

A'21

AIA CONFERENCE ON ARCHITECTURE 2021

MAKING PASSIVE HOUSE STANDARD

4+ Case Studies Showcasing the Adaptability of Passive House Design



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Making Passive House Standard: 4+ Case Studies Showcasing the Adaptability of Passive House Design

Buildings are responsible for a significant chunk of our world's carbon emissions and their rate of impact is particularly high in dense, urban environments. In response, New York (among other cities) is seeing an uptick in low-energy, high performance building standards, including Passive House, for their large multi-family and mixed-use buildings. While Passive House design can certainly be a powerful tool in reducing carbon emissions, buildings constructed to meet this standard have also proven to provide tenants with healthier living environments that are also more affordable to operate and maintain.

From the initial successes of large-scale Passive House projects in NYC, are we able to scale up Passive House construction to other urban areas and beyond? Do technologies exist that will allow us to seamlessly, and affordably, transition to a low-carbon future for our built environment? Can we make Passive House standard?

In this session we will hear from a leading design firm on how they successfully implemented Passive House strategies on a number of their large scale urban buildings. We will explore the technologies they adopted and take a close look at the products that have helped them to transition to making Passive House principles standard in their practice.

(AIA CES Course RWNA210601)

Course / Learning Objectives

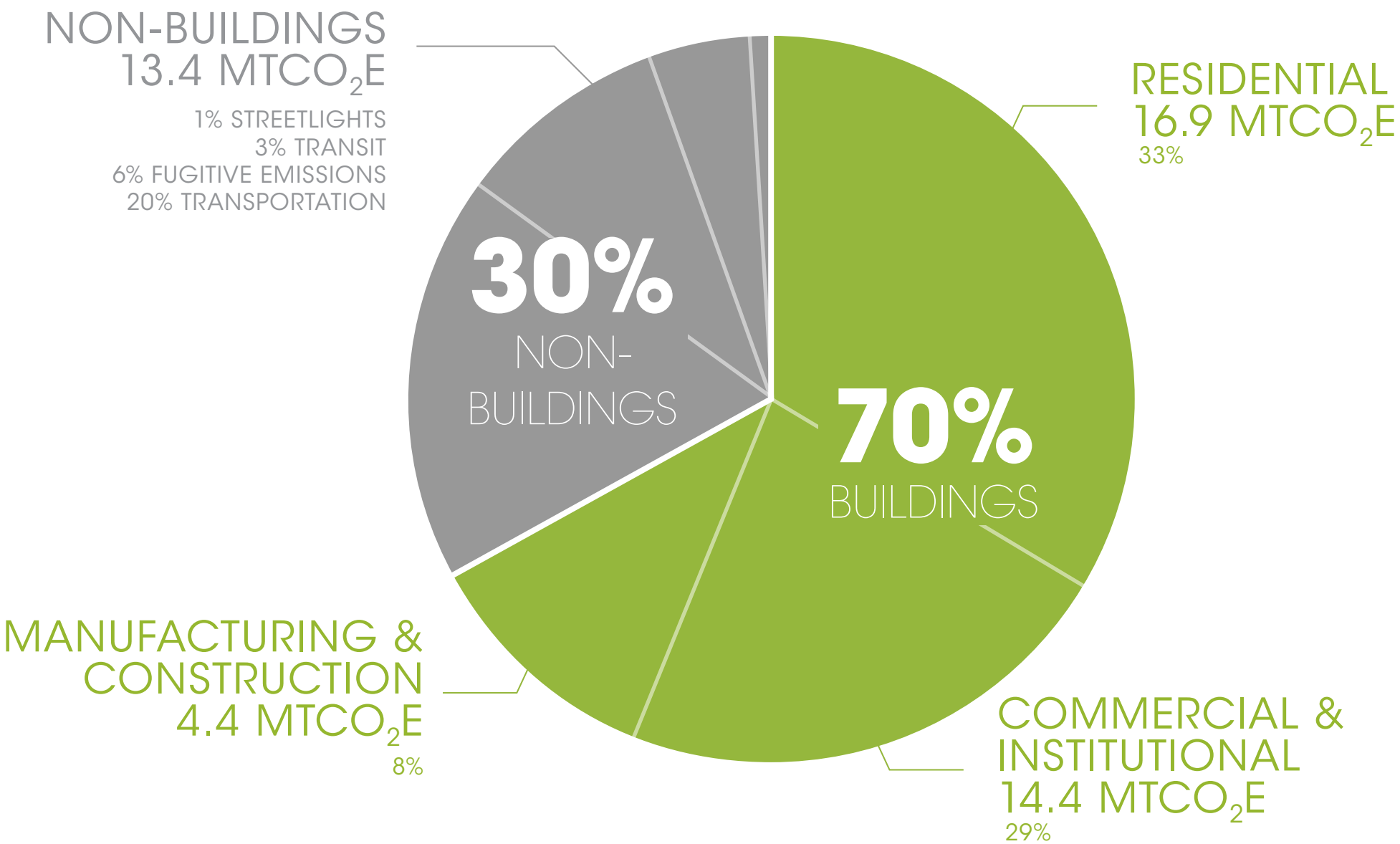
1. Participants will learn varied methods and concepts of how to apply the Passive House design standard to large, multi-story buildings, including material selection.
2. Participants will learn the difference between prescriptive and performance-based design standards, and specifically how the Passive House performance-based standard allows the design team flexibility during the architectural process to respond to various program requirements, client expectations, and construction budgets.
3. The challenges and lessons learned from The House at Cornell Tech will be reviewed and participants will learn how these were applied to the design and construction for Sendero Verde, Winthrop Center, and University of Toronto Scarborough. The lessons will focus on the exterior envelope design, interior air quality and occupant comfort, HVAC systems, and how total energy demand is lowered in large buildings (>200,000 SF).
4. Attendees will learn about the challenges presented by designing extremely energy-efficient buildings and how they can be effectively addressed with readily available products and technologies, including innovative stone wool solutions that can be applied to solve these design challenges.

Why Are We Here?



Greenhouse gas emissions

Since buildings make up a majority of the world's carbon output, making them even just a little bit more efficient would have an out-sized result.

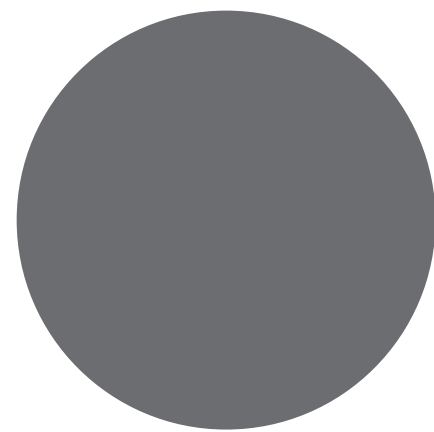


To Reduce Carbon Emissions, Density is Our Friend



Exurban Average

0.7 to 1
dwelling units per acre

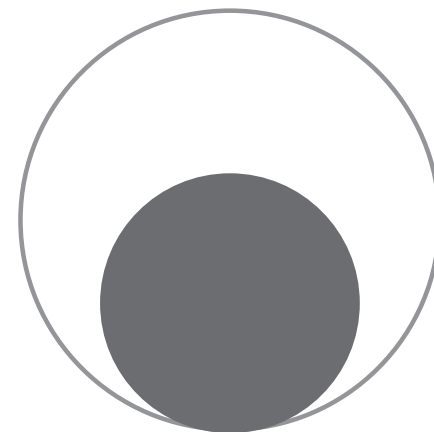


8.47
TONS



Suburban Average

3 to 4
dwelling units per acre

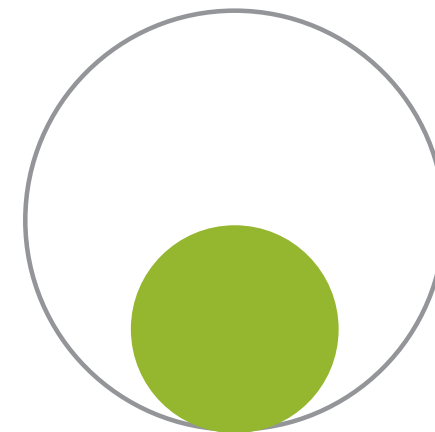


5.25
TONS



Urban Average

30+
dwelling units per acre

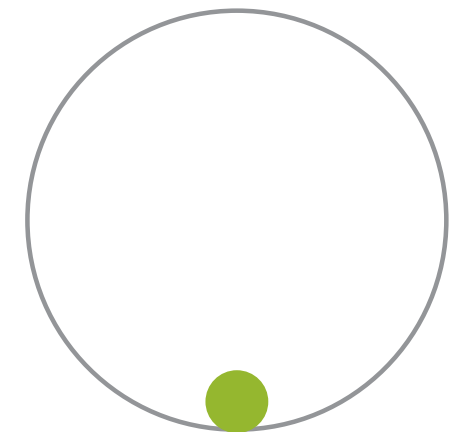


4.2
TONS



Carless Urban Average

60+
dwelling units per acre



1.29
TONS

Annual Carbon Emissions per Household

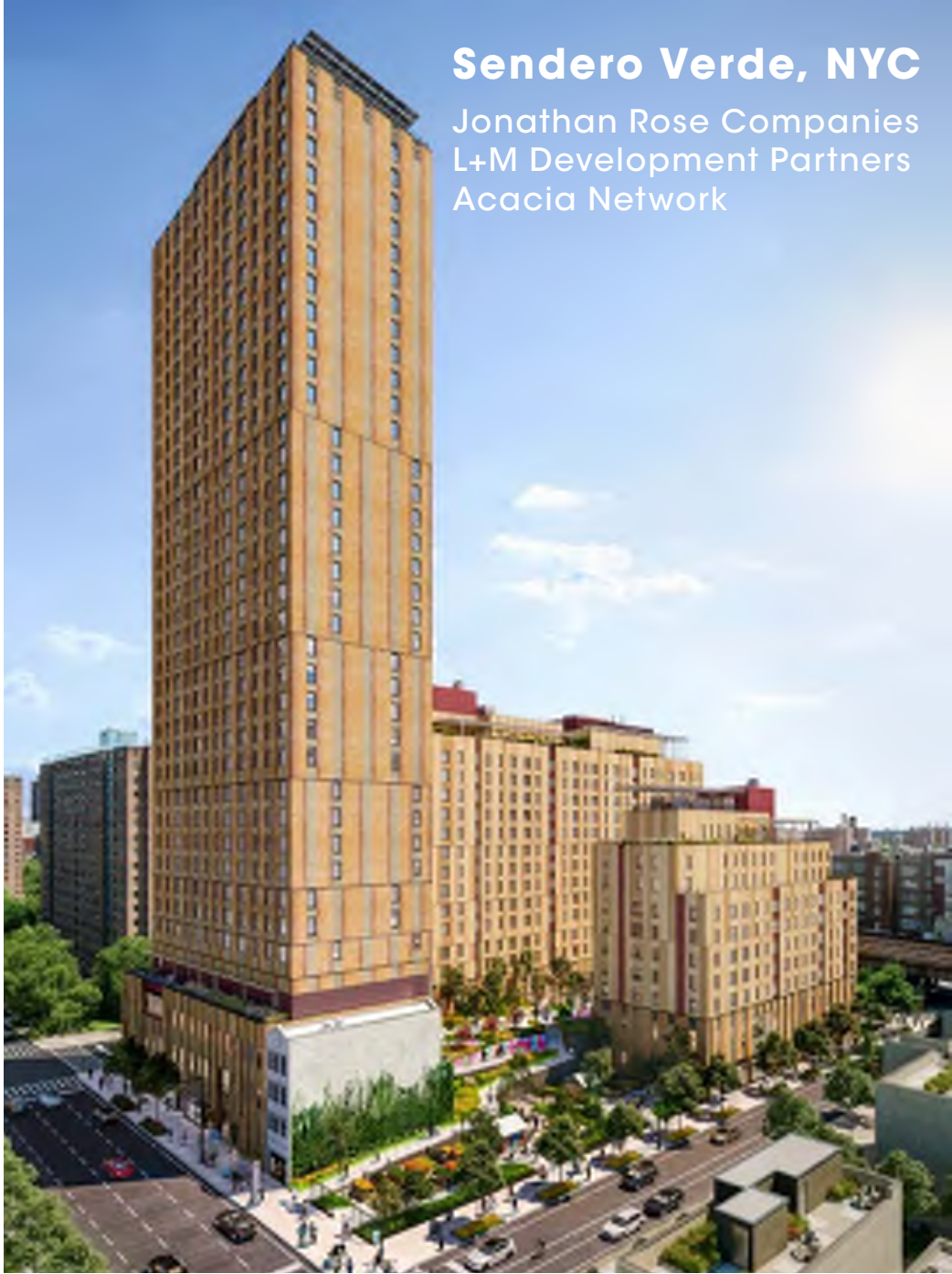
The House at Cornell Tech, NYC

The Hudson Companies
The Related Companies
Cornell Tech



Sendero Verde, NYC

Jonathan Rose Companies
L+M Development Partners
Acacia Network



Winthrop Center, Boston

Millennium Partners



University of Toronto at Scarborough

Fengate Asset Management



Passive House - International



PASSIVE HOUSE

MAKING PASSIVE HOUSE
STANDARD



NYC Climate Mobilization Act

- Phases incremental decreases of building carbon emissions
- NYC Local Law 97 (todd.kimmel@rockwool.com)



NYSERDA Strategic Grant Funding

- Workforce development and Training
- Buildings of Excellence Program
 - Focused on replicability to the market
 - Awards for Early-Design, Late-Design, Construction, Post-Occupancy



LIHTC Funding, PHFA Model

- Pennsylvania Housing Finance Agency tweaks Low Income Housing Tax Credits scoring to give additional points for Passive House Design
- Passive Houses won 50% of the tax credit over the course of 3 years
- Comparative 2-3% cost increase for PH initially, now PH housing actually slightly cheaper than “business as usual”!
- Prototype funding program in 10 other states and expanding

GREEN BUILDING

MAKING PASSIVE HOUSE
STANDARD



Austin Climate Equity Plan 2020

- New Climate Goal #1: by 2030, decarbonize buildings and achieve net zero carbon for 100% of new buildings and 25% of existing buildings
- New Climate Goal #2: by 2030, reduce community-wide greenhouse gas emissions from refrigerant leakage by 25%



San Francisco is at the leading edge of energy related ordinances

- As of 2021, new construction must be all electric (San Francisco Gas Ban Ordinance)
- By 2022, San Francisco will require large projects to use 100% renewable electricity (Mayor Breed's "All-Electric City" vision)

By 2030, will eliminate carbon emissions from all new building construction (C40 agreement for Net Zero Carbon Buildings Declaration) and Net Zero Emissions by 2050 (Global Climate Action Summit commitment)



Denver 2035 Net Zero Energy Buildings (2031 for Boulder)

- All buildings over 25,000 SF will be required to be NZE and submit annual benchmark data



Nashville Affordable Housing and Sustainability

- Nashville projected to have shortage of 31,000 affordable housing units by 2025
- Metro Nashville just adopted 2018 IBC and updated energy code; more stringent energy standards becoming the norm
- Low-income families are hit disproportionately hard by the ill effects of climate change. Equity and sustainability must go hand in hand

WHAT IS PASSIVE HOUSE?

