Existing Building Electrification– PS XXXX

*For*

NYC School Construction Authority

PS XXXX

D xxxxxxx

X/XX/2024

**IMPORTANT NOTE: This document is an example of an Existing Building Report and is intended only as a reference to be used when creating new reports. Certain sections may have been edited or removed to fit this particular school. Data in this report may not pertain to the actual school in question. For modelers, use the Existing Building Report Template, which is a blank version of this report more appropriate for all cases.**

Report template version 2.3

April 2024

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# Executive Summary

**1.1 Existing Building Conditions and Scope of Work:**

The existing building is a five-story school building initially constructed in 1993. The fourth and fifth floors were renovated around 1995 and the roofs were replaced in 2015. The envelope is in satisfactory condition. The building was initially served by dual-fuel boilers and primarily using natural gas as fuel. Cooling is provided by an electric chiller. Classrooms were served by unit ventilators and all other spaces were served by air handling units. The scope of modeling is to compare the existing building to the proposed design. Utility bills were provided and the existing building baseline was matched to the bills before EEMs were modeled. The design will also be compared to the LL51/2023 baseline which will follow the 2020 NYCECC using the ASHRAE 90.1-2016 ECB path.

**1.2 Proposed Building Upgrades:**

The proposed energy efficiency measures (EEMs) that were analyzed were limited to windows, lighting, kitchen equipment, and HVAC upgrades only. They are as follows:

* Window Components
	+ U-0.45 fenestration replacement (17% WWR retained)
* Lighting
	+ Fluorescent lighting replaced with LEDs in the corridors, mechanical spaces, kitchen, cafeteria, and two classrooms.
* HVAC Equipment
	+ Gas boilers are replaced by new heat-pump chillers and supplemental electric boilers
	+ AHUs with heat pumps for heating and cooling
	+ Energy recovery ventilation
	+ Heat pump service water heaters.
* Kitchen equipment
	+ Replacement of gas-fired range/ovens with electric range/oven.

**1.3 Savings vs. Existing Building Baseline:**

1. Projected cost savings: $37,325/year
2. Projected energy savings
3. Electricity savings: 330,131 kWh/year
4. Natural gas savings: 42,840 Therms/year
5. Building energy use intensity savings (site): 47.1 kBtu/sf.yr
6. Building energy use intensity savings (source): 64.2 kBtu/sf.yr
7. Building CO2 emissions savings:300.1 Tons CO2e/year

**1.4 Savings vs. Local Law 51 Baseline:**

Construction costs for electrifying the HVAC system exceeds $2 million, per the Final Scope Report prepared by Shenoy Engineering for this project. To demonstrate compliance with the NYC LL51/2023 the project must achieve energy use reductions of at least 10% for the renovated HVAC system versus the LL51 baseline. The LL51 baseline is ASHRAE 90.1-2016 ECB as amended in the 2020 NYC ECC.

The energy model results show that the design achieves 11.7% energy use savings for the renovated HVAC system.

|  |  |  |
| --- | --- | --- |
| **Case** | **End Use Electricity** | **Savings** |
| **Space Heating [kWh/year]** | **Space Cooling [kWh/year]** | **Pumps & Aux [kWh/year]** | **Vent Fans [kWh/year]** | **HT Pump Supplement [kWh/year]** | **Total HVAC [kWh/year]** | **Total Savings [kWh/year]** | **%** |
| **LL51 Baseline Renovated HVAC** |  267,720  |  158,213  |  4,125  |  176,143  |  3,896  |  610,097  |   |   |
| **Design Case Renovated HVAC** |  187,001  |  116,136  |  24,533  |  211,009  |  4  |  538,683  |  71,414  | 11.7% |

# Existing Building Model

* 1. **Describe existing building baseline modeling.**
	2. **Building general description:**



* 1. **Fuel types:**

Electricity and natural gas are used.

* 1. **Existing HVAC systems.**

The existing HVAC consisted of air handling units, unit ventilators, and fin tube radiators. Unit ventilators are connected to a dual temperature water loop for both heating and cooling. Hot water is provided by gas boilers, and chilled water is provided by an electric chiller. All HVAC systems are being replaced in the proposed design.

* 1. **Site visit details**

The envelope is in satisfactory condition. The dual-fuel boilers are capable of burning No. 2 oil and natural gas, but currently only natural gas is being used. School personnel have indicated malfunctioning thermostats. Additionally, air dampers and other control devices have been disconnected and are non-operational.

* 1. **Details differing from SCA templates.**

Envelope conditions were modeled based on information from existing drawings. Lighting and equipment power densities were modified per the SCA *Modeling Guide for Existing Building Electrification*. Temperature setpoints were changed to reflect the malfunctioning thermostats.

* 1. **Utility Bill matching**

Utility bill matching was performed for electricity and natural gas. The matching was performed per the SCA *eQuest Modeling Guide for Existing Building Electrification* and using the SCA Appendix A calculator. It was not possible to match the electric demand. The profile of the modeled electric demand is of a similar shape to the profile from the utility bill, but the modeled demand is slightly higher. Matching the electric demand may require assumptions that deviate far from those specified in the Existing Building Electrification Guide.

