Passive NOT Houses

REBUILD 2022

Lois B. Arena, Director PH Services

Steven Winter Associates, Inc.

Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

Our services include:

- Energy Conservation and Management
- Sustainability Consulting
- Green Building Certification
- Accessibility Consulting

We have over 125 staff across four office locations:
New York, NY | Washington, DC | Norwalk, CT | Boston, MA

For more information, visit
www.swinter.com

Objectives

- Understand that the PH standard applies to any building type
- Identify how you move forward with a challenging typology
- List one of the main challenges in meeting the standard for:
  - High Rise Apartments
  - Hotel
  - Office Space
  - Industrial buildings
- Say “Yes!” to your next challenging PH project

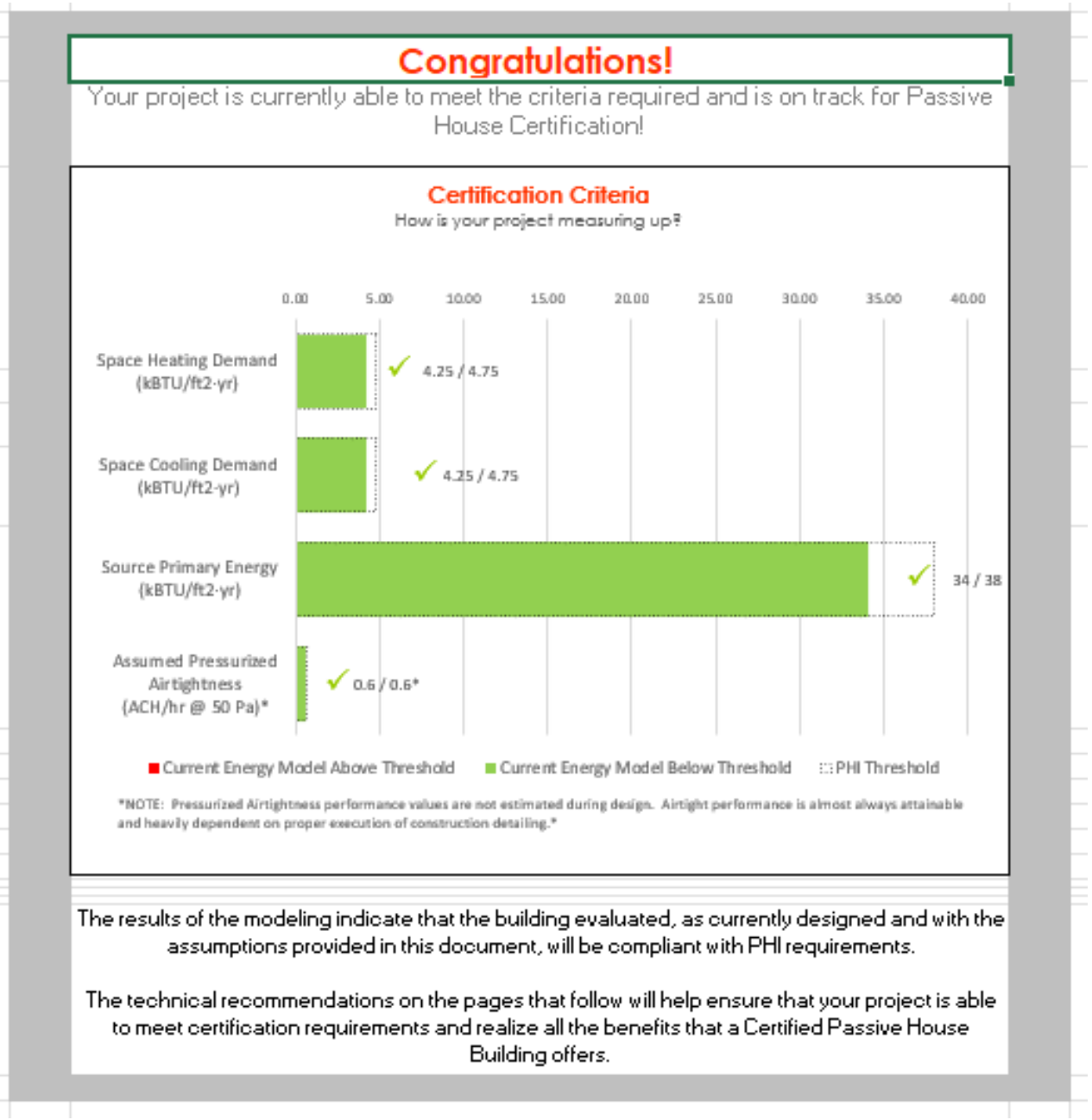
What is Passive House?

What is Passive House (PH)?

- First and foremost, PH is a building standard
- Applies to New & Existing buildings
- The most rigorous energy efficiency certification available
- Performance-based approach
- Attention to insulation continuity and reduction of thermal bridges
- Emphasis on balanced ventilation

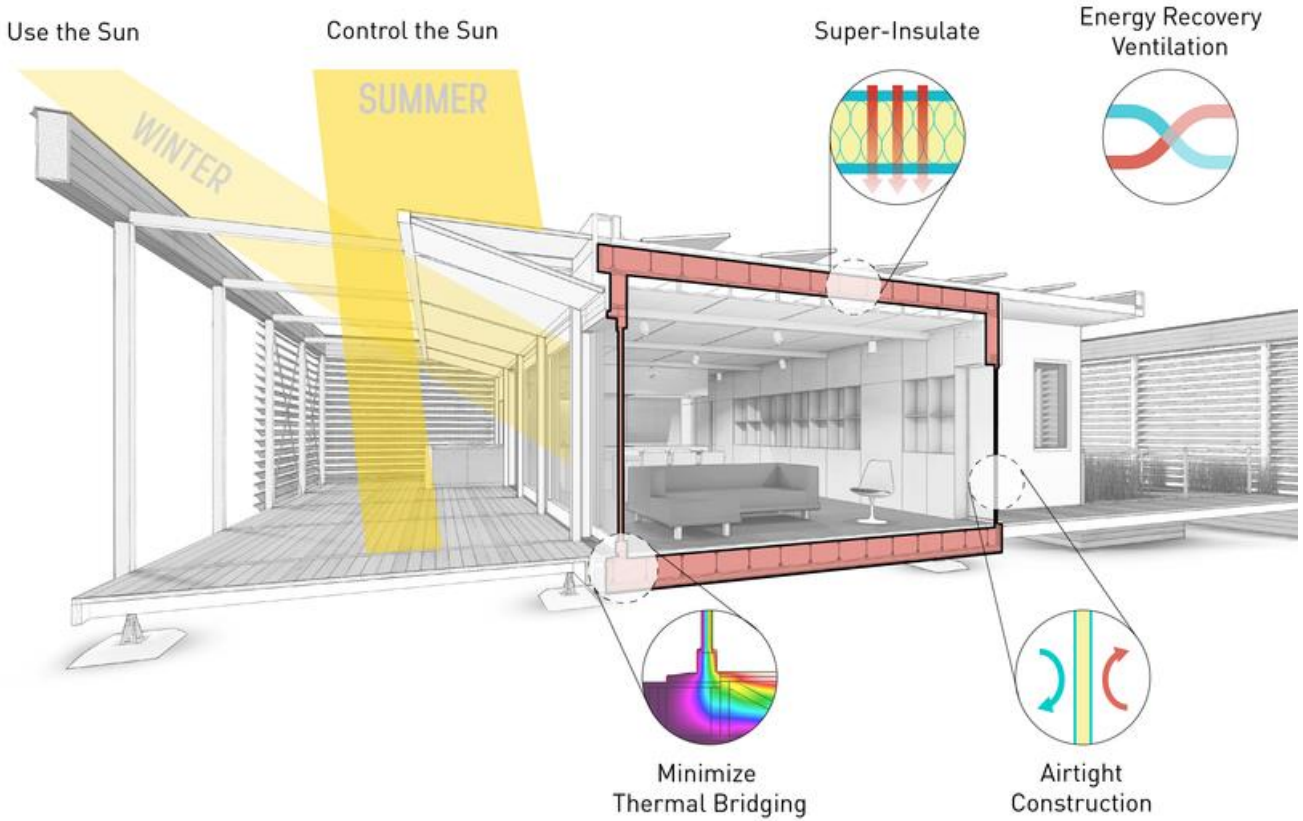
Criteria

- Heating Demand
- Cooling Demand
- Primary Energy Demand
- Air Tightness



Passive House Principals

- Thermal insulation continuity
- Thermal bridge free construction
- Solar control
- Airtightness
- Balanced mechanical ventilation



The SURE House

Winner of the 2015 D.O.E. Solar Decathlon

www.surehouse.org

Goals of PH

- Building durability
- Energy $ reduction
- Optimal thermal comfort
- Superior indoor air quality
- Carbon emissions reductions

