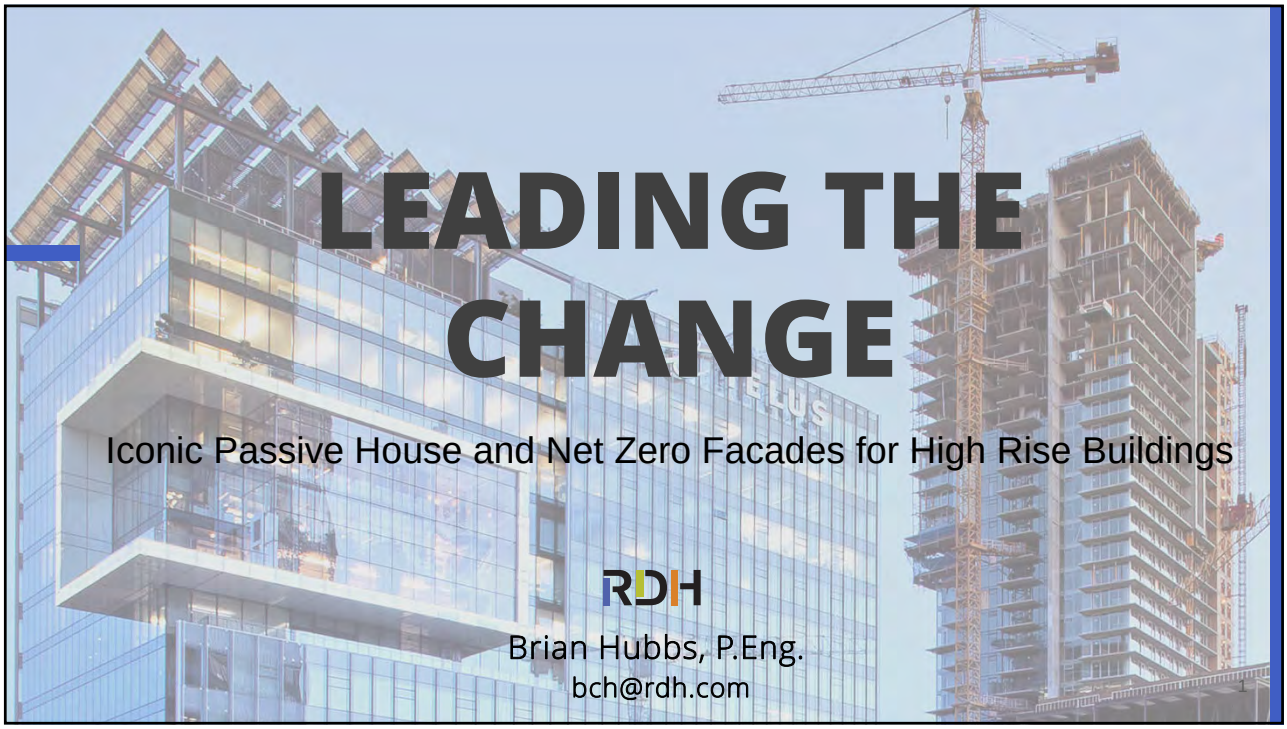

LEADING THE CHANGE

Iconic Passive House and Net Zero Facades for High Rise Buildings

RDH
Brian Hubbs, P.Eng.
bch@rdh.com

1

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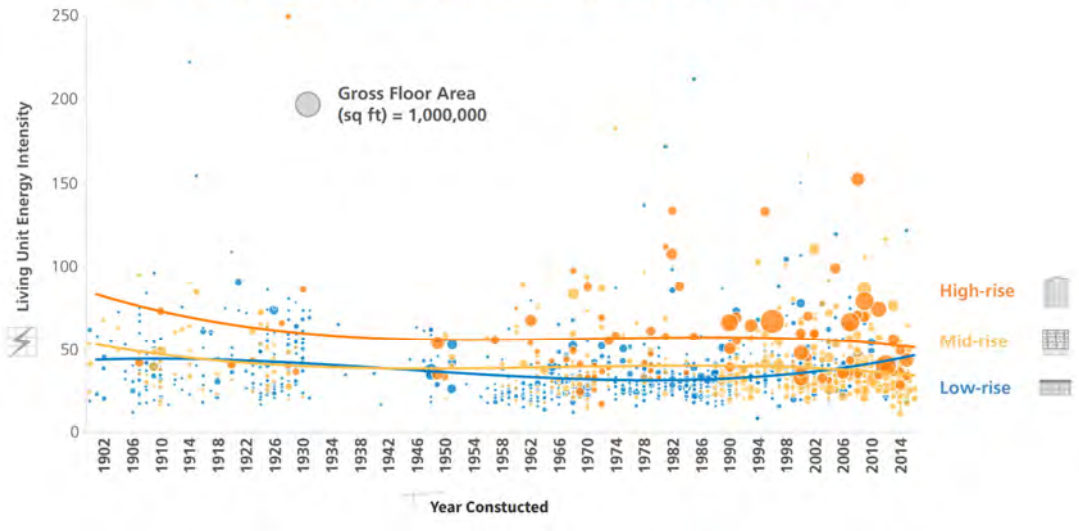
RDH
Making Buildings Better