# Energy Model Calibration Results

**3.1 Statistical Analysis:**

The CVRMSE and NMBE are referenced in Section 10.2.2 of the SCA *eQuest Modeling Guide for Existing Building Electrification.*



**3.2 Electric Consumption:**

****

**3.3 Gas Consumption:**



# Proposed Design Modeling Approach.

|  |  |  |  |
| --- | --- | --- | --- |
| **EEM Number and Description** | **Existing Building** | **Proposed Design** | **LL51 Baseline** |
| EEM1: Window Replacements | Existing WindowsU-1.25, SHGC-0.82 | New WindowsU-0.25, SHGC-0.36 | **Identical to Proposed Design** |
| EEM2: Lighting Upgrades and Kitchen Electrification | Fluorescent Lighting and Gas Kitchen | LED lighting with lower LPDs in the kitchen, cafeteria, mechanical rooms, and two classrooms. The kitchen is fully electric. | **Identical to Proposed Design** |
| EEM3: Heating Plant Electrification | 2 Gas Boilers, 80% efficiency2 Reciprocating Chillers, 2.7 COP | 2 Electric Boilers, 99% efficiency2 Heat Pump Chillers, 9.63 EER | No BoilersNo Chillers |
| EEM4: HVAC System Replacements | Existing AHUs, Unit Ventilators, and Fin Tube Radiators | All existing HVAC is replaced. The AHU condensing units have a higher efficiency and unit ventilators are served by the heat pump chiller. | System 3: Packaged VAV with parallel fan power boxesSystem 9: Packaged rooftop heat pump |
| EEM5: DHW Heat Pumps | Gas Water Heaters | Heat Pump Water Heaters | **Identical to Proposed Design** |

# Estimating Savings from EEMs



# Comparison of Existing and Proposed Building





# Appendix A: Side-by-side comparison

|  |  |  |
| --- | --- | --- |
| **Existing Building Baseline** | **Proposed Design** | **LL51 Baseline** |
| **Above grade walls**Brick at Full Height: **U-0.133 average**Face BrickAir Space1-1/2” Rigid XPS Insulation (R-5/inch)6” CMU, Solid-Grouted | **Above grade walls****Identical to Existing Building Baseline** | **Above grade walls****Identical to Existing Building Baseline** |
| **Below grade walls** Foundation Wall: **C-0.096**Concrete1-1/2” Rigid XPS Insulation (R-5/inch)Air Space4” CMU, Partially-Grouted | **Below grade walls** **Identical to Existing Building Baseline** | **Below grade walls** **Identical to Existing Building Baseline** |
| **Slab on Grade Floors**Slab on Grade: **F-0.73**Damp SoilConcrete | **Slab on Grade Floors****Identical to Existing Building Baseline** | **Slab on Grade Floors****Identical to Existing Building Baseline** |
| **Roof** Built-Up Roof: **U-0.138 average**Gravel Ballast5” Rigid XPS Insulation (R-5/inch)Concrete Slab on Steel DeckingConcrete Slab on Steel DeckingUninsulated parapet (U-1.282) | **Roof****Identical to Existing Building Baseline** | **Roof****Identical to Existing Building Baseline** |
| **Vertical fenestration** WWR: 17%Assuming ASHRAE A8.2 All Frame Types, Single GlazingU-1.25SHGC-0.82 | **Vertical fenestration**WWR: 17%U-0.45SHGC-0.40 | **Vertical fenestration****Identical to Proposed Design** |
| **Doors**Swinging Door: U-0.7 | **Doors****Identical to Existing Building Baseline** | **Doors****Identical to Existing Building Baseline** |
| **Lighting Power Density**

|  |  |
| --- | --- |
| **Zone Type** | **W/ft2** |
| Auditorium | 1.58 |
| Cafeteria | 1.33 |
| Classroom | 1.13 |
| Community | 1.75 |
| Conference | 0.70 |
| Copy | 1.25 |
| Corridor | 1.32 |
| IDF/MDF | 0.66 |
| Electrical Room | 0.98 |
| Elevator Lobby | 0.52 |
| Gymnasium | 1.88 |
| Kitchen | 2.00 |
| Library | 2.00 |
| Locker | 1.13 |
| Lounge | 1.10 |
| Mechanical Room | 0.90 |
| Media Room | 1.85 |
| Nurse | 2.00 |
| Office | 0.86 |
| Records | 2.00 |
| Restroom | 1.51 |
| Stair | 1.00 |
| Storage | 0.92 |
| Vestibule | 1.45 |

 | **Lighting Power Density**

|  |  |
| --- | --- |
| **Zone Type** | **W/ft2** |
| Auditorium | 1.58 |
| Cafeteria | 0.26 |
| Classroom | 1.05 |
| Community | 0.49 |
| Conference | 0.70 |
| Copy | 1.25 |
| Corridor | 0.47 |
| IDF/MDF | 0.66 |
| Electrical Room | 0.98 |
| Elevator Lobby | 0.52 |
| Gymnasium | 1.88 |
| Kitchen | 0.61 |
| Library | 2.00 |
| Locker | 0.93 |
| Lounge | 0.39 |
| Mechanical Room | 0.40 |
| Media Room | 1.85 |
| Nurse | 0.75 |
| Office | 0.66 |
| Records | 2.00 |
| Restroom | 1.50 |
| Stair | 1.00 |
| Storage | 0.91 |
| Vestibule | 1.45 |

