THE WORLD’S TALLEST AND LARGEST RESIDENTIAL PASSIVE HOUSE

THE HOUSE AT CORNELL TECH
NEW YORK, NY
Vision

The House at Cornell Tech forms the cornerstone of the university’s 2.1 million sf Roosevelt Island Technology Campus and the hub of student life. Currently the world’s tallest and largest residential Passive House certified building, it establishes a new precedent in low energy, sustainable high-rise design. The tower also provides students, staff and faculty with an inspiring and inclusive living environment that reinforces the social and intellectual connectivity at the heart of the school’s ethos.

Challenge

The most rigorous international energy building standard is known as Passive House. It aims to reduce energy use by 60-70%, while creating healthier and more comfortable living environments.

The House at Cornell Tech took Passive House design into uncharted territory, prompting unparalleled levels of innovation. The main challenge: a 26-story high building, located in a region where average temperatures range from 23°F (-5°C) in winter to 86°F (30°C) in summer.
Solution

As lighting designers and engineers for structure, mechanical, electrical and plumbing, BuroHappold played a key role in supporting the development of a high performance facade, well insulated building envelope and highly efficient indoor environmental systems to reduce energy use and carbon emissions. Prefabricated, insulated facade panels work in tandem with energy recovery ventilation and a low-energy heating and cooling system to provide residents with exceptional air quality and temperature control all year round.

Value

A combination of fearless ambition and groundbreaking design, The House signals Cornell Tech’s position as leaders in the field of tech education – now and for the future. It supports the school’s academic mission, providing residents with a high quality environment for living and learning, while also raising the bar for future sustainable development in New York and beyond.
Passive House is an international building standard, developed to drastically reduce energy use while providing a healthier and more comfortable indoor environment for occupants. It sets specific performance criteria, and requires designers and contractors to identify the best design and construction strategies to achieve these criteria for a project.

Reduced energy use also lowers utility costs, a key tenet of Passive House’s “do more with less” philosophy.

WHAT IS PASSIVE HOUSE?

PASSIVE HOUSE CRITERIA

38.1 kBTU/SF.YR source energy

4.75 kBTU/SF.YR heating energy

5.39 kBTU/SF.YR cooling energy (specific to this project’s climate)

0.60 maximum air changes per hour at 50 Pascals from whole-building pressure test

PASSIVE HOUSE PRINCIPLES

Over 75% reduction in heating and cooling energy consumption compared to average new construction

Requires a high performance enclosure

Passive building maintains consistent temperatures

Ventilation system is balanced for neutral pressure in the building

Requires heat recovery from all exhaust air

Leads to superior user comfort and building durability
While the concept of Passive House was not new to New York City, realizing it at the scale of The House presented a timely opportunity for the city as it pursues its own ambitious agenda for reducing greenhouse gas emissions, in line with the Roadmap to 80x50.

The House has therefore been a beneficial case study with city officials and certifying entities – the design team worked closely with these partners and more to ensure all building code and certification requirements were met.
Looking forward, New York City is establishing energy efficiency targets based on actual averages determined by NYC building data collected over the past years.

The 67-70 EUI target shown above represents what The House requirement would have been under this new system – still nearly twice that of the resulting building.

**EUI = Energy Use Intensity**: a ratio of energy use per year (kBtu/year) divided by the area of the building (square feet). Source EUI accounts for the energy used at the building as well as energy transmission, delivery and production losses attributable to the building. This metric allows for benchmarking and comparison within building types. As shown here, the EUI values of 133.9 and 140.8 kBtu/sf.yr represent the residential buildings in the New York City Local Law 84 database, as of the data collected through 2013 when we started the design of this project.
A HOME FOR INNOVATION

A revolutionary education and entrepreneurship campus, Cornell Tech is bringing together academia and industry to catalyze pioneering technologies and create new leaders for the digital age. Pulling out all the stops to achieve new levels of sustainability, The House is the first step toward making Cornell Tech campus one of the most energy-efficient in the world.
From concept to completion, we worked with Cornell Tech, the wider project team and the City of New York to realize Passive House on a greater scale than ever before. Taking advantage of this project’s ambition and unique location, we turned challenges into opportunities and set an inspirational new precedent for high performance sustainable design. The project participated in the NYSERDA Multifamily Performance Program to obtain incentives and achieve ENERGY STAR certification. Additionally, The House achieved LEED Platinum as well as Passive House certification.
Compact form

The building’s low surface-to-volume ratio reduces thermal transfer between inside and outside, helping the building stay cool in summer and warm in winter.

