Clean Energy Communities Impact Evaluation: Program Years 2019-2023

Final Report

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Table of Contents

List of Tables

1 Introduction

As part of its Clean Energy Fund, the New York State Energy Research and Development Authority (NYSERDA) created an Investment Plan for local governments in New York State (NYS). Integral to this effort is the Clean Energy Communities (CEC) program, which encourages investments in energy efficiency and the deployment of clean energy in local government operations and in their communities. Local governments include counties, cities, towns, and villages. The Contractor team uses the terms 'municipality' and 'community' to refer to the local governments and the area in which they have jurisdictional control.

1.1 Program Description

The program provides outreach, guidance from program Coordinators, and support, including technical assistance and tools, to overcome common barriers to implementing clean energy projects experienced by local governments. These barriers include a lack of awareness of clean energy opportunities available to municipalities, difficulty prioritizing clean energy projects, a lack of funding, and limited staff capacity and technical knowledge to implement clean energy projects. The CEC program also provides a list of High Impact Actions (HIAs) that communities can take. The program activities are designed to achieve the following goals:

- Decrease the amount of time, expertise, and funding needed to prioritize and implement clean energy actions in NYS communities.
- Increase adoption of high-impact, clean energy policies and actions in city, town, village, and county governments across NYS.
- Support and replicate innovative clean energy initiatives and demonstration projects.
- Demonstrate the value proposition associated with high-impact clean energy actions.

1.2 Evaluation Objectives and Methods

The main objectives of this impact evaluation were to verify the per-unit savings between 2019 and 2023 for three HIAs that were decided upon in consultation with NYSERDA: Benchmarking – Advanced Reporting, Clean Energy Upgrades, and Clean Heating and Cooling Demo. These HIAs were selected because they involve buildings, which will be a focus area for the CEC program going forward, and either had high uncertainty in prior savings estimations or were not included in the prior impact evaluation. Table 1 summarizes the objectives and methods; see Section Three for methodological details.

Table 1. Evaluation Objectives and Methods

Objective	Purpose	Method
What are the verified unit savings for the three HIAs of interest?	Perform verification of per-unit savings for selected HIAs	Review of Program data, desk reviews, and interviews of communities and contractors working on those projects within communities where needed
What are the normalized per-unit, per-community (small and large) savings for each HIA?	Update the impact forecasting for the selected HIAs	Use the population size of the sampled communities and the verified impacts

2 Results, Findings, and Recommendations

2.1 Results

This section will discuss the findings for the three HIAs evaluated.

2.1.1 Benchmarking – Advanced Reporting

For the Benchmarking – Advanced Reporting HIA, savings are claimed for electricity (MWh), natural gas (MMBtu), fuel oil (MMBtu), and propane (MMBtu). The Benchmarking – Advanced Reporting HIA requires the public disclosure on an annual basis of energy use information for each municipal building that is owned or occupied by the applying jurisdiction and is 1,000 square feet or larger as well as making available no less than 24 months of energy use information to NYSERDA. Energy use information includes a building's energy use intensity (EUI), annual greenhouse gas emissions, and an energy performance score, where available. Savings from this HIA arise from energy efficiency actions taken by a municipality through continuous monitoring and comparing EUIs for similar buildings in the EPA ENERGY STAR Portfolio Manager database.

The Contractor team found the total gross first-year CO2e emissions savings equal to 994 MTCO2e for all 178 communities completing the HIA in the 2019-2023 period, summarized in Table 2. The total verified gross value represents the first-year savings for all participating communities during the evaluation cycle covering 2019 through 2023. Total verified gross annual impacts are converted into per-capita savings using the population size of the communities that completed the HIA, representing the impact of the HIA on the community members of participating communities. These are then converted into small and large community verified gross impacts, showing the varied scale of impact on those communities. Savings by small and large communities showed similar trends, with positive savings for electricity and natural gas

Propane and fuel oil, i.e., delivered fuels, exhibited contrasting outcomes, with increases in fuel oil consumption for both community groups and opposing outcomes for propane. Delivered fuels are difficult to evaluate due to a lack of consumption metering. The Contractor team only had delivery dates of the fuels and assumed 100% consumption of the delivered volume between the next delivery date, a simplification necessary for evaluating these fuels. While the results of fuel oil and propane are not statistically significant due to small sample sizes in small communities (n=6 and 4, respectively) and large communities (n=1 for both fuels), the results do suggest that

consumption of fuel oil and propane was relatively steady after completing the benchmarking in both community groups.

