ranged from 60% to 79%.	▪ Discontinue use of planning assumptions for ex-ante savings estimates. ▪ Enable field verification of electric or fossil water heating if fossil water heaters are included in REAP.

7.2.4.2 Reasons for Differences between Consumption Analysis and Ex-ante Savings

The 2023 consumption analysis resulted in much lower overall ex-post gross savings than ex-ante gross savings, as shown by the 22.1% realization rate. The results were stable across multiple model specifications but have a relatively wide margin of error. The 95% confidence interval of the realization rate ranges from 9.2% to 35.0%. There are a few factors that could be driving the realization rate.

7.2.4.2.1 2020-2023 TRENDS

To start, the average per-customer claimed savings has increased steadily from year to year, from about 700 kWh/customer in 2020 to almost 1,241 kWh/customer in 2023. Meanwhile, the results of the billing analyses show variable average customer impacts from year to year, driving down realization rates. While the billing impacts this year were lower than previous years, the realization rate was driven even lower by the increase in per/customer claimed impacts.

Figure 7-3: kWh Impacts per Customer from 2020 to 2023

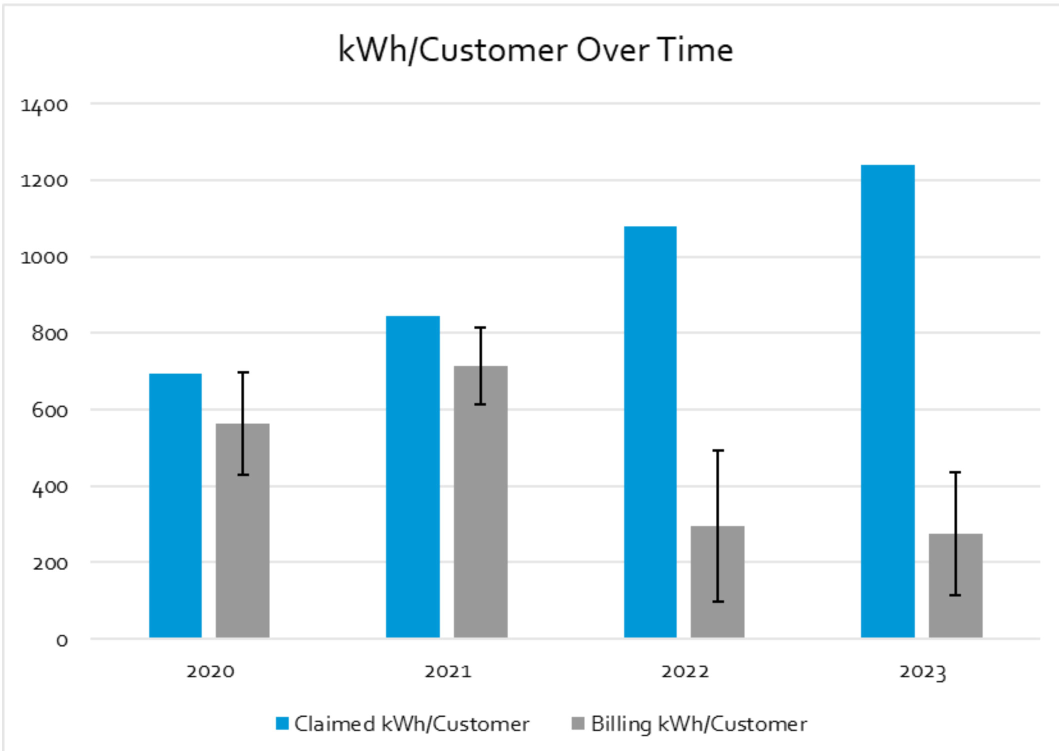
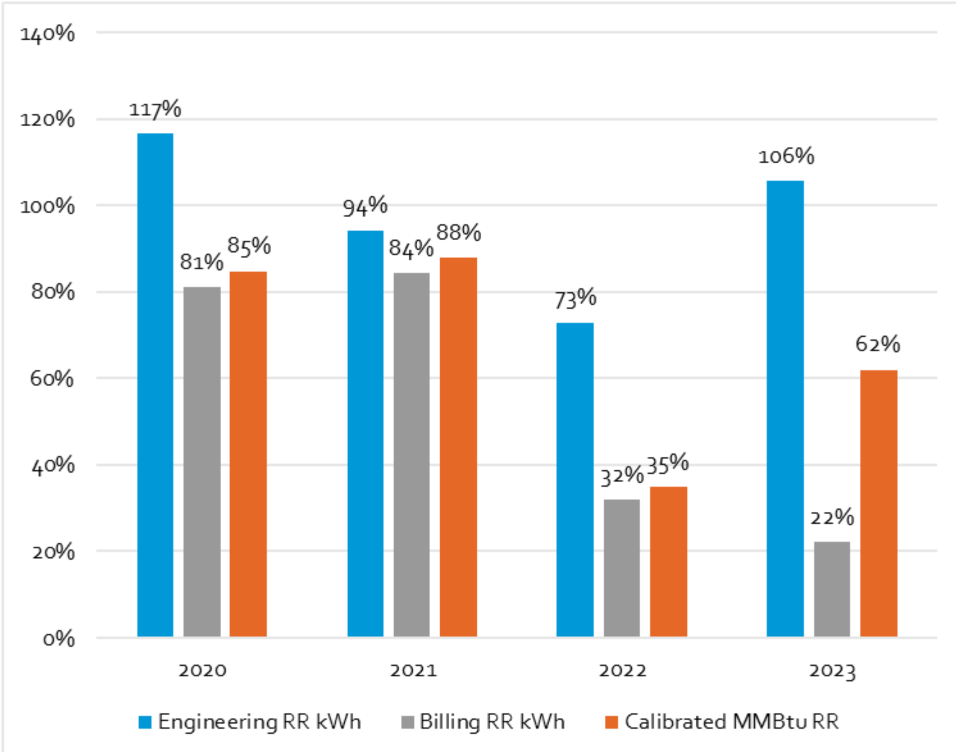


Figure 7-4 shows that while the claimed savings are increasing year to year, the engineering realization rate is consistently decreasing year to year.

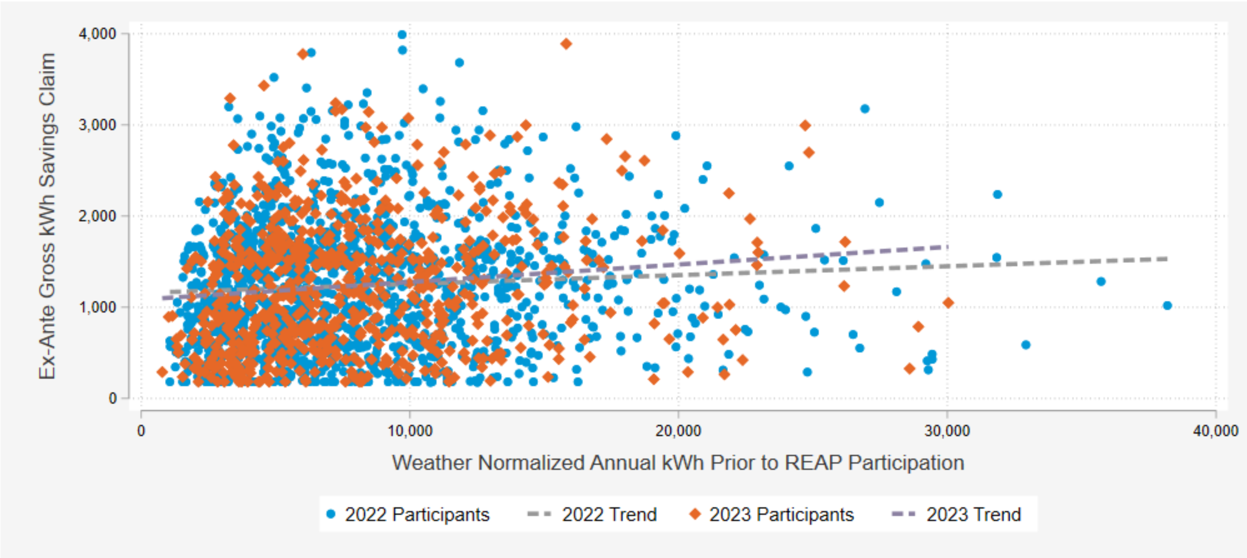
Figure 7-4: Engineering, Consumption, and Calibrated Realization Rates 2020-2023



7.2.4.2.2 ENGINEERING CALCULATIONS VS. ANNUAL HOUSEHOLD USAGE PATTERNS

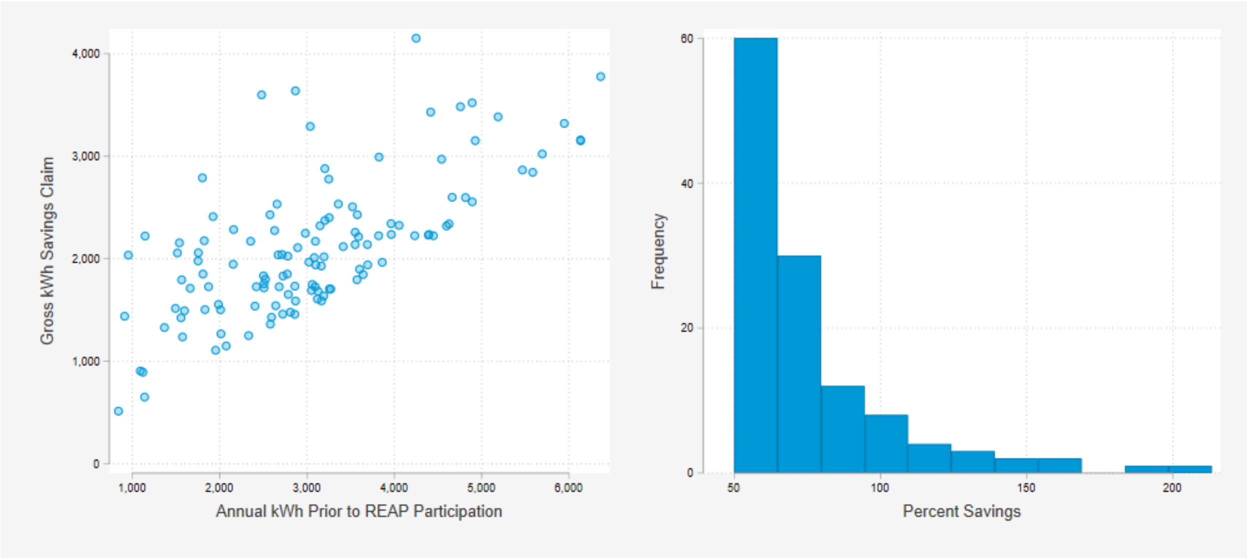
One potential explanation for the results is that ex-ante kWh savings claims are decoupled from the usage patterns of the home while the consumption analysis is intrinsically linked to actual billed kWh. Figure 7-5 compares the ex-ante gross kWh savings claim (y-axis) to the weather-normalized annual kWh consumption (x-axis) for each participant in 2022 and 2023. The trend line is effectively flat for both years. This is expected with deemed savings as the parameters and estimated energy savings are "averages of averages" and as a result are high for some homes and low for others. The homes with high ex ante claims and relatively low annual kWh, located in the upper left portion of Figure 7-56, are likely pulling the REAP realization rate below 100%.

Figure 7-5: Comparison of Ex-Ante Gross kWh Savings and Pre-Retrofit Annualized Consumption



It is unlikely any set of EE measures will save over 2,000 kWh in household that only uses less than 5,000 kWh per year. PSEG Long Island and TRC might consider creating a flag in Captures that is tripped by projects claiming kWh savings equal to or greater than half of their last 12 months of billed consumption.

Figure 7-6: Projects Claiming Savings Over 50% Annual Consumption



7.2.4.2.3 LOAD ADDING MEASURES

A second explanation could lie with non-replacement measures, like the Room Air Purifiers, that have potential to add electric load to a household's annual consumption if the home did not have an air purifier previously. The engineering estimates for the Room Air Purifier measure assume an ENERGY STAR unit is replacing a standard efficiency air purifier. If a participating household did not own an air purifier prior to participating in REAP, the ENERGY STAR purifier would lead to increased electric consumption compared to no air purifier at all. The baseline expectation outlined in the TRM is that each home will replace an existing Air Purifier, however under the Healthy Homes Initiative[8], customers with breathing issues or allergies will be provided an air purifier regardless of whether one currently exists in the home. These homes will have claimed electric savings under current TRM specifications, however in a billing analysis they may see increased electric load driving down the realization rate. Even though these measures have potential to add load, they can be associated with other, non-energy benefits to the customer. Installing air purifiers can help alleviate symptoms and additional stress from breathing issues and illnesses, such as asthma, or allergies experienced in the home, improving the health of the customer. For customers with asthma, this can lead to a reduction in the number of doctor's visits or hours of missed work.

7.3 CONCLUSIONS AND RECOMMENDATIONS

Our key findings and recommendations based on this evaluation are shown in Table 7-14. In most cases, our recommendations apply to the 2025 program year. Planning for the 2024 program year was finalized a year ago, and program delivery is almost half complete. These types of changes are often most efficient to implement at the beginning of a new program year. Most of our recommendations are also reflected in the recently completed 2025 PSEG Long Island TRM.

Table 7-14. REAP Findings and Recommendations

Finding	Recommendation
▪ Claimed savings are rooted in deemed assumptions and calculations that are independent from actual customer consumption. In some cases, this can lead to claimed savings that are too high for the household's annual kWh.	▪ Create a flag in Captures that indicates if claimed savings are more than half of the customer's last 12 months of billing consumption.
▪ REAP lighting engineering realization rates were highly variable in 2023 due to differences between baseline and efficient lamp wattages and hours of use.	▪ Each lighting product is tracked separately in REAP so there is no need to assume a mix of lamps and claim savings using averages. The 2025 PSEG Long Island TRM provides product-specific measure characterizations, which if implemented, would eliminate differences between ex-ante savings claims and ex-post engineering calculations.

[8] NYS Healthy Neighborhoods Program: https://www.health.ny.gov/environmental/indoors/healthy_neighborhoods/#:~:text=The%20New%20York%20State%20Healthy%20Neighborhoods%20Program%20%28HNP%29,and%20injury%20through%20a%20holistic%2C%20healthy%20homes%20approach.

