REPORT

# 2020 Annual Evaluation Report – Volume I Portfolio Summary

Prepared for PSEG-LI

By Demand Side Analytics Evaluation Team

June 2021

# TABLE OF CONTENTS


1 Introduction ........ 1

2 Energy Savings and Performance ........ 5

3 Cost-Effectiveness ........ 10

3.1 Cost-effectiveness Results ........ 11
3.2 Sensitivity Analysis ........ 14
3.3 2020 Expenditure Summary ........ 15
3.4 Economic Impacts ........ 16

4 Process Evaluation ........ 18

5 COVID-19 Pandemic Effects ........ 22

6 Upcoming Changes in Energy efficiency and Beneficial Electrification ........ 24

6.1 Future of Lighting Measures ........ 25
6.2 Software-Based Measures ........ 26
6.3 Emphasis on Disadvantaged Communities ........ 26
6.4 Beneficial Electrification Challenges and Opportunities ........ 26

6.4.1 Economics of Electrification ........ 26
6.4.2 Heat Pump Technology ........ 27
6.4.3 Battery Storage ........ 27
6.4.4 Electric Vehicles ........ 28

6.5 Conclusions ........ 28

Appendix A: Abbreviations ........ 29

Appendix B: Electricity Energy (kWh) and Demand Savings (kW) ........ 30

Appendix C: Additional Cost-Effectiveness Perspectives and Metrics ........ 32

## Figures

Figure 1: Annual Evaluation Data Flow ........ vi

Figure 2: Energy Efficiency Cycle, Objectives, and Key Terms ........ 3

Figure 3: Portfolio MMBtu Savings ........ 6

Figure 4: Portfolio Performance Metrics ........ 6

Figure 5: Societal Cost Test Ratios by Program ........ 13

Figure 6: Portfolio Net Present Value Benefit and Cost Shares by Category ........ 14

Figure 7: Efficiency Portfolio SCT Ratio Sensitivity to +/-50% Changes in Costs & Benefits ........ 15

Figure 8: 2020 PSEG Long Island Expenditures for the Energy Efficiency and Beneficial Electrification Portfolio ........ 16

Figure 9: Ex-Ante Gross Savings versus Goal by Month and Sector ........ 22

Figure 10: LED Market Share (2015-2020) ........ 25

## Tables

Table 1: Energy Efficiency and Beneficial Electrification Program Descriptions ........ 3

Table 2: Summary of 2020 Energy Program Performance ........ 5

Table 3: Summary of Differences between Ex-Ante and Ex-Post Savings ........ 7

Table 4: Societal Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio ........ 12

Table 5: Economic Impact of 2020 Energy Efficiency and Beneficial Electrification Portfolio Investments ........ 17

Table 6: Process Evaluation Findings and Recommendations ........ 19

Table 7: Total Energy Efficiency and Beneficial Electrification Program MWh Impacts ........ 31

Table 8: Total Energy Efficiency and Beneficial Electrification Program kW impacts ........ 31

Table 9: Utility Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio ........ 33

Table 10: Ratepayer Impact Test Results for Energy Efficiency and Beneficial Electrification Portfolio . 34

Table 11: First Year Costs for Energy Efficiency and Beneficial Electrification Portfolio ........ 34

Table 12: Levelized Costs for Energy Efficiency and Beneficial Electrification Portfolio ........ 35

## GLOSSARY

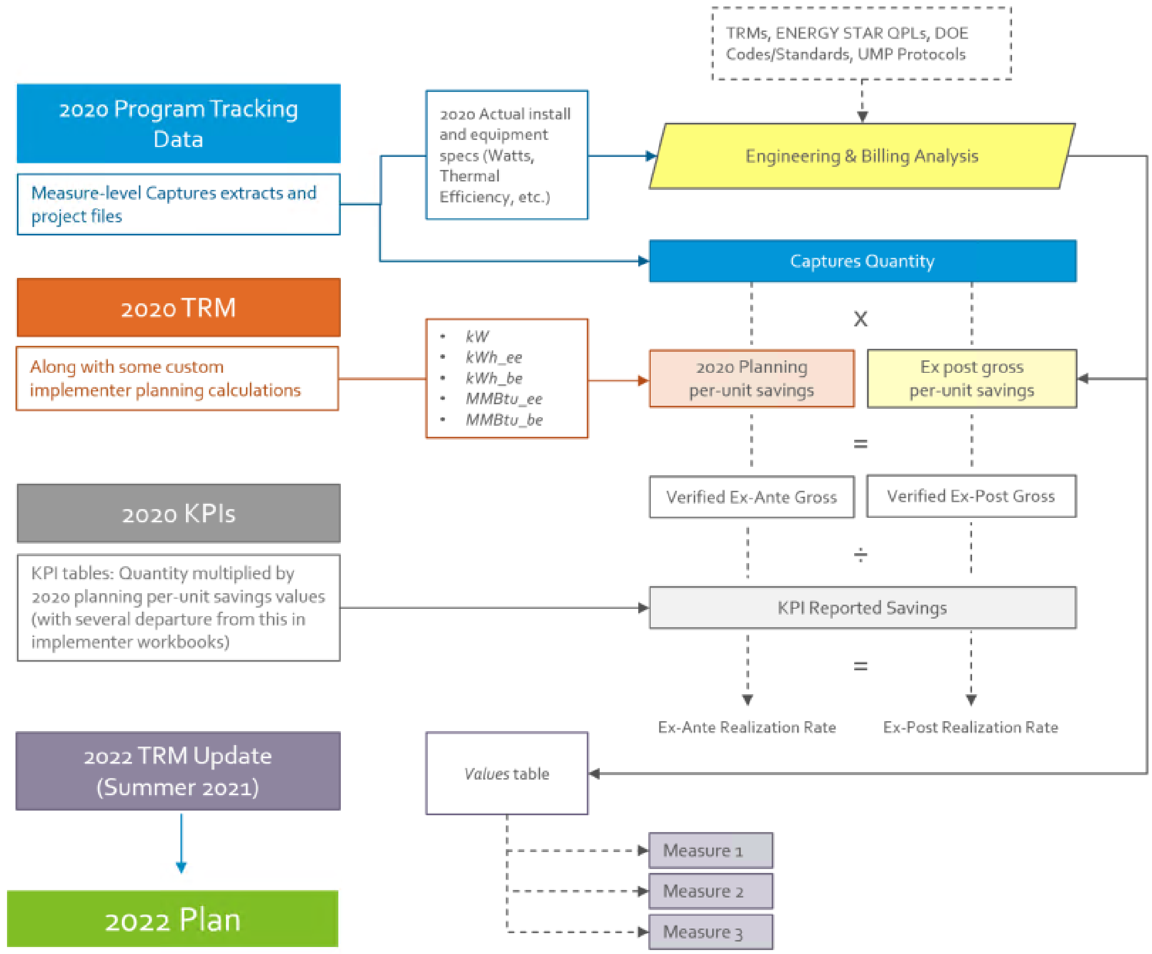
| Key Term | Definition |
|---|---|
| **Delta kWh** | The total change in annual electric energy consumption. Equal to $kWh_{ee} - kWh_{be}$. A negative value of Delta kWh indicates the measure or program increases electric consumption on the PSEG Long Island system as a whole. A positive value of Delta kWh indicates the measure or program reduces electric consumption on the PSEG Long Island system. |
| **Discount Rate** | The time value of money is used to calculate the present value of future benefits and costs. PSEG Long Island uses a weighted average cost of capital supplied by LIPA that represents the cost of borrowing to build additional capacity to meet the service territory's future supply needs. Based on these factors, we used a nominal discount rate of 6.16% in the 2020 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. |
| **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. Ex-post net savings also include line losses. The evaluation team uses the ex-post net impacts in the cost-effectiveness calculation to reflect the current best industry practices. |
| **Gross Impacts** | The change in energy consumption or demand directly due to the participants' program-related actions, regardless of why they participated. These impacts include coincidence factors (CFs) for demand, waste-heat factors, and installation rates. Gross impacts presented in this report do not include line losses and, therefore, represent the energy and demand savings as would be measured at the customers' meters. |
| **kW (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. |
| **kWh Beneficial Electrification ($kWh_{be}$)** | The increase in weather-normalized annual electric energy consumption attributable to beneficial electrification measures. |
| **kWh Energy Efficiency ($kWh_{ee}$)** | The reduction in weather-normalized annual electric energy consumption attributable to energy efficiency programs or measures. |

| Key Term | Definition |
|---|---|
| **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 $kW/year. |
| **Levelized Cost of Energy** | The equivalent cost of energy (kWh) over the life of the equipment that yields the same present value of costs, using a nominal discount rate of 6.16%. The levelized cost of energy is a measure of the program administrator's program costs in a form that planners can compare to the cost of supply additions. |
| **Line Loss Factor** | The evaluation team applies line losses of 6.0% on energy consumption (resulting in a multiplier of 1.0638 = [1 ÷ (1 – 0.060)]) and of 8.5% on peak demand (resulting in a multiplier of 1.0929 = [1 ÷ (1 – 0.085)]) to estimate energy and demand savings at the power plant. |
| **MMBtu Beneficial Electrification ($MMBtu_{be}$)** | For fuel-switching measures, the reduction in site-level fossil fuel consumption minus the site level increase in the electric consumption ($kWh_{be}$) converted to MMBtu at 0.003412 MMBtu per kWh. |
| **MMBtu Energy Efficiency ($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 $kWh_{ee}$ impacts by a static 0.003412 MMBtu per kWh 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. |
| **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 |

| Key Term | Definition |
| --- | --- |
| | Uplight on behalf of PSEG Long Island. TRC and its subcontractors implement the remainder of the portfolio. |
| **Societal Cost Test (SCT)** | A test that measures an energy efficiency 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** | The primary performance metric for 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 energy. |
| **Utility Cost Test (UCT)** | A test that measures the net costs of an energy efficiency program as a resource option, based on the costs that the program administrator incurs (including incentive costs) and excluding any net costs incurred by the participant. To allow for direct comparison with PSEG Long Island's assessment of all supply-side options and consistent with previous evaluation reports, we 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. |

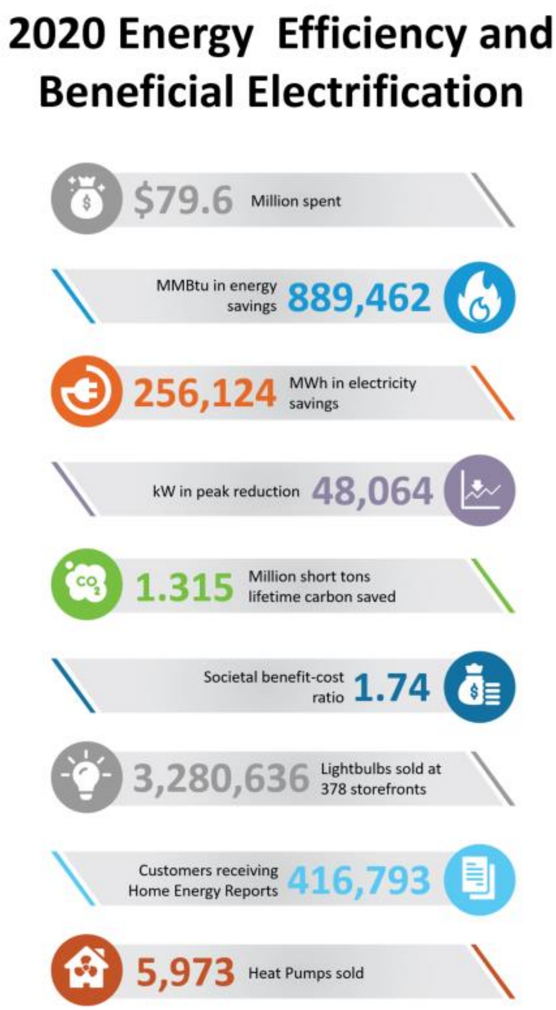
Figure 1 outlines annual programming processes and the resources that inform planning, verified ex-ante, and verified ex-post assumptions. It is important to note that the feedback loop is a nearly two-year cycle. The findings and recommendations of this 2020 impact evaluation will be reflected in 2022 planning assumptions, goal setting, and ex-ante savings values but PSEG Long Island has already established 2021 goals and planning assumptions.