 | **Lighting Power Density****Identical to Proposed Design** |
| **Equipment Power Density**

|  |  |
| --- | --- |
| **Zone Type** | **W/ft2** |
| Auditorium | 0.66 |
| Cafeteria | 0.25 |
| Classroom | 1.67 |
| Community | 1.96 |
| Conference | 1.96 |
| Copy | 2.87 |
| Corridor | 0.00 |
| IDF/MDF | 28.1 |
| Electrical Room | 0.00 |
| Elevator Lobby | 0.00 |
| Gymnasium | 0.00 |
| Kitchen | 10.81 |
| Library | 0.50 |
| Locker | 0.00 |
| Lounge | 1.96 |
| Mechanical Room | 0.00 |
| Media Room | 1.25 |
| Nurse | 9.07 |
| Office | 4.32 |
| Records | 0.00 |
| Restroom | 0.00 |
| Stair | 0.00 |
| Storage | 1.81 |
| Vestibule | 0.00 |

 | **Equipment Power Density****Identical to Existing Building Baseline** | **Equipment Power Density****Identical to Existing Building Baseline** |

|  |
| --- |
| **HVAC equipment** |
| **Existing Building Baseline** | **Proposed Design**  | **LL51 Baseline** |
| **Classroom Systems**Unit Ventilators* Dual temperature water loop for both heating and cooling
* Constant volume fan control
* No energy recovery

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Fan kW** |
| **UV-A** | 750 | 195 | 0.087 |
| **UV-B** | 1,000 | 555 | 0.087 |
| **UV-C** | 1,250 | 555 | 0.087 |
| **UV-D** | 1,500 | 555 | 0.087 |

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| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **UV-A** | 20 | 18.9 |
| **UV-B** | 53.3 | 51.8 |
| **UV-C** | 57.9 | 54.3 |
| **UV-D** | 63.0 | 55.3 |

Air Handling Unit serving 5th Floor Classrooms* DX Cooling Coil
* Hot Water Heating Coil
* Constant volume fan control assumed due to disconnected dampers
* No energy recovery
* Cooling Efficiencies assumed based on ASHRAE 90.1-1999 Table 6.2.1A
* Cooling Efficiency: 8.9 EER, 7.5 IEER

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-8** | 14,900 | 3,235 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-8** | 13.6 | 7.24 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-8** | 487 | 299 |

**Offices and Staff Systems**Air Handling Units* DX Cooling Coil
* Hot Water Heating Coil
* Constant volume fan control assumed due to disconnected dampers
* No energy recovery
* Cooling Efficiencies assumed based on ASHRAE 90.1-1999 Table 6.2.1A
* Cooling Efficiency: 8.9 EER, 7.5 IEER

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| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-4** | 7,500 | 2,700 |
| **AHU-6** | 13,570 | 825 |
| **AHU-7** | 12,000 | 1,000 |
| **AHU-10** | 7,770 | 2,270 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-4** | 6.35 | 2.10 |
| **AHU-6** | 11.6 | 6.64 |
| **AHU-7** | 11.2 | 5.53 |
| **AHU-10** | 7.22 | 2.56 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-4** | 289 | 192 |
| **AHU-6** | 406 | 169 |
| **AHU-7** | 373 | 105 |
| **AHU-10** | 295 | 278 |

**Cellar System serving Electrical/Mechanical and Storage Rooms**Air Handling Unit* No Cooling
* Hot Water Heating Coil
* Constant volume fan control
* No energy recovery

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| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-5** | 3,000 | 3,000 | 1.92 |

|  |  |
| --- | --- |
| **Unit** | **Heating Capacity (MBH)** |
| **AHU-5** | 227 |

**Gymnasium System**Air Handling Unit* DX Cooling Coil
* Hot Water Heating Coil
* Constant volume fan control assumed due to disconnected dampers
* No energy recovery
* Cooling Efficiencies assumed based on ASHRAE 90.1-1999 Table 6.2.1A
* Cooling Efficiency: 8.9 EER, 7.5 IEER

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-1** | 3,200 | 1,500 | 2.08 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-1** | 167 | 170 |

**Auditorium System**Air Handling Unit* DX Cooling Coil
* Hot Water Heating Coil
* Constant volume fan control assumed due to disconnected dampers
* No energy recovery
* Cooling Efficiencies assumed based on ASHRAE 90.1-1999 Table 6.2.1A
* Cooling Efficiency: 8.9 EER, 7.5 IEER

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| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-2** | 8,785 | 6,000 |

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| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-2** | 6.26 | 3.75 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-2** | 493 | 532 |