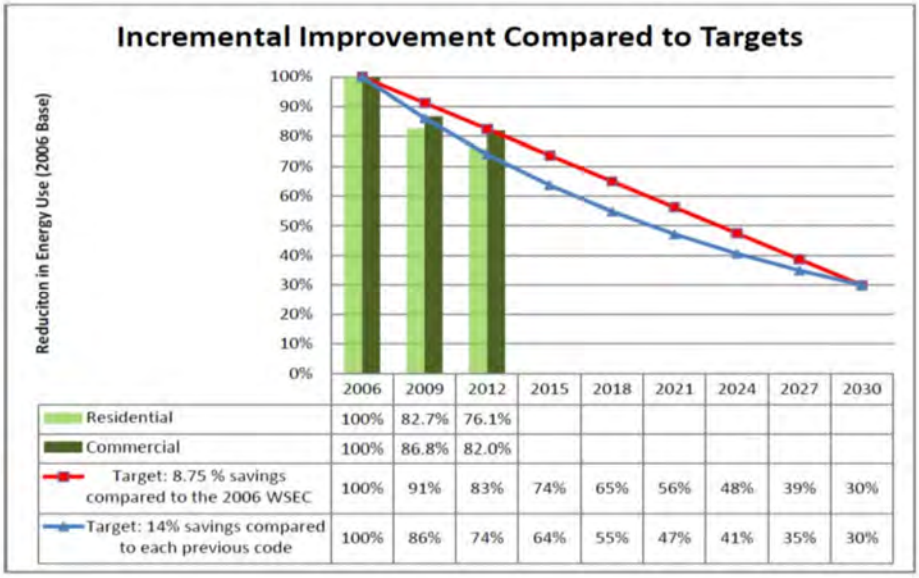
2

Washington's Energy Performance

Figure 20: **Living Unit Energy Intensity of Multifamily Buildings by Year Built**

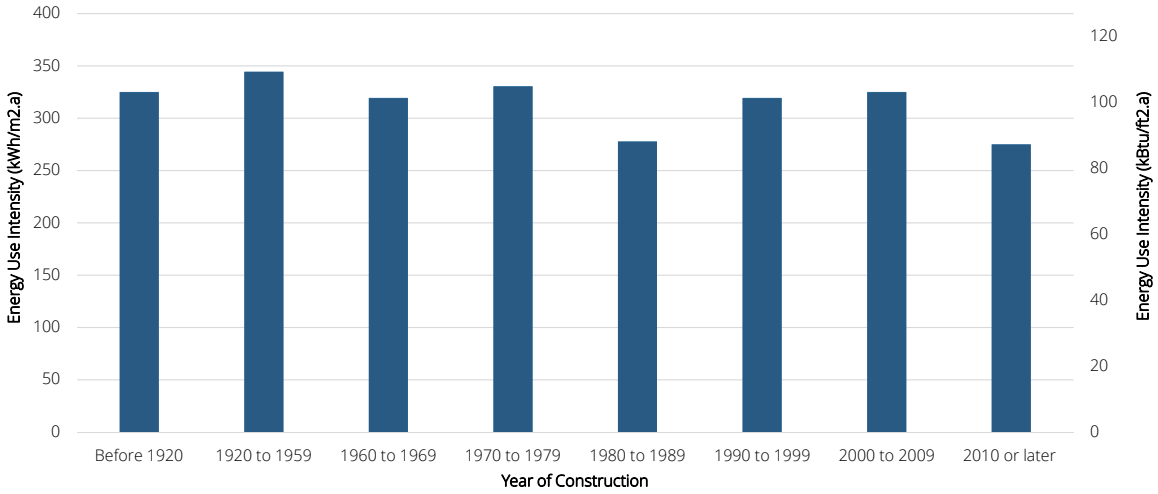


Washington's Energy Targets



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%						
Commercial	100%	86.8%	82.0%						
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%

Building Trends?



Source: NRCan, Survey of Commercial & Institutional Energy Use (SCIEU) – Buildings (2014)

Performance Gap - Predicted vs. Measured

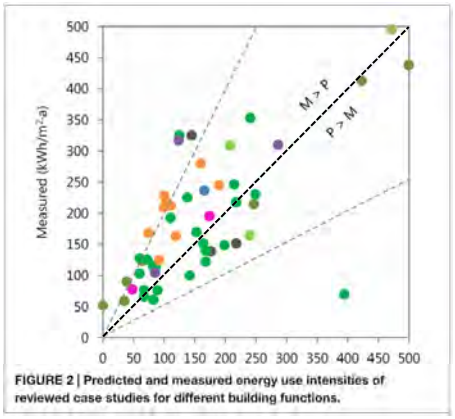


FIGURE 2 | Predicted and measured energy use intensities of reviewed case studies for different building functions.

