# TH TREEHOUSE

## by engiNUity

**Northwestern University**
Multifamily Building



## The Concept

TreeHouse is a net-positive, low lifecycle carbon, economically diverse development that addresses both Chicago's lack of diverse housing options and the built environment's contribution to $CO_2$ emissions. Multifamily buildings often maximize the number of units at the expense of the climate and their residents. TreeHouse's holistic approach to sustainability starts with passive design strategies to optimize natural ventilation, daylighting, and energy loads in Chicago's harsh, heating-dominant climate. Geothermal and solar energy, high-efficiency HVAC and greywater systems, natural and recycled materials, super-insulated and continuous envelopes, and prefabrication reduce both the operational and embodied carbon of our building. The first two floors of TreeHouse are dedicated to commercial spaces designed to provide valuable resources to residents of all income levels, including a grocery store, daycare center, doctor's office, library, tutoring center, gym, and local retailers. By developing green infrastructure on the riverfront, TreeHouse improves the urban environment to further the vision of a "Wild Mile", a proposed expanse of green space on Chicago's waterfront. Through cost savings from prefabrication, Low Income Housing Tax Credits, and sustainability rebates, TreeHouse achieves lower lifecycle costs than baseline construction. Altogether, TreeHouse pioneers the future of multifamily housing developments.

## Local Context

TreeHouse is located on the riverfront across from Goose Island, Chicago, at the intersection of two major roads, Halsted and Division. The site is adjacent to Chicago bus #8 and #70, and is a 10-minute walk away from a commuter rail station. This connectivity helps provide customer traffic to TreeHouse's commercial spaces and makes the area attractive for residents. The site is near the former location of the Cabrini Green public housing projects, which were multifamily apartment buildings torn down between 1995 and 2011. Cabrini residents were promised replacement housing and well-paying construction jobs, which were unfortunately never received. The surrounding neighborhood has transformed demographically, making it difficult for former Cabrini residents to move back to this area, due to rising home costs. TreeHouse is uniquely situated to provide the area with more affordable housing options as well as commercial spaces to energize the local economy and resident experience.

TreeHouse's site is predominantly oriented to the southwest, along the North Branch of the Chicago River. The adjacency to the river results in an extremely high water table, and the southwest facade is optimal for natural ventilation, but receives glare. Chicago's cold winters and hot, humid summers further make net-zero design difficult.

## Technical Specifications



### Lot
| | |
|---|---|
| Gross Area | **84,500 sq ft** |
| Usable Area | **69,000 sq ft** |
| | **(40' river setback)** |

### Basics
| | |
|---|---|
| Total Area | **334,035 sq ft (10 stories)** |
| Commercial | **121,403 sq ft** |
| | **Doctor's Office, Daycare, Grocery, Tutoring, Library, Gym, Retail** |
| Residential | **212,632 sq ft** |
| | **160 units (25% AH)** |
| Total Cost | **$126 million total ($377/sq ft)** |

### Envelope
| | |
|---|---|
| Walls: | **R-40** |
| Ceiling: | **R-60** |
| Floor: | **R-38** |

### Systems
**1688 kW** Solar PV
**294 ton** Geothermal
**40Kgal/d** Greywater

### Performance
| | |
|---|---|
| EUI w/o PV: | **18.67** |
| EUI w/ PV: | **-2.89** |
| $CO_{2e}$ Cut: | **-50.8%** |

## 1. ARCHITECTURE

Passive design strategies optimize natural ventilation and daylighting to maximize energy efficiency and comfort. Two floors of commercial spaces include local businesses, a doctor's office, a daycare, and a grocery store to provide quick access to everyday needs. Residential floors consist of one, two, and three bedroom units to fit a wide range of residents, with a double-story shared space to prioritise community engagement and interaction.

## 2. ENGINEERING

A borehole array and energy pile foundation supply geothermal energy to a water-source VRF system to provide heating and cooling. A direct-outdoor air system (DOAS) with energy recovery provides ventilation. The timber structure reduces steel and concrete use, minimizing embodied carbon, and it integrates with a prefabricated wall system, reducing construction time and waste. Greywater treatment and low-flow fixtures minimize water consumption .

## 3. MARKET ANALYSIS

A Rent-to-Own model provides an equitable opportunity for low-income residents to develop roots within the new building. Low Income Housing Tax Credits subsidise the cost of the building's affordable units, providing 11% overall construction cost reductions. Prefabricated structural systems, and various renewable energy incentives and rebates further offset construction & maintenance costs. Overall, TreeHouse's 30-year lifecycle construction cost is 340/sqft, 30% below Chicago's $488/sqft baseline.

## 4. DURABILITY AND RESILIENCE

TreeHouse is designed to withstand extreme events accelerated by climate change, such as floods, using flow-through planters and vegetated swales to redirect 100% of stormwater and designed to handle 100 year storms. The terracotta rainscreen decreases water permeation, and mineral wool provides fire, water, and pest protection. Mass timber's 1.5-hour fire rating aligns with Chicago's fire code, further protecting the building and its occupants.

## 5. EMBODIED ENVIRONMENTAL IMPACT

The biogenic storage of mass timber, low-embodied carbon of mineral wool, and recyclability of terracotta cladding helps reduce embodied $CO_2$ by 50.8% compared to the average multifamily building. Prefabricated megapanels, superstructure, and plumbing fixtures minimize construction and demolition waste. Using refrigerant R455A (93% lower GWP vs. R410A) further reduces the climate impact.

## 6. INTEGRATED PERFORMANCE

The building was designed to maximize solar exposure on the roof area, using PV overhangs (designed to avoid self-shading), that maximize solar energy generation while providing passive solar shading. The energy pile foundation provides structure and supplements the geothermal energy produced by the geothermal bore field. A highly insulating envelope (R-40 walls, R-60 roof, U-0.25 windows) reduces energy needs within the building. Drain water heat recovery from wastewater helps minimize water heating loads. Double-paned windows minimize conductive heat losses and use the optimal solar heat gain coefficient to optimize passive solar heating.

## 7. OCCUPANT EXPERIENCE

Occupants have access to a variety of nearby transportation options, alongside various community amenities and essential services. The open concept living spaces and ENERGY STAR appliances allow for modern, sustainable living. Biophilic design is incorporated throughout the building, including the large outdoor space on the 8th floor, views of the Chicago River, and a nature walk connection to Chicago's Wild Mile river development project. The building automation system integrates sensors that detect abnormal equipment behavior, enabling staff to effectively respond to maintenance needs, minimizing inefficiencies and repair times.

## 8. COMFORT AND ENVIRONMENTAL QUALITY

A super-insulated envelope combined with a geothermal HVAC system maintains an optimal indoor climate. Within units, personalized temperature control, operable windows, and dimmable lighting allow for individualized comfort. The DOAS system with MERV 13 filtration and operable windows, provide healthy fresh air. Low VOC construction materials such as CLT enable Indoor airPLUS compliance. Concrete layers between floors reduce acoustical vibration. Residents enjoy views of Chicago's skyline, the river, and the surrounding green spaces.

## 9. ENERGY PERFORMANCE

The 1688 kW solar array and 210 kW geothermal system provide 2.09 million kWh of electricity annually and 294 tons of heating/cooling capacity, fully offsetting energy demands. PV oversupply enables a 48% reduction of peak time grid loads. ENERGY-STAR's best appliances, an advanced building automation system, LED lighting, and efficient MEP systems combine with passive design to make TreeHouse a net-positive building, even with 30 EV chargers, active PV snow melting systems, and the impact of refrigerant leakage included.