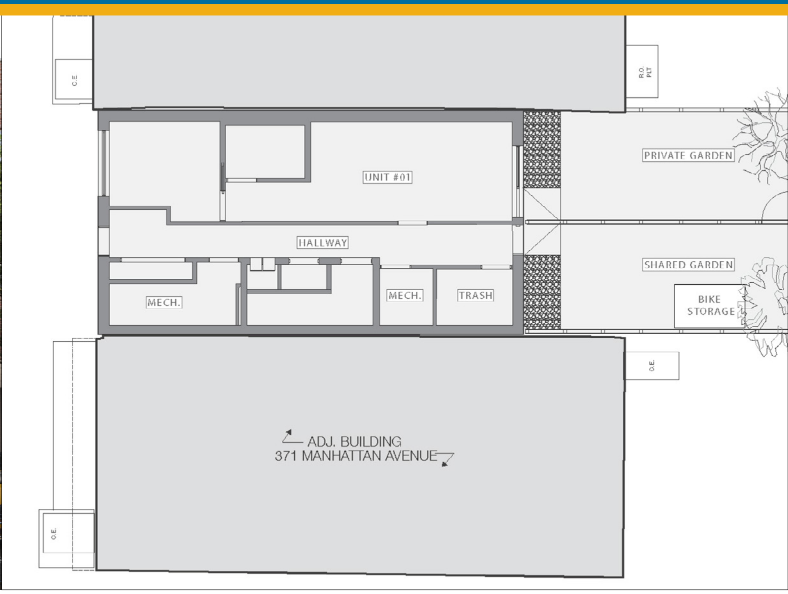
Street Smart: 369 Manhattan Avenue

NEW YORK STATE | 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:
Brooklyn, New York

Project Area:
4,463 sq. ft.

Number of Buildings:
1

Number of Stories Per Building:
4

Number of Units:
4

Project Cost:
$2,300,000

Cost per Gross Square Foot:
$515.35

Market Sector:
Market Rate Rental

Construction Type:
New Contruction

Construction Start Date:
2020

Completion Date:
December 2023

REDC Region:
New York City

Developer:
369 Manhattan LLC

Architect & Design Team Lead:
ZH Architects

Technologies Used:
PV, CO_2 DHW, VRF, ERV, induction cooktop, HP clothes dryers, panelized rain screen, foam glass foundation fill/insulation

All-electric multifamily, Passive House project

Background

Street Smart is a four-unit, multifamily Passive House project in Brooklyn, New York that is achieving carbon neutral performance. Utilizing an iterative design and analysis process, every aspect and component is carefully designed to reduce the building's energy use intensity (EUI) and carbon footprint. The design and development team hopes that Street Smart will act as a model to demonstrate the benefits of sustainable residential buildings and the high level of architectural design quality that this building typology can, and should, exhibit. The project incorporates both resiliency and sustainable strategies, focusing on passive survivability and a high-performing building envelope.

Key Project Features

This all-electric project is expected to consume 90% less energy for heating and cooling than a typical code-compliant building in New York City. By utilizing on-site solar photovoltaics (PV) and eliminating gas usage, Street Smart will have a very low-carbon footprint. Along with all-electric space conditioning and domestic hot water (DHW) equipment, the units are equipped with high-performing, electric appliances.

- ✓ **HVAC:** Variable refrigerant flow (VRF), energy recovery ventilation (ERV).
- ✓ **Water Heating:** Air source heat pump (ASHP) w/ CO_2.
- ✓ **Envelope:** Mineral wool and foam glass.
- ✓ **Passive:** Passive House Institute (PHI) certification.
- ✓ **Lighting:** Light emitting diode (LED), daylighting.
- ✓ **Appliances:** Heat pump (HP) dryer, induction cooktop.
- ✓ **Renewables:** On-site photovoltaic (PV).
- ✓ **Resilience strategies:** Passive survivability and storm resilience.