**Kitchen/Cafeteria System(s)**Cafeteria Air Handling Unit* DX Cooling Coil
* Hot Water Heating Coil
* Constant volume fan control assumed due to disconnected dampers
* No energy recovery
* Cooling Efficiencies assumed based on ASHRAE 90.1-1999 Table 6.2.1A
* Cooling Efficiency: 8.9 EER, 7.5 IEER

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-3** | 7,545 | 5,250 | 4.75 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-3** | 4.75 | No return fan |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-3** | 417 | 419 |

Kitchen Makeup Air Unit* No Cooling
* Hot Water Heating Coil
* Constant volume fan control
* No energy recovery

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-9** | 3,300 | 3,300 | 2.17 |

|  |  |
| --- | --- |
| **Unit** | **Heating Capacity (MBH)** |
| **AHU-9** | 250 |

**IDF/EMR Room Systems**Split AC Unit* DX Cooling Coil
* Heat Pump Heating
* No outside air
* Constant volume fan control
* No energy recovery

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Supply Fan kW** |
| **AC-3** | 205 | 0.174 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AC-3** | 16.1 | 9.2 |

**Heating/Ventilation Systems**Hot Water Unit Heaters* Serving mechanical rooms
* Hot Water Heating Coils
* No outside air
* Constant volume fan control

|  |  |
| --- | --- |
| **Unit** | **Heating Capacity (MBH)** |
| **UH-1** | 85 |
| **UH-2** | 40 |
| **UH-3** | 30 |
| **UH-4** | 75 |
| **UH-5** | 115 |
| **UH-6** | 32 |
| **UH-7** | 27 |
| **UH-8** | 32 |
| **UH-9** | 32 |

Fin Tube Radiators* Serving corridors, mechanical rooms, offices and the cafeteria
* Hot Water Heating
* Heating Capacity: 740 Btu/hr per LF
 | **Classroom Systems**Unit Ventilators* Dual temperature water loop for both heating and cooling
* Constant volume fan control
* No energy recovery

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Fan kW** |
| **UV-A** | 750 | 195 | 0.235 |
| **UV-B** | 1,000 | 555 | 0.276 |
| **UV-C** | 1,250 | 555 | 0.327 |
| **UV-D** | 1,500 | 555 | 0.327 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (kBtu/hr)** | **Heating Capacity (kBtu/hr)** |
| **UV-A** | 31.5 | 37.2 |
| **UV-B** | 40.5 | 52.1 |
| **UV-C** | 53.1 | 66.6 |
| **UV-D** | 53.1 | 80.0 |

Air Handling Unit serving 5th Floor Classrooms* DX Cooling Coil
* Heat Pump and Electric Resistance Heating
* Variable volume fan control
* No energy recovery
* Demand control ventilation
* Cooling Efficiency: 11.5 EER, 21.5 IEER
* Heating Efficiency: 3.6 COP

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-8** | 14,900 | 3,250 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-8** | 12.6 | No return fan |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-8** | 455 | 372 |

**Offices and Staff Systems**Air Handling Units* DX Cooling Coil
* Heat Pump and Electric Resistance Heating
* Variable volume fan control
* Energy recovery on AHU-4, 77% effectiveness
* Energy recovery on AHU-10, 79% effectiveness
* Demand control ventilation

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-4** | 7,500 | 2,700 |
| **AHU-6** | 13,600 | 3,400 |
| **AHU-7** | 12,000 | 3,000 |
| **AHU-10** | 7,800 | 2,270 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-4** | 7.06 | 5.54 |
| **AHU-6** | 11.2 | No return fan |
| **AHU-7** | 9.63 | No return fan |
| **AHU-10** | 7.39 | 5.49 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-4** | 254 | 121 |
| **AHU-6** | 514 | 389 |
| **AHU-7** | 455 | 345 |
| **AHU-10** | 256 | 97 |

Outdoor Condensing Units

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **EER** | **IEER** | **COP** |
| **AHU-4** | 11.5 | 21.5 | 3.6 |
| **AHU-6** | 11.5 | 21.5 | 3.6 |
| **AHU-7** | 11.5 | 21.5 | 3.6 |
| **AHU-10** | 11.5 | 21.5 | 3.6 |

**Cellar System serving Electrical/Mechanical and Storage Rooms**Air Handling Unit* DX Cooling Coil
* Heat Pump and Electric Resistance Heating
* Constant volume fan control
* No energy recovery
* Demand control ventilation
* Cooling Efficiency: 12.5 EER, 24.6 IEER

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-5** | 3,000 | 3,000 | 2.62 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-5** | 120 | 246 |

**Gymnasium System**Air Handling Unit* DX Cooling Coil
* Heat Pump and Electric Resistance Heating
* Variable volume fan control
* No energy recovery
* Demand control ventilation
* Cooling Efficiency: 12.1 EER, 23 IEER
* Heating Efficiency: 3.8 COP

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-1** | 3,200 | 1,500 | 2.73 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-1** | 142 | 194 |