Figure 1: Annual Evaluation Data Flow



# 1 INTRODUCTION

PSEG Long Island's Energy Efficiency programs make a wide array of incentives, rebates, and programs available to PSEG Long Island residential and commercial customers to assist them in reducing their energy usage and thereby lowering their energy bills. The Energy Efficiency and Beneficial Electrification Portfolio is administered by PSEG Long Island and its subcontractor, TRC, on behalf of the Long Island Power Authority (LIPA). The sole exception is the residential behavioral program, Home Energy Management (HEM), which is administered by Uplight. This report presents the 2020 Energy Efficiency and Beneficial Electrification Portfolio program evaluation results and covers the period from January 1, 2020, to December 31, 2020.




The Demand Side Analytics evaluation team produced two volumes that together compose the entire Annual Evaluation Report. This document, the 2020 Annual Evaluation Report (Volume I), provides an overview of the portfolio-level evaluation findings. The 2020 Program Guidance Document (Volume II) provides detailed program-by-program impact analysis results, process evaluation findings, and a discussion of data collection and analytic methods.

For 2020, PSEG Long Island spent $79.6 million implementing the Energy Efficiency and Beneficial Electrification Portfolio. The investment led to 889,462 of total MMBtu savings and avoided 1.315 million short tons of $CO_2$ emissions – the equivalent of removing 255,000 combustion engine cars for a year.[1] PSEG Long Island's efforts led to $55 million in net societal benefits, with a societal benefit cost ratio of 1.74. Overall, the 2020 activities reduced the Long Island's electricity use by 1.27% and peak demand by 0.91%.

As part of its overall goal of reducing GHG emissions by 40% by 2030, New York set new statewide energy efficiency targets as part of its New Efficiency New York (NENY) Order in 2018. The New York goals establish savings targets on an energy (Btu) basis for New York State as a whole and Long Island. By laying out these targets, New York established fuel-

[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

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:

- **Included beneficial electrification measures in its offerings**. PSEG Long Island expanded 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.
- **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 0.003412 MMBtu per kWh - the thermal efficiency of the electric power generation fleet does not affect the calculations. The lack of algorithms tailored for MMBtu was a key challenge in planning for 2020. Many of the changes had to be built from the bottom up in short time. The transition was overall quite successful, and most of the variation between ex-ante and ex-post evaluated savings are attributable to this fundamental shift in resource accounting.

PSEG Long Island was the first utility in New York to shift to a MMBtu performance metric and one of the first utilities in the U.S. to do so. The shift placed beneficial electrification on par with energy efficiency. When 2020 activities were planned, guidance documents and algorithms were not available to PSEG Long Island.

Energy efficiency programs undergo a yearly cycle including planning, implementation, audit and verifications, evaluation, and cost-effectiveness. At each stage, the term "energy savings" is used, leading to the need to be precise about the type of savings. Figure 2 below shows the energy efficiency cycle, the main objectives at each step, and the key terms. Because energy efficiency has a unique lexicon, we include a comprehensive glossary with definitions immediately after the Table of Contents and encourage readers who are less familiar with the key terms to review them.

The planning activities for 2020 were conducted in 2019 and set the goals, rules, and algorithms for calculating energy savings. Because PSEG Long Island was the first utility to shift to a MMBtu performance metric, in 2019, statewide guidance documents for MMBtu impacts did not exist. On its own, PSEG Long Island developed the algorithms and assumptions required to estimate the MMBtu resource impacts of energy efficiency and beneficial electrification. The shift in metrics required PSEG Long Island to change it planning, tracking, and reporting infrastructure, and update its key performance indicators. The 2020 activities were evaluated nearly two years after planning occurred.

Figure 2: 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 2019**: Planning for 2020 using draft 2020 TRM assumptions. | • **2020**: Portfolio Programs implemented | • **January 2021**: Verified Ex-Ante Savings Calculated using assumptions from 2019 | • **Spring 2021**: Ex-Post evaluation of 2020 portfolio using most up-to-date methods (including PSEG-LI TRMs 2019-2021, NYS TRMs v7 and v8) | • **Spring 2021**: Using Ex-Post Net evaluation values |
| **Key terms** | • Planned Savings<br>• Technical Resource Manual (TRM) | • Gross Ex-ante Savings (Claimed Savings) | • Verified Ex-Ante Savings | • Ex-post Gross Savings<br>• Ex-Post Net Savings<br>• Realization Rate<br>• Net-to-Gross Ratio (NTGR) | • Societal Cost Test (SCT)<br>• Utility Cost Test (UCT)<br>• Levelized Cost of Energy<br>• Levelized Cost of Capacity |

A notable event in 2020 was the COVID-19 pandemic. It affected all aspects of life during 2020 and PSEG Long Island's energy efficiency and beneficial electrification portfolio was no exception. New York was among the country's hardest hit areas during the first wave of the pandemic in spring 2020 and the state was under comprehensive stay-at-home orders for several months. In March, PSEG Long Island paused all residential and commercial onsite work and did not resume any onsite activities until the summer. Implementation contractors were forced to adapt program processes to accommodate virtual audits and inspections. Despite the significant disruptions to program delivery, PSEG Long Island showed strong performance compared to goals.

In 2020, PSEG Long Island administered six programs, described in Table 1.

Table 1: Energy Efficiency and Beneficial Electrification Program Descriptions

| Program | Description |
|---|---|
| Commercial Efficiency Program | The program assists non-residential customers in saving energy by offering customers rebates and incentives to install energy conservation measures as well as beneficial electrification measures. In addition, Technical Assistance rebates are available under the CEP to offset the cost of engineering and design services for qualifying projects. |
| Energy Efficient Products (Residential) | 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 in 2020 such as Battery-Operated |

| Program | Description |
|---|---|
| | Lawn Equipment. The program supports the stocking, sale, and promotion of efficient residential products at retail locations. |
| **Home Energy Management (Residential)** | 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 (Residential)** | The Residential "Home Comfort" HVAC program, formerly the Cool Homes Program, aims to reduce the energy usage of residential customers with heat pumps. The program seeks to influence PSEG Long Island customers to make high-efficiency choices when purchasing and installing ENERGY STAR ducted air-source heat pumps (ASHP), ductless mini split heat pumps, and ground source heat pumps (GSHP). Using a single application for all measures (heat pumps and weatherization), the Program seeks to promote Whole House solutions. The program has established strong business partnerships with heating and cooling contractors, manufacturers, and program support contractors. |
| **Home Performance (Residential)** | The program 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 customers who utilize gas, oil, or propane as a primary heat source. The Home Performance Direct Install targets customers with electric heating and includes an energy assessment and select free efficiency upgrades. After the free direct install measures are delivered, customers receive a free home energy assessment and are eligible for HPwES rebates. |
| **Residential Energy Affordability Partnership (Residential)** | 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. |

The remainder of the portfolio report presents the results and key findings. Section 2 summarizes the energy savings and performance. Section 3 presents the portfolio cost-effectiveness and economic impacts. Section 4 presents the executive summary of the Process Evaluation. Section 5 discusses the effects of the COVID-19 pandemic on program implementation and evaluation.  Finally, Section 6 outlines upcoming changes in beneficial electrification and energy efficiency planning considerations.

# 2 ENERGY SAVINGS AND PERFORMANCE

Table 2 compares planned, claimed, verified, and ex-post gross and net savings under the primary performance metric, MMBtu. A few observations stand out. The claimed and verified ex-ante values exceeded planning targets. Implementation contractor performance is best judged using 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. However, the goals, rules, and algorithms for calculating energy savings were developing in spring of 2019, during the infancy of MMBtu goals in New York, and before the 2019 evaluation results were available. The ex-post evaluation results are lower, 86% of the goal, because of a small number of overstated planning assumptions that PSEG has since identified and updated.

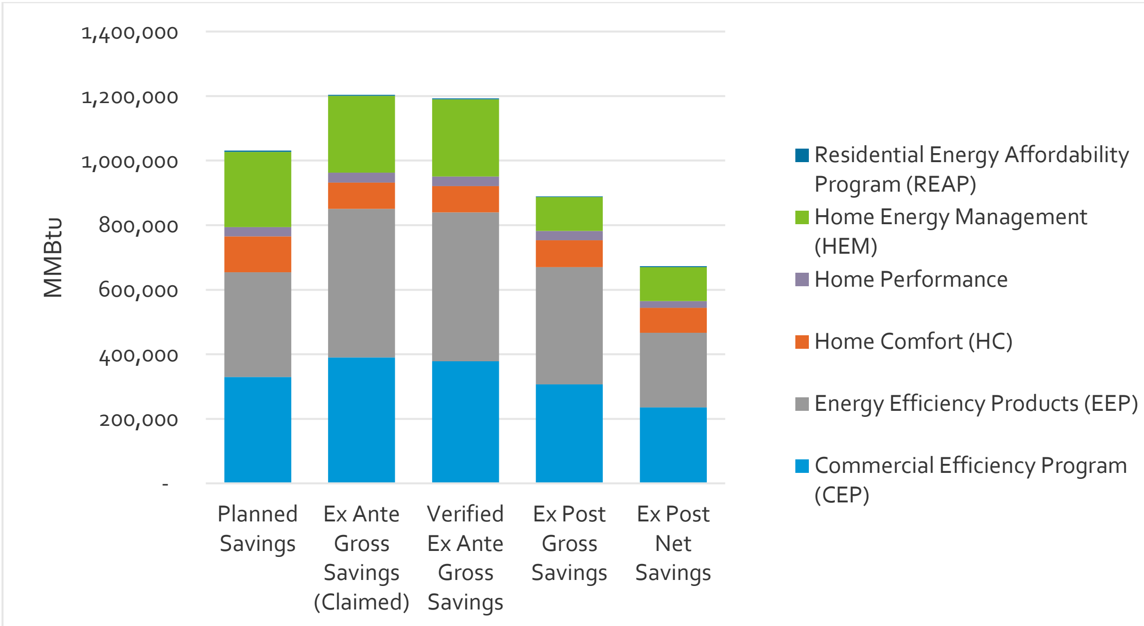
Table 2: Summary of 2020 Energy Program Performance

| Sector | Program | Planned Savings (Goals) | Ex-Ante Gross Savings (Claimed) | Verified Ex-Ante Gross Savings | Ex-Post Gross Savings (Evaluated) | Ex-Post Net Savings |
|---|---|---|---|---|---|---|
| | | MMBtu | MMBtu | MMBtu | MMBtu | MMBtu |
| Commercial | Commercial Efficiency Program (CEP)[1] | 329,232 | 390,069 | 378,438 | 306,343 | 235,044 |
| Residential | Energy Efficiency Products (EEP) | 324,990 | 460,988 | 461,136 | 363,522 | 231,890 |
| | Home Comfort (HC) | 111,021 | 81,264 | 81,266 | 83,487 | 76,546 |
| | Home Performance | 28,387 | 30,247 | 30,260 | 28,329 | 21,259 |
| | Home Energy Management (HEM) | 233,883 | 238,507 | 238,507 | 105,204 | 105,204 |
| | Residential Energy Affordability Program (REAP) | 3,903 | 3,038 | 3,048 | 2,577 | 2,577 |
| | **Subtotal Commercial**: | 329,232 | 390,069 | 378,438 | 306,343 | 235,044 |
| | **Subtotal Residential:** | 702,184 | 814,044 | 814,217 | 583,119 | 437,476 |
| | **Total Portfolio:** | 1,031,416 | 1,204,113 | 1,192,655 | 889,462 | 672,520 |

