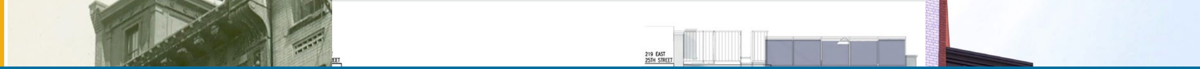

Engine 16

NEW YORK STATE OF OPPORTUNITY. | Buildings of Excellence

As part of the State's effort to achieve a carbon-neutral economy, NYSERDA initiated the Buildings of Excellence (BOE) Competition in early 2019. The competition recognizes and rewards the design, construction, and operation of very low- or zero-carbon emitting multifamily buildings.

nyserda.ny.gov/boe

Project Details

Location:
New York, New York

Project Area:
13,134 sq. ft.

Number of Buildings:
1

Number of Stories Per Building:
5

Number of Units:
4

Project Cost:
$8,400,000

Cost per Gross Square Foot:
$639.56

Market Sector:
Market Rate

Construction Type:
Gut Rehab

Construction Start Date:
January 2021

Completion Date:
July 2022

REDC Region:
New York City

Developer:
223 East 25th Street, LLC

Architect & Design Team Lead:
Baxt Ingui Architects

Technologies Used:
ASHP for HVAC, ERV, HP for DHW, PV, induction cooktop, and smart building controls

All-electric, adaptive reuse, multifamily and community building in New York City

Background

This adaptive reuse project rehabilitates the former Metropolitan Steam Fire Engine Company No.16 building in Manhattan's Kip Bay neighborhood. The space will be brought back to life through a full-scale, Passive House certified renovation and conversion into a four-unit multifamily residence with a community facility on the ground floor. Through open collaboration between the development and design teams, the general contractors, engineers, consultants, and Passive House certifiers, the Engine 16 project respects, celebrates, and extends the building's historical character while creating an energy efficient, carbon neutral building.

The design and development teams aim to create a replicable process for adaptive reuse projects and to educate others on resilient, energy-efficient building strategies. They hope that Engine 16 can become a model for Passive House certified retrofits of existing New York City buildings by demonstrating the possibilities of energy efficiency and carbon neutrality in a city setting.

Key Project Features

Engine 16 is an all-electric project that utilizes sustainable and resilient building strategies, such as a high-performing building envelope, daylighting, and energy-efficient mechanical equipment.

- ✓ **HVAC:** Minisplit air-source heat pumps (ASHP), energy recovery ventilation (ERV).
- ✓ **Water Heating:** ASHP
- ✓ **Envelope:** Interior insulated existing masonry wall.
- ✓ **Passive:** Passive House Institute (PHI) certification.
- ✓ **Lighting:** Light emitting diode (LED), daylighting, occupancy sensors areas.
- ✓ **Appliances:** Heat pump clothes dryers and induction cooktops.
- ✓ **Renewables:** On-site solar photovoltaic (PV).
- ✓ **Resilience Strategies:** Airtight envelope, mold resistance.

Predicted Site Energy Use Intensity (EUI): 9.3 kBtu/SF/yr

Net Site Energy Use Intensity (EUI): 7.4 kBtu/SF/yr

Predicted Renewable Production Intensity (RPI): 1.9 kBtu/SF/yr

Energy Code Baseline: 2016 NYS Energy Conservation Construction Code (ECCC)

Performance Path: PHI EnerPHit By-Component

Certification: EnerPHit Classic

Planning and Design Approach

Project Goals

A primary goal for the Engine 16 project team is to create solutions for rehabilitating and increasing the efficiency of existing buildings without sacrificing their historic character and design quality. As there are many buildings of a similar scale already in existence in NYC, Engine 16 could become an exemplary project to share a systematic approach to passive retrofits. By producing an efficient and aesthetically pleasing mixed-use historic renovation using Passive House methods, the project team can further promote the benefits of passive construction for tenants, the community, and the planet. Additionally, the team hopes to promote and foster a culture of beautiful, environmentally responsible building practices, and socially conscious living. The team is targeting no incremental initial cost and reduced operating costs for the lifetime of the building.