**Auditorium System**Air Handling Unit* DX Cooling Coil
* Heat Pump and Electric Resistance Heating
* Variable volume fan control
* Energy recovery, 73% effectiveness
* Demand control ventilation
* Cooling Efficiency: 11.1 EER, 21.9 IEER
* Heating Efficiency: 3.6 COP

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-2** | 8,800 | 6,000 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-2** | 8.28 | 6.32 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-2** | 329 | 387 |

**Kitchen/Cafeteria System(s)**Kitchen/Cafeteria Air Handling Unit* DX Cooling Coil
* Heat Pump and Electric Resistance Heating
* Variable volume fan control
* Energy recovery, 75% effectiveness
* Demand control ventilation
* Cooling Efficiency: 12.1 EER, 23 IEER
* Heating Efficiency: 3.8 COP

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-3** | 7,600 | 5,250 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-3** | 7.08 | 5.68 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-3** | 283 | 247 |

Kitchen Makeup Air Unit* AHU-9 removed
* The kitchen is served by AHU-2

**IDF/EMR Room Systems**Existing Split AC Unit serving telecom space* AC-3 removed
* The telecom space is now served by AHU-5

New Split AC Units* DX Cooling Coil
* Heat Pump Heating
* No outside air
* Constant volume fan control
* No energy recovery

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Supply Fan kW** |
| **AC-E1** | 661 | 0.056 |
| **AC-E2** | 661 | 0.056 |
| **HP-1** | 581 | 0.056 |
| **HP-2** | 581 | 0.056 |
| **HP-3** | 399 | 0.030 |
| **AC-5** | 215 | 0.046 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AC-E1** | 22.5 | n/a |
| **AC-E2** | 22.5 | n/a |
| **HP-1** | 18.0 | 21.6 |
| **HP-2** | 18.0 | 21.6 |
| **HP-3** | 12.0 | 9.79 |
| **AC-5** | 12.0 | n/a |

|  |  |  |
| --- | --- | --- |
| **Unit** | **SEER2** | **COP** |
| **AC-E1** | 23.0 | n/a |
| **AC-E2** | 23.0 | n/a |
| **HP-1** | 23.0 | 2.5 |
| **HP-2** | 23.0 | 2.5 |
| **HP-3** | 23.0 | 2.5 |
| **AC-5** | 21.0 | n/a |

**Heating/Ventilation Systems*** Unit heaters and fin tube radiators will be replaced, but have not yet been specified on mechanical schedules

Fin Tube Radiators* Serving corridors, mechanical rooms, offices and the cafeteria
* Hot Water Heating
* Heating Capacity: 1080 – 1220 Btu/hr per LF

Hot Water Convectors* Serving toilets, stairs, storage rooms
* Hot Water Heating

Electric Unit Heaters* Serving mechanical and storage rooms
* Electric Resistance Heating

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Heating Capacity (kW)** |
| **EUH-1** | 2,100 | 25 |
| **EUH-2** | 2,100 | 25 |
| **EUH-3** | 350 | 3 |
| **EUH-4** | 350 | 3 |

 | **Classroom Systems**System 9: Packaged Rooftop Heat Pump* DX Cooling Coil
* Heat Pump Heating
* Cooling Efficiency: 14 SEER
* Heating Efficiency: 8 HSPF

System 3: Packaged VAV with Parallel Fan-Powered Boxes* DX Cooling Coil
* Electric Resistance Heating
* Variable volume fan control
* No energy recovery
* Demand control ventilation
* Cooling Efficiency: 10 EER, 11.6 IEER

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-8** | 15,131 | 3,223 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-8** | 13.1 | No return fan |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-8** | 471 | 569 |

**Offices and Staff Systems**System 3: Packaged VAV with Parallel Fan-Powered Boxes* DX Cooling Coil
* Electric Resistance Heating
* Variable volume fan control
* Energy recovery on AHU-4 and AHU-10, 50% effectiveness
* Demand control ventilation

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-4** | 8,518 | 2,700 |
| **AHU-6** | 12,865 | 3,383 |
| **AHU-7** | 11,683 | 3,003 |
| **AHU-10** | 7,889 | 2,272 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-4** | 7.25 | 6.44 |
| **AHU-6** | 10.8 | No return fan |
| **AHU-7** | 9.58 | No return fan |
| **AHU-10** | 7.15 | 5.32 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-4** | 280 | 161 |
| **AHU-6** | 498 | 514 |
| **AHU-7** | 446 | 473 |
| **AHU-10** | 253 | 122 |

Cooling Efficiency

|  |  |  |
| --- | --- | --- |
| **Unit** | **EER** | **IEER** |
| **AHU-4** | 11 | 12.4 |
| **AHU-6** | 10 | 11.6 |
| **AHU-7** | 10 | 11.6 |
| **AHU-10** | 10 | 11.6 |

**Cellar System serving Electrical/Mechanical and Storage Rooms**System 3: Packaged VAV with Parallel Fan-Powered Boxes* DX Cooling Coil
* Electric Resistance Heating
* Constant volume fan control
* No energy recovery
* Demand control ventilation
* Cooling Efficiency: 11.2 EER, 12.9 IEER

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-5** | 3,015 | 3,015 | 2.69 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-5** | 121 | 247 |