[1] CEP includes a fuel cell project initiated in 2019 before PSEG Long Island ended support of on-site generation projects. Planned and ex-ante savings for the fuel cell project reflect a simple conversion of electricity produced to MMBtu at 0.003412 MMBtu per kWh. Ex-post savings take into account the increased natural gas use at the facility and the heat rate of the grid and represent the total MMBtu impact "at source". The ex-ante gross savings for the fuel cell project was 49,031 MMBtu and the ex-post gross savings was 55,732 MMBtu (realization rate = 114%). For all other measures in Table 2, the MMBtu savings are "at site"

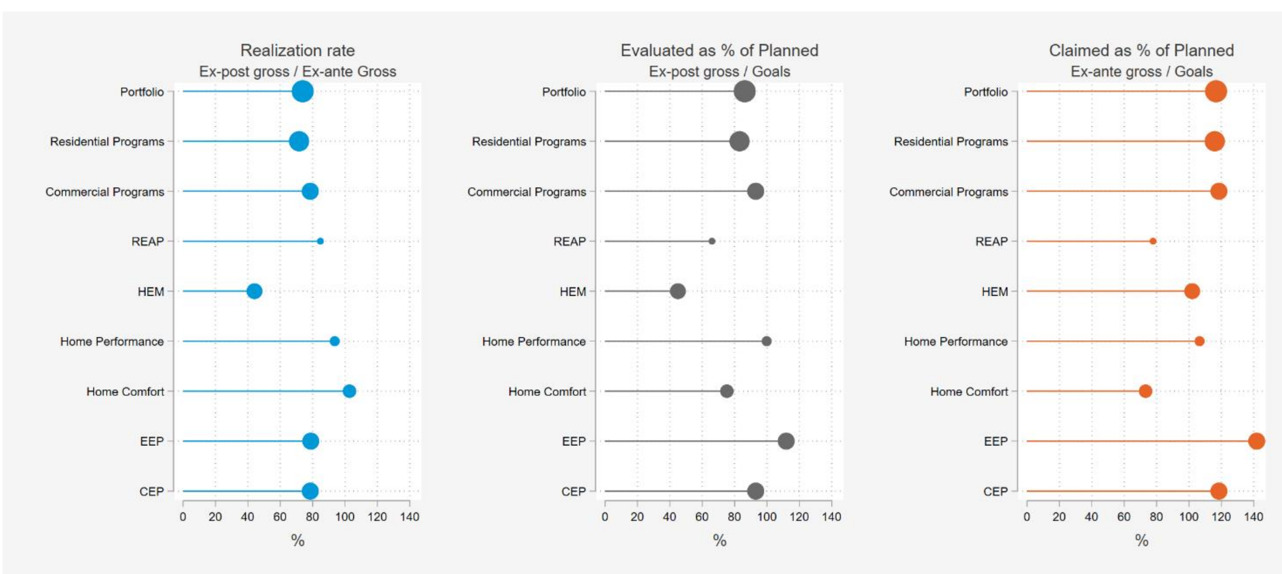
Figure 3 and Figure 4 visualize the program performance. Because the goals are based on MMBtu gross savings, the appropriate comparisons are between MMBtu planned, claimed, and evaluated gross savings. Appendix B below provides the energy (MWh) and demand (kW) savings to facilitate comparison with prior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

Figure 3: Portfolio MMBtu Savings




The ex-post results are driven by a handful of measures in the three most prominent programs, Energy Efficient Product (EEP), Commercial Efficiency Program (CEP), and Home Energy Management (HEM), which were identified and resolved in advance of the evaluation report. Figure 4 visualizes how evaluated results compare to claimed savings (the Realization Rate), how evaluated savings compare to planned savings, and how claimed savings compare to planned savings. The size of the circle in the plots is scaled based on the goals for the program.

Figure 4: Portfolio Performance Metrics



As Figure 4 shows, the biggest driver of the gap between claimed and ex-post gross savings are the results for the behavioral program, HEM. The HEM program was a relatively new offering when planning for 2020 occurred in spring of 2019. At the time, PSEG Long Island assumed savings would mature to 1.5% of household annual energy use, consistent with other utilities in the area. The 2019 evaluation indicated the savings were lower than expected, 0.7% of annual consumption, but by the time the evaluation results were available, the 2020 program year planning assumptions had been cemented nine months earlier. For EEP, the main driver for differences between claimed and ex-post evaluated results are heat pump pool heaters, a new electrification measure at the time. For CEP, the gap between claimed and ex-post gross (evaluated) saving is the application of waste heat factors, an issue arising due to the shift from electricity (MWh) and peak demand (kW) metrics to MMBtu.

Table 3 summarizes the primary reasons as to why portfolio ex-post gross (evaluated) savings departed from the planned and claimed savings. These five items almost entirely account for the 314,651 MMBtu difference between ex-ante gross and ex-post gross portfolio savings shown in Table 2. As noted earlier, the change in the primary performance metric from electric energy (kWh) and peak demand (kW) to MMBtu required significant modifications to PSEG Long Island's planning, tracking, and reporting infrastructure. Except for HEM, most of the differences between claimed and evaluated savings for EEP and CEP are linked to the transition to the MMBtu metric and were identified and resolved in advance of the evaluation.

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

| Portfolio Component | Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings | Summary of Savings Difference |
|---|---|---|
| **Home Energy Management** | ▪ Ex-post gross < ex-ante gross<br>▪ 133,303 MMBtu difference<br>▪ 44.1% realization rate | ▪ In planning, PSEG Long Island assumed saving would mature to 1.5% of household annual energy use.<br>▪ Ex-post savings were 0.7% of annual consumption, consistent with the 2019 evaluation results, and lower than most behavioral programs.<br>▪ 2020 planning assumptions were established before the 2019 evaluation results were available. 2021 planning assumptions assume a reduced per-home savings for HEM. |
| **CEP Comprehensive and Fast Track Lighting Calculations** | ▪ Ex-post gross < ex-ante gross<br>▪ ~ 90,000 MMBtu<br>▪ Primary driver of 71% MMBtu realization rate | ▪ LED lighting equipment produces less waste heat than traditional lighting technologies. These HVAC interactive effects reduce cooling load in the summer and increase heating consumption in the winter. |

| Portfolio Component | Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings | Summary of Savings Difference |
|---|---|---|
| | | ▪ The ex-ante savings calculations account for waste heat impacts on cooling consumption and electric heating systems, but do not account for increased fossil fuel heating consumption.<br>▪ Our ex-post savings calculations leverage the HVAC interactive assumptions developed by the evaluation team to estimate the fossil fuel heating increases and incorporate these increases into the final MMBtu totals.<br>▪ Fossil fuel interactive effects were not included in the 2020 PSEG Long Island TRM or 2020 planning assumptions, so this variance only appears in the ex-post results and not the verified ex-ante totals. |
| **EEP - Heat Pump Pool Heaters** | ▪ Ex-post gross < ex-ante gross<br>▪ 80,336 MMBtu difference<br>▪ 37% MMBtu realization rate | ▪ In 2020 planning assumptions, electric baseline pool heaters were assumed to deliver ten times more heat to the pool water than the HPPH. Standardizing the algorithm assumptions about heat load lowers the baseline electric use significantly. This variance only appears in the ex-post results and not the verified ex-ante totals.<br>▪ Unless there is a mid-year correction, we expect the 2021 evaluation will show the same variance between ex-ante and ex-post as the 2020 evaluation. The realization rate volatility from this evaluation should lessen considerably in 2022 once planning assumptions are aligned with the PSEG Long Island TRM.<br>▪ Ex-post evaluation results use a federal standard baseline efficiency (82%) for beneficial electrification installations. This change increases the MMBtu savings slightly.<br>▪ The actual efficiency of HPPH rebated in 2020 was higher than planning assumptions (COP = 5.98 versus 5.0). Using the actual efficiency values increases MMBtu savings. |
| **EEP – LED Lighting** | ▪ Ex-post gross < ex-ante gross<br>▪ 20,474 MMBtu difference<br>▪ 93% MMBtu realization rate | ▪ The first-year installation rate assumption of 89% was included in the ex-ante kWh and kW savings formulas but omitted from the MMBtu |

| Portfolio Component | Difference Between Ex-Ante Gross and Ex-Post MMBtu Savings | Summary of Savings Difference |
|---|---|---|
| | | equation. Ex-post savings estimates include the 89% installation rate assumption for MMBtu.<br>▪ The ex-ante MMBtu savings values for in-storage LEDs that were incented in prior years but installed in 2020 do not include a waste heat penalty. Our ex-post savings calculations apply the same waste heat factors to new and in-storage LEDs. |
| **CEP Fuel Cell Project** | ▪ Ex-post gross > ex-ante gross<br>▪ 6,701 MMBtu difference<br>▪ 114% realization rate | ▪ Consistent with state policy, PSEG Long Island no longer sponsors new distributed generation (DG) measures. This project was initiated prior to the change.<br>▪ PSEG Long Island, LIPA, and the CEP implementer had extensive discussions and agreed to claim impacts from any remaining DG projects with a simple conversion of electricity produced to MMBtu at 0.003412 MMBtu per kWh. The evaluation team's approach considers both the increased natural gas consumption at the facility, line losses, and an estimated heat rate for a natural gas power plant (9,413 Btu/kWh) to estimate MMBtu impacts at source. The thermal efficiency of the fuel cell is much better than a marginal generating unit on the downstate New York grid, so the project generates significant MMBtu impacts at source. |

# 3 COST-EFFECTIVENESS

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

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

- Were the 2020 energy efficiency and beneficial electrification activities and investments cost-effective in retrospect?
- How did cost-effectiveness vary by program?
- How sensitive are cost-effectiveness results to key inputs?