Finding	Recommendation
▪ Under some circumstances, measures are installed differently from TRM assumptions, such as: ➢ Air purifiers installed where one did not exist before. TRM assumes air purifiers are installed as a replacement to a market baseline efficiency unit. ➢ Remote assessment and self-install measure packages. Claimed savings will assume all measures are installed while it is possible self-install measures were not installed correctly, or at all.	▪ If possible, better track these nuances in program delivery in the measure records. This would allow evaluators to extract data that informs savings for all projects rather than refer to project workbooks one by one. Most notably for the following data fields: ➢ Indicator for if the air purifier was installed new or as a replacement. ➢ Standardized indicator for type of program implementation: home visit vs. remote audit.
▪ The mix of REAP offerings has remained relatively consistent year-to-year. LED bulbs and power strips are the most consistently implemented measures and make up the largest portion of claimed savings. As a result of the lighting phasing out of energy efficiency programs, there is a statewide policy push towards expanding building efficiency and electrification in LMI. It will be necessary to think about what the next iteration of the REAP program includes. We expect that REAP program offerings will start to include more measures that fall under the Home Performance Program.	▪ As the REAP program evolves to meet state policy objectives around equity it would be beneficial to explore identifying additional REAP program benefits. Many jurisdictions have additional SCT benefit streams for low income programs such as: decrease in health issues, reduced bill assistance, fewer sick days taken, etc.

8 HOME ENERGY MANAGEMENT (HEM) PROGRAM

PSEG Long Island's Home Energy Management (HEM) program currently delivers paper and electronic home energy reports (HERs) to about 520,000 residential customers. Residential behavioral programs, such as HEM, leverage behavioral psychology and social norms to lower residential energy usage by comparing a customer's energy consumption to similar neighboring households. In addition to HERs, treatment customers can participate in "opt-in" interventions, such as High Usage Alerts, Home Energy Assessment Tools, Online Marketplace, and HEM Controls Pilot. While PSEG Long Island's behavioral program delivers cost-effective energy savings from a large number of customers, the Public Service Commission elected to no longer fund behavioral programs through energy efficiency funds starting in 2026.

This report summarizes the program year 2023 (PY2023) energy savings from PSEG Long Island's Home Energy Management Program. Although behavioral programs typically deliver small percentage changes in energy use, they typically yield considerable aggregate savings because they reach a large volume of customers and do not require rebates or installations. The primary challenge is the need to accurately detect small changes in energy consumption while systematically eliminating plausible alternative explanations for those changes, including random chance. Thus, accurate measurement relies on large scale randomized control trials, the use of pre-intervention and post-intervention data, and is analyzed using difference-in-differences.

The 2023 evaluation had five main research questions:

- Were the participant and control groups similar in terms of energy use prior to the introduction of the HERs?
- What is the magnitude of annual electricity savings?
- Is there an overlap with other energy efficiency programs (to avoid double-counting)?
- Do HERs lead to different heat pump adoption rates?
- What steps can be undertaken to improve delivery and performance?

8.1 PROGRAM OVERVIEW

The Home Energy Management program offers a set of intervention strategies to influence customers' energy use behaviors. The primary strategy is a HER engagement campaign leveraging a randomized control trial (RCT) design. In addition to HERs, treatment customers can participate in "opt-in" interventions, such as High Usage Alerts, Home Energy Assessment Tools, Online Marketplace, and HEM Controls Pilot. The specific objectives of the program are to:

- Reduce energy usage,
- Increase peak hour energy savings,

- Increase awareness of and participation in energy efficiency programs,
- Consider renewable energy/energy storage and demand response programs, and
- Increase customer satisfaction with PSEG Long Island.

Home energy reports are behavioral interventions designed to encourage energy conservation in both gas and electricity. The paper or electronic reports compare a customer's energy consumption to similar neighboring households, thus leveraging behavioral psychology and social norms to lower residential energy usage. They are sent to customers in the treatment group by mail and email and contain the following information:

- Customer electric energy usage for the previous month,
- A comparison of the customer's energy usage to the energy usage of nearby homes with similar characteristics from the previous month,
- Information showing which energy use categories contribute the most to the customer's overall energy consumption,
- A chart depicting the customer's energy use over the past year,
- Promotion of applicable PSEG Long Island programs and rebates, and
- Tips for reducing energy consumption.

The program launched in September 2017 when 341,570 customers began receiving HERs. This first wave of customers is referred to as Cohort 1 for the remainder of the report. In August 2018, the program began to send HERs to an additional 159,348 customers. This second wave of customers is referred to as Cohort 2 for the remainder of the report. The third wave, called Cohort 3, started in May 2021, when the program began to send HERS to another 60,000 customers. Finally, a fourth and fifth cohort began treatment in February 2023. Cohort 4 consisted of 80,000 treatment and 25,000 control customers who will receive email and paper reports and were selected from PSEG Long Island customers who had an email address on file. Cohort 5, consisting of 50,000 treatment and 20,000 control customers, were drawn from only customers who had no email on file, so they only received paper reports.

The program's initial goal, set in 2017, was to achieve over 30,000 MWh of behavior-based energy savings per year over a two-year period. The new goal set for 2023 was to achieve 32,758 MWh in energy savings across all cohorts. Due to attrition (mostly move-outs), the treatment and control groups for all cohorts are smaller now compared to when the cohorts were first launched, but thanks to the new cohorts, 519,924 households were regularly receiving HERs in 2023. Additional details on attrition and current treatment numbers are provided in section 8.2. From 2023 onward, PSEG Long Island anticipates continuing to send HERs to treatment customers in all cohorts. Cohorts 4 and 5 are new this year to the report, but they may not have been treated long enough to show impacts as high as the older three cohorts. We expect the impact of HEMs on the new cohorts to grow over time.

8.2 2023 PROGRAM ENROLLMENT AND REPORT COUNTS

Table 8-1 presents HEM program participation in Cohorts 1, 2, 3, 4, and 5. Cohort 1 contained 242,024 treatment customers, Cohort 2 contained 114,093 treatment customers, which represents an attrition rate of 8% from PY2022 for both Cohorts. Cohort 3 had an 11% attrition rate from the prior year, and Cohorts 4 and 5 had comparable rates (8% and 11%) from the 80,000 and 50,000 households that had been selected for treatment. The evaluation method used requires before and after data for each participant and control. Thus, we only analyze sites with a full year of data before they receive the behavioral intervention and a full year of 2023 billing data, which are approximately 98% of the evaluation, and apply the results to the full population.

Table 8-1: 2023 HEM Program Participation Summary[9]

Cohort	Number of Treatment Customers	Number of Control Customers	Number of Customers per Cohort
Cohort 1	242,024	29,504	271,528
Cohort 2	114,093	24,957	139,050
Cohort 3	45,992	19,074	65,066
Cohort 4	73,305	22,919	96,224
Cohort 5	44,510	22,281	66,791
Total	**519,924**	**118,736**	**638,659**

Each treatment group household is sent approximately five reports over the course of the year. Based on the program tracking data, the verified count of paper reports sent was 2,206,148 with each participant receiving multiple reports throughout the year. The verified number of paper and electronic reports sent each month and the total for 2023 are presented in Table 8-2.

[9] Counts represent the average number of customers with active billing data in 2023. Savings were calculated for each month separately based on the number of customers with active billing data that month.

Table 8-2: HEM Program Paper HERs Sent by Month in 2023

Month	Verified Paper Report Count	Verified Electronic Report Count
January	3,712	32,608
February	187,941	14,241
March	222,795	60,095
April	-	33,602
May	277,329	49,250
June	408,521	21,215
July	252,868	20,930
August	78,239	48,124
September	185,987	50,316
October	378,250	29,402
November	115,175	21,616
December	95,331	38,751
Total	**2,206,148**	**420,150**

8.3 EQUIVALENCY RESULTS

This section compares customers receiving HER treatments to their corresponding control group prior to the intervention. The goal is to compare the energy use patterns and ensure that there are no systematic differences. A good control group should behave and use energy in a similar manner to the participants before either group has received an HER.

Electricity use is characterized by a wide range of end uses and technologies, including lighting, cooking and cleaning appliances, entertainment, and more. But the primary driver of energy loads is the heating and cooling systems. Electric usage peaks in the summer as air conditioning systems are running and in the winter for electrically heated homes. Because of this, energy use is highly dependent on weather. The home energy reports focus on conservation through a range of electric devices. For each wave of HER distribution, pre-treatment energy consumption should be identical across the participant and control groups, on average.

Figure 8-1 shows the distribution of annual consumption by cohort for the treatment and control groups prior to each HER cohort launch. Treatment and control groups are comparable, and the average customer size is relatively similar between cohorts. Cohort 5 is clearly much different than the other 4 cohorts. Unlike all other cohorts, Cohort 5 is drawn solely from customers without email addresses. These customers have a lower total demand, and very few of them have above average demand, which results in a distribution with a much higher peak. Most importantly, though, the control and treatment distributions are nearly identical within each cohort, indicating the random assignment was properly implemented.

Figure 8-1: Pre-Treatment Annual Electric Consumption by Cohort

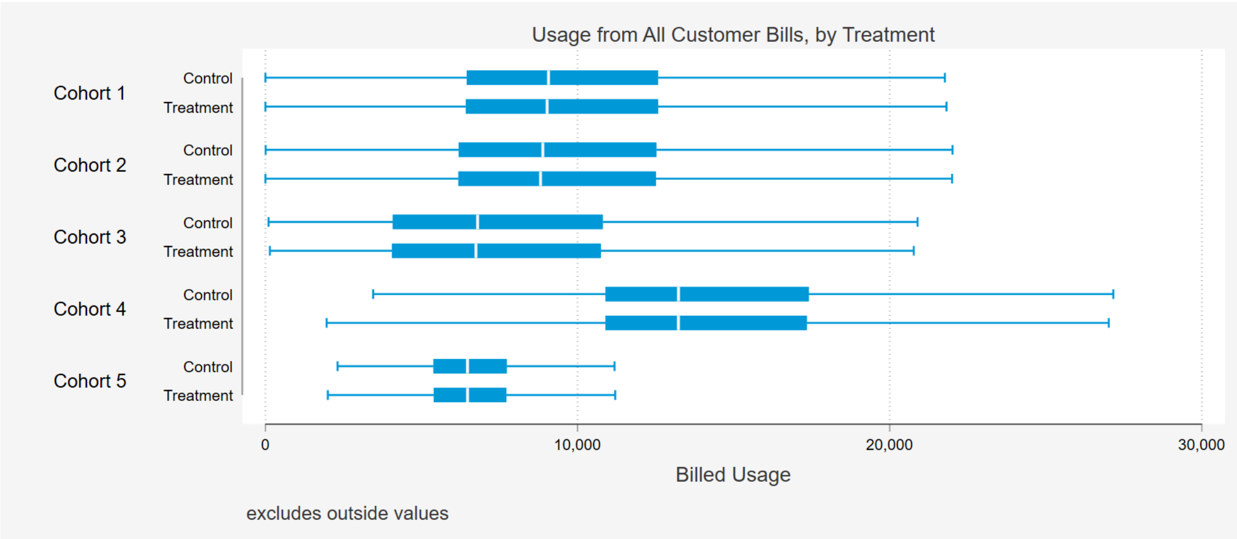


Table 8-3 shows the average annual usage between treatment and control groups by cohort. No wave shows a statistically significant difference between the two groups. The minor pre-existing difference is netted out in the statistical analysis.

Table 8-3: HEM Program Pre-Participation Average Daily Consumption, Treatment vs. Control

Wave	Start Date	Number of Homes Analyzed[1]		Annual Use (kWh)		Difference in Annual Use		
		Control	Treated	Control	Treated	kWh	%	95% Conf. Interval
Cohort 1	10/1/2017	29,041	238,623	10,366.5	10,348.9	-17.5	-0.17%	(-94.0,58.9)
Cohort 2	8/27/2018	24,312	111,398	10,276.4	10,233.5	-42.9	-0.42%	(-140.1,54.3)
Cohort 3	5/15/2021	15,813	38,042	8,480.3	8,457.4	-22.9	-0.27%	(-146.2,100.3)
Cohort 4	2/1/2023	20,985	67,262	15,639.1	15,668.7	29.6	0.19%	(-96.4,155.6)
Cohort 5	2/1/2023	16,981	33,900	6,599.2	6,600.2	0.9	0.01%	(-25.5,27.4)

[1] The estimating sample is limited to participants and control with a full year of pre-intervention data and are roughly 98% of the total participants

8.4 ELECTRIC EX-POST SAVINGS SUMMARY

Table 8-4 depicts the ex-post savings results for HEM in MMBtu and MWh. A total of 519,924 customers participated in the program in PY2023, on average saving 78 kWh per participant annually for total annual savings of 40,865 MWh, or 139,430 MMBtu before accounting for any dual enrollment in other programs, referred to here as uplift. The uplift refers to energy savings due to the boost in energy efficiency program participation delivered by HERs. The savings are backed out to avoid double-counting since they are already accounted for in the other programs. Once we account for uplift, the average participant saved 71 kWh annually for total annual savings of 37,090 MWh and 126,552 MMBtu.

The HEM realization rate is the ratio between claimed ex-post savings and claimed ex-ante savings. In 2023, the realization rate for electric savings was 108.6%. The ex-post savings were 113.2% of the HEM goal for 2023.

Table 8-4: 2023 HEM Program Ex-Post Gross Impacts

Metric	Participation	kWh per participant	Energy Savings	
			MMBtu	MWh
Goal	440,000	74.5	111,770	32,758
Claimed Ex-Ante	519,924	63.0	116,214	32,758
Verified Ex-Ante	519,924	65.5	116,214	34,075
Unadjusted Ex-Post	519,924	78.0	139,430	40,865
Uplift Adjustment	519,924	7.3	12,878	3,774
Adjusted Ex-Post After Accounting for Uplift	519,924	70.7	126,552	37,090
Realization Rate of Ex-Post to Claimed Ex-Ante	100.0%	107.9%	108.9%	113.2%
Ex-Post as Percent of Goal	118.2%	95.0%	113.2%	113.2%

Table 8-5 summarizes the demand savings in kW for the HEM program for 2023. The HEM population was able to reduce demand by 10.34 MW between 4 and 5 PM during summer 2023. While no kW demand savings were claimed for HEM during the program year, we did assess the kW demand reduction for the program as a part of the ex-post analysis and included the demand savings as a part of the cost-effectiveness assessment. The kW impacts were estimated for sites that had AMI data in 2023 and scaled for the full population of participants. Detailed methodology in Appendix A, Subsection 0 provides additional details on the peak demand savings calculations. It should be noted that because there is so much noise in these estimates and the signal is so small, none of the hourly estimates are statistically different than zero. This means that, while as a whole, we can say that the HEM program results in statistically significantly different outcomes, when we look at each hour individually, there is not enough evidence to reject a null impact for each hour.[10]

[10] A key limitation of the hourly peak demand analysis is smart meter hourly data is not available during the pre-treatment for the largest cohorts, which precludes the use of more statistically powerful techniques such as difference-in-differences.