**Gymnasium System**System 9: Packaged Rooftop Heat Pump* DX Cooling Coil
* Heat Pump Heating
* Two-speed fan control
* No energy recovery
* Demand control ventilation
* Cooling Efficiency: 10.4 EER, 11.4 IEER
* Heating Efficiency: 3.2 COP

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** | **Supply Fan kW** |
| **AHU-1** | 3,197 | 1,499 | 2.79 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-1** | 143 | 194 |

**Auditorium System**System 9: Packaged Rooftop Heat Pump* DX Cooling Coil
* Heat Pump Heating
* Two-speed fan control
* Energy recovery, 50% effectiveness
* Demand control ventilation
* Cooling Efficiency: 9.3 EER, 10.4 IEER
* Heating Efficiency: 3.2 COP

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-2** | 8,878 | 6,002 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-2** | 7.96 | 6.07 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-2** | 329 | 389 |

**Kitchen/Cafeteria System(s)**System 9: Packaged Rooftop Heat Pump* DX Cooling Coil
* Heat Pump Heating
* Two-speed fan control
* Energy recovery, 50% effectiveness
* Demand control ventilation
* Cooling Efficiency: 9.3 EER, 10.4 IEER
* Heating Efficiency: 3.2 COP

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply CFM** | **Outside Air CFM** |
| **AHU-3** | 7,632 | 5,243 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Supply Fan kW** | **Return Fan kW** |
| **AHU-3** | 6.69 | 5.38 |

|  |  |  |
| --- | --- | --- |
| **Unit** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AHU-3** | 282 | 247 |

Kitchen Makeup Air Unit* No unit modeled

**IDF/EMR Room Systems**System 9: Packaged Rooftop Heat Pump* DX Cooling Coil
* Heat Pump Heating
* No outside air
* Two-speed fan control
* No energy recovery

|  |  |  |
| --- | --- | --- |
| **System** | **Supply CFM** | **Supply Fan kW** |
| **AC-E1-E2-HP-3** | 1,721 | 0.142 |
| **HP-1-2** | 1,162 | 0.136 |
| **AC-5** | 549 | 0.142 |

|  |  |  |
| --- | --- | --- |
| **System** | **Cooling Capacity (MBH)** | **Heating Capacity (MBH)** |
| **AC-E1-E2-HP-3** | 57 | 9.79 |
| **HP-1-2** | 36.1 | 76.8 |
| **AC-5** | 18.64 | n/a |

|  |  |  |
| --- | --- | --- |
| **System** | **SEER** | **HSPF** |
| **AC-E1-E2-HP-3** | 14 | 8 |
| **HP-1-2** | 14 | 8 |
| **AC-5** | 14 | 8 |

**Heating/Ventilation Systems**System 9: Packaged Rooftop Heat Pump* DX Cooling Coil
* Heat Pump Heating
* No outside air
* Two-speed fan control
* No energy recovery
* Cooling Efficiency: 14 SEER
* Heating Efficiency: 8 HSPF
 |
| **Heating plant** |
| **Existing Building Baseline**2 Natural Gas Boilers* 5,021 kBtu/hr each
* 80% thermal efficiency

1 Primary Boiler Pumps (plus 1 standby)* 518 GPM each
* 11.2 kW each

1 Secondary Boiler Pumps (plus 1 standby) for Perimeter Heating* 50 GPM each
* 1.6 kW each
 | **Proposed Design**2 Electric Boilers* 478 kBtu/hr each
* 99% thermal efficiency

1 Primary Hot Water Pump (plus 1 standby) for Perimeter Heating* 50 GPM each
* 1.4 kW each
 | **LL51 Baseline**No heating plant |
| **Cooling plant** |
| **Existing Building Baseline**2 Reciprocating Air Cooled Chillers* 100 tons each
* 2.7 COP per ASHRAE 90.1-1999 Table 6.2.1C

2 Primary Chiller Pumps (plus 1 standby)* 200 GPM each
* 4.0 kW each

1 Dual Temperature Water Pumps (plus 1 standby)* 312 GPM each
* 7.4 kW each
 | **Proposed Design**2 Heat Pump Chillers* Cooling Capacity: 1,378 kBtu/hr
* Heating Capacity: 1,445 kBtu/hr
* Cooling Efficiency: 9.63 EER, 13.14 IEER
* Heating Efficiency: 3.15 COP

2 Dual Temperature Water Pumps (plus 1 standby)* 280 GPM each
* 5.9 kW each
 | **LL51 Baseline**No cooling plant |
| **Domestic hot water heating** |
| **Existing Building Baseline**2 Gas Hot Water Heaters* Capacity: 500 kBtu/hr each
* 65% thermal efficiency
* One 74 gallon tank each (148 gallons total)
 | **Proposed Design**2 Heat Pump Water Heaters* Capacity: 108 kBtu/hr each
* 2.04 COP
* One 150 gallon tank for both units
 | **LL51 Baseline****Identical to Proposed Design** |