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

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

Consistent with PSEG Long Island's Benefit-Cost Analysis (BCA) Handbook, we applied the SCT test as the primary method of determining cost-effectiveness. We also ensured that key assumptions including

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

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

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

Critical drivers of portfolio SCT ratio and net benefit changes in 2020 compared to prior years include:

- **Removal of the non-energy benefit adder**: in 2019, an adder of 15% was applied to all measures to account for non-energy benefits, except for in the residential low-income segment, where a 30% non-energy benefits adder was applied. Following guidance from the New York State Department of Public Service, PSEG Long Island discontinued the approach for the 2020 program year.
- **Reduced realization rates**: The lower realization rates were due in part to corrections in savings calculations related to the transition to the MMBtu savings metric.
- **Expansion of the heat pump measures**: beneficial electrification measures now make up a more substantial portion of the Home Comfort program.
- **Use of retail rates for avoided fuel oil and propane**: Avoided costs should reflect the cost of an avoided marginal unit of energy. For regulated resources such as electricity and natural gas this is the marginal cost is well established as the cost of production. For unregulated resources such as fuel oil or propane, the cost to society is the retail market rate of these fuels. Historically, wholesale prices had been used for these fuels but beginning in 2020 retail market rates are used to ensure consistency with the methodology applied elsewhere in New York.[3] Retail rates are higher than wholesale rates and their use increases waste heat penalties for efficient lighting but also increases benefits for electrification measures.

## 3.1 COST-EFFECTIVENESS RESULTS

Table 4 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 1.18 and 2.35 for Commercial and Residential Energy Efficiency programs, respectively. The full energy efficiency portfolio SCT value is 1.74. From a societal perspective the Energy Efficiency and Beneficial Electrification Portfolio is cost-

---

[3] "Because these fuels are not regulated, retail rates reflect the marginal societal costs". NYSERDA Commercial Baseline Study, Appendix 2, page 12: https://www.nyserda.ny.gov/-/media/Statewide-Commercial-Baseline-Study-Report/NYSERDA-CBS-Appendix-2-Potential-Study.pdf

effective. The Commercial subtotal is close to 1.0 and the Residential program subtotal is well over 1.0 (a benefit/cost ratio greater than 1 indicates that portfolio benefits outweigh costs).

Table 4: 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 | **$58,710** | **$49,563** | **1.18** |
| Residential | Energy Efficient Products | $72,326 | $25,402 | 2.85 |
| | Home Comfort | $36,959 | $13,640 | 2.71 |
| | Residential Energy Affordability Partnership | $725 | $1,534 | 0.47 |
| | Home Performance | $8,025 | $8,315 | 0.97 |
| | Home Energy Management | $3,357 | $2,734 | 1.23 |
| | Total Residential Portfolio: | **$121,392** | **$51,625** | **2.35** |
| | **Total Portfolio[1]:** | ***$180,101*** | ***$103,428*** | ***1.74*** |

[1] Portfolio costs include $2M of advertising that was not allocated to individual programs

Figure 5 shows SCT ratios for each program. Note that the size of markers are proportional to the planned MMBtu savings for each program. The SCT ratio was less than 1.0 for two programs in 2020: REAP and Home Performance, though the reasons for each and the change relative to prior years vary by program. Some key observations are:

- **CEP**: The SCT ratio for CEP is 1.18 in 2020. Because it is close to 1.0, all inputs have the potential to tip the outcome. SCT results for the CEP program are driven substantially by incremental costs which are largely a function of project costs. However, the project costs are high relative to energy savings compared to the rest of the portfolio. These higher costs lead to a lower SCT ratio for CEP compared to other programs. Further, administrative costs are about a quarter of total costs at the portfolio level. Given that energy savings are relatively low compared to the incremental costs for CEP, spreading these costs proportionately to energy savings further reduces the cost effectiveness margin for CEP.
- **EEP:** The SCT ratio for EEP is 2.85 in 2020. The residential energy efficiency portfolio was the most cost-effective program in portfolio. However, it relies heavily on lighting and the role of lighting is expected to diminish as LEDs become the code baseline.
- **Home Comfort**: The SCT ratio for Home Comfort is 2.71 in 2020. The cost effectiveness increased due to the shift to predominantly electrification measures. The economics of Home Comfort, and beneficial electrification measures in general, are sensitive to assumptions about the benefits of avoided emissions and the avoided cost of delivered fuels like oil and propane. The substantial improvement in program cost-effectiveness reflects the increase in fuel avoided due to electrification and the increase in the value placed on avoided delivered fuels. Because the avoided cost is so much higher, electrification of homes with

delivered fuel end uses (oil and propane) are much more cost effective for society than homes with natural gas. Similar economics exist for participants making beneficial electrification offerings more cost-effective and attractive for homes and businesses with delivered fuel. Not surprisingly, most electrification projects in 2020 were for sites with delivered fuels.

- **REAP**: The cost-effectiveness of REAP SCT ratio is 0.47. The SCT ratio dropped mostly due to the removal of the non-energy benefit adder. Notably, cost-ineffectiveness is not unusual for income-qualified programs, which typically are not required to be cost-effective.
- **Home Performance**: The SCT for Home Performance is 0.97 in 2020 despite the removal of the non-energy benefit adder.
- **HEM**: Despite removal of the non-energy benefit adder, the SCT is 1.23 in 2020. Benefits were higher due to the inclusion of peak demand benefits, which were not included in prior years. In addition, implementation costs were about 10% lower in 2020.

Figure 5: Societal Cost Test Ratios by Program

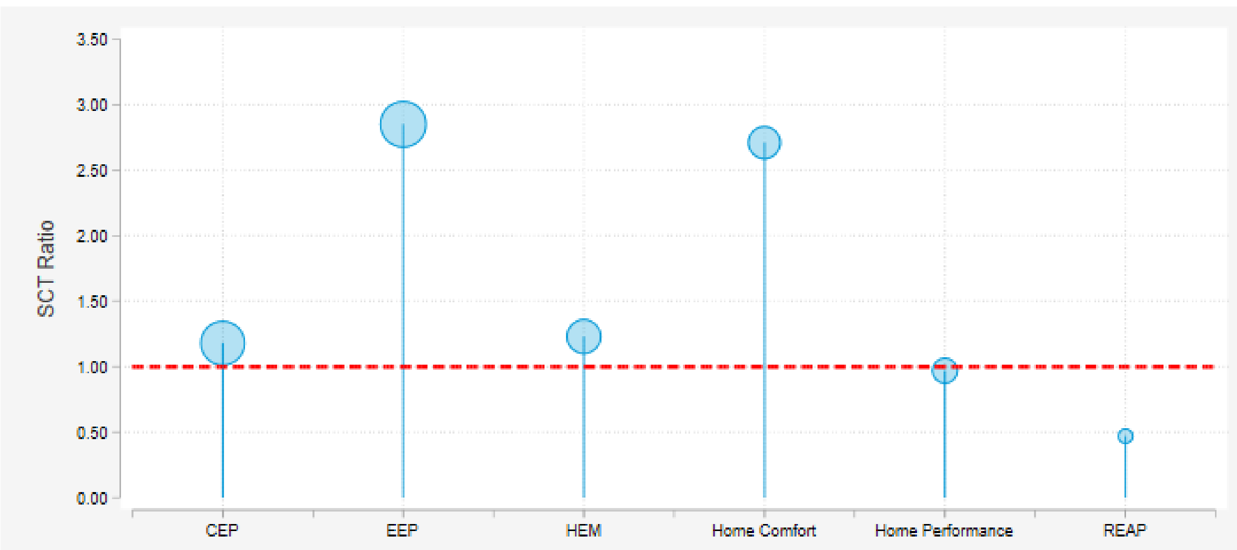
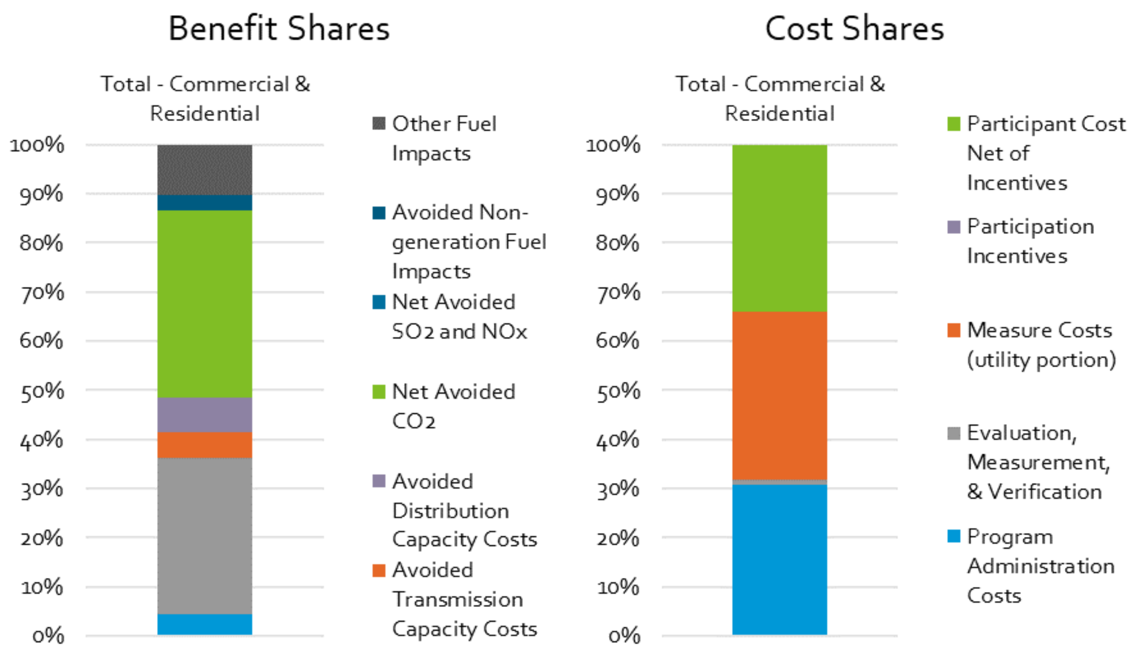



Figure 6 summarizes the benefit and cost categories analyzed and the share each contributed to the SCT. The primary two benefits for the SCT are avoided electric energy (LBMP) at 32% of benefits and avoided carbon emissions at 38% of benefits[4][5]. The combined benefits for capacity (generation, transmission, distribution) together comprise about 19% of societal benefits. From a societal perspective, the largest cost category is the measure costs borne by participants, followed by the measure costs borne by the utility in the form of customer rebates and contractor incentives. Together

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

these two categories comprise the full incremental cost of efficiency measures over baseline measures. Program administration costs, including utility labor, advertising, and implementation vendor fees, comprise about 31% of societal costs.

