welcome.

be ex

building energy exchange

NEW YORK STATE OF OPPORTUNITY

Buildings of Excellence

Buildings of Excellence: Large-Scale Passive House

February 12, 2020

Building Energy Exchange

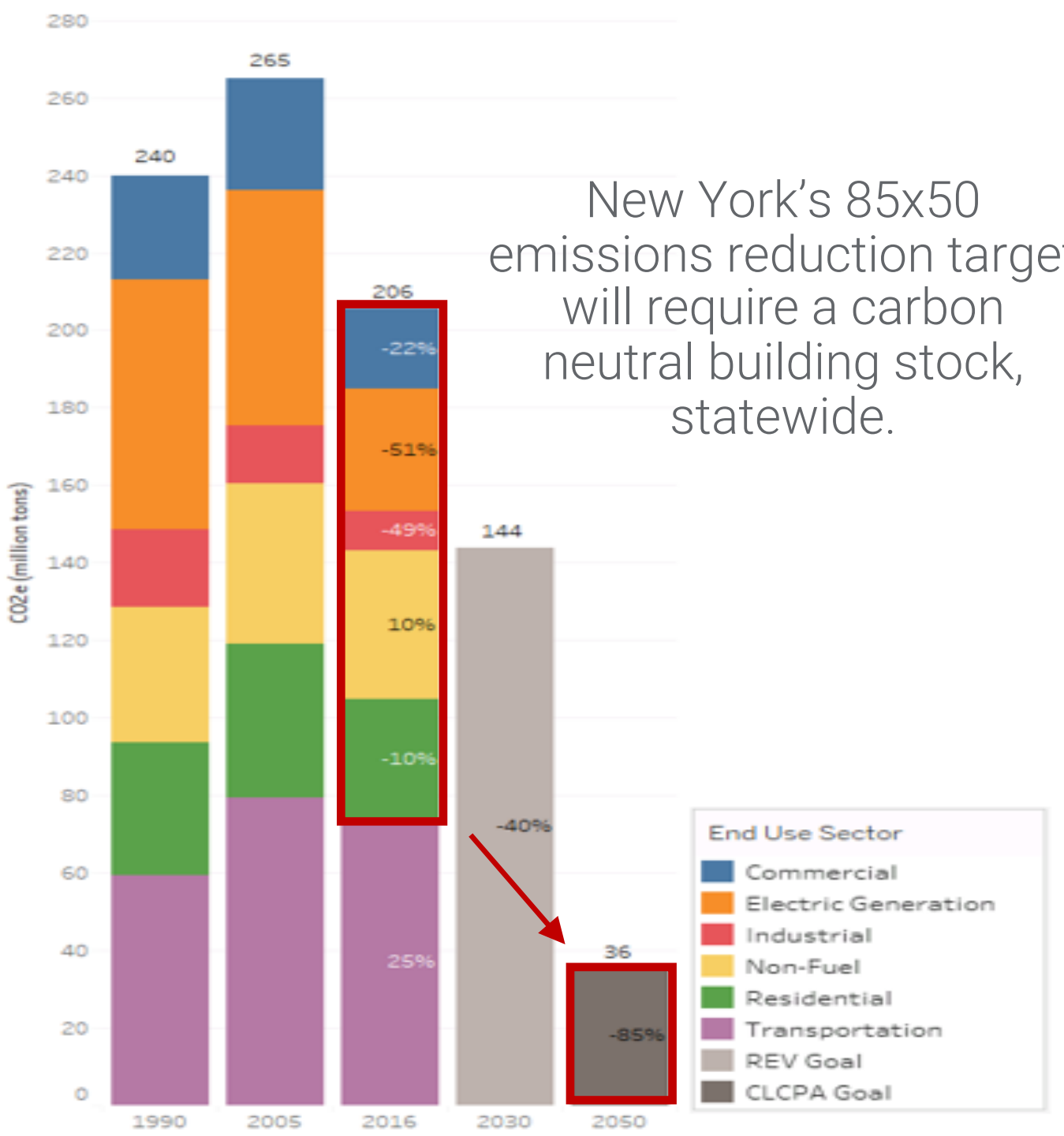
NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Why a Building Decarbonization Competition?

85

x

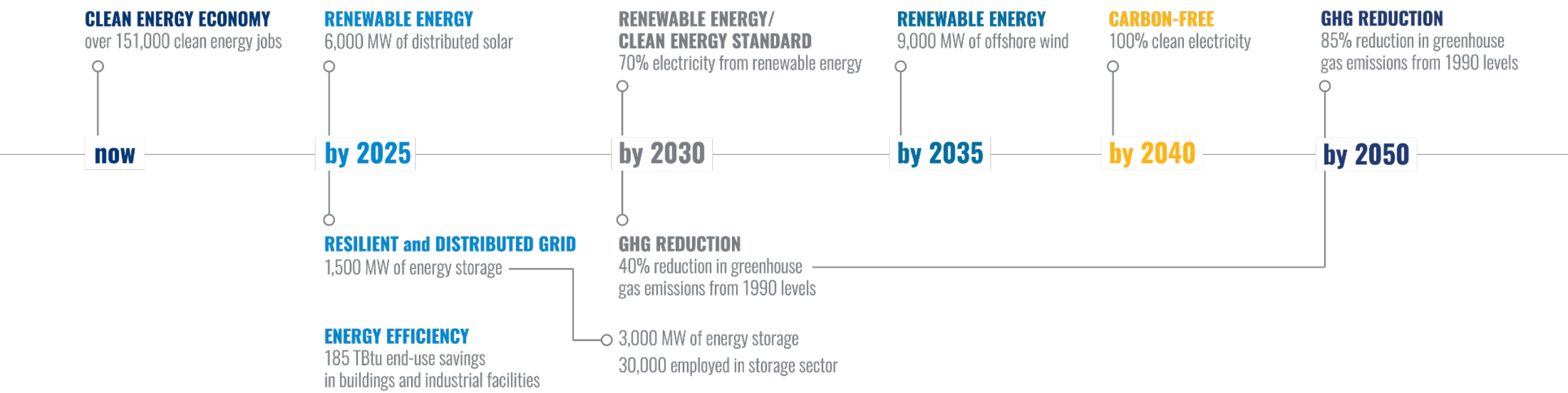
50



New York's 85x50 emissions reduction target will require a carbon neutral building stock, statewide.

New York State Clean Energy Goals

Climate Leadership and Community Protection Act (CLCPA)



NYC: Climate Mobilization Act

What is “CMA”?

> In April 2019, NYC passed a package of legislation to accelerate buildings’ progress toward the City’s 80x50 target

What’s Included

> **Local Law 92 and 94**: requires roofs of certain buildings be covered in green roofs or solar
PV systems

> **Local Law 95**: revises the City’s energy efficiency grade

> **Local Law 96**: establishes a sustainable energy loan program (i.e. PACE)

> **Local Law 97**: requires certain greenhouse gas emissions reductions by 2050 in buildings greater than 25,000 sq. ft.

Buildings of Excellence

$40 million

Over 3 rounds

Awards low carbon multifamily buildings that are beautiful, replicable, resilient, affordable, comfortable, and connected to the surrounding community.

Buildings of Excellence: Round 2

- Design competition targeting affordable housing
- $1M max project award
- Net Zero Energy / Low-Carbon / Passive House
- Layers on top of Standard Offer NYSERDA Incentives
- Applicants: Developers, Building Owners & Designers

- **Submissions due April 22, 2020**

PASSIVE HOUSE ON A LARGE SCALE

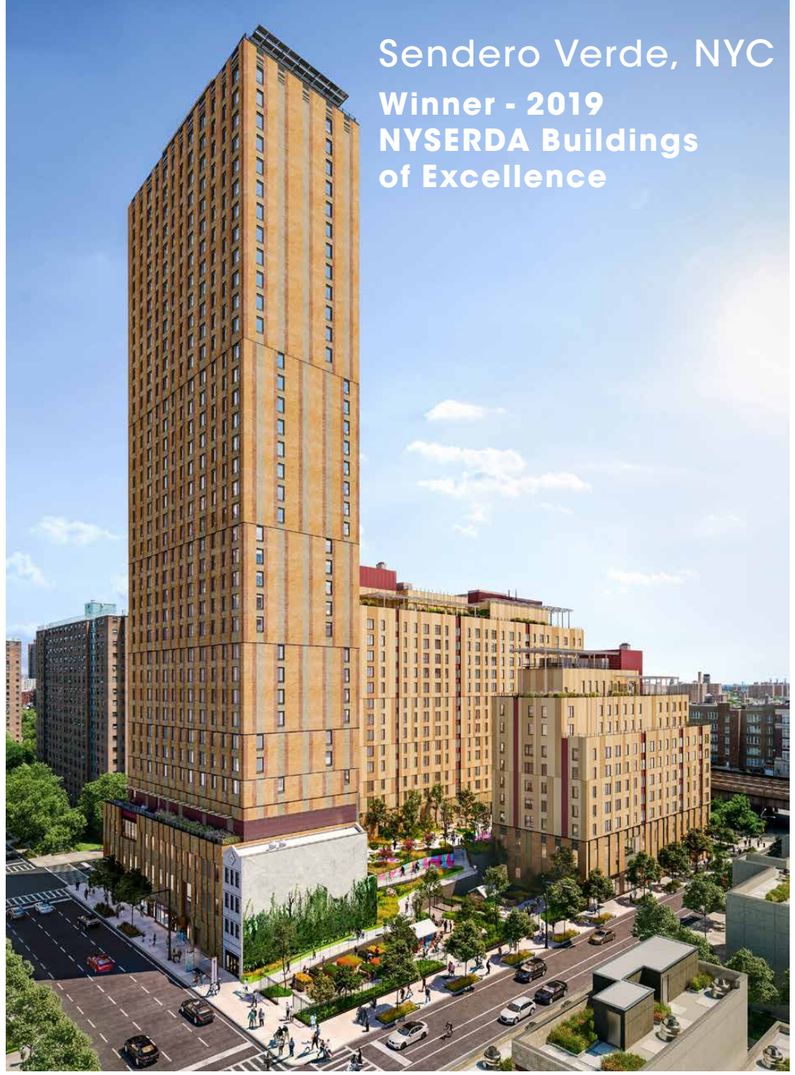
ONWARD AND UPWARD!

Lois Arena PE
Director of Passive House Services | Steven Winter Associates

Deborah Moelis AIA CPHD
Principal | Handel Architects

February 12, 2020

The House at Cornell Tech, NYC



Sendero Verde, NYC

Winner - 2019 NYSERDA Buildings of Excellence

University of Toronto at Scarborough

Winthrop Center, Boston

02.12.2020 | BEEx Passive House on a Large Scale | © Handel Architects

High Rise Passive House Applied

TORONTO
CLIMATE ZONE 6

RESIDENCES AT THE
UNIVERSITY OF TORONTO
AT SCARBOROUGH

BOSTON
CLIMATE ZONE 5

WINTHROP CENTER

NEW YORK CITY
CLIMATE ZONE 4

THE HOUSE AT CORNELL TECH

SENDERO VERDE

WHAT IS PASSIVE HOUSE?

- **The most rigorous** of the energy focused building standards/certifications
- **An overall holistic** approach to the design of a building that is guided by both curtailing energy usage and increasing user comfort
- **A strict quality control** program during construction that assures the building is assembled as designed

Passive House Institute (PHI) Performance Criteria for Certification

PEUI (source) KBTU/ft²/yr

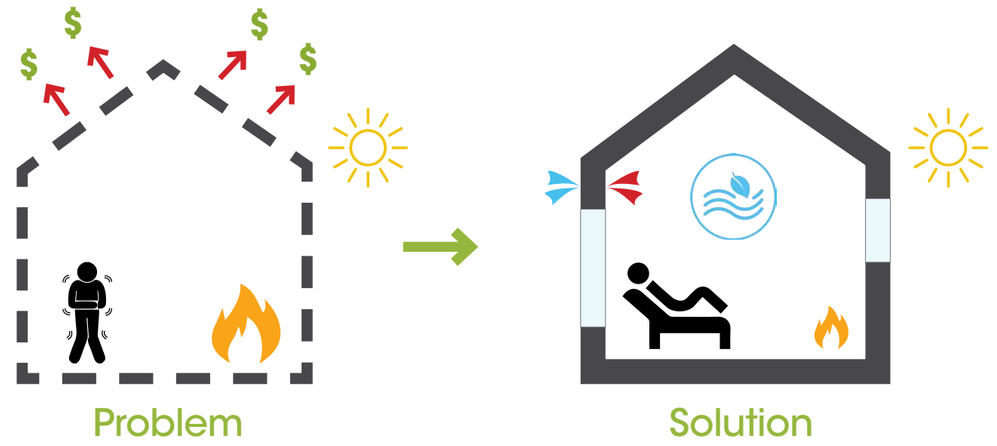
130.0 IECC 2018 Average from NYSERDA Energy 2018 Report

38.1* Passive House

Overall Source Energy Allowed	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)
Air Changes per Hour (ACH) through the facade @ 50 pascals of pressure	0.6 ACH 5-10 times tighter than typical
Exhaust and Supply Ventilation	Balanced, with energy recovery

*Can be adjusted for density and use.

WHY PASSIVE HOUSE?



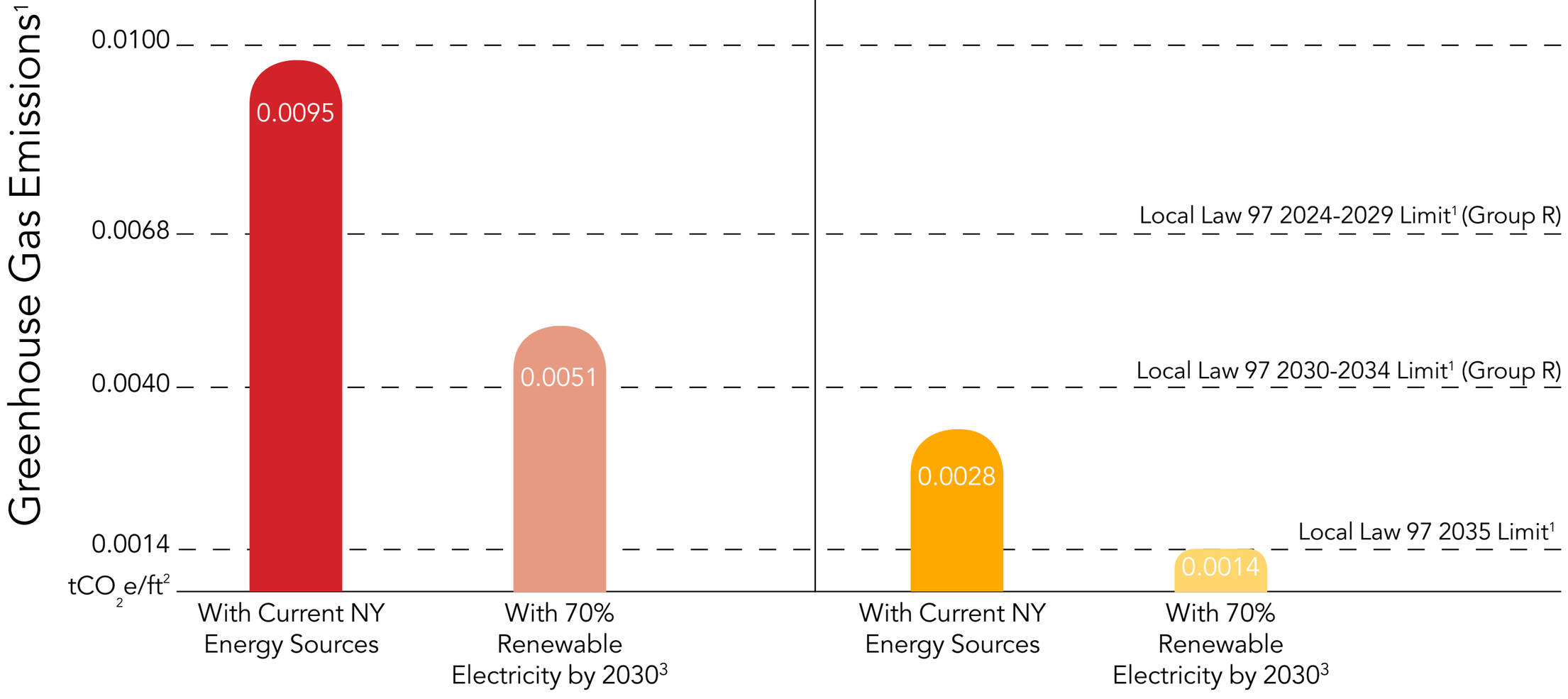
- **Reduce carbon emissions**, lower green house gasses, combat global warming.
- **Reduce energy** needed to operate a building by 60-80%
- **Provide superior** thermal comfort, indoor air quality and acoustics.
- **Improve health** of inhabitants
- **Increase durability** of building materials
- **Ease compliance** with government mandates (new laws, codes, standards)

Local Law 97

Passive House Standard for Energy Efficiency

130 kbtu/ft^2 IECC 2018 Average[1]

Passive House Institute 38* kbtu/ft^2



[1]New York State Energy Research and Development Authority-Energy 2018
[2]New York Local Law 97 of 2019
[3] New York Climate Leadership and Community Protection Act

*Can be adjusted for density and use.

HOW TO ACHIEVE PASSIVE HOUSE?