- ✓ **A rigorous certification** program whose primary focus is to curtail energy usage and increase user comfort
- ✓ **Unlike pass/fail checklists** of Prescriptive standards, Passive House is an overall holistic approach based on ultimate full building Performance
- ✓ Focus is on **Building Enclosure** and **MEP systems**
- ✓ **Requires careful detailing** during design and a strict quality control program during construction to yield an extremely **well built building**

WHY PASSIVE HOUSE

TO COMBAT CLIMATE CHANGE



- ✓ **Reduce energy** needed to operate buildings by 60-80%
- ✓ **Eliminate** dependence on fossil fuels
- ✓ **Reduce** carbon emissions
- ✓ **Lower** greenhouse gas impact
- ✓ **Bridge the gap** to NZR and/or NZC buildings
- ✓ **Ease compliance** with government mandates (new laws, codes, standards)

WHY PASSIVE HOUSE

HEALTH AND WELLNESS



- ✓ **Offer a healthier** interior environment
- ✓ **Provide superior indoor air quality** via fresh filtered ventilation to every habitable rooms 24/7
- ✓ **Offer a quieter** interior environment
- ✓ **Increase durability** of building materials
- ✓ **Eliminate** drafts/temperature differentials and provide **superb thermal comfort**

HOW TO ACHIEVE PASSIVE HOUSE?



Enclosure: Roofs, Walls, and Foundation

- Strive for a compact shape
- Take building orientation into account
- Carefully detail to achieve air tightness
- Select Windows with exceptionally low U-Values.
- Provide Continuous insulation and thermal bridge free detailing leading to high R-Values



MEP Systems

- Provide a high performance, low energy heating and cooling system that is powered primarily by electricity
- Ventilate all habitable spaces with constant fresh air with heat recovery
- Balance exhaust and supply ventilation within 10% of one another
- Specify energy efficient equipment, lighting and appliances

Passive House Institute (PHI) Performance Criteria for Certification

pEUI (source) kBTU/ft²/yr

130.0 IECC 2018 Average from
NYSERDA Energy 2018 Report

38.1* Passive House

Overall Source Energy Allowed(pEUI) 38.1 kBTU/ft²/yr*

Heating Energy Allowed Max 4.75 kBTU/ft²/yr

Cooling Energy Allowed (NY) Max 5.39 kBTU/ft²/yr
(region specific)

Minimize Air Infiltration (5-10 times tighter than typical) 0.6 ACH (Air Changes per Hour) through the facade at 50 pascals of pressure

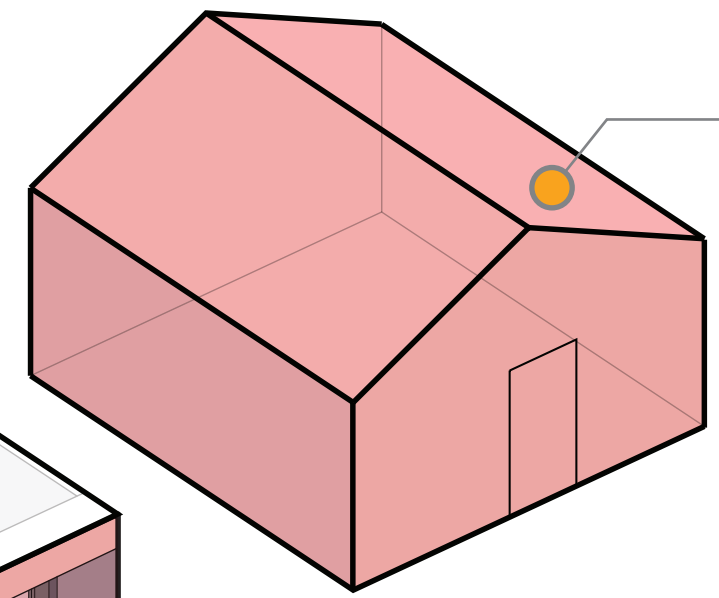
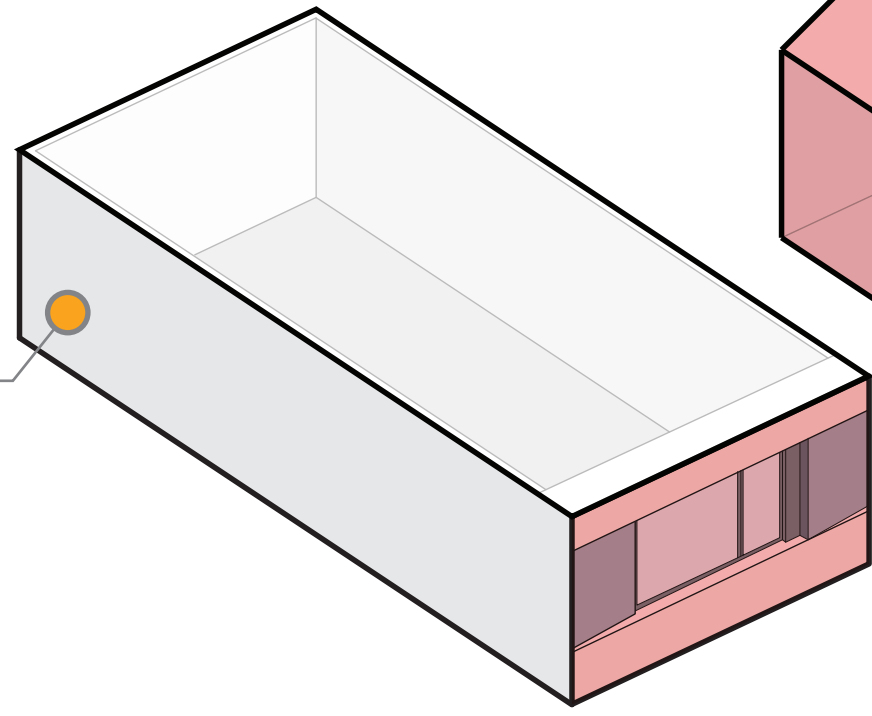
Exhaust and Supply Ventilation Balanced, with energy recovery

*Can be adjusted for density and use.

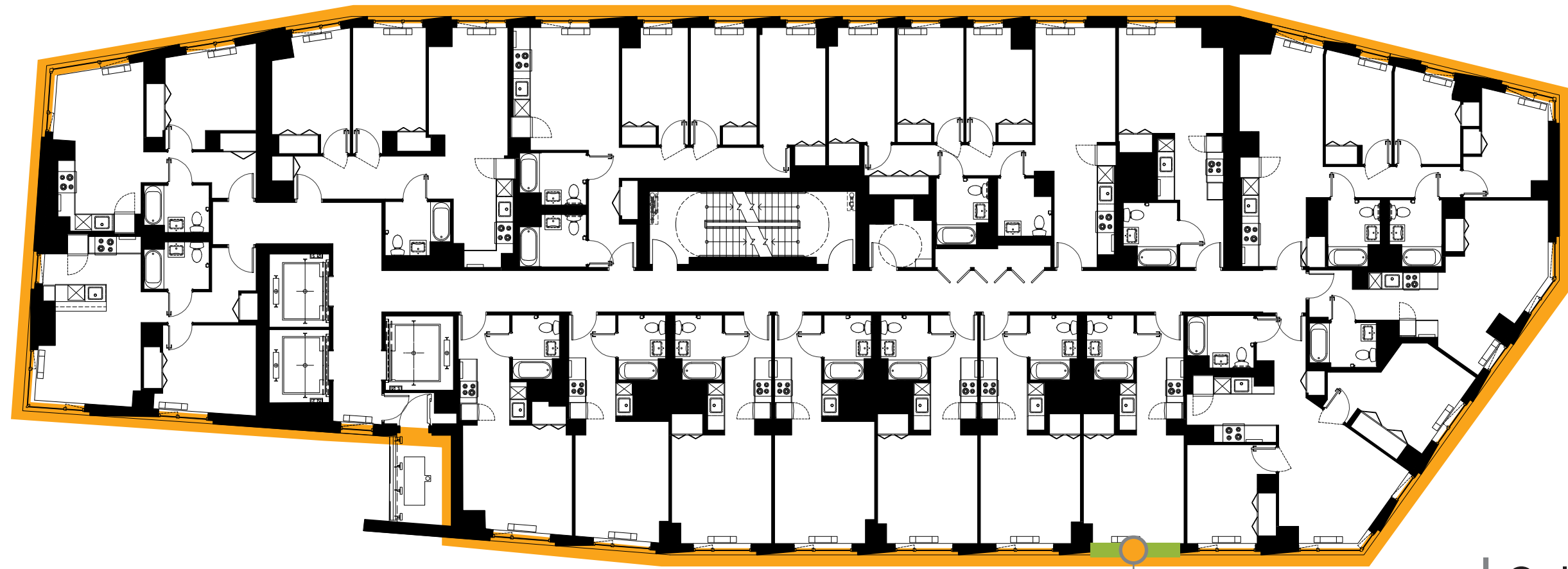
Low Surface to Volume Ratio

16 Units per Floor

Typical studio apartment at the house



Freestanding house



Only one surface of this apartment is exposed.

Large Scale Passive House: NYC & Beyond



THE HOUSE AT CORNELL TECH, NYC

- 270,000 SF
- 352 Units; 500 beds
- 26 Floors
- Graduate Student & Faculty Housing
- PH System: PHI
- LEED Project of the Year 2017



SENDERO VERDE, NYC

- 812,250 SF
- 700 Units
- 3 Buildings: 37 Floors, 16 Floors and 10 Floors
- 100% Affordable Housing & Community Facilities
- PH System: PHI



WINTHROP CENTER, BOSTON

- 1,882,150 SF Total
- 735,000 SF of Commercial Office Passive House
- 21 Floors
- Mixed-Use Office, Retail & Condo
- PH System: PHI



UNIVERSITY OF TORONTO (UTSC)

- 270,000 SF
- 369 Units; 752 Beds
- 9 Stories
- Undergraduate Dorm & Cafeteria
- PH System: PHI

The PH Standard is Adaptable

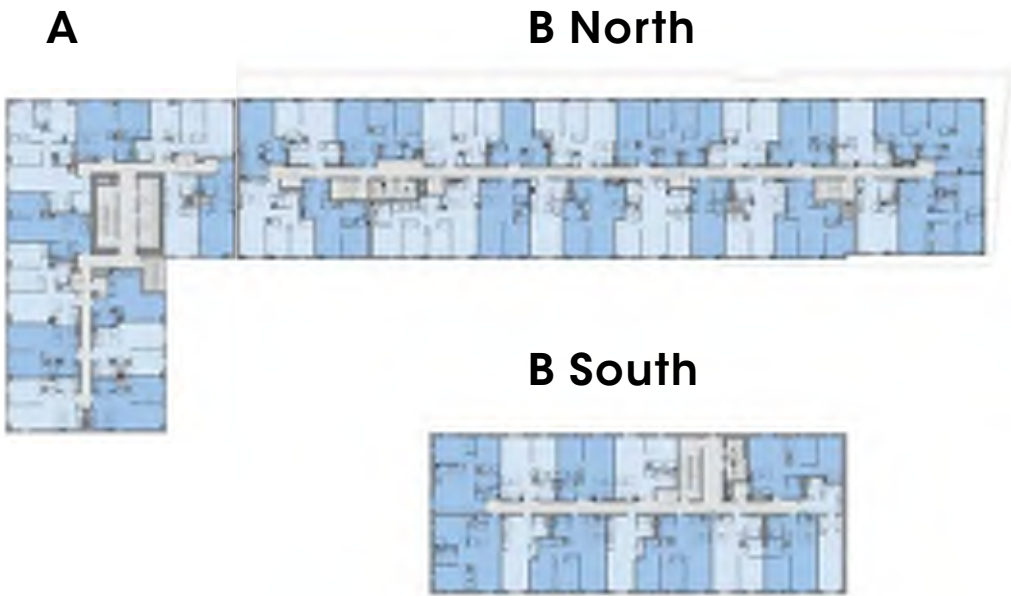
THE HOUSE AT
CORNELL TECH



- Density: 1 pp / 385 GSF avg.
- Climate Zone 4
- Energy Budget:

38.1 kBTU/ft²/yr

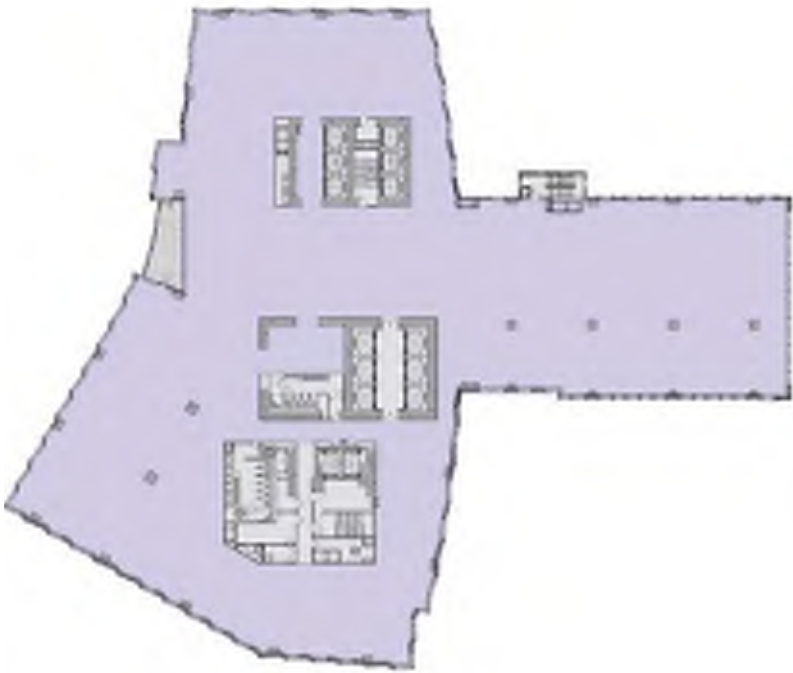
SENDERO VERDE



- Density: 1 pp / 330 GSF avg.
- Climate Zone 4
- Energy Budget:

Building A: 38.1 kBTU/ft²/yr
Building B: 48.1 kBTU/ft²/yr

WINTHROP CENTER



- Density: 1 pp / 123 GSF avg.
- Climate Zone 5
- Energy Budget:

47.4 kBTU/ft²/yr

U. OF TORONTO

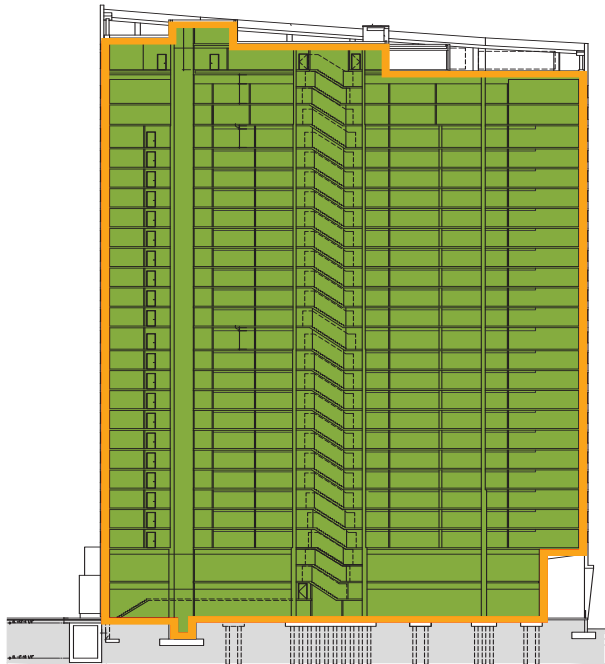


- Density: 1 pp / 297 GSF avg.
- Climate Zone 6
- Energy Budget:

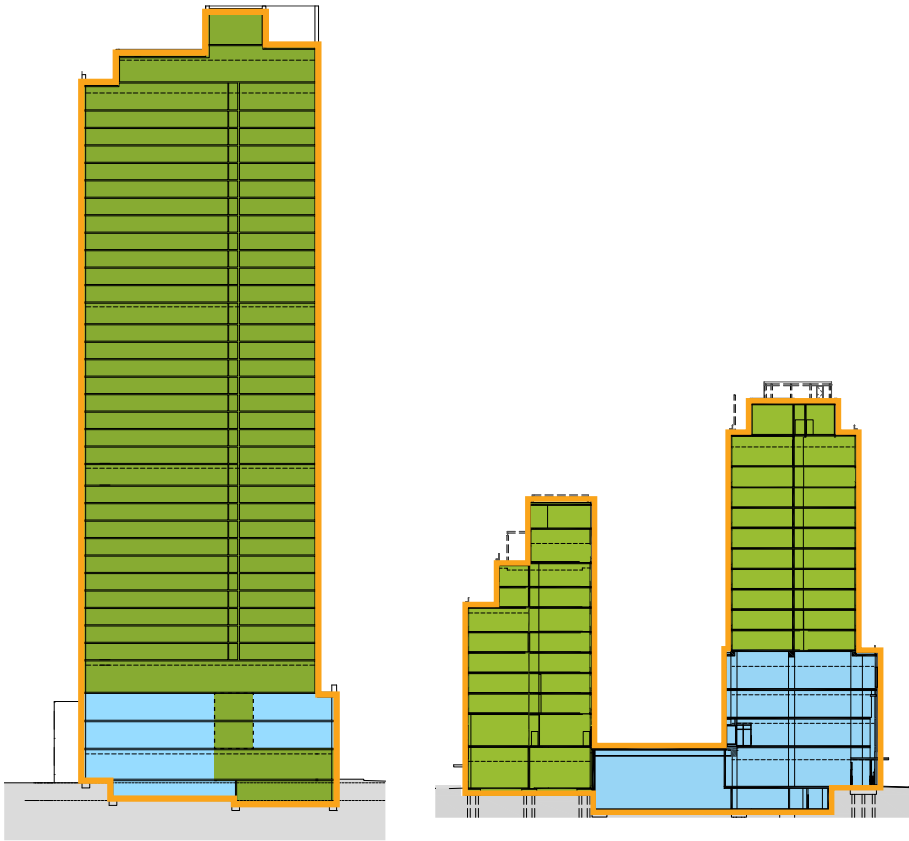
70.5 kBTU/ft²/yr

Passive House Envelope & Certified Area

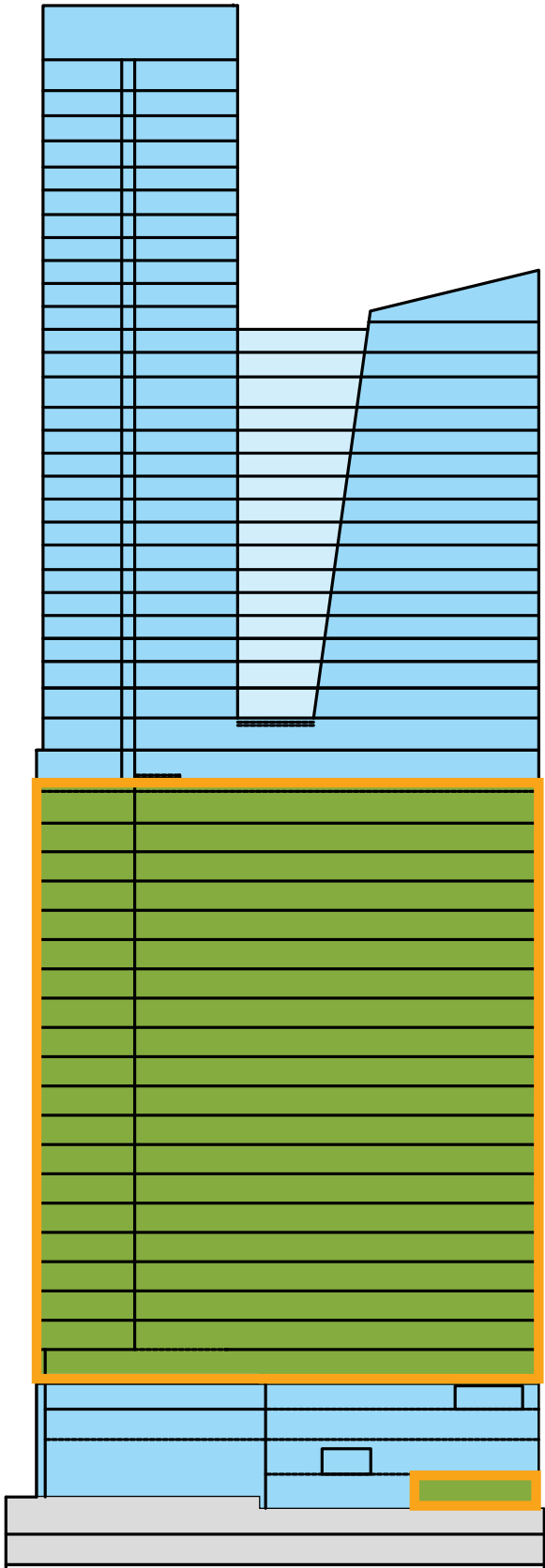
- PH AIRTIGHT LAYER
- PH CERTIFIED AREA
- NON-CERTIFIED AREA



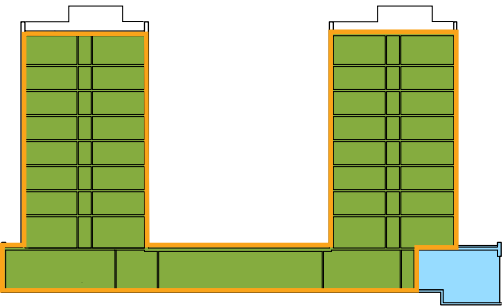
CORNELL TECH



SENDERO VERDE A & B



WINTHROP CENTER



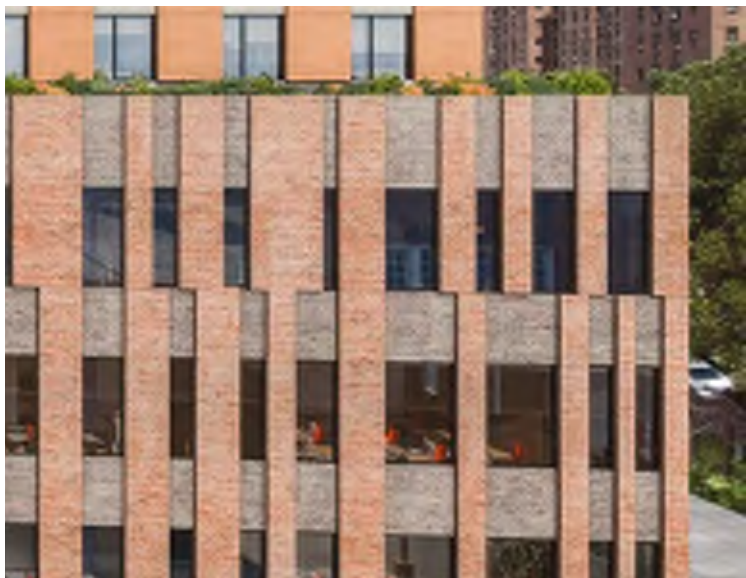
U. OF TORONTO

5 Methods to the Target



THE HOUSE AT CORNELL TECH, NYC
Facade: Mega-Panel Rainscreen

Component	Efficiency
Roof	R-50
Walls	R-19 Avg.
Windows	U-0.18
Slab Edge	R-10+
Cantilevered Floors	R-40



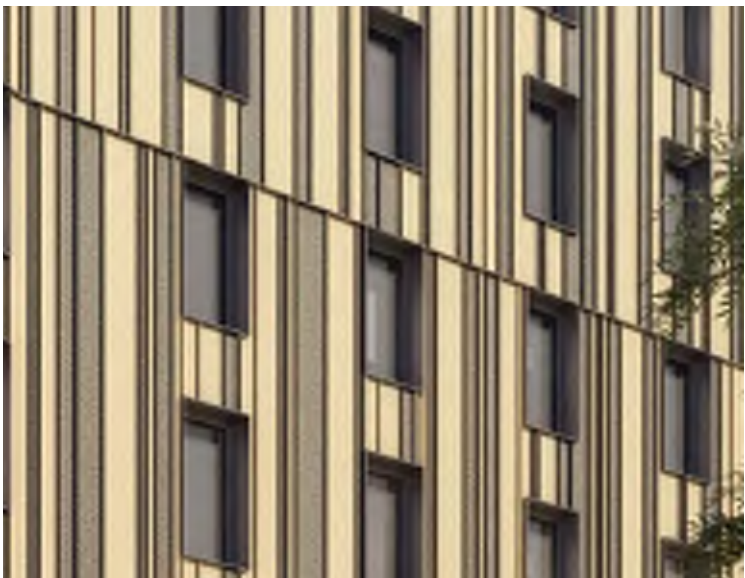
SENDERO VERDE, NYC
Facade: Masonry Cavity Wall & EIFS

Component	Efficiency
Roof	R-40
Walls	R-20 Effective
Windows - Operable	U: 0.149
Windows - Fixed	U: 0.134
Cantilevered Floors	R-11



WINTHROP CENTER, BOSTON
Facade: Curtainwall

Component	Efficiency
Roof	R-30
Walls	R-18 Effective
Windows	Fixed U: 0.22 Effective

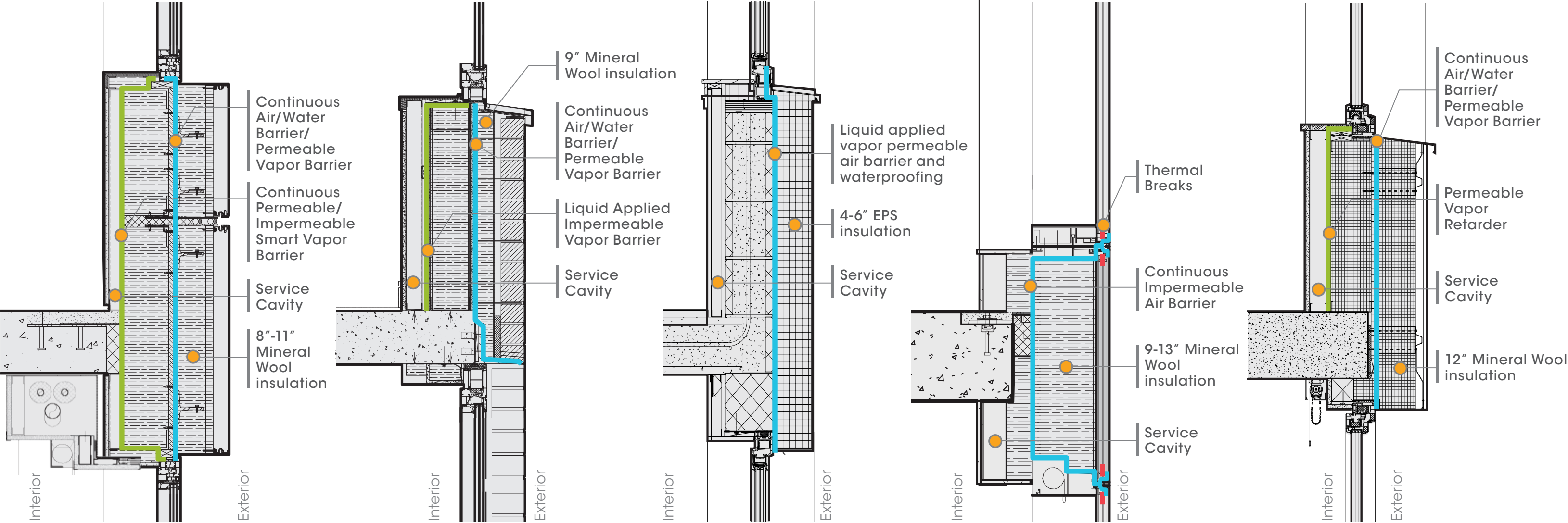


UNIVERSITY OF TORONTO (UTSC)
Facade: Stickbuilt Rainscreen

Component	Efficiency
Roof	R-40
Walls	R-30 Avg.
Windows	U: .013

Reference: Typical NYC Exterior Wall is ~ R-12
Typical Double Glazed Aluminum Window U ~ 0.45

Exterior Wall Section Comparison



The House at Cornell Tech
Mega Panel Rainscreen

Sendero Verde A
Masonry Cavity Wall

Sendero Verde B
EIFS

Winthrop Center
Curtainwall

University of Toronto
Stick Built Rainscreen

ROCKWOOL: Rainscreen Exterior Insulation Comparison

“Not all Rainscreens are Equal”

No matter the insulation type, you also cannot practically get to $>R-15.6$ with continuous steel girts through exterior insulation