Table 8-5: HEM Peak Demand Reduction

Wave	MW Impact
Cohort 1	5.60
Cohort 2	2.67
Cohort 3	0.70
Cohort 4	1.28
Cohort 5	0.11
Total	**10.34**

8.4.1 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 8-6 shows the HEM program ex-post Engineering impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in the Introduction, Section 2.1.1. Overall, 11% of HEM MMBtu impacts count towards the DAC and Low Income standards. No Low Income impacts were claimed since income eligibility is not tracked for HEM participants.

Table 8-6: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	112,758	89%
DAC Only	13,794	11%
Low Income Only	0	0%
DAC & Low Income	0	0%
Total	**126,552**	**100%**

8.5 ELECTRIC EX-POST SAVINGS DETAIL

Table 8-7 depicts the unadjusted ex-post savings from the analysis, calculated using a Lagged Dependent Variables (LDV) model. Across all waves, participants saved approximately 78.0 kWh ± 18.5 kWh annually (95% confidence), or approximately 0.89% of their annual consumption. On an aggregate basis, HEM reduced electricity use by 139,430 MMBtu. All cohorts had statistically significant savings, with the exception of Cohort 5, a new cohort. The savings tend to build as customers received more reports, and new cohorts are not expected to be statistically significant in the initial years. It should be noted that the new cohort is unique. It has much lower annual usage and does not receive any emails.

Table 8-7: 2023 HEM Unadjusted Ex-Post Per-Household and Program Energy Savings, Monthly LDV Model

Cohort	Number of Customers Treated in 2021	Unadjusted Savings (% per household)	Unadjusted Energy Savings (kWh per household)	Upper Bound	Lower Bound	Unadjusted Program Savings (MMBtu)
Cohort 1	242,024	1.20%	112.08	128.68	95.14	86,530
Cohort 2	114,093	0.85%	80.01	101.64	59.56	29,535
Cohort 3	45,992	0.51%	39.39	60.19	14.32	5,364
Cohort 4	73,305	0.32%	39.59	80.46	17.10	9,175
Cohort 5	44,510	-0.15%	-8.35	9.20	-28.11	-1,478
Total	**519,924**	**0.89%**	**83.92**	**96.52**	**76.32**	**139,430**

Table 8-8 depicts the percent savings for each cohort by month. We see that the highest percent savings generally occur in the winter, with about 1.4% savings in November and December on average across the pooled cohorts. This reflects both a higher baseline of energy usage in summer, and slightly higher kWh savings during the winter.

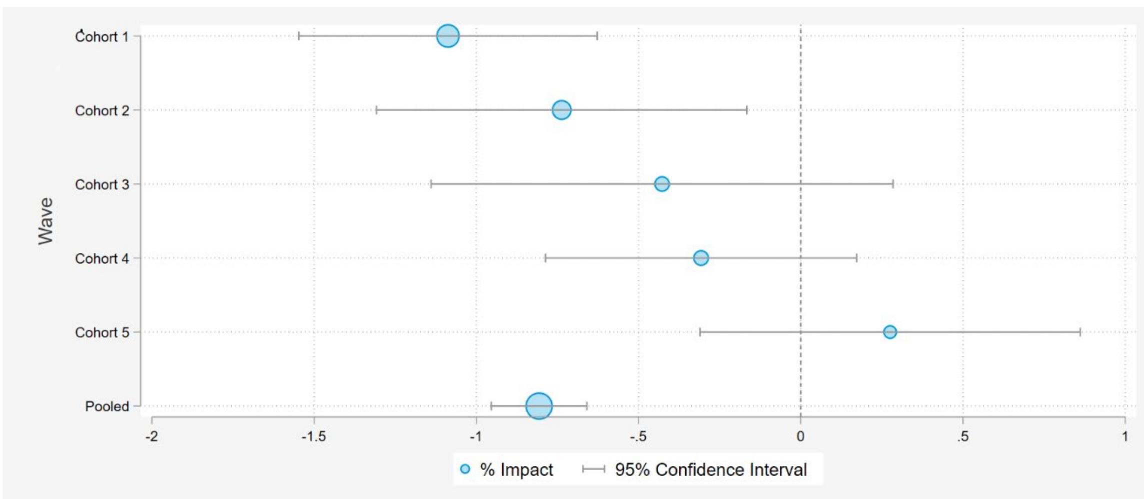
Table 8-8: 2023 HEM Unadjusted Ex-Post Percent Savings by Month, Monthly LDV Model

Month	Cohort 1 Unadjusted Savings (% per household)	Cohort 2 Unadjusted Savings (% per household)	Cohort 3 Unadjusted Savings (% per household)	Cohort 4 Unadjusted Savings (% per household)	Cohort 5 Unadjusted Savings (% per household)	Program Unadjusted Savings (% per household)
January	1.30%	0.98%	0.37%	--	--	1.12%
February	1.38%	0.89%	0.57%	--	--	1.16%
March	1.16%	1.34%	0.26%	0.18%	0.04%	0.97%
April	1.04%	1.06%	0.46%	-0.08%	-0.26%	0.81%
May	0.98%	0.41%	0.25%	-0.15%	-0.42%	0.60%
June	0.89%	0.65%	0.23%	0.24%	-0.30%	0.67%
July	0.85%	0.60%	0.30%	0.48%	-0.39%	0.67%
August	1.03%	0.90%	0.49%	0.57%	-0.38%	0.86%
September	0.97%	0.70%	0.45%	0.29%	-0.24%	0.75%
October	1.63%	0.82%	0.53%	0.34%	0.07%	1.14%
November	1.99%	0.89%	1.50%	0.63%	0.79%	1.39%
December	2.03%	1.18%	1.76%	0.65%	0.58%	1.45%
Annual	**1.20%**	**0.85%**	**0.51%**	**0.32%**	**-0.15%**	**0.89%**

The evaluation team tested the robustness of the impacts by implementing two other common methods for estimating behavioral impacts: a panel difference-in-difference model and a classic difference-in-difference calculation. The panel difference-in-difference model uses data from both the pre and post periods and analyzed impacts via a regression model with fixed effects and time effects. The classic difference-in-difference approach examines differences in raw averages using the same data. It compares the change observed among participants between the before and after period and nets out the change observed among controls in the before and after period.

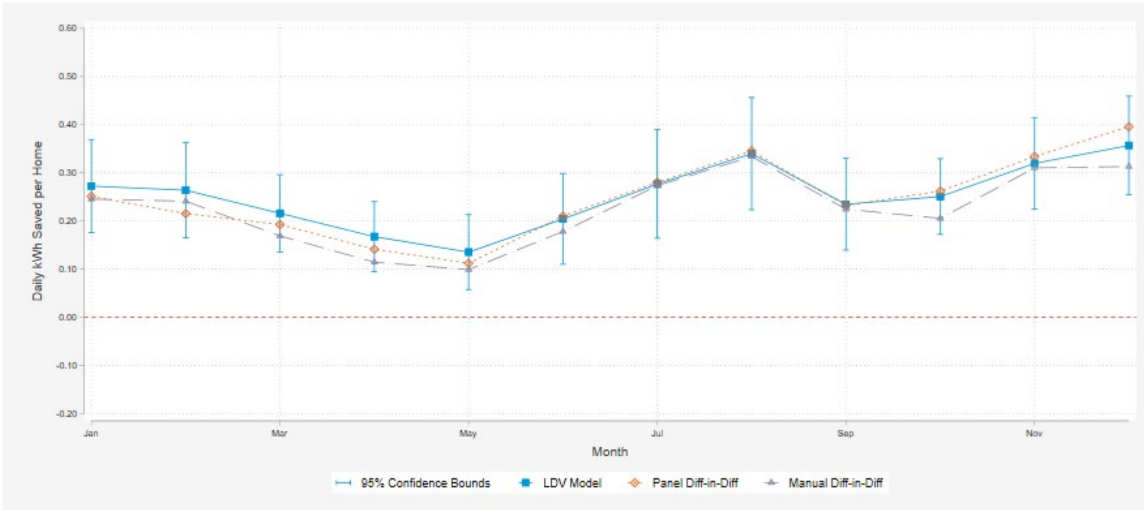
Figure 8-2 shows the percent savings by cohort and for all cohorts pooled using the classic difference in difference model. The size of the marker indicates the relative participant population size for each wave. The focus is on the pooled analysis, which combines the results across all the waves. The overall savings are 0.89% ± 0.08% with 95% confidence. The individual waves are not expected to be significant, particularly for newer cohorts, and have substantially noisier results.

Figure 8-2: Electric Percent Savings by Wave



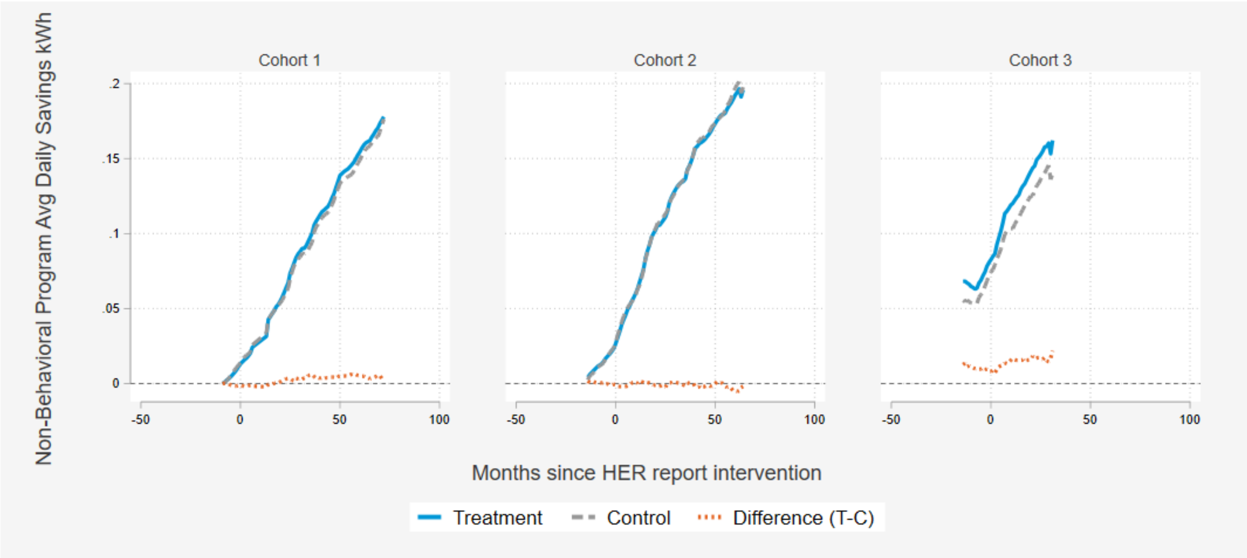
The monthly savings point estimates were very similar across the three methods for the pooled population. Figure 8-3 provides a comparison of the average daily savings estimates each method yields. Figure 8-3 also displays 95% confidence bounds for savings estimates from the lagged dependent variable (LDV) model, which is the primary model. The point estimates of the alternative modeling approaches are within the margin of error of the LDV model estimate each month. The pooled savings are also statistically significant for each month.

Figure 8-3: Unadjusted Savings by Month by Model Specification



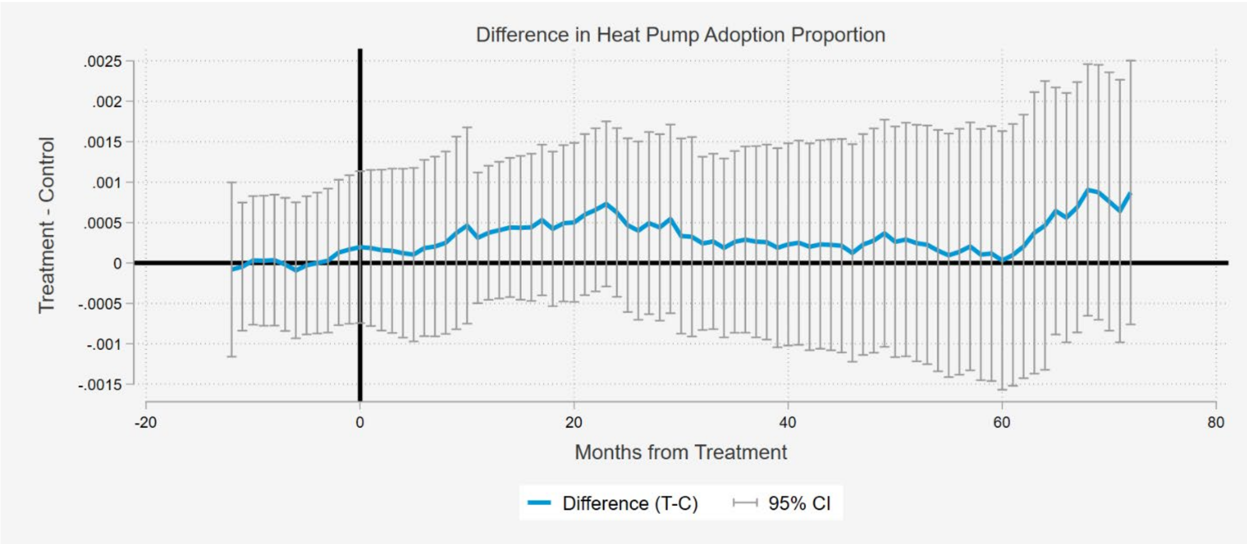
As noted earlier, HERs can boost participation in energy efficiency programs (uplift), which can lead to double counting since programs also claim the savings. In order to avoid double counting, we also conducted a dual participation analysis to see if there was significantly higher participation in other energy efficiency programs in the treatment group compared to the control group. Customers engage in energy efficiency through either rebate programs (downstream) or through in-store discounts (upstream). Figure 8-4 shows the results of the dual participation analysis for rebate programs. Both the treatment and control groups gradually accrued additional efficient installations from the start of each wave, so the average savings go up gradually over time for both groups, with a small difference occurring between the treatment and control groups. The uplift analysis led to a downward adjustment from 78.0 kWh to 70.7 kWh in the annual savings per participant, a difference of 7.3 kWh.