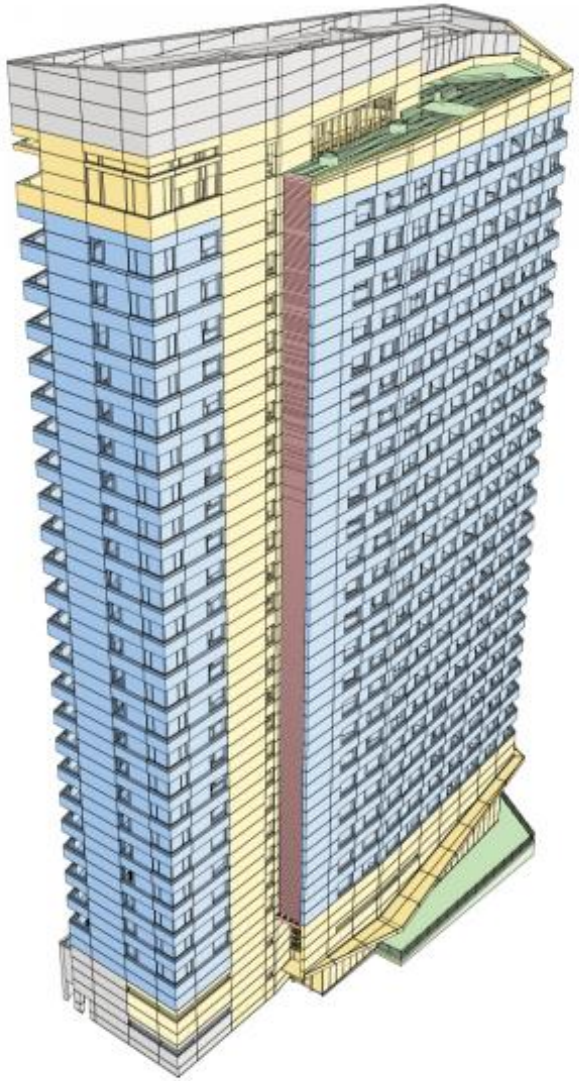
High Rise Apartment Buildings

THE HOUSE AT CORNELL TECH

TEAM

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

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

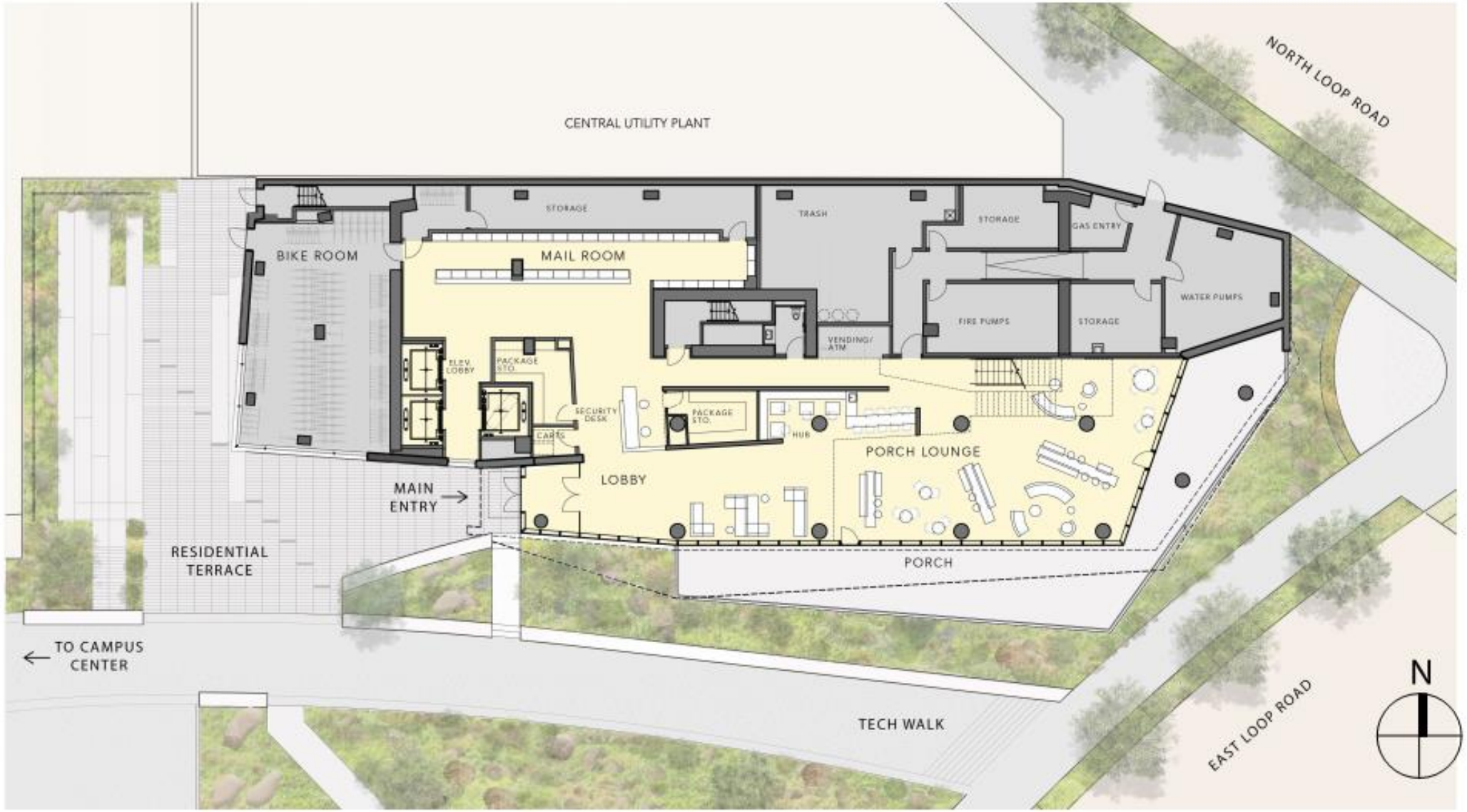
Graduate Students

PhD Candidates

Post Doctoral

Faculty

Ground Floor Plan

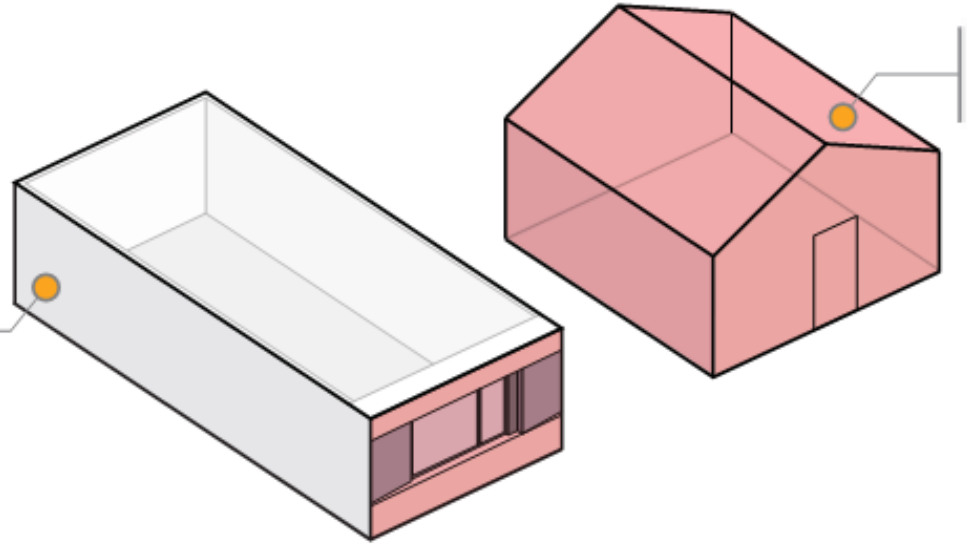


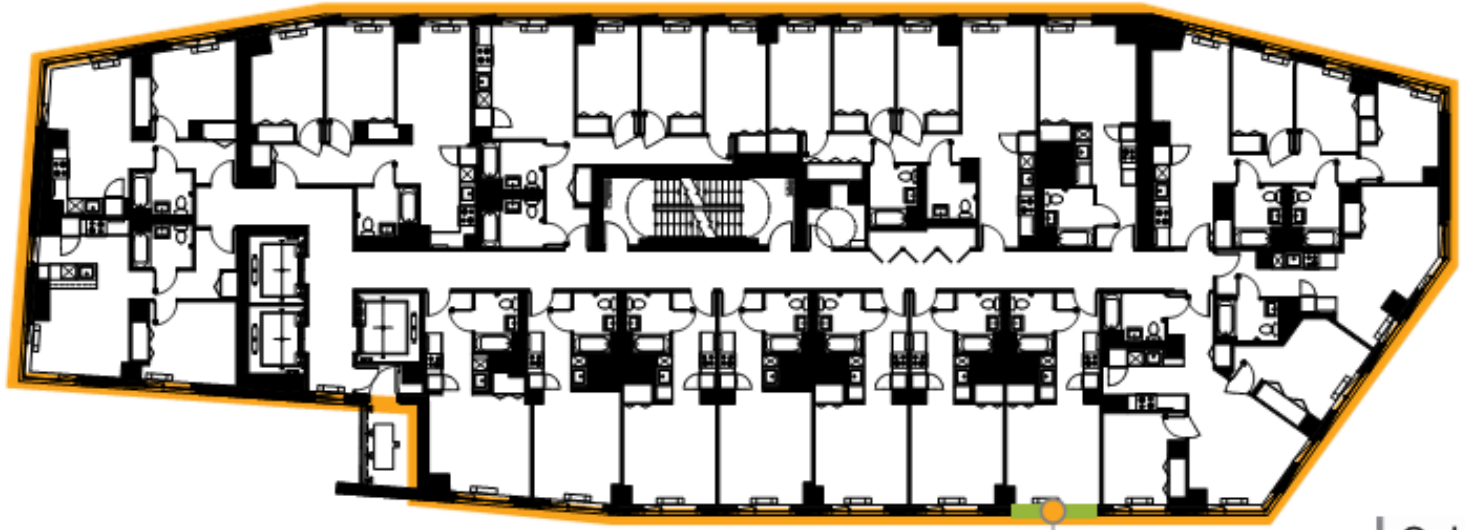
Typical Floor

16 Units per Floor

Low Surface to Volume Ratio

16 Units per Floor





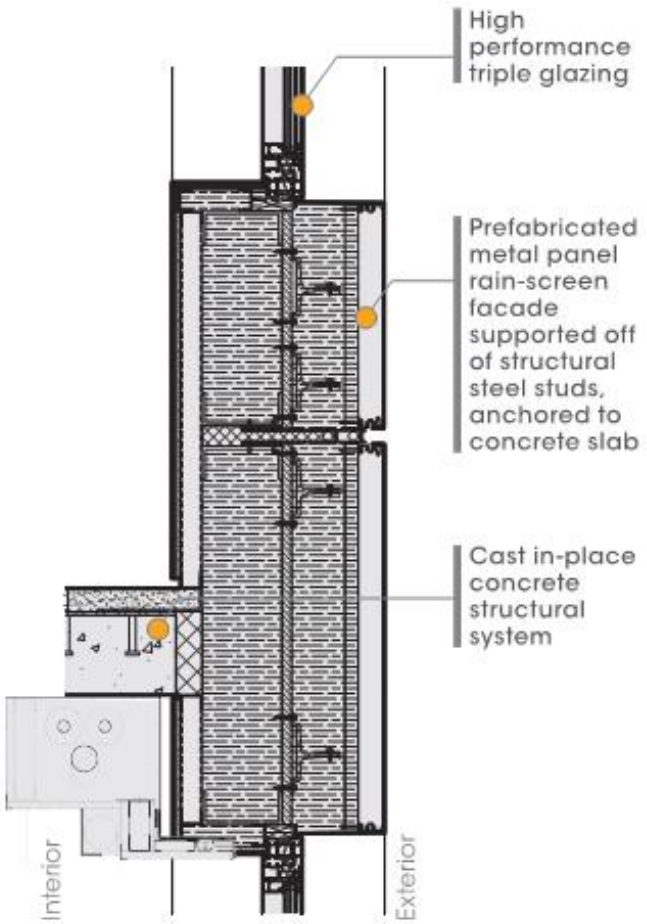
Enclosure

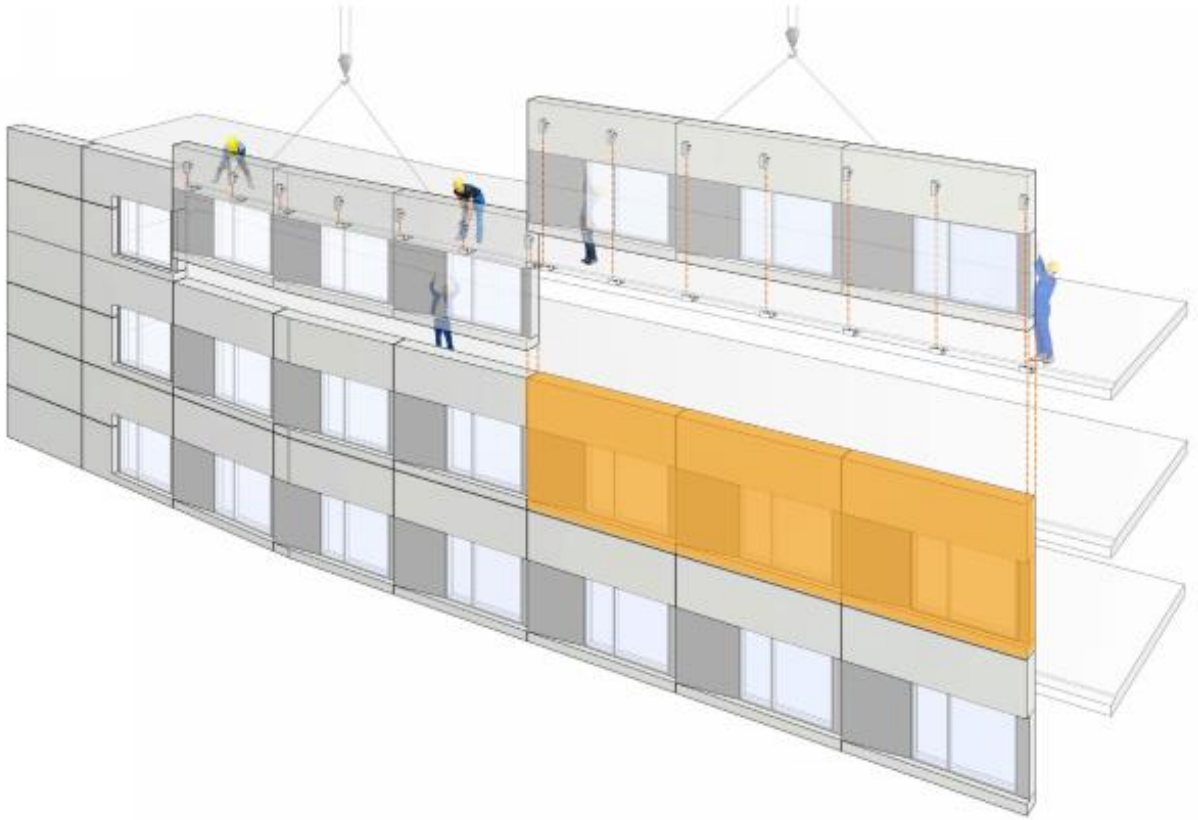
Component	Efficiency
Roof	R-50
Walls	R-19 Average
Windows	U-0.18
Slab Edge	R-10+
Cantilevered Floors	R-40