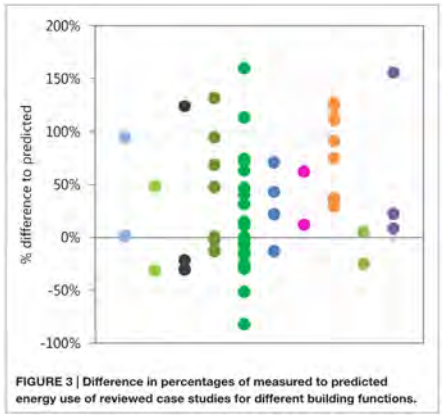
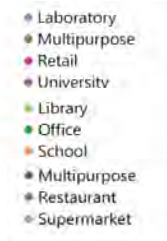
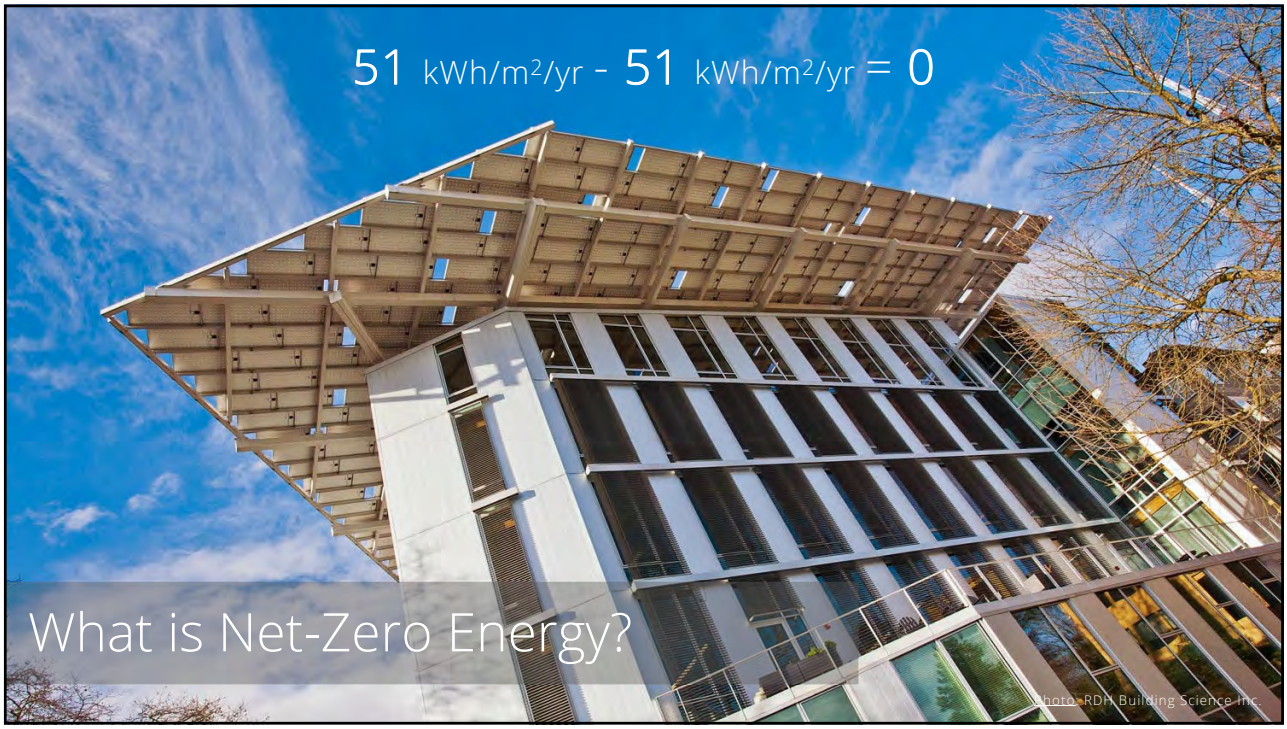


FIGURE 3 | Difference in percentages of measured to predicted energy use of reviewed case studies for different building functions.



----- Line representing Measured (M) = Predicted data (P)

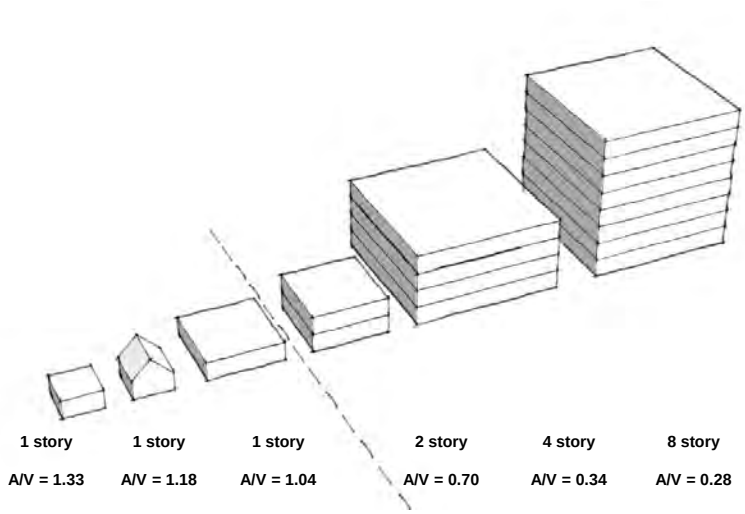
Source: A review of the Energy Performance Gap and its Underlying Causes in Non-Domestic Buildings, Van Dronkelaar et al. 2016



What is Passive House ?