Figure 8-4: Downstream Dual Participation Analysis Output



In addition to uplift, the evaluation team examined if there was any difference between the proportion of households that installed a heat pump between those who received the HEM treatment and those who did not. The proportions of households with installs were compared for each month and cohort, and test of proportions was conducted to measure the 95% confidence intervals. If HEM treatment was impacting installations, we would expect to see similar proportions in the months before treatment, and then a positive difference in proportions to open afterwards. Figure 8-5 shows that there was no observed difference in installs before versus after treatment, and therefore the evaluation team concluded that there is no spillover effect to heat pumps detectable.

Figure 8-5: Difference in Adoption Rate of Heat Pumps between Treatment and Control



8.6 COMPARISON TO PY2021 AND PY 2022

Table 8-9 compares per-customer savings from PY2022 and PY2023. In PY2023, the per-customer and percent savings were higher for Cohort 1. Cohort 2 was flat for the second year in a row. While Cohort 3 had higher impacts compared to 2022, they still have impacts well below the more established cohorts. Overall, the HEM program saw higher per customer impacts. This aligns with the expectation that customers savings increase over the first few years of HEM program participation.

Table 8-9: Unadjusted Ex-Post Savings by Cohort and Evaluation Year

Cohort	2021 Energy Impact Per account		2022 Energy Impact Per account		2023 Energy Impact Per account	
	kWh Impact	% Impact	kWh Impact	% Impact	kWh Impact	% Impact
Cohort 1	75.29	0.73%	93.84	0.93%	112.08	1.20%
Cohort 2	87.35	0.86%	83.88	0.83%	80.01	0.85%
Cohort 3	n/a	n/a	20.29	0.25%	39.39	0.51%
Cohort 4	n/a	n/a	n/a	n/a	39.59	0.32%
Cohort 5	n/a	n/a	n/a	n/a	-8.35	-0.15%

8.7 CONCLUSIONS AND RECOMMENDATIONS

PSEG Long Island's HEM program remains a significant component of PSEG Long Island's portfolio, currently reaching nearly 520,000 electric accounts. While home energy reports deliver small individual percentage changes in energy use, they typically yield large aggregate savings because they reach a considerable number of customers and do not require rebates or installations. In PSEG Long Island, the program yielded 40.9 GWh (or 139,430 MMBtu) of electric savings. With the adjusted expectations for per customer savings, the realization rate for the program is also substantially higher than the previous program year. Some key findings and recommendations are provided in Table 8-10.

Table 8-10: HEM Findings and Recommendations

Finding	Recommendation
▪ HEM's percent savings (0.89%) are generally lower than other HER programs.	▪ As the program continues to mature, we recommend investigating potential drivers for the lower-than-anticipated savings. In specific, we would continue to recommend coordination of the evaluation with National Grid, which provides natural gas delivery to customers. It is likely that some of the customers in the HEM control group are receiving behavioral energy reports from National Grid, diluting the energy savings estimate.
▪ PSEG Long Island does not claim peak demand savings for HEM.	▪ The 2023 evaluation used AMI data to estimate peak demand savings. We recommend that PSEG Long Island use an assumption of 0.02 kW/household to claim ex-ante peak demand savings in 2024. 0.02 kW/household is equal to the total kW impact/average number of customers treated in 2023.

9 ALL ELECTRIC HOMES

PSEG Long Island's All Electric Homes Program provides approved developers and contractors rebates for building new single-family all-electric homes or for converting existing single-family homes to all-electric appliances and HVAC units. The All Electric Homes program was designed and launched in 2021 and saw its first completed project in 2022. Participation grew in 2023 to three homes, but All Electric Homes is still by far the smallest program in PSEG Long Island's portfolio.

9.1 ALL ELECTRIC HOMES PROGRAM DESIGN AND PARTICIPATION

The following sections detail the program design, implementation strategies, participation, and performance for the All Electric Homes program in PY2023.

9.1.1 Program Design and Implementation

The All Electric Homes program is an extension of New York state policy goals to reduce reliance on fossil fuel combustion appliances in homes. As the electric grid in New York becomes decarbonized, this transition from fossil fuel space heating, domestic hot water, and appliances to electricity will lower greenhouse gas emissions. New construction participants are not allowed to have fossil fuel connections in the home other than an emergency backup generator and existing home participants must disconnect their natural gas service and remove any equipment that relies on delivered fuel. The All Electric Homes program offers two participation pathways, or tiers:

- **Tier 1 Pathway**: includes cold climate air source heat pumps, tankless water heaters, and ENERGY STAR appliances and a 10% bonus on all required rebated measures.
- **Tier 2 Pathway**: includes cold climate air source heat pumps, geothermal heat pumps, heat pump water heaters, and ENERGY STAR Most Efficient appliances and a 25% bonus on all required rebated measures.

Both pathways included a $2,000 contractor bonus to stimulate the market. Electric cooking equipment like induction stoves are encouraged, but not required and PSEG Long Island does not claim savings from cooking equipment.

TRC implements the All Electric Homes program and leverages its existing relationships with Home Comfort Partners, Home Performance Partners, and Multi-Family Partners and Developers to drive participation. All partners who participate in All Electric Homes have already been trained and vetted by others PSEG Long Island program to ensure customers will have a positive "All Electric" participation experience.

9.1.2 Program Participation and Performance

The All Electric Homes program recorded three completed projects in 2023. Each project represents a single home. Two projects were new construction and the third was a major renovation of an existing home. Based on verified ex-ante estimates, the All Electric Homes program reached 50% of its energy savings goal in 2023. Table 9-1 presents 2023 All Electric Homes programs verified ex-ante gross MMBtu savings compared to goal.

Table 9-1: All Electric Homes Program Verified Ex-Ante Gross MMBtu Savings versus Goals

Metric	MMBtu
Goal	1,038
Verified Ex-Ante Gross Savings	519
% of Goal	50%

9.2 ALL ELECTRIC HOMES PROGRAM IMPACTS

The following sections provide the results of the impact analysis for the All Electric Homes program.

9.2.1 OVERVIEW OF IMPACTS BY RESOURCE TYPE

Table 9-2 shows ex-post gross MMBtu impacts by measure category. Table 9-3 and Table 9-4 show the ex-post kWh and kW impacts, respectively. Realization rates are calculated by dividing ex-post gross savings values by ex-ante gross savings values. Overall, the All Electric Homes program realized 73% of its ex-ante gross MMBtu energy savings claims. The realization rate for cooking measures is listed as "n/a" in Table 9-2 because no ex-ante savings were claimed, but the evaluation team used savings calculations from an induction cooktop measure developed for the 2025 PSEG Long Island TRM to estimate ex-post results. The electric energy realization rate of 70% indicates that less electricity consumption was added since the claimed savings were negative in aggregate due to beneficial electrification. The peak demand realization rate was 95% for 2023. Section 9.2.1.1 explores the beneficial electrification impacts of the All Electric Homes program results in more detail.

Table 9-2: 2023 All Electric Homes Program Ex-Post Gross MMBtu Impacts

Measure	N	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings	Realization Rate
		MMBtu	MMBtu	%
Lighting	263	34.5	34.3	100%
Heat Pump	7	439.7	337.8	77%
ENERGY STAR Appliances	16	59.9	4.6	8%
Cooking	4	0.0	5.6	n/a
Thermostats	5	4.3	4.3	100%
HPWH	4	38.4	37.3	97%
Lawn	1	0.1	0.1	100%
Totals[1]	**300**	**576.8**	**423.9**	**73%**

[1] Totals may not sum due to rounding.

Table 9-3: 2023 All Electric Homes Program Ex-Post Gross kWh Impacts

Measure	N	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings	Realization Rate
		kWh [2]	kWh [2]	%
Lighting	263	10,097	10,052	100%
Heat Pump	7	-29,291	-22,301	76%
ENERGY STAR Appliances	16	604	604	100%
Cooking	4	0	-780	n/a
Thermostats	5	1,252	1,252	100%
HPWH	4	-2,161	-2,476	115%
Lawn	1	-11	-11	100%
Totals[1]	**300**	**-19,510**	**-13,660**	**70%**

[1] Totals may not sum due to rounding.
[2] These kWh impacts include both energy efficiency (EE) and beneficial electrification (BE) components. The kWh impacts are negative measures that involve displacement of fossil fuel combustion with electricity

Table 9-4: 2023 All Electric Homes Program Ex-Post Gross kW Impacts

Measure	N	Ex-Ante Gross Savings (Claimed)	Ex-Post Gross Savings	Realization Rate
		kW	kW	%
Lighting	263	1.90	1.75	92%
Heat Pump	7	3.18	3.18	100%
ENERGY STAR Appliances	16	0.13	0.13	98%
Cooking	4	0.00	-0.09	n/a
Thermostats	5	0.00	0.00	n/a
HPWH	4	-0.25	-0.28	115%
Lawn	1	0.00	0.00	n/a
Totals[1]	**300**	**4.96**	**4.69**	**95%**

[1] Totals may not sum due to rounding.

9.2.1.1 Beneficial Electrification Impacts

Table 9-5 shows the breakdown of Energy Efficiency (EE) and Beneficial Electrification (BE) components of MMBtu and kWh savings for measures where a BE component exists. The Heat Pump, HPWH, Appliance, and Cooking measures include a mixture of electric energy efficiency and beneficial electrification impacts.

Table 9-5: Breakdown of Ex-Post Gross Impacts by EE and BE Components

Measure	kWh_{ee}	kWh_{be}	kWh Total (EE - BE)	$MMBtu_{ee}$	$MMBtu_{be}$	MMBtu Total (EE + BE)
Heat Pump	4,537	26,838	-22,301	15.5	322.3	337.8
HPWH	295	2,771	-2,476	1.0	36.3	37.3
Appliances	1,214	609	604	4.1	0.4	4.6
Cooking	0	780	-780	0.0	5.6	5.6
Lawn Equipment	0	11	-11	0.0	0.1	0.1
Total	**6,046**	**31,009**	**-24,964**	**20.6**	**364.6**	**385.2**

9.2.2 Overview of Impacts by Disadvantaged Community and Low Income Identifiers

Table 9-6 shows the All Electric program ex-post Engineering impacts subdivided into four categories: 1) Non-Disadvantaged Community (DAC) & Non-Low Income, 2) DAC Only, 3) Low Income Only, and 4) DAC & Low-Income. A more detailed definition of each category can be found in Introduction, Section 2.1.1. Overall, 68% of All Electric Homes MMBtu impacts count towards the DAC and Low Income standards. No Low Income impacts were claimed.

Table 9-6: Ex-Post Impacts with DAC and Low Income Breakouts

Category	Ex-Post Gross Savings (MMBtu)	% of Ex-Post MMBtu
Non-DAC & Non-Low Income	134	32%
DAC Only	290	68%
Low Income Only	0	0%
DAC & Low Income	0	0%
Total	**424**	**100%**

9.2.3 Key Drivers for Differences in Impacts

Table 9-7 discusses the factors which led to realization rates above or below 100% and offers recommendations for program delivery and savings claims in 2023 and beyond.

Table 9-7: Key Contributors to Home Comfort Realization Rates and Recommended Adjustments

Component	Summary of Contributing Factors	Recommendation
Geothermal Heat Pump	▪ The ex-ante claimed savings for this measure were based on a screen shot of a Manual J form which appear to overstate the heating and cooling load of the home. The building heating load in the Manual J estimates are more than three times the rated heating capacity of the installed geothermal heat pumps. This indicates the heat pumps could not serve the full heating load without supplemental heat. For ex-post, we set the building heat load equal to the average of the Manual J values and the rated capacity of the installed heat pumps.	▪ Where contractors are required to complete Manual J calculations, PSEG Long Island should make sure to use those values as inputs to the claimed savings. However, it is important to validate that the values are reasonable given the home size and installed heat pump capacity. If the installed heat pump capacity is very different from the Manual J heating load, this suggests a data quality issue or that the home will still use fossil fuel to meet a portion of the heating load.
ENERGY STAR Appliances	▪ Similar to 2022 AEH evaluation, a workbook configuration error led to significantly over claimed MMBtu savings for the ENERGY STAR Refrigerator measure. The project workbook recorded 14.0 MMBtu for the measure, which is the intended EUL (14 years). The PSEG Long Island TRM value this measure is less than 1 MMBtu. The kWh and kW savings claims for the measure were unaffected by this issue.	▪ Review projects in the AEH pipeline ENERGY STAR refrigerators and correct the measure-level MMBtu savings assumption before ingesting the workbook values into Captures.