- Airtightness
- Thermal Continuity
- Eliminate Thermal Bridging

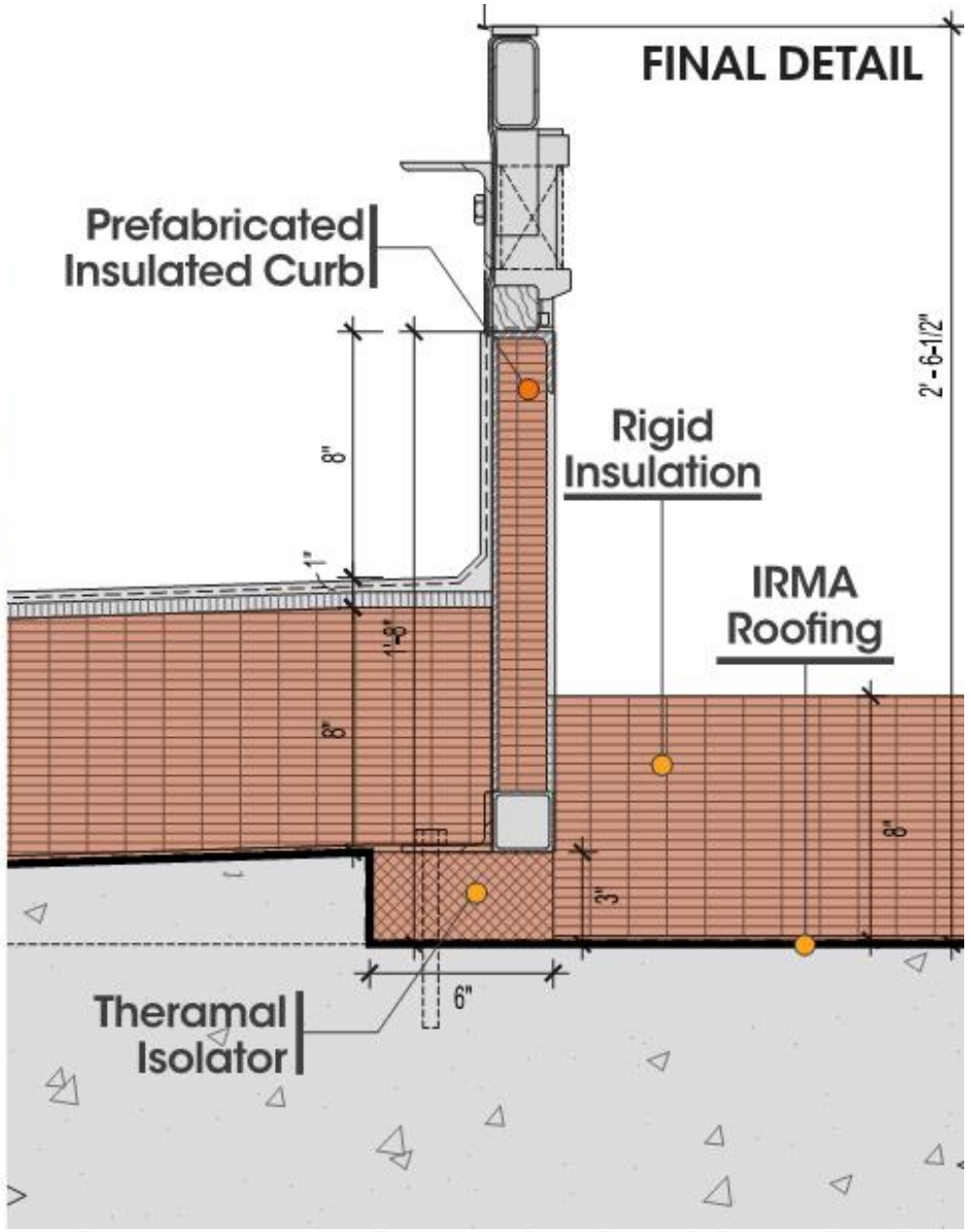
WEST SOUTH

Panelized Wall System





Eliminate Thermal Bridging

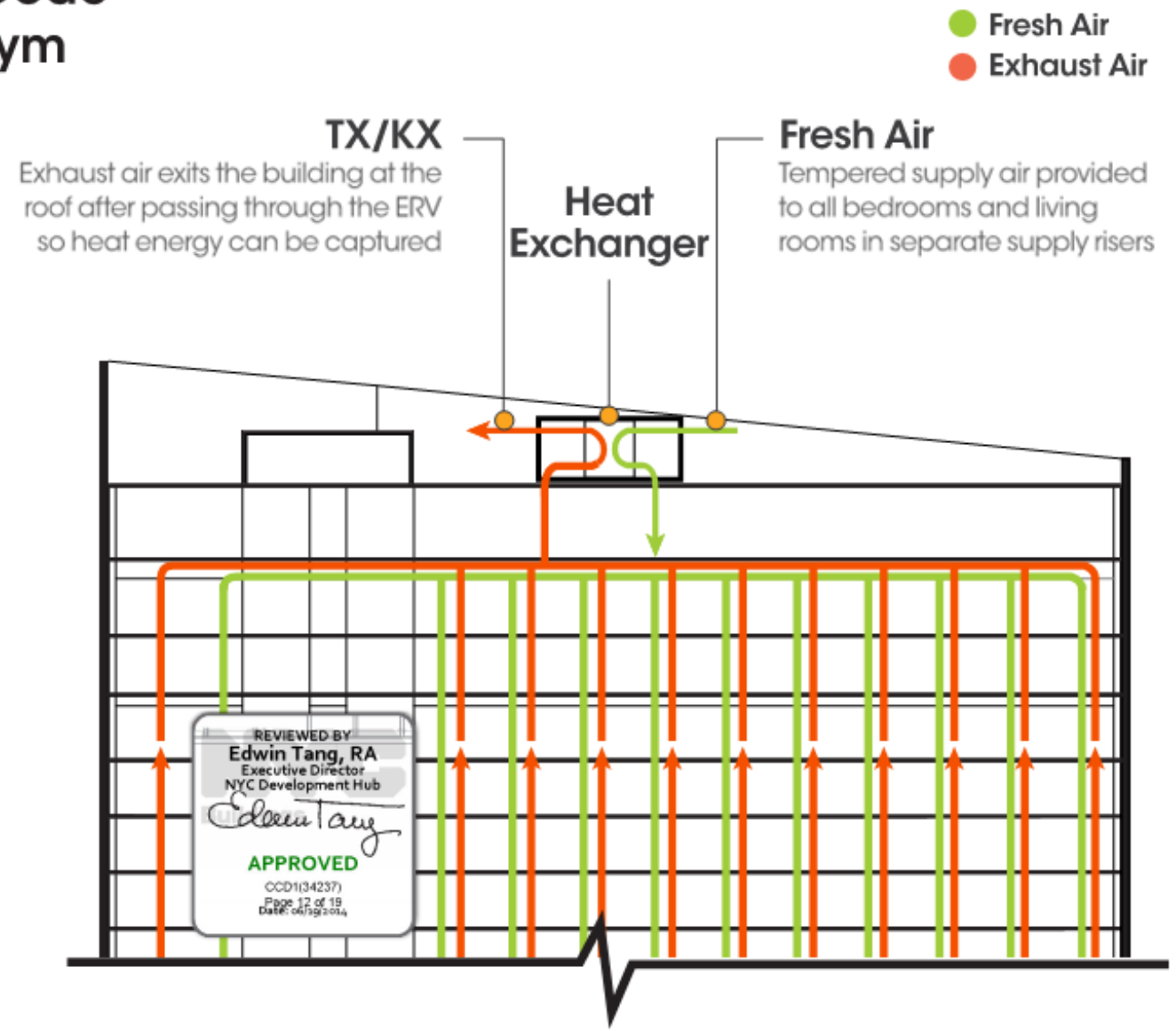


Change to the Building Code
Mechanical Exhaust Ststym

- 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:

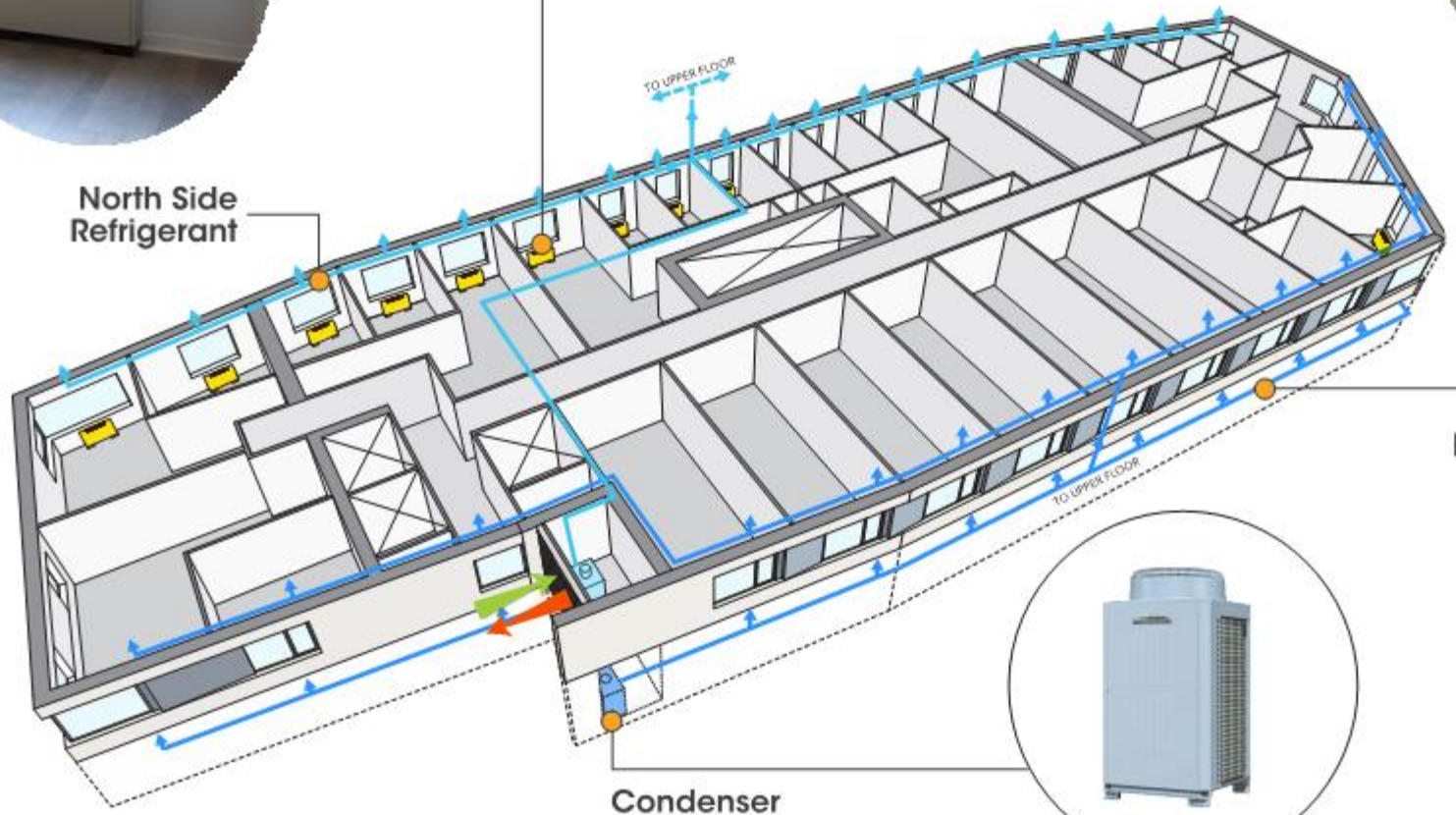
501.5.1. Single or combined mechanical exhaust systems from bath, toilet, urinal, locker, service sink closets and similar rooms shall be independent of all other exhaust systems



VRF: Heating & Cooling

Evaporator in all bedrooms & living rooms

North Side Refrigerant



South Side Refrigerant

Condenser

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!

How are we doing – Cornell Tech

	Site EUI [kBTU/SF] (W/m^2)	Source EUI [kBTU/SF] (W/m^2)	LL97 GHG [kgCO2e/SF]
Electricity	22.85 (72)	64.0 (202)	2.01
Gas	10.24 (32.3)	10.7 (33.7)	0.54
Total	**33.09 (104.4)**	**74.7 (235.6)**	**2.55**

42% energy reduction compared to LL84 data (130 kBtu/ft^2 yr source energy)

Meets LL97 GHG cap for multifamily buildings (<= 4.07 kgCO2e/SF in 2030)

Using Energy Star Score for Multifamily Housing methodology
Energy Star Score: 99
NYC Energy Efficiency Grade: A

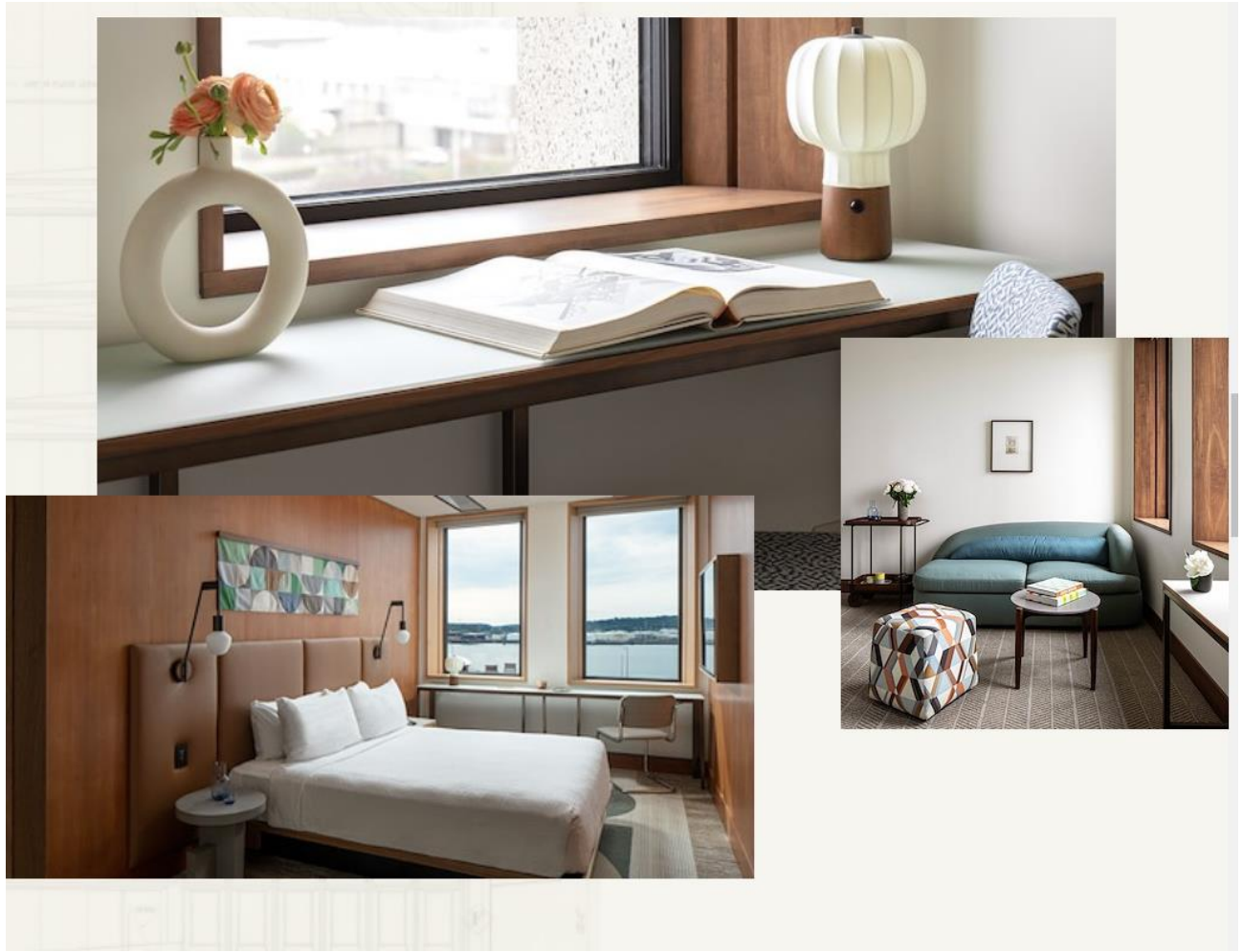
Hotel & Commercial Kitchen

Hotel Marcel

New Haven, CT

Hotel Marcel Retrofit (New Haven, CT)