Graph: Passive House Institute

1. Form & Compactness



Photos: Passive House Canada | Maison Passive Canada

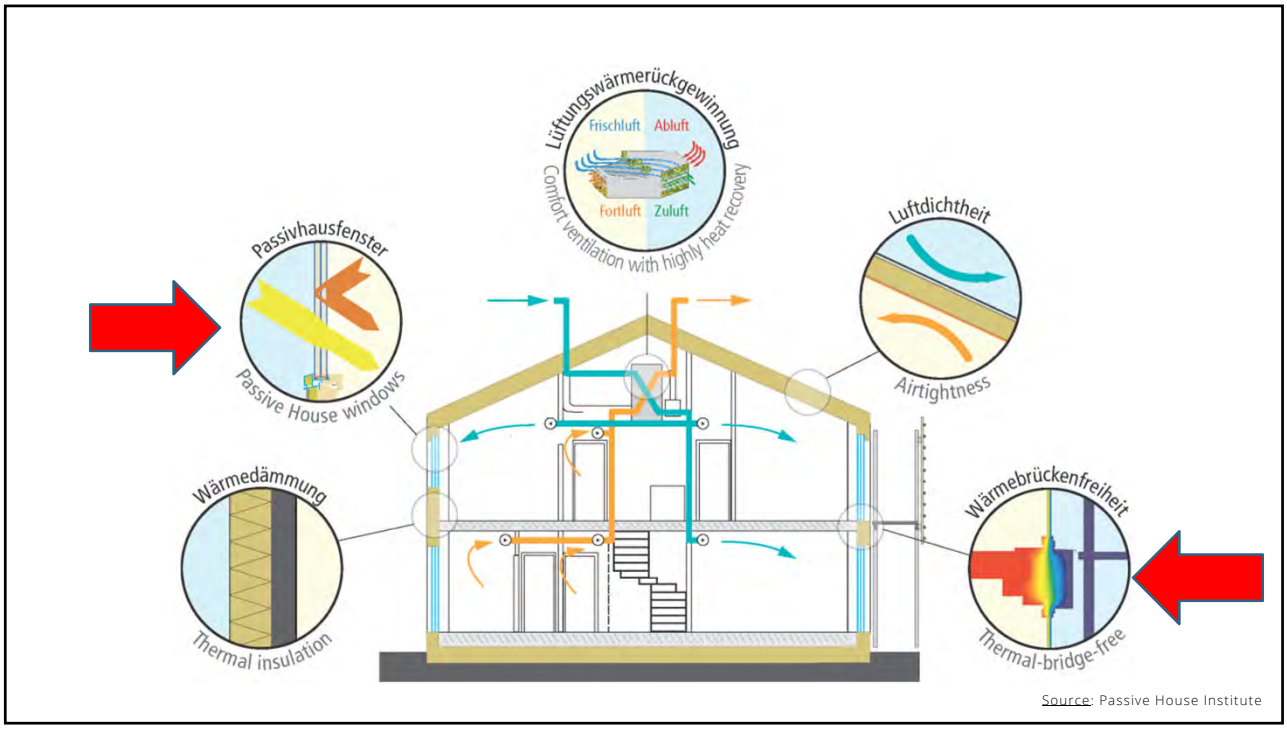
Larger buildings

- Less heat loss area per internal volume
- More compact
- Thinner insulation compared to single-family PH

Typical R-values

- Single-family ~R50 to R55
- MURBs ~R20 to R35

Source: Bjarke Ingels Group

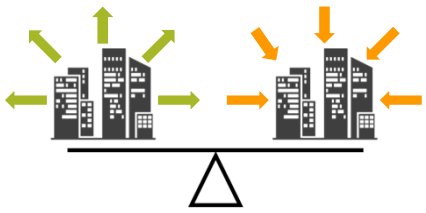


Source: Passive House Institute

Energy Budget

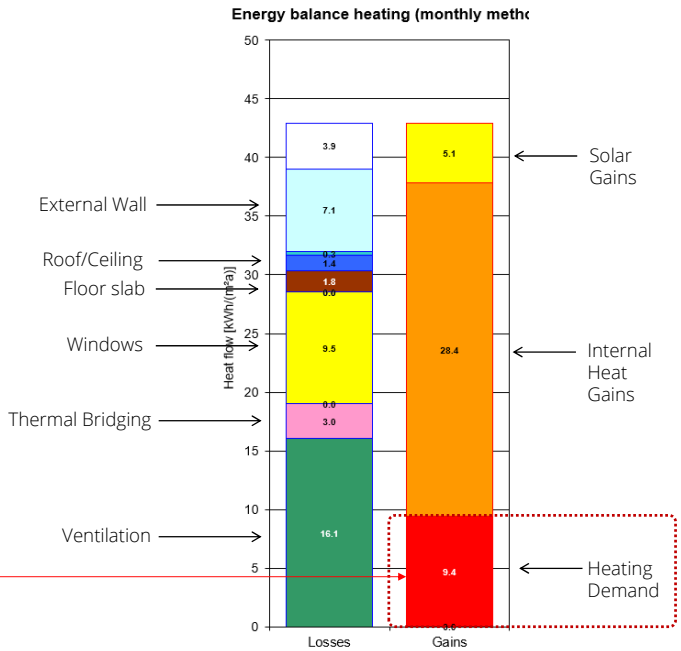
To maintain a comfortable environment:

Σ Heat Loss = Σ Heat Gains



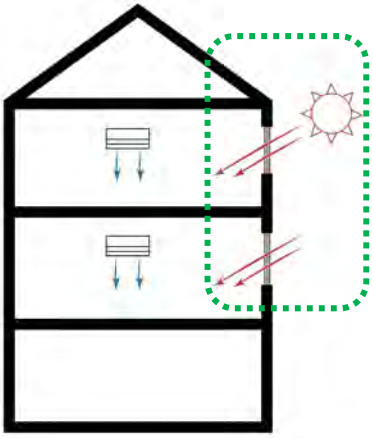
$$TEDI = \frac{\text{Thermal Energy Demand (kWh)}}{\text{Floor Area (m2)}}$$

≤ 15 kWh/m2.yr

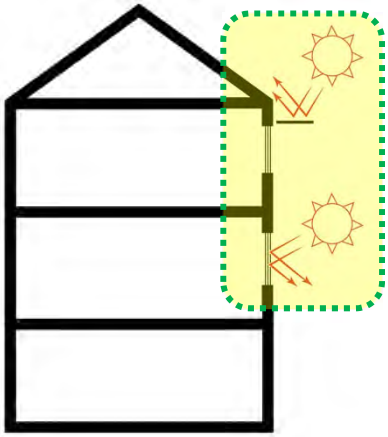


Graph: PHPP Energy Balance – UBC Okanagan PHPP by RDH

Attention to Solar Control & Overheating



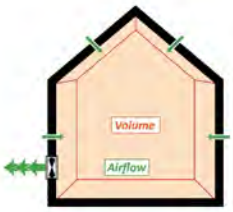
Past – overheating and management of cooling loads managed by air-conditioning

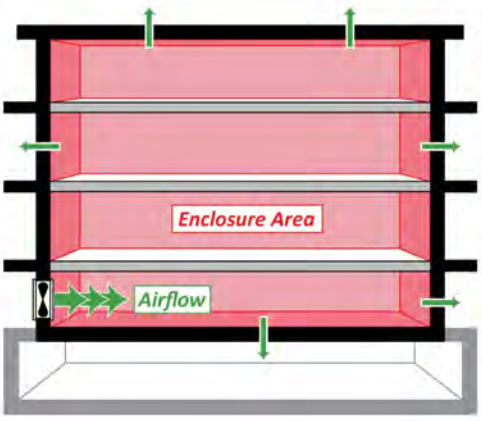


Future – Overheating reviewed & cooling loads minimized by glazing solar control & effective shading. Smaller more efficient cooling when necessary*