Enclosure: Roofs, Walls, and Foundation

Provide a robust, high performance enclosure to achieve:

- Air tightness
- Windows with exceptionally low U-Values.
- Continuous insulation and thermal bridge free detailing leading to high R-Values

MEP Systems

- Provide a high performance, low energy heating and cooling system
- 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

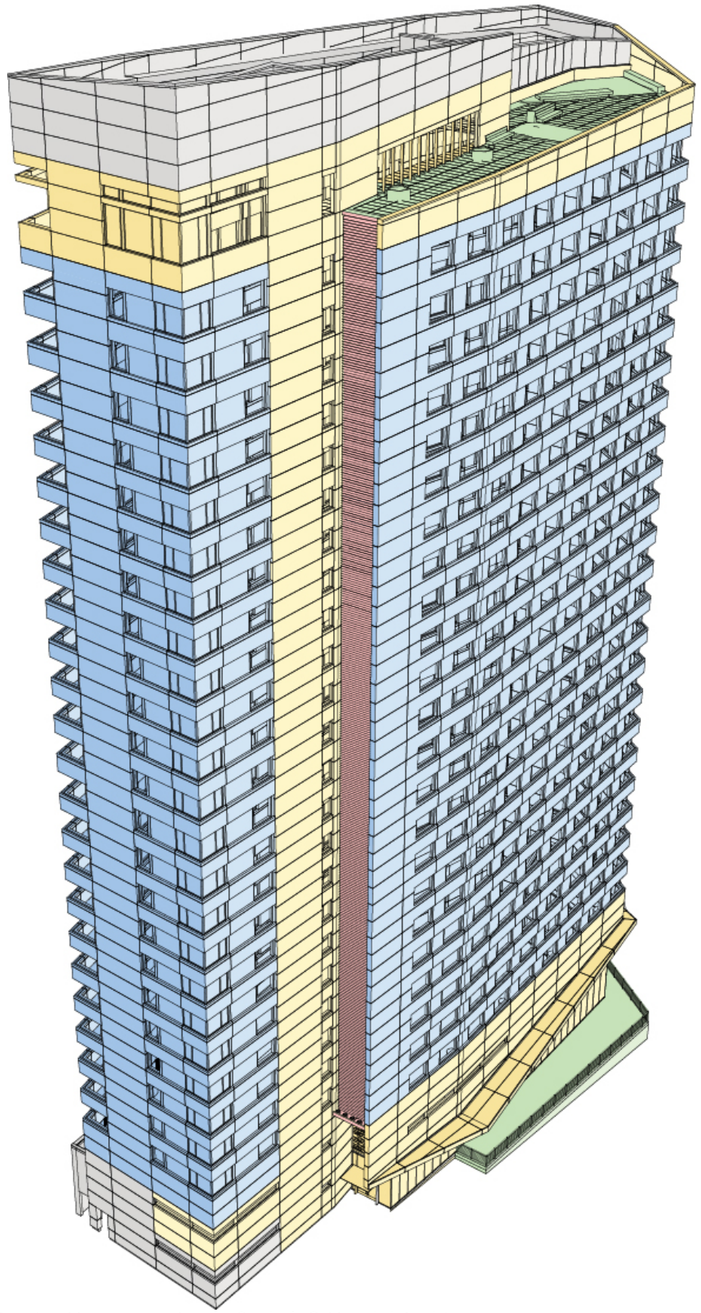
THE HOUSE AT CORNELL TECH

TEAM

Cornell University
Hudson Companies
Related Companies
Handel Architects
Steven Winter Associates
BuroHappold
Vidaris
Monadnock Construction

02.12.2020 | BEEx Passive House on a Large Scale | © Handel Architects

The House: Project Summary



- COMMON AREAS
- APARTMENTS
- GREEN / OPEN AREAS

PROJECT SUMMARY

Area: 270,000 GSF / 25,083 GSM
26 Stories
270' / 25m to Roof
352 Units, 500 Beds
10,600 GSF/Floor / 984 GSM/Floor

USERS

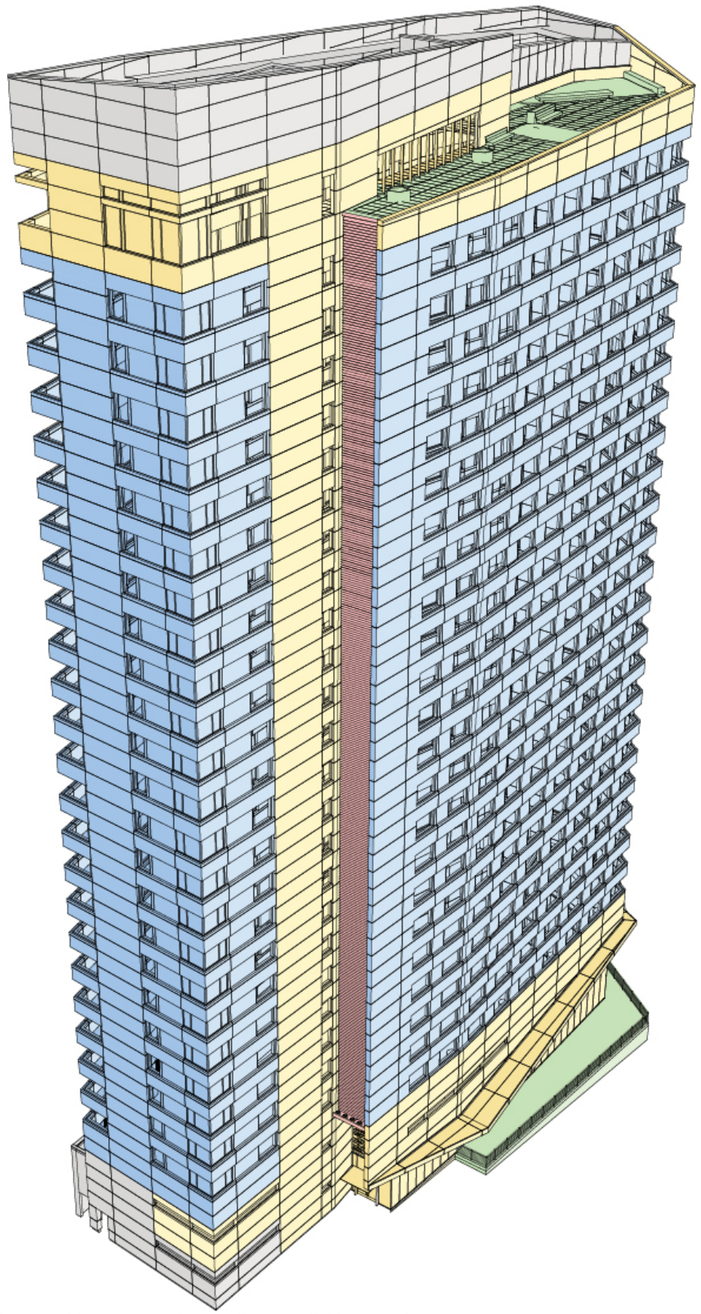
Graduate Students

PhD Candidates

Post Doctoral

Faculty

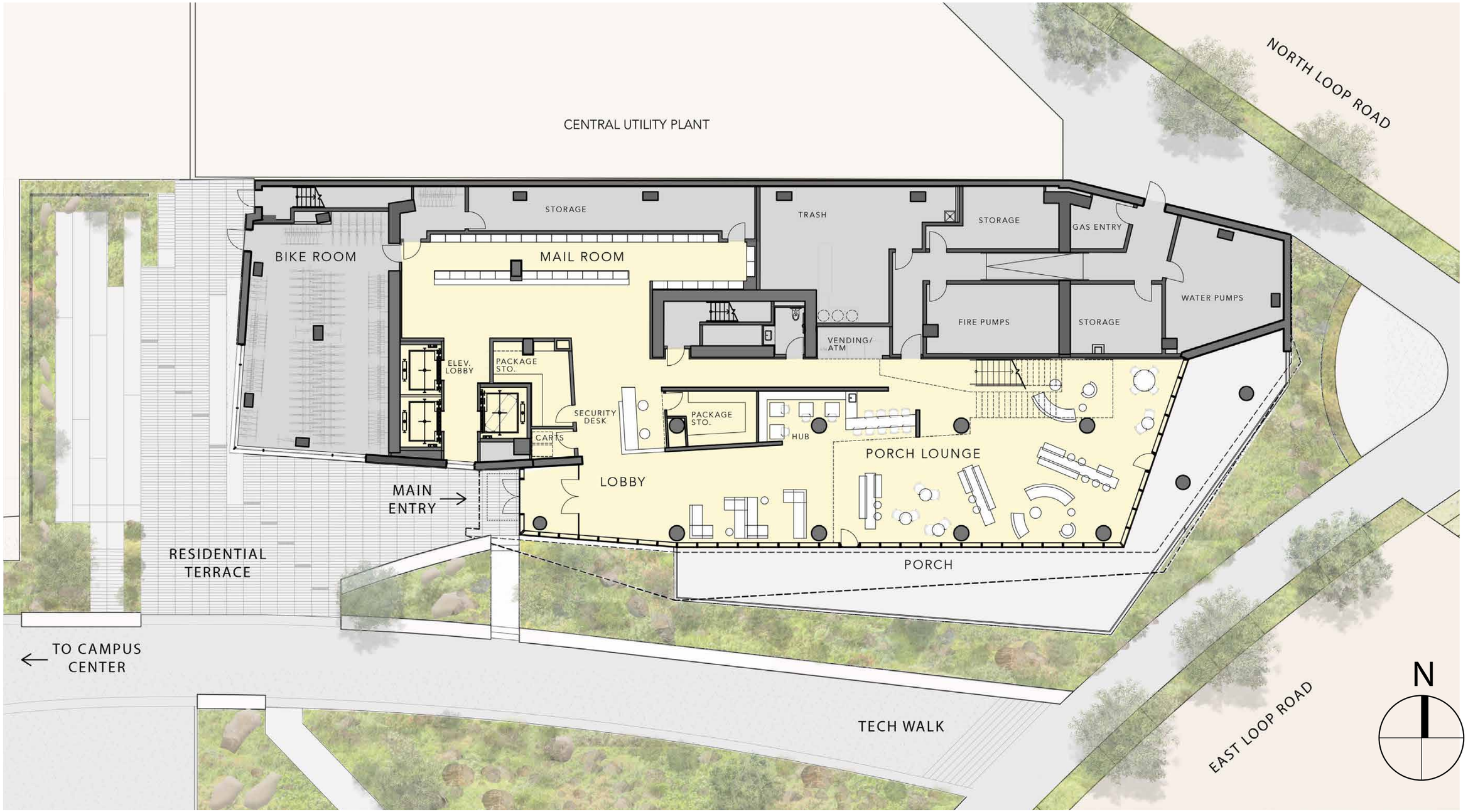
The House: Project Challenges



PROJECT CHALLENGES

- **Experience of entire team applying PH to a large scale**
- **Supply stream**
  - Efficient ERVs/HRVs
  - PH compliant aluminum windows & storefronts
  - Thermal break mateials
  - PH level exterior doors
  - Small enough heating/cooling equipment
- **Heating & cooling controls – desire to provide each room w/ individual control**
- **Code conflicts**
  - Ventilation flow rates,
  - Refrigerant line lengths in dwelling units,
  - Ventilation of shafts – elevator, stairs
  - Fire rated windows
- **Height challenges for VRF line lengths**
- **Air barrier validation during construction**
- **Very dense building – Source EUI target needs adjusting**

Ground Floor Plan

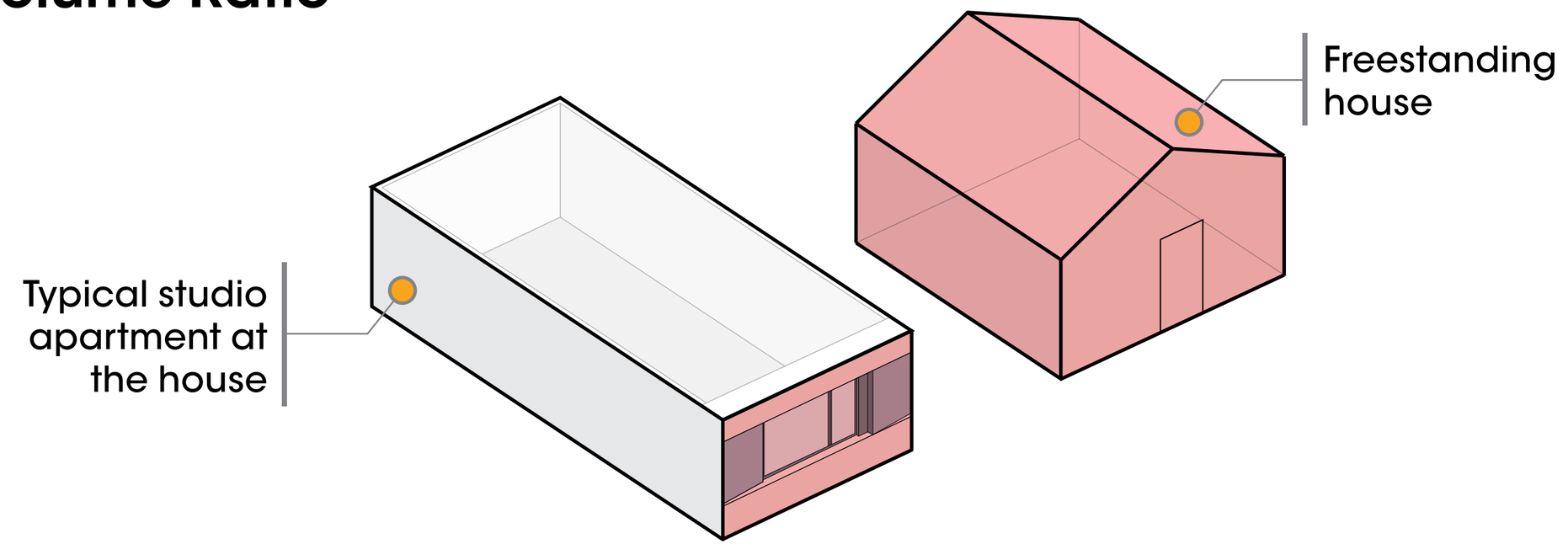


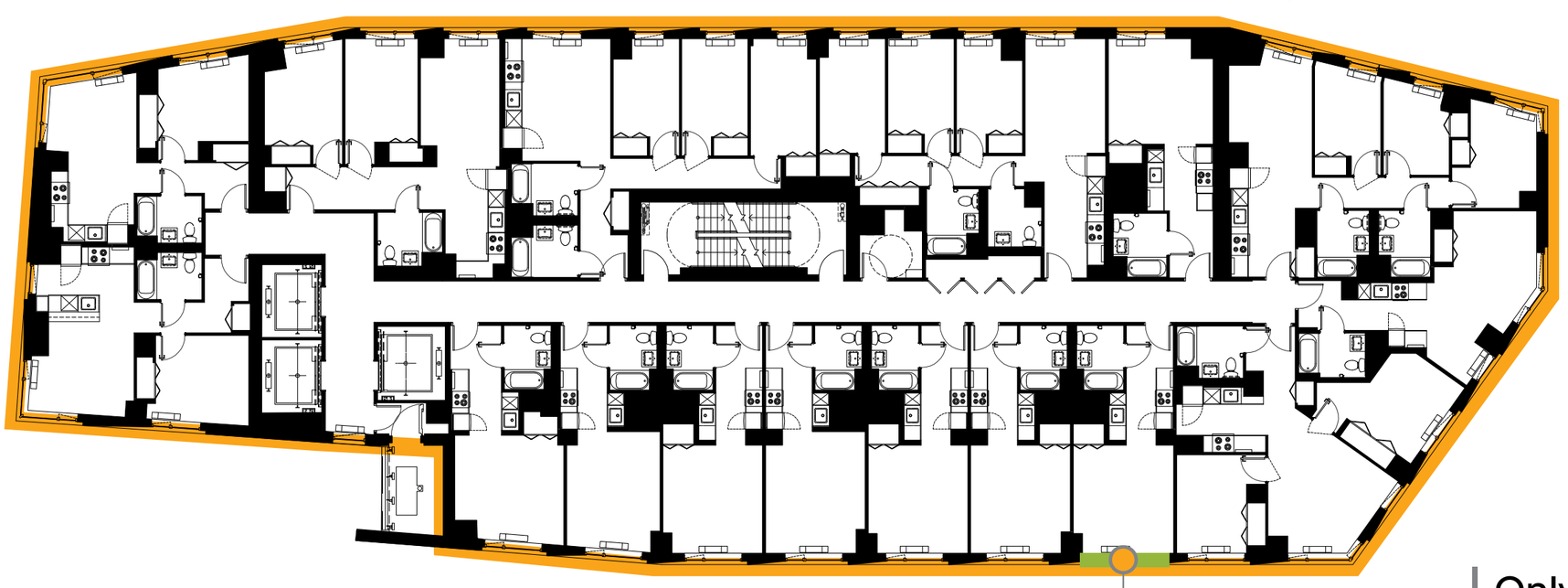
Typical Floor

16 Units per Floor

Low Surface to Volume Ratio

16 Units per Floor





Only one surface of this apartment is exposed.

Enclosure

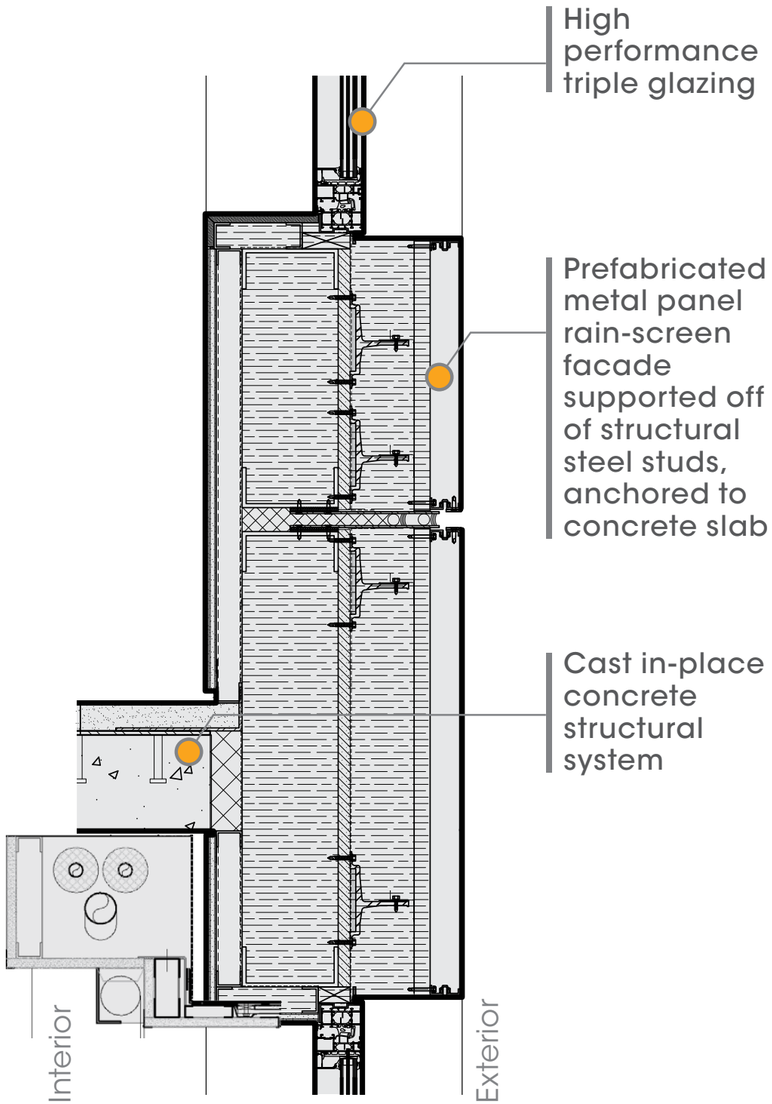
Component	Efficiency
Roof	R-50
Walls	R-19 Average
Windows	U-0.18
Slab Edge	R-10+
Cantilevered Floors	R-40

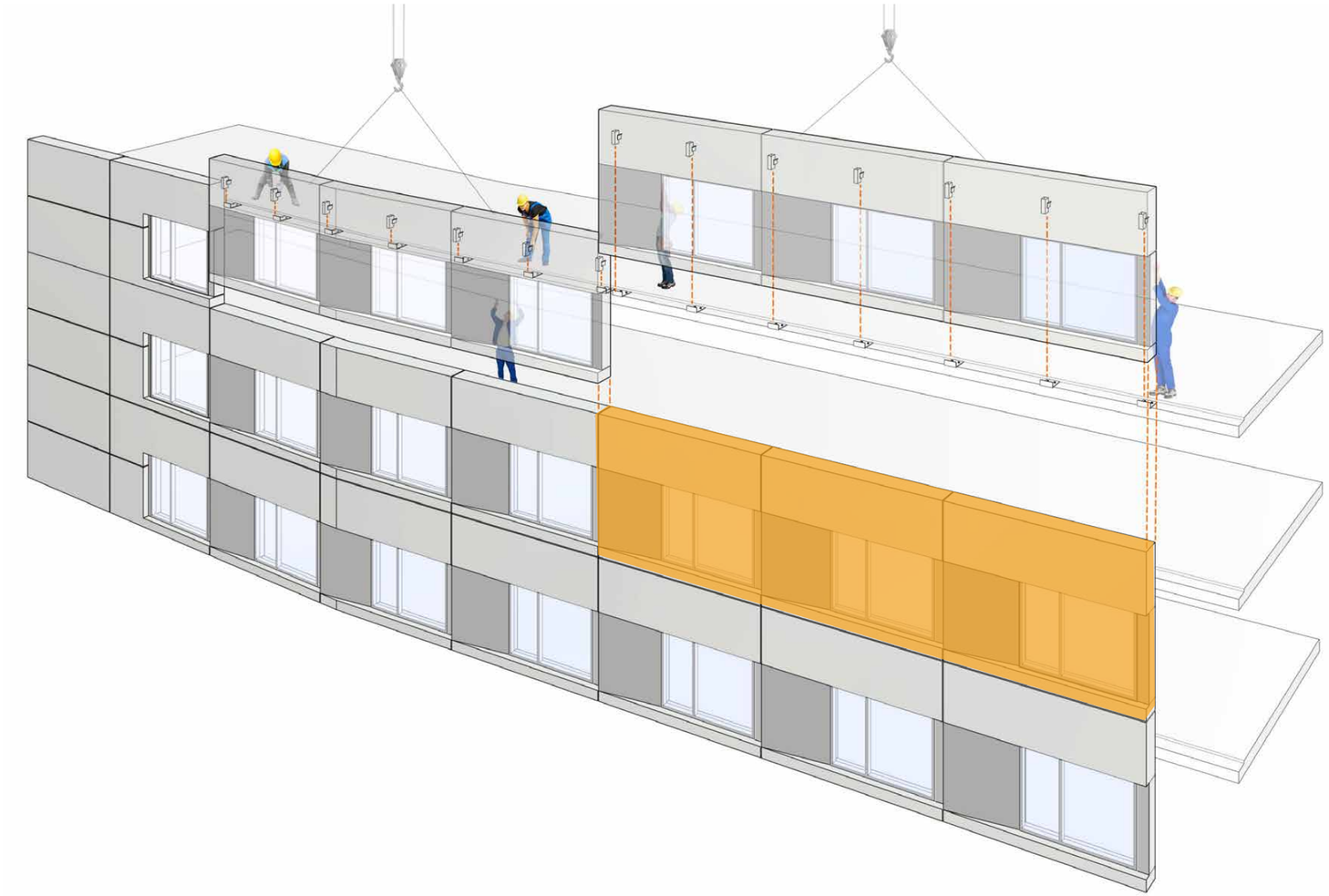
- Airtightness
- Thermal Continuity
- Eliminate Thermal Bridging