Table 2. Summary of Evaluated Savings for Benchmarking – Advanced Reporting 2019—2023[a]

Benchmarking – Advanced Reporting	Annual Efficiency kWh Savings	Annual Natural Gas Btu Savings	Annual Beneficial Electrification Btu Savings	Annual Propane Btu Savings	Annual lbCO2e
Total Verified Gross Annual Impacts	1,281,721	14,216,984	-8,351,172	3,469,157	2,191,711
Per-capita Verified Gross Annual Impacts	0.246	2.729	-1.603	0.666	0.42
Per Small Community Verified Gross Annual Impacts	880	392	-3,957	-1,434	176
Per Large Community Verified Gross Annual Impacts	81,247	1,010,904	-550,155	264,594	154,484

a Impacts are reported in units of kW, kWh, Btu, and lbCO2e for purposes of improving readability. I

2.1.2 Clean Heating and Cooling Demo

For the Clean Heating and Cooling Demo HIA, gross annual impact savings are claimed for electricity (MWh), natural gas (MMBtu), and fuel oil (MMBtu). The Clean Heating and Cooling Demo HIA requires the community to upgrade buildings that are at least 1,000 square feet in floor area and show at least one educational kiosk, display, and/or materials relating to the installed demonstration project. Savings for the HIA are achieved by upgrading municipal heating and cooling equipment to higher efficiency heat pumps, which the Contractor team verified using the submitted data from the communities.

The Contractor team found that the most common type of project completed to meet the HIA requirements were air source (ASHP) and ground source heat pumps (GSHP), with 81% of projects accounting for 91% of CO2e reductions. The remaining projects included domestic hot water (13% of projects and 9% of CO2e reductions) and HVAC controls (6% of projects and <1% of CO2e reductions).

The majority of ASHP installations displaced fossil fuel heating equipment, either fuel oil or natural gas, resulting in beneficial electrification. Beneficial electrification yields two forms of impact: (1) fossil fuel savings from the displacement of that fuel for space heating and (2)

increased electricity consumption for space heating. However, the carbon benefits of displacing fossil fuels outweigh the emissions from increased consumption of grid electricity, depicted in Table 3.

The Contractor team was unable to secure documentation on either the replaced or installed equipment efficiencies from the participant interviews or through certification forms. As a result, the Contractor team applied the NYS TRM assumptions for the replaced equipment efficiency, which aligned with the code minimum efficiency. For the installed equipment, the Contractor team determined the most reliable assumption was to apply the code minimum efficiency, because the HIA does not include efficiency requirements for the installed equipment and installed equipment efficiencies were unknown. Therefore, the Contractor team assumed that the installed equipment replaced an existing system of similar size and efficiency, resulting in no electric efficiency savings for these projects. The Contractor team recommends the CEC Program should collect evidence of replacement equipment efficiencies to adequately demonstrate electric efficiency savings from this HIA. This recommendation has been responded to by the CEC Program as they will strive to utilize existing data sources

Results for the Clean Heating and Cooling Demo HIA are provided in Table 3. Total verified gross annual impacts are converted into per-capita savings using the population size of the communities that completed the HIA. These are then converted into per small and per large community verified gross impacts.

Table 3. Summary of Evaluated Savings for Clean Heating and Cooling Demo 2019—2023[a]

Clean Heating and Cooling Demo	Annual Efficiency kWh Savings	Annual Natural Gas Btu Savings	Annual Fuel Oil Btu Savings	Annual Beneficial Electrification kWh	Annual lbCO2e
Total Verified Gross Annual Impacts	18,343	1,728,992	364,728	-203,321	57,163
Per-capita Verified Gross Annual Impacts	0.016	1.476	0.311	-0.174	0.049
Per Small Community Verified Gross Annual Impacts	1,672	13,712	8,171	-2,044	2,460
Per Large Community Verified Gross Annual Impacts	0	164,337	0	-16,033	1,576

a Impacts are reported in units of kW, kWh, Btu, and lbCO2e for purposes of improving readability.

For the Clean Energy Upgrades HIA, gross annual impact savings are claimed for electricity (MWh), natural gas (MMBtu), fuel oil (MMBtu), propane (MMBtu), and renewable generation (MW and MWh). To complete the Clean Energy Upgrades HIA, it is required that communities meet at least an overall ten percent reduction in greenhouse gas emissions by completing upgrades in buildings that are at least 1,000 square feet in size. Communities have the option to complete different kinds of municipal energy upgrades, including, but not limited to, lighting upgrades, HVAC upgrades, or solar installations. The Contractor team verified these energy upgrades using the submitted data from the communities.