Front view rendering by Baxt Ingui Architects

Project Team

From the onset of the project, there has been close collaboration between the building owner, developers, design team, general contractor, engineers, and consultants, specifically:

- 223 East 25th Street LLC, the developer.
- Baxt Ingui Architects PC, the architect of record and the design team lead.
- RJD Engineering, LLC, the mechanical, electrical, and plumbing (MEP) engineer.
- blgtyp, llc, the Passive House consultant.
- Landmarks Preservation Commission and Department of Buildings.
- R. Sutton & Co LLC, the general contractor.
- Celin Munoz Consulting Engineer, PC, the structural engineer.

This continuous collaboration prevents re-design disruptions during construction and aids in the development of a replicable design and construction process. It also ensures the creation of a design that responds to changing environmental needs, while respecting the site's context and history. The development team also required the completion of Passive House Certified Installer courses for general contractors. All colleagues at Baxt Ingui Architects took Passive House Certified Designer courses.

Building Design

The design of Engine 16 is revitalizing the former Metropolitan Steam Fire Engine Company No. 16 through a full-scale, passive renovation. The building will be converted into a multifamily residence with a community facility. The design respects the history of the building and leaves the original façade completely intact, including the cast-iron base, the ornate terracotta brick details, the deep cornice, and the cast-iron firehose shed on the roof. The site is not part of a landmarked district, but the design team is treating it as if it were.

The design process began with an extensive zoning and code analysis to determine how best to maximize the square footage and efficiency of the building envelope. The team retained as much of the historic site as possible, focusing on salvaging the original structure and finishes. As a retrofit building, the project is seeking the PHI EnerPHit certification using the component method. This certification process was developed specifically for retrofit buildings with existing masonry walls. This method specifies the minimum U-factors necessary for each building component, rather than meeting demand limits for heating and cooling energy.

Along with the effort to salvage the structure and envelope, many other components will be repurposed and featured throughout the various spaces to preserve the original character of the firehouse, such as the following:

- The original third-floor wooden railing will be used for the mezzanine in unit number three.
- The red, cast-iron railing that was originally part of the staircase that led from the garage to the firemen's quarters will be moved to the original first-floor staircase.
- The nine-foot interior wood windows will be used as a partition between the second-floor hallway and the staircase.
- The original tin ceilings will be relocated and reinstalled in each unit's living spaces.
- The firehouse jacket hooks will be mounted in each apartment's entry space.
- Original floor joists that need to be replaced will be used as decorative elements, flooring, or donated to a local millworker. Original floor joists that were intact have been reinstalled as structural framing.
- The existing plank subfloor will be re-planed to create flooring material.