# Appendix B: Energy Model Outputs - Existing Building TMY3 with Current Utility Rates

***Existing Building Baseline***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:39:14 BDL RUN 7**

 **EXISTING BUILDING MODEL w/ STD WEATHER**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 248315. 2431. 376338. 0. 351909. 0. 19478. 496891. 0. 0. 0. 12473. 1507838.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 790. 35938. 0. 0. 0. 0. 0. 0. 6113. 0. 42840.**

 **TOTAL ELECTRICITY 1507838. KWH 13.128 KWH /SQFT-YR GROSS-AREA 13.128 KWH /SQFT-YR NET-AREA**

 **TOTAL NATURAL-GAS 42840. THERM 0.373 THERM /SQFT-YR GROSS-AREA 0.373 THERM /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 72.36**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 5870**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 895**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:39:14 BDL RUN 7**

 **EXISTING BUILDING MODEL w/ STD WEATHER**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1507838. KWH 313173. 0.2077 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 42840. THERM 53360. 1.2456 YES**

 **==========**

 **366533.**

 **ENERGY COST/GROSS BLDG AREA: 3.19**

 **ENERGY COST/NET BLDG AREA: 3.19**

***Proposed Design***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 15:13:54 BDL RUN 5**

 **DHW AND OTHER MEASURES**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 213391. 2431. 389412. 264170. 116450. 0. 20466. 205659. 0. 3. 21314. 12473. 1245772.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.**

 **TOTAL ELECTRICITY 1245772. KWH 10.846 KWH /SQFT-YR GROSS-AREA 10.846 KWH /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.15**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 6.76**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 141**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 135**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 15:13:54 BDL RUN 5**

 **DHW AND OTHER MEASURES**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1245772. KWH 361334. 0.2900 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 0. THERM 0. 0.0000 YES**

 **==========**

 **361334.**

 **ENERGY COST/GROSS BLDG AREA: 3.15**

 **ENERGY COST/NET BLDG AREA: 3.15**

***LL51 Baseline***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 12:35:41 BDL RUN 4**

 **ASH90.1-2016 NYC ECB MODEL**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 215015. 2453. 391576. 347701. 150672. 0. 4119. 176176. 0. 5614. 21332. 12473. 1327134.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.**

 **TOTAL ELECTRICITY 1327134. KWH 11.554 KWH /SQFT-YR GROSS-AREA 11.554 KWH /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.23**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.02**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 87**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 196**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 12:35:41 BDL RUN 4**

 **ASH90.1-2016 NYC ECB MODEL**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1327134. KWH 373610. 0.2815 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 0. THERM 0. 0.0000 YES**

 **==========**

 **373610.**

 **ENERGY COST/GROSS BLDG AREA: 3.25**

 **ENERGY COST/NET BLDG AREA: 3.25**

***EEM 1: Window Replacements***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:23:40 BDL RUN 2**

 **ENVELOPE MEASURES**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 248315. 2431. 376338. 0. 349040. 0. 17866. 505273. 0. 0. 0. 12473. 1511739.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 790. 25258. 0. 0. 0. 0. 0. 0. 6113. 0. 32161.**

 **TOTAL ELECTRICITY 1511739. KWH 13.162 KWH /SQFT-YR GROSS-AREA 13.162 KWH /SQFT-YR NET-AREA**

 **TOTAL NATURAL-GAS 32161. THERM 0.280 THERM /SQFT-YR GROSS-AREA 0.280 THERM /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 77.19**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 6529**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 432**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:23:40 BDL RUN 2**

 **ENVELOPE MEASURES**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1511739. KWH 310055. 0.2051 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 32161. THERM 39994. 1.2436 YES**

 **==========**

 **350049.**

 **ENERGY COST/GROSS BLDG AREA: 3.05**

 **ENERGY COST/NET BLDG AREA: 3.05**

***EEM 2: Lighting Upgrades and Kitchen Electrification***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:28:19 BDL RUN 3**

 **INTERIOR LOAD MEASURES**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 213391. 2431. 389412. 0. 342982. 0. 17876. 497544. 0. 0. 0. 12473. 1476111.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 0. 24943. 0. 0. 0. 0. 0. 0. 6113. 0. 31056.**

 **TOTAL ELECTRICITY 1476111. KWH 12.851 KWH /SQFT-YR GROSS-AREA 12.851 KWH /SQFT-YR NET-AREA**

 **TOTAL NATURAL-GAS 31056. THERM 0.270 THERM /SQFT-YR GROSS-AREA 0.270 THERM /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 74.71**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 6300**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 454**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:28:19 BDL RUN 3**

 **INTERIOR LOAD MEASURES**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1476111. KWH 301940. 0.2046 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 31056. THERM 38572. 1.2420 YES**

 **==========**

 **340512.**

 **ENERGY COST/GROSS BLDG AREA: 2.96**

 **ENERGY COST/NET BLDG AREA: 2.96**

***EEM 3: Heating Plant Electrification***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 17:30:45 BDL RUN 6**

 **HEATING PLANT MEASURES**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 213391. 2431. 389412. 408378. 314257. 0. 19099. 507322. 0. 0. 0. 12473. 1866767.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 6113. 0. 6113.**