Predicted Site Energy Use Intensity (EUI): 8.8 kBtu/SF/yr

Net Site Energy Use Intensity (EUI): 1.1 kBtu/SF/yr

Predicted Renewable Production Intensity (RPI): 7.7 kBtu/SF/yr

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

Performance Path: PHI

Certification: PH Plus

Planning and Design Approach

Project Goals

Street Smart is an economical, replicable, desirable, efficient, and resourceful small-scale, high-performance multifamily building with a low-carbon footprint. Along with resilience and sustainability goals, the design focuses on architectural and urban design qualities. The project team believes that for sustainable buildings to gain consumer awareness and popularity, they must be beautiful, enticing, and high performing. Street Smart is a thoughtful addition to the neighborhood that will enrich its character and build upon the existing identity of the community.

Project Team

Street Smart was developed using an integrated project delivery approach that increased the efficiency in both the design and construction processes. The entire project team is experienced with Passive House construction in NYC, including the developer, 369 Manhattan LLC, as well as the engineer and architects: ZH Architects, RJD Engineering (mechanical) and A Degree of Freedom (structural). ZH Architects will be the design team lead; they also performed the energy modeling and Passive House certification in-house. This overlap in services optimizes the design and energy modeling process. The project has a unique multifamily real estate approach because the developer will also be an owner-operator residing in one of the units. Here, the developer has a personal, vested interest in a high-quality and low-energy development. As the operator, there is a financial interest in minimizing operating costs; as a resident, there is incentive to invest in good design techniques and high-quality construction.

Building Design

Street Smart is a four-unit, multifamily building in Brooklyn that maximizes the spatial efficiency of its small mid-block lot size. Through an iterative design and analysis process, the project team was able to create a high-performing and cost-effective design with a focus on the building envelope. From the form of the building to the envelope and windows, the building systems, and all of the appliances—every aspect will be on the leading edge of performance, while still using off-the-shelf materials. Specifying common construction materials and installation techniques eliminates the learning curve for the general contractor typically associated with Passive House projects. Street Smart will achieve carbon-neutral performance. Utilizing a dense and efficient layout, the high occupancy and ratio of usable space allow for greater energy efficiency per resident. In addition to a low-operational carbon footprint through efficiency, on-site PV, and no on-site fossil fuel combustion, the project includes materials that were chosen for their low-embodied carbon. The majority of the exterior walls use a mineral wool exterior insulation finish system (EIFS) system, and the slate façade was designed with wool and glass fiber reinforced cladding panels. These techniques limit the use of foam insulation, minimize the amount of overall material used, and utilize fully recyclable materials.

Aerial exterior rendering by ZH Architects

The façade design aligns with the surrounding context of the low-rise residential neighborhood while providing variety through depth, articulation, texture, and material. It is designed with vertical and horizontal slate tiles, which is consistent with the vernacular design of nearby façades. The design avoids a large number of industrial vent grills breaking the rhythm of the façade by using a central ERV shaft design. The design further enhances the site by including newly planted trees along the front sidewalk and rear yard. Permeable surfaces in the yard provide an enjoyable outdoor space while limiting stormwater runoff.

Energy Modeling

The building classifies as Passive House Plus and serves as an example of a hyper-efficient, all-electric, mid-rise building with renewable generation in New York City.

Energy Model Inputs	
Certification Path	Passive House Plus
Software	PHPP v9.5
TFA (% of Gross)	3,663 ft^2 (82%)
HVAC	Central ASHP, SEER 11, HSPF 5.6
ERV	Zehnder ERVs, SRE of 0.93
DHW	43 gal. HPWH per unit
Windows	U-factor: 0.15, SHGC: 0.51
Walls	R-26 to R-29
Cellar Slab	R-48
Roof	R-62
Thermal Bridges	None
Additional Loads	HP dryer, induction ranges

Energy Model Resultes	Target	Modeled
Air Leakage (ACH50)	0.6	0.6
Heating Demand (kBtu/ft^2-yr)	4.8	3.1
Peak Heating Load (Btu/hr-ft^2)	3.2	3.0
Cooling Demand (kBtu/ft^2-yr)	5.7	4.1
Peak Cooling Load (Btu/hr-ft^2)	3.4	3.0
PER Demand (kBtu/ft^2-yr)	14.3	12.9
PER Generation (kBtu/ft^2 roof-yr)	19.0	32.5