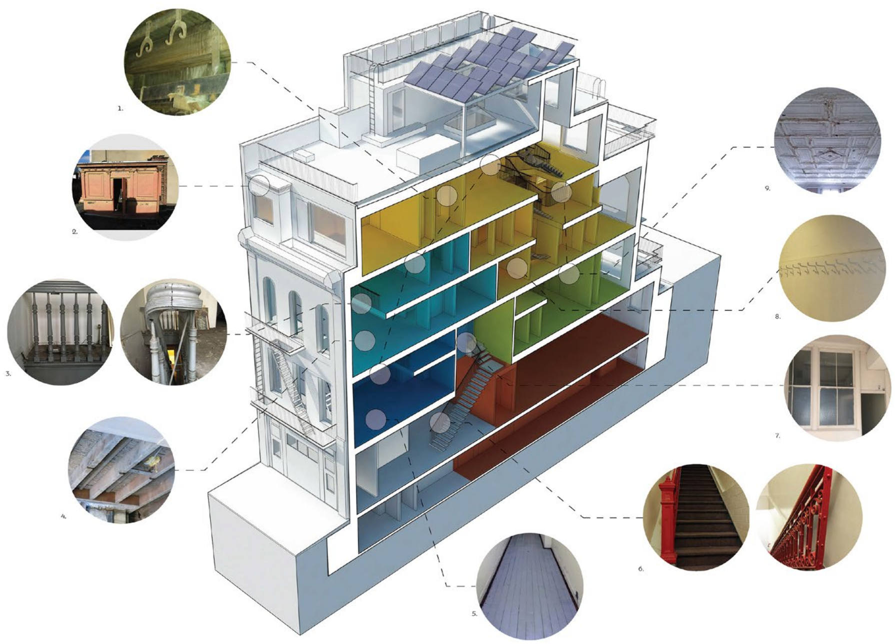

Diagram showing unit breakdown and the locations of the repurposed historical elements by Baxt Ingui Architects.

The building will consist of four apartments, one of which will be the owner's unit and a two-level community space on the first and basement levels. The project was designed mainly through sectional drawings and three-dimensional sketches and models to develop a complex arrangement of alternating double-height spaces and mezzanines.

Energy Modeling

The building is targeting PHI's retrofit certification, EnerPHit Classic, through the component method. By meeting the targets for primary energy demand along with envelope, fenestration, and ventilation efficiency, the team showed that retrofit projects in urban areas can meet Passive House certification standards with efficient electric mechanical systems and strategic envelope insulation.

Energy Model Inputs	
Certification Path	EnerPHit Classic
Software	EnerPHit with PHPP v9.6a
Residential CFA	5,092 ft2 (49%)
HVAC	3-ton Fujitsu HPs, SEER 11.7, HSPF 7.4
ERV	Central ERV, SRE of 0.81
DHW	Sanden CO2 HPWHs, 80 gallons
Thermal Bridges	Fully modeled, all included
Additional Loads	Electric clothes dryer, electric range

Energy Model Resultes	Target	Modeled
PER Demand (kBtu/ft²-yr)	24	16
Heating Demand (kBtu/ft²-yr)	N/A	8.6
Peak Heating Load (Btu/hr-ft²)	N/A	7.6
Cooling Demand (kBtu/ft²-yr)	N/A	3.1
Peak Cooling Load (Btu/hr-ft²)	N/A	4.8
Air Leakage (ACH at 50 Pascals)	1.0	1.0
Building envelope to exterior air (U-factor Btu/hr-ft²-°F)	0.05	0.03
Building envelope to ground (U-factor Btu/hr-ft²-°F)	0.06	0.06
Wall to exterior air (U-factor Btu/hr-ft²-°F)	0.09	0.05
Vertical windows/entrance doors (U-factor Btu/hr-ft²-°F)	0.18	0.17
Glazing (g-value)	0.19	0.51
Ventilation (effective heat recovery efficiency)	75%	81%

Energy Efficient, All-Electric Design

High-Efficiency Lighting Fixtures and Appliances

Along with LED lighting, the units within Engine 16 are equipped with ventless heat pump clothes dryers and electric ranges. All appliances in the apartments including refrigerators, dishwashers, and stoves will be high-efficiency or ENERGY STAR rated to provide maximum energy efficiency. Apartments will be furnished with energy efficient ceiling fans, which will reduce the need for air conditioning in temperate/warm temperatures and will distribute heated winter air that rises in the apartments' tall spaces.

Building Envelope

The most difficult part of meeting the PHI EnerPHit requirements for the Engine 16 project is the building envelope; most of the envelope is existing masonry walls, which need to be insulated on the interior. To maintain the integrity of the existing masonry, the team had to avoid over insulating. Therefore, the primary wall assembly is slightly under insulated when compared with a typical new Passive House build. The combination of efficient air sealing and insulation reduces the need for heating and cooling interior spaces by 80–90%.