APPENDIX A DETAILED METHODOLOGY

A. CEP METHODOLOGY

Evaluation Methodology: Commercial Efficiency Program	
Key Considerations	• Availability of project-specific inputs in Capture queries vs. supporting workbooks for Comprehensive Lighting • Waste Heat Factors for Commercial Lighting
General Approach (Ex-post gross)	• Engineering calculations rooted in PSEG-LI TRM algorithms and informed by install tracking (Captures) database
Sampling Method(s)	• Lighting & Multifamily Categories: Census of all measure installs for measures where Captures data includes all parameters • Standard, Custom & HVAC Categories: Measure installs that constituted 85% of savings • Stratified random sample of projects where the parameters and calculations are housed in supporting workbooks
Primary Data	• Captures install tracking data for PY2023 CEP measures • Project specific pre- and post-inspection details • Custom measure inputs and calculations • Updated lighting waste heat factors developed by the evaluation team
Secondary Sources	• New York State TRM and PSEG Long Island TRM • Department of Energy Codes and Standards • Lighting cut sheets and other manufacturer equipment specifications • PSEG LI Planning documents and workbooks • 2010 LIPA Technical Manual • New York Clean Heat Calculator Output (CEP Custom Measures, variable refrigerant flow heat pumps)
Net-to-Gross Approach	• Net-to-gross factors for CEP lighting are based on the results of 2020 CEP participant survey efforts.
Other Evaluation Techniques	• Engineering Calculations
Opportunities for Refinement	• **Track more project and measure level data in Captures** and make it available to be downloaded for evaluations • **Align with PSEG Long Island TRM** on full load heating and cooling hours, lighting operating hours and coincidence factors based on building type, savings algorithms, and savings estimation methods

B. EEP METHODOLOGY

Evaluation Methodology: Energy Efficient Products	
Key Considerations	• Prescriptive measures with thorough tracking data • Low-to-moderate measure complexity • Moderate uncertainty of key savings parameters • High program contribution to portfolio savings • Program savings are highly skewed to three measure categories: Lighting (61%), Thermostats (24%), and Heat Pump Pool Heaters (10%).
General Approach (Ex-post gross)	• Engineering calculations rooted in PSEG-LI TRM algorithms and informed by install tracking (Captures) database
Sampling Method(s)	• Census of all measure installs
Primary Data	• Captures install tracking data for PY2023 EEP measures
Secondary Sources	• PSEG LI Technical Reference Manuals 2023-2025 • New York State TRM v10 • ENERGY STAR Qualified Product Lists • Uniform Methods Project for Determining Energy Efficiency Program Savings (UMP) • Department of Energy Codes and Standards • Other manufacturer equipment specifications • PSEG LI Planning documents and workbooks
Net-to-Gross Approach	• Stipulated NTG ratios
Other Evaluation Techniques	• Regression analysis, deemed savings used for certain measures • Diverged from TRM algorithm when enough data is available • Assumed baseline is federal standard for end-of-life replacement measures
Opportunities for Refinement	• **Inform savings estimates with supplemental research:** Research assumptions around baseline condition, capacity, namely for heat pump pool heaters. • **Use UMP regression for measures where install data permits** • **Increase focus on beneficial electrification** (data flow, rigor, and techniques)

C. HOME COMFORT METHODOLOGY

Evaluation Methodology: Home Comfort	
Key Considerations	• Beneficial Electrification measures result in an increase in site-level electric consumption by displacing fossil fuel systems sometimes resulting in negative MWh savings for those measures.
General Approach (Ex-post gross)	• Engineering calculations are rooted in the PSEG-LI TRM algorithms and informed by install tracking (Captures) database.
Sampling Method(s)	• Census of all measure installs • Stratified random sample of GSHP measures
Primary Data	• Captures install tracking data for PY2023 Home Comfort measures
Secondary Sources	• New York State TRM and PSEG Long Island TRM • Department of Energy Codes and Standards • Other manufacturer equipment specifications • PSEG LI Planning documents and workbooks • Northeast/Mid-Atlantic Air-Source Heat Pump Market Strategies Report 2016 Update • NYSERDA Heat Pump Study: "Analysis of Residential Heat Pump Potential and Economics" -May 2019
Net-to-Gross Approach	• Net-to-gross factors for heat pumps and HPWH are based on the results of 2022 EEP and Home Comfort participant survey efforts.
Other Evaluation Techniques	• Engineering Calculations
Opportunities for Refinement	• **Align with PSEG-LI TRM** on Quality Install savings algorithms, full load heating and cooling hours, savings algorithms, and savings estimation methods • **Track preexisting boiler and furnace heating system data** to improve accuracy of ex-ante savings • **Adopt deemed savings values** that vary based on the HVAC equipment controlled by the thermostats • **Align with PSEG-LI TRM** on using EER2, SEER2 and HSPF2 baseline values as opposed to converting EER, SEER and HSPF values to EER2, SEER2 and HSPF2 respectively.

D. HOME PERFORMANCE METHODOLOGY

Evaluation Methodology: Home Performance	
Key Considerations	• Beneficial Electrification measures result in an increase in site-level electric consumption by displacing fossil fuel systems sometimes resulting in negative kWh and kW savings for those measures • Impact Evaluation values are a combination of engineering calculations and consumption analysis
General Approach (Ex-post gross)	• Engineering calculations rooted in PSEG-LI TRM algorithms and informed by install tracking (Captures) database. Consumption calculations were rooted in participant billing data and used to estimate kWh energy efficiency realization rates • Ex-post gross kWh energy efficiency savings were calculated by applying consumption analysis realization rate to EE savings. Ex-post gross kWh beneficial electrification impacts were calculated from engineering analysis • Ex-post gross kW and MMBtu savings were calculated using kW/kWh and MMBtu/kWh ratios from engineering calculations applied to ex-post gross kWh savings derived from the consumption analysis
Sampling Method(s)	• Census of all measure installs from Captures • Matched participants provided in billing data
Primary Data	• Captures install tracking data for PY2023 Home Performance measures • Billing data from 2022 and 2023 Home Performance participants
Secondary Sources	• New York State and PSEG LI Technical Reference Manuals • Department of Energy Codes and Standards • Other manufacturer equipment specifications • PSEG LI Planning documents and workbooks
Net-to-Gross Approach	• Heat Pump NTG developed in the 2022 EEP and Home Comfort participant survey efforts. • Stipulated NTG ratios for all other measures
Other Evaluation Techniques	• Engineering Analysis • Consumption Analysis using participant matching and fix effects panel linear regression model
Opportunities for Refinement	• Track impacts by fuel: (positive and negative) rather than zero out negative savings for HPwES projects • Focused effort on tracking measure-level parameters in Captures: specifically CFM values and conditioned square footage for air and duct

Evaluation Methodology: Home Performance	
	sealing projects; HVAC system type and fuel type; pre-installation wattages and quantities for direct-install lighting

E. REAP METHODOLOGY

Evaluation Methodology: Residential Energy Affordability Partnership Program	
Key Considerations	• REAP Evaluation was a combination of engineering calculations and consumption analysis • Consumption analysis will estimate savings that take into account the interactive effects of implementing multiple measures at one location • REAP savings were dominated by lighting measures
General Approach (Ex-post gross)	• Engineering calculations rooted in PSEG-LI TRM algorithms and informed by install tracking (Captures) database. These calculations were used to calculate MMBtu to kWh and kW to kWh ratios. • Consumption analysis rooted in billing data from 2022 and 2023 customers using pre-participation data from 2023 customers as a baseline and post-participation data from 2022 customers as the treatment. Consumption analysis was used to estimate kWh realization rates. • The engineering calculation ratios and kWh realization rate from consumption were then used to estimate energy (MMBtu) and demand (kW) savings. • Engineering results were used for smart thermostats since the measure contribution soared in 2023 and most of the savings come from fossil fuel heating reductions.
Sampling Method(s)	• Engineering Calculations: Census of all projects from the measure categories that comprised 95% of program savings • Consumption Analysis: Matched participants provided in billing data
Primary Data	• Captures install tracking data for PY2023 EEP measures • Billing data from 2022 and 2023 REAP participants
Secondary Sources	• PSEG LI Technical Reference Manuals 2021-2025 • New York State and PSEG LI Technical Reference Manuals • Department of Energy Codes and Standards • Other manufacturer equipment specifications • PSEG LI Planning documents and workbooks
Net-to-Gross Approach	• Stipulated NTG ratios
Other Evaluation Techniques	• Engineering Analysis • Consumption Analysis using participant matching and fixed effects panel linear regression model

Evaluation Methodology: Residential Energy Affordability Partnership Program	
Opportunities for Refinement	• Align baseline and installed wattage values with the assumptions in the PSEG-LI TRM

F. ALL ELECTRIC HOMES METHODOLOGY

Evaluation Methodology: All Electric Homes	
Key Considerations	• Heating and cooling load of the home as specified in the contractor's Manual J calculations and efficiency of installed heat pump system. • HVAC interactive effects on LED lighting and heat pump water heater measures given the all-electric home construction.
General Approach (Ex-post gross)	• Engineering analysis similar to other residential programs. Ground source heat pump calculations mirror Home Comfort. The LED lighting, appliance, connected thermostat, and HPWH measure calculations mirror their EEP counterparts.
Sampling Method(s)	• No sampling required. Detailed review of the lone AEH project completed during the 2022 program year.
Primary Data	• Program tracking data from the Captures system • TRC measure workbook • Contractor invoices and Manual J calculations • Manufacturer specification sheets
Secondary Sources	• ENERGY STAR Qualified Products List • New York State TRM and PSEG Long Island TRM
Net-to-Gross Approach	• Net-to-gross factors for heat pumps and HPWH are based on the results of 2022 EEP and Home Comfort participant survey efforts. ENERGY STAR appliances, connected thermostats, and LED lighting NTG factors come from previous EEP program analysis.
Other Evaluation Techniques	• Long Island market baseline blend of space heating and domestic water heating assumed for baseline fuel and efficiency blend.
Opportunities for Refinement	• Inclusion of savings for electric induction cooktop • Include a flag for zoned HVAC systems to allow for multiple thermostats controlling a single condensing unit without double-counting the capacity.

G. HOME ENERGY MANAGEMENT METHODOLOGY

The primary challenge of an impact evaluation is the need to accurately detect changes in energy consumption while systematically eliminating plausible alternative explanations for those changes, including random chance. Did the introduction of HERs cause a decrease in customer energy consumption? Or can the differences be explained by other factors? To estimate energy savings, it is necessary to estimate what these patterns would have been in the absence of treatment—this is called the counterfactual. At a fundamental level, the ability to measure energy reductions accurately depends on four key components:

1. **The effect or signal size:** The effect size is most easily understood as the percent change. It is easier to detect large changes than it is to detect small ones. For most HER programs, the expected impact is between 0.5% and 2.5%, a relatively small effect.
2. **Inherent data volatility or background noise:** The more volatile a customer's billing data are from month to month (or bimonthly billing period), the more difficult it is to detect small changes.
3. **The ability to filter out noise or control for volatility:** At a fundamental level, statistical models, baseline techniques, and control groups—no matter how simple or complex—are tools to filter out noise (or explain variation) and allow the effect or impact to be more easily detected.
4. **Population size:** It is easier to precisely estimate average impacts for a large population than a small one because individual customer behavior patterns smooth out and offset across large populations.

APPROACH OVERVIEW

Because the expected percent reduction from HERs is typically small (i.e., less than 5%), we followed the principles below to ensure accurate results:

1. **Verify that participant and control customers had similar usage before the introduction of HERs.** By design, randomized control trials ensure that the only systematic difference between the two groups is that one receives the HER and one does not. However, random assignment is sometimes not implemented correctly or maintained. Thus, we compare the treatment and control groups across a host of characteristics—electricity use, location, etc.—in order to ensure the implementer did indeed randomly assign customers to the treatment and control groups.

2. **Include at least one year of pre-treatment data and post-treatment data for both HER and control groups.** The pre-treatment data is useful for assessing if energy consumption changed and allows the evaluation team to use more powerful statistical techniques such as difference-in-differences and lagged dependent variable models. If HERs reduce consumption, we should observe a change in consumption for customers who received the HER treatment but no similar change for the control group. Thus, participant and control customers that lacked pre-intervention data were not included in the analysis.

3. **Ensure sample sizes large enough to detect meaningful differences**. If sample sizes are too small, it is not possible to distinguish meaningful differences from random noise. When evaluated on their own, each wave tends to have wider confidence bands (i.e., they lack statistical power). Thus, this study's focus is on the overall program savings rather than on the savings delivered by specific waves.
4. **Apply the same data management procedures to both the HER and control groups.** Because of random assignment, data management decisions should impact the treatment and control group similarly.
5. **Pre-specify the analysis method and segmentation in advance of the study.** This required documenting the hypothesis, specifying the intervention, randomly assigning customers to treatment and control conditions, establishing the sample size and the ability to detect meaningful effects, identifying the data that will be collected and analyzed, and identifying the outcomes that will be analyzed.
6. **Ensure impacts are robust.** Impacts can be estimated using both a difference-in-difference approach and by using a post-only model. A difference-in-difference approach compares energy usage before and after the intervention for both the participant group and the control group and net out any pre-existing differences. A post-only model leverages data from the pre-treatment period as an explanatory variable, but only includes observations from the post-treatment period in the regression. In the evaluation, we estimated impacts using both approaches in order to ensure the different methods did not produce significantly different results.

Model Specification

DSA used the lagged dependent variable (LDV) model to estimate ex-post impacts. The LDV model is a "post-only" model because only observations from the post-treatment period are included in the regression. However, as its name suggests, the LDV model does leverage data from the pre-treatment period as an explanatory variable.

The formal model specification is shown in Equation 1 below with additional detail on the terms provided in Table A- 1.

Equation 1: LDV Model Equation to Estimate HEM Ex-Post Impacts

$$Daily\ Use_{im} = \beta_0 + \beta_{1m} * AvgPre_{im} + \beta_{2m} * CDD_m + \beta_{3m} * HDD_m + \tau_m * \text{treatment}_{\text{im}} + \sum_{m=1}^{12} \beta_4 * m + \varepsilon_{\text{im}}$$

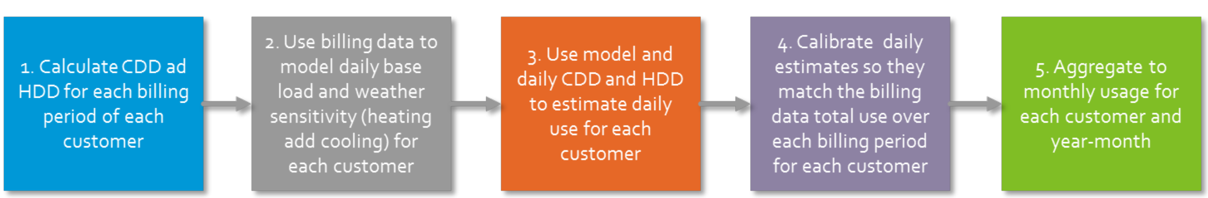
Table A- 1: Lagged Dependent Variable Model Definition of Terms

Variable	Definition
Daily Use_{im}	Customer i's average daily usage in bill month m.
β_0	Intercept of the regression equation.
β_{1m}	Coefficient explaining any variation that occurs as a result of pre-treatment usage for month m.
$AvgPre_{im}$	Average daily usage for customer i in the pre-treatment period for month m.
β_{2m}	Coefficient explaining any variation that occurs as a result of average monthly CDD for month m.
CDD_m	Difference between average temperature and 60 for month m.
β_{3m}	Coefficient explaining any variation that occurs as a result of average monthly HDD for month m.
HDD_m	Difference between 60 and average temperature for month m.
treatment_{im}	The treatment indicator variable. Equal to one when the treatment is in effect for the treatment group. Zero otherwise. Always zero for the control group.
τ_m	The estimated treatment effect in kWh per day per customer; the main parameter of interest.
β_4	Coefficient for Year Month Variable.
m	Year month indicator.
ε_{im}	The error term.