15

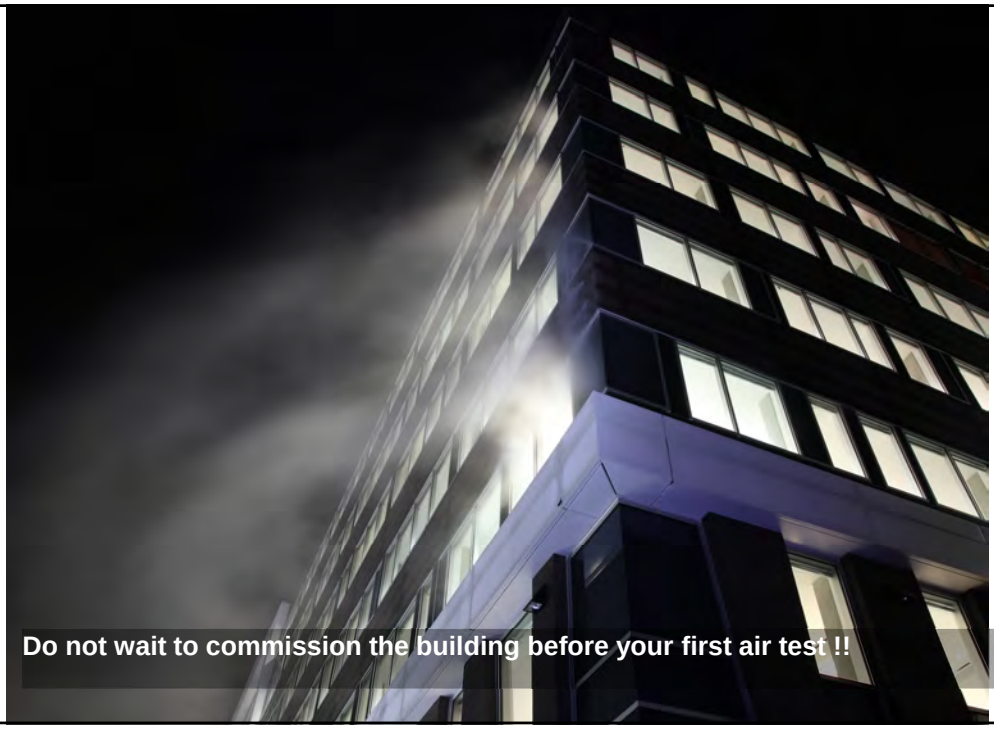
Airtightness Testing for All Buildings



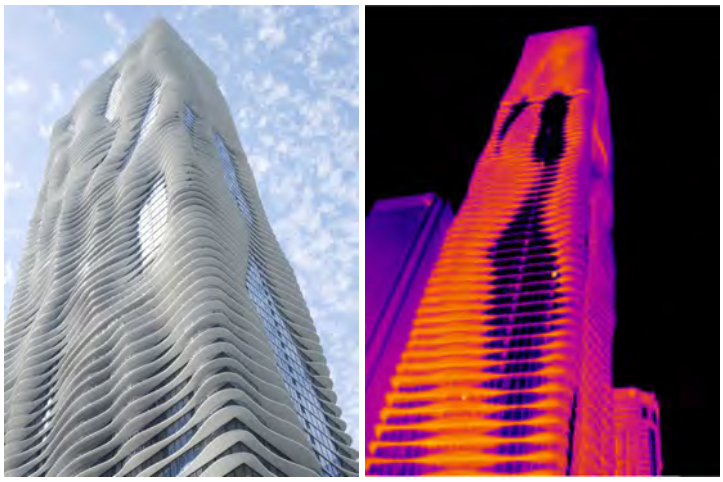


16


Airtightness is easy right ?…

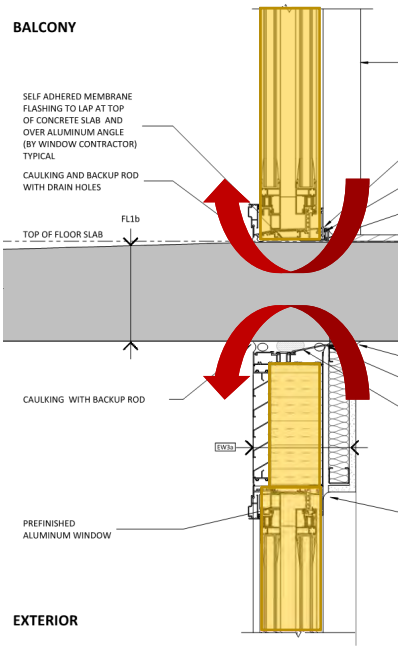

Do not wait to commission the building before your first air test !!