- Owner / Architect – Becker & Becker
- Re-developing to be all electric, net zero hotel and conference space
- Registered as a historic building
- Pursuing:
  - Net Zero
  - LEED Platinum
  - EnerPHit
  - Energy Star
  - UI Incentives
- **Main Driver: Owner wanted to do it!**
- Just finished Construction



Net Zero – Energy Production

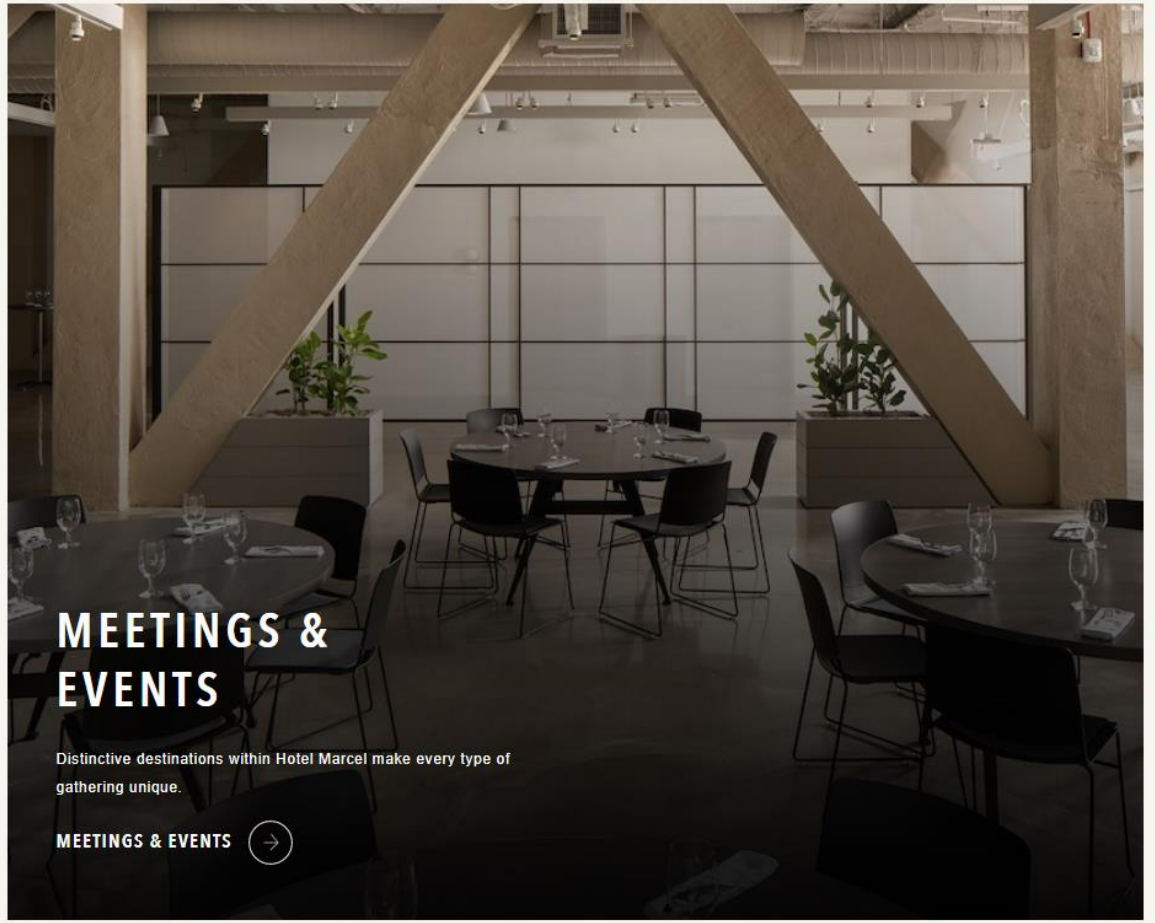
- Total annual production ≈ 510,000 kWh/yr
  - ~130 kW on roof (30%)
  - ~290 kW on carport canopies (70%)

Net Zero – Energy Consumption

- Goal < 510,000 kWh/yr
  - **Equates to a site EUI < 18.0 kBtu/sf.yr**

KEY CONSIDERATIONS

- Limiting commercial kitchen energy use
- Limiting common area lighting energy
- Ventilation controls
- High efficiency heat recovery on ventilation
- Electrification of domestic hot water (in addition to space heating)



Limiting Commercial Kitchen Energy Use

- *Eliminating the one electric fryer*
- *Cutting electric kettles (qty. 2) time of use from 12 to 2 hrs/day.*

- Kitchen designer
  - All electric possible? **Yes**
  - Can we get away with only Type II hoods? **No, need Type I hoods**
  - Heat recovery limitations on ventilation air **Glycol loop (max SRE ≈ 30%)**
  - Equipment electrical power draw
  - Run Time

Initial Pirelli estimates

Proposed scenario = 301,000 kWh/yr (site EUI - 9.9 kBtu/sf.yr - 31 kWh/m^2) !!

Improved scenario = 150,000 kWh/yr (site EUI – 4.9 kBtu/sf.yr - 15 kWh/m^2)

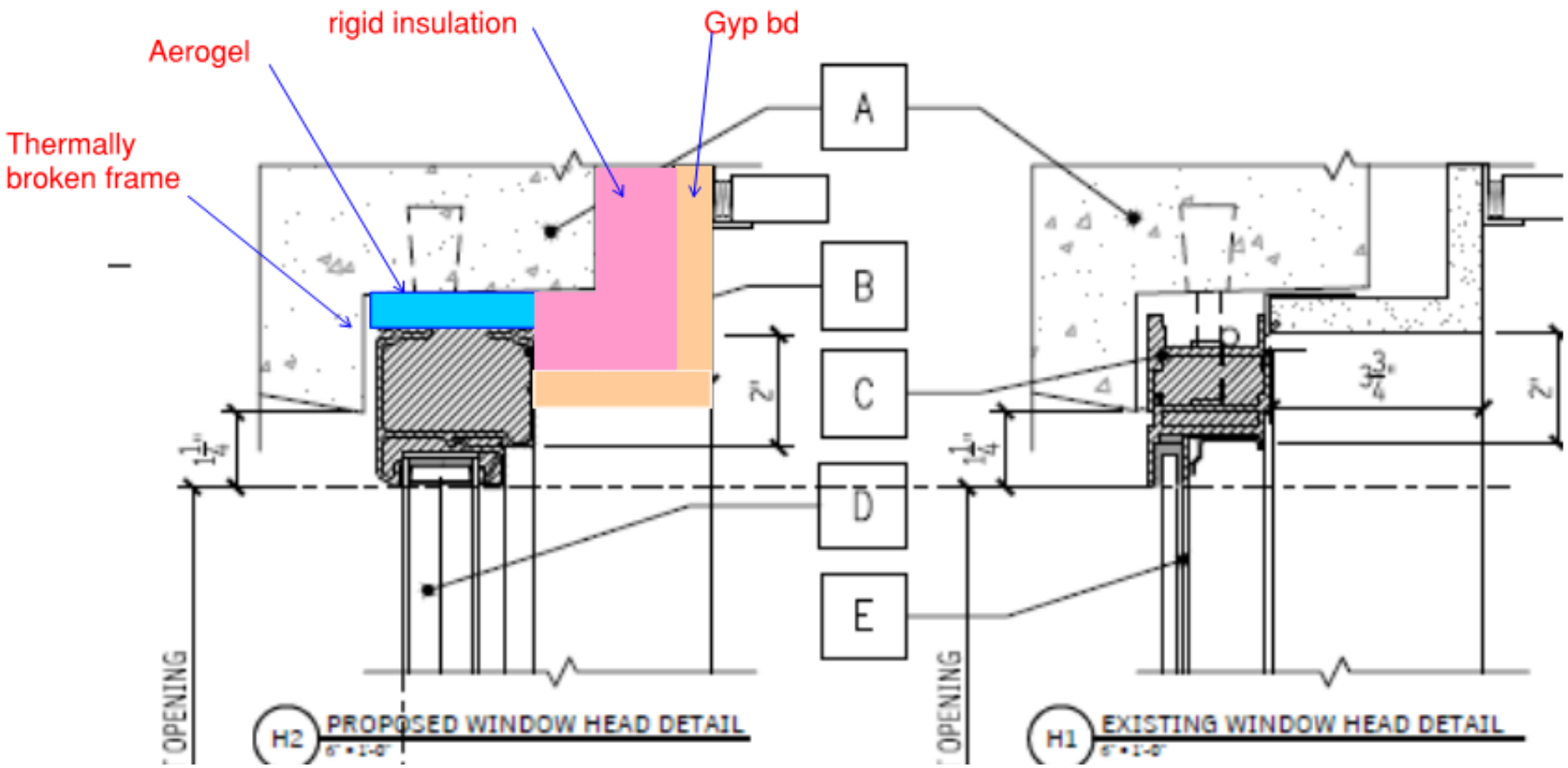
Electrification of DHW

- **Load reduction measures**
  - Low flow fixtures
  - Efficient recirculation pipe layout
- **Efficient heating strategy**
  - 4 air-sourced heat pump water heaters (located indoors)
  - 700 gallons of DHW storage
- Initial energy estimate = 48,000 kWh/yr (site EUI: 1.6 kBtu/sf.yr - 5 kWh/m^2)

Passive House Level Enclosure

Passive House Level Enclosure

- **Windows**
- Triple pane
- Metal / uPVC / fiberglass (TBD)