Calendarizing Billing Data

The time of the month when customer meters are read and the number of days between billing statements varies. Thus, we prorated billing data into a standard calendar month basis. The process of converting bills to usage is known as calendarization. Figure A- 1 summarizes the process employed to calendarize the data.

Figure A- 1: Calendarization of Billing Data



Opt Outs and Attrition

Over time, some homes assigned to the HER program will close their accounts with PSEG Long Island. The most common reason for this is that the occupant is moving, but other possibilities exist. This account churn happens at a predictable rate and can be forecasted with some degree of certainty. It is also completely external to the program, so there is no reason to suspect that it happens differently in the treatment and control when the groups were randomly assigned. The analysis includes all active accounts for a given month and all participation counts used to calculate aggregate savings. Once an account closes, there will no longer be consumption records in the billing data set, so the home is removed naturally from the analysis without requiring any special steps.

Treatment group homes are allowed to opt-out of receiving HER mailings if they choose. Typically, only a small proportion of the treatment group exercises this option. Those who opt out must not be removed from the analysis because doing so could compromise the randomization (control group homes do not opt-out).

UPLIFT ANALYSIS

Exposure to behavioral program messaging often motivates participants to take advantage of other energy efficiency and beneficial electrification programs. This creates a situation where the treatment group participates in other programs at a higher rate than control group homes. To avoid double-counting these impacts, our team calculated savings from program uplift and subtracted them from the aggregate savings.

For downstream programs where participation is tracked at the account level, dual participation was calculated using the following steps:

1) Match the energy efficiency and beneficial electrification program tracking data to the treatment and control homes.
2) Assign each transaction to a month based on the participation date field in the tracking data.
3) Exclude any installations that occurred before the home was assigned to the treatment or control group.
4) Calculate the daily kWh savings of each efficient measure. This value is equal to the reported kWh savings of the measure divided by 365.
5) Sum the daily kWh impact, by account, for all measures installed prior to a given month.
6) Calculate the average kWh savings per day for the treatment and control groups by month. Multiply by the number of days in the month.
7) Calculate the incremental daily kWh from energy efficiency (treatment – control). The evaluation team subtracted this value from the treatment effect determined via regression analysis prior to calculating gross verified savings for behavioral programs.

Upstream programs present a unique challenge for dual participation analysis because participation is not tracked at the customer level and therefore cannot be tied back to treatment and control group homes for comparison. While incremental uptake of upstream measures by the treatment group has been observed in multiple studies, the size of the effects that are typically subtracted is disproportionate to the evaluation resources required to estimate it.

Table A- 2 provides default values that can be used to calculate a dual participation adjustment factor for upstream offerings. To account for the growing separation between the treatment and control groups over time, Table A- 2 relies on a conditional lookup based on the number of years since cohort inception to calculate the reduction factor.

Table A- 2: Default Upstream Adjustment Factors[11]

Years Since Cohort Inception	Default Upstream Reduction Factor
1	0.75%
2	1.5%
3	2.25%
4 and beyond	3.0%

PEAK DEMAND REDUCTION ANALYSIS

While no kW demand savings were claimed for HEM during the program year, we did assess the kW demand reduction for the program as a part of the ex-post analysis. The demand reduction analysis utilized hourly metered household data (referred to here as advanced metering infrastructure or AMI data) to estimate demand reduction for HEM customers at the hourly level. As no pre-treatment AMI data was available, we utilized a simple difference in means comparison, which examined differences in raw averages between the treatment and control groups for each hour. For the purpose of this analysis, we defined peak demand as hour-ending 4-5 PM and looked at customer demand reductions for the top 20 system load days in 2023. Figure A- 2 depicts the average raw differences between the treatment and control group for each hour and each wave on the top 20 system load days from 2023. While there is a clear directionality in the difference between the treatment and control group, the differences overall are very small and not statistically significant. We can also see that the shape of the savings differs for each wave. Cohort 2 savings are flatter, with slightly higher savings in the morning and evening while both Cohort 1 and Cohort 3 savings are higher overall and concentrated in the middle of the day.

[11] Default values were developed via a review of two studies that used primary data collection with large sample sizes to estimate a dual participation adjustment for upstream lighting. A 2012 PG&E evaluation found values larger than those in this table. http://www.calmac.org/publications/2012_PGE_OPOWER_Home_Energy_Reports__4-25-2013_CALMAC_ID_PGE0329.01.pdf A 2014 Puget Sound evaluation found values lower than those in this table. https://conduitnw.org/_layouts/Conduit/FileHandler.ashx?RID=2963.

Figure A- 2: HEM Hourly Demand Reduction on Peak Summer Days

The raw differences approach does not account for any pre-treatment differences that may exist between the treatment and control groups, as no pre-treatment interval data was available for analysis. To account for any pre-existing differences between the treatment and control groups we adjusted the control group reference load based on the observed pre-treatment percent difference between treatment and controls in the billing analysis. The pre-treatment percent differences ranged from 0.15% to 0.26%. Once we adjusted for the pre-treatment difference, we found that the HEM population was able to reduce demand by 9.70 MW between 4 and 5 PM during the summer. Table A- 3 summarizes the peak demand reduction for each wave.

Table A- 3: HEM Peak Demand Reduction

Wave	MW Impact (Adjusted)
Cohort 1	5.60
Cohort 2	2.67
Cohort 3	0.70
Cohort 4	1.28
Cohort 5	0.11
Pooled	**10.34**

H. CONSUMPTION ANALYSIS METHODOLOGY FOR REAP AND HOME PERFORMANCE

The consumption analysis relies on a comparison between consumption prior to and following the energy efficiency upgrades. In 2023, the consumption analysis leveraged a matched control design. To control for selection effects, we select matches from future participants rather than Long Island households with no energy efficiency participation. Participants from 2022 acted as the "treatment" group and participants from

2023 were part of the control pool. Steps taken to prepare the billing data for the analysis – including the selection of a matched control group – are discussed in subsequent sections.

AMI Data Cleaning

We lean on Advanced Metering Infrastructure (AMI) data for comprehensive and accurate consumption analysis, as it provides more granular data than monthly bills and allows use to create regression models with more explanatory power. This approach was new for 2023 and represents a methodological enhancement compared to the monthly billing data used in prior REAP and Home Performance consumption analyses.

To ensure the accuracy and relevance of our data for analysis, we follow a series of steps to clean the AMI data.

1. **Adjust for Daylight Savings:** We check and adjust the data for daylight saving time changes to ensure that the time stamps accurately reflect actual usage periods and avoid misinterpreting consumption patterns.

2. **Collapse Data to Hourly Intervals:** The data is initially in 15-minute intervals, then collapsed into hourly intervals. This reduction in data granularity simplifies analysis while still capturing detailed consumption trends.

3. **Ensure Full Days' Worth of kWh Data:** We filter out any records that do not represent a full day's worth of data (i.e., 24 hours of readings). This ensures the analysis is based on complete and representative daily consumption figures.

4. **Drop Zero kWh Readings:** Zero kWh readings are removed as they may indicate periods of non-usage or data errors, which could distort the analysis of energy efficiency impacts.

5. **Filter by Program Participation:** Only data from customers exclusively involved in the REAP or Home Performance programs are retained. This eliminates any confounding effects from participants engaged in multiple programs, such as Home Comfort, ensuring a clean and focused analysis of the targeted energy efficiency interventions.

Matching

In a matched control framework, each participant is matched to exactly one control home that shows a similar energy-use profile. In our 2023 analysis, this was done via Euclidean Distance matching based on the most similar annual load. Steps taken to develop the matches were as follows:

1. For each treatment participant, select units from the control pool whose installation date is one month before or after the treatment participant's installation date. This means that a treatment

participant with an installation month of May 2022 can only be matched with future or earlier participants with an installation month of April, May, or June 2023.

2. Filter the treatment and the remaining control pool units to have more than 330 days of pre-intervention data. Specifically, for a treatment unit with an installation date of May 1st, 2022, we filter the consumption reading from May 1st, 2021, to May 1st, 2022, ensuring both treatment and controls have comparable, year-long consumption data for accurate pre-treatment comparisons.

3. Estimate the average consumption for the treatment and control groups over the previous twelve months.

4. Rank participants in the control pool based on the distance between their twelve-monthly consumption data points to select the closest neighbor. Matched Control units get assigned the installation date of their corresponding treated participant.

    a. For Home Performance only, create an additional set of indicator variables denoting which program component the household participated in (HPwES, HPDI, and HEA).

Figure A- 3 shows the distribution of weather-normalized consumption for the REAP treatment and control group pools prior to matching. Without any matching, participating households from the 2022 and 2023 show similar distributions and central tendency. Figure A- 4 compares average daily consumption in the REAP treatment and matched control groups across 2021 after the Euclidean distance matching procedure. Although not perfect, there is clearly strong alignment between the two groups. The differences observed in the pre-treatment are netted out of the post-participation impacts via the regression model specification.

Figure A- 3: Distribution of Annual Consumption Prior to Matching, REAP

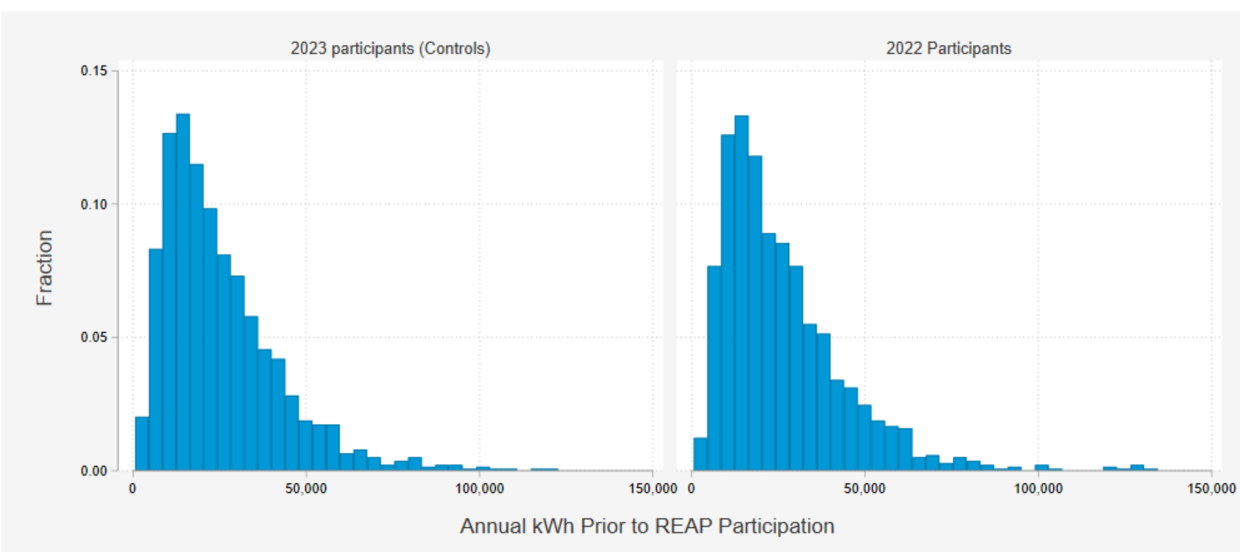


Figure A- 4: Average Daily Usage of Treatment and Comparison Groups (kWh), REAP

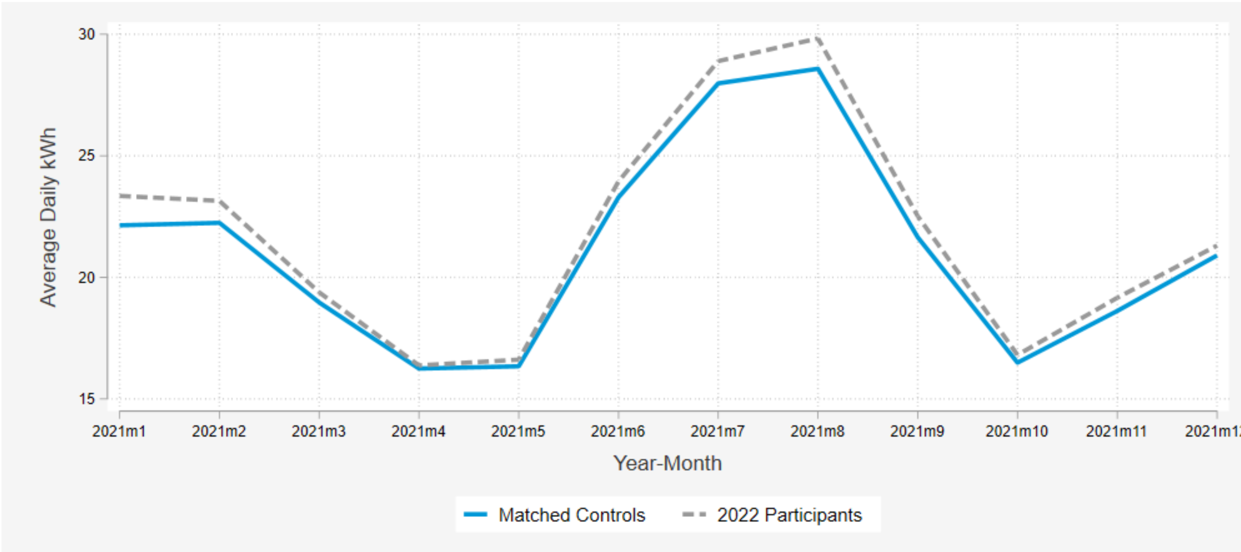


Figure A- 5 and Figure A- 6 are similar to Figure A- 3 and Figure A- 4 but represent Home Performance treatment and comparison group rather than REAP. The takeaways for Home Performance are the same as REAP – the participant group and the matched control groups are well-aligned in their annual consumption and the seasonality of their consumption trends.