3. Thermal Bridging

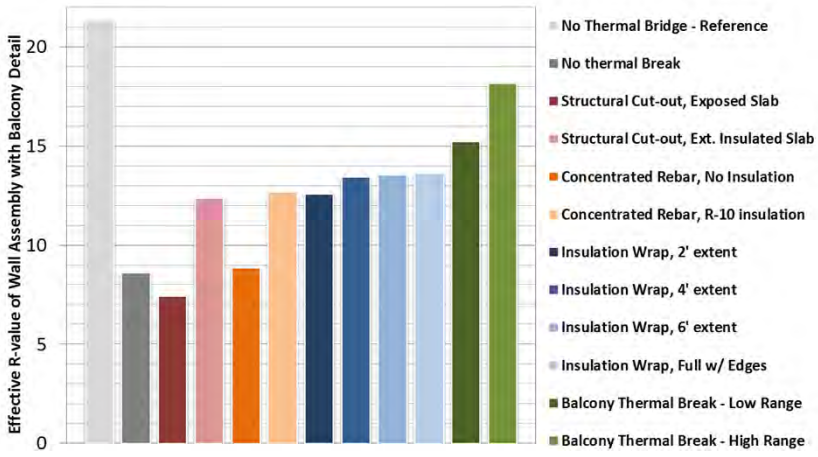


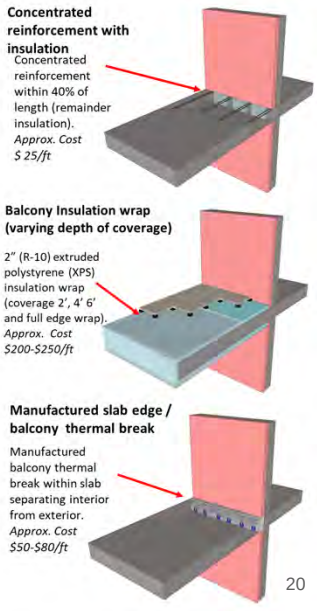
These exposed slab edges would double the TEDI.