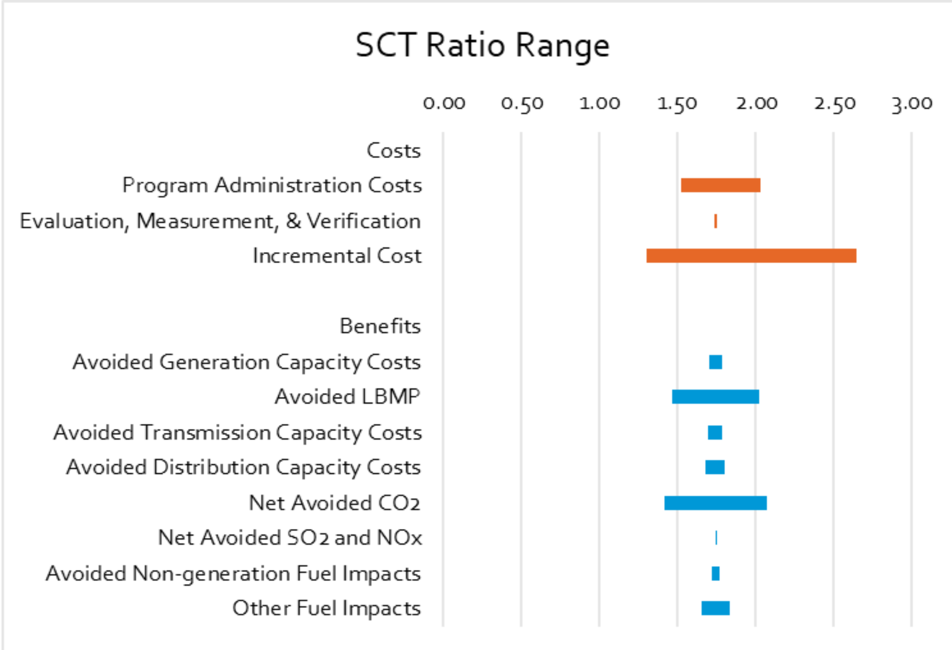
Figure 6: Portfolio Net Present Value Benefit and Cost Shares by Category




## 3.2 SENSITIVITY ANALYSIS

When considering the prospective implications of a cost-effectiveness analysis, it is important to assess how sensitive results may be to assumptions about cost and benefit inputs. Figure 7 shows the range of portfolio SCT ratios when each cost and benefit category is independently varied up and down by 50%. For example, if incremental costs were 50% higher the portfolio SCT would be about 1.3, but if incremental costs are 50% lower, the portfolio SCT ratio would be about 2.6. Similarly, if the avoided cost of carbon was 50% lower, the portfolio SCT would be 1.4, but if avoided carbon costs were 50% higher, the portfolio SCT ratio would be 2.1. The sensitivity analysis demonstrates that cost-effectiveness results are primarily driven by incremental cost assumptions, followed by assumptions regarding avoided electric energy and avoided carbon costs. The finding is logical given that these components comprise the largest shares of costs and benefits, respectively.

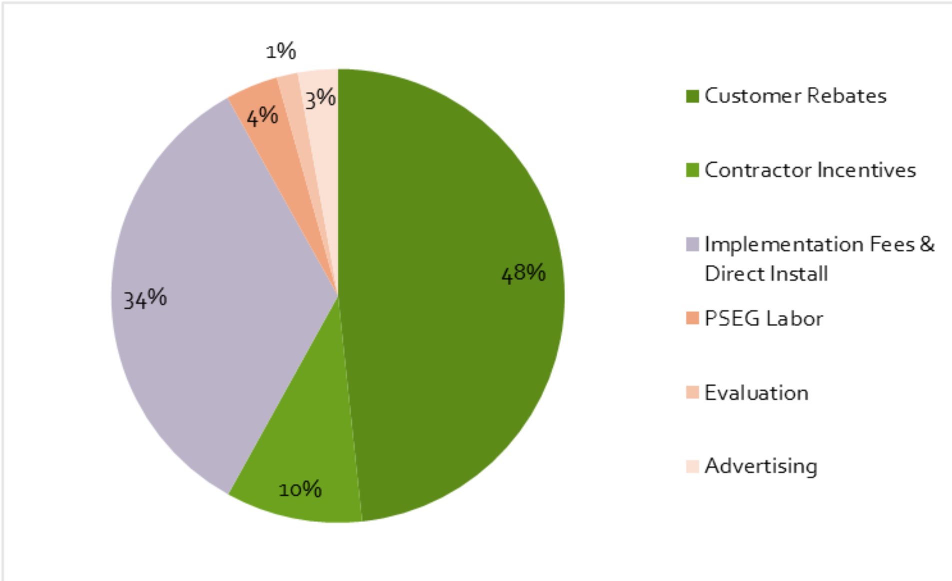
Figure 7: Efficiency Portfolio SCT Ratio Sensitivity to +/-50% Changes in Costs & Benefits




## 3.3 2020 EXPENDITURE SUMMARY

PSEG Long Island spent $79.6 million on the Energy Efficiency and Beneficial Electrification Portfolio in 2020, compared to $74.7 million in 2019. Figure 8 summarizes the $79.6 million in spending related to implementation, management, and evaluation of energy efficiency programs in the 2020 Energy Efficiency and Beneficial Electrification Portfolio by type of expenditure. Customer "Rebates" consists of payments made to participating customers. Customer "Incentives" consists of payments made to participating contractors (e.g., heating, ventilation, and air conditioning (HVAC) installers).

Figure 8: 2020 PSEG Long Island Expenditures for the Energy Efficiency and Beneficial Electrification Portfolio




## 3.4 ECONOMIC IMPACTS

Table 5 summarizes the estimated changes to Long Island's overall economic output and employment resulting from PSEG Long Island's 2020 Energy Efficiency Energy portfolio investments. Over 25 years, the 2020 investments in the Energy Efficiency Portfolio are expected to return $736.2 million in total economic benefits to the regional economy (in 2020 dollars), with an employment benefit of 1,130 new full-time equivalent employees (FTEs)[6] over that time period.

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

Table 5: Economic Impact of 2020 Energy Efficiency and Beneficial Electrification Portfolio Investments

| 2020 Portfolio Investments | | 2020 Economic Impact | 2020-2045 Economic Impact NPV[a] |
|---|---|---|---|
| **Economic Impact** | Total Economic Output | $173.8 | $736.2 |
| | Direct Effects | $148.6 | $148.6 |
| | Indirect & Induced Effects | $25.2 | $587.6 |
| | Employment FTE | 484 | 1,130 |
| **Impact per $1M Investment** | 2020 Program Investment (Millions) | $78.7 | $78.7 |
| | Total Economic Output in Dollars per $1M Investment | $2.21 | $9.36 |
| | Employment (FTE) per $1M Investment | 6.2 | 14.4 |

[a] Using nominal discount rate of 6.11%, based on PSEG Long Island Utility 2.0 filing assumptions.

The effective useful lives of the measures installed in Program Year 2020 generally ranged from five years to 25 years. The notable exception is HEM, which is treated as having a one year EUL. Accordingly, the NPV of economic output of $736.2 equals the present value of participant energy costs savings over 25 years of $562.4 million plus the 2020 economic impact of $173.8 million. A discount rate of 6.11% and an energy price inflation rate of 2.1% were used to calculate the NPV and participant energy costs, respectively and are consistent with PSEG Long Island's assumptions for supply-side planning and the cost-effectiveness analyses.

The net present value of future economic impacts is comprised primarily of participant energy cost savings resulting from installation of energy efficiency measures in Program year 2020. The NPV increased from $142.8 million in 2019 to $736.2 million in 2020 because retail energy prices were used to estimate energy costs savings for 2020 instead of wholesale marginal prices that have been used in previous years. Extending the number of years for the NPV calculation to 25 years to match the effective useful lives of the installed measures also contributed to the increased NPV.

# 4 PROCESS EVALUATION

The process evaluation examined barriers to participation, effectiveness of program delivery, customer satisfaction, and uptake of program measures. As part of the process evaluation, the evaluation team interviewed six program and implementation staff, ten heat pump installers, and eight lighting contractors. Two overarching goals were to examine barriers to heat pump adoption in the residential sector and gain insights into the future of the lighting market in the commercial sector.

The process evaluation objectives include:

- Examine and document current program processes.
- Determine whether processes are followed.
- Assess whether there are opportunities to improve programs.

The process evaluation found that program staff, implementers, and trade allies follow the established processes for both commercial and residential programs. Additionally, the Captures Platform generally works well, but there are opportunities for enhancements like decreasing application loading times, further trainings for contractors to familiarize themselves with the platform, and enhanced queries that can contribute to targeting marketing efforts. Table 6 summarizes the key findings and recommendations.

Table 6: Process Evaluation Findings and Recommendations

| Finding | Recommendation |
|---|---|
| **Lag time:** Feedback from heat pump and lighting contractors indicate that the system for submitting applications is straightforward; however, some contractors indicated that there is lag time with the platform, which can make it difficult to upload application materials. Some contractors asked for the capability to see the status of their projects at a glance through a dashboard, indicating a lack of familiarity with the portal. | ▪ The Captures portal offers value to both Program Administrators (application processing, reporting, QA/QC, and process standardization) and the contractor community. Continue to develop this platform to address contractor complaints regarding portal responsiveness.<br>▪ Consider developing video vignettes or other training materials specifically regarding the benefits offered to contractors by the portal, including the capability to track the progress of individual incentive or rebate applications. |
| **Relationship to trade allies:** Contractor communities across all programs trust PSEG-LI, its programs, and its implementation contractors, which is an achievement. Although all interviewed contractors relayed specific barriers or recommendations for program improvement, an overwhelming majority of contractors spoke about their longstanding, positive, and trusting relationships with PSEG-LI staff and their faith that PSEG-LI and its contractors have the best interest of the market and customers at heart. An overwhelming majority of contractors complimented PSEG-LI's deep relationships within the contractor communities and specifically spoke to PSEG-LI's openness and communication as key strengths in the partnership. | ▪ Although PSEG-LI has built deep, trusting relationships with the contractor community, there are opportunities to improve upon this success and drive increased adoption of underserved market areas. Particularly within the residential market, the current contractor base is dominated by HVAC companies who focus on supplemental systems, which limit opportunities for whole-home programs and water heating measures. We recommend that PSEG-LI and their contractors apply the same relationship- and trust-building methodology to groom a new cadre of solution providers to deliver in these new program areas. |
| **Heat pump education and awareness:** Home Comfort Partners perceive that a lack of customer knowledge on the benefits of heat pumps is preventing increased adoption of the technology. Contractors reflected that barriers to adoption for heat pumps included that customers were unaware of their capabilities, that homeowners were concerned about costs and resiliency during a power outage, and that the reputation of older heat pump technology as ineffective is persistent. | ▪ Continue to develop marketing materials for the PSEG-LI residential marketplace with a focus on expanding program awareness and explaining the benefits of heat pump systems especially compared to fossil-fuel-based technologies. Major heat pump manufacturers – Fujitsu, Mitsubishi, Carrier, and others – already have such education programs in place, and it may be beneficial to partner with these firms to deliver information cost-effectively to the Home Comfort Program's target market.<br>▪ Encourage further use of program-supported educational materials by Home Comfort Partners for more proactive outreach. Most contractors indicated that they receive leads through referrals or word-of-mouth. Given the need to drive beneficial electrification through increased adoption of heat pumps on |

| Finding | Recommendation |
| --- | --- |
| | Long Island, consider marketing approaches that supplement HVAC contractors' traditional referral-based approach to winning work, especially in geographies with a larger footprint of oil and electric resistance heating. This may include efforts such as expanding awareness of the program, the benefits offered by heat pumps, or expanding the availability of co-branded marketing materials for Home Comfort Partners. |
| **Low income marketing of heat pumps:** Seven of the Home Comfort Partners interviewed indicated that they did not actively market to low- to moderate-income (LMI) customers and were not receiving calls from those customers – most respondents stated that their marketing is passive and driven primarily by inbound calls and customer referrals. | ▪ To increase participation from LMI communities, specific LMI marketing and proactive outreach is an option to target this segment and increase participation. Also consider enhanced offerings for LMI customers or strategies to target multifamily buildings for heat pumps. |
| **Heat pumps calculation method:** Although the Home Comfort Program offers enhanced incentives for cold-climate heat pumps, the rebate calculation methodology for partial-house and electric-resistance heating replacement projects promotes the installation of regular (not cold-climate) heat pumps. Several contractors stated that the heating capacity for traditional equipment at 47°F is often significantly greater than cold-climate heat pumps at 17°F and that, as a result, traditional systems were receiving larger incentives than cold-climate heat pumps even with the enhanced rebates. | ▪ The rebate calculations for Home Comfort Program partial-house and electric resistance heating replacement projects were recently re-visited in response to this feedback, and the rebates for ccASHPs were increased as a result. Trade allies might need some additional communication and reinforcement about this update to ensure that the rebate calculations truly align with not only higher efficiency equipment but also minimizing grid impacts. |
| **Financing of heat pumps:** Home Comfort Partners indicate that many customers take advantage of financing through third-party lenders or NYSERDA, but typically do not engage in on-bill recovery loans through NYSERDA's Green Jobs Green New York program, which is perceived as an onerous process. | ▪ Given the prevalence and widespread market adoption of existing financing solutions, the evaluation team does not recommend that PSEG-LI consider additional program-wide financing options. However, a targeted financing intervention may help increase adoption of heat pumps in under-served market segments like LMI, where Home Comfort Partners perceive the high capital cost of heat pumps is a major barrier to lower-income customers. |