Careful positioning

The House’s north-south orientation maximizes solar gain in winter and minimizes gain in summer. With a form that minimizes the east and west exposures, the cooling system will not be required to handle all the low-angle sun, particularly from hot summer afternoons. The broad southern exposure, by contrast, invites ample daylight from the orientation where the sun is highest in the sky and therefore has less of a negative impact on cooling loads.
Reaching new heights

The largest Passive House project in the world

**Completed 2017**
**26 Stories**
**352 Units**

**Total Area**
**272,500 SF**
**10,600 GSF/Floor**
**270 Feet to Roof**
Superinsulated, airtight enclosure

The building enclosure plays a critical role in maintaining a comfortable interior environment using minimal energy.

- Prefabricated metal panels help to ensure a higher quality envelope along with additional insulation and continuous water/vapor barriers.
- Triple-glazed windows on the residential floors have an assembly U-value of 0.193; this is compared to the NYC code requirement of 0.40.
- Facade panels, windows, building joints and connections are sealed to minimize heat transfer.
- Thermal breaks in the structure, and careful mechanical equipment locations were coordinated closely with the design team to ensure a successful thermal envelope.
Constructing the first Passive House residential high rise in the world is the latest and most exciting example of our effort to set new benchmarks in sustainability and innovation. We hope this will serve as a model for how Passive House standards can be brought to scale in the United States and create a new template for green design here in New York City.

Daniel Huttenlocher
Dean, Cornell Tech
Balanced ventilation and energy recovery

Efficient energy recovery ventilation (ERV) is required by Passive House to provide a steady supply of fresh, tempered air for health and comfort.

- Two rooftop ERV units serve the residential floors. A third ERV on the second floor serves floors 1-2. As incoming and exhaust air pass through the ERVs, heat and humidity are exchanged, producing a constant supply of dry, tempered air.
- Dampers are set to balance supply and exhaust air flow. Using Aeroseal® on these ducts significantly reduced leakage and improved air flow.
- Kitchen and bathroom exhaust were combined to facilitate the balance of air flows. We liaised closely with city officials to gain approval for this design, which was an exception to local codes.
- To achieve the required heat recovery, the ERVs are protected against frost and humidity. Their rooftop location also keeps mechanical noise below an already quiet 35 decibels.
Low-energy heating /cooling

A variable refrigerant flow (VRF) system adds an energy efficient boost of heating during New York’s chilly winters, and cooling during the hot summers. Each pair of residential floors is served by two stacked condenser rooms: one condenser room serves two floors of north-facing apartments, and the other condenser room serves two floors of south-facing apartments.

A metal grill enclosure, painted to echo the facade palette, hides a "mechanical balcony" that houses the condenser for each floor.

Indoor evaporator units in each apartment give residents complete climate control, while individual billing and building dashboards influence behavior.
Concrete-to-concrete thermal separation

The efficient concrete structure is detailed to eliminate thermal bridging at the facade, roof, foundation and exterior elements such as the entry canopy and mechanical balconies, in some cases using specialized components. Our design employs Schöck Isokorb® thermal isolators at the concrete-to-concrete balcony assemblies, load-bearing thermal isolators for rooftop equipment footings, and thermally broken CMUs.
Low energy lighting

Special consideration was given to selecting light fixtures that meet Passive House requirements. LED fixtures are used throughout The House, dramatically reducing lighting energy use by 36% under ASHRAE 90.1-2007 standards.

- Our lighting design accommodates the differing energy and program needs of each space throughout the building, to create inspiring and comfortable conditions for students and faculty.

- The lobby lighting achieves a number of separate yet harmonious moods. From providing visitors with a warm welcome, to well-lit study spaces and more muted areas for lounging and socializing.