Cladding Attachment: Vertical Steel Z-Girts

20-40%

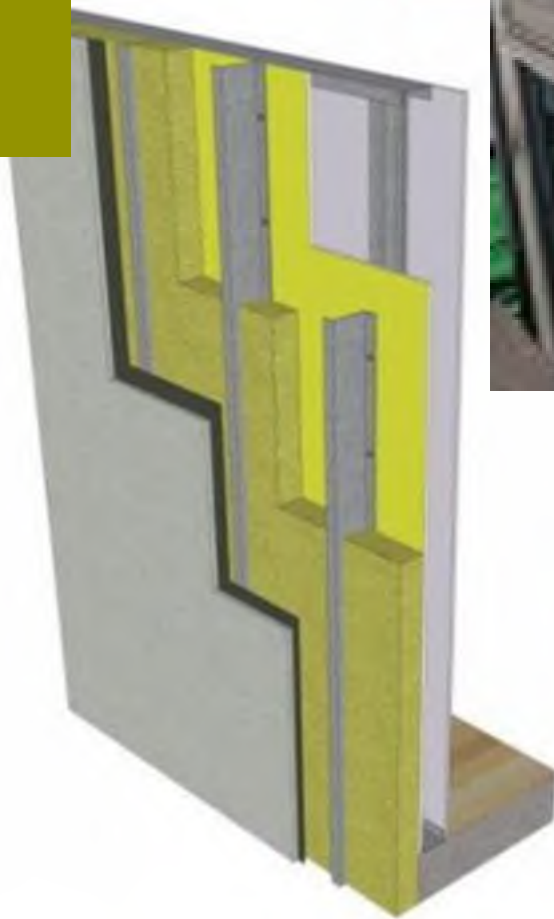
Thermal Efficiency
of Vertical Z-girts

RELATIVE COST

\$\$\$

CONSTRUCTABILITY

⚒⚒⚒

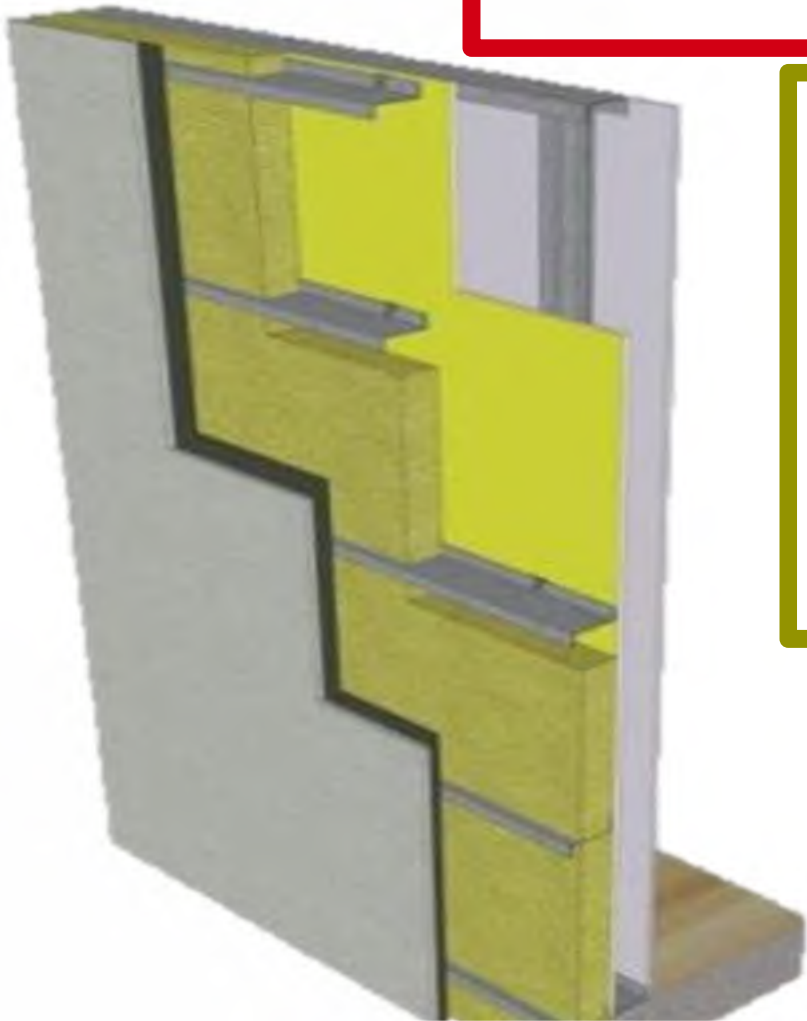


Cladding Attachment: Horizontal Steel Z-Girts



30-50%

Thermal Efficiency
of Horizontal Z-girts



RELATIVE COST

\$\$\$

CONSTRUCTABILITY

⚡⚡⚡

Cladding Attachment: Clip & Rail, Steel

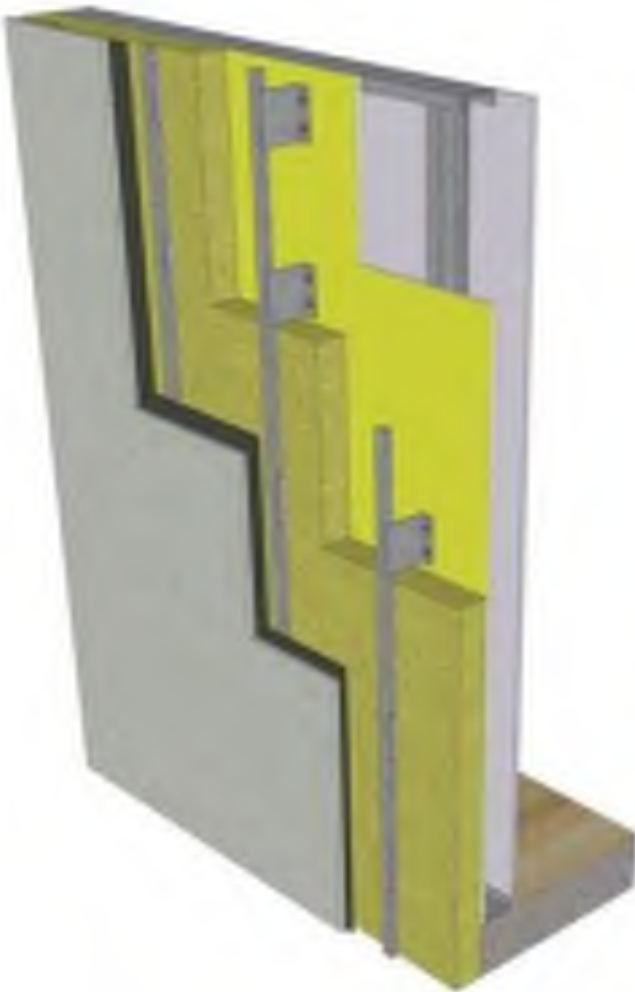
50-75%

Thermal Efficiency
of Galvanized
Steel Clips

RELATIVE COST

\$\$\$

CONSTRUCTABILITY



Other Steel & Aluminum Cladding Clip & Rail Technologies



425 Grand Concourse - Passive House

Bronx, NY

Dattner Architects

Cladding Attachment: Clip & Rail, Fiberglass

Remove the metal – maximize the performance



Hoboken Multi-Family Passive House - Nastasi Architects

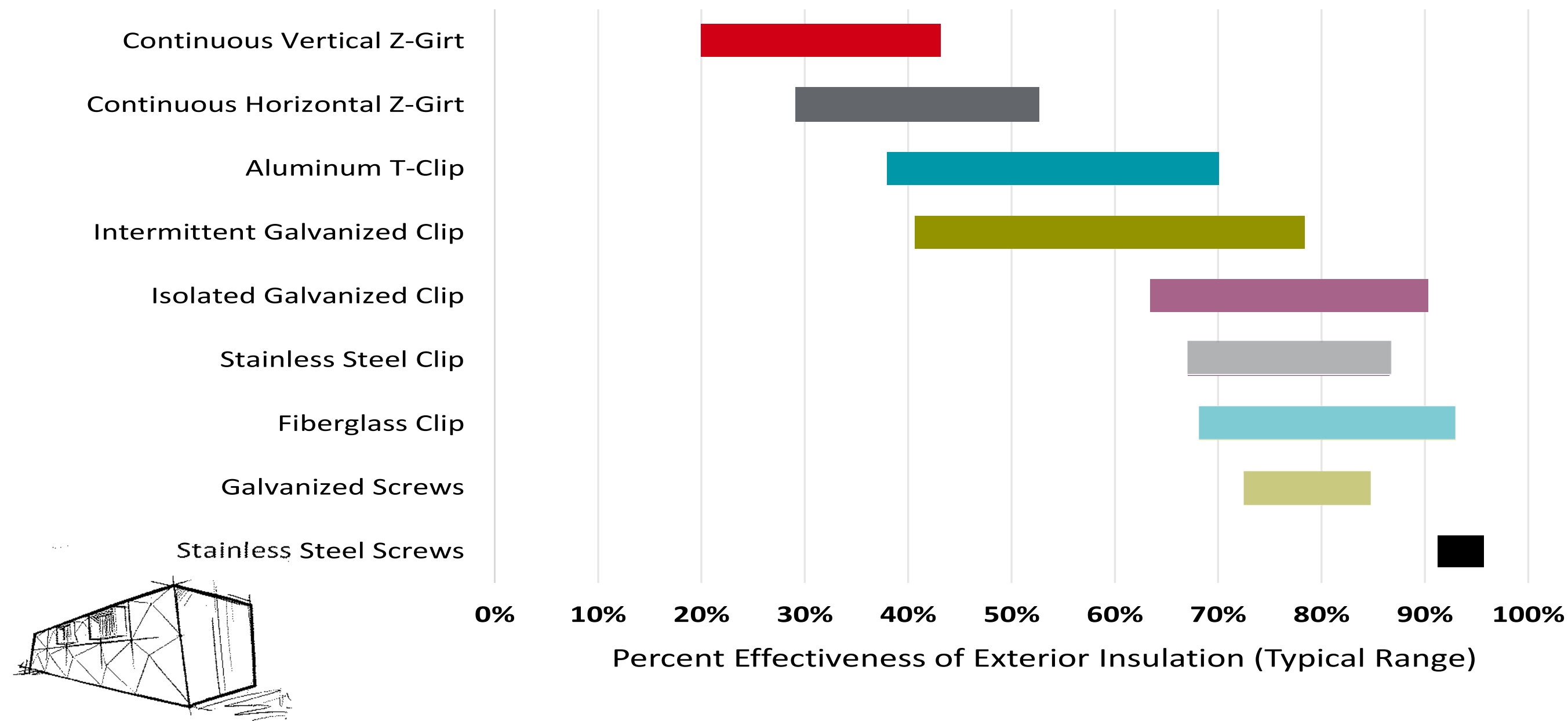
Cladding Attachment: Screws Through Insulation



Corona Senior Housing Project – Passive House
Think Architecture

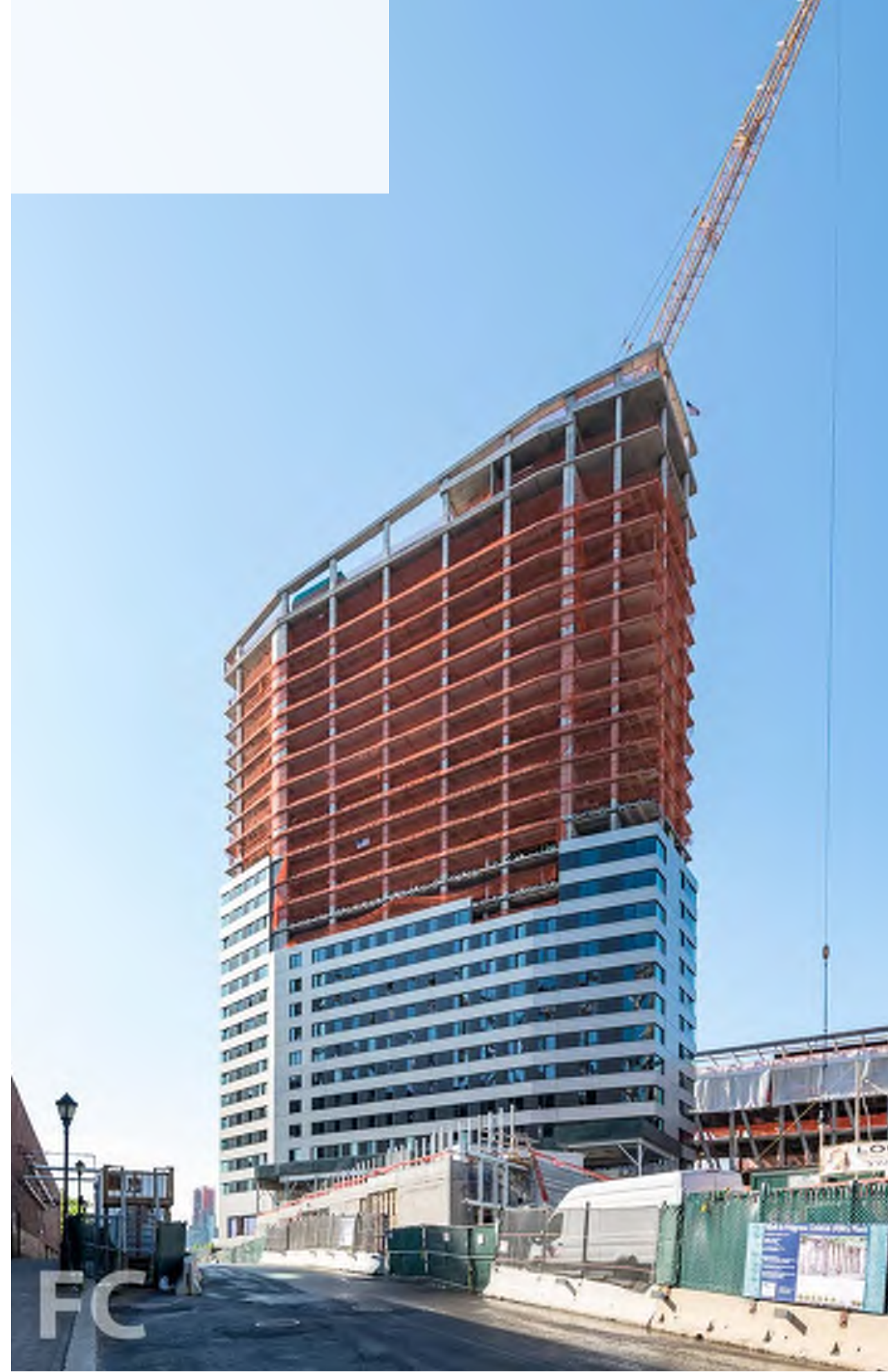
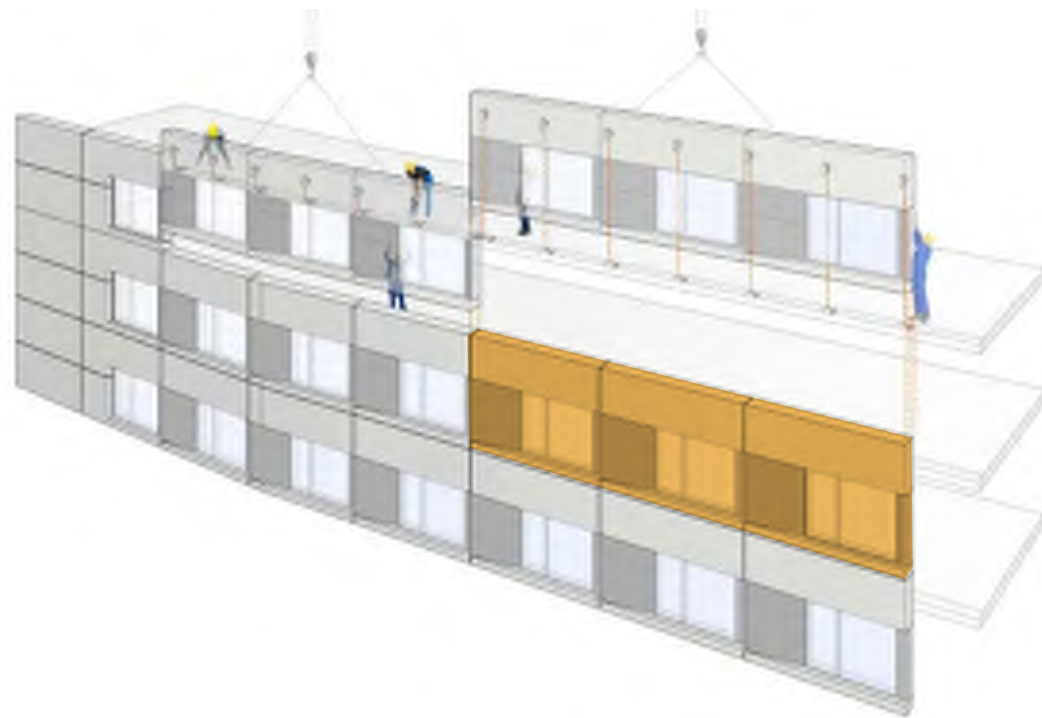


Percent Effectiveness of Exterior Insulation with Various Cladding Support Systems