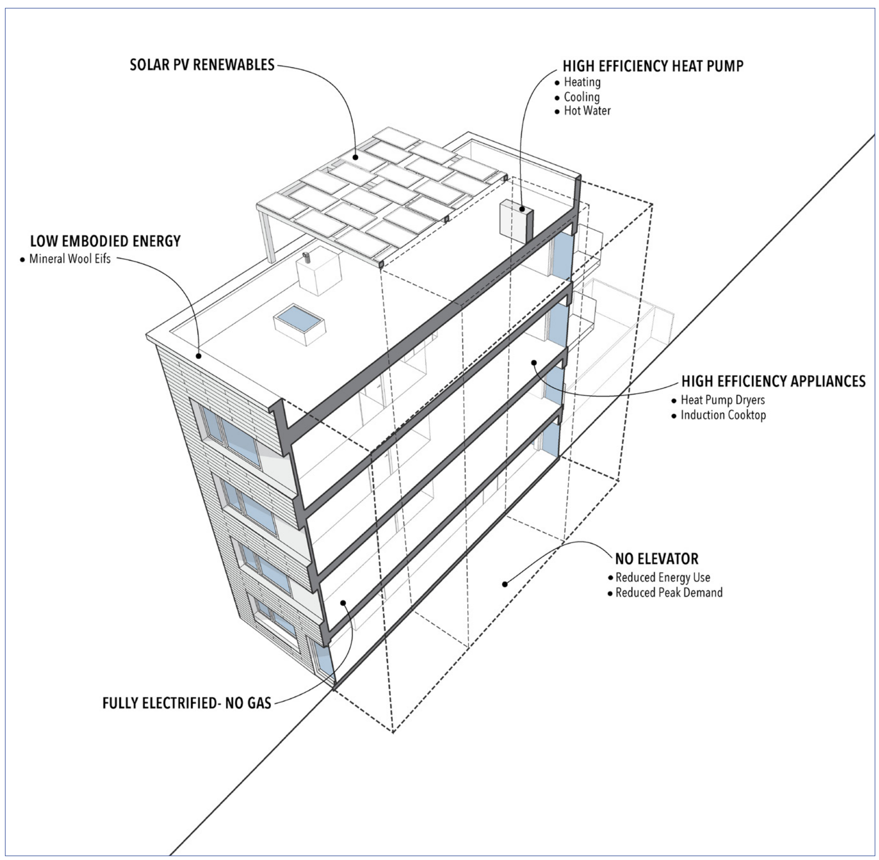
Energy Efficient, All-Electric Design

High-Efficiency Lighting Fixtures and Appliances

A All units are equipped with LED lighting and the glazing system is designed to maximize daylighting possibilities. Induction cooktops are provided in all dwelling units. Heat pump clothes dryers are used in place of gas dryers to further minimize energy use and avoid additional ventilation losses.

Building Envelope

The high-performing building envelope has continuous exterior insulation around the exterior walls, roof, and foundation. The exterior walls are clad with a mix of continuous rigid energy panel structures (EPS) EIFS and a mineral wool insulated rainscreen. The R-62 roof system includes exterior tapered rigid polyiso insulation over the roof deck with interior mineral wool batt insulation in the joist cavities. The foundation uses Glavel foam glass as the control fill, which acts as both an insulating material and the required structural subgrade. The building is designed with improved air tightness, minimized thermal bridging, and triple glazed, Passive House windows. The air barrier is on the interior structural wall to maintain a high-performance envelope design while alleviating the difficultly of air sealing a project that is built up against an adjacent building.



High efficiency systems and renewables diagram by ZH Architects

All-Electric Systems

All-electric heating and cooling is provided by a coupled ASHP-VRF system. A highly efficient ASHP water heater that uses CO_2 as its refrigerant reduces hot water energy use by 70% compared to electric resistance hot water heaters. Ventilation is provided through an ERV that performs 94% more efficiently than what is required under Passive House certification standards.

Renewable Energy

The project includes an on-site, rooftop solar PV array that has the capacity to produce about 10,060 kilowatt-hours per year (kWh/year), roughly 87% of the total annual site energy. The array sits on a lightweight canopy, which provides shading on the roof deck for tenant use, while still allowing HVAC equipment to fit on the roof.