The Contractor team found that the most common type of project completed to meet the Clean Energy Upgrade requirements between 2019 and 2023 was community distributed generation (CDG) projects, accounting for 34% of projects and 32% of CO2e reductions. Following closely behind were the municipal lighting upgrades, with 32% of projects and 36% of CO2e reductions. The next most impactful type of project from the sample is HVAC upgrades (19% of projects), which includes electrification of space heating or replacement of existing equipment with more efficient equipment, and is responsible for 23% of the CO2e reduction. Solar array installations (13% of projects responsible for 5% of the CO2e reduction) and building envelope upgrades (2% of projects, responsible for 4% of the CO2e reductions) made up the rest of the projects. This spread of completed project types is possibly due to the ease of executing a community distributed generation contract compared with implementing capital investments, which require the process of requesting proposals, securing an engineering assessment, and installing the new equipment to complete the project.

The Contractor team made some observations about the results. Unlike the prior evaluation study, projects resulting in beneficial electrification impacts were observed in this evaluation's sample. Renewable generation had two contributing projects: (1) executed CDG subscriptions and (2) installation of solar arrays that supply directly to municipal-owned buildings. While solar installations accounted for only 13% of the renewable generation seen, they offer the added benefit of creating renewable capacity in contrast to CDG subscriptions, which secure renewable energy from an existing solar array. Lighting upgrades accounted for 80% of electric efficiency savings. Lighting upgrades also contributed to a small increase in natural gas usage for space heating due to LEDs producing less heat than the less efficient incandescent or CFL bulbs they replaced. But this increase in heating is partially offset by a decrease in cooling requirements during the cooling season for the same reason.

Results for the Clean Energy Upgrades HIA are provided in Table 4. Total verified gross annual impacts are converted into per-capita savings using the population size of the communities that completed the HIA. These are then converted into per small and per large community verified gross impacts.

Table 4. Summary of Evaluated Savings for Clean Energy Upgrades 2019—2023[a]

Clean Energy Upgrades	Annual Efficiency kWh Savings	Annual Natural Gas Btu Savings	Annual Fuel Oil Btu Savings	Annual Propane Btu Savings	Annual Renewable kW Generation	Annual Renewable kWh Generation	Annual Beneficial Electrification kWh	Annual lbCO2e
Total Verified Gross Annual Impacts	7,762,154	2,505,934	16,625,933	324,373	676	7,903,977	-140,085	20,167,959
Per-capita Verified Gross Annual Impacts	4.135	1.335	8.857	0.173	0.0004	4.211	-0.075	10.744
Per Small Community Verified Gross Annual Impacts	92,172	21,341	9,293	8,069	2	197,893	-1,800	323,013
Per Large Community Verified Gross Annual Impacts	3,252,875	8,701,519	1,944,794	0	314	398,759	0	5,363,453

a Impacts are reported in units of kW, kWh, Btu, and lbCO2e for purposes of improving readability.

2.2 Findings and Recommendations

Finding 1: **Results of the Benchmarking – Advanced Reporting HIA showed better performance in large communities than in small ones.** Achieving energy savings from benchmarking is a long-term investment with greater potential for success in communities that have dedicated energy managers and buildings with integrated controls. While those characteristics are more commonly found in larger communities, small communities can also achieve savings but may require additional support and continued touchpoints with their NYSERDA CEC Coordinators.

Recommendation 1: To promote longer-term engagement, NYSERDA should consider adding a new HIA within the benchmarking activities that requires continued tracking of energy use, up to 24 months, and that demonstrates an improvement in energy use intensity tracking for all buildings that were a part of the Benchmarking – Advanced Reporting HIA. The HIA would drive deeper savings in municipal buildings and provide NYSERDA with detailed building-level energy use data that might be useful in identifying targeted HIAs.

- **NYSERDA Response to Recommendation 1**: Implemented. Benchmarking - Municipal Buildings - receive points if they submit a certified copy of an executed local law, ordinance, or resolution that requires the applying jurisdiction to make available to the public on the internet on an annual basis energy use information for each municipal building that is owned or occupied by the applying jurisdiction that is 1,000 square feet or larger. At a minimum, publicly disclosed energy use information shall include each building's energy use intensity (EUI), annual greenhouse gas emissions, and an energy performance score where available.