Panelized Installation



Theory vs. Practice

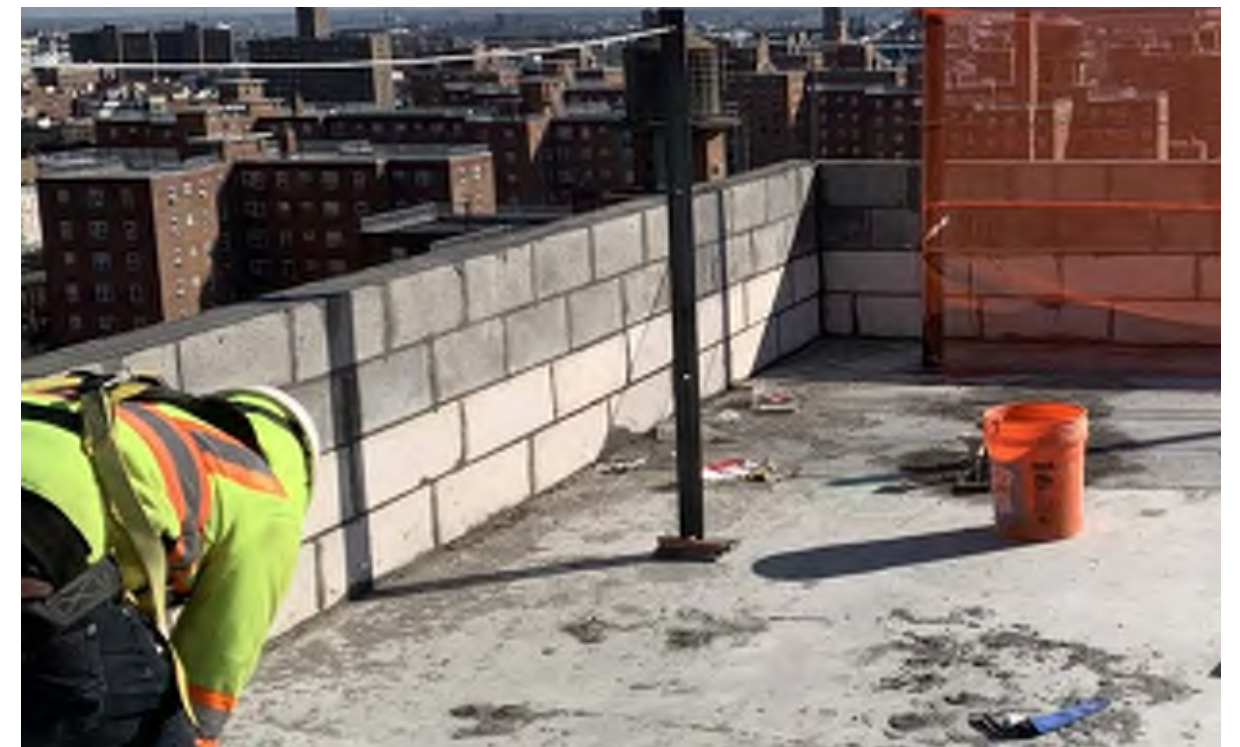
Before Panel Supports Sealed



After Panel Supports Sealed

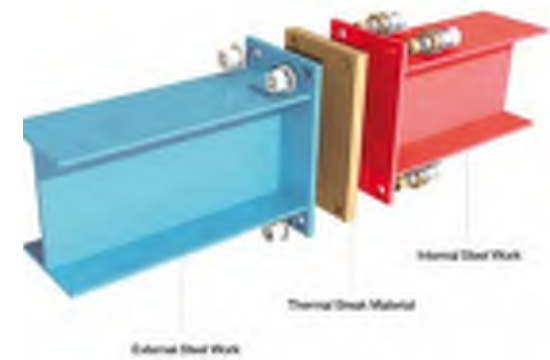


Eliminate Thermal Bridging



Innovative Materials

Schedule 4:
Material
Schedule



ISO-4

Armatherm Thermal Break Pads

Thermally broken shims for steel-to-steel and steel-to-concrete attachments such as base plates and shelf angles.



CL-2

Thermal Clip

Thermal clip assembly with thermal studs/isolators. Improves performance by 60 - 90%.



AAC-1

Autoclaved Aerated Concrete Masonry Units

8" = R-10
10" = R-12.5
12" = R-15
For use in parapets, curbs, or in lieu of CMU walls.



GS-1

Warm Edge IGU Glass Spacers

Can lower IGU U values by approx .04 as compared to standard aluminum spacer.

Innovative Materials

Schedule 4:
Material
Schedule



ISO-1

**Schock -
Structural
Thermal
Break**

Thermal isolators - Steel to Steel.
Concrete to concrete available.
Parapet isolators too.



ISO-3

**General
Plastics**

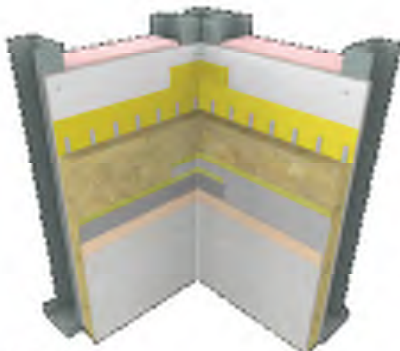
Load bearing thermal isolator.
Pre-cut and pre-drilled



T-1

**Vapor
Permeable
Tape**

- 1. Windows & Door openings
- 2. Inside face of exterior wall in contact with vapor barrier
- 3. Inside face of exterior wall in contact with vapor barrier
- 4. Interior walls adjacent to hammerhead shear walls



WT-3

**Mineral Wool
Backed EIFS**

Continuous insulation cladding system with lower embodied energy from traditional systems..

Manufacturers are Stepping Up Too



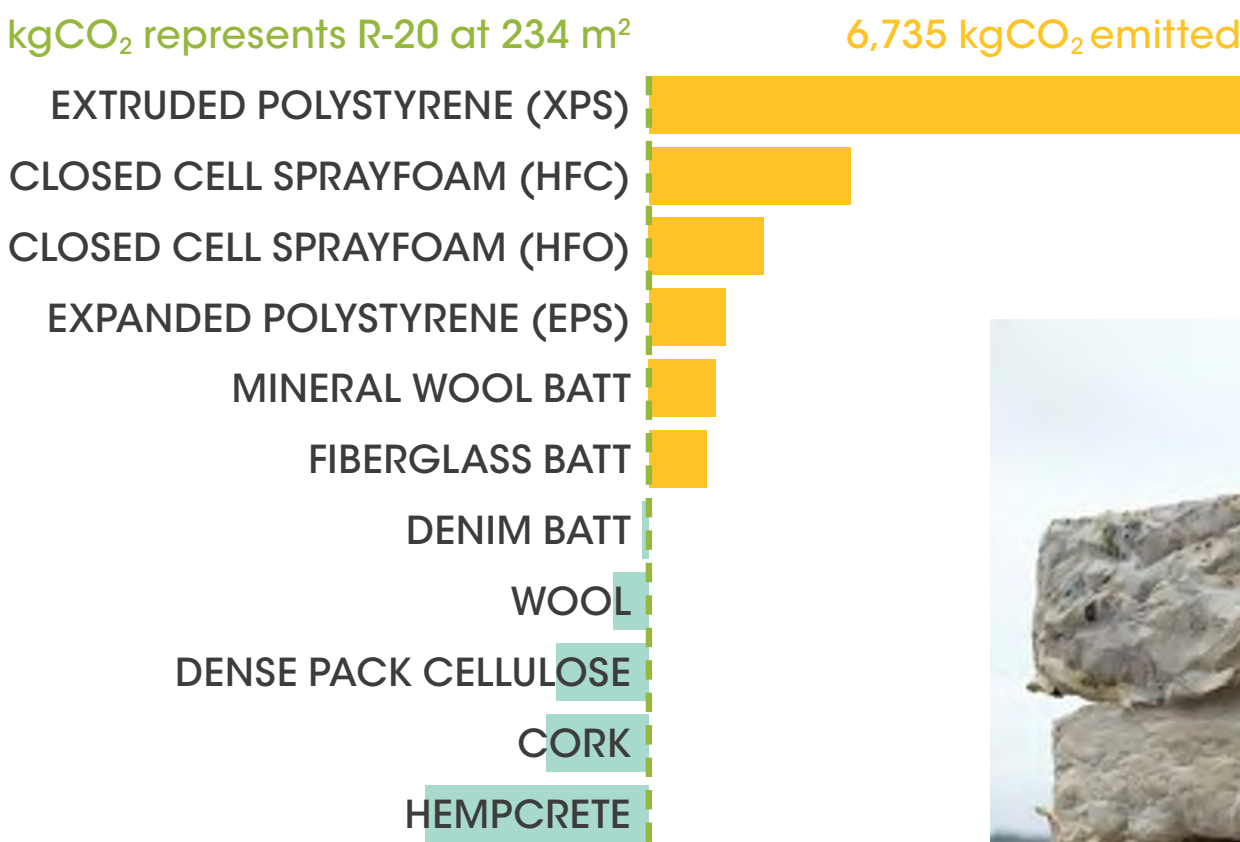
The House



Sendero Verde

Passive House: Embodied Carbon

CARBON IMPACTS OF INSULATION



Mineral wool has a much lower embodied carbon than foam insulations.

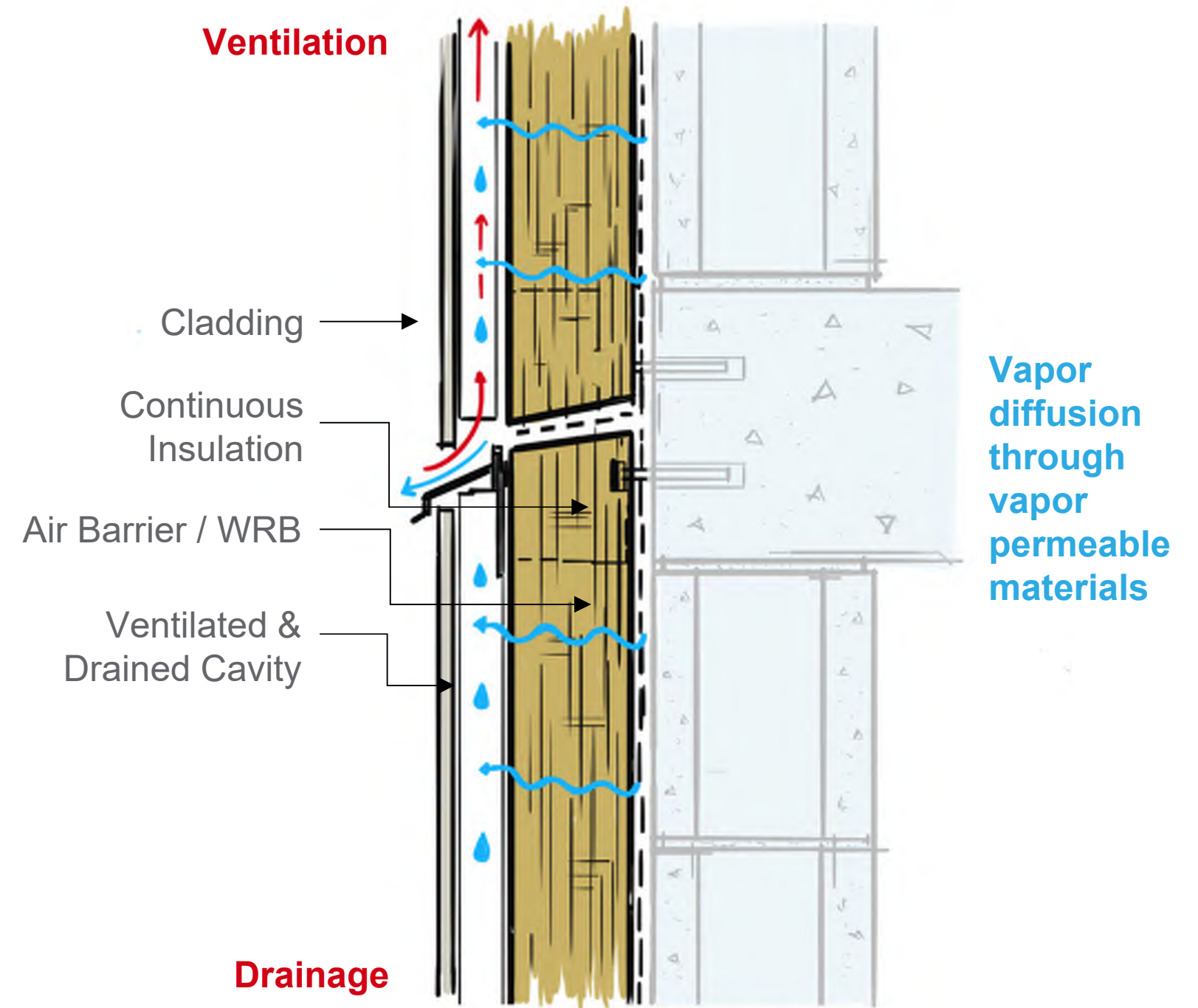


Mycelium insulation is grown from mushroom spores eating waste materials like cardboard or sawdust.

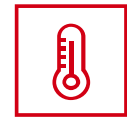
Durable, Moisture Tolerant Enclosures

Hygrothermal properties must allow for drying without excessive moisture accumulation.

- Consider wetting mechanism
- Consider vapor retarder requirements based on climate (interior vs. exterior)
- Consider permeability of all materials (permeable vs impermeable)
- Ensure continuity of control layers
- Drained screen assembly works best



Stone Wool Retrofit



Stone Wool for EIFS - Micro-case study: Passive House Retrofit

STONE WOOL RETROFIT SOLUTIONS

Ken Soble Tower

Key Challenges:

- Deteriorating envelope
- Lack of insulation
- Mold and hazardous materials
- Lack of thermal control
- Systems at end of life



Architect: ERA Architects
Photo Credit: Cordrin Talaba



Existing exterior substrate:

CMU plus brick masonry veneer, slab edges exposed (balconies taken down)

Stone Wool Retrofit



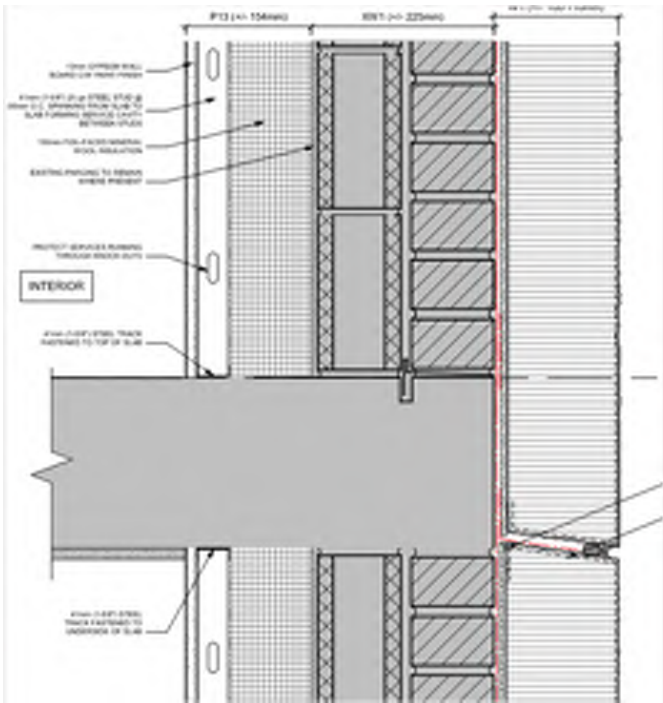
Stone Wool for EIFS - Micro-case study: Passive House Retrofit

STONE WOOL RETROFIT SOLUTIONS

Ken Soble Tower

Goals:

- Ultra-low energy retrofit that maintains affordability
- Reduce greenhouse gas emissions by over 90%
- EnerPhit certified project
- Reduce thermal bridging to enhance indoor thermal comfort and limit heat loss
- Passive climate resilience to extreme conditions
- Fire resiliency
- Adequate ventilation



Exterior wall retrofit build-up:

Existing substrate, new fluid applied air/water barrier, 6" rigid stone wool EIFS



Photo Credit: Cordrin Talaba
Detail Credit: ERA Architects

Stone Wool Retrofit



Stone Wool for EIFS - Micro-case study: Passive House Retrofit

STONE WOOL RETROFIT SOLUTIONS

Ken Soble Tower



▲
Insulation board mechanically fixed with
base coat applied



▲
Exterior wall retrofit build-up:
6” rigid stone wool EIFS board integrated GDDC, reinforcing mesh and base coat