Figure A- 5: Distribution of Annual Consumption Prior to Matching, Home Performance

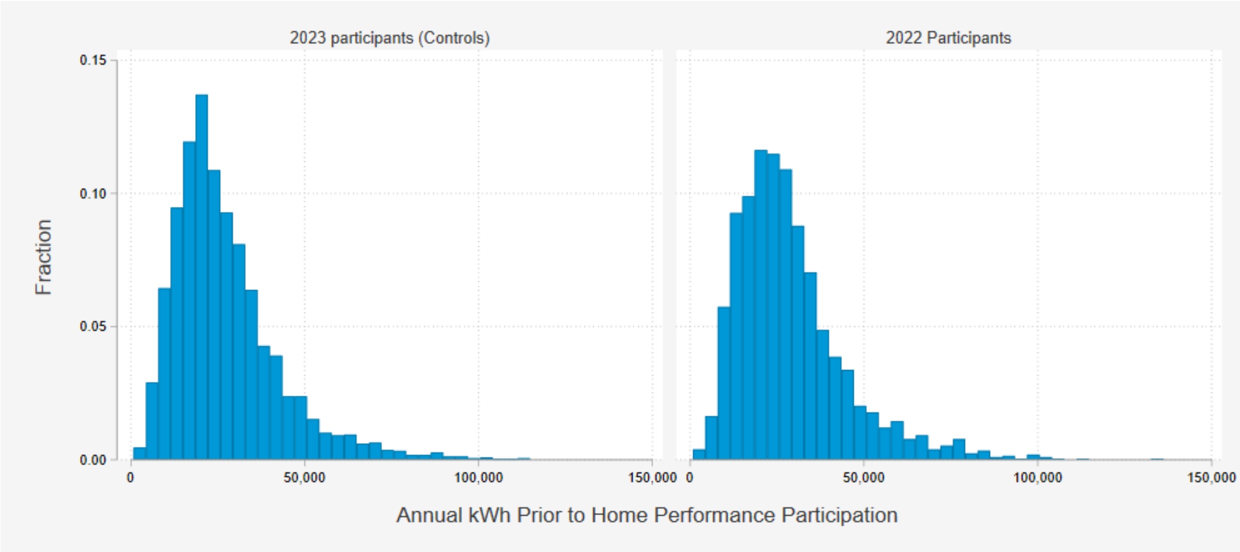
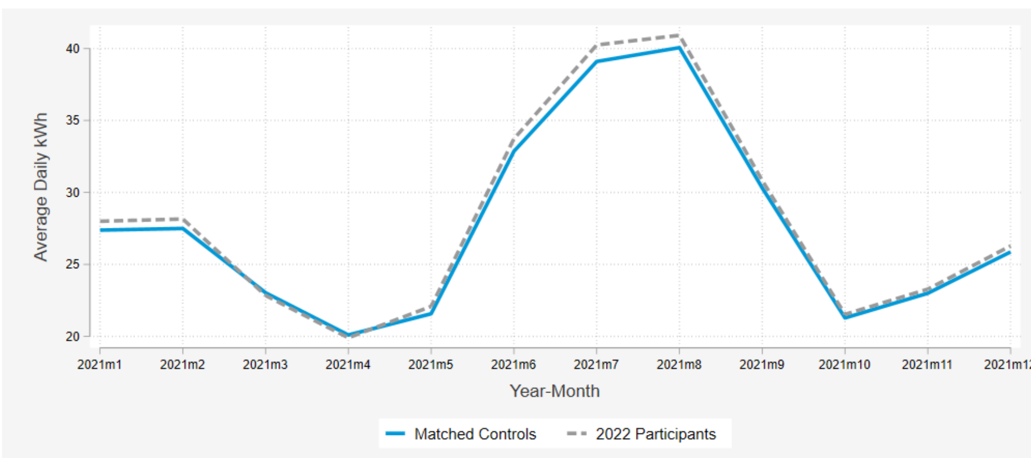


Figure A- 6: Average Daily Usage of Treatment and Comparison Groups (kWh), Home Performance



Impact Analysis

The consumption analysis model is a weather-normalized linear fixed effects panel regression model. A fixed effects model absorbs time-invariant household characteristics via inclusion of separate intercept terms for each account in the treatment and comparison group. Table A- 4 shows the full model specification. The treatment effect is the difference in daily energy use that is associated with participating in the program. We normalized for weather by modeling the interaction of the treat-post variable with the HDD and CDD variables. We then multiply the interaction coefficient of the treat-post and CDD estimates by the expected number of CDD for the McArthur Airport. CDD was calculated using 1991-2020 NOAA climate normals. The same calculations are done using HDD. We then multiply the treatment effect by the number of days in a year to annualize the savings.

Equation 2: Linear Fixed Effects Regression Model Specification

$$\text{kWh}_{\text{it}} = \beta_0 + \beta_1 * Post_{it} + \beta_2 * CDD_t + \beta_3 * TreatPost_{it} * CDD_t + \beta_4 * HDD_t + \beta_5 * TreatPost_{it} * HDD_t + \beta_6 * TreatPost_{it} + \beta_7 * DOW_{it} + \varepsilon_{\text{it}}$$

Table A- 4 defines the model terms and coefficients in Equation 2. The impacts are calculated by summing the following terms, 1) the coefficient of the treatpost term (β_6) multiplied by the number of days in a year, 2) the coefficient of treatpost by CDD (β_3) multiplied by the number of cooling degree days in a year, and 3) the coefficient of the treatpost by HDD (β_4) multiplied by the number of heating degree days in a year.

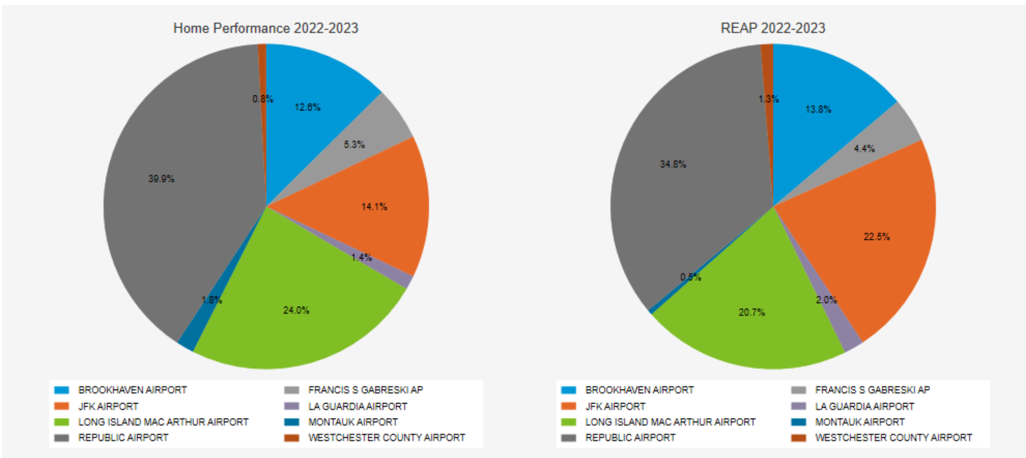
Table A- 4: Regression Model Parameter Definitions

Variable	Definition
kWh_{it}	Customer i's average daily electric usage in day t.
β_0	The intercept term for customer i, or the "fixed effect" term. Equal to the mean daily energy use for each customer.
Post_{it}	An indicator equal to one if customer i participated in the program prior to day t and zero otherwise. Coding of the post term for each member of the comparison group mirrors its matched participant.
β_1	The coefficient on the post indicator variable. This variable captures the change in consumption in the matched control group during the post-period due to exogenous factors such as the COVID-19 pandemic.
CDD_t	The average daily cooling degree days at base 60 degrees (F) for the nearest weather station in day t
β_2	The coefficient on the cooling degree day variable.
β_3	The coefficient on the interaction between cooling degreed day and the post indicator. This captures weather-related factors driving customer consumption behavior during the summer months.
HDD_t	The average daily heating degree days at base 60 degrees (F) for the nearest weather station in day t
β_4	The coefficient on the heating degree day variable.
β_5	The coefficient on the interaction between cooling degreed day and the post indicator. This captures weather-related factors driving customer consumption behavior during the winter months.
$\text{TreatPost}_{\text{it}}$	The indicator variable for post-period of treatment customers. Equal to one for the participant group in the post period, zero for the participant group in the pre-period, and zero for the matched control group.
β_6	The estimated treatment effect in kWh per day; the main parameter of interest. The change in daily kWh consumption attributable to program participation.
DOW_{it}	A set of indicator variables for the day of the week.

β_7	The coefficient on the day of week indicator variables. This captures day-specific factors driving consumer consumption behavior.
ε_{it}	The error term.

The Evaluation Team used service zip code to map each participating household to one of eight weather stations. Figure A- 7 shows the distribution of participants across the weather stations, by program. REAP participants are more likely to live in the western portion of PSEG Long Island service territory near Brooklyn and Queens, while Home Performance participants tend to live further east.

Figure A- 7: Weather Station Mapping by Program



The REAP consumption analysis returned an annual savings estimate of 274.0 kWh (95% confidence interval: 113.6 kWh/year, 434.4 kWh/year), and the Home Performance analysis returned an annual savings estimate of 163.6 kWh (95% confidence interval: -3.1 kWh/year, 330.3 kWh/year). Savings for REAP and Home Performance are visualized in Figure A- 8 and Figure A- 9, respectively. Statistical regression output for the REAP and Home Performance models is shown in Figure A- 10 and Figure A- 11, respectively. The key terms in the regression output are, 1) the coefficient for the "treatpost" term, which represents the change in average daily consumption for the treatment group in the post period, 2) the coefficient for the treatpost by cooling degree days, which represents the relationship between the change in daily consumption and summer weather, and 3) the coefficient for the treatpost by heating degree days, which represents the relationship between the change in daily consumption and winter weather. The HDD and CDD coefficients weather normalize the regression results.

Figure A- 8: REAP Consumption Analysis Results Visualized

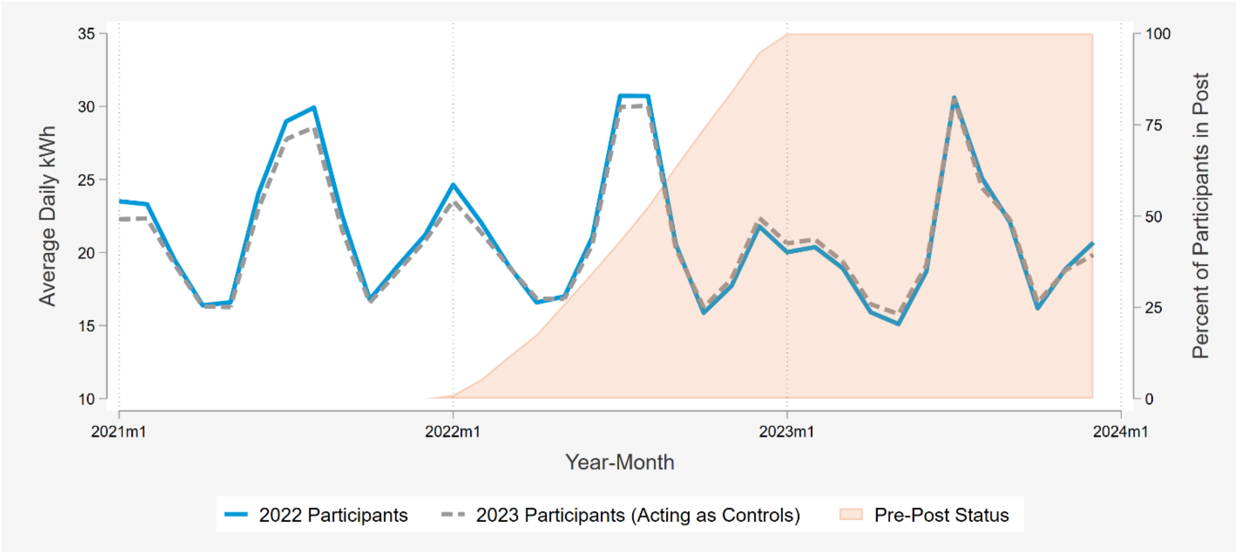


Figure A- 9: Home Performance Consumption Analysis Results Visualized

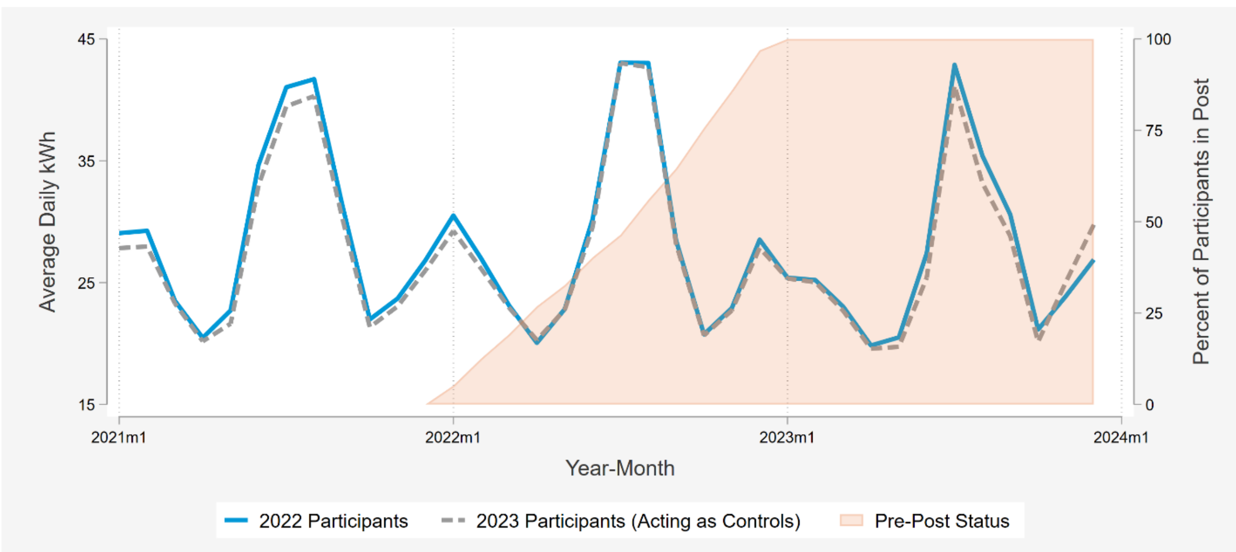


Figure A- 10: Regression Output – REAP

```
Linear regression, absorbing indicators          Number of obs     =  3,080,583
Absorbed variable: account_number                No. of categories =      2,785
                                                 F(  12,    2784)  =     339.42
                                                 Prob > F          =     0.0000
                                                 R-squared         =     0.6203
                                                 Adj R-squared     =     0.6199
                                                 Root MSE          =    11.0892

                             (Std. Err. adjusted for 2,785 clusters in account_number)
```

kwh_del	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
post	-.2511207	.1211639	-2.07	0.038	-.4887008	-.0135405
1.treatpost	-.7361343	.2700575	-2.73	0.006	-1.265667	-.206601
cdd60	.8990985	.0210316	42.75	0.000	.8578594	.9403375
treatpost#c.cdd60						
1	-.004525	.0283836	-0.16	0.873	-.06018	.0511299
hdd60	.3043017	.0103242	29.47	0.000	.2840578	.3245457
treatpost#c.hdd60						
1	.0187889	.0155919	1.21	0.228	-.011784	.0493618
dow						
1	-.7375582	.046753	-15.78	0.000	-.8292322	-.6458842
2	-.7985171	.0502871	-15.88	0.000	-.8971209	-.6999133
3	-.7391789	.0516739	-14.30	0.000	-.8405019	-.6378559
4	-.6861557	.0518295	-13.24	0.000	-.7877838	-.5845275
5	-.7248961	.0559764	-12.95	0.000	-.8346556	-.6151367
6	-.270483	.0401692	-6.73	0.000	-.3492475	-.1917185
_cons	15.07453	.1345341	112.05	0.000	14.81073	15.33833