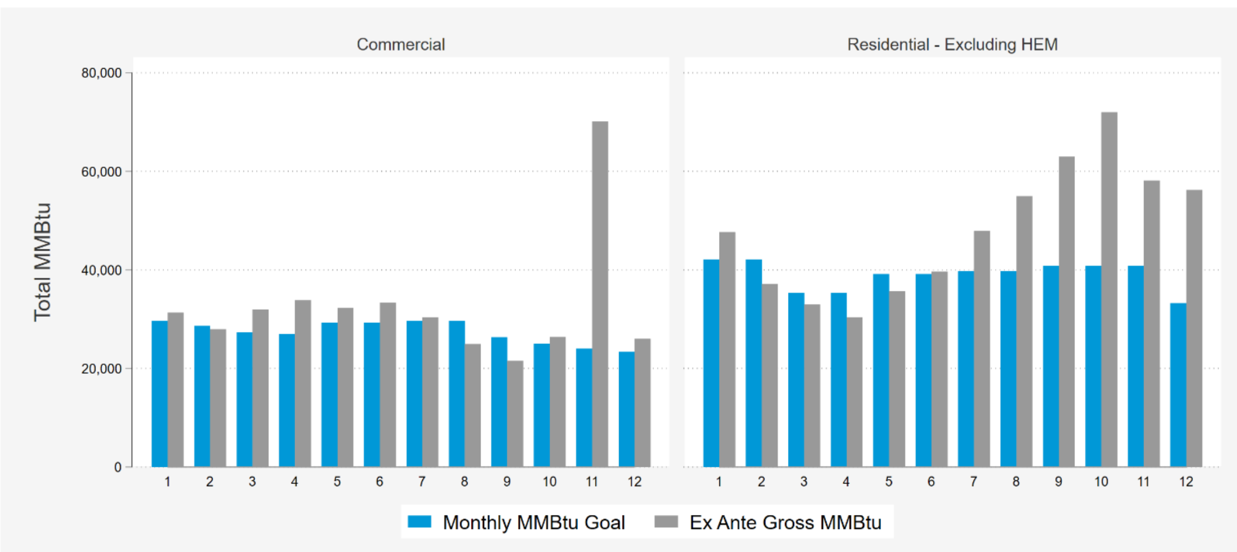
| Finding | Recommendation |
|---|---|
| **Home comfort application process:** A majority of the Home Comfort Partners interviewed stated that the application process is burdensome – several indicated the application process was a major bottleneck to selling and delivering projects in a timely manner at scale. | ▪ Invest in tool improvements for the application process to reduce the overall time required per-application. Explore options to reduce the technical literacy required to complete Manual J calculations, in particular for high-volume, relatively low-cost partial-home projects. |
| **Commercial lighting outlook:** Four of the lighting contractors interviewed see a diminishing market for LEDs on Long Island in the commercial sectors, driven by increased market adoption and the recognized value offered by LEDs over outmoded lighting technologies. Facility owners who have not already transitioned to LEDs are not likely to engage lighting retrofits until their existing equipment reaches the end of its useful life. | ▪ Keep this in mind for planning, as the program starts to target the facility owners who are less inclined to engage in lighting retrofits, then cost of acquisition will start to increase with less opportunity for impacts. |
| **Lighting controls uptake**: Lighting contractors almost uniformly specify lighting controls in project bids, but there is little current customer demand for this type of project outside of warehouses. | ▪ Develop and market educational materials targeted at specific customer segments that explain the benefits of lighting controls and provide case studies that demonstrate how those benefits may be realized at their facility. |
| **Lighting baseline consistency:** Baselines are challenging to establish for lighting replacement projects and may be more complicated for projects that incorporate controls. Several lighting contractors indicated that pre-inspectors are inconsistent in the methodology/processes employed to set baselines across different projects. Additionally, contractors noted that miscommunication about scheduling pre-installation visits or about anticipated incentive values can derail projects eroding trust and leading to missed savings opportunities. | ▪ Standardize program processes around pre-inspection scheduling and baseline determination, especially as the program pivots away from standard LED projects and into additional measures (e.g., controls). The contractor community has stated a preference for dependable, transparent processes over inconsistent timelines, even if those dependable timelines are a bit longer. |

# 5 COVID-19 PANDEMIC EFFECTS

The COVID-19 pandemic affected all aspects of life during 2020 and PSEG Long Island's energy efficiency portfolio was no exception. New York was among the country's hardest hit areas during the first wave of the pandemic in spring 2020 and the state was under comprehensive stay-at-home orders for several months. In March, PSEG Long Island paused all residential and commercial onsite work and did not resume any onsite activities until the summer. Implementation contractors were forced to adapt program processes to accommodate virtual audits and inspections. Trade allies had to pause their work as well and some lost employees or went out of business completely. The implementation team had frequent meetings with trade allies, and some credited PSEG Long Island's programs with helping them stay afloat during an extremely challenging period. Trade allies and customers alike appreciated the commitment to keep the programs moving and rebate dollars flowing when many were struggling. From an evaluation standpoint, measuring savings at the meter in 2020 required the use of control groups, a practice that evaluators will need to continue for the foreseeable future.

Despite the significant disruptions to program delivery, PSEG Long Island showed strong performance compared to goals. Figure 9 compares the ex-ante gross MMBtu savings claims for each month of 2020 to program goals. We exclude the behavioral Home Energy Management (HEM) program from the figure because it does not have monthly goals.

Figure 9: Ex-Ante Gross Savings versus Goal by Month and Sector




We offer the following observations about the trends shown in Figure 9.

- There is a noticeable drop in savings for the residential portfolio during March, April, and May. The drop corresponds to the period when offerings like REAP, Home Performance, and the appliance recycling component of EEP were paused.

- Point-of-sale LED lighting discounts are the most significant offering in PSEG Long Island's residential portfolio, and New York deemed many of the largest retail partners as essential businesses. PSEG Long Island also chose to reintroduce discounts for general service A-lamps in April 2020, which helped the residential portfolio keep pace with and ultimately outperform goals for the year.
- Commercial energy efficiency projects generally have a longer lead time than residential projects, so the effect of the COVID-19 pandemic shows up later in Figure 9 for the commercial portfolio.
- The large spike in November 2020 comes from a 2 MW fuel cell project which closed that month and delivered approximately 50,000 MMBtu.
- Anecdotally, some commercial building operators took advantage of low occupancy during the pandemic to complete retrofit projects. Of course, businesses in affected industries will need to put all available capital into their recovery and may be unable to invest in efficiency or other capital upgrades for some time.

The resumption of traditional PSEG Long Island's program activities will be gradual. Although air sealing projects have resumed, New York state still does not allow blower door testing. We expect a certain amount of program processes will remain virtual/remote rather than in-person based on successes during the pandemic. This could lead to cost savings for PSEG Long Island. The pandemic's long-term effects on the economy, energy use patterns, and customer demand for efficiency are harder to forecast. Many businesses are planning to retain increased work-from-home options indefinitely, which will have implications for load patterns and housing demand on Long Island. Commercial building operators will have a keen interest in air quality and other safety measures, which may generate program opportunities for HVAC measures.

# 6 UPCOMING CHANGES IN ENERGY EFFICIENCY AND BENEFICIAL ELECTRIFICATION

With statewide electrification and decarbonization goals, New York and PSEG Long Island are expected to undergo several changes in planning and operating conditions. PSEG Long Island was the first utility in the state to shift its primary performance metric to MMBtu to align with New York targets. This change created opportunities to pursue Beneficial Electrification measures, which PSEG Long Island incorporated into their 2020 Portfolio through measures such as heat pump pool heaters and electric lawn equipment.

As a result of increasing pursuit of decarbonization and electrification in New York:

- New York is projected to shift from a summer peaking system to a winter peaking system between 2030 and 2040 assuming heating and transportation are electrified.
- A larger mix of Distributed Energy Resources (DERs) such as solar and wind will come online forcing the focus of planning to shift from planning for the gross peak load to planning for the net load peak – the load minus intermittent solar and wind.
- There is the potential for oversupply (where renewable supply is greater than baseload), especially in shoulder months in spring and fall.
- Ramping needs and fast response resources like battery storage will increase because of the intermittent nature of renewable generation.