WEST

SOUTH

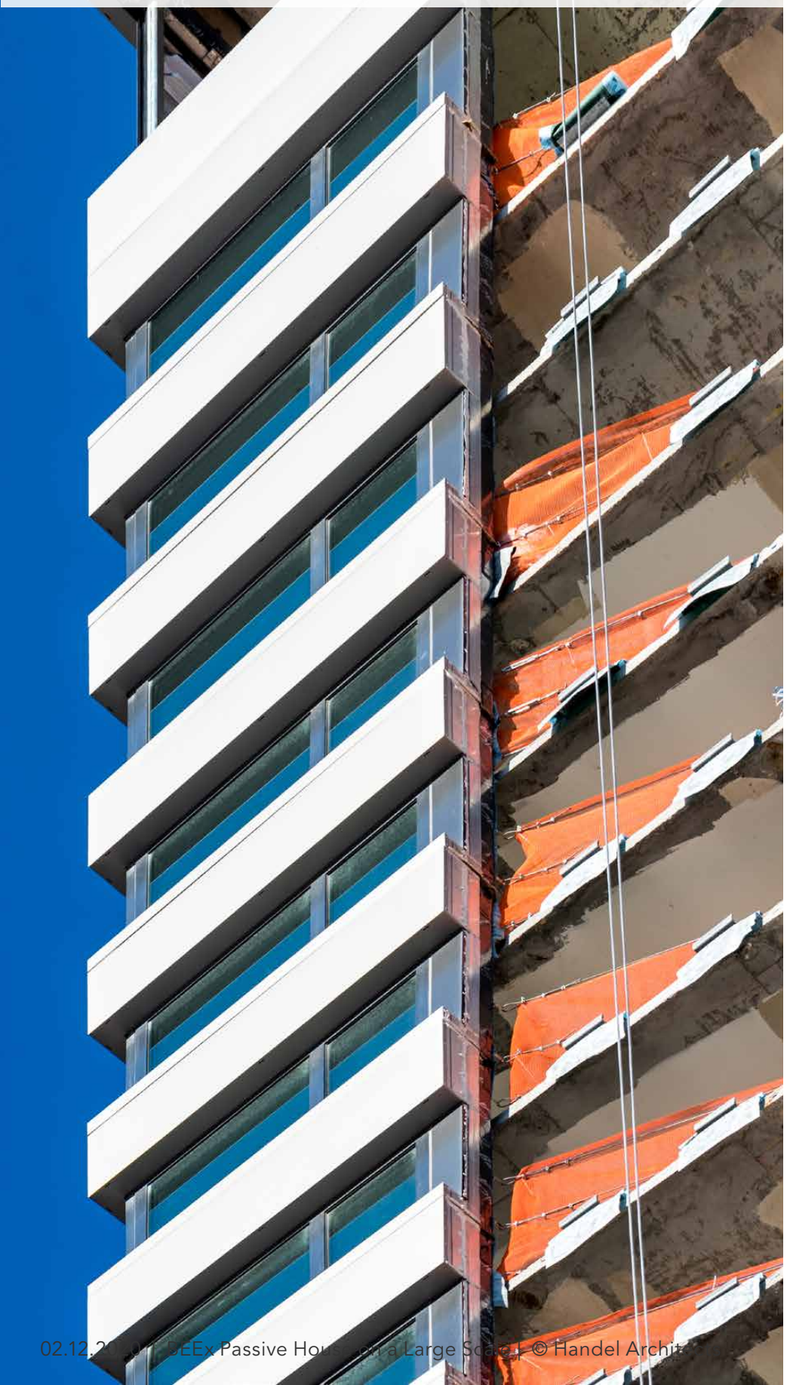
Panelized Wall System

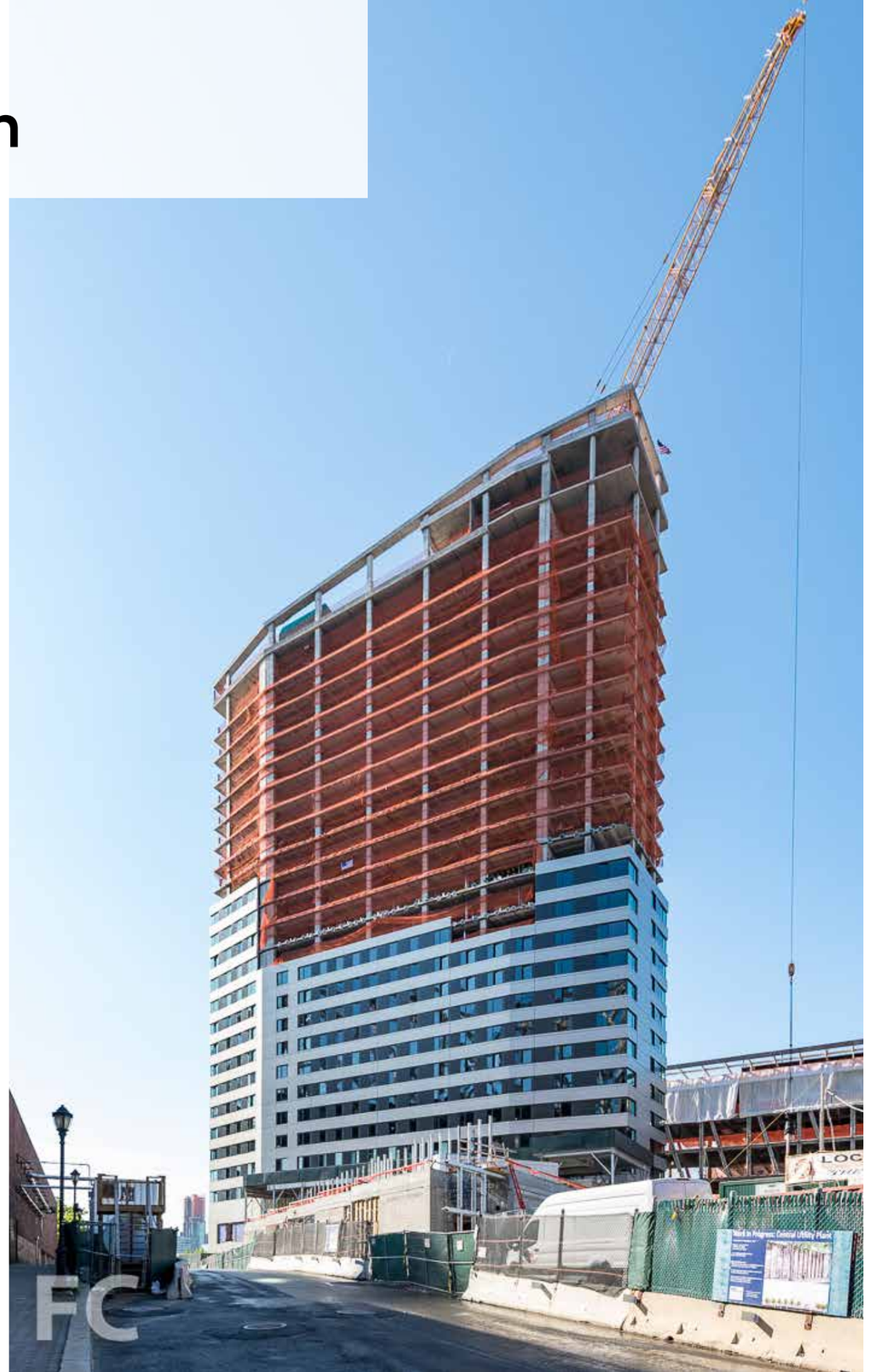




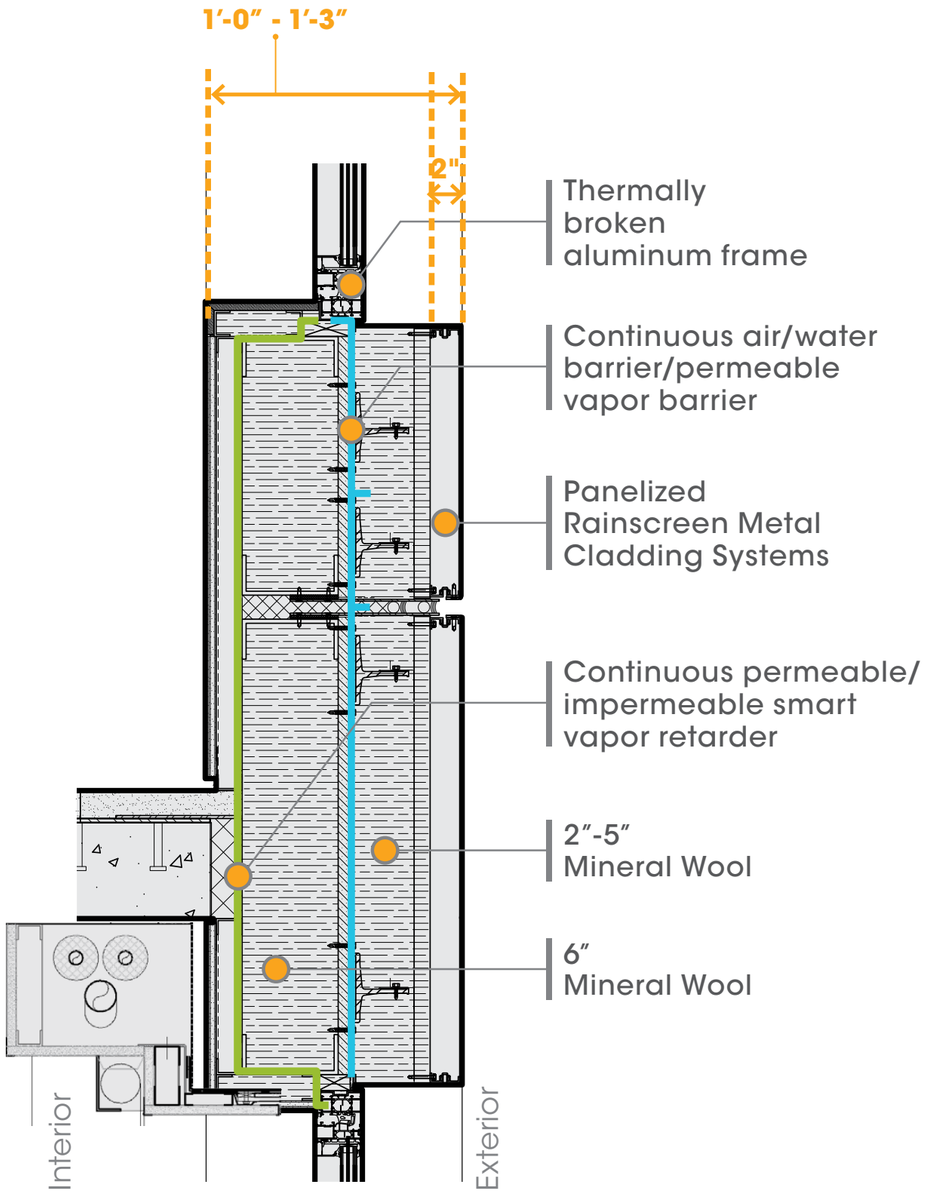
The House at Cornell Tech

Panelized Installation



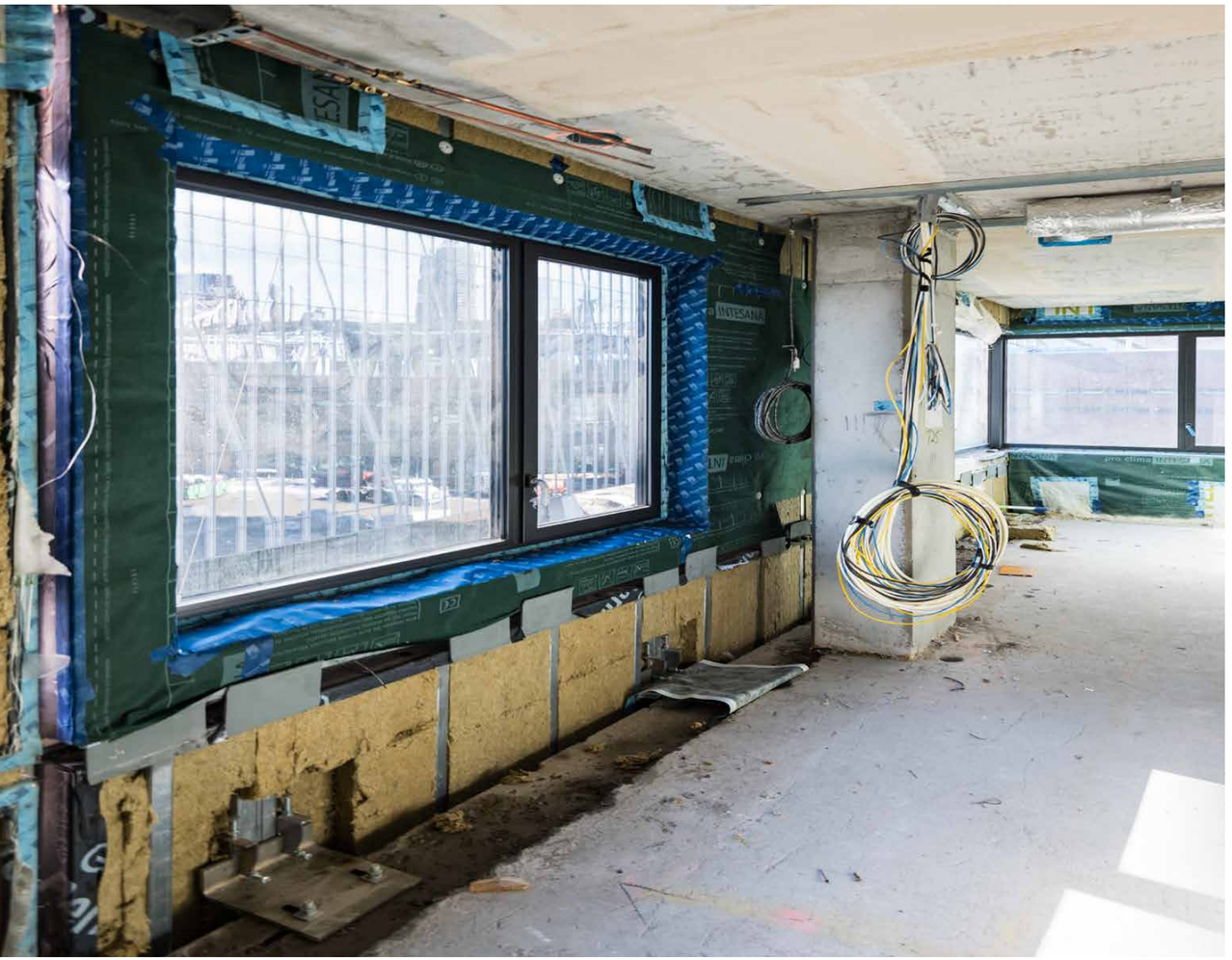


Exterior Wall Composition

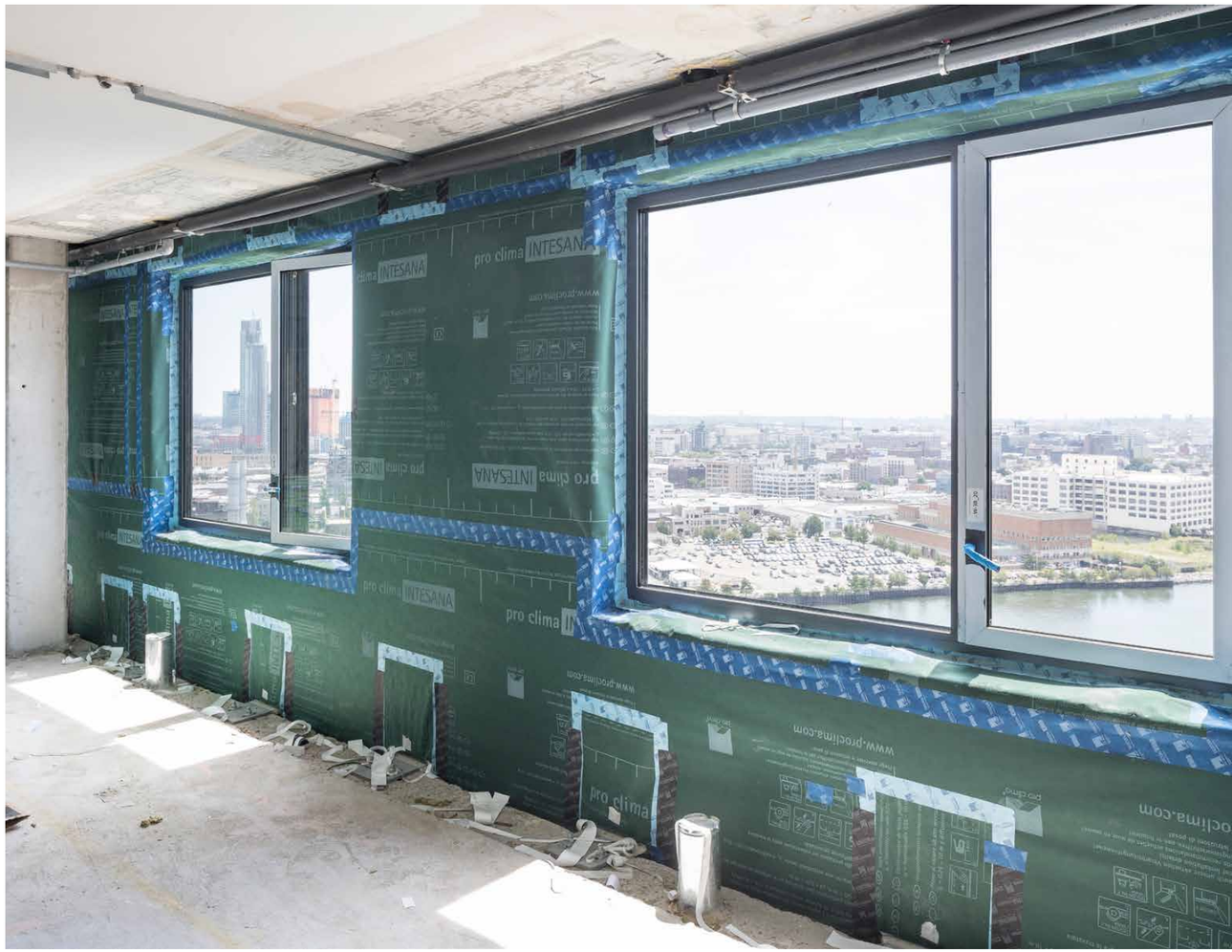


Theory vs. Practice

Before Panel Supports Sealed

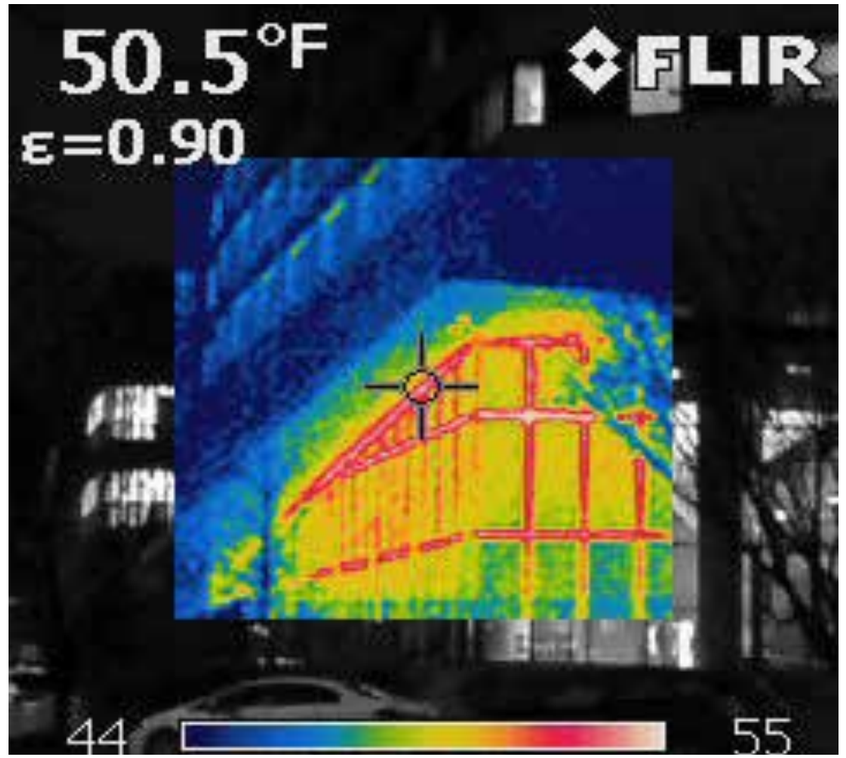


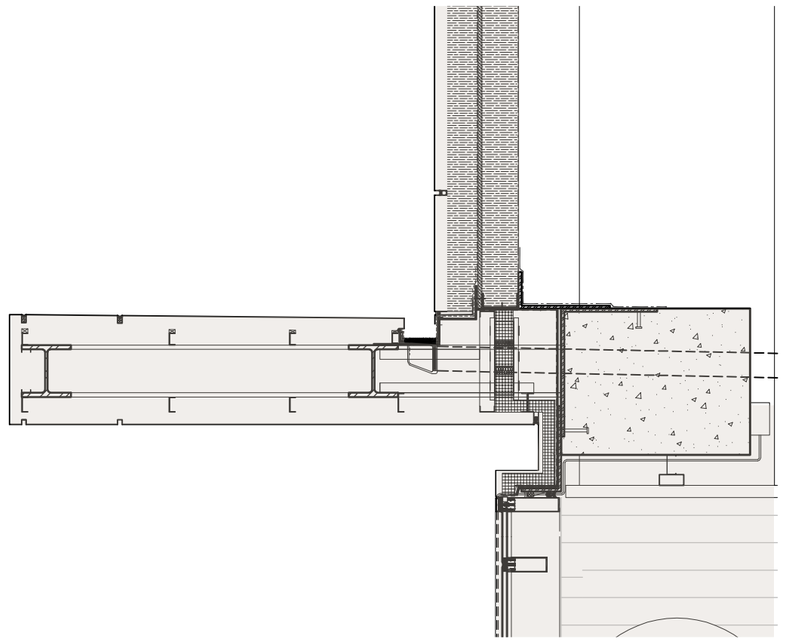
After Panel Supports Sealed



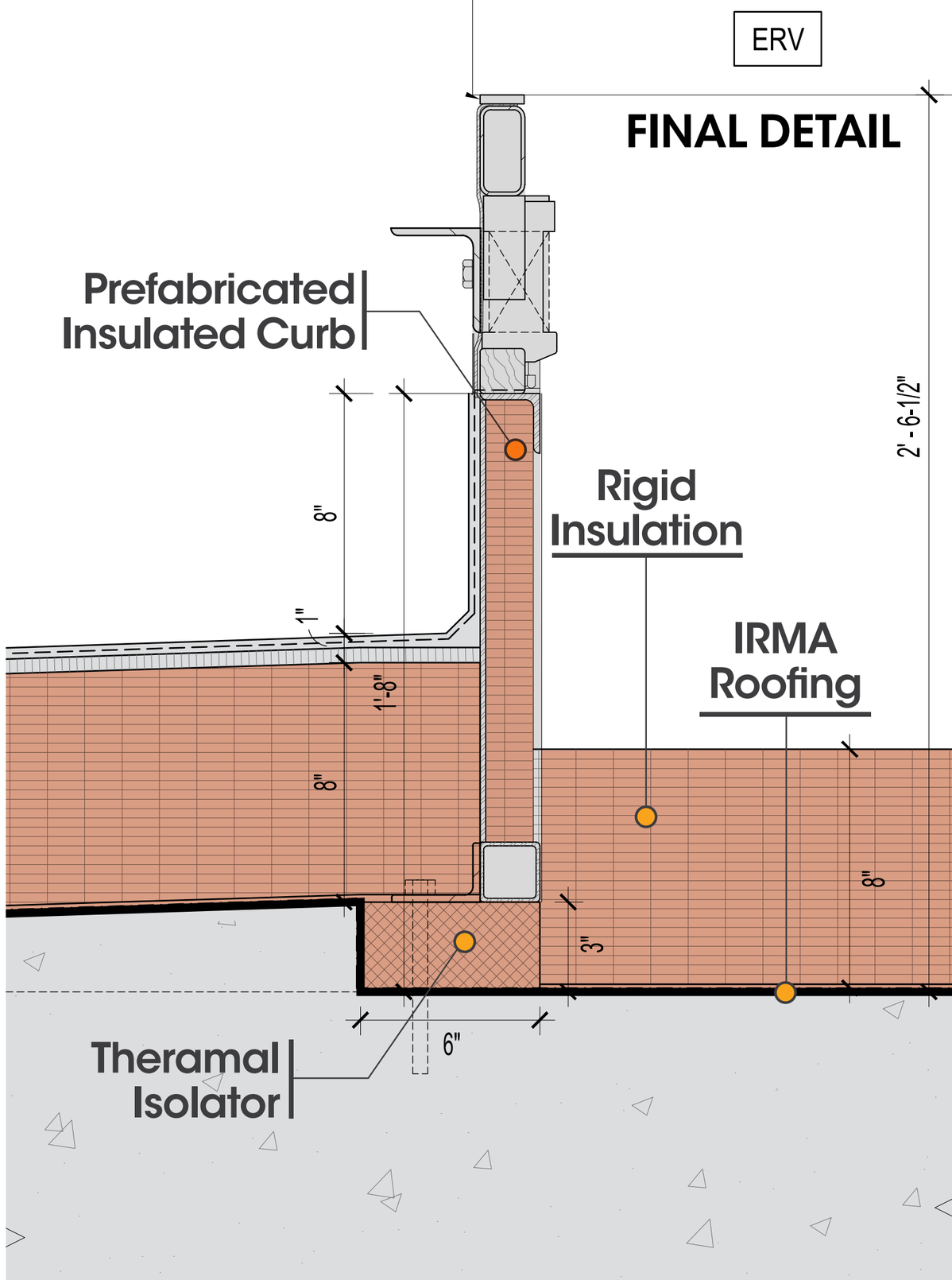
Thermal Bridge Free Design

- All details must be reviewed and modeled by PH consultant
- Too much thermal bridging can result in condensation and comfort issues
- This can completely undermine the exterior insulation of the building



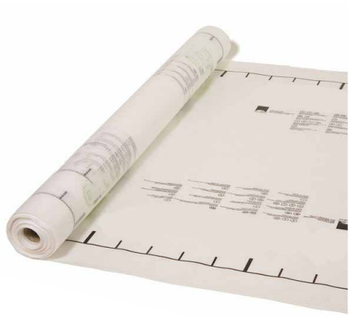


Eliminate Thermal Bridging



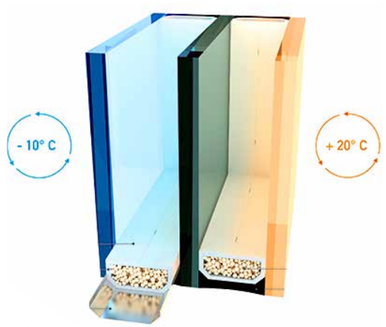
Innovative Materials

Schedule 4: Material Schedule

	**ISO-1**	**Schock - ISO-1**	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/ Impermeable Tapes**	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
	**V-1**	**Vapor Retarder**	Inside face of exterior wall

Innovative Materials

Schedule 4: Material Schedule

	**B-1**	**Thermal Clip**	Thermal clip assembly with thermal studs/isolators. Improves performance by 60 - 90%.
	**CMU-2**	**Insulated CMU Block**	12" Block - R22 10" Block - R20 8" Block - R6
	**G-1**	**Vapor Permeable Gasket**	Incoming conduit & pipes Install in sequence!
	**GS-1**	**Warm Edge IGU Glass Spacers**	Can lower IGU U values by approx .04 as compared to standard aluminum spacer.

Prefab Metal Panel Wall Specification

Air Tightness

Thermal Performance

Cornell NYCTech – H/R Residential
Roosevelt Island, NY
Handel Architects LLP

Construction Documents
March 12, 2015

b. Field Test repuirements for Passive House Certification by Owner's consultant:

1). Air leakage testing will be conducted using blower door equipment from Minneapolis Blower Door at a test pressure of 50 Pascals (1.044 psf). The building will be both pressurized and depressurized th this test pressure. Total air leakage of the structure cannot exceed an average value from both tests of 0.12 cfm/ft2 of facade area - fixed or operable - resulting in an air change rate of no more than 0.6 air changes per hour at 50 Pascals (ACH50). This value is based on 100% Design Development plan documents.

c Thermal Performance:

1). Thermal component of joint movement shall be based on minimum material temperature increase of 200 degrees F and decrease of 180 degrees F relative to nominal condition. Assume entire cross section has uniform temperature. Components including adhesives and sealant shall be capable of withstanding, without failure, design temperatures with simultaneous specified loads. For thermal design other than joint movement, design winter surface temperature is -20 degrees F. Design summer surface temperature shall be at least 180 degrees F. All components including adhesives and sealants shall be capable of withstanding (and remain durable) without failure design temperatures with simultaneous specified loads.

2) Opaque Wall Areas:Overall R-30/R-18 as per locations indicated on Architectural drawings. Modeling using an accepted software tool showing compliance with these thermal performance levels is required.

3) There shall be no interior condensation on visible surfaces or those that would wet insulation when the wall is subjected to 0° F exterior, 68° F interior (+/-2 °F), 30% interior relative humidity, 15 mph exterior wind.

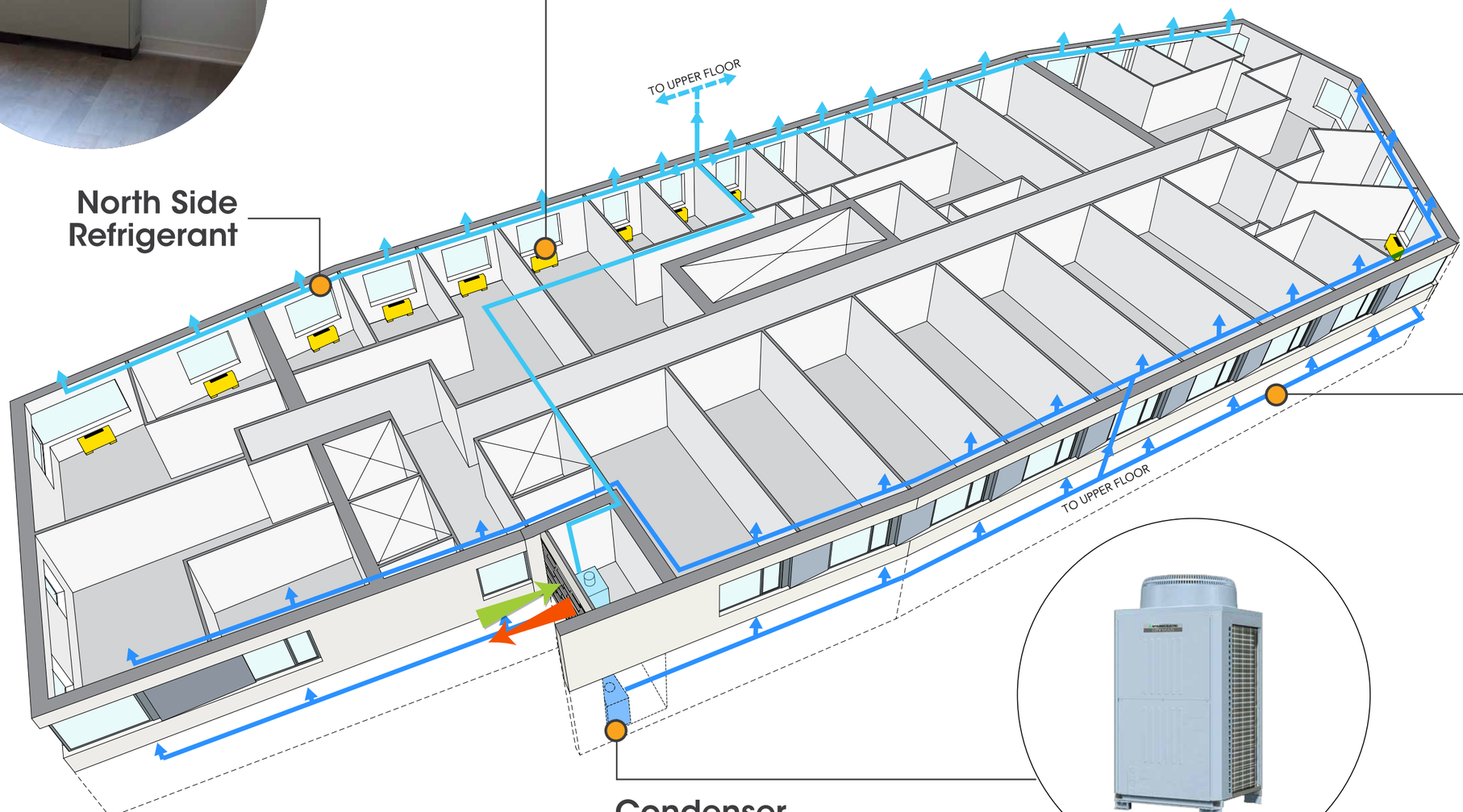
Heating & Cooling

- Height challenge
- Individual control
- Zoning
- No heat recovery
- Switch over seasons

VRF: Heating & Cooling

Evaporator in all bedrooms & living rooms

North Side Refrigerant



South Side Refrigerant

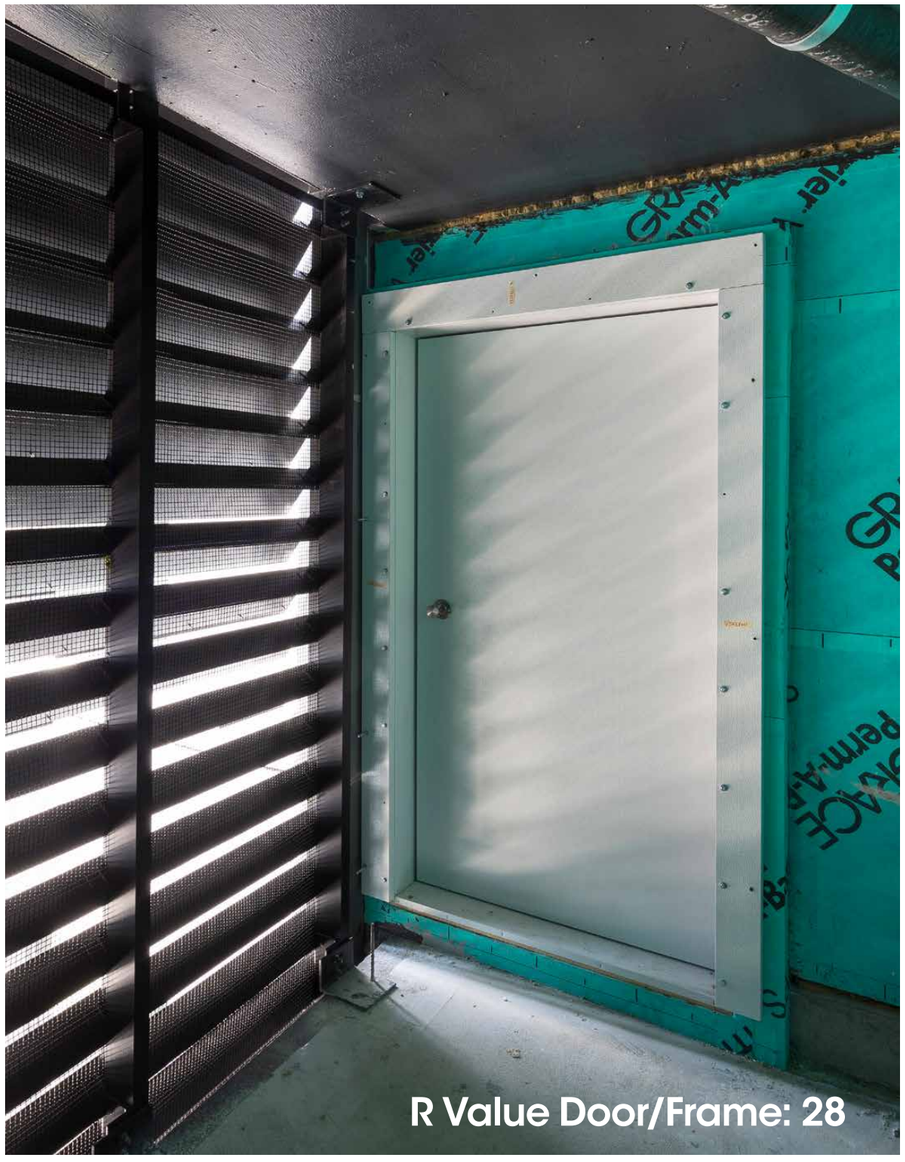
Condenser

A Market Niche to be Filled (one of many...)