Figure A- 11: Regression Output – Home Performance

```
Linear regression, absorbing indicators         Number of obs     =  3,982,532
Absorbed variable: account_number               No. of categories =      4,148
                                                F(  12,    4147)  =     696.15
                                                Prob > F          =     0.0000
                                                R-squared         =     0.6046
                                                Adj R-squared     =     0.6042
                                                Root MSE          =    13.9324

                         (Std. Err. adjusted for 4,148 clusters in account_number)
```

kwh_del	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
post	-.2125604	.1214083	-1.75	0.080	-.4505857	.0254649
1.treatpost	-.5158971	.2567701	-2.01	0.045	-1.019304	-.0124901
cdd60	1.370885	.0204574	67.01	0.000	1.330778	1.410993
treatpost#c.cdd60						
1	-.0293173	.0295012	-0.99	0.320	-.0871554	.0285208
hdd60	.3480792	.0115349	30.18	0.000	.3254647	.3706938
treatpost#c.hdd60						
1	.0147719	.0164051	0.90	0.368	-.0173909	.0469347
dow						
1	-1.207142	.0476219	-25.35	0.000	-1.300507	-1.113778
2	-1.309287	.0517208	-25.31	0.000	-1.410688	-1.207887
3	-1.19591	.0521995	-22.91	0.000	-1.298249	-1.093571
4	-1.210574	.0512292	-23.63	0.000	-1.31101	-1.110137
5	-1.129602	.0537389	-21.02	0.000	-1.234959	-1.024245
6	-.4365568	.0419265	-10.41	0.000	-.5187552	-.3543583
_cons	19.3963	.1419863	136.61	0.000	19.11793	19.67467

APPENDIX B 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.

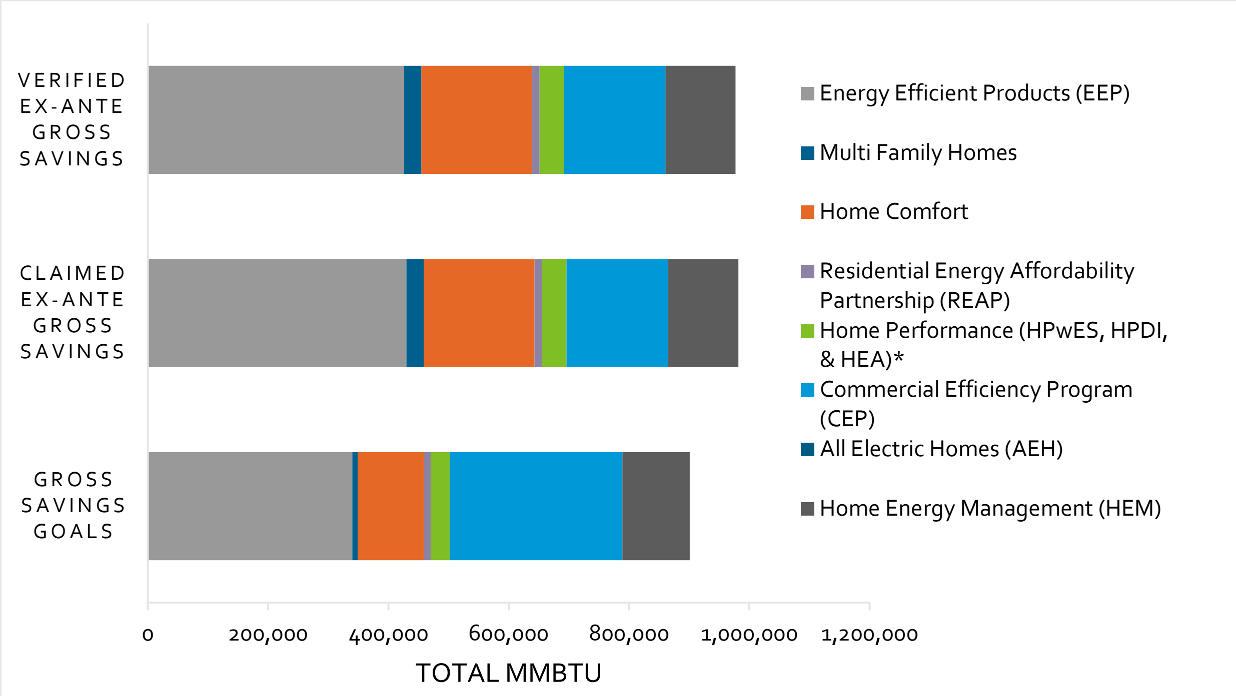
TABLE 1: SUMMARY OF 2023 VERIFIED EX-ANTE MMBTU SAVINGS AND GOALS

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

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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 C 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**

APPENDIX D COST EFFECTIVENESS EX-POST NET TABLES

Appendix D- 1: Commercial Ex-Post Net Data for Cost Effectiveness

Resource	End Use	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
MMBtu	Lighting	Comprehensive Lighting	108,293	67%	1.00	72,253
		Fast Track Lighting	9,482	67%	1.00	6,326
		Refrigerated Case Lighting	1,474	67%	1.00	983
		Lighting Subtotal	119,248			79,562
	Multi-Family	Multi-Family	29,944	100%	1.00	29,944
	Standard	Refrigeration	2,630	72%	1.00	1,881
		Motors & VFDs	634	72%	1.00	454
		Compressed Air	2,554	72%	1.00	1,827
		Nonroad Vehicle Electrification	2,372	72%	1.00	1,697
		Other Comm. Equipment	570	72%	1.00	408
		Standard Subtotal	8,760			6,267
	Custom	Custom	33,181	72%	1.00	23,741
	HVAC	HVAC	2,783	72%	1.00	1,991
		MMBtu Total	**193,916**			**141,506**
MWh	Lighting	Comprehensive Lighting	38,551	67%	1.06	27,267
		Fast Track Lighting	3,531	67%	1.06	2,498
		Refrigerated Case Lighting	432	67%	1.06	305
		Lighting Subtotal	42,514			30,070
	Multi-Family	Multi-Family	-374	100%	1.06	(396)
	Standard	Refrigeration	914	72%	1.06	693
		Motors & VFDs	186	72%	1.06	141
		Compressed Air	749	72%	1.06	568
		Nonroad Vehicle Electrification	-206	72%	1.06	(156)
		Other Comm. Equipment	98	72%	1.06	74
		Standard Subtotal	1,740			1,320
	Custom	Custom	612	72%	1.06	464
	HVAC	HVAC	446	72%	1.06	338
		MWh Total	**44,938**			**31,797**

Resource	End Use	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
kW	Lighting	Comprehensive Lighting	9	67%	1.08	6
		Fast Track Lighting	1	67%	1.08	1
		Refrigerated Case Lighting	0	67%	1.08	0
		Lighting Subtotal	10			7
	Multi-Family	Multi-Family	0	100%	1.08	0
	Standard	Refrigeration	0	72%	1.08	0
		Motors & VFDs	0	72%	1.08	0
		Compressed Air	0	72%	1.08	0
		Nonroad Vehicle Electrification	0	72%	1.08	(0)
		Other Comm. Equipment	0	72%	1.08	0
		Standard Subtotal	0			0
	Custom	Custom	0	72%	1.08	0
	HVAC	HVAC	0	72%	1.08	0
		kW Total	**11**			**8**

Appendix D- 2: EEP Ex-Post Net Data for Cost Effectiveness

Resource	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
MMBtu	Lighting	260,217	55%	1.00	143,119
	Heat Pump Pool Heaters	41,371	97%	1.00	40,039
	Pool Covers	139	90%	1.00	125
	Thermostats	103,302	77%	1.00	79,543
	Appliances	16,131	90%	1.00	14,518
	Recycling	4,986	57%	1.00	2,842
	Water Heaters	2,256	100%	1.00	2,261
	Lawn Equipment	14	90%	1.00	13
	Advanced Power Strips	379	100%	1.00	379
	MMBtu Total	**428,794**	**66%**	**1.00**	**282,838**
MWh	Lighting	115,760	55%	1.06	67,495
	Heat Pump Pool Heaters	1,137	97%	1.06	1,166
	Pool Covers	41	90%	1.06	39
	Thermostats	3,051	77%	1.06	2,491
	Appliances	4,053	90%	1.06	3,867
	Recycling	1,461	57%	1.06	883
	Water Heaters	-138	100%	1.06	-147
	Lawn Equipment	0	90%	1.06	0
	Advanced Power Strips	111	100%	1.06	118
	MWh Total	**125,476**	**57%**	**1.06**	**75,912**

Resource	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
kW	Lighting	20,686	55%	1.08	12,259
	Heat Pump Pool Heaters	0	97%	1.08	0
	Pool Covers	0	90%	1.08	0
	Thermostats	0	77%	1.08	0
	Appliances	656	90%	1.08	636
	Recycling	221	57%	1.08	136
	Water Heaters	-15	100%	1.08	-16
	Lawn Equipment	0	90%	1.08	0
	Advanced Power Strips	12	100%	1.08	13
	kW Total	**21,560**	**56%**	**1.08**	**13,027**

Appendix D- 3: Home Comfort Ex-Post Net Data for Cost Effectiveness

Resource	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
MMBtu	Ductless Mini-splits	96,641	91%	1.00	88,079
	Ducted Air-source Heat Pumps	85,178	91%	1.00	77,631
	Geothermal Heat Pumps	6,577	100%	1.00	6,577
	Smart Thermostats	98	90%	1.00	88
	Heat Pump Water Heaters	1,202	100%	1.00	1,205
	MMBtu Total	**188,908**			**173,579**
MWh	Ductless Mini-splits	(13,981)	91%	1.06	(13,508)
	Ducted Air-source Heat Pumps	(7,651)	91%	1.06	(7,392)
	Geothermal Heat Pumps	(450)	100%	1.06	(477)
	Smart Thermostats	29	90%	1.06	27
	Heat Pump Water Heaters	(59)	100%	1.06	(62)
	MWh Total	**(22,110)**			**(21,412)**
kW	Ductless Mini-splits	180	91%	1.08	177
	Ducted Air-source Heat Pumps	237	91%	1.08	233
	Geothermal Heat Pumps	113	100%	1.08	122
	Smart Thermostats	-	90%	1.08	-
	Heat Pump Water Heaters	(7)	100%	1.08	(7)
	kW Total	**526**			**524**

Appendix D- 4: Home Performance Ex-Post Net Data for Cost Effectiveness

Resource	Ex-Post Gross Savings	NTG	Line Loss Factor	Ex Post Net Savings
MMBtu	32,372	74%	1.00	25,811
MWh	378	74%	1.06	301
kW	2,038	74%	1.08	1,633

Appendix D- 5: REAP Ex-Post Net Data for Cost Effectiveness

Resource	Ex-Post Gross Savings	NTG	Line Loss Factor	Ex Post Net
MMBtu	7,466	100%	1.00	7,466
MWh	448	100%	1.06	475
kW	57	100%	1.08	61

Appendix D- 6: HEM Ex-Post Net Data for Cost Effectiveness

Resource	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
MMBtu	HER	126,552	100%	1.00	126,552
MWh	HER	37,090	100%	1.06	39,320
kW	HER	8,697	100%	1.08	9,370

Appendix D- 7: AEH Ex-Post Net Data for Cost Effectiveness

Resource	Measure	Ex-Post Gross Savings	Net-to-Gross Ratio	Line Loss Factor	Ex-Post Net
MMBtu	Lighting	34.3	55%	1.00	18.9
	Heat Pump	337.8	91%	1.00	307.8
	Appliances	4.6	90%	1.00	4.1
	Cooking	5.6	90%	1.00	5.0
	Thermostats	4.3	77%	1.00	3.3
	HPWH	37.3	100%	1.00	37.4
	Lawn	0.1	90%	1.00	0.1
	MMBtu Total	**423.9**			**376.6**
MWh	Lighting	10,051.8	55%	1.06	5,860.8
	Heat Pump	(22,300.8)	91%	1.06	(21,544.3)
	Appliances	604.3	90%	1.06	576.6
	Cooking	(780.0)	90%	1.06	(744.2)
	Thermostats	1,251.9	77%	1.06	1,021.9
	HPWH	(2,476.3)	100%	1.06	(2,631.5)
	Lawn	(10.8)	90%	1.06	(10.3)
	kWh Total	**(13,659.8)**			**(17,470.9)**
kW	Lighting	1.90	55%	1.08	1.12
	Heat Pump	3.18	91%	1.08	3.12
	Appliances	0.13	90%	1.08	0.13
	Cooking	-	90%	1.08	-
	Thermostats	-	77%	1.08	-
	HPWH	(0.25)	100%	1.08	(0.27)
	Lawn	-	90%	1.08	-
	kW Total	**4.96**			**4.11**