**ELECTRIFICATION OF THE GRID INFLUENCES:**

- Value of Carbon (increasing)
- Avoided Cost of Electricity (decreasing)
- Lighting (phasing out)
- Heat pumps (ramping up)
- Battery Storage (ramping up)
- Electric Vehicles (ramping up)

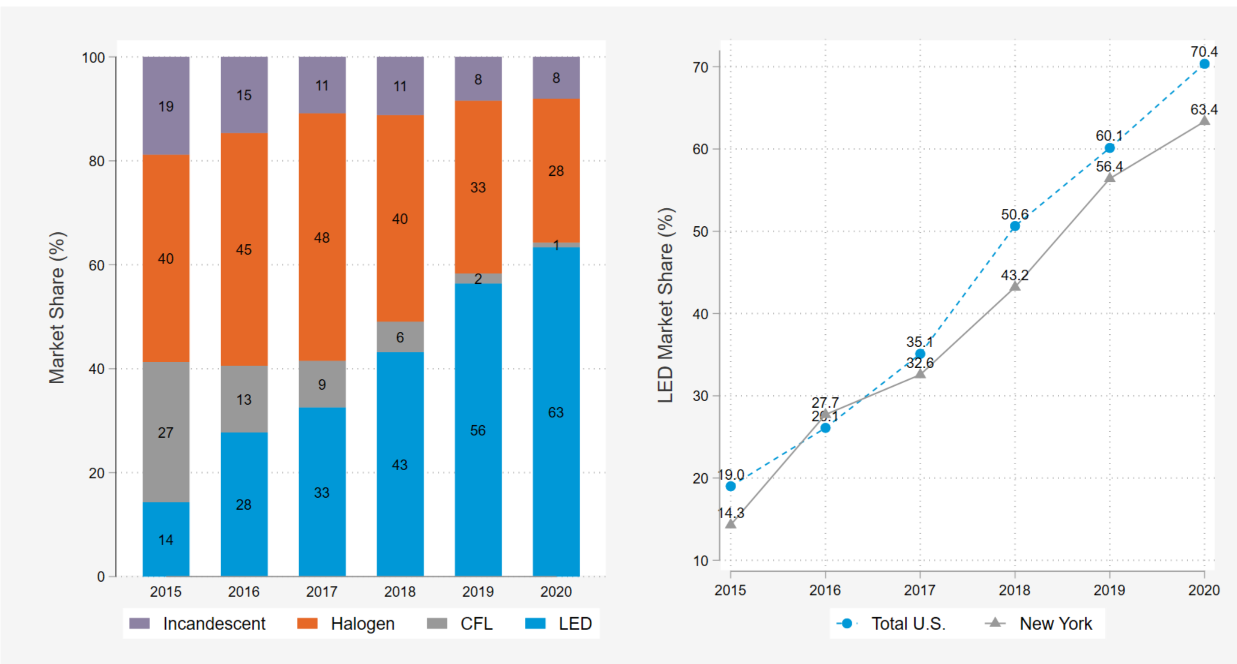
Additionally, we anticipate that the US Department of Energy will propose more stringent codes and standards under the Biden administration, and these changing baselines will reduce the traditional energy efficiency opportunities available to programs. This will require program administrators to be nimble regarding eligible products to ensure the PSEG Long Island portfolio continues to push market transformation.

## 6.1 FUTURE OF LIGHTING MEASURES

One of the largest potential shifts in planning is the eventual phase out of residential and commercial LED lighting measures. Approximately 54% of PSEG Long Island's ex-post gross MMBtu savings in 2020 came from LED lighting measures in homes and businesses. Without the LED lighting component of EEP, the SCT ratio of the PSEG Long Island Portfolio is 1.30 (vs. 1.74). However, the EEP program SCT drops from 2.85 with lighting to 0.92 without lighting indicating that the program would not be cost effective from a societal standpoint without LED lighting measures.

Figure 10 below shows the increasing market share of screw-based LEDs over time. These figures were generated from data collected by the CREED lighting project[7]. The bar chart shows the New York-specific mix of bulb types from 2015 through 2020. Over those years, LED market share increased from 14% to 63%. However, when compared to total US LED market share of 70.4%, New York falls short of the average at 63%. Figure 10 shows that the work of programs like EEP is not done yet, but it is time for PSEG Long Island to start thinking about the exit strategy.

Figure 10: LED Market Share (2015-2020)




It is likely that the Department of Energy will reinstate the Energy Independence and Security Act (EISA) provisions for lighting and phase out non-LED bulbs for certain categories or entirely. Should EISA be reinstated, the point-of-sale lighting component of EEP would likely no longer be viable, and it will be important to prepare for that scenario.

[7] CREED Lighting Tracker: https://www.creedlighttracker.com/

For commercial lighting measures, interviews with commercial lighting contractors indicated that they see a diminishing opportunity for commercial lighting due to increased LED market saturation.

## 6.2 SOFTWARE-BASED MEASURES

There are increasing opportunities for software-based measures such as thermostat optimization, building automation systems, and network lighting controls. Most smart thermostat optimization software aims to provide users with customized weather response that keeps the home comfortable while providing energy savings to the customer. This represents an opportunity for increased grid management control and energy savings, but it also presents an implementation challenge compared to the traditional equipment-based energy efficiency accounting practices. However, as more customer AMI data becomes available, through the expansion of smart thermostats and smart meters, it will give PSEG Long Island the ability to conduct continuous evaluation of various program measures.

## 6.3 EMPHASIS ON DISADVANTAGED COMMUNITIES

New York's Climate Leadership and Community Protection Act (CLCPA) established a goal that 35-40% of benefits of spending on clean energy and energy efficiency programs will go to disadvantaged communities. This goal will be a major factor in shaping future Portfolio planning efforts. PSEG Long Island will have to identify and target these communities and potentially offer higher incentives for those locations.

## 6.4 BENEFICIAL ELECTRIFICATION CHALLENGES AND OPPORTUNITIES

### 6.4.1 ECONOMICS OF ELECTRIFICATION

The economics of electrification are complex. The avoided cost of electricity in New York is low, which is largely a function of low natural gas prices (Henry Hub is trading around $2.50 per MMBtu) and competition from renewables. While this places pressure on the economics of traditional energy efficiency, it can improve the economics of electrification measures. As shown in Figure 6, the value of avoided $CO_2$ emissions is paramount to the benefit-cost results under the SCT perspective. Currently, the $CO_2$ emissions associated with an avoided (or added) kWh are locked in based on the current mix of electricity supply. The current social cost of carbon assumed in the PSEG Long Island Cost Effectiveness evaluation is $60 per short ton. The value of avoided $CO_2$ emissions varies widely. In neighboring Pennsylvania, the 2021 Act 129 Total Resource Cost Test Order[8] directs utilities to set the value at $0. Meanwhile the Avoided Energy Supply Cost Study Group for New England recommended $128 per short ton in their 2021 Avoided Energy Supply Component (AESC[9]) report. The table below shows the recommended value of $128 and results from alternative methods.

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

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

ES-Table 13. Comparison of GHG costs under different approaches (2021 $ per short ton) in Counterfactual #1

| | AESC 2018 | AESC 2021 | Difference | % Difference |
|---|---|---|---|---|
| Social cost of carbon (SCC or "damage cost") at 2% discount rate | Not quantified | $128 | - | - |
| Global marginal abatement cost | $105 | $92 | -$13 | -12% |
| New England-based marginal abatement cost, derived from the electric sector | $72 | $125 | $53 | 75% |
| New England-based marginal abatement cost, derived from multiple sectors | Not calculated | $493 | - | - |

### 6.4.2 Heat Pump Technology

The big push in electrification is the expansion of heat pumps for space heating and cooling, heat pump pool heaters, and heat pump water heaters. Currently, the downstate New York grid is fairly carbon intense with 0.53846 tons of CO2 per MWh[10]. This carbon intensive grid is expected to change rapidly with the Climate Leadership and Community Protection Act (CLPA) 70/30 goals. This sets the goal for New York to source 70% of its electric grid from renewable energy by 2030. As the electric grid becomes cleaner, measures that replace fossil fuel combustion with cleaner and cleaner electricity will be more cost-effective and beneficial from an emissions standpoint.

At some point, with enough heat pumps, in the early 2030's, New York could switch from a summer-peaking system to a winter-peaking system. This would require a host of planning considerations such as assessing coincidence for both winter and summer months in the TRM, and considering the effects of heat pumps on generation, transmission, and distribution capacity requirements.

### 6.4.3 Battery Storage

Increasingly, energy efficiency, battery storage, and demand response are used in T&D planning to avoid, defer, or reduce T&D infrastructure costs. Currently the energy efficiency portfolio does not fund battery storage or EVs. Any efforts to incentivize battery storage would likely be funded by PSEG Long Island's Utility 2.0 program, not through energy efficiency funding.

Behind the meter battery storage in Long Island is increasing. Battery storage is essential to de-carbonization because it allows the use of solar and wind energy during time periods when the sun is not shining, or the wind is not blowing. New York has incentives in place for battery storage and customers are increasingly adopting it, especially at the time of solar installation. Based on PSEG Long Island's interconnection data, roughly 10% of customer installing solar are also adding battery storage.

---

[10] Assumed Marginal Emissions Rate (tons of CO2/MWh) sourced from "Order Adopting a Clean Energy Standard" PDF from NY DPS:
http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=15-e-0302

Unlike other measures, battery storage also provides backup power to customers, which is increasingly beneficial given the increased frequency of severe storms.

Additionally, batteries can help stabilize the grid as more solar and wind resources come online if they can also be used for grid needs. Batteries are effective ramping resources since they can dispatch their stored energy when needed, offsetting the intermittent nature of wind and solar. They also prove beneficial when the system is over-producing and excess energy production needs to be stored.

### 6.4.4 Electric Vehicles

As part of its efforts to decarbonize the transportation sector, New York has set statewide goals for electric vehicle adoption. Based on its share of vehicles (21%), Long Island's share of the goals is 178,500 electric vehicles by 2025.

Electric vehicles have the potential to fundamentally transform the electric grid. As electric vehicle market saturation grows, it will impact all aspects of the electric grid. Additional fast charging stations will need to be installed and loads for households in established neighborhoods will likely grow. There will also be a need for additional research into charging patterns, driving patterns, and the ability to manage the timing of charging. However, the most immediate grid impacts will be highly localized in areas where adoption of electric vehicles is high. When adjacent homes purchase electric vehicles, if left unmanaged, their loads can lead to larger interconnections, upgrades of pad mount and pole top transformers, and upgrades of line sections. Any efforts to incentivize electric vehicles would likely be funded by PSEG Long Island's Utility 2.0 program, not through energy efficiency funding.

## 6.5 CONCLUSIONS

While the focus for the last decade has been on energy efficiency as a low cost, green resource, we anticipate the Long Island portfolio to shift from traditional energy efficiency to heating electrification, transportation electrification, behind the meter storage, and flexible loads to manage distribution and system planning needs. As the LED market becomes saturated, it will be critical to identify cost-effective high potential measures and to evolve delivery channels to align with statewide clean energy goals and targets for electrification. Additionally, targeting disadvantaged communities will be a major factor in shaping future Portfolio planning efforts.

# APPENDIX A: ABBREVIATIONS

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

# APPENDIX B: ELECTRICITY ENERGY (KWH) AND DEMAND SAVINGS (KW)

In 2020, PSEG Long Island's savings goals shifted from gross MWh and MW savings to site-level MMBtu savings. This change comes one year after shifting goals from net savings at the generator to gross savings at the customer's meter. The intent of these changes is alignment with the targets established by the New Efficiency: New York December 2018 Order.[11] Although the primary reporting metric for 2020 evaluation results is on total site-level MMBtu savings for consistency with goals, we also report fuel-specific results for several reasons.

- PSEG Long Island is an electric utility, so the MWh and MW impacts of the Portfolio have discrete implications for a host of forecasting and system planning functions.
- Consistency with prior reports. We believe it is important for readers to have the ability to compare the results of the 2020 evaluation with prior evaluations.
- While site-level MMBtu is useful as a single metric for all conservation programming, the benefit-cost analysis requires us to keep track of resources separately. The avoided cost of one delivered MMBtu of electricity is much higher than the avoided cost of one MMBtu of fossil fuel. The emissions per MMBtu also vary by resource because generators combust 2-3 MMBtu of fossil fuel to generate power[12] to deliver one MMBtu of electricity to a Long Island home.

While the evaluation team elected to report fuel-specific results, we caution that due to beneficial electrification, measures that reduce fossil fuel use, such as heat pumps, can increase electricity consumption and demand.

---

[11] Case 18-M-0084, In the Matter of a Comprehensive Energy Efficiency Initiative, Order Adopting Accelerated Energy Efficiency Targets (issued December 13, 2018).