1 Ton Evaporator

1/4 Ton Evaporator

Lessons Learned



The House

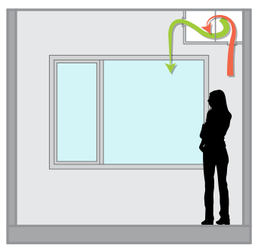
Sendero Verde

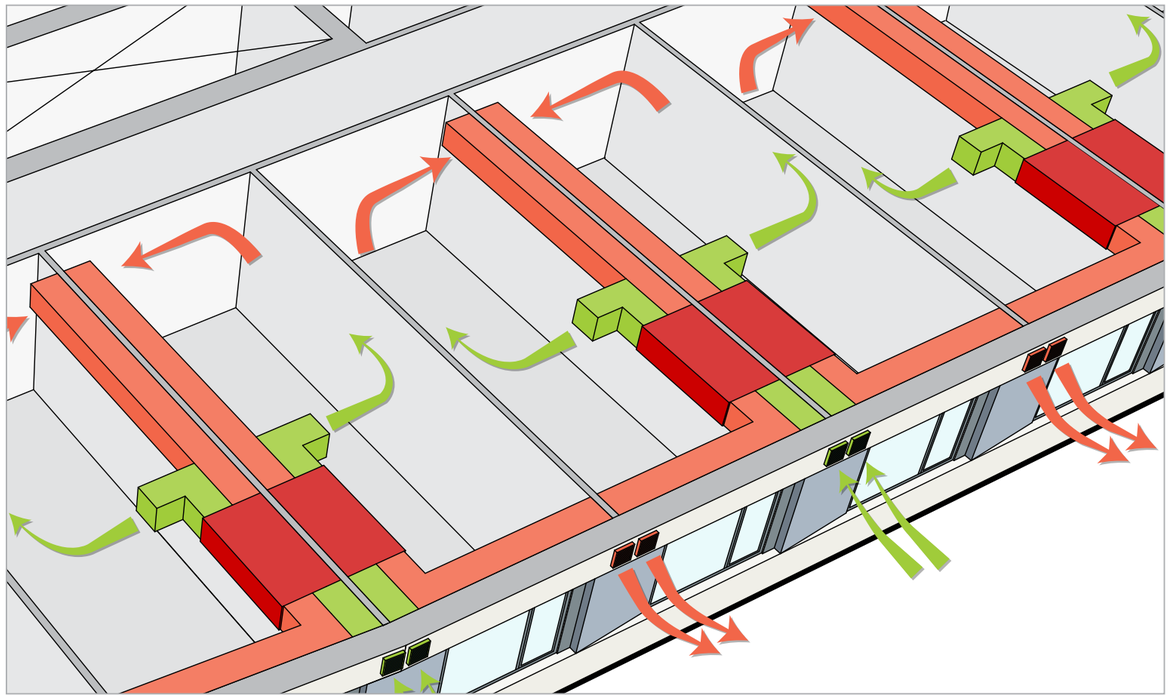
Balanced Ventilation with Heat Recovery

- All bedrooms and living rooms require supply air, balanced within 10% of exhaust
- Conflict in codes regarding amount of Ventilation: LEED / CODE / PH
- Delivery methodology:

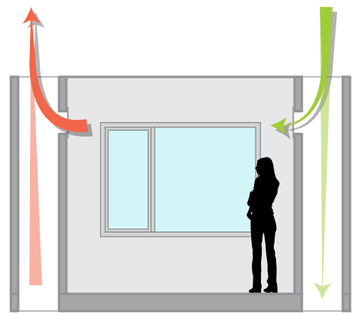
Exhaust Air
Fresh Air
ERV

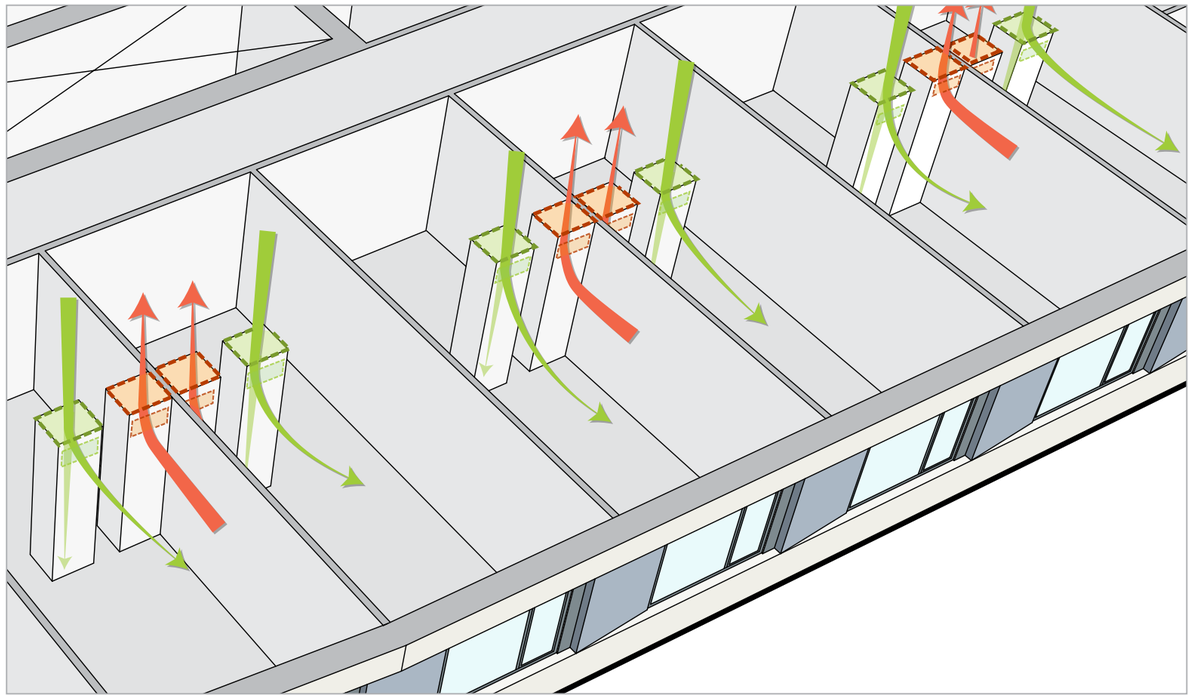
Unitized





Central



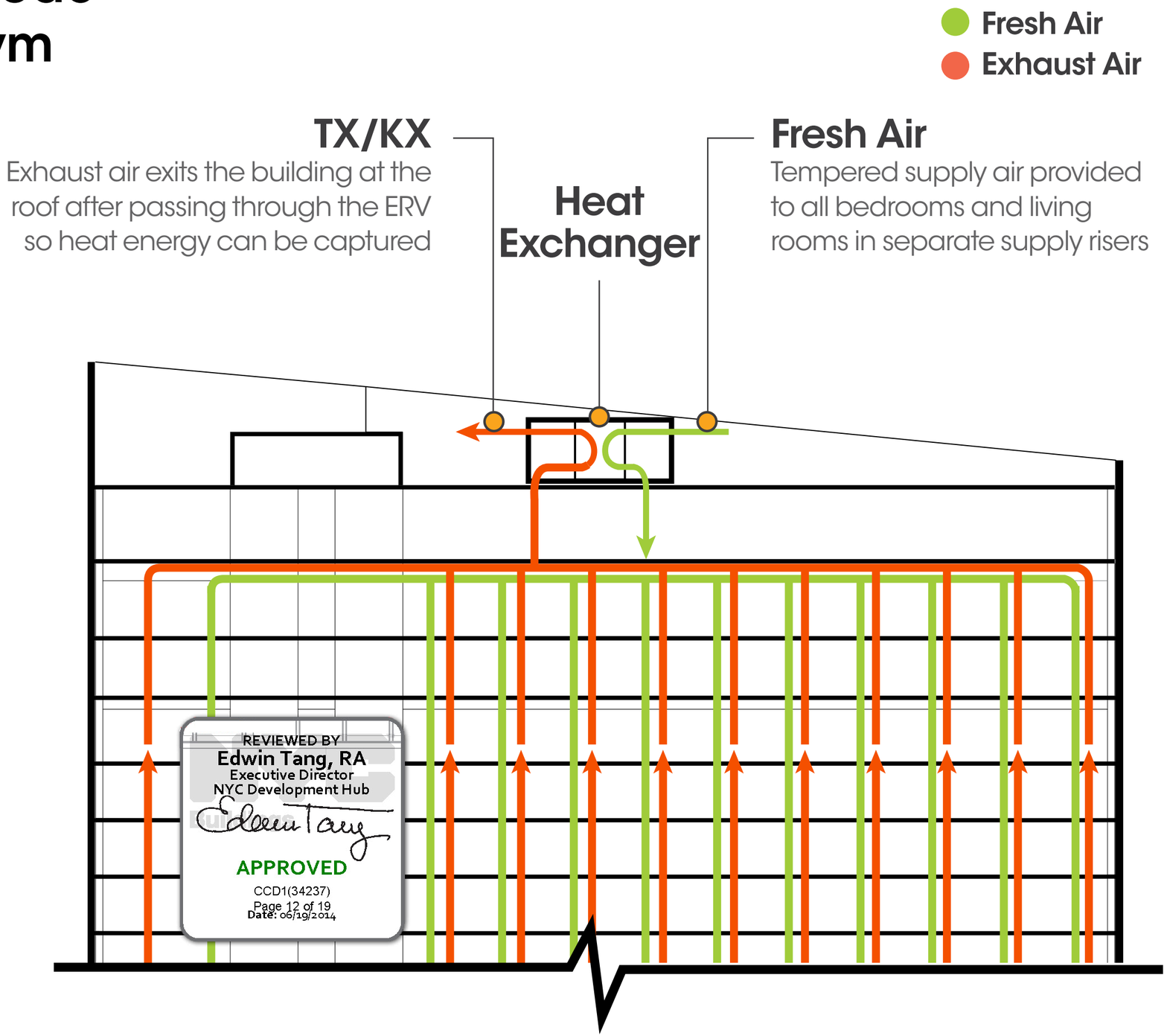


Change to the Building Code Mechanical Exhaust Ststym

- Permission by DOB to combine toilet and kitchen exhaust from multiple apartments, which is not typically allowed by NYC code.
- Collect vertical risers into one large horizontal duct
- Necessary for proper balancing and operation of ERV

Section of the Code:

501.5.1. Single or combined mechanical exhaust systems from bath, toilet, urinal, locker, service sink closets and similar rooms shall be independent of all other exhaust systems



Airtightness

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**

Site Inspection Checklist

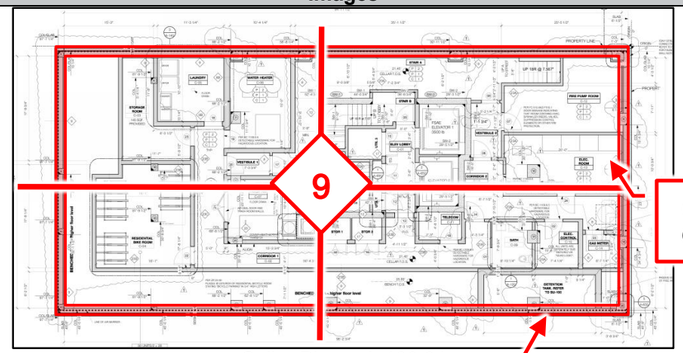
Unique Conditions

Item #	Inspection	Detail Date
U3	**Below Grade Wall – Insulation**	100% CD – 08/25/17

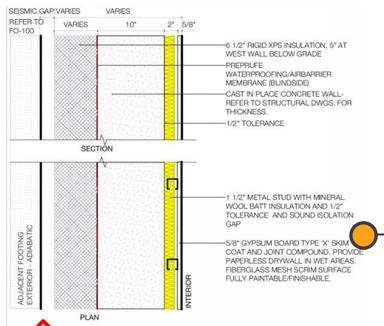
Description

See Wall Type 9; 6” (approved by ZHA) or 5” of Owens Foamular 400; insulation continuous at benched area; must be inspected before Preprufe is installed.

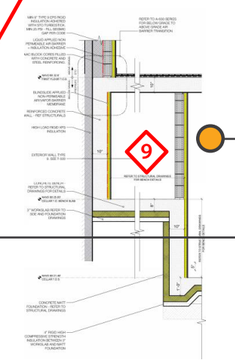
Images



Cellar Plan – A-100.01

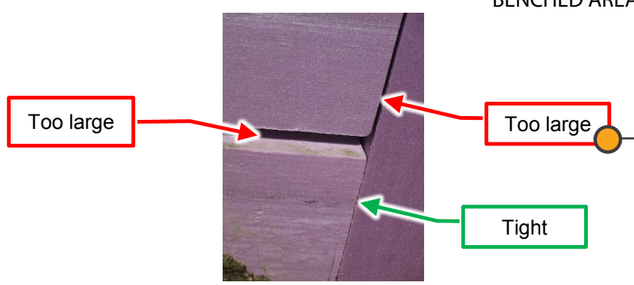


5” of XPS
@ West



9 EXTERIOR WALL (BELOW GRADE)
4 HR FIRE RATED TABLE 720.1.(2) #4-1.1

BENCHED AREA: A-315.00



Rigid insulation install: all seams are tight – can’t fit a beer coaster.

Checklist developed during construction documents

Instructions provided to inspector for items to inspect

Details provided to assist on-site inspection

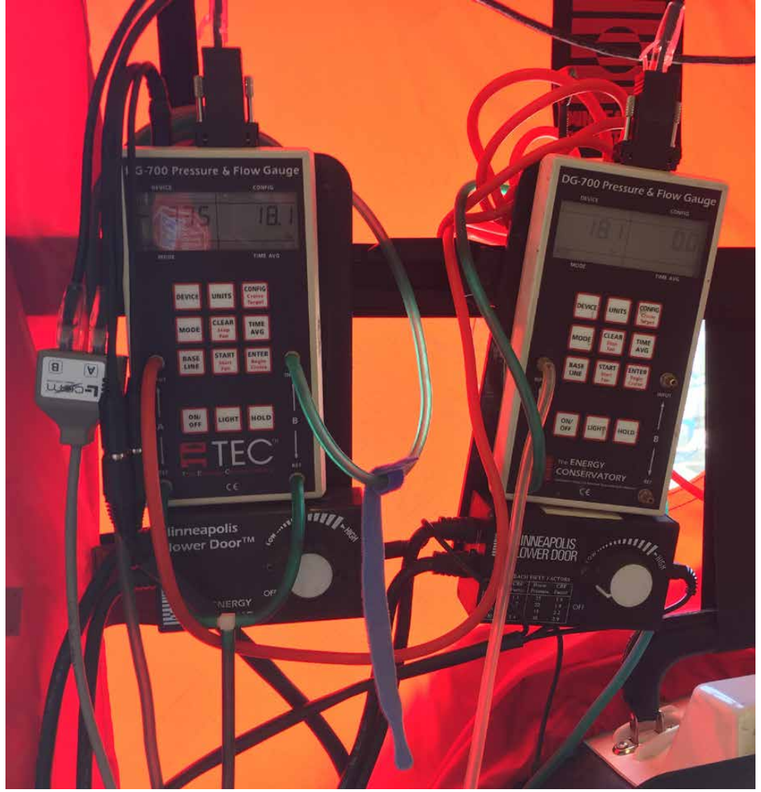
Photos annotated to help guide visual inspection

Quality Control Pays Off

Final Blower Door Test

- Final Blower Door Test results for The House were .15 Air Change/ Hour (ACH).
- Passive House requirements allow a maximum .6 ACH.

4 TIMES TIGHTER THAN REQUIRED!



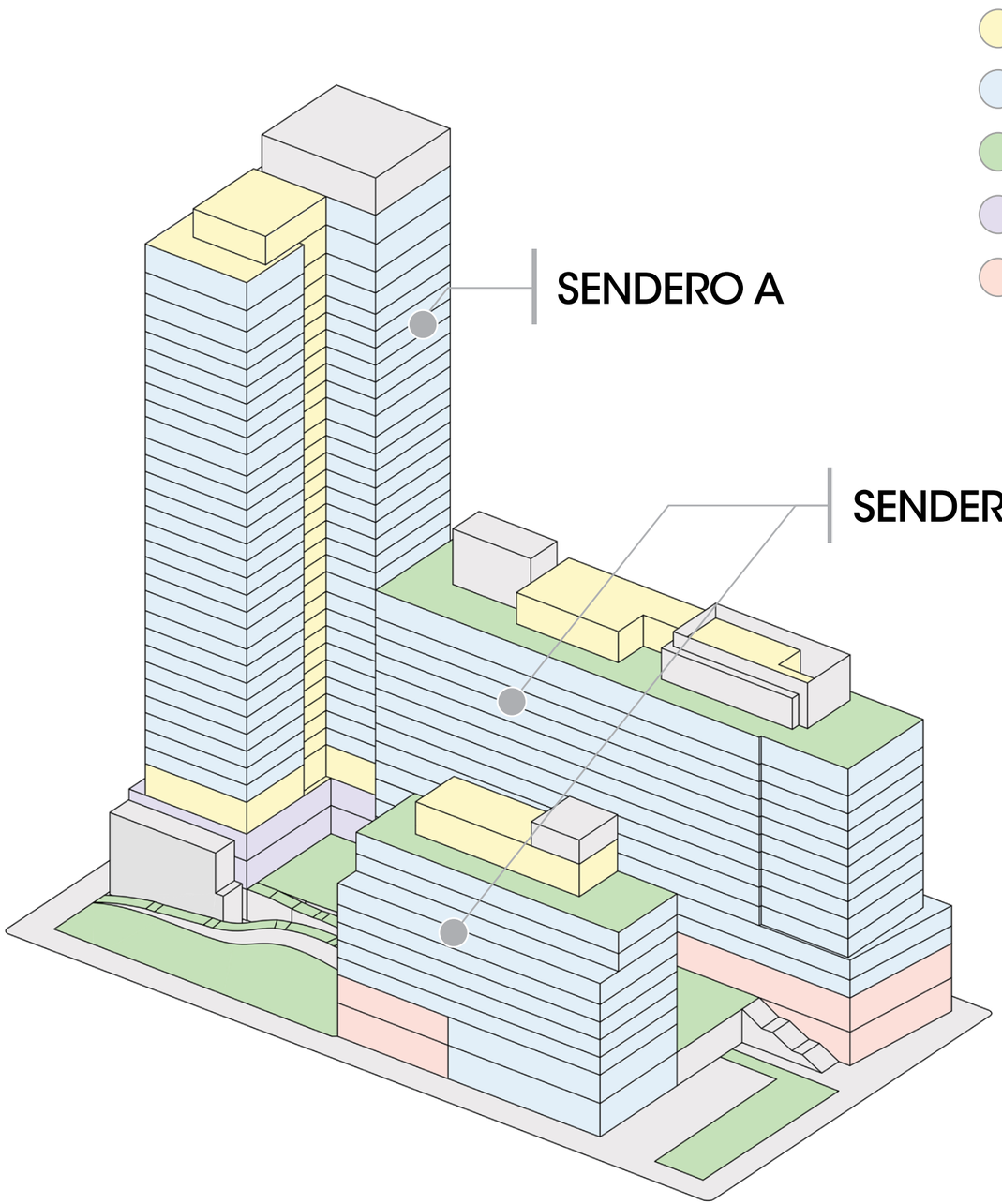
02.12.2020 | BEEx Passive House on a Large Scale | © Handel Architects

SENDERO VERDE

TEAM

Jonathan Rose Companies
L+M Development Partners
Acacia Network
Handel Architects
Steven Winter Associates
Cosentini
DeSimone Consulting Engineers
Vidaris

Sendero Verde: Project Summary



Community of Opportunity

PROJECT SUMMARY

Overall: 812,250 GSF / 75,460 GSM
Residential: 627,646 GSF / 58,310 GSM
Community Facilities: 150,110 GSF / 13,394 GSM
Commercial: 34,494 GSF / 3,204 GSM
698 Affordable Units