 **TOTAL ELECTRICITY 1866767. KWH 16.253 KWH /SQFT-YR GROSS-AREA 16.253 KWH /SQFT-YR NET-AREA**

 **TOTAL NATURAL-GAS 6113. THERM 0.053 THERM /SQFT-YR GROSS-AREA 0.053 THERM /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 76.76**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 4.61**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 6261**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 2275**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 17:30:45 BDL RUN 6**

 **HEATING PLANT MEASURES**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1866767. KWH 444301. 0.2380 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 6113. THERM 8067. 1.3197 YES**

 **==========**

 **452368.**

 **ENERGY COST/GROSS BLDG AREA: 3.94**

 **ENERGY COST/NET BLDG AREA: 3.94**

***EEM 4: HVAC System Replacements***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 17:51:56 BDL RUN 7**

 **ALL HVAC MEASURES**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 213391. 2431. 389412. 264170. 116450. 0. 20466. 205659. 0. 3. 0. 12473. 1224458.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 6113. 0. 6113.**

 **TOTAL ELECTRICITY 1224458. KWH 10.660 KWH /SQFT-YR GROSS-AREA 10.660 KWH /SQFT-YR NET-AREA**

 **TOTAL NATURAL-GAS 6113. THERM 0.053 THERM /SQFT-YR GROSS-AREA 0.053 THERM /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.15**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 6.76**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 141**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 135**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 17:51:56 BDL RUN 7**

 **ALL HVAC MEASURES**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1224458. KWH 357618. 0.2921 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 6113. THERM 8067. 1.3197 YES**

 **==========**

 **365684.**

 **ENERGY COST/GROSS BLDG AREA: 3.18**

 **ENERGY COST/NET BLDG AREA: 3.18**

***EEM 5: DHW Heat Pumps***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 15:13:54 BDL RUN 5**

 **DHW AND OTHER MEASURES**

**REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 213391. 2431. 389412. 264170. 116450. 0. 20466. 205659. 0. 3. 21314. 12473. 1245772.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.**

 **TOTAL ELECTRICITY 1245772. KWH 10.846 KWH /SQFT-YR GROSS-AREA 10.846 KWH /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.15**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 6.76**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 141**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 135**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 15:13:54 BDL RUN 5**

 **DHW AND OTHER MEASURES**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- NEW YORK CENTRAL NY**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1245772. KWH 361334. 0.2900 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 0. THERM 0. 0.0000 YES**

 **==========**

 **361334.**

 **ENERGY COST/GROSS BLDG AREA: 3.15**

 **ENERGY COST/NET BLDG AREA: 3.15**

***Utility Matched Model***

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:42:57 BDL RUN 8**

 **EXISTING BUILDING MODEL**

**REPORT- BEPU Building Utility Performance WEATHER FILE- EPW NYC-CENTRAL-PARK**

**---------------------------------------------------------------------------------------------------------------------------------**

 **TASK MISC SPACE SPACE HEAT PUMPS VENT REFRIG HT PUMP DOMEST EXT**

 **LIGHTS LIGHTS EQUIP HEATING COOLING REJECT & AUX FANS DISPLAY SUPPLEM HOT WTR USAGE TOTAL**

 **------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- ------- --------**

**ME-M ELECTRICITY**

 **KWH 250171. 2453. 378475. 0. 363829. 0. 18260. 500821. 0. 0. 0. 12473. 1526483.**

**MF-M NATURAL-GAS**

 **THERM 0. 0. 796. 28259. 0. 0. 0. 0. 0. 0. 6062. 0. 35117.**

 **TOTAL ELECTRICITY 1526483. KWH 13.290 KWH /SQFT-YR GROSS-AREA 13.290 KWH /SQFT-YR NET-AREA**

 **TOTAL NATURAL-GAS 35117. THERM 0.306 THERM /SQFT-YR GROSS-AREA 0.306 THERM /SQFT-YR NET-AREA**

 **PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 74.63**

 **PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00**

 **HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 6256**

 **HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 478**

 **NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.**

**DOE 2.2 MEDIUM SCHOOL TEMPLATE DOE-2.2-50a 3/28/2024 9:42:57 BDL RUN 8**

 **EXISTING BUILDING MODEL**

**REPORT- ES-D Energy Cost Summary WEATHER FILE- EPW NYC-CENTRAL-PARK**

**---------------------------------------------------------------------------------------------------------------------------------**

 **METERED TOTAL VIRTUAL**

 **ENERGY CHARGE RATE RATE USED**

**UTILITY-RATE RESOURCE METERS UNITS/YR ($) ($/UNIT) ALL YEAR?**

**-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------**

**REG-ELEC-TARIFF ELECTRICITY ME-M 1526483. KWH 310267. 0.2033 YES**

**REG-GAS-TARIFF NATURAL-GAS MF-M 35117. THERM 43795. 1.2471 YES**

 **==========**

 **354062.**

 **ENERGY COST/GROSS BLDG AREA: 3.08**

 **ENERGY COST/NET BLDG AREA: 3.08**