The different components of the exterior envelope include:

- PHI certified, triple-glazed windows with a U-factor less than 0.18.
- Various above grade wall assembly types, all with R-values over 25.
  - New steel stud wall with exterior foam.
  - Existing masonry wall with wood studs and cellulose insulation.
  - Existing masonry wall with steel studs and mineral wool insulation at the cellar (below grade).
  - New masonry wall with cellulose interior insulation and exterior foam.
  - 2x4 steel stud wall with mineral wool batt insulation (interior walls only).
- Roof assembly with an R-value over 55.
- Below grade walls with R-values over 20.

The building uses a passive design to capture solar energy on the south facing facade without the use of mechanical or electrical devices. The south façade is equipped with exterior solar shades, which are more efficient than interior shades at preventing overheating since they block solar gain from high-summer sun by preventing it from entering the building altogether, thus reducing cooling needs. In the winter, when the sun is lower, solar gains passively heat the space and the high-performance windows retain this heat, reducing heating needs.

All-Electric Systems

Engine 16 is an all-electric design that incorporates maximum efficiency HVAC equipment. Heating and cooling is provided by a Fujitsu ASHP and is individualized through separate wall-mounted air handlers throughout most of the rooms in each unit. Domestic hot water (DHW) is provided through a Sanden ASHP that uses low-global warming potential CO_2 based refrigerant. The Ventacity ERV system in the residential portion of the building has 82% heat recovery and 70% energy recovery. This system is centralized, which avoids individual unit maintenance and is more energy efficient than having units in each dwelling space. The community facility will have its own dedicated Zehnder ERV system with 84% heat recovery.

Renewable Energy

There will be a solar electric PV array mounted to the steel canopy on the roof that is expected to produce about 20% of the total annual source energy. As the building is only 25 feet wide, it poses a challenge to add the PV system while still providing a usable outdoor space, a roof bulkhead for both private and public access, and the NYC Fire Department's required clearance path. To maximize roof space, the steel canopy will extend out from the bulkhead roof, nearly doubling the available PV area. While this is still not enough energy production to support the total energy demand, the PV system will be used to supply a future onsite battery system that will provide limited electricity during grid outages and blackouts. The system will be designed to utilize high-performance lithium battery systems in the future, once they can be installed within New York City limits. Until then, it will feed into the building's main electrical panel and will supply energy for the car charging station in the garage and deliver energy back into the grid.

Smart Building Technologies

Smart building technologies will be incorporated throughout the project and the team is exploring several options, including:

- **Lighting:** Common areas will be equipped with occupancy sensors and low-wattage LED lighting will be installed throughout. Exterior lighting will have dusk to dawn timers, and the apartments make use of natural daylight.
- **Whole-building controls:** The Ventacity heating, ventilation, and air conditioning (HVAC) 2 Smarter Building Platform—which was created through a partnership between Fujitsu and Ventacity—will monitor building energy use as well as temperature and humidity. These systems work together to enhance comfort, provide better zoning, and create a healthier indoor environment.
- **Domestic hot water (DHW):** The DHW system will have time of day control for the circulation loop.

Commissioning

Third-party inspections will be performed throughout the construction phases. Performance testing will be required prior to the completion of construction and the commissioning phase. All equipment will be tested and routine blower door tests will be performed to confirm proper installation of all systems and of the air barrier. The HVAC system will be carefully commissioned, and any flow rates that differ from the design will be updated in the as-built mechanical plans and energy model.

Building Operations

Leasing Structure

The Engine 16 building will have a market-rate rental structure where tenants are billed for utility usage, ensuring that the energy savings are returned directly to the residents. The owner who privately funds the building project and will occupy one of the units has a vested interest in the overall outcome and success of this project.

Historical photo of the fire crew in front of the Metropolitan Steam Fire Engine Company No. 16 building.

Cost Reduction

The relative construction cost is approximately on par with similar code compliant buildings. While the rental prices are 10% above comparable buildings, the relative energy cost per resident is expected to be at least 50% lower than that of comparable buildings.