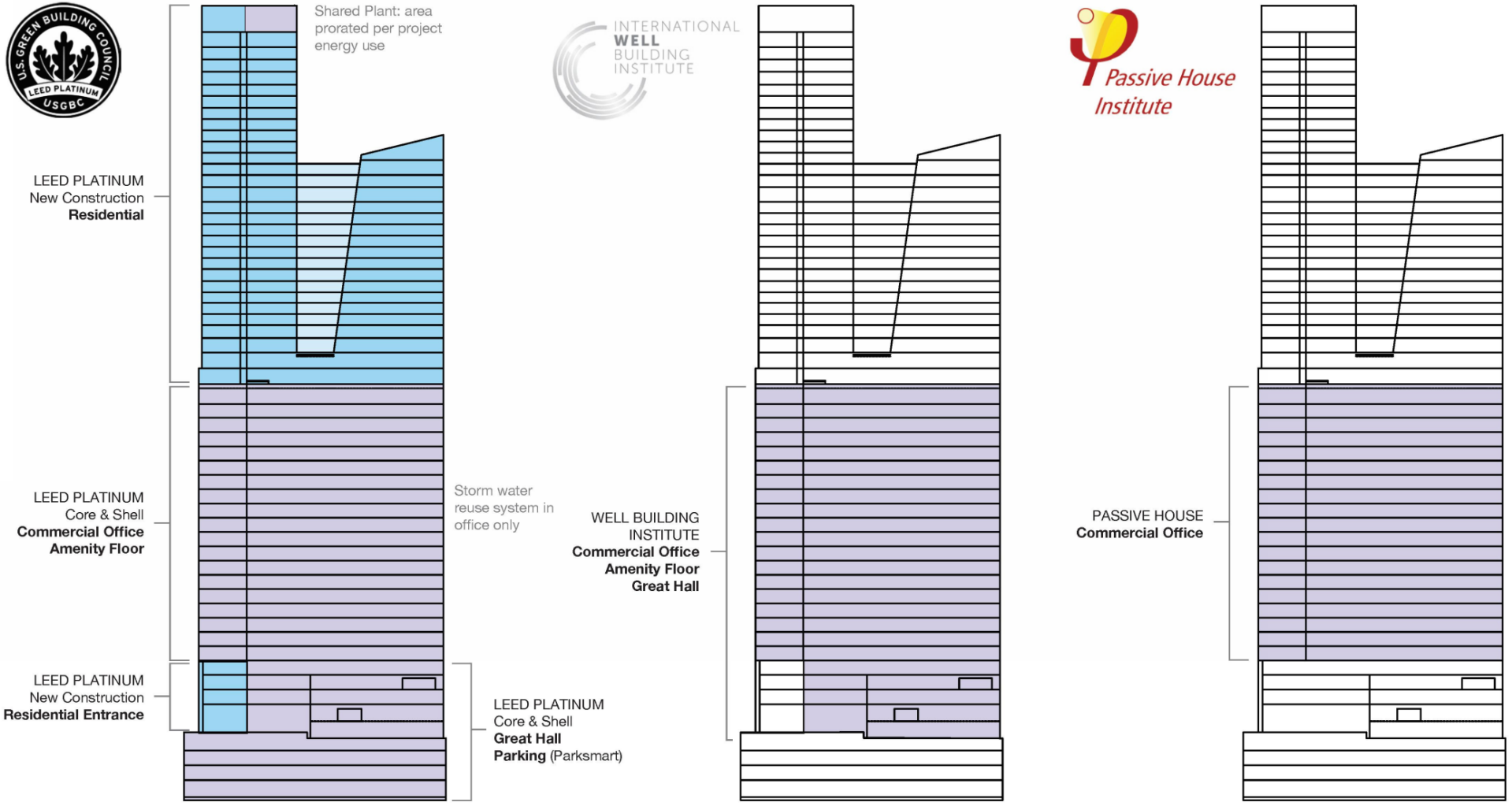


Office

Winthrop Square

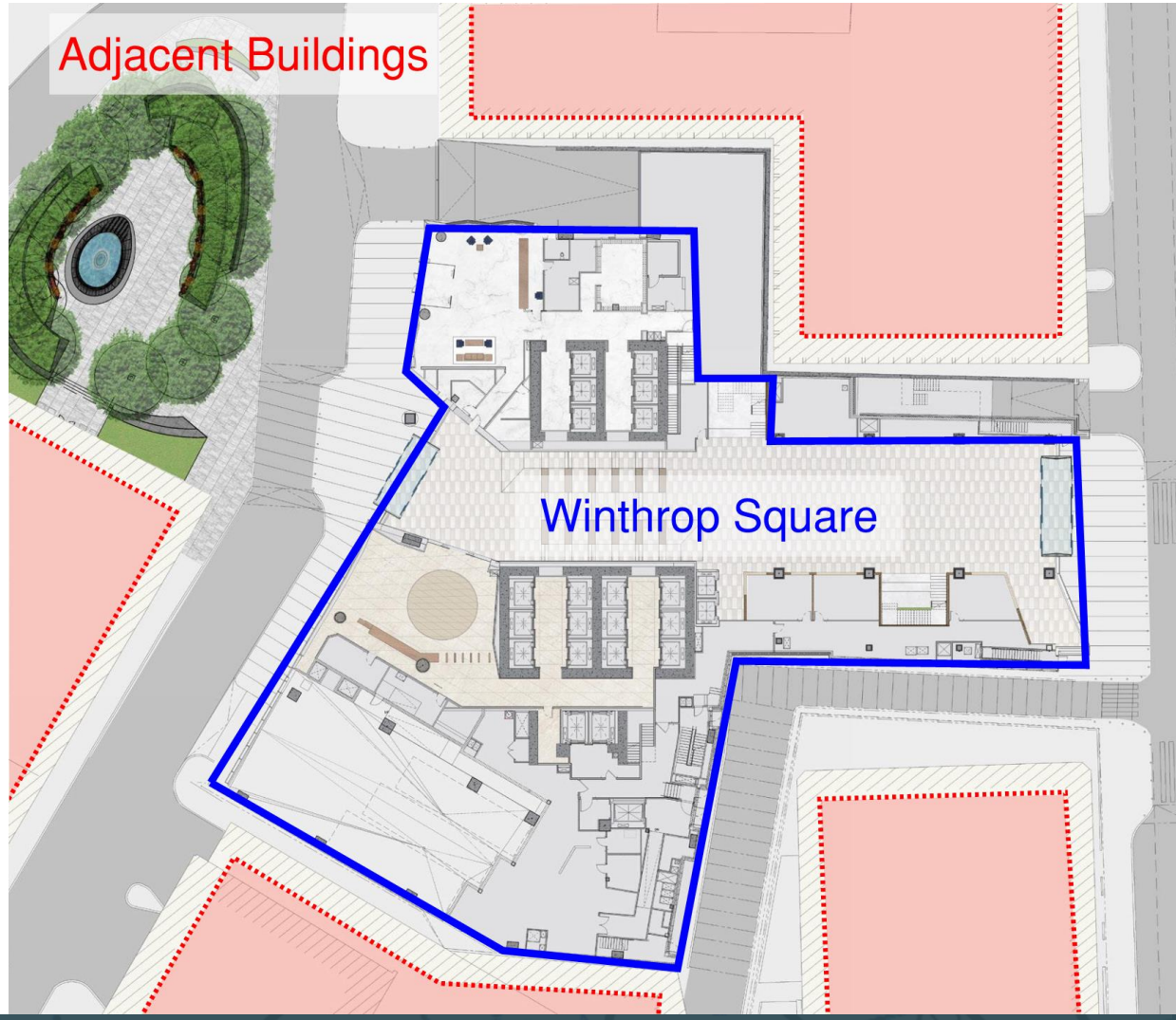
- Downtown Boston
- (Very) high-rise mixed use
- Numerous sustainability goals
- Office portion → **PH Pilot Project**

Winthrop Square



Winthrop Square
Design Requirements

- Completely custom system
- Unitized system in 5 ft modules
- Hung from inside
- High wind loads
- **Stringent thermal requirements for PH** **R-18**
  - Opaque U-value ≤ 0.055 Btu/hr.ft².°F *(0.312 W/m².K)*
  - Vision U-value ≤ 0.220 Btu/hr.ft².°F *(1.249 W/m².K)*



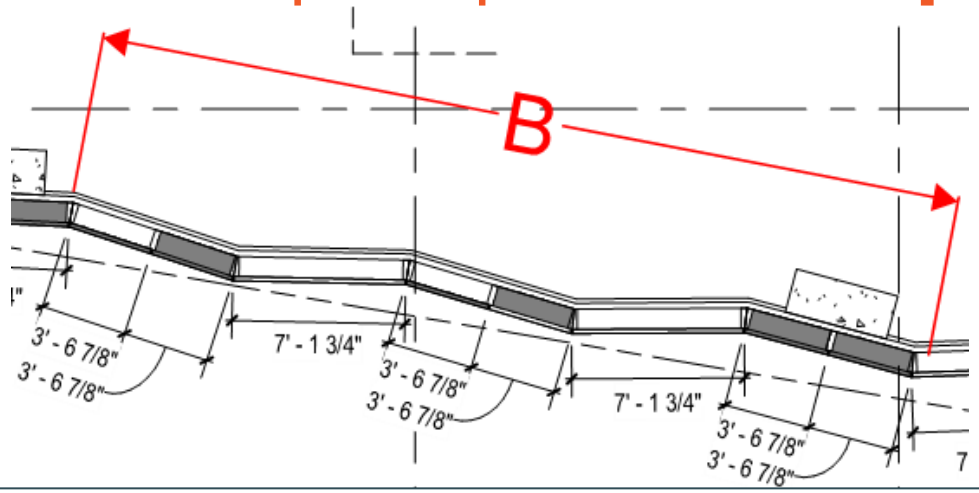
Winthrop Square **Unique Wall Types**

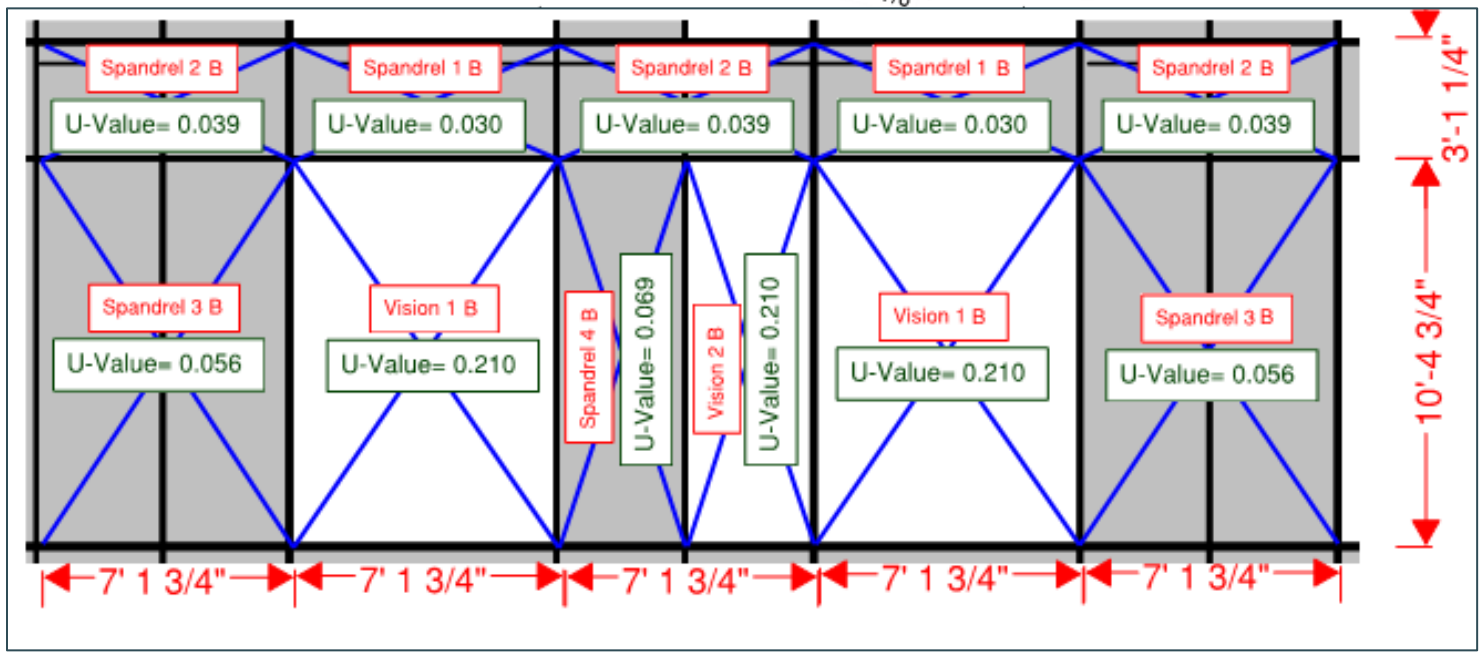
Unique Wall types =

WT-A
WT-B
WT-C
WT-D
WT-DB
WT-E
WT-ES
WT-F
WT-F1.SB

Unique U-values

Winthrop Square **Unique Wall Types**





Overall U-Value Spandrel WT-B			
Typical Repeating Bay	Area	U	Area x U
	(ft^2)	(BTU/hr-ft^2-F)	(BTU/hr-F)
Spandrel 1 A x2	44.36	0.030	1.3
Spandrel 2 A x3	66.55	0.039	2.6
Spandrel 3 A X 2	148.57	0.056	8.3
Spandrel 4 A	37.14	0.069	2.6
Total	**296.63**		**14.81**
Overall U-Value		0.05	BTU/hr-ft^2-F

Overall U-Value Vision WT-B			
Typical Repeating Bay	Area	U	Area x U
	(ft^2)	(BTU/hr-ft^2-F)	(BTU/hr-F)
Vision 1 A X 2	148.57	0.210	31.2
Vision 2 A	37.14	0.210	7.8
Total	**185.72**		**39.00**
Overall U-Value		0.21	BTU/hr-ft^2-F