Finding 2: The Clean Heating and Cooling Demo participation requirements include submission of a certification form, with limited estimated energy information. It does not include essential equipment details such as the heat pump make, model, or rated capacity. Collecting this information at the time of installation is the most reliable approach to ensure data accuracy and would enable NYSERDA to verify compliance with HIA technical requirements. This data is critical for estimating the magnitude of energy and emissions impacts across participating communities. In the Clean Energy Upgrades HIA, the option for "comparable information" remains inadequately defined, introducing uncertainty regarding the data's completeness and comparability.

Recommendation 2: To improve the accuracy of energy savings estimates, NYSERDA should revise the certification form for the Clean Heating and Cooling Demo HIA to include a required photo of the equipment nameplate, along with data entry fields for equipment capacity, heating efficiency, and cooling efficiency. Communities can obtain this information with support from the installation contractor. Additionally, the Contractor team recommends removing the option to submit "comparable information" under the Clean Energy Upgrades HIA. Eliminating this vague provision will help ensure that backup documentation includes sufficient detail to support more precise energy savings calculations.

- **NYSERDA Response to Recommendation 2**: Rejected. At first attempt, minimal CEC projects were able to be matched to the Clean Heat dataset. NYSERDA is confident this will be a useful data set in the future by working on the alignment needed for matching purposes.

Finding 3: The current work applied the 2010 US Census data for normalizing results to per capita totals, which is consistent with the Program Opportunity Notice (PON) during the Program years 2019—2023. The 2020 Census showed an overall increase in statewide population of 4.2%. However, community-to-community population changes vary positively and negatively.

Recommendation 3: Future iterations of the CEC Program PON should update community size descriptions (large and small) to use 2020 Census data. Future evaluations can also apply 2020 Census values to stay aligned.

NYSERDA Response to Recommendation 3: Implemented. All future analysis and evaluations will implement the 2020 Census.

3 Methods

To conduct this study, the Contractor team used a combination of program data, data from the ENERGY STAR Portfolio Manager, and interviews with municipal representatives, and desk reviews of project documentation. These data sources allowed the team to verify the per-unit savings from the three HIAs of interest. The team completed interviews with 10 municipalities to support the Clean Heating and Cooling Demo HIA and 18 municipalities for the Clean Energy Upgrades HIA. Municipal representatives also provided technical specifications of heat pump equipment, lighting upgrades, community solar array installations, or high-efficiency boilers and furnaces. ENERGY STAR Portfolio Manager data was sufficient to complete the analysis for the Benchmarking – Advanced Reporting HIA. The Contractor team analyzed the data to verify the indirect energy impacts of the CEC program for 2019–2023. The sections below describe these research methods in more detail.

3.1 Sampling

The team compiled the population of NYS communities that completed the three HIAs of interest during the evaluation period of 2019–2023. The team calculated sample sizes necessary to achieve a Confidence/Precision of 90/10 based on the expected error distribution from the previous evaluation for a given HIA. Samples were stratified by community size: small communities (<40,000 population) and large communities (≥40,000 population). Due to the low population numbers, a census was sampled for the Clean Energy Upgrades and Clean Heating and Cooling Demo HIAs. Table 5 shows the population, the sample target, and the achieved sample and confidence and precision for each HIA of interest.

Table 5. Sampling Strategy

HIA	Stratum	Population (N=208)[a]	Target Sample (n=115)	Sample Achieved (n=93)	Confidence/ Precision
Benchmarking Advanced Reporting	Large Community	14	14	7	90/11
	Small Community	164	36	36	
Clean Energy Upgrades	Large Community	6	6	3	90/10
	Small Community	60	34	32	
Clean Heating and Cooling Demo	Large Community	3	3	2	85/10
	Small Community	22	22	13	

[a] Values do not equal the sum of the population due to a subset of communities completing multiple HIAs.

3.2 Data Collection

For the interview process, during late 2024 through early 2025, the Contractor team contacted 77 municipalities in NYS that completed either the Clean Energy Upgrades or Clean Heating and Cooling Demo HIA. Evaluation of the Benchmarking – Advanced Reporting HIA did not require interviews. The team emailed and called municipal representatives up to five times to collect the necessary data and spoke with up to two representatives per municipality who were most knowledgeable about their community's clean energy efforts. The interview length ranged from 30 to 60 minutes.