Source: Hedrich Blessing



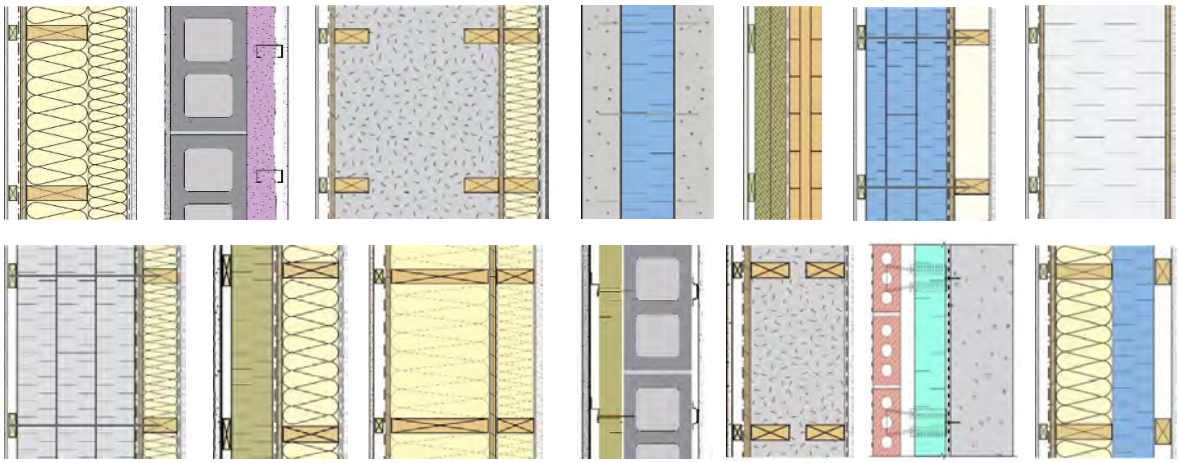
Balcony Thermal Bridging Solutions



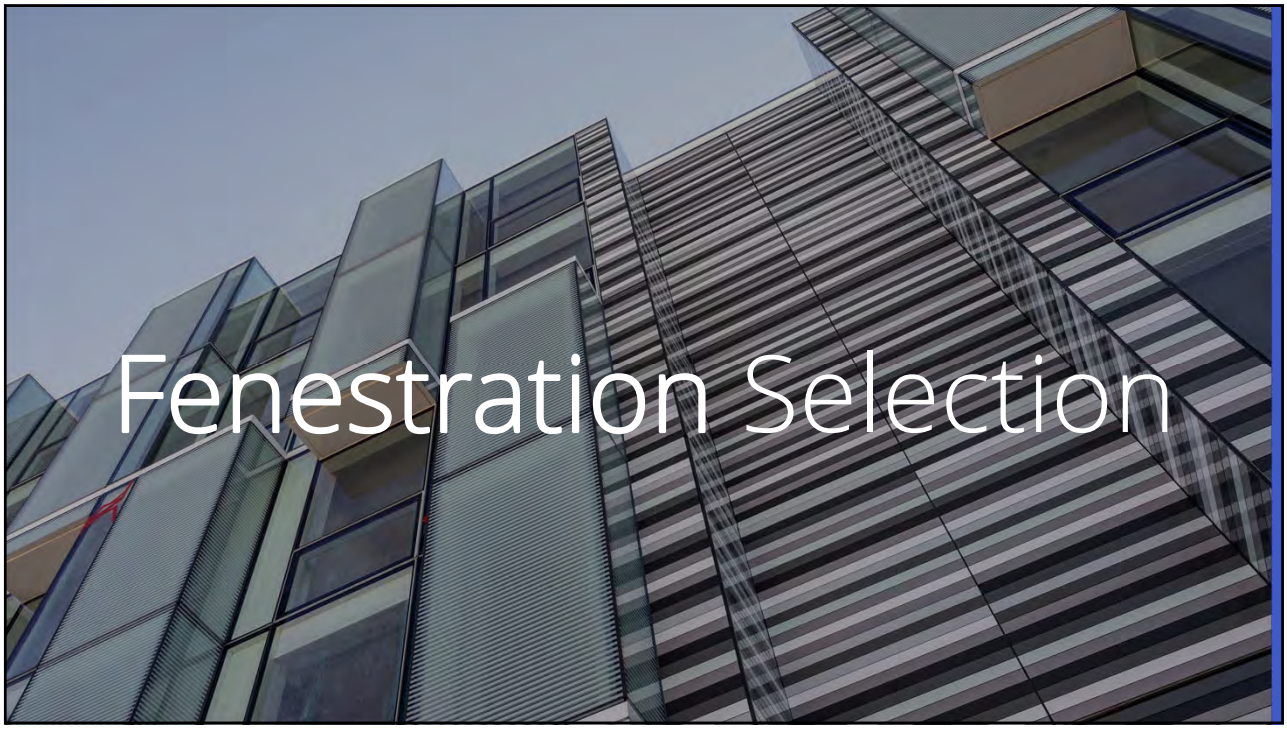


20

2. High-Performance Enclosure



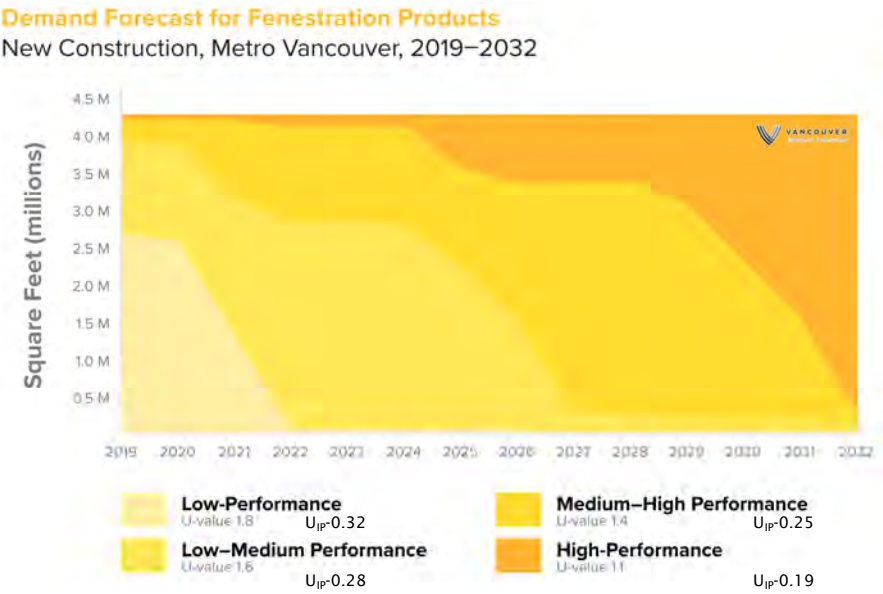
More than one way to get there…



How are Windows Selected when No Prescription is Provided?

- Windows selected significantly influence: TEDI, MEUI, cooling, overheating risk & thermal comfort
- Energy modeling used as tool for selection informed by:
  - Building Type & Occupancy
  - Building Shape & Form factor
  - Climate
  - Window to Wall Ratio
  - Available Products, Cost
  - **Technical Specs (U-value, SHGC..)**
  - Other requirements

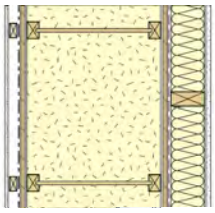
23



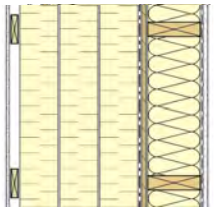
Green Buildings Market Forecast – Vancouver Economic Commission

Increasing Wall Insulation Levels with Step Code

Deep/Double Stud

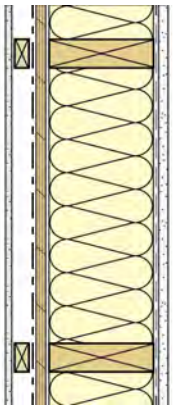


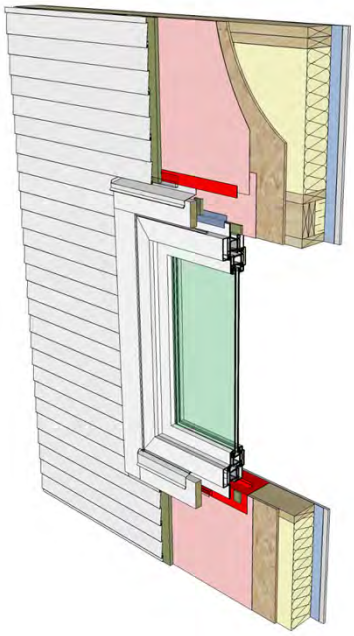
Exterior Insulated



26

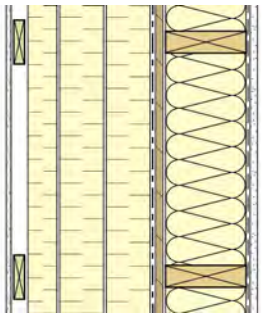
Current 2x6 Wood Frame

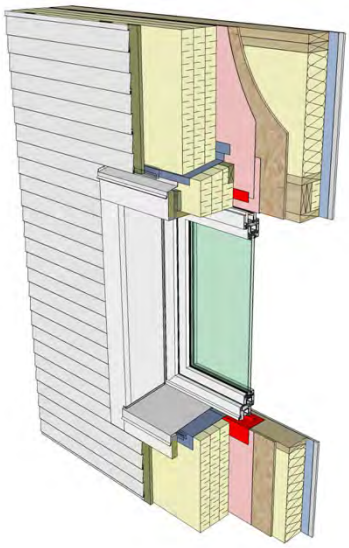




27

Split Insulated Wall – Thick Exterior Insulation





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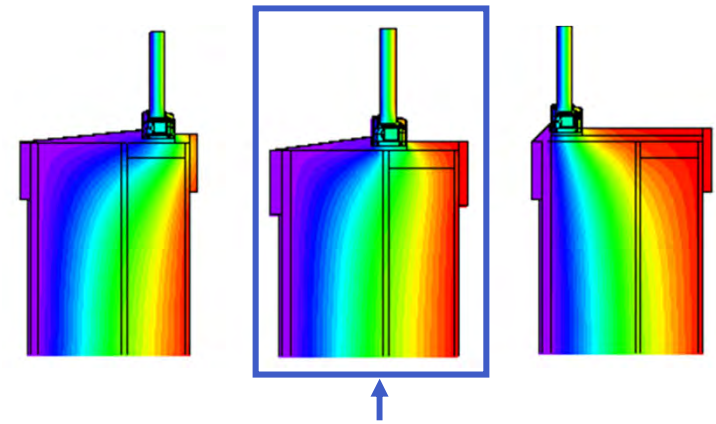
Deep Wall Window Installation Considerations