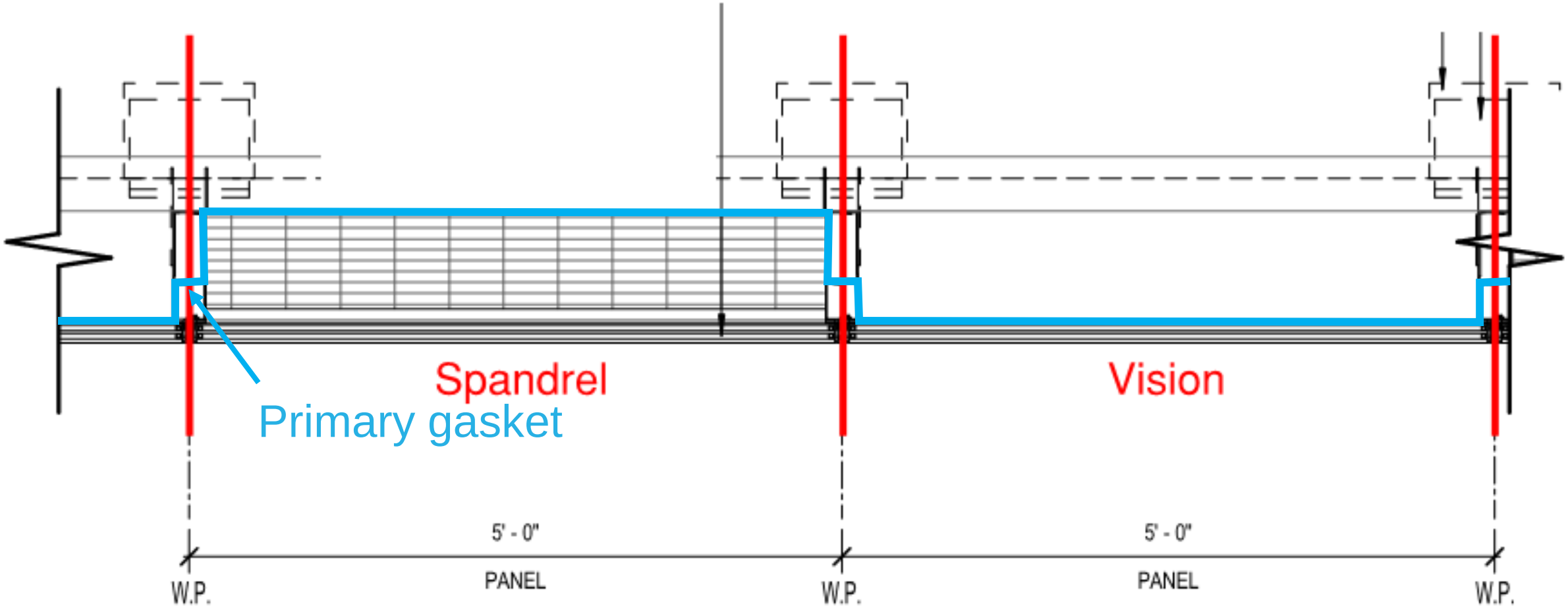
Winthrop Square **Unique Wall Types**

Wall Type	Wall Name	Gross Area	Weighted U - vis	Weighted R-value - op
B	C1_16_EAST	1,102	0.203	18.7
D	C3_16_EAST	284	0.239	14.7
F	D1_16_SOUTH	1,132	0.232	14.6
E	D3_16_SOUTH	476	0.226	17.7
E	E1_16_NORTH	284		18.1
F	E2_16_NORTH	994	0.223	16.7
F1	E3_16_EAST	988	0.190	n/a
B	F1_16_EAST	941	0.218	16.6
C	G1_16_NORTH	1,169	0.214	17.6

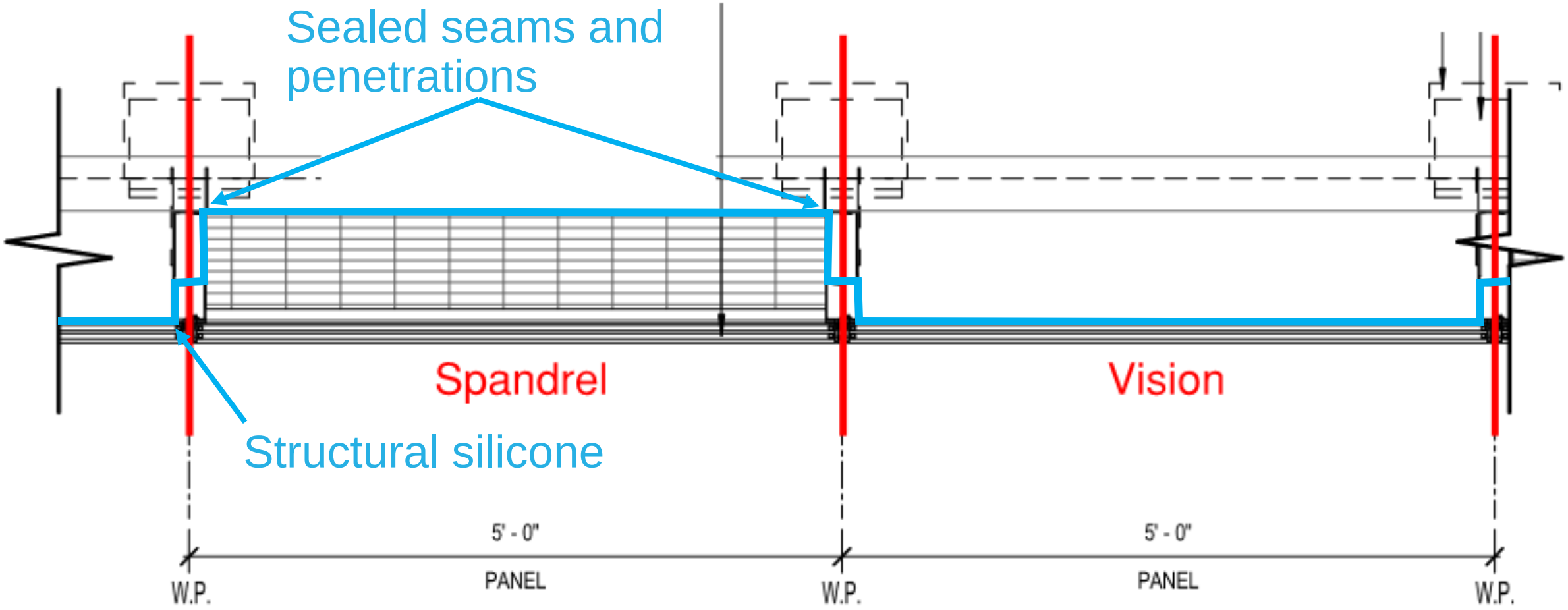
and more…

Real-time UxA Results			
Office Floors (based on current CW unit inputs)			
Opaque Area:	6,343	sf	50%
Vision Area:	6,426	sf	50%
Weighted U - op:	**0.064**	**Weighted R-value:**	**15.7**
Weighted U - vis:	**0.221**		

Winthrop Square **Air Tight Layer**

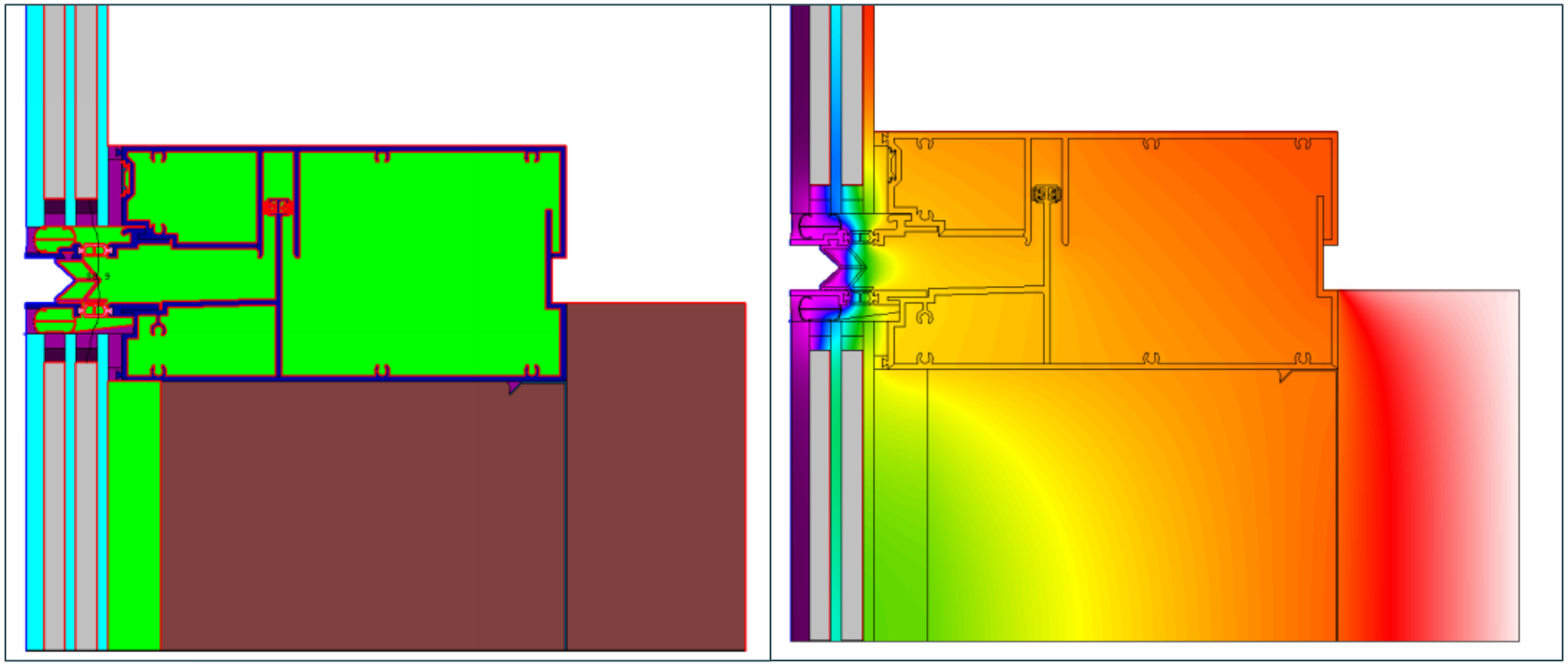


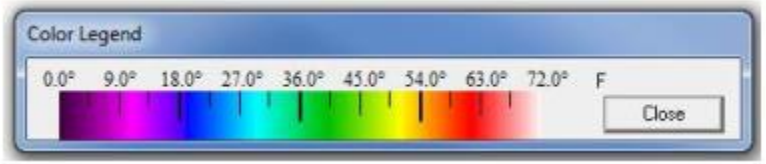
Winthrop Square **Air Tight Layer**



Winthrop Square **Condensation Evaluation**

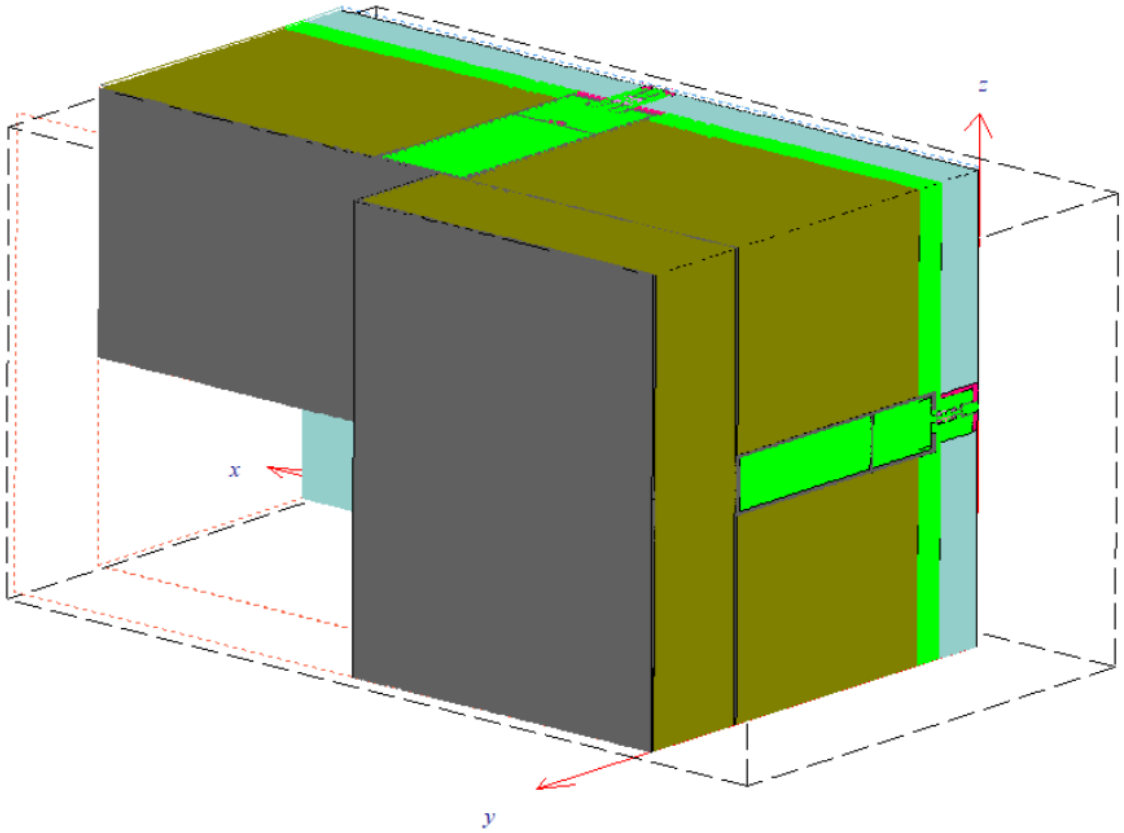
Typical Sill Detail (THERM)