Stone Wool Retrofit



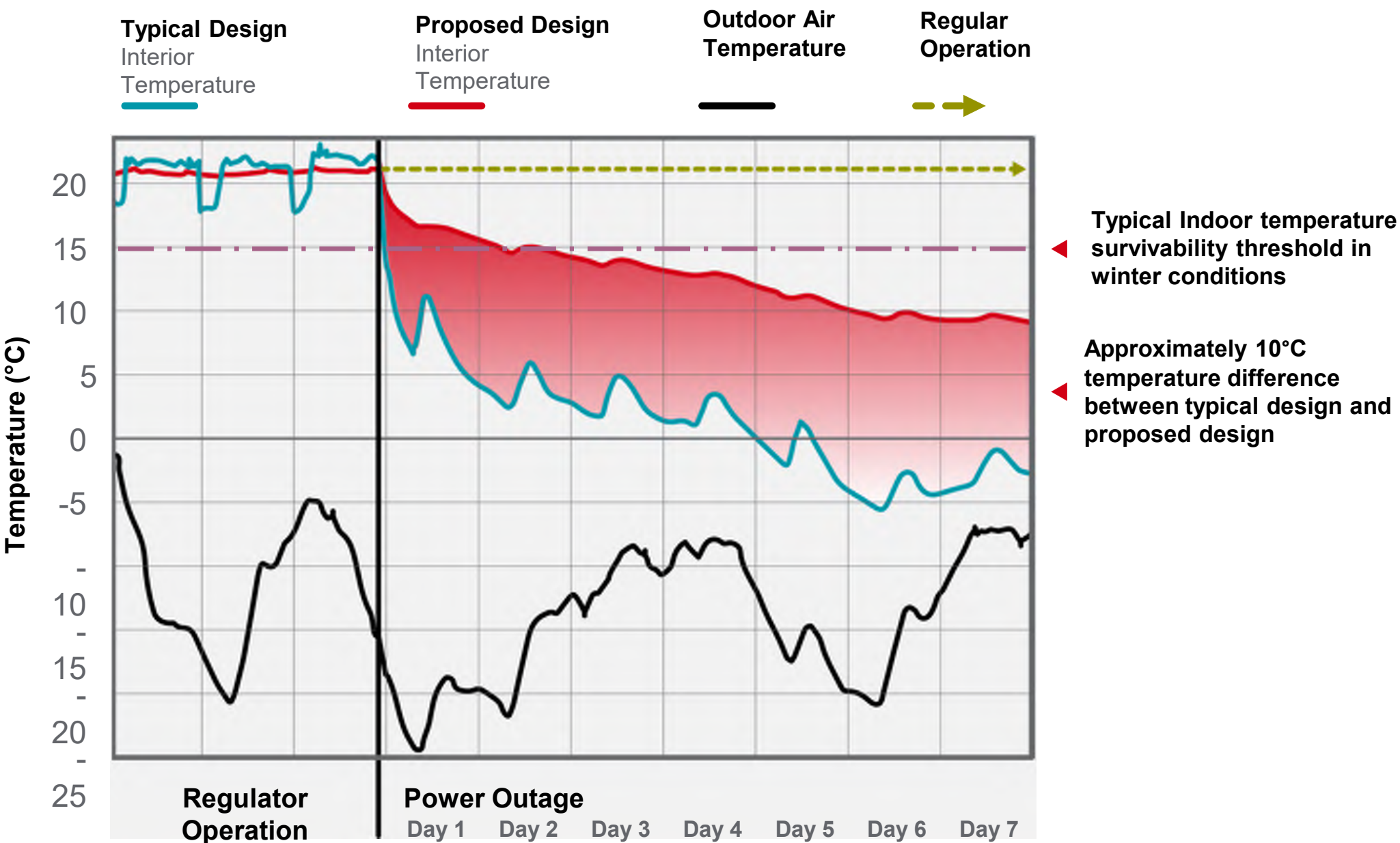
Stone Wool for EIFS - Micro-case study: Passive House Retrofit

STONE WOOL RETROFIT SOLUTIONS

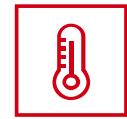
Ken Soble Tower

Considering survivability:

- In case of failure of active systems, the building will stay warm in winter for up to two days (compared to 2 hours in a typical building) and below dangerous heat levels in summer for up to four days (compared to half a day in a typical building).



Stone Wool Retrofit



Interior Stone Wool Insulation Solution – Micro case study

STONE WOOL RETROFIT SOLUTIONS

1701 Albemarle Rd. Brooklyn, NY

Key Challenges:

- Efficiency, sustainability, and occupant wellness
- Compliance with Local Law 97
- Adhering to Passive House standards
- Maintaining the historic integrity of the building as a whole.

Architect: Scott Henson



▲
Existing exterior substrate:
6 storey brick masonry multi-unit apartment building



Stone Wool Retrofit



Interior Stone Wool Insulation Solution

STONE WOOL RETROFIT SOLUTIONS

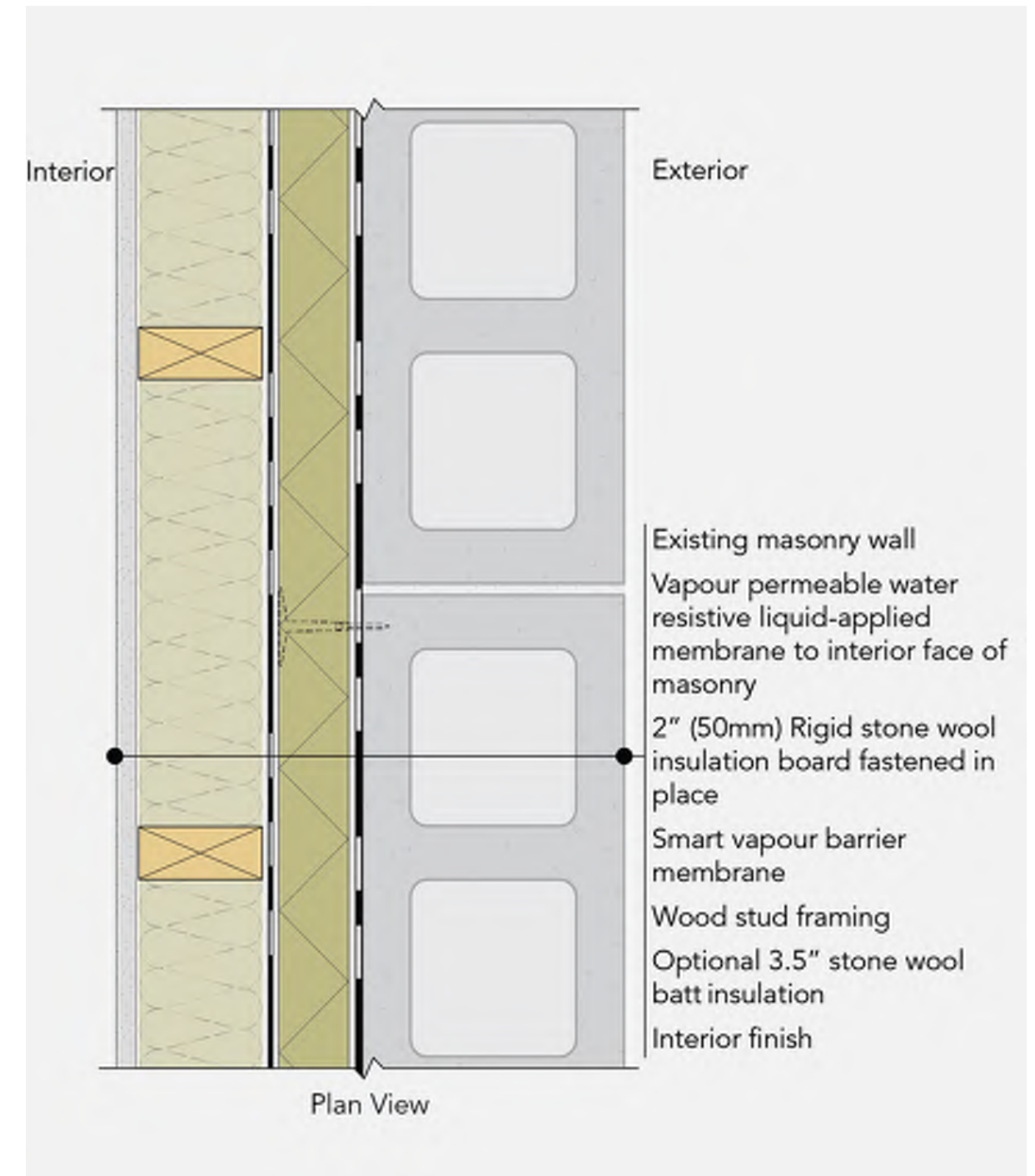
A smart Interior retrofit strategy using a combination of rigid stone wool insulation boards

Assembly layers:

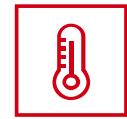
- **Primary air control** ► fluid applied membrane
- **Thermal control** ► semi-rigid stone wool insulation
- **Vapor control (secondary air control)** ► smart vapour barrier

Critical Considerations:

- Characteristics and condition of existing brick masonry wall
- Appropriate insulation levels to manage freeze-thaw potential
- Enabling interior drying



Stone Wool Retrofit



Interior Stone Wool Insulation Solution – Micro case study

STONE WOOL RETROFIT SOLUTIONS

1701 Albemarle Rd. Brooklyn, NY

Goals:

- Improve thermal comfort and acoustics
- Achieve PH standard level of airtightness
- Ensure strategy is durable with limited risks of damage to the existing brick wall
- Compare pre- and post-performance
- Use this project as a “template” for how retrofits in this archetype can be achieved



▲ **Pre-retrofit build-up:**
Existing wall substrate, existing masonry wall, no air barrier, single-pane windows



▲ **Post-retrofit build-up:**
3” rigid stone wool insulation over existing brick masonry and fluid applied vapour permeable membrane. Smart vapour barrier to tie into ceiling air barrier.