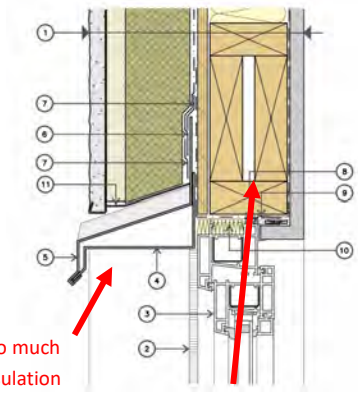
Optimal Placement of Windows in Rough Openings



Optimal placement aligns window with insulation… to a point

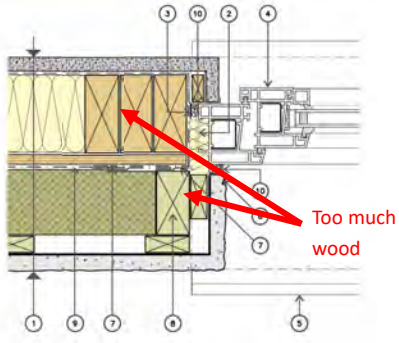
30

Installation Perimeter Flanking Losses Matter a LOT



Too much insulation displaced & too large of metal flashing & leg

Too much wood



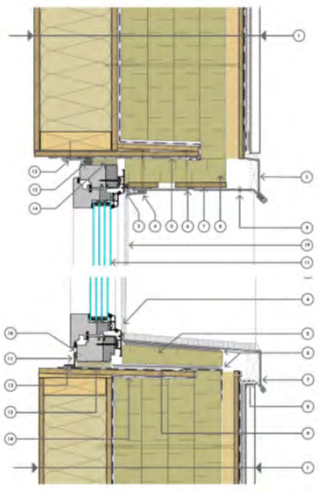
Too much wood

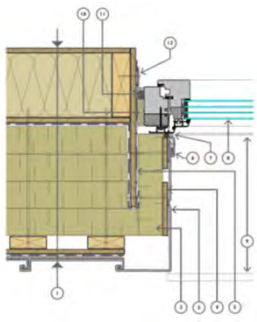
Key considerations:

- **Avoid metal flashings that bypass framing or insulation (especially placement of metal pan flashings at sill)**
- **Reduce wood framing around window**
- **Over-insulate the window frames where feasible**

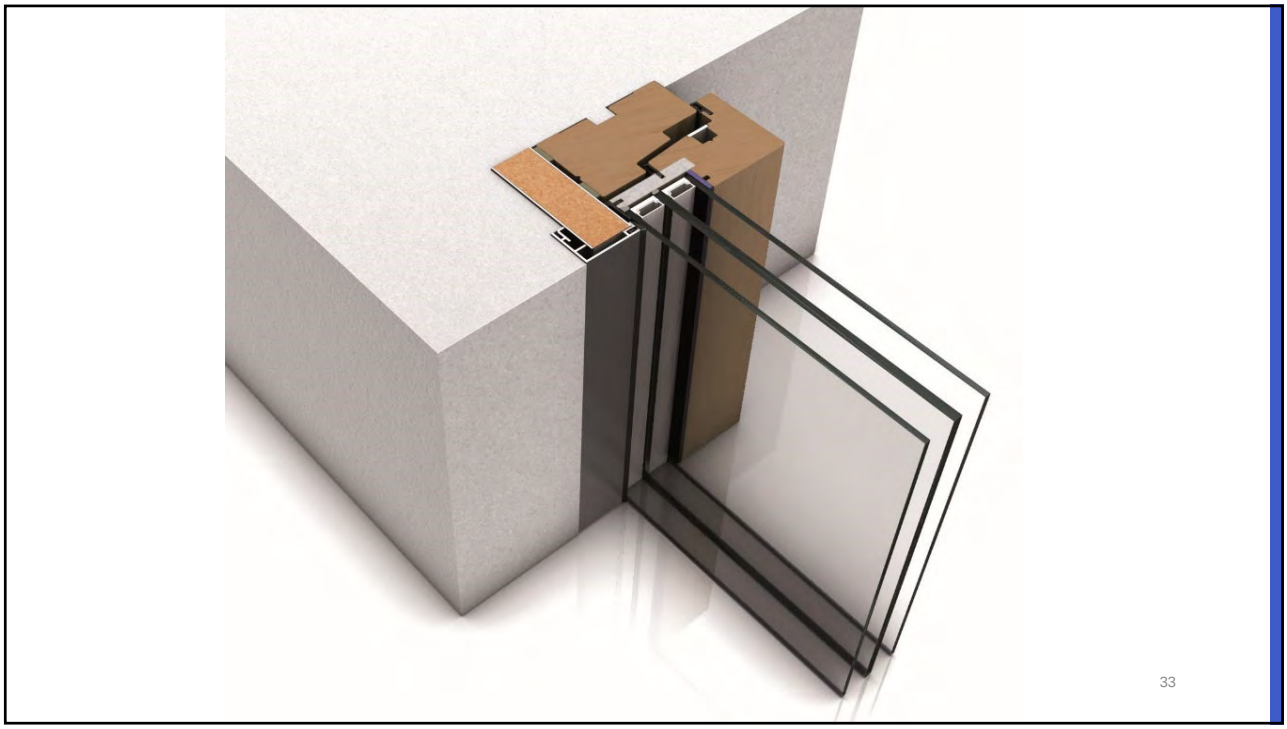
31

Quad Window Overinsulated in R60+ Wall