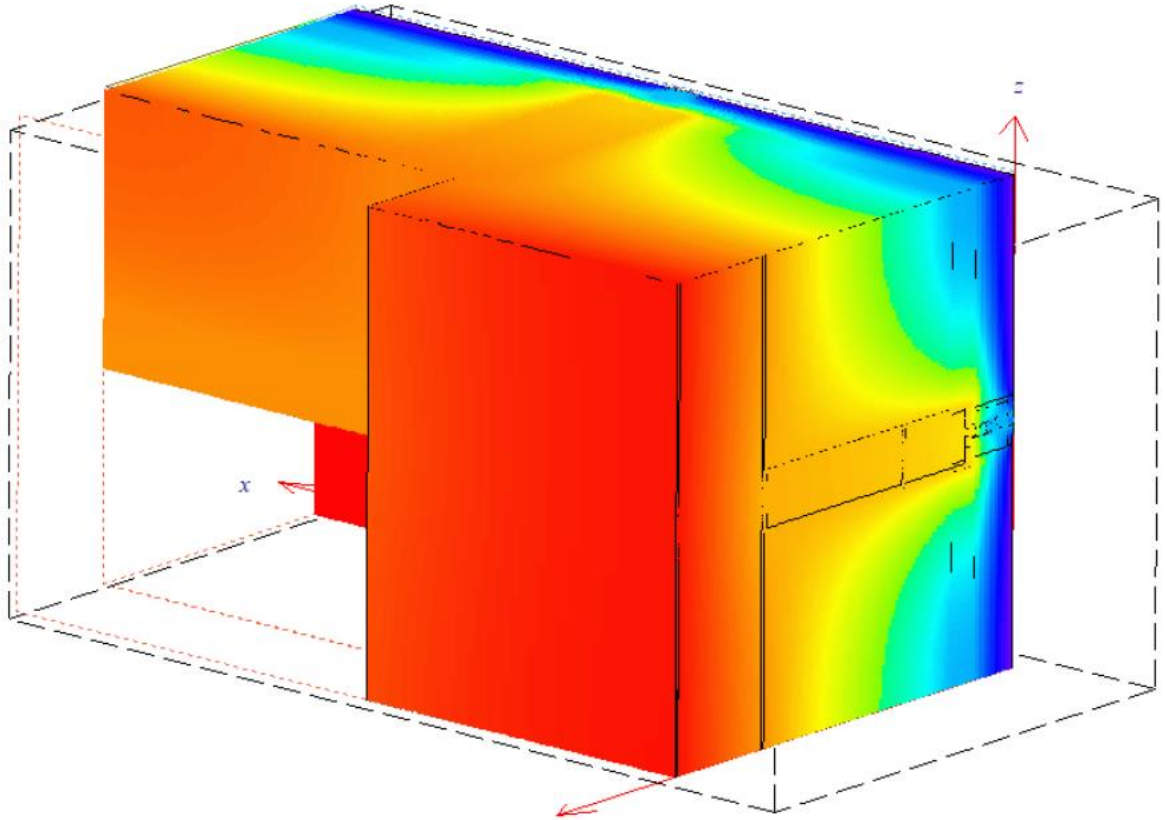




Winthrop Square **Condensation Evaluation**

Unique 3D Details (Heat3)





Takeaways for Towers of the Future

- We're going to *have to* build more efficient towers
- Understand and model internal gains properly
  - Set the right U-value requirements for façade
- Custom curtain walls requires detailed thermal modeling
- Limits to thermal performance on metal curtain walls in US given current technology
- **Passive House levels of design are possible**

Industrial

Existing Building

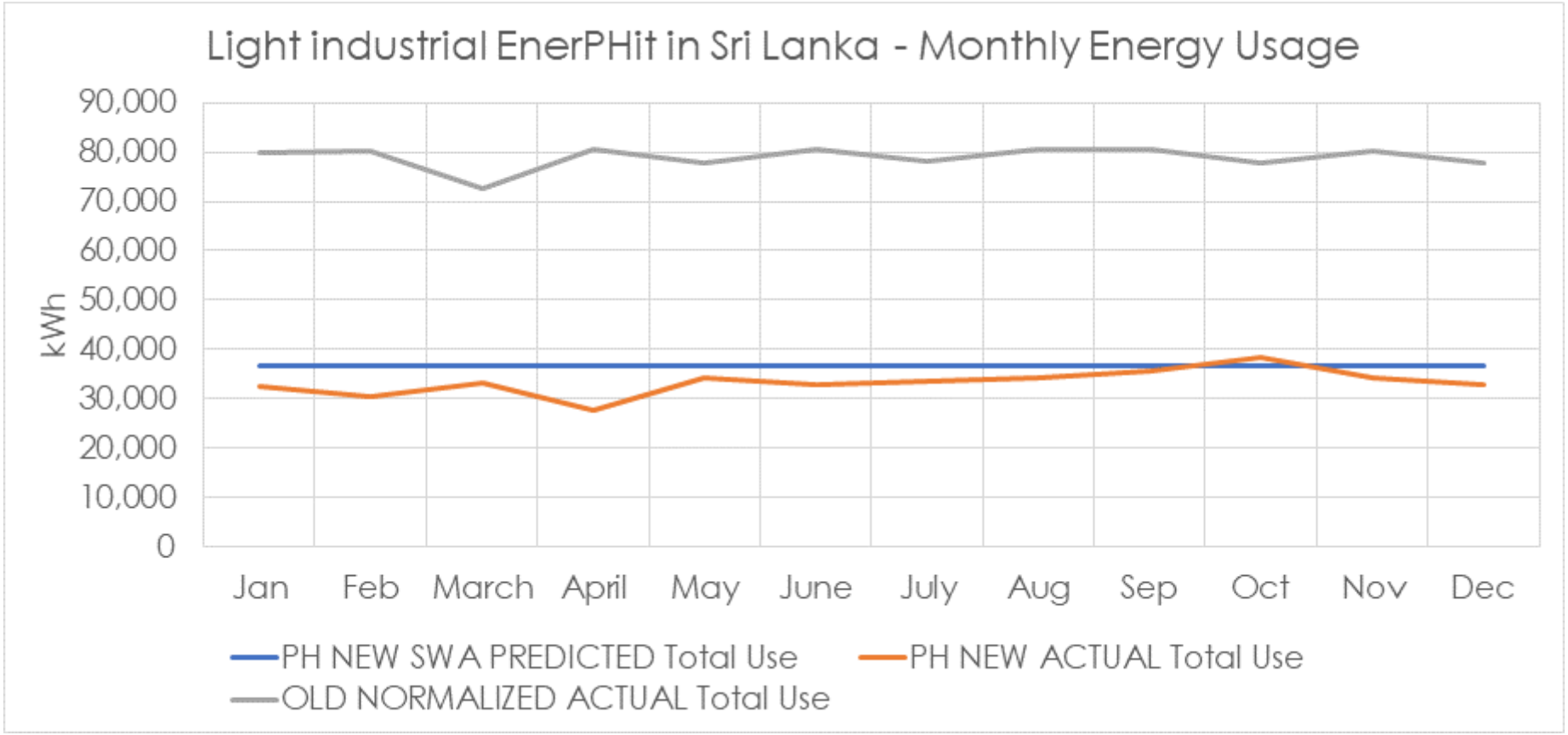
The renovation of an existing two story factory building to EnerPHit standards.

Steven Winter Associates, Inc.
Jordan Parnass Digital Architecture

Existing Interior

Exposed steel structure with few partitions.