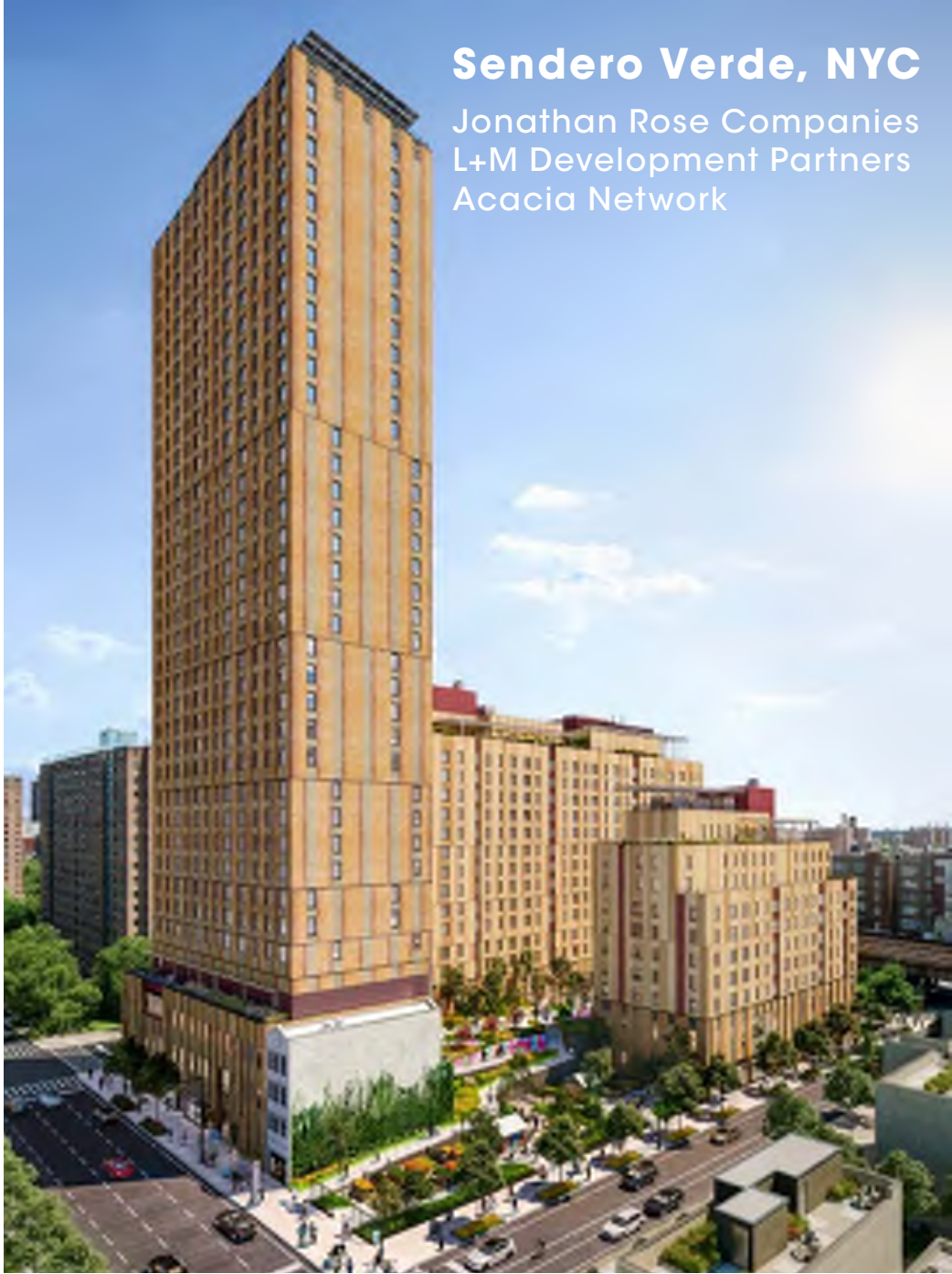
The House at Cornell Tech, NYC

The Hudson Companies
The Related Companies
Cornell Tech



Sendero Verde, NYC

Jonathan Rose Companies
L+M Development Partners
Acacia Network



Winthrop Center, Boston

Millennium Partners

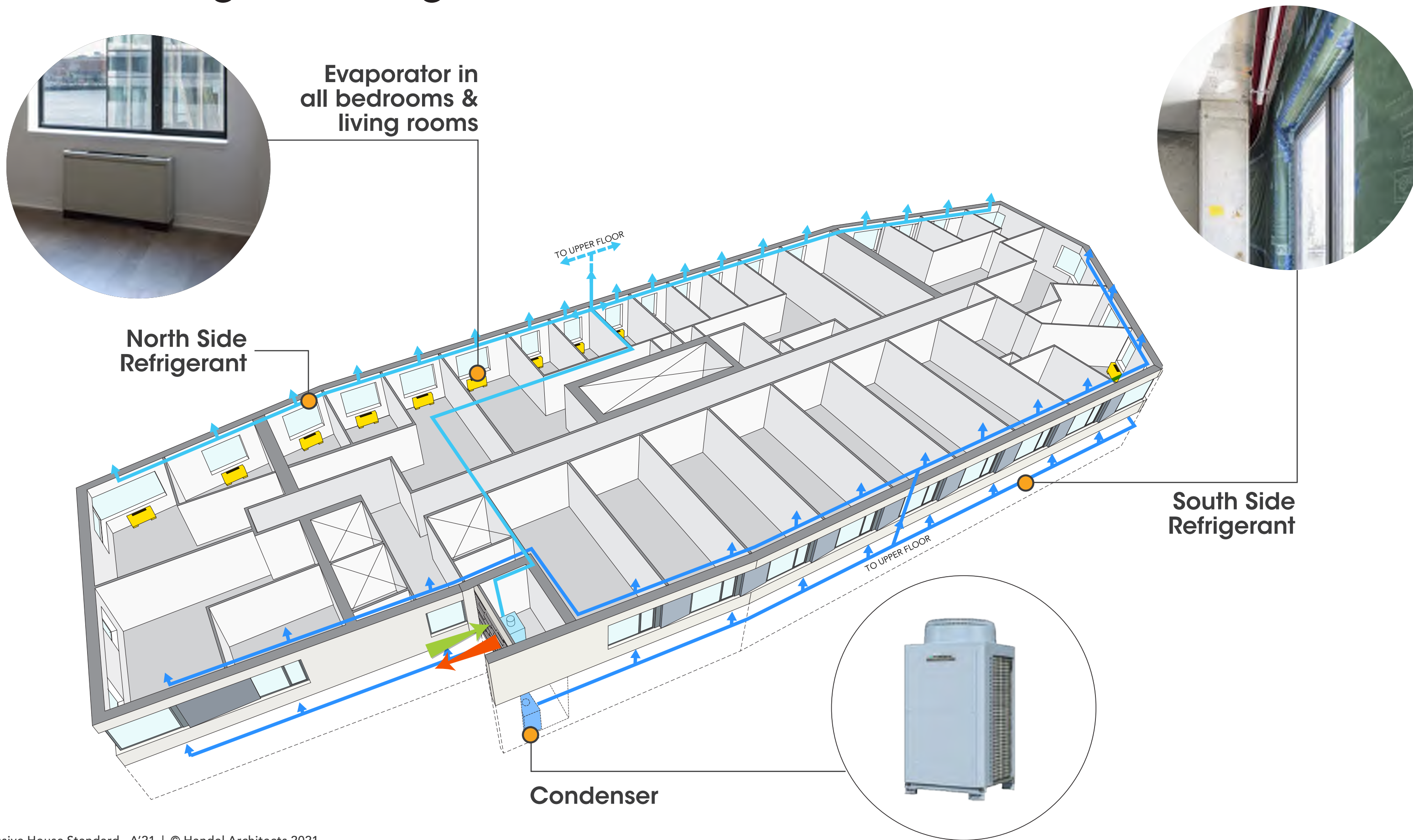


University of Toronto at Scarborough

Fengate Asset Management

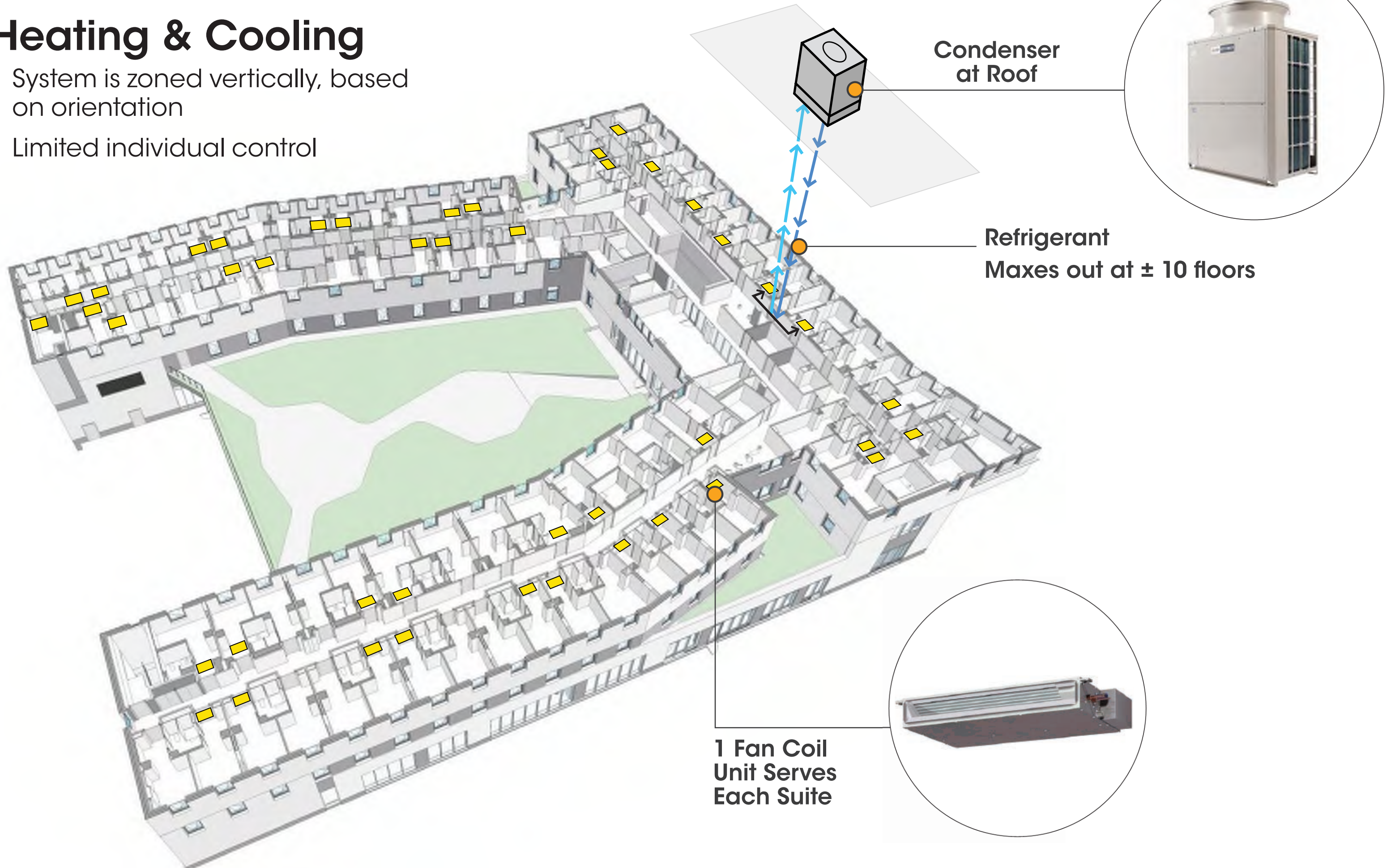


VRF: Heating & Cooling



Heating & Cooling

- System is zoned vertically, based on orientation
- Limited individual control



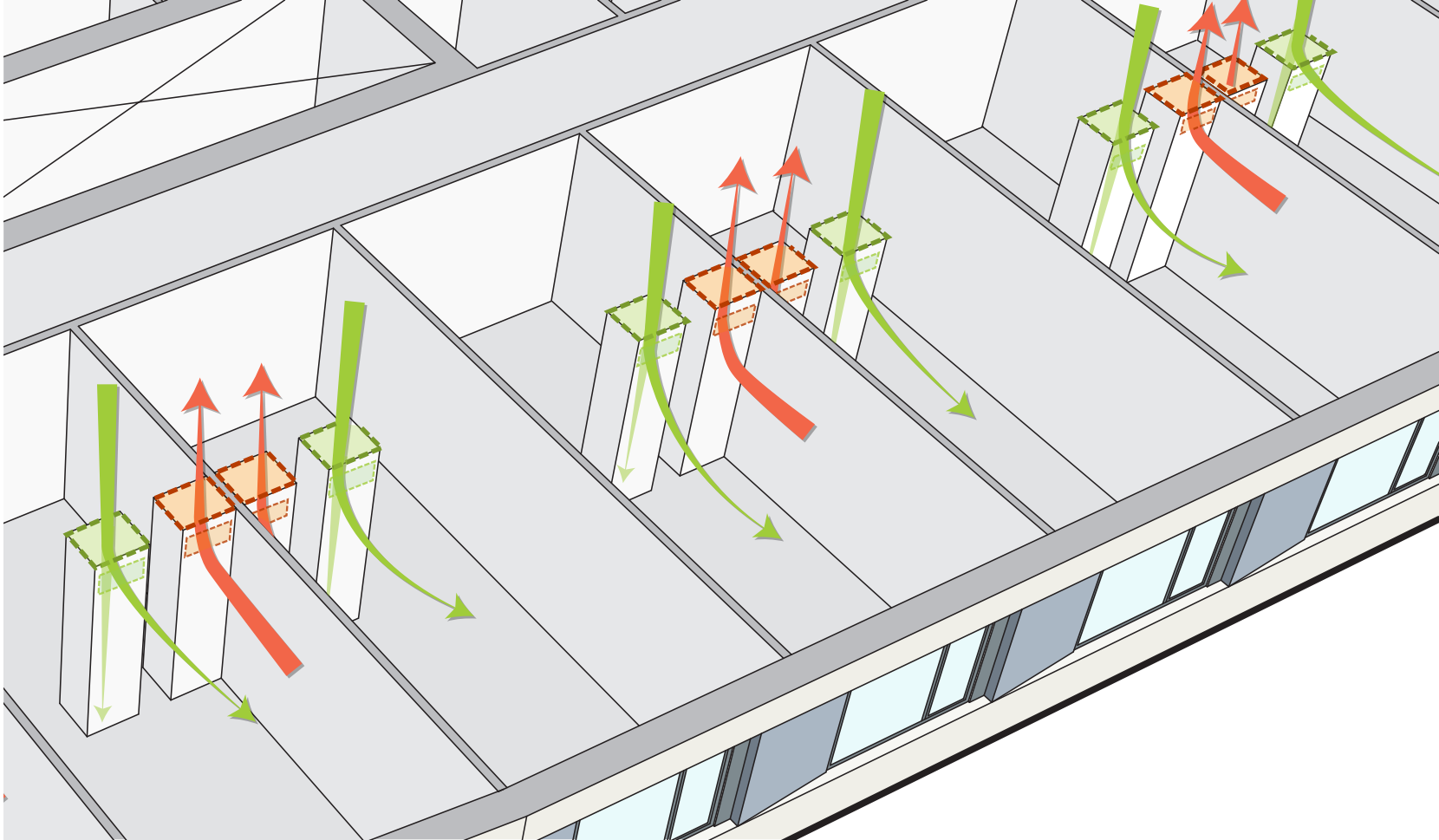
Ventilation

Balanced Ventilation
with Heat Recovery
Central Systems

- Exhaust Air
- Fresh Air

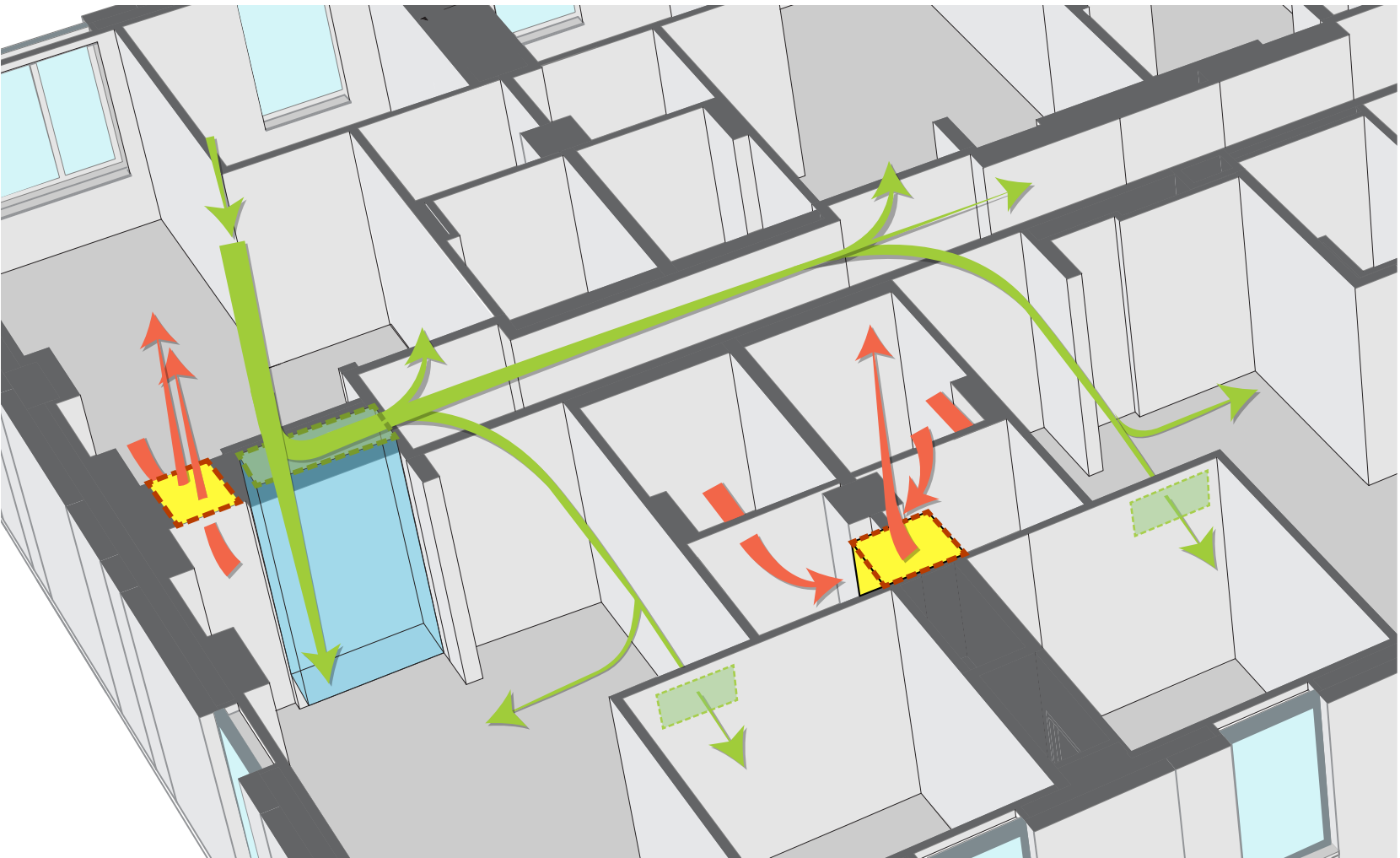
THE HOUSE

INDIVIDUAL
RISERS PER UNIT,
ALL VERTICAL
DISTRIBUTION



SENDERO VERDE

SHARED RISERS WITH
SPLIT HORIZONTAL
AND VERTICAL
DISTRIBUTION

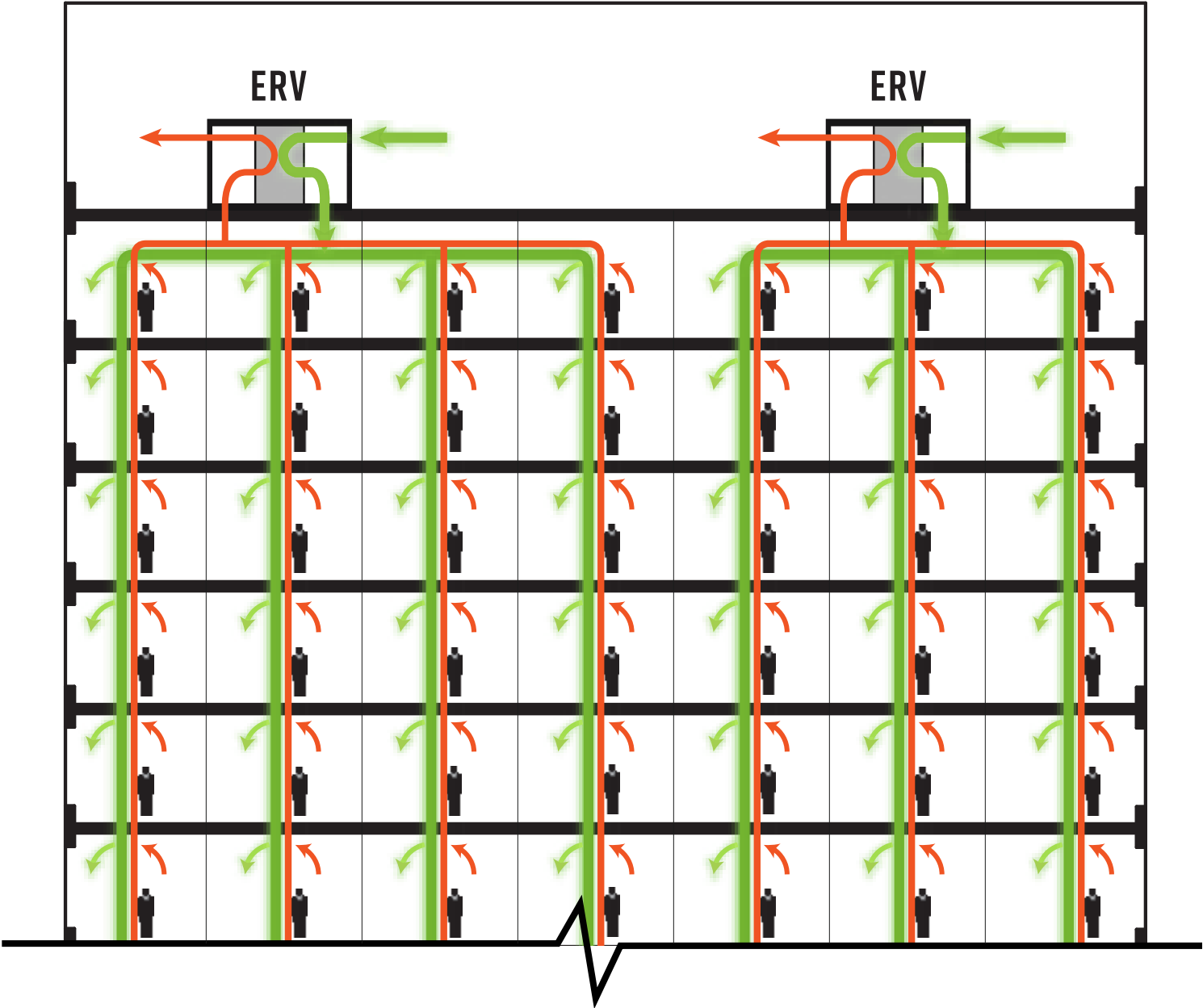


Ventilation

- Exhaust Air
- Fresh Air
- ERV



Central:
RISER PER SUITE



Quality Control During Construction



Control of Scope of work

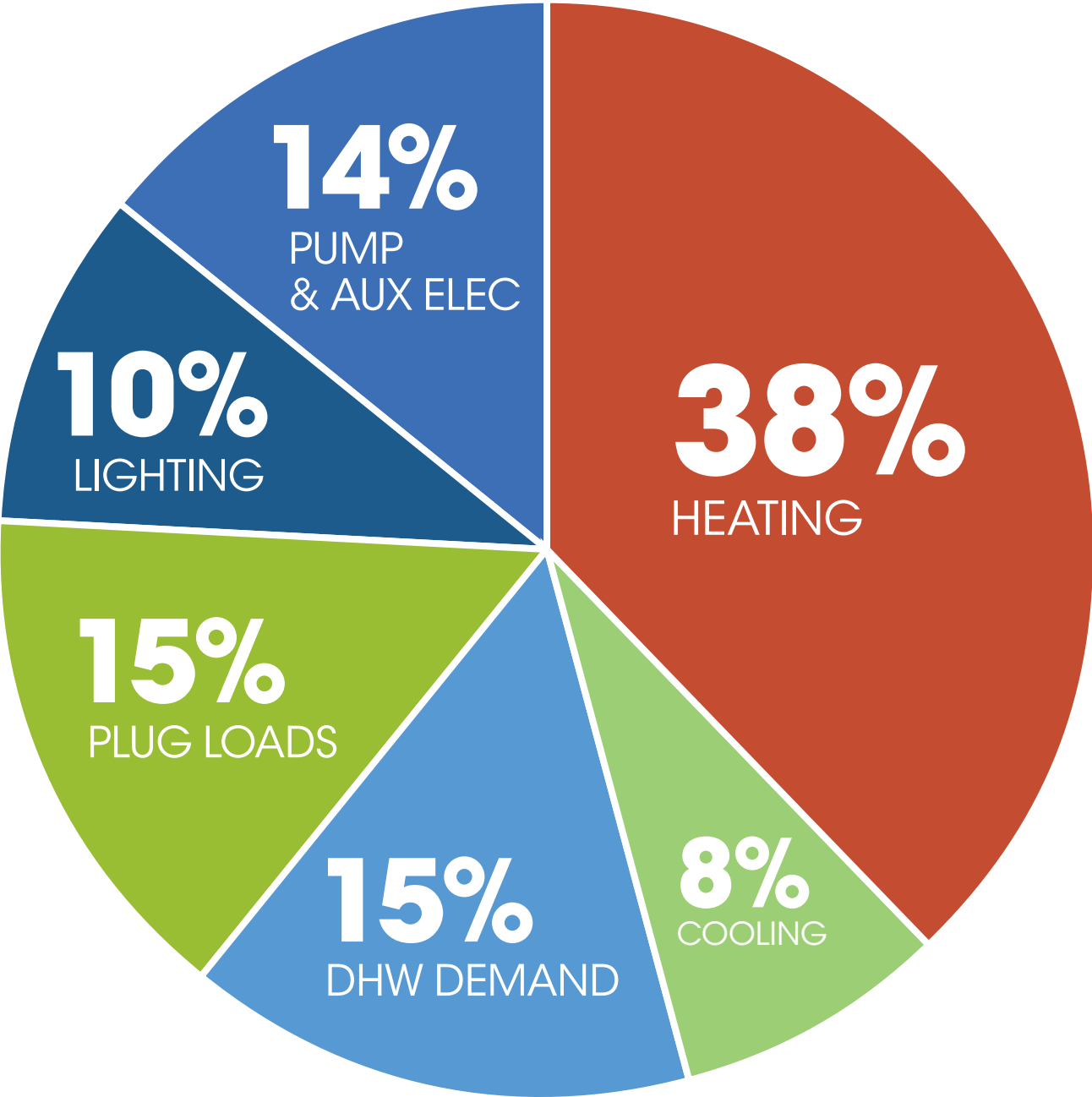
- Bid/Buy documents need to be sure to cover passive house requirements
- Not enough to say “follow spec”
- Work with contractor and trades to make sure full scope is included in buy to meet passive house requirements