Energy Consumption Feedback and Smart Building Technologies

The project team will install monitoring equipment to monitor total energy use, solar PV production, and unit-by-unit energy use break down. Total energy use will be monitored and compared to the projected energy use from the Passive House Planning Package (PHPP) energy model to see how well the building is performing. The collected unit-level information will be available to tenants via an online energy dashboard. This will allow residents to see their own usage in comparison to the other three units in the building. The project team believes this strategy will engage a friendly competition among residents and further drive energy-use reduction.

Common spaces, mechanical rooms, and utility rooms will be equipped with occupancy sensors. An energy monitoring system will cover the apartments, common areas, major sub-systems, and solar PV generation systems. Air-quality monitoring equipment will be installed to monitor temperature, humidity, CO_2 levels, and volatile organic compounds (VOC)/particulate levels. There are also individual HVAC controls in each room of the units.

Commissioning

Inspections and testing of the various systems and building components will be conducted periodically throughout construction. Educational mock-ups of key details, such as with the building envelope, will be built on site to allow all trades to understand their roles and coordinate early in construction. Interim and final blower door testing will be conducted by a third party. Both the ERV and HVAC systems will be commissioned by third parties to ensure they are installed properly and running at optimal performance. The project team will install Indoor Air Quality monitoring equipment to monitor interior temperature, humidity, CO_2 levels, and VOC levels.

Building Operations

Leasing Structure

Street Smart is a market-rate rental property. The tenants are billed for electricity (which includes heating and cooling) and water usage, although utility bills are expected to be very low due to the efficient design and on-site PV system.

Cost Reduction

The relative construction costs for Street Smart are 4% above comparable, code-compliant buildings prior to tax credits and incentives. The premium is small largely because of the project team's prior collective experience with Passive House design and construction. Heat pump water heater (HPWH) equipment and induction cooktops are more expensive than their gas counterparts, but these costs are offset by the elimination of gas lines and service. Similarly, buildings designed with a high-performance envelope save costs from reduced mechanical system sizes and less spatial requirements for mechanical systems.

Additional Benefits

Site Context

The enhancement of Street Smart reclaims an old asphalt parking lot, which had been overlooked for development for decades due to its small size. The building is designed with a particularly dense and efficient layout with no common hallways above the first floor and no elevator. This efficient layout means that the building has a high occupancy and high proportion of usable square footage given the zoning and height restrictions of the site. Most similar sites in the area provide fewer apartments or a single-family home on the same size lot.

The site is located within a quarter mile of two subways lines and multiple local and express bus route stops. There are also many parks and local commercial zones nearby.

Community Engagement

The development team plans to use the construction process as a way to educate and engage both the local community and others in the building sector. Informational placards will be placed at the construction site with explanations of the high-performing aspects of the building. These are intended to both generate interest in the project in the local market and to educate local communities about the benefits of Passive House buildings. Tours will be offered during construction phases through the Passive House Open Days event to give the public unique insight into the project. A blog will also be set up to record the construction process, emphasizing the economics and benefits of high-performing buildings.

Occupant Health, Comfort, and Productivity

The ERV system will use minimum efficiency reporting values (MERV) grade 13, or better, air filter to provide continuous fresh air throughout the building. The high-quality air filters keep outdoor pollutants, dust, and allergens out of the interior air. Studies show improved air quality can increase productivity and reduce the risk of illness. The airtight envelope is designed to avoid drafts, cold spots, and temperature asymmetry. The high-performing enclosure also limits sound transmission, making a more acoustically comfortable interior space. The windows are designed to be as large as possible, maximizing the amount of natural daylight that is able to penetrate the units. Outdoor space, both communal and private, is also provided for tenants.

Exterior rendering from Manhattan Avenue by ZH Architects

Resiliency

Street Smart will be durable and low maintenance, constructed to last 100 years. Concrete masonry units (CMU), utilized for the structure and envelope substrate, is a robust and long-lasting material choice. All mechanical equipment is located above grade within the apartments and on the roof, so the building does not require a basement. This equipment placement reduces the risk of damaging critical building systems during a flood. Adherence to Passive House design strategies, such as a highly insulated building enclosure, high-performance and optimized windows and doors, airtight envelope, thermal bridge-free construction, and high-performance ERVs, inherently increase the resilience and passive survivability of the building. These components, for instance, help keep the interior temperatures at safe, livable levels during extended periods without power.

