

# **Brighter Futures: Electrifying NYC's Vital Spaces to Build Resilient Communities**

## **Appendix C. Technical Appendix**

### **Greenhouse Gas Emissions (GHG) Reduction Estimate Method**

#### ***New York Public Library (NYPL) Electrification***

The GHG emission reductions were calculated based on Energy Conservation Measure (ECM) analysis in recent energy audits performed for each location. These calculations were made considering various parameters such as existing equipment specifications (including metal tags, as-built drawings, etc.), hours of operation, equipment efficiencies, and heating and cooling calculations, etc. Arup performed the energy audits for Parkchester and St. George (2022), and Trane performed the audit for Schomburg (2021, rev. 2023). More information can be found in the attachment *GHGcalcs\_DCAS* under the tab *NYPL Data*.

#### ***New York City Police Department (NYPD) Electrification***

DCAS provided estimates for the proposed upgrades, including DHW heat pumps, HVAC upgrades, and BMS installation, and their impact on energy and fuel use in each NYPD precinct included. These estimates were calculated based on utility data, 3-year average consumption baseline, energy analysis and calculations included in the ASHRAE Level II energy audits developed at these facilities. These calculations were made considering various parameters such as existing equipment specifications (including metal tags, as-built drawings, etc.), hours of operation, equipment efficiencies, and heating and cooling calculations, etc.

To estimate energy savings, the report used Bin analysis, proposed efficiencies of new equipment, coefficient of performance, operating schedules, and other key factors as primary resources to estimate savings. All calculations and assumptions are included in the energy audits. More information can be found in the attachment *GHGcalcs\_DCAS* under the tab *NYPD Data*.

#### ***New York City Health Building Electrification***

The GHG emission reductions for the Health Building were calculated based on ECM analysis in a recent energy audit NORESO performed in 2023. These calculations were made considering various parameters such as existing equipment specifications (including metal tags, as-built drawings, etc.), hours of operation, equipment efficiencies, heating and cooling calculations, etc. More information can be found in the attachment *GHGcalcs\_DCAS* under the tab *Health Building Data*.

#### ***New York City Public Schools (NYCPS) Electrification***

The GHG emission reductions for 500 NYCPS buildings were estimated based on average size and water heating load. Of the 500 buildings, 172 buildings are under 100,000 square feet, 283 buildings are between 100,000 and 200,000 square feet, and 45 are greater than 200,000 square feet. The calculations for the average GHG energy savings of each building size were based on average occupancy and the following assumptions:

- Existing building systems (poor condition) have a Coefficient of Performance (COP) of 2.50 and 73% efficiency.
- Proposed heat pump systems have a COP of 4.20 with 90% efficiency.
- Students and staff wash their hands using hot water from faucets (rated at 2.2 gpm each) an average of twice per day, for 15 seconds each use.
- Average incoming city water temperature is 55F. Measured hot water storage temperature was 150F. The average measured hot water temperature was 120F at restrooms sinks and 150F at kitchen sinks.
- Hot water used by faucets is a mixture of city water and stored hot water. The amount of stored hot water used at hot water faucets is based on the average measured hot water temperature at the faucets, average city water temperature, and hot water storage temperature.
- Two (2) gallons of domestic hot water are used for each meal. On average, one (1) meal is served per day for every student and staff member.

Average savings were found for small, medium, and large buildings and then calculated by the number of buildings in each category to provide the total GHG savings of installing the proposed systems. More information can be found in the attachment *GHGcalcs\_DCAS* under the tab *NYCPS Data*.

#### ***New York City Housing Authority (NYCHA) Electrification***

This analysis used the average gas and fuel oil #2 usage for June through September 2022 and 2023 (non-heating season months) for each development – Morrisania Air Rights, Pelham, and Pomonok - and multiplied the usage by 0.97 (3% cooking gas) to estimate the average gas and fuel oil consumption for DHW use only.

To then estimate the annual energy usage required for DHW heat pumps, the report assumed an efficiency of 0.5 for existing systems, and the average annual COP for DHW heat pumps is assumed to be 2.5. More information can be found in the attachment *GHGcalcs\_DCAS* under the tab *NYCHA Data*.

#### ***New York City Housing Preservation & Development (HPD) Electrification***

Using an Engineering Based Methodology as allowed by HUD to calculate allowances for a “particular type of dwelling unit or household”, engineering calculations and technical data were used to estimate reasonable energy consumption for HPD projects using electric heat and hot water systems. The allowances are set based on assumptions made in these calculations.

Hot water consumption is based on several criteria including occupant density, incoming water temperatures, fixture flows allowed by code, fixture delivery temperatures, fixture run times per use, and incoming water temperatures. Usage is based on the Water Research Foundation’s study<sup>i</sup> and assumes 61 °F average annual mains temperature and a delivery temperature of 120 °F before mixing with cold water.