- Contracts / Change orders

Trades Affected by PH Requirements

- **Exterior Sealing**
 - Exterior Panel Fabricator
 - Window Supplier
 - Carpenter
 - Mason
 - Caulker
- **Interior Sealing**
 - Mechanical
 - Electrical
 - Plumbing
- **Heating / Ventilation / Airside Contractor**
- **MEP Equipment and Lighting Supplier**

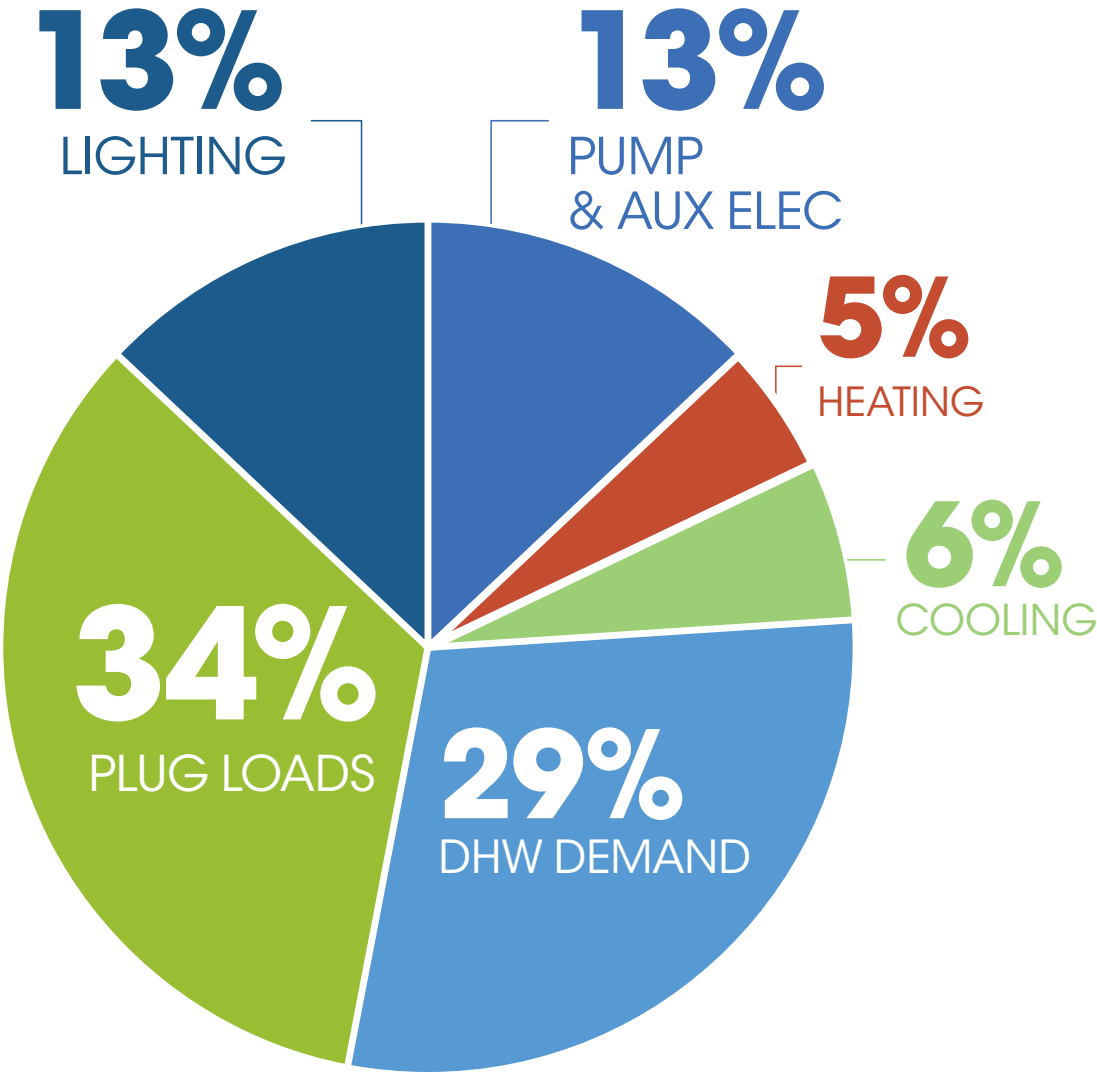
Making the Case for PH

The Passive House Impact: Source Energy Use Intensity (pEUI) Distribution Comparison



Typical NYC Multifamily Residential Building¹

Source : Urban Green Council: NYC's Energy and Water Use Report, October 2017



Multifamily Passive House Building

¹IECC 2018 Average
Making Passive House Standard - A'21 | © Handel Architects 2021

Construction Photos



Construction Photos



The House at Cornell Tech



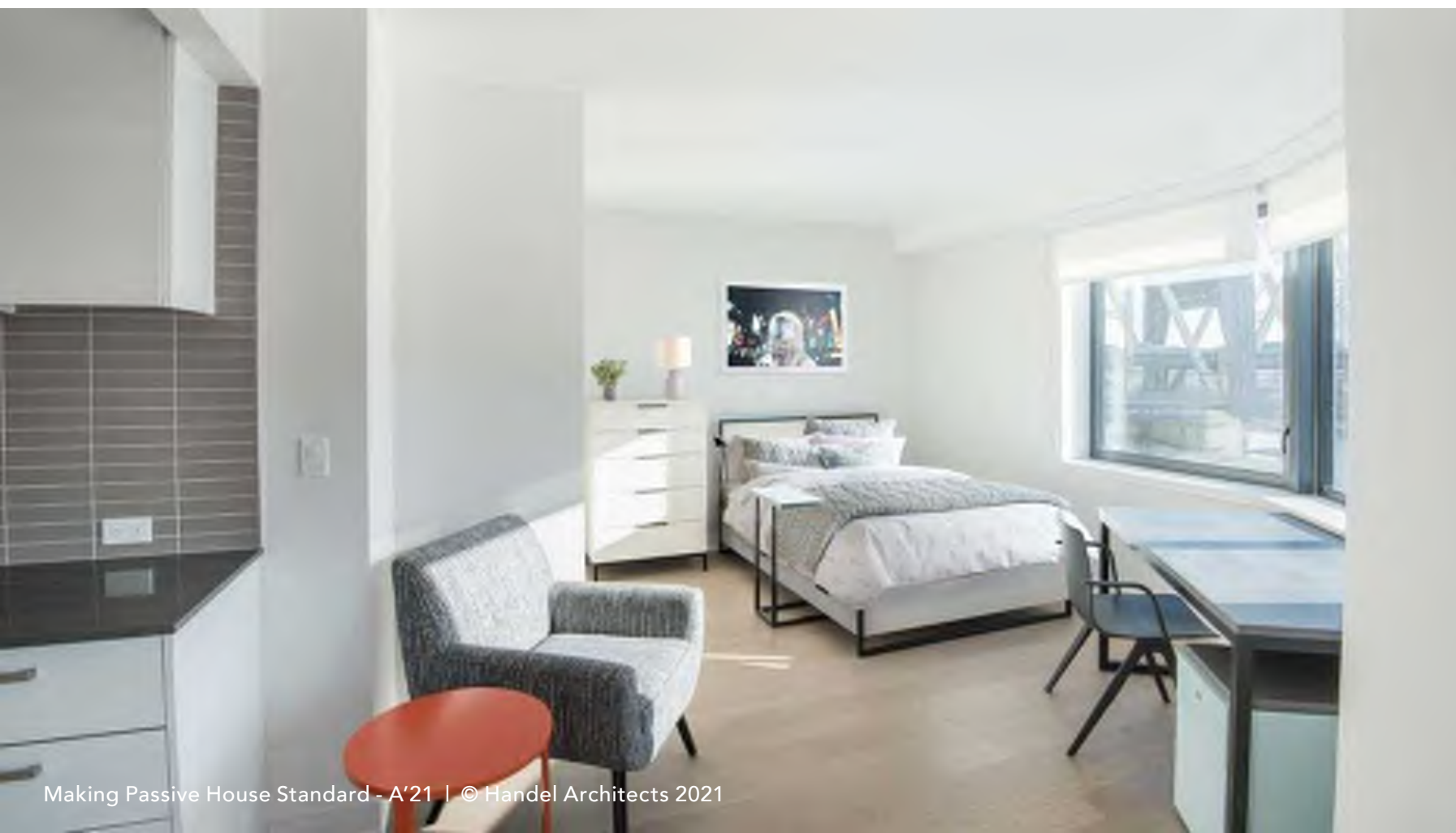
It's About the People!

- Enhance the living experience!
- Great acoustical separation from neighboring units and exterior.
- Low cost for heating and cooling (equitability)
- Comfortable temperatures, with option for control
- Healthy filtered fresh air 24/7



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Rockwool & Handel Architects

PROTECT THIS HOUSE

Q&A



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July 8, 2021