- At night, a custom LED feature concealed in the entrance canopy animates the vertical metal screen of the Manhattan-facing mechanical balconies, elevating an integrated design measure into a visual symbol that defines The House as a beacon for Cornell’s new campus.
Sealed ducts

In a typical building, air lost through leaky duct work means more energy is required to heat or cool a building and circulate air. With The House the use of Aeroseal, a polymer sealant blown through the ducts, reduced leakage by more than 90 percent, greatly improving energy efficiency.

Whole building leakage requirements & results

Sealed envelope construction

A whole-building pressure test measures total leakage through the building envelope - with external windows and doors closed - to ensure a project achieves the Passive House criteria. The results of the test on June 3rd, 2017 resulted in a measured airtightness of just 0.13 air changes per hour (ACH50) at 50 pascals – an exceptionally successful result against the maximum 0.60 ACH50 criteria. Based on calculations by Steven Winter Associates, 0.60 ACH50 is approximately equivalent to 0.15 CFM/SF for this building.

Note: CFM/SF at 50 Pa has been estimated as 66.5% of CFM/SF at 75 Pa where applicable so units are comparable in the graph shown above.

Note: Emmerich and Persily (2014) provide six-sided average results from 79 buildings with an air barrier from the NIST US Commercial Building Air Leakage Database.
WHAT’S NEXT?

As cities worldwide strive for leaps in building performance, The House at Cornell Tech exemplifies the collaboration needed to achieve these gains. With everyone at the table – owner, builder, design team, regulatory agencies, and certifying entities – further breakthroughs in Passive House and other sustainable design strategies are within reach.
World’s *tallest* and largest Passive House residential building

- 26 stories high
- Total area: 272,500sf
- 352 residential units
- Amount of CO₂ saved each year*: 882 tons, equal to*: 5,300 trees planted
- Cornerstone of Cornell Tech’s new 2.1 million sf campus
- Certified LEED Platinum
- Obtained incentives from the NYSERDA MPP
- Attained Passive House accreditation

* Projected savings
# The House at Cornell Tech

New York, NY

## Project Team

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<thead>
<tr>
<th>Role</th>
<th>Company/Consultant</th>
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<tbody>
<tr>
<td>Owner</td>
<td>Cornell Tech</td>
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<tr>
<td>Co-owner</td>
<td>The Hudson Companies</td>
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<tr>
<td>Co-owner</td>
<td>Related Companies</td>
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<tr>
<td>Architect</td>
<td>Handel Architects</td>
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<tr>
<td>Structural engineering, MEP, lighting design, concept Passive House feasibility</td>
<td>BuroHappold Engineering</td>
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<tr>
<td>Facade consultant</td>
<td>Vidaris</td>
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<tr>
<td>Sustainability and Passive House consultant</td>
<td>Steven Winter Associates</td>
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<tr>
<td>General contractor</td>
<td>Monadnock Construction</td>
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ABOUT BUROHAPPOLD ENGINEERING

BuroHappold is an independent consultant engineering practice with an international presence. Over 41 years, our name has become synonymous with the delivery of elegant, efficient and resilient engineering that responds to the challenges of our ever changing world. With a global network of 23 offices, including five in the US, we have worked on every continent and our clients include most of the world’s leading architectural practices.

Our core offering of structural and MEP services, complemented by our suite of specialisms and strategic urban expertise, enables us to creatively integrate sound engineering principles and advance high performance design in all our projects. Our interconnected global community of professionals is committed to pushing the boundaries of engineering design, combining creative thinking with the latest technologies to realize iconic projects.

Projects from top right

CORNELL TECH, EXECUTIVE EDUCATION CENTER
New York, NY
Architect: Snøhetta
Image: Snøhetta

THE TOWER AT PNC PLAZA
Pittsburgh, PA
Architect: Gensler
Image: Connie Zhou

ARIZONA STATE UNIVERSITY, BEUS CENTER FOR LAW AND SOCIETY
Phoenix, AZ
Architect: Ennead Architects
Image: Bill Timmerman, Timmerman Photography, Inc

NEW YORK CITY’S ROADMAP TO 80 X 50:
AN INTEGRATED RESPONSE
New York, NY
WE MAKE THE VISION VIABLE

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