USERS

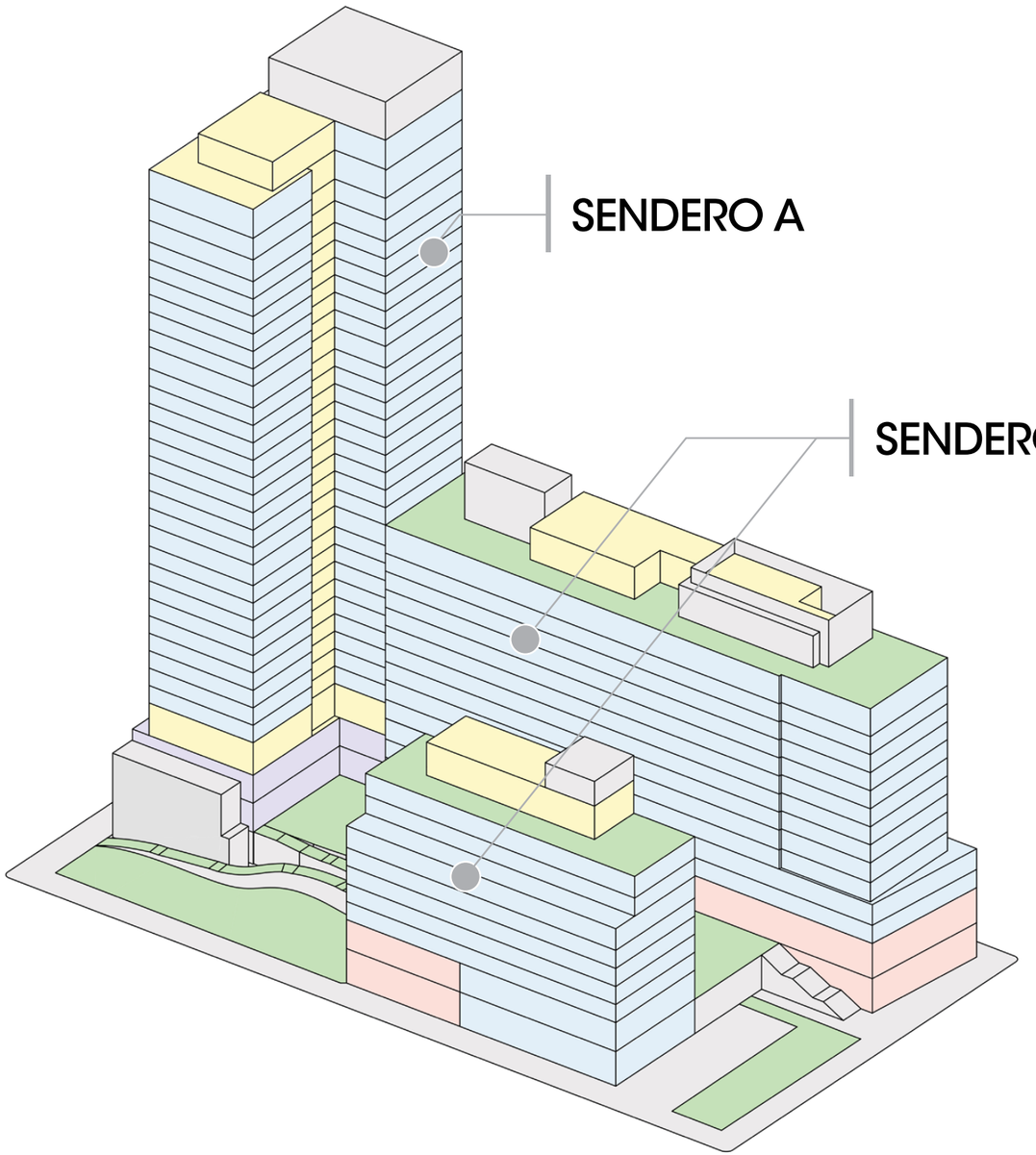
High School Students

Residents

Seniors

Health Clinic Users

Sendero Verde: Project Challenges



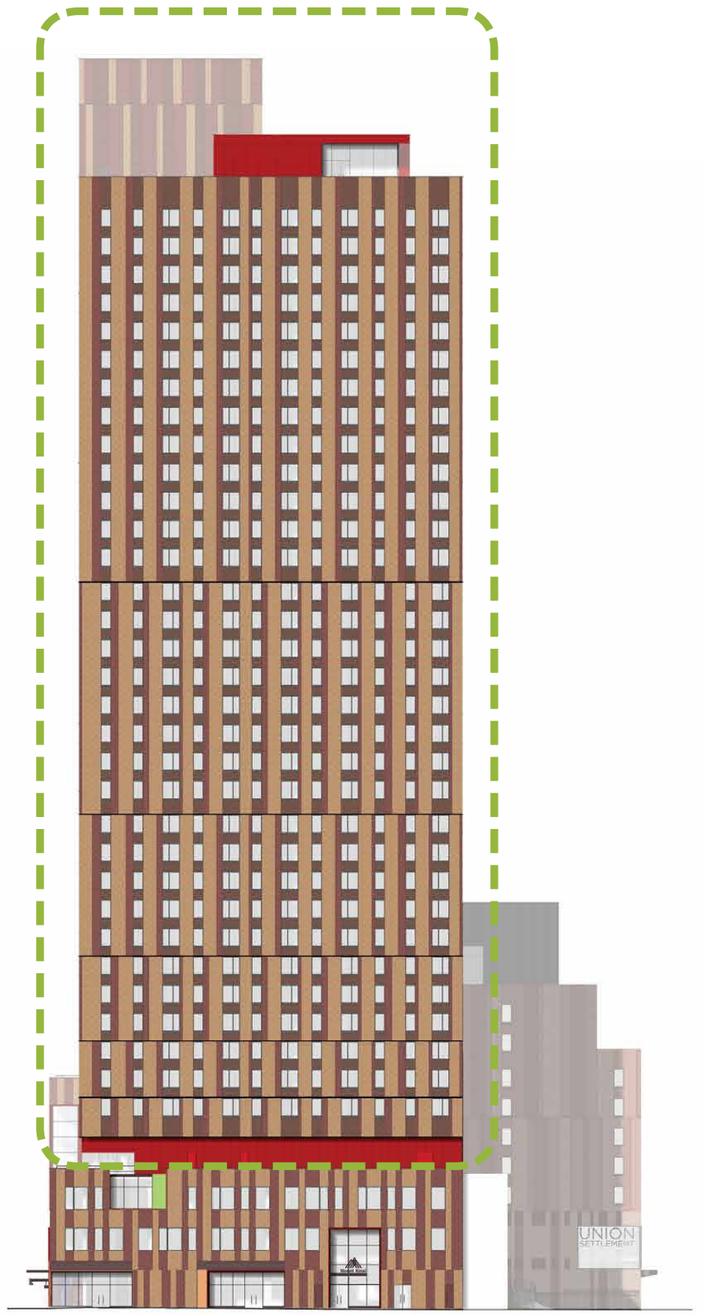
PROJECT CHALLENGES

- Supply chain – small enough equipment
- Steel stud back up wall – thermal bridge mitigation at window heads and sills
- Sequencing of façade vs. window install & air barrier continuity
- Duct run conflicts between ERV's & VRF in unit
- Height impacts on ERV fan power
- Very dense building – Source EUI target needs adjusting

Enclosure

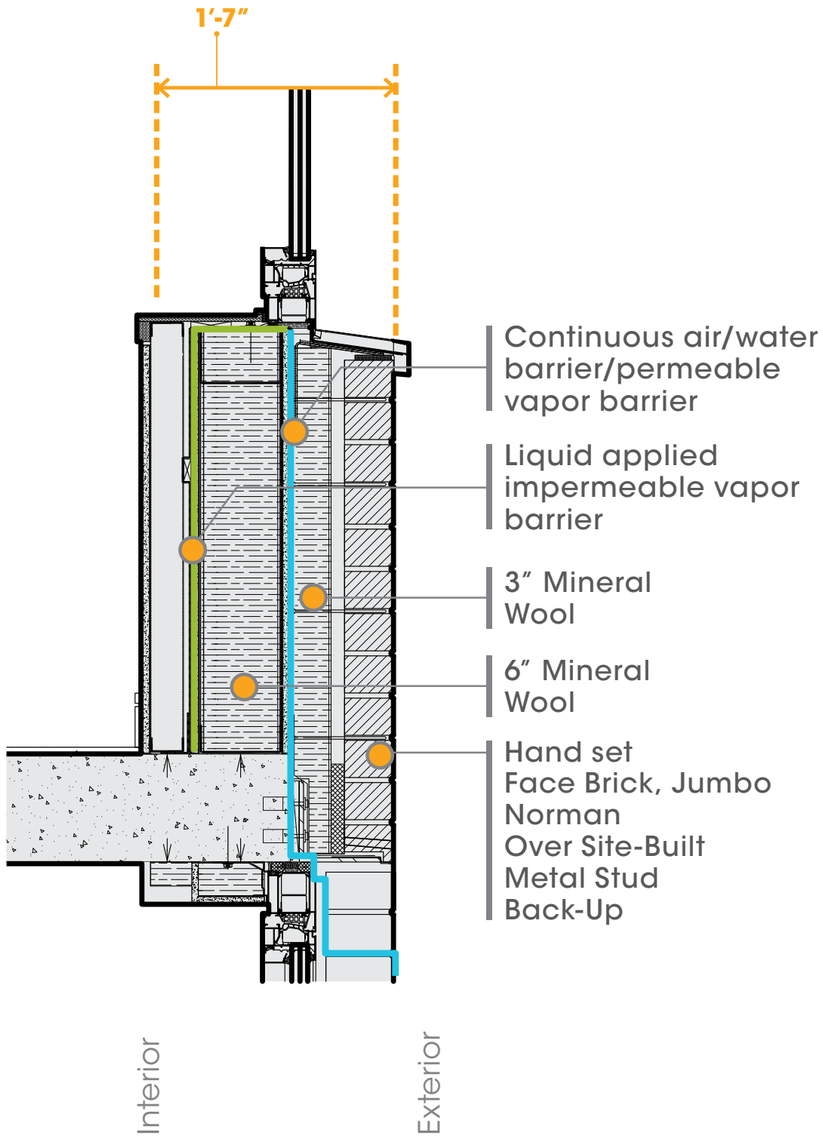
Component	Efficiency
Roof	R-40
Walls	R-20 Effective
Windows	Operable - U: 0.149 Fixed U: 0.134
Cantilevered Floors	R11