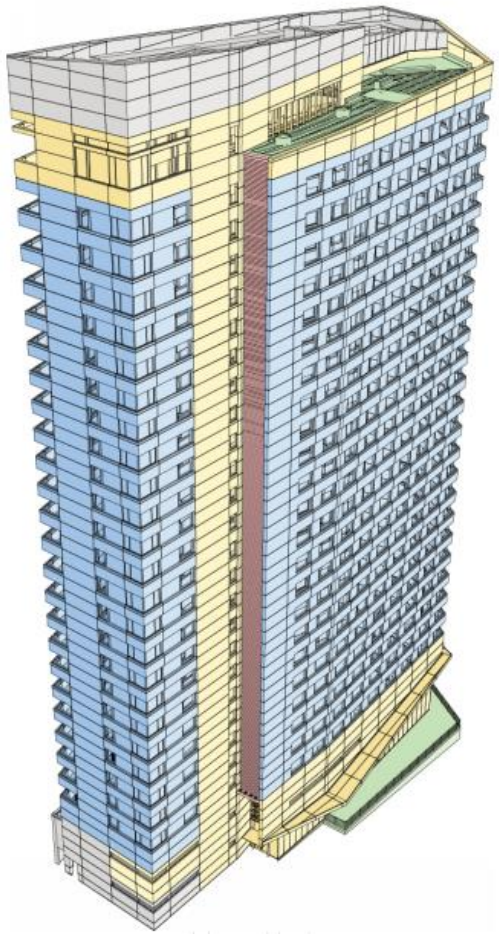
Hipster Lorum



Challenges over the Years

Challenges Over the Years

The House: Project Challenges

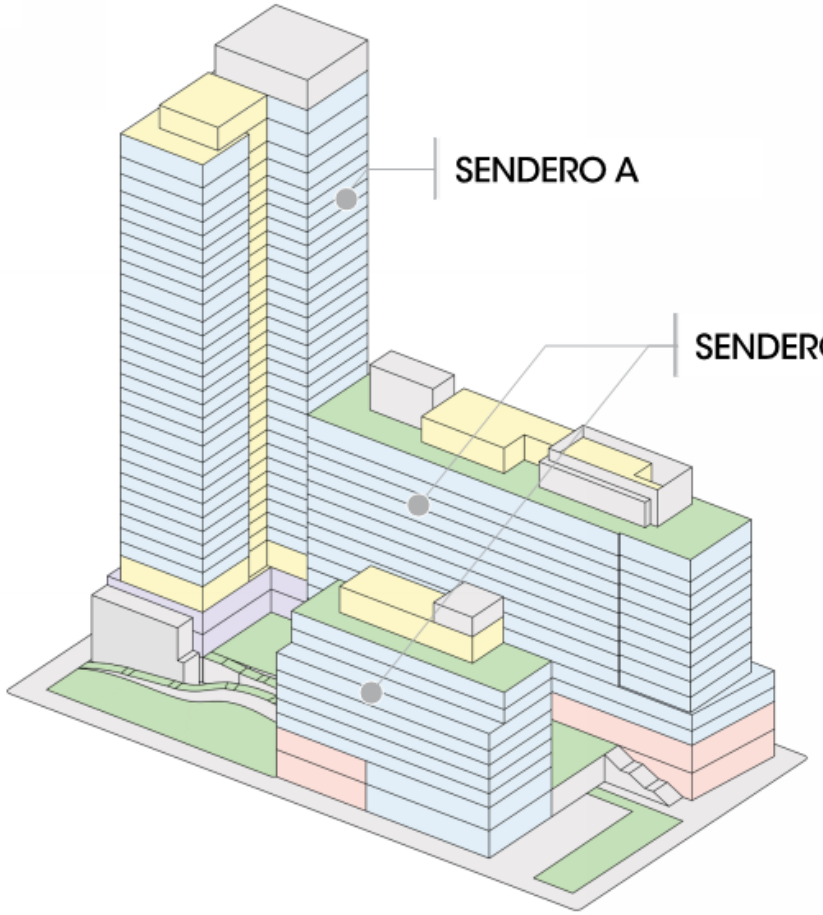


PROJECT CHALLENGES

- 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

Challenges Over the Years

Sendero Verde: Project Challenges

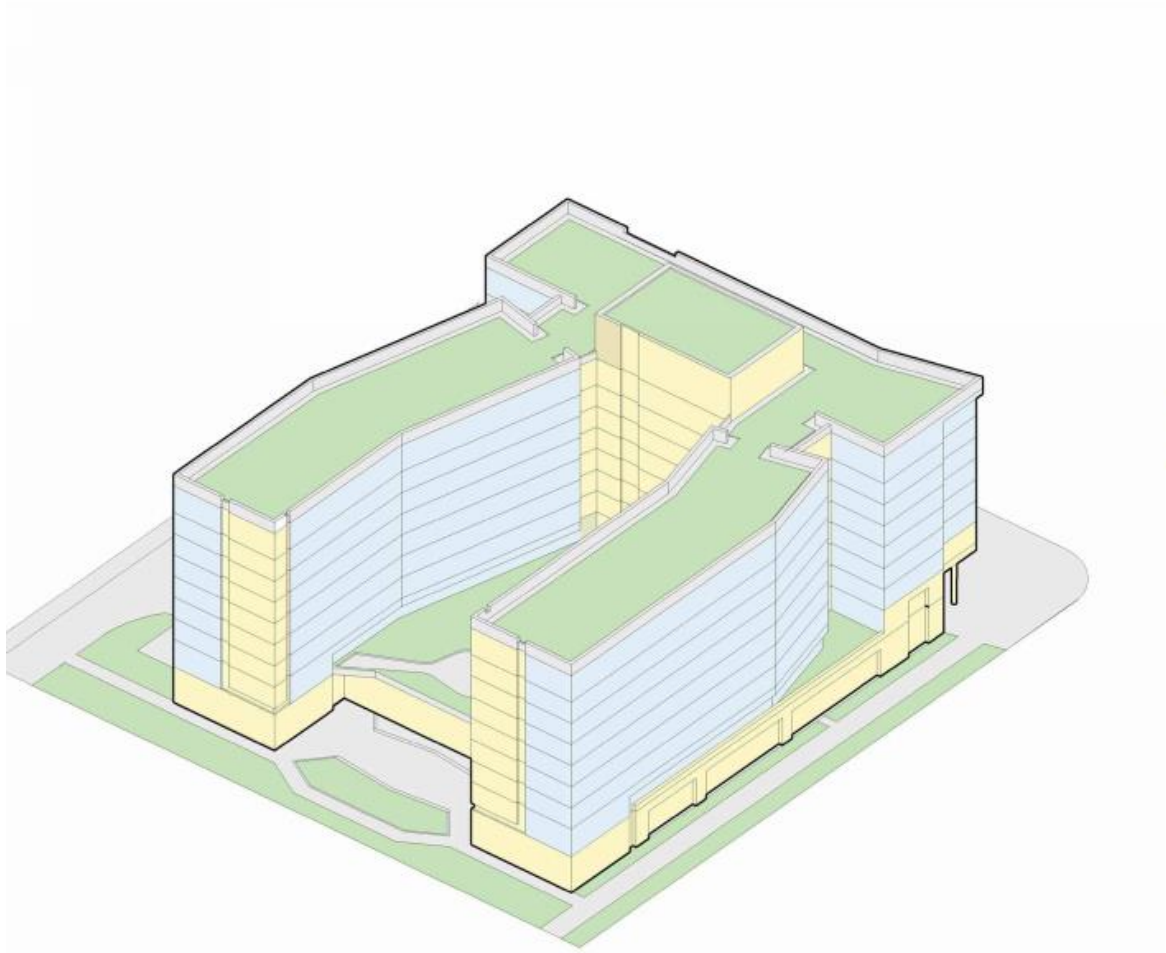


PROJECT CHALLENGES

- 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

Challenges Over the Years

Student Residences: Project Challenges

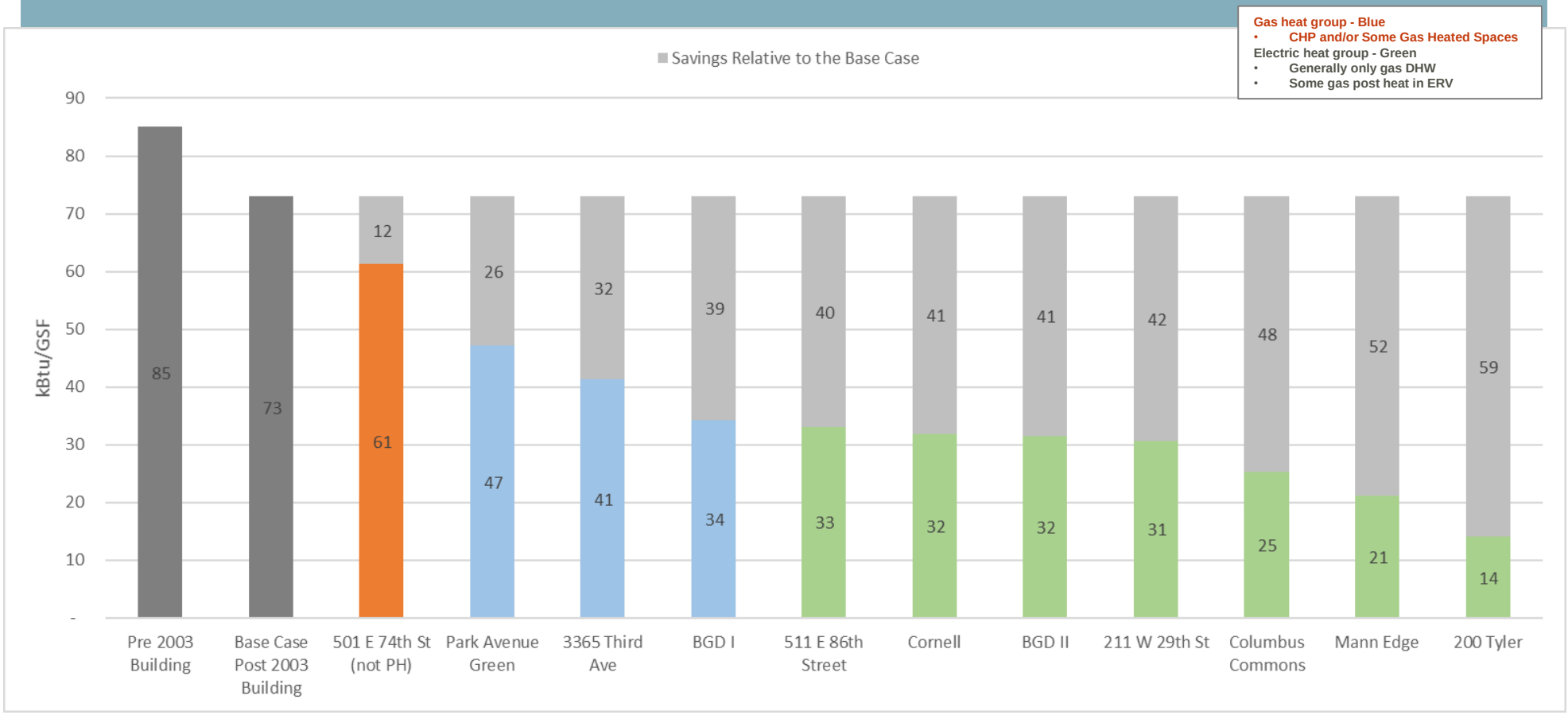


PROJECT CHALLENGES

- 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~~

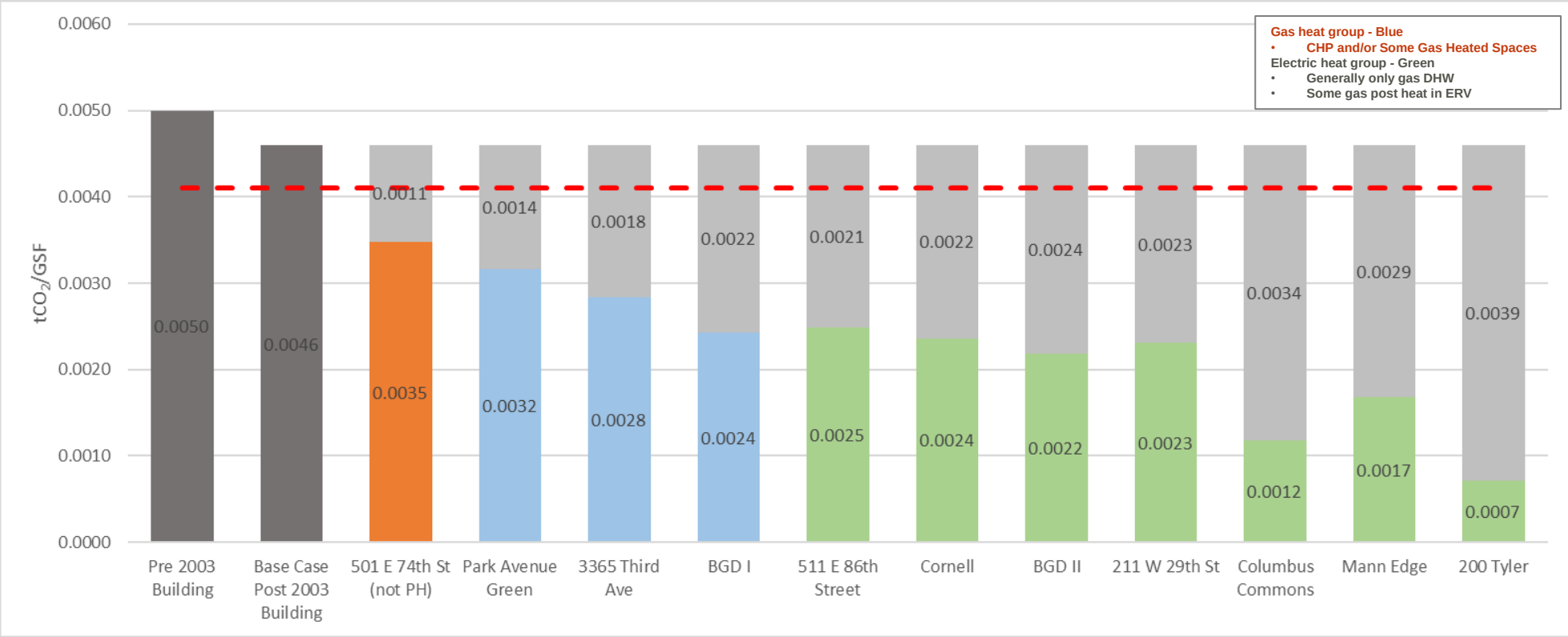
How are we doing?

WHOLE BUILDING SITE EUI



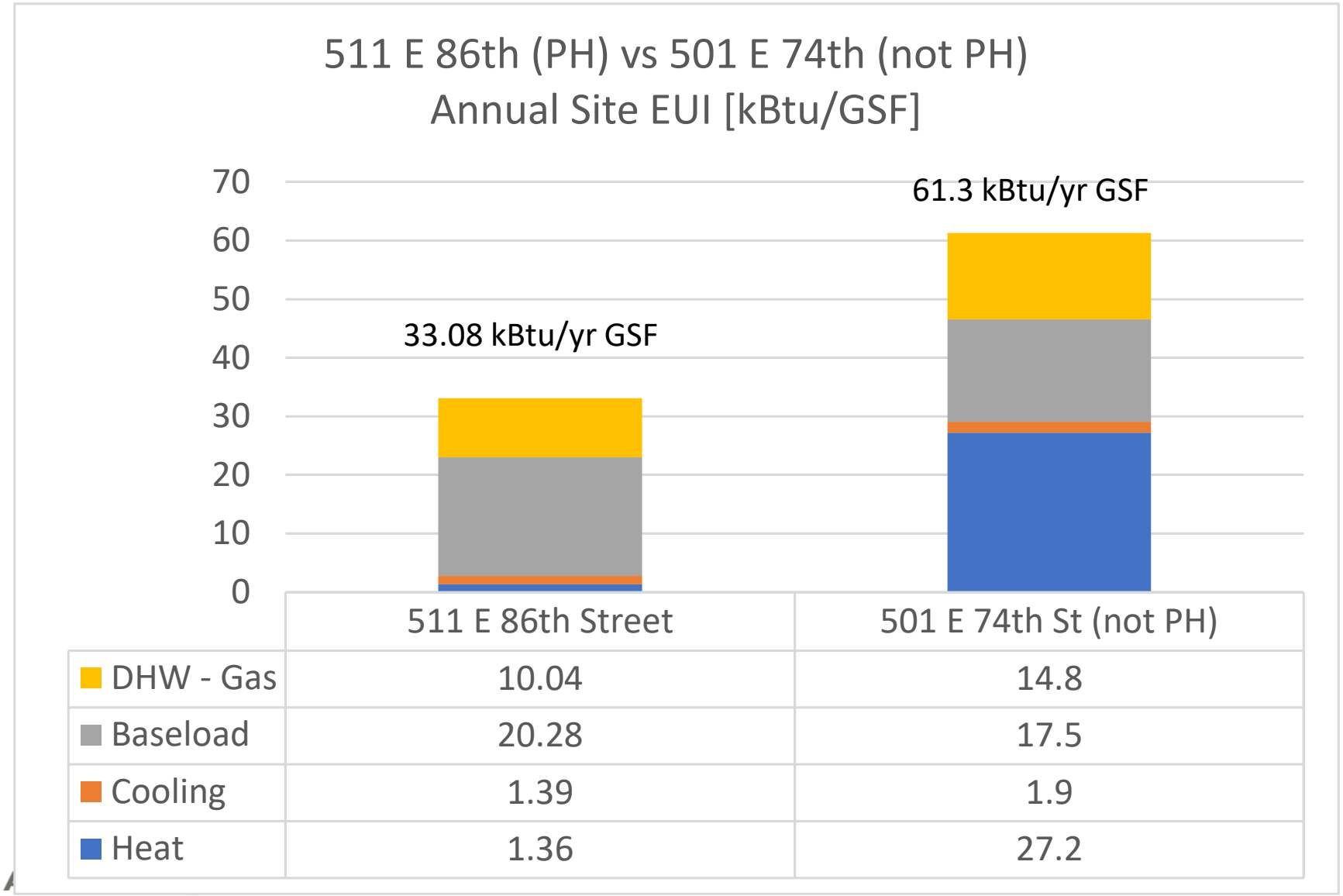
1. Post 2003 Building sample is made up of NYC buildings with at least one full year of consumption data and includes approximately 94% buildings with gas heating, 6% with electric heating.
2. PH-1A & PH-1B have gas heating and hot water. The remaining projects have electric heating (VRF)
3. PH current target based on PHI standard 38 kBtu/sf/yr. Ranges from 20 (model) upper 20's-low 30s (25% gas + 75% electric fuel mix – typ. of gas DHW + elec heat) when building commissioned.

WHOLE BUILDING GREENHOUSE GAS EMISSIONS: RELATIVE TO LL97 2030 TARGET



1. GHG emissions use 2024-2029 emissions coefficients outlined by Local Law 97 of NYC. Note that the emissions factors for 2030 have not yet been established. There is a strong likelihood that the combination of Indian Point closing and gains made as part of the CLCPA, the coefficient will be similar to the one set for 2024-2029.

2021 PH vs. 2016 non-PH



	511 E 86th Street	501 E 74th St (not PH)
DHW - Gas	10.04	14.8
Baseload	20.28	17.5
Cooling	1.39	1.9
Heat	1.36	27.2

Questions?

Contact Us

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