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

### Table 7: Total Energy Efficiency and Beneficial Electrification Program MWh Impacts

| Sector | Energy Efficiency Program | Ex-Ante Gross Savings (Claimed*) | Ex-Post Gross Savings (Evaluated) | Ex-Post Net Savings |
|---|---|---|---|---|
| | | MWh | MWh | MWh |
| Commercial | Commercial Efficiency Program | 111,580 | 99,512 | 80,565 |
| Residential | Energy Efficiency Products | 156,012 | 129,245 | 83,866 |
| | Home Comfort | (2,638) | (4,926) | (4,527) |
| | Home Performance | 960 | 671 | 539 |
| | Home Energy Management | 69,902 | 30,834 | 32,802 |
| | Residential Energy Affordability Program | 973 | 789 | 839 |
| | Subtotal Commercial: | 111,580 | 99,512 | 80,565 |
| | Subtotal Residential: | 225,209 | 156,612 | 111,519 |
| | **Total Energy Efficiency Portfolio:** | **339,789** | **256,124** | **194,084** |

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

### Table 8: Total Energy Efficiency and Beneficial Electrification Program kW impacts

| Sector | Energy Efficiency Program | Ex-Ante Gross Savings (Claimed*) | Ex-Post Gross Savings (Evaluated) | Ex-Post Net Savings |
|---|---|---|---|---|
| | | kW | kW | kW |
| Commercial | Commercial Efficiency Program | 20,313 | 19,203 | 15,643 |
| Residential | Energy Efficiency Products | 33,286 | 19,315 | 13,398 |
| | Home Comfort | 1,063 | 836 | 1,079 |
| | Home Performance | 611 | 413 | 338 |
| | Home Energy Management** | 14,509 | 8,173 | 8,932 |
| | Residential Energy Affordability Program | 226 | 120 | 132 |
| | Subtotal Commercial: | 20,313 | 19,203 | 15,643 |
| | Subtotal Residential: | 46,695 | 28,860 | 23,878 |
| | **Total Energy Efficiency Portfolio:** | **70,007** | **48,064** | **39,521** |

*kW 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.

**HEM kW calculated assuming a residential load factor of 0.43. kW = kWh/8760/0.43

# APPENDIX C: ADDITIONAL COST-EFFECTIVENESS PERSPECTIVES AND METRICS

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

We also report the Utility Cost Test (UCT).[13] The tests are similar in most respects but consider slightly different benefits and costs in determining a benefit/cost ratio. The UCT measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the program administrator, including all program costs and any rebate and incentive costs, but excludes costs incurred by the participant. The UCT only includes benefits that accrue to the utility and therefore does not include the benefits of non-electric (i.e., gas and fuel oil) energy savings or increases, or emissions of carbon or particulates. Because both costs and benefits are different those considered from the societal perspective, the UCT benefit-cost ratio is also different.

As shown in Table 9, the UCT was 1.12 for the Energy Efficiency and Beneficial Electrification Portfolio. This indicates that the portfolio is also cost-effective from the utility perspective. Notably, the Home Comfort UCT ratio was negative, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, the net benefits from the utility perspective are negative. While electrification produces societal benefits in the form of reduced carbon emissions and reduced non-electric fuel consumption (e.g., natural gas and fuel oil), it increases electricity consumption to serve the newly electrified end uses. From the perspective of an electric utility, such as PSEG Long Island, the increased electricity costs are not offset by fuel and carbon reductions which only accrue from the societal perspective. In contrast, the Home Comfort SCT ratio is 2.65 indicating that from the societal perspective benefits do outweigh costs associated with this program comprised primarily of electrification measures.

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

Table 9: Utility Cost Test Results for Energy Efficiency and Beneficial Electrification Portfolio

| Sector | Program | NPV Benefits ($1,000) | NPV Costs ($1,000) | B/C Ratio |
|---|---|---|---|---|
| Commercial | Commercial Efficiency Program | **$38,803** | $37,285 | **1.04** |
| Residential | Energy Efficient Products | $45,887 | $20,987 | 2.19 |
| | Home Comfort | -$585 | $8,463 | -0.07 |
| | Residential Energy Affordability Partnership | $439 | $1,534 | 0.29 |
| | Home Performance | $592 | $5,129 | 0.12 |
| | Home Energy Management | $2,286 | $2,734 | 0.84 |
| | Subtotal Residential Efficiency Portfolio: | **$48,619** | **$38,847** | **1.25** |
| | **Total Energy Efficiency Portfolio[1]:** | ***$87,422*** | ***$78,372*** | ***1.12*** |

[1] Portfolio costs include $2M of advertising that was not allocated to individual programs

Another relevant metric in the context of electrification measure is the Ratepayer Impact test (RIM). This test considers the perspective of non-participating ratepayers and reflects the impact of programs on rates. The benefits and costs considered are similar to those considered from the utility perspective in that participant costs and societal benefits are not considered. The key difference is that changes in utility revenue are considered and increases in revenue are a considered as a benefit. This is the key component for assessing the impact on rates. Electricity rates are determined in part by allocating the fixed costs of maintaining and operating the electric grid across ratepayers. The primary metric for allocating costs across most rate payers is consumption as measured by kWh. Because consumption is the denominator for determining rates average rates increase as total consumption decreases, and average rates decrease as total consumption increases. To the extent that energy efficiency results in reduced consumption, it places upward pressure on rates while electrification places downward pressure on rates by increasing total consumption.

As shown in Table 10, the RIM was 0.22 for the Energy Efficiency and Beneficial Electrification Portfolio. This indicates that the portfolio is not cost-effective from the ratepayer perspective. This is to be expected since most of the portfolio is comprised of energy efficiency measures which decrease consumption. In contrast, Home Comfort was the only program with a RIM ratio greater than 1.0, indicative of the increase in electricity associated with electrification measures such as heat pumps. Essentially, the net benefits for electrification from the ratepayer perspective are positive in this case, after factoring in program costs.

Table 10: Ratepayer Impact Test Results for Energy Efficiency and Beneficial Electrification Portfolio

| Sector | Program | NPV Benefits ($1,000) | NPV Costs ($1,000) | B/C Ratio |
|---|---|---|---|---|
| Commercial | Commercial Efficiency Program | **$38,874** | **$213,315** | **0.18** |
| Residential | Energy Efficient Products | $46,680 | $245,232 | 0.19 |
| | Home Comfort | $16,532 | $12,718 | 1.30 |
| | Residential Energy Affordability Partnership | $439 | $3,608 | 0.12 |
| | Home Performance | $1,610 | $7,580 | 0.21 |
| | Home Energy Management | $2,286 | $9,667 | 0.24 |
| | Total Residential Efficiency Portfolio | **$67,547** | **$278,805** | **0.24** |
| | **Total Energy Efficiency Portfolio** | ***$106,421*** | ***$494,360*** | ***0.22*** |

In addition to benefit-cost ratios, there are two metrics which can be of value for assessing the performance of a program or portfolio. These are the first-year or acquisition cost of energy and the levelized or lifetime cost of energy. In budget planning and goal setting, the planned budget is compared to planned gross energy impacts (which do not include line losses or net to gross ratios). The actual first-year cost is comparable to this planning metric in that it compares actual spending to actual gross energy impacts. Importantly, gross impacts are considered to ensure comparability to planned budgets and energy targets. Table 11 shows the first-year cost for demand (kW), electricity (kWh), and the energy agnostic MMBtu planning metric. Both the utility and societal perspective are shown. The difference between the two is that the societal perspective includes the full incremental measure costs. Program or portfolio acquisition costs can be compared with acquisition costs for other utility programs or portfolios. As with the UCT benefit cost ratio, the first-year cost per kWh for the Home Comfort program is negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table 11: First Year Costs for Energy Efficiency and Beneficial Electrification Portfolio

| Sector | Program | 2020 Ex-Post Gross UCT First-Year Acquisition Cost | | | 2020 Ex-Post Gross SCT First-Year Acquisition Cost | | |
|---|---|---|---|---|---|---|---|
| | | $/MMBtu | $/kW-year | $/kWh | $/MMBtu | $/kW-year | $/kWh |
| Commercial | Commercial Efficiency Program | **$122.02** | **$1,939** | **$0.37** | **$212.54** | **$3,377** | **$0.65** |
| Residential | Energy Efficient Products | $57.73 | $1,087 | $0.16 | $89.90 | $1,692 | $0.25 |
| | Home Comfort | $101.37 | $10,129 | -$1.72 | $167.23 | $16,710 | -$2.83 |
| | Residential Energy Affordability Partnership | $595.42 | $12,710 | $1.94 | $595.42 | $12,710 | $1.94 |
| | Home Performance | $181.04 | $12,327 | $7.65 | $330.92 | $22,533 | $13.97 |
| | Home Energy Management | $25.99 | $335 | $0.09 | $25.99 | $335 | $0.09 |
| | Subtotal Residential Portfolio: | **$66.62** | **$1,346** | **$0.25** | **$103.38** | **$2,089** | **$0.38** |
| | **Total Portfolio:** | ***$88.19*** | ***$1,630*** | ***$0.31*** | ***$143.44*** | ***$2,651*** | ***$0.50*** |

Levelized cost is another useful metric which essentially divides costs by the lifetime net energy impacts (which include line losses and net to gross ratios). Net impacts are used to compare the cost of energy efficiency programs more directly with energy or capacity costs from other sources. Because levelized costs are expressed as $/kW-year and $/kWh, planners can readily compare them to the cost of alternative supply options. Table 12 shows the levelized cost for demand (kW), electricity (kWh), and the energy agnostic MMBtu planning metric. Both the utility and societal perspective are shown. The difference between the two is that the societal perspective includes the full incremental measure costs. Levelized costs can be compared with marginal costs for other resources. As with the UCT benefit cost ratio, the levelized cost per kWh for the Home Comfort program is negative. This is the nature of electrification measures that increase rather than reduce electricity consumption.

Table 12: Levelized Costs for Energy Efficiency and Beneficial Electrification Portfolio

| Sector | Program | 2020 Ex-Post Net UCT Levelized Costs | | | 2020 Ex-Post Net SCT Levelized Costs | | |
|---|---|---|---|---|---|---|---|
| | | $/MMBtu | $/kW-year | $/kWh | $/MMBtu | $/kW-year | $/kWh |
| Commercial | Commercial Efficiency Program | **$25.33** | **$259** | **$0.05** | **$33.67** | **$345** | **$0.07** |
| Residential | Energy Efficient Products | $8.27 | $151 | $0.02 | $10.01 | $183 | $0.03 |
| | Home Comfort | $9.64 | $680 | -$0.16 | $15.54 | $1,097 | ($0.26) |
| | Residential Energy Affordability Partnership | $59.42 | $1,118 | $0.18 | $59.42 | $1,118 | $0.18 |
| | Home Performance | $21.12 | $1,331 | $0.88 | $34.24 | $2,158 | $1.42 |
| | Home Energy Management | $24.43 | $306 | $0.08 | $24.43 | $306 | $0.08 |
| Subtotal Residential Portfolio: | | **$10.23** | **$235** | **$0.04** | **$13.60** | **$312** | **$0.06** |
| **Total Portfolio:** | | ***$14.88*** | ***$254*** | ***$0.05*** | ***$19.63*** | ***$335*** | ***$0.06*** |