Energy savings for the 500 units included in the project were calculated by taking the average per square foot of five representative apartment buildings. More information can be found in the attachment *GHGcalcs\_DCAS* under the tab *HPD Data*.

## Models/Tools Used

### ***New York Public Library (NYPL) Electrification***

The energy modeling in the audits Arup and Trane conducted was performed using Integrated Environmental Solutions (IES) 2021.4.0.0 software.

### ***New York City Public Schools (NYCPS) Electrification***

Assumptions and calculations for the NYCPS GHG emission reductions were performed following DCAS Estimated Energy Requirement (EER) guidelines and referencing several energy audits performed on a sample of school buildings after 2022 by NORESO and Loring Consulting Engineers.

### ***New York City Police Department (NYPD) Electrification***

All precincts underwent ASHRAE Level II energy audits in compliance with ASHRAE Standard 211-2018. These audits enabled the measurement of energy use associated with both current operations and proposed retrofits.

- Energy audits for the 32nd and 25th precincts were conducted by Loring Consulting Engineers, Inc. utilizing Writesoft Universal Software to assess R-Values and U-Values of building envelope components.
- Energy audits for the 48th, 72nd, 73rd, and 84th precincts were conducted by Edison Energy.
- Energy audits for the 43rd, 47th, and 75th precincts were conducted by NORESO.

### ***New York City Housing Authority (NYCHA) Electrification***

NYCHA GHG emission reduction calculations were performed in Excel following EER guidelines and using historical gas and fuel oil consumption.

### ***New York City Health Building Electrification***

The energy modeling in the audit conducted by NORESO was performed using eQuest version 3.65 build 7175 using DOE 2.2.

### ***New York City Housing Preservation & Development (HPD) Electrification***

HPD GHG emission reduction calculations were performed in excel following HUD-approved Engineering-Based Methodology.

## Measure Implementation Assumptions

Section 3.c in the Workplan (attachment Workplan\_DCAS) and the attachment ProjectSchedules\_DCAS detail project implementation timelines, including major tasks and milestones, for each of the six electrification measures proposed, with additional details regarding the assumptions for implementation timing of the proposed GHG reduction measures. For the DCAS-led initiatives – NYPL, NYPD, and Health

Building – and NYCPS and NYCHA initiatives, coalition member agencies consulted with internal capital project implementation teams and used implementation timelines from prior projects involving extremely similar or the same electrification upgrades to establish precedent for assumed implementation timelines and milestones.

In terms of expected measure lifetime, heat pumps, which will make up the substantial portion of this project, have an expected service life of 15-20 years with periodic maintenance, and the City intends to replace or repair the equipment at the end of its useful life; this will ensure durability of emissions reductions through 2030 and 2050.<sup>xxv</sup> If a system needs replacement before 2050, upcoming mandates like LL97 and future technologies are expected to maintain the estimated long-term emissions savings outlined in this application, ensuring the measures will provide consistent emissions reductions through 2050 and beyond.

Detailed budget breakdowns for each electrification measure can be found in the attached Budget Spreadsheet – Budgetcalcs\_DCAS, and accompanying narrative including capital, operation, and maintenance cost assumptions can be found in the attached Budget Narrative – Budget\_DCAS.

## GHG Reduction Estimate Assumptions

### ***NYPL, NYPD, Health Building, NYCPS, and NYCHA***

The emission factors in the [Inventory of New York City Greenhouse Gas Emissions annual report](#) were used for all public/government buildings. These factors reflect expected emissions over time associated with electricity purchased from the New York Power Authority (NYPA). These emission factors can be found in the attachment *GHGcalcs\_DCAS* under the tab *Emissions Factors*.

### ***New York City Housing Preservation & Development (HPD) Heat Pump Pilot***

The LL97 emission factors for 2023 for natural gas, fuel oil #2, and grid electricity were used to calculate the GHG emissions reductions in private buildings.

#### **NYC LL97 GHG Coefficient of Energy Consumption Coefficients**

| Utility                | 2025-2029   | 2030-2034 (+) | Unit         |
|------------------------|-------------|---------------|--------------|
| Electricity (via grid) | 0.000288962 | 0.000145      | (tCO2e/kWh)  |
| Natural Gas            | 0.00005311  | 0.00005311    | (tCO2e/kbtu) |
| #2 Fuel Oil            | 0.00007421  | 0.00007421    | (tCO2e/kbtu) |

## Reference Case Scenario

For all GHG emission reductions in the Brighter Futures proposal, the net savings were calculated by estimating the current energy usage of the existing systems that will be replaced and the estimated future energy usage of the newly installed systems, calculating the associated GHG emissions for both scenarios, and taking the difference. These estimates were calculated through energy modeling when available and/or following standard estimation methodologies. Although the total emissions for the specific buildings in this project were not used as the baseline, the emission reductions – and future emission reduction possibilities if projects are scaled – were compared to a baseline and Local Law 97 GHG targets for the relevant sectors to provide specific benchmarking. The specific benchmarking was calculated for each agency as follows:

### ***NYPL, NYPD, NYCPS, and DCAS Health Building***

Reference case emissions data for NYPL, NYPD, NYCPS, and DCAS (including the Health Building) include 2019 baseline emissions and 2025 and 2030 emission targets from the [Local Law 97 Implementation Action Plan](#) for 2021. Below is the information summarized from p. 91:

#### **LL97 2021 Report**

| <b>Buildings</b> | <b>2019 Emissions Status (MT CO2e)</b> | <b>2025 Emissions Target (MT CO2e)</b> | <b>2030 Emissions Target (MT CO2e)</b> | <b>Total No. of Buildings in NYC (MT CO2e)</b> |
|------------------|--|--|--|--|
| DCAS             | 92,313                                 | 73722                                  | 18276                                  | 55   |
| NYPD             | 63949                                  | 51964                                  | 19179                                  | 77   |
| NYPL             | 19788                                  | 13831                                  | 3767                                   | 195  |
| NYCPS            | 740129                                 | 654415                                 | 380102                                 | 800  |

The data above was used to understand both how the Brighter Futures proposed upgrades would contribute to achieving 2030 emissions targets for each agency and their respective building sector, and also the potential impact that could be achieved from these measures if they were scaled up across all eligible buildings for each agency.

The scalability potential for these measures is significant, and if these decarbonization measures were scaled up across each agency's portfolio for eligible buildings, enormous additional annual GHG reductions could be realized. In total, the emissions saving potential through scaling up the proposed Brighter Futures measures across the relevant building portfolios could reach almost **100,000 MT CO2e** of avoided annual emissions. For more information and calculations, please see the attachment *GHGcalcs\_DCAS* under the tab *Reference Case*.

### ***NYCHA and HPD***

The NYCHA and HPD measures provide promising potential impacts for the residential sector, specifically affordable housing and related facilities still utilizing fuel oil. According to NYCHA, total emissions from building operations was 1,265,495 MT CO2e in 2022. In addition, up to 1,539 buildings across 183 developments are eligible to implement the specific DHW electrification measures proposed by this project. This number excludes all sites in the PACT pipeline, ConEd district steam sites, non-residential buildings, and buildings targeted for geothermal decarbonization. It includes all other residential buildings, including the 61 buildings in Brighter Futures, buildings already receiving similar decarbonization measures, and standalone and scattered-site buildings where alternate approaches may be necessary, due to lack of space or other constraints. While the decarbonization measures applied to the buildings included in the Brighter Futures project is going to be NYCHA's primary decarbonization method, it is important to note that this will not realistically be a one-size-fits-all approach for other buildings. The Brighter Futures upgrades alone impact 61 buildings, reducing the total NYCHA portfolio GHG emissions by 1.2% annually after 2030. If these upgrades are scaled across 1,539 additional NYCHA buildings that are eligible to implement the specific DHW electrification measures proposed by this project, annual emissions could then be reduced by 31%, or over 389,000 MT CO2e avoided every year.

More information and calculations can be found in the attachment *GHGcalcs\_DCAS* under the tab *Reference Case*.

While baseline emissions were more difficult to estimate, an average current energy usage per square foot was calculated (see *GHGcalcs\_DCAS* under tab *HPD Data*) that could then be extrapolated across both the 500 units included in Brighter Futures proposed upgrades and all multi-family units under HPD jurisdiction determined by HPD to be eligible for those same upgrades (approximately 168,000). If fully scaled, annual GHG emissions reductions could reach 360,000 MT CO<sub>2</sub>e across approximately 2,000 residential buildings.

For additional reference, the entire residential sector was found to produce 16.4M MT CO<sub>2</sub>e in 2022 according to the NYC GHG Inventories Report. Combining both NYCHA and HPD potential scale-ups, these measures have the potential to reduce GHG emissions for the NYC residential sector by 5% annually. More information and calculations can be found in the attachment *GHGcalcs\_DCAS* under the tab *Reference Case*.

### Measure-Specific Activity Data

Relevant activity data, including proposed upgrade descriptions and energy savings (therms of natural gas, kWh of electricity, gallons of No.2 Fuel Oil) can be found in the attachment *GHGcalcs\_DCAS* under the tab *Emissions Breakdown*.

### GHG Emissions Reduced

The measure-specific estimated annual GHG emissions reductions can be found in the attachment *GHGcalcs\_DCAS* file under the tabs *Summary Tables* and *Emissions Breakdown*.

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<sup>i</sup> [Residential End Uses of Water, Version 2 | The Water Research Foundation \(waterrf.org\)](https://www.waterrf.org/residential-end-uses-of-water-version-2)