NORTH ELEVATION

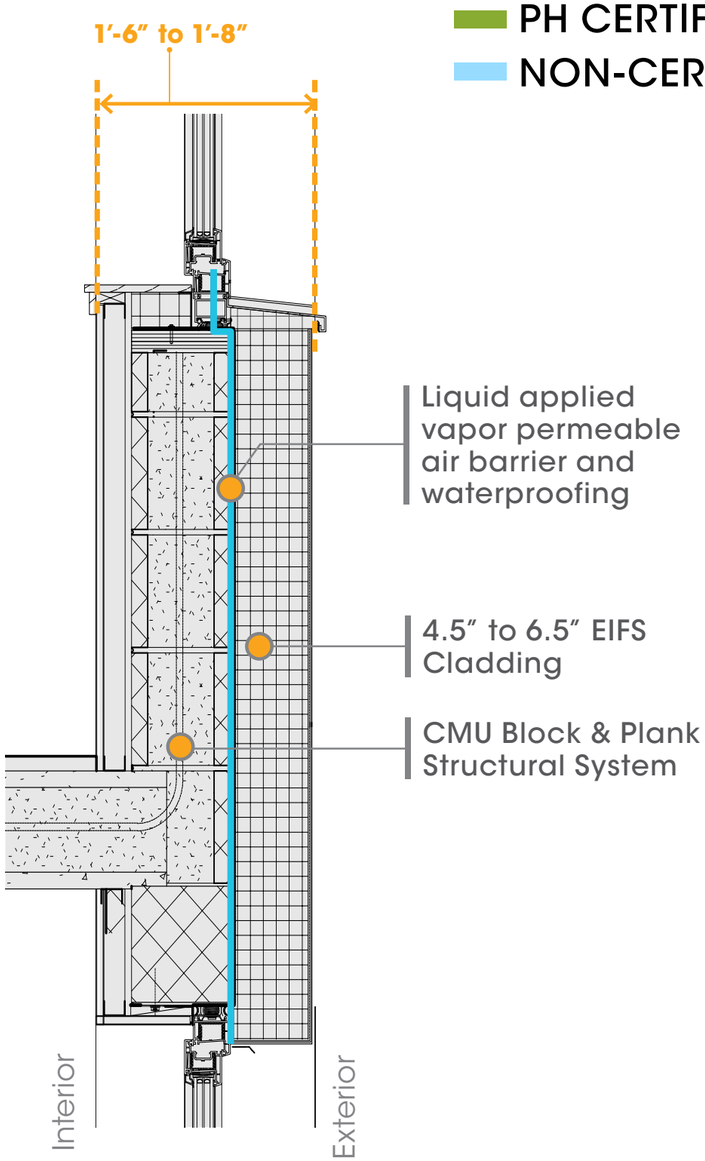


WEST ELEVATION

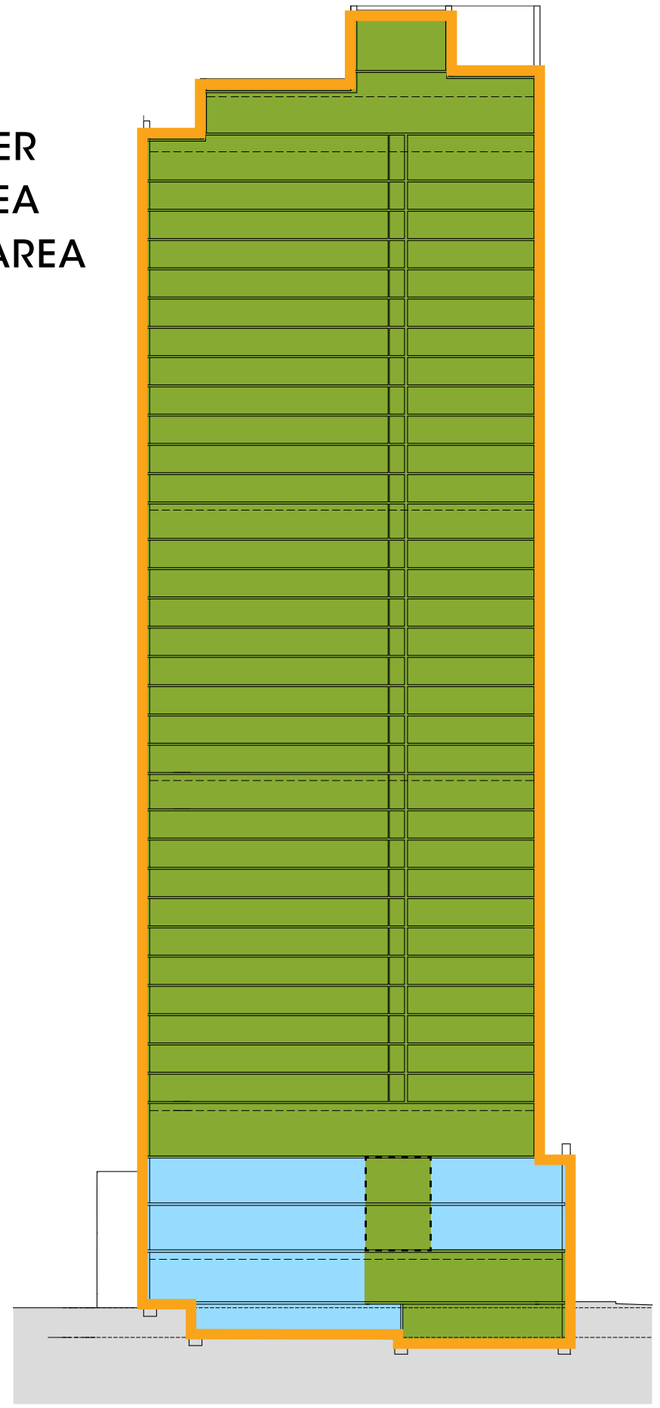
Exterior Wall Composition



Sendero A



Sendero B

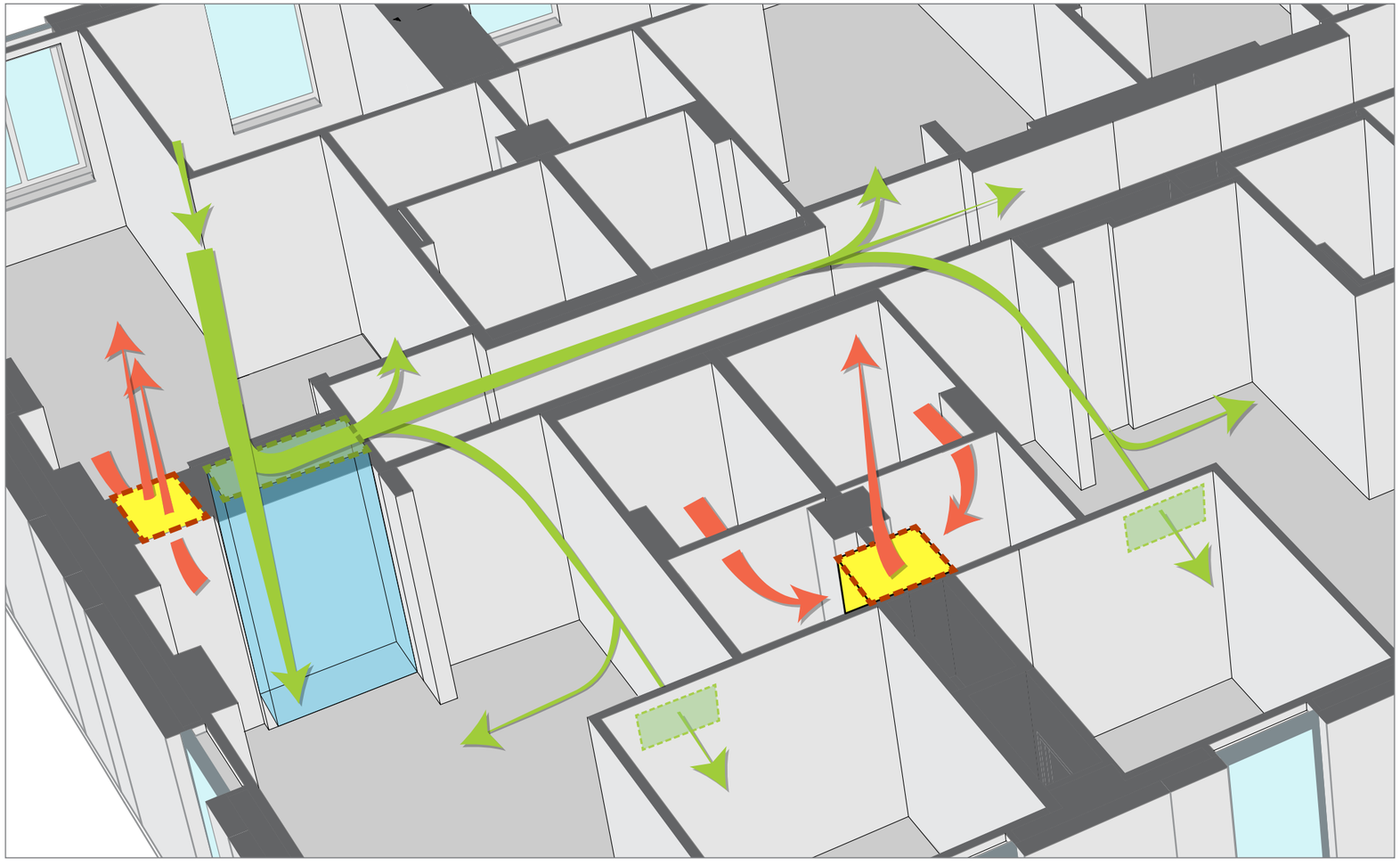


Sendero A

Ventilation

Balanced Ventilation with Heat Recovery Central Systems

Fresh Air
Exhaust Air



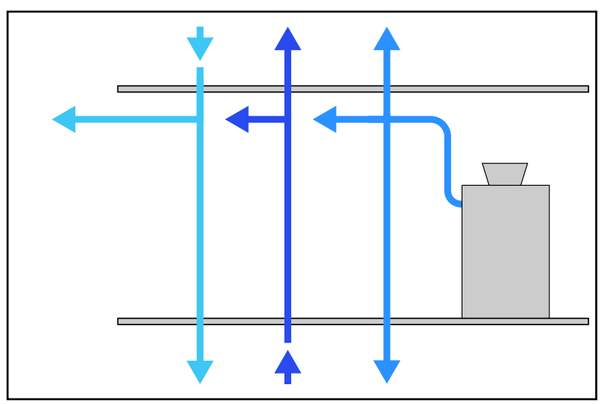
SENDERO VERDE BLDG A: CENTRAL RISER

Heating & Cooling

1 Floor Mounted Air Handling Unit in Each 1- 2- & 3-bed-room Apartment.

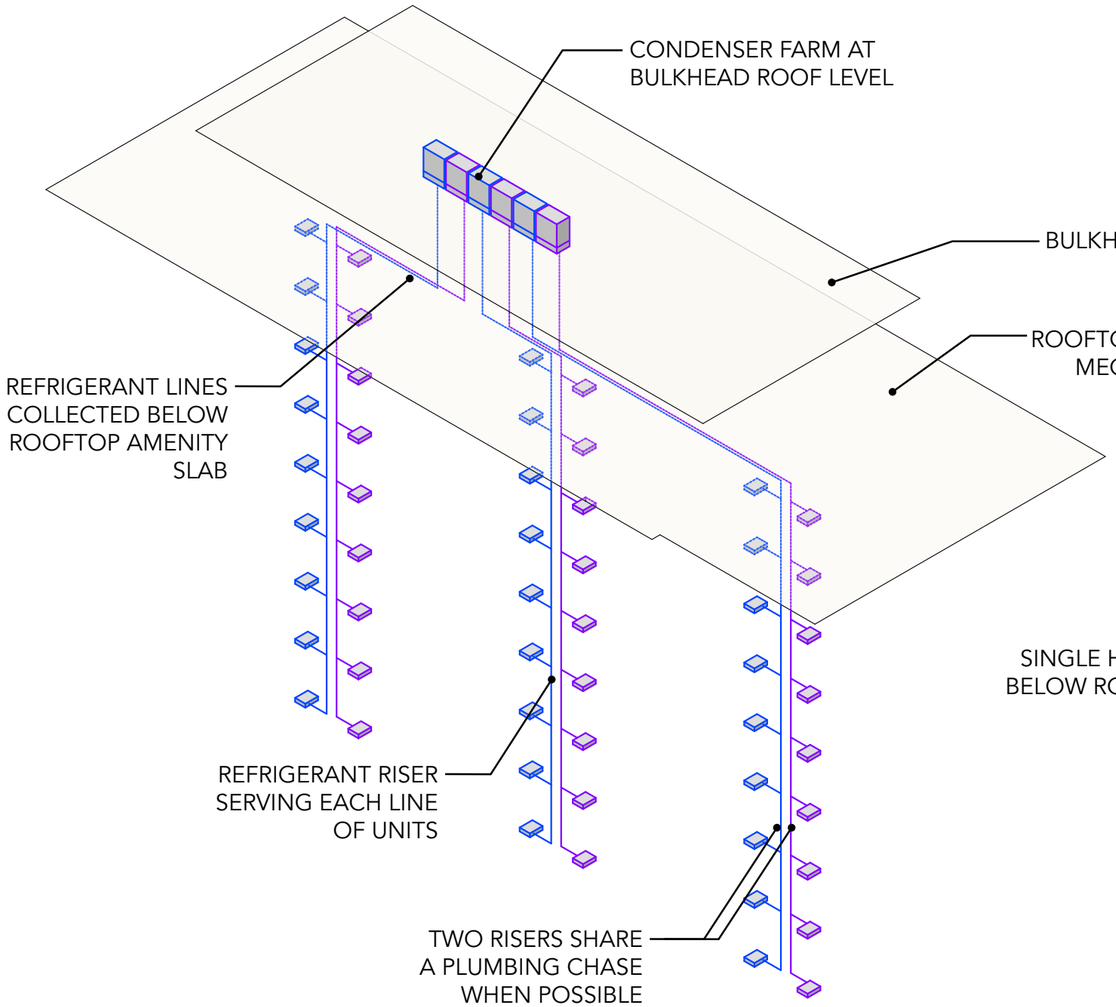
1 Wall Mounted Air Handling Unit. Unit Serves Each Studio.

Condenser

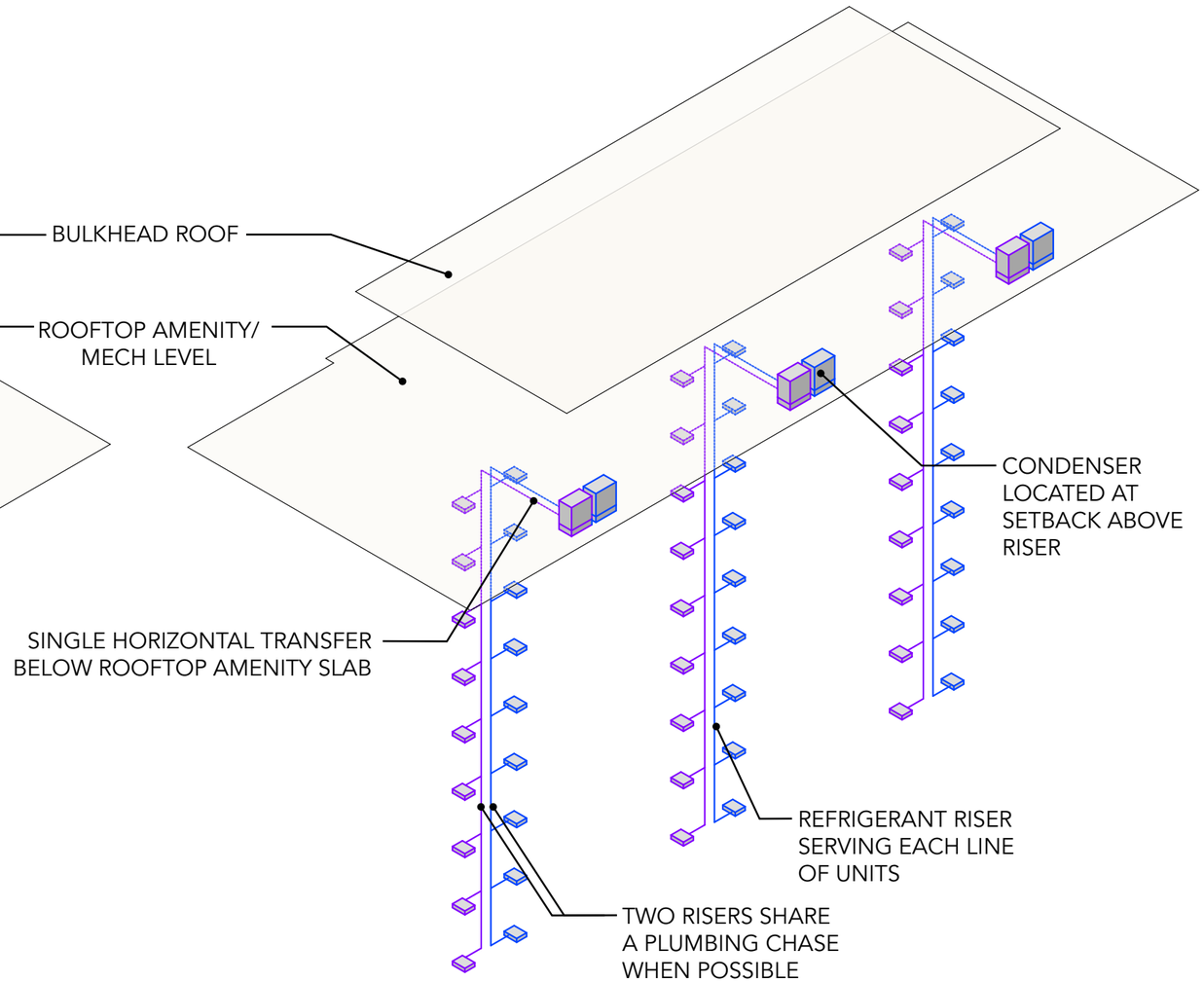


VRF Diagram

Rooftop Design



SOUTH SIDE DISTRIBUTION STRATEGY



NORTH SIDE DISTRIBUTION STRATEGY

STUDENT RESIDENCE AT UNIVERSITY OF TORONTO SCARBOROUGH

TEAM

University of Toronto Scarborough
Fengate Asset Management
Handel Architects
Steven Winter Associates
Integral Group
RWDI Consultant Company
Finnegan Marshall

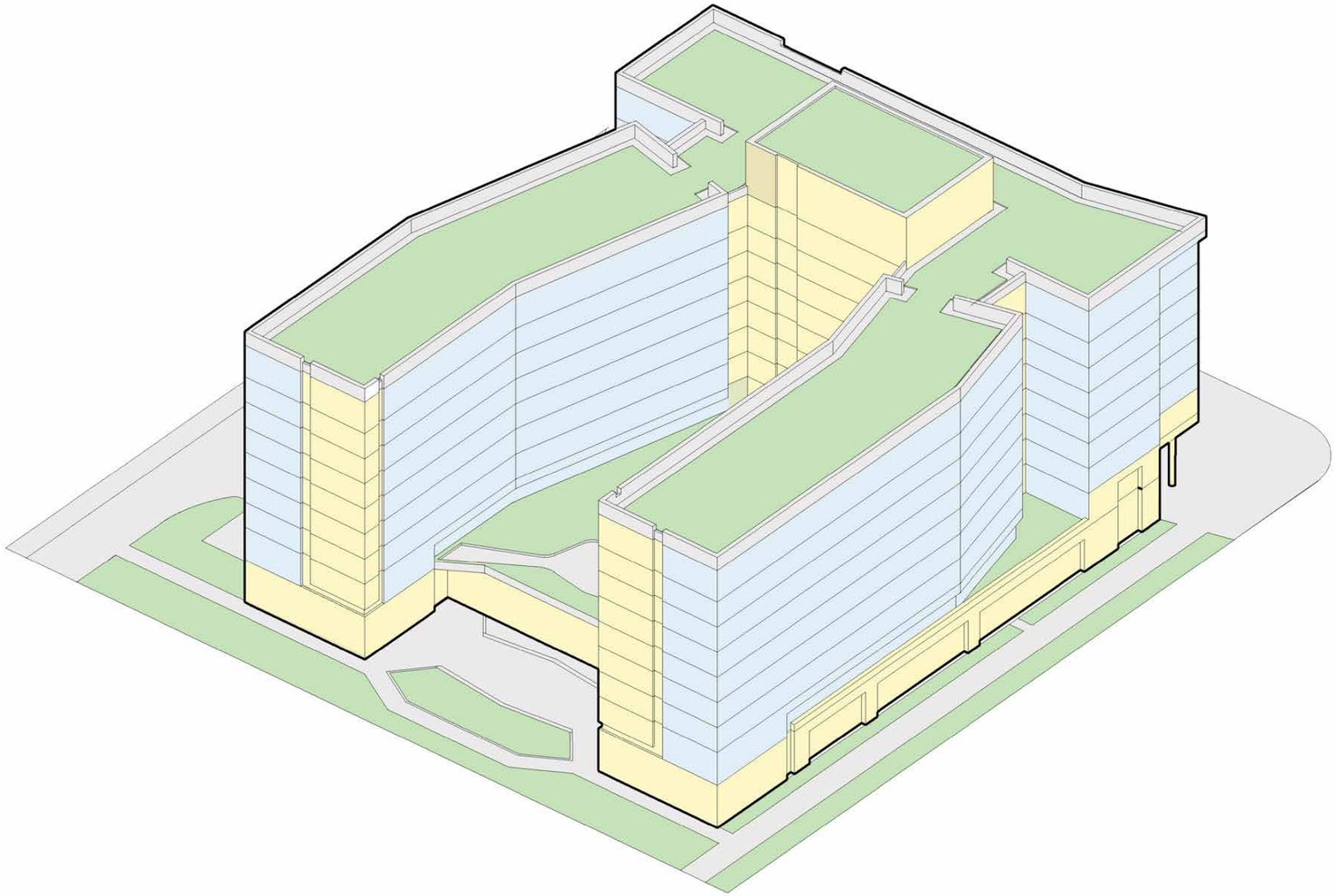
02.12.2020 | BEEx Passive House on a Large Scale | © Handel Architects

Student Residences: Project Summary

COMMON AREAS

APARTMENTS

GREEN / OPEN AREAS



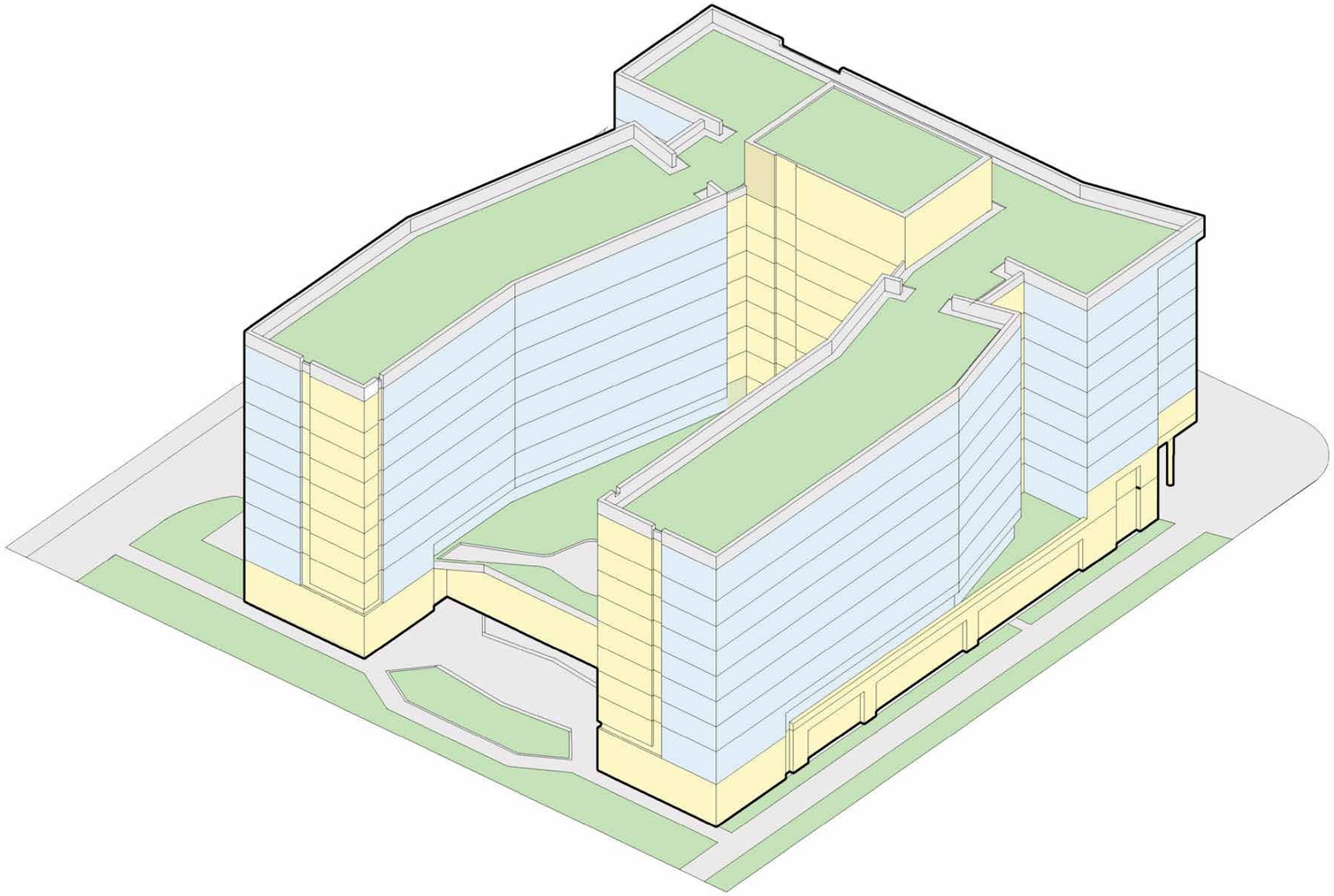
PROJECT SUMMARY

Area: 270,000 GSF / 25,083 GSM
9 Stories
112’ / 210m to Roof
369 Suites, 752 Beds
28,500 GSF/Floor / 2,369 GSM/Floor

USERS

Undergraduate Students

Student Residences: Project Challenges



PROJECT CHALLENGES

- Supply chain – PH compliant windows for climate zone 6
- Colder climate leading to stricter window criteria
- Dining hall – very high energy intensity for commercial kitchens
- Conflict between U of T energy efficiency requirements, building type and Passive House criteria
- Incredibly dense building – Source EUI target needs adjusting

Mechanical Comparison

Passive House Air Source VRF Vs 4 Pipe Fan Coil

- Evaluate systems to study if performance meets/exceeds ASHRAE 2013 (as amended by SB.10) by 40%
- Keep lighting, misc. electric/gas, equipment, DHW, and PH envelope steady.

40% better than ASHRAE is not achievable for this building type (high rise multi-family)

ASHRAE does not allow the design to take credit for:

- Air Tightness
- Lower plug loads
- Ventilation efficiency

kWh	Current PH Design - Air Source VRF		Conventional Design - 4PFC	
End Use	Baseline	Proposed	Baseline	Proposed
Lighting	606,100	368,127	606,393	368,127
Misc. Equipment Elec.	503,027	502,763	503,057	502,822
Misc. Equipment Gas	23,739	23,739	23,739	23,739
Space Heating	571,225	260,276	1,333,474	679,339
Space Cooling	264,585	226,485	140,909	153,980
Heat Rejection	0	0	938	1,290
Pumps and Auxiliary	16,236	2,784	113,331	131,325
Ventilation Fans	559,766	676,408	513,167	564,162
Domestic Hot Water Elec.	11,781	11,781	11,781	11,781
Domestic Hot Water Gas	413,172	258,371	413,172	258,371
Exterior Usage	13,130	13,130	13,130	13,130
Total Energy	2,982,878	2,343,895	3,673,353	2,708,123
% Energy Better than ASHRAE Baseline		21%		26%
% Energy Better than Conventional Baseline	19%	36%		26%
Required Solar PV to hit 40% Target (m^2)		5,540		5,040
GHGI $kgCO_2e/m^2$	7.94	5.93	15.77	9.88
% GHG Better than ASHRAE Baseline		25%		37%
% GHG Better than Conventional Baseline	50%	62%		37%