Lessons Learned

By working through Street Smart's careful design process and relying on their previous Passive House certified design experience, the design team has several lessons learned that can be applied to similar residential projects to produce attractive high-performance buildings.

- **Experienced and integrated team:** An integrated design team is essential to provide successful and efficient design and construction. In this case, the developers, architect, mechanical engineers, and structural engineers are also experienced with Passive House construction, and the architect performs energy modeling and Passive House certification in-house, which further optimizes the design and energy modeling process.
- **Attractive design:** The design team believes that for high-performance sustainable buildings to become mainstream, they must be beautiful and enticing as well. Design quality and urban design are a main focus in this project through:
  - **Context and material sensitivity:** The design is sensitive to the existing context by maintaining height consistent with the existing buildings on the street. The street facade is designed with slate façade tiles that complement the vernacular façades of nearby buildings. The photovoltaic (PV) panels are only glimpsed from the street and an innovative common energy recovery ventilation (ERV) shaft design avoids numerous industrial ventilation grills.
  - **Communal spaces and nature access:** Outdoor spaces with access to nature and vegetation are prioritized for their benefits to health and wellness. Three out of four units have a private outdoor space, and additionally, there is a communal rear garden. The PV canopy is patterned to create shaded roof space with attractive dappled lighting.
  - **Quality of space:** The glazing is carefully calibrated to meet strict energy-performance targets, while still offering expansive views to the street and rear garden as well as enabling daylight penetration to create bright comfortable interiors. The mechanicals and services use open-steel joists without drop ceilings, which allow for healthy and comfortable ceiling heights, despite fitting in four stories where all neighboring properties only fit three stories.

- **Cost-Effectiveness:**
  - **Shortening learning curves:** A major driver of increased costs in high-performance buildings is the contractor learning curve. Through their extensive Passive House construction experience, the design team alleviated this issue by carefully simplifying details and installation sequencing as well as specifying conventional materials (such as exterior insulation finish system (EIFS) with water-resistive barrier for air barriers).
  - **Cost-effective systems:** Another cost minimizing strategy is the selection of high-performing, yet cost-effective equipment and systems, such as ductless HVAC components, drained EIFS systems on non-street facades, and high-performance uPVC windows.
  - **Innovative ventilation strategy:** ERVs usually have separate exhaust and supply ducts to the exterior, which require extensive ducting, soffits, and envelope penetrations with expensive waterproofing and thermal breaks. This project combines the exterior ducting for all units into a single centrally located common shaft, reducing duct lengths by 90% and providing efficient duct runs to living spaces. This also reduces the costs for associated insulation, attachments, fittings, and exterior grills and penetrations.
  - **Low-impact foundation:** Foundations can be one of the largest construction costs due to the potential for significant excavation, underpinning, and costly structural systems. Through the lower tonnage HVAC requirements, the absence of gas service, and the relocation of equipment to apartments and the roof, the project does not need a basement, resulting in significant material and cost savings.
- **Simple, replicable design:** The design focuses on using common building materials and construction methods.
  - **Air sealing:** Typically, it is difficult to air seal a project that is built up against an adjacent building. Through experience and hygrothermal modeling, the team has shown that it is equally effective—and much easier—to shift the air barrier to the structural wall interior, dramatically decreasing installation time and complexity, and simplifying inspections and maintenance by making the air barrier visible. The design also includes a foundation stem wall projecting up above the grade level. By raising this juncture, this critical connection becomes easier to install and protect during construction.
  - **Open-web floor framing:** The design allows easy installation of the variety of mechanical, electrical, and plumbing services. The foundation includes a plenum space which allows flexibility for routing of utilities and services. The floor structure is composed of open-web steel joists with openings that allow services to run through the floor structure, creating flexibility and reducing additional construction of soffits and drop ceilings.
  - **Window and exterior door detail:** For the best thermal performance, high-performance windows and doors should be located in the plane of the exterior insulation, but this requires a structural cantilever and adds air sealing and accessibility challenges. The design solves this issue with a simple wood blocking, which has low-conductivity, high-tensile strength and is familiar to any carpenter.

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