The interviews sought to characterize the HIA project completed in the community. To characterize the HIA project, the Contractor team asked questions about the following: the building and space type, the existing heating and cooling equipment, the existing operating conditions, what type of equipment was installed through the HIA, and the manufacturing specifications for the equipment installed through the HIA.

For all HIAs, the Contractor team pulled program data from NYSERDA's CEC program portal where communities upload submission forms to demonstrate completion of an HIA. ENERGY STAR Portfolio Manager was used to pull building-level billing data for communities, which was the key source of information for the Benchmarking – Advanced Reporting HIA evaluation. The data helped characterize the projects that went into the HIA and provided backup documentation for the data analysis for most of the communities.

3.3 Data Analysis

The Contractor team analyzed the data collected from the sample of surveyed municipalities using three separate methods, one for each HIA of interest.

For Benchmarking – Advanced Reporting, monthly energy bills were normalized to average daily consumption, ranked, and compared against other similar billing periods to check for outliers. Outlier bills, such as those showing an order of magnitude increase or decrease in consumption for a single billing cycle, were excluded from the regression analysis. The Contractor team aimed for twelve months of pre- and post-HIA adoption billing data, but due to limitations in the data and effects of COVID-19 on energy use patterns, determined that a minimum of eight months of billing data was sufficient.

A change-point regression was run to identify an inflection point in energy consumption based on outdoor temperature. The resulting change-point temperature was used to construct a subset of monthly bills that fell into either heating, cooling, or baseload end-uses. For electricity, which might serve all three end-uses, a second change-point temperature was selected based on observation, but only where the plotted monthly bills showed evidence of a heating load (i.e., increasing electricity usage at temperatures below 45F). Change-point temperatures were adjusted to identify the best fit (i.e., aiming for R^2>0.7 for heating and cooling end-uses) while maintaining practical building HVAC set points (i.e., between 50F and 70F).

The resulting regressions were used with: (1) actual meteorological year (AMY) weather data for a pre-period reference year, typically the calendar year closest to the HIA completion date outside of the COVID-19 period, as a validation check for the model and (2) version 3 typical meteorological year (TMY3) weather files for normalization to typical climate patterns.

As a test of the model accuracy, the resulting estimated energy consumption from the AMY regression model was compared to actual consumption. On average, model results were within 4% of actual for electricity, 6% for natural gas, and 8% for delivered fuels. Results of the AMY models were compared against national energy use intensities (EUI) of similar buildings, as reported in Portfolio Manager, as a validation step. Where the ratio of the modeled EUI to national EUI was larger than two, a second review of the model was conducted, and models deemed unreasonable were removed from the sample.

For the Clean Heating and Cooling Demo HIA, the Contractor team used the program data collected from various sources to conduct desk reviews of each community's project. To complete the desk reviews, the team used savings algorithms, methods, and assumptions that came from version 12 of the New York State TRM.[1] The team used the existing and efficient (installed) equipment descriptions and specifications to determine annual savings for these HIAs. Interviews completed with the individual municipalities provided valuable context, history, and details of the HIAs that were critical in providing accurate, verified savings estimates.

For the Clean Energy Upgrades HIA, the Contractor team used the program data collected from various sources to conduct desk reviews of each HIA. Projects completed for the Clean Energy Upgrade HIA included municipal lighting upgrades, Community Distributed Generation, HVAC

[1] New York State TRM Version 12, https://dps.ny.gov/technical-resource-manual-version-12-filed-october-28-2024-effective-january-1-2025

upgrades (heat pump installations, high-efficiency boilers/furnaces, etc.), solar array installations, and building envelope upgrades. The Contractor team used the existing and efficient (installed) equipment descriptions and specifications to determine annual savings for municipal lighting upgrades, HVAC upgrades, and building envelope upgrades. For those three types of upgrades, the savings algorithms, methods, and assumptions came from version 12 of the New York State TRM. For the solar array installations, the Contractor team employed the use of the National Renewable Energy Laboratory's PV Watts calculator to verify the size and annual generation reported in the documentation.[2] For community distributed generation, the Contractor team used the energy allocation provided in signed contracts and other types of supplemental information to verify the annual generation reported in the documentation.

After results were produced for all three HIAs, the Contractor team aggregated the results by stratum. Using the community population from the 2010 census, the team normalized the results and produced impacts on three different levels: per capita, per small community, and per large community. For a full explanation of how the sample was expanded to the population, see Appendix D.

[2]"PVWatts - NREL," PVWatts Calculator, accessed April 1, 2025, https://pvwatts.nrel.gov/index.php.