Occupant Engagement

The management team will develop an educational process for tenants to help them understand the energy efficient and eco-friendly features of their units. Residents will also be able to engage with other sustainability features of the Engine 16 project that will enhance their ability to reduce carbon emissions. Bike racks will be installed in the lower-level common hallway, accessible by elevator for ease of use. There will be compost bins in the common area and the building will be enrolled in the city's Organic Collection Service to reduce waste. There will be a green roof where residents can enjoy the space surrounded by greenery and shade as well as grow their own plants in freestanding planters placed throughout the roof.

Energy Management

Electricity, heating, cooling, DHW, and water are directly metered. The HVAC incorporates wall-mounted air handlers so that individual rooms can be controlled by tenants and units can be turned off when they are not needed. Each air handler is monitored and billed directly to the tenant for their own usage, which should incentivize efficient energy use. Fujitsu has a new cloud-based software that collects usage data. By incorporating this system in the design, the building owner and manager will be able to track usage by unit and easily identify any issues. In the future, this system could be linked with Demand Response programs.

Additional Benefits

Adaptive Reuse

The Engine 16 project retrofits an existing masonry building. Originally a fire house, the building was converted to a church in 1974. It was partially used and then fell into disuse and disrepair. This new adaptation will utilize many of the original features, such as some stairs and railings, interior windows and doors, tin ceilings, flooring, and floor joists.

Site Context

The project is sited in a dense urban area in Manhattan's Kips Bay district and is in a deeply rooted place in the city's fabric and history. There are multiple nearby Citi Bike stations, providing tenants with easy access to transportation.

Community Engagement

The development team will host an open house during the construction process to educate the building community. And the building itself has the potential to both educate and provide an educational space for the immediate community. The large open bay area on the first floor can be used as an educational space before, during, and after construction to provide sessions including onsite builder training, educational seminars for architects and builders, and onsite awareness seminars for the realty and development community.

Occupant Health, Comfort, and Productivity

The dedicated ERV units supply constant filtered air and ensure high-quality indoor air. The airtight envelope with reduced thermal bridging severely limits the risk of mold growth. Passive House Institute certified windows provide both thermal and acoustic comfort, and the exterior shading on the south face improves summertime interior comfort. The skylights above the fifth floor and the large interior floor openings draw ample daylight down to the third and fourth floors in the top unit. The design limits the use of foam and plastic materials throughout.

Resiliency

In-depth existing masonry testing was performed to evaluate the moisture durability with interior insulation. The project team will thoroughly waterproof all existing below grade surfaces using the highest rated materials available and carefully install interior-side vapor and moisture control materials. Thermal bridge analysis for construction junctions, windows, and doors will be performed to ensure condensation resistance. Air-tightness compartmentalization will prevent air quality contamination between each apartment unit. During grid outages, limited electricity will be supplied by the battery system, which will be supplied by PV generation in the future.

Lessons Learned

Working through this retrofit project, the design and development teams learned a number of lessons that can help prevent cost increases, including the following:

- Involving a Passive House consultant during the schematic design phase can significantly reduce the need for redesigns. Continued involvement throughout the design development and construction phases will ensure that challenging details are collaboratively reviewed and solutions are worked into the construction document set.
- Thermal bridge analysis is key to identifying problem areas and checking solutions prior to construction.
- Using programs like the Passive House Planning Package (PHPP) allow the design team to confirm that the overall envelope and energy model are successful, reducing disruptions during construction.
- A properly trained general contractor is a crucial component for a cost-effective Passive House certified project. The Certified Passive House Tradesperson course (CPHT) conducted by the Passive House Network is valuable resource that provides such training.
- Baxt Ingui Architects arranges collaborative contractor meetings on their job sites, fostering the constant development of better designs, lower cost, and faster details. This has proven to accelerate the learning curve and lower the cost of completing a Passive House certified project.

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