Ground Floor Plan

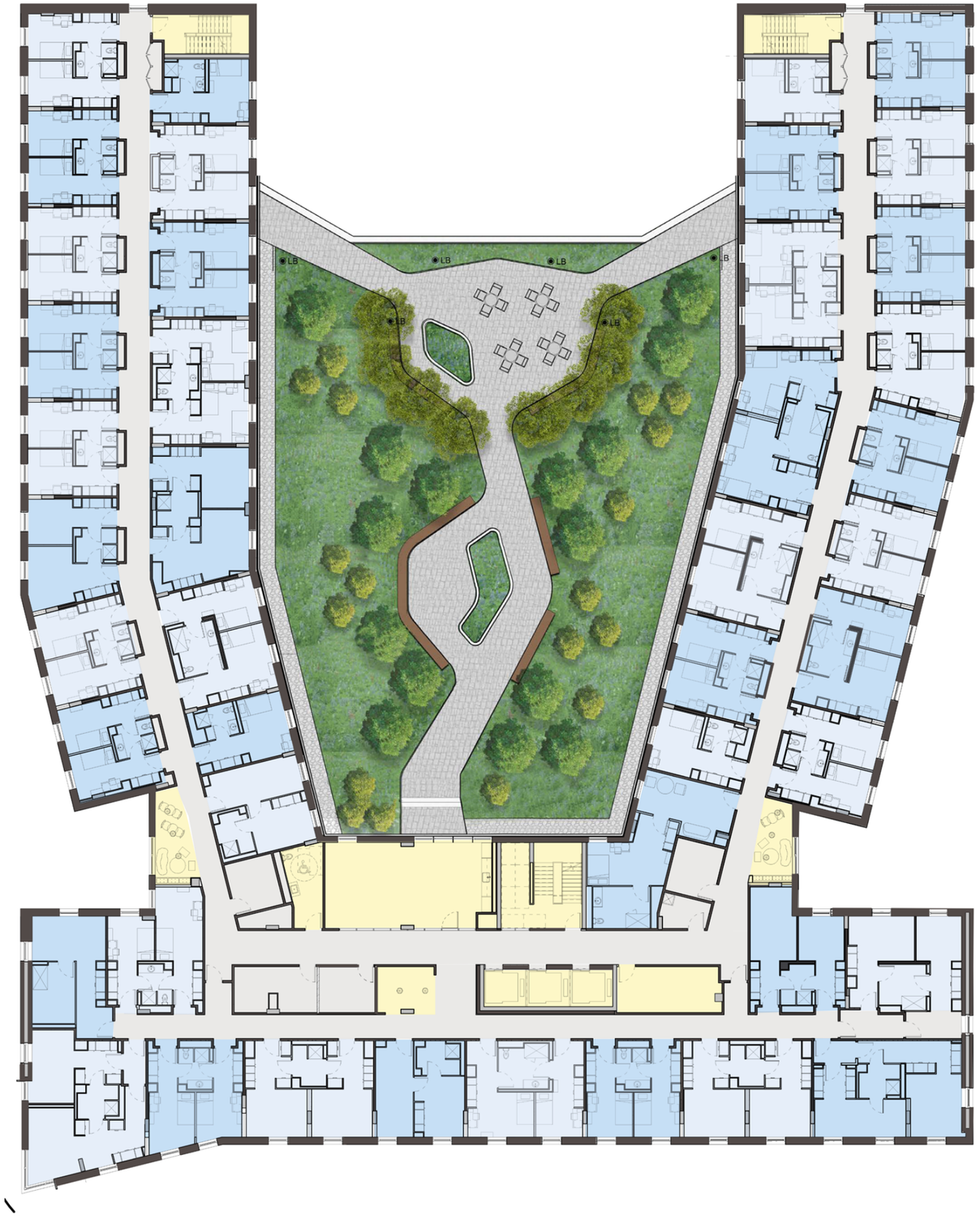
University of Toronto

Typical Floor Plan

University of Toronto at Scarborough

96 people per floor

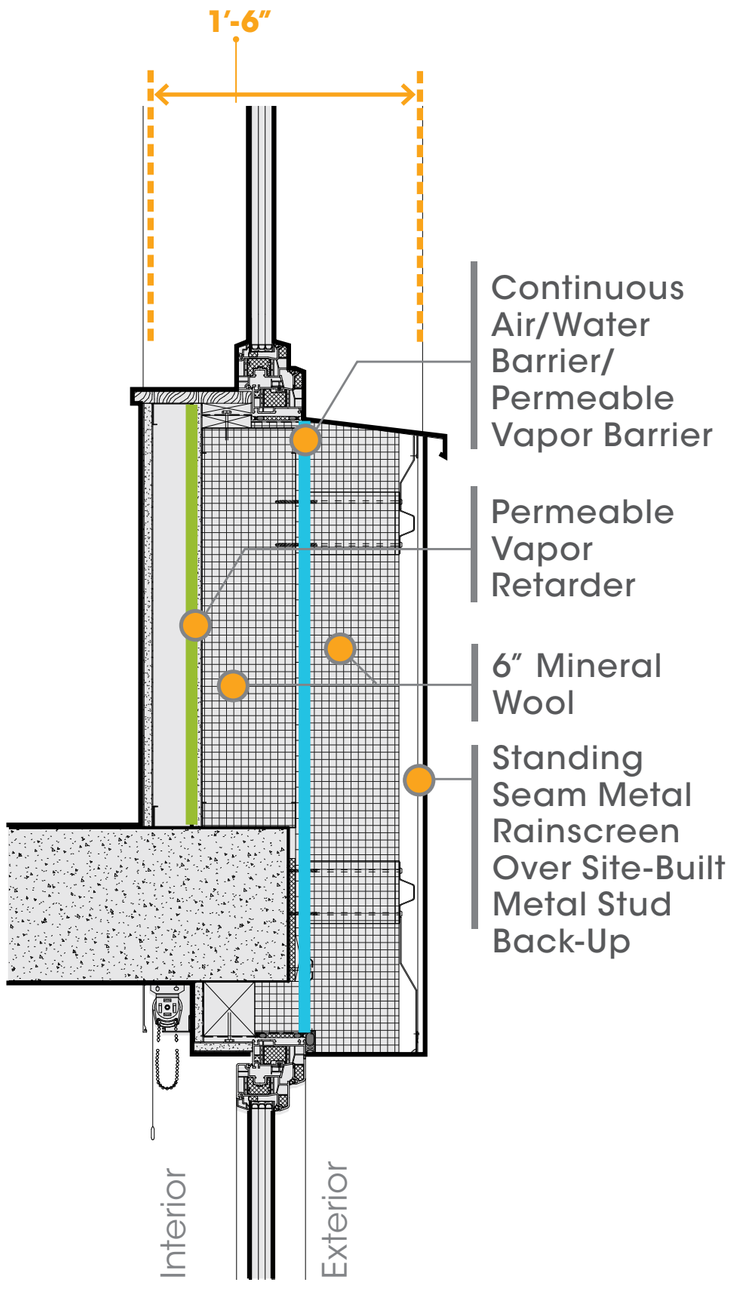
28,500 GSF/floor / 2,647 SM/floor



Enclosure

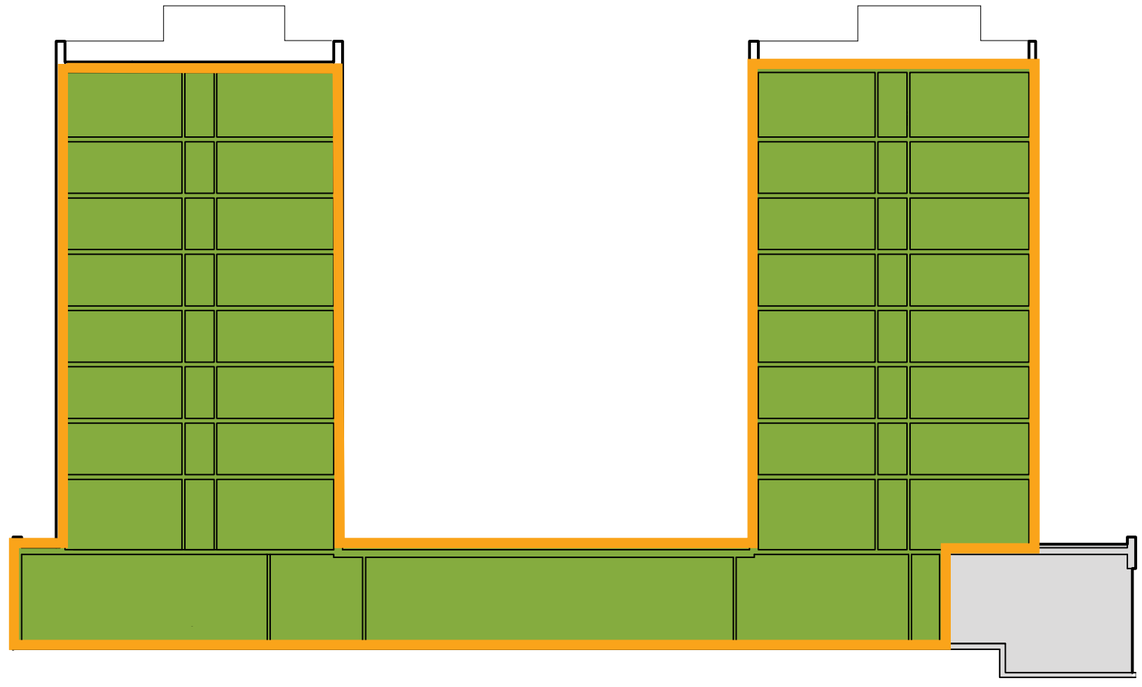
Component	Efficiency
Roof	R-40
Walls	R-30 Avg.
Windows	U: 0.13

Exterior Wall Composition



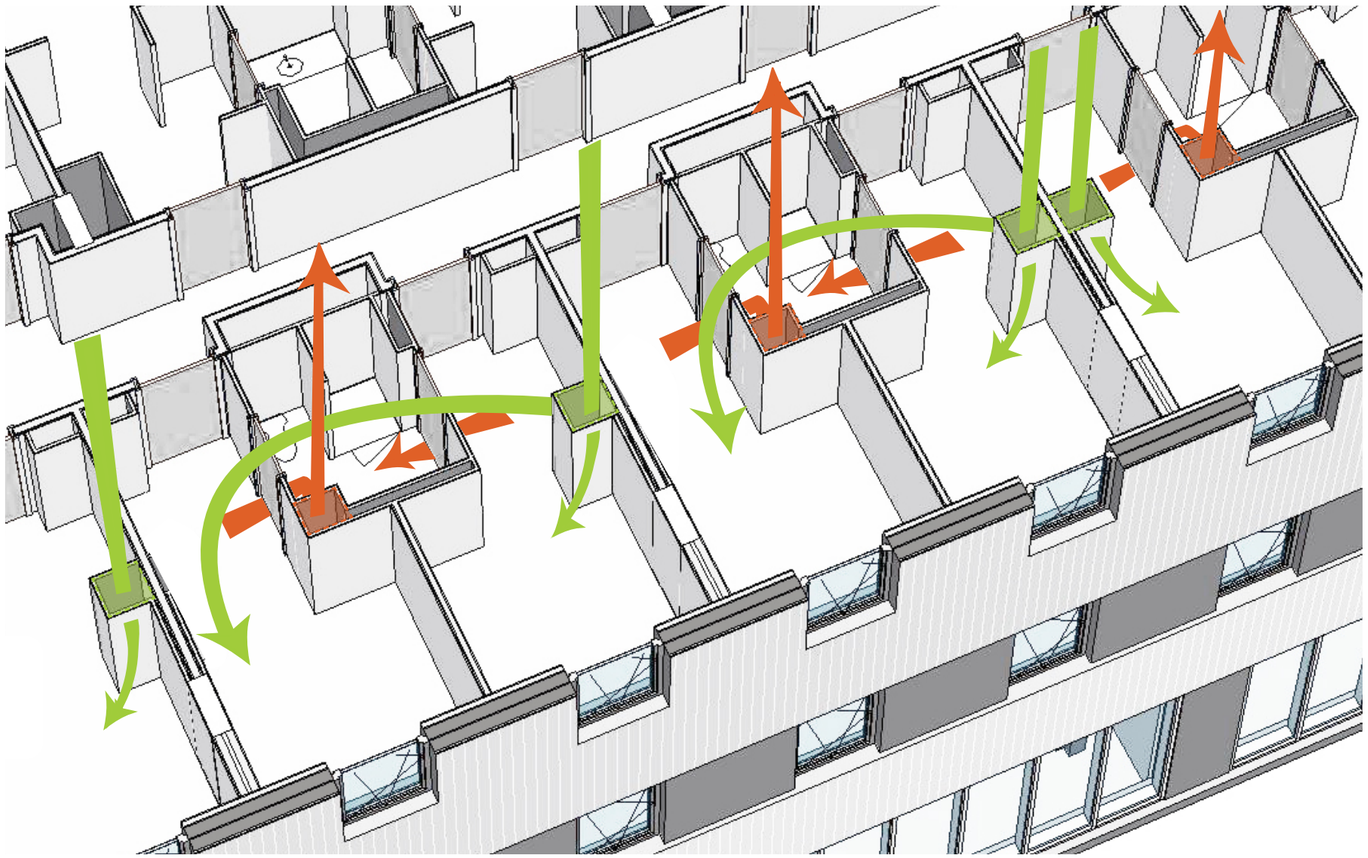
PH AIRTIGHT LAYER

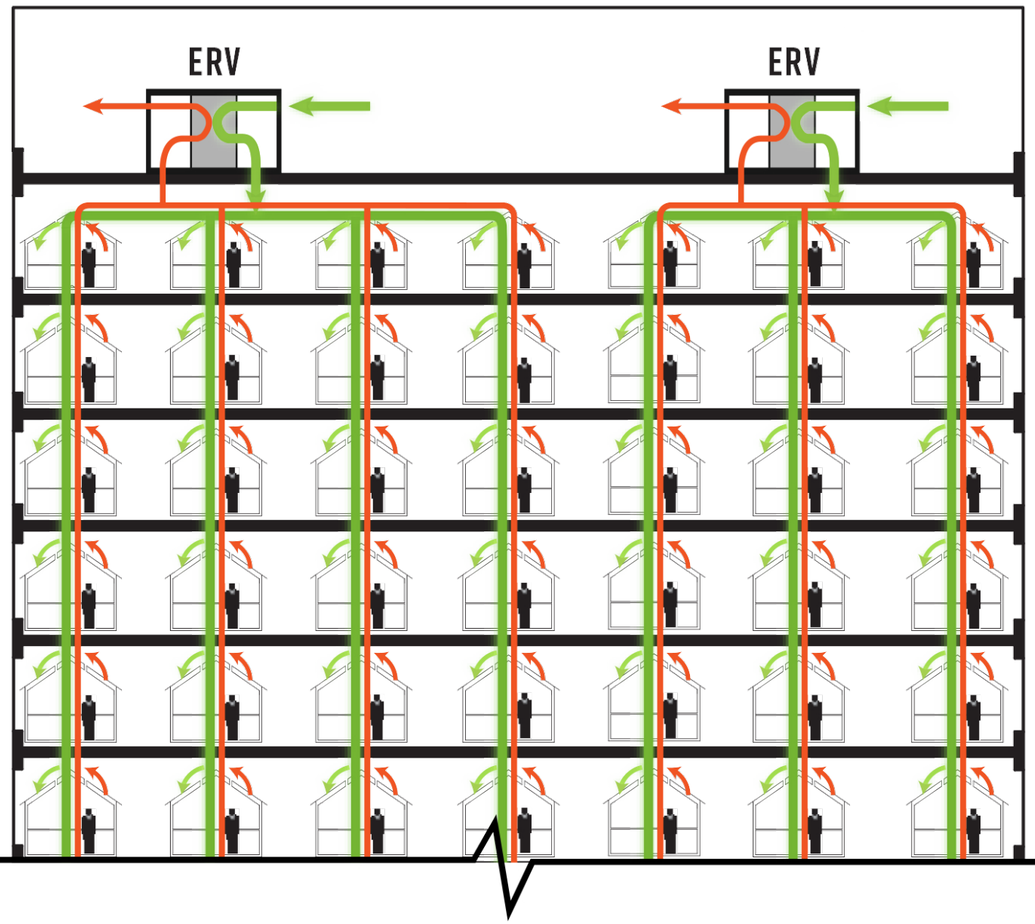
PH CERTIFIED AREA



Ventilation

Exhaust Air
Fresh Air
ERV



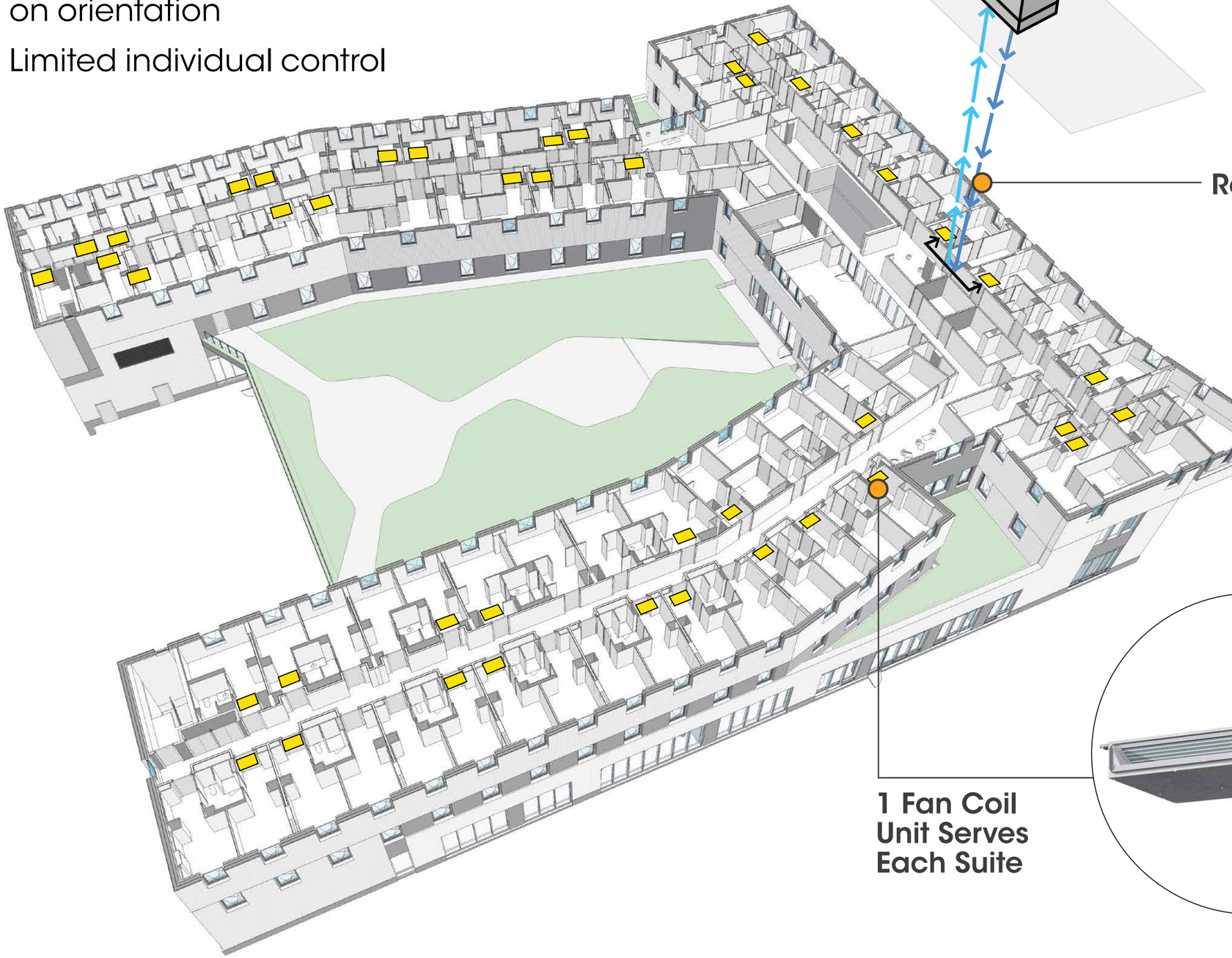


Central:

RISER PER SUITE

Heating & Cooling

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



Condenser at Roof

Refrigerant

1 Fan Coil Unit Serves Each Suite

Cost Comparison - VRF vs. 2/4 Pipe Fan Coil

16-Jul-19

	UTSC	Comparable 1	Comparable 2
Suite Count	342	204	172
GFA - Fit out space (m2)	26,690	17,422	17,076
GFA / Suite (m2)	78.0	85.4	99.3
Common area %	42%	40%	43%
Mechanical System	Air-Cooled VRF	4-Pipe FCU	2-Pipe FCU
Plumbing $/m2 (ex Site)	$359.95	$398.95	$314.00
Plumbing $/Suite	$28,090.83	$34,071.11	$31,173.63

Doing radically **more** with radically **less**

2088 GWP

R-410A

R-32
Transition

675 GWP

1 GWP

2088%
REDUCTION

Doing radically **more** with radically **less**

.06 kWh

60 Watt Incandescent

60 Watt Compact Fluorescent

.016 kWh

60 Watt LED Equivalent

~750%
REDUCTION

.008 kWh

Source: Consumer Reports 2016

Doing radically **more** with radically **less**

Early 1950's Fleet

Avg. 12 MPG

1998 Fleet

Avg. 22 MPG

Tesla

Avg. 100 MPG

750%

IMPROVEMENT

Doing Radically More With Radically Less

129.4
kBTU/SF/YR (pEUI)

Median Energy Use of All
NYC Buildings over 200,000 sq. ft.

Energy Use of Passive
House Buildings

60-80%
REDUCTION

38.1*
kBTU/SF/YR (pEUI)

*Can be adjusted for density and use


The House at Cornell Tech, NYC


Sendero Verde, NYC


University of Toronto at Scarborough


Winthrop Center, Boston

PROTECT THIS HOUSE

discussion.

be ex
building energy exchange

NEW YORK
STATE OF
OPPORTUNITY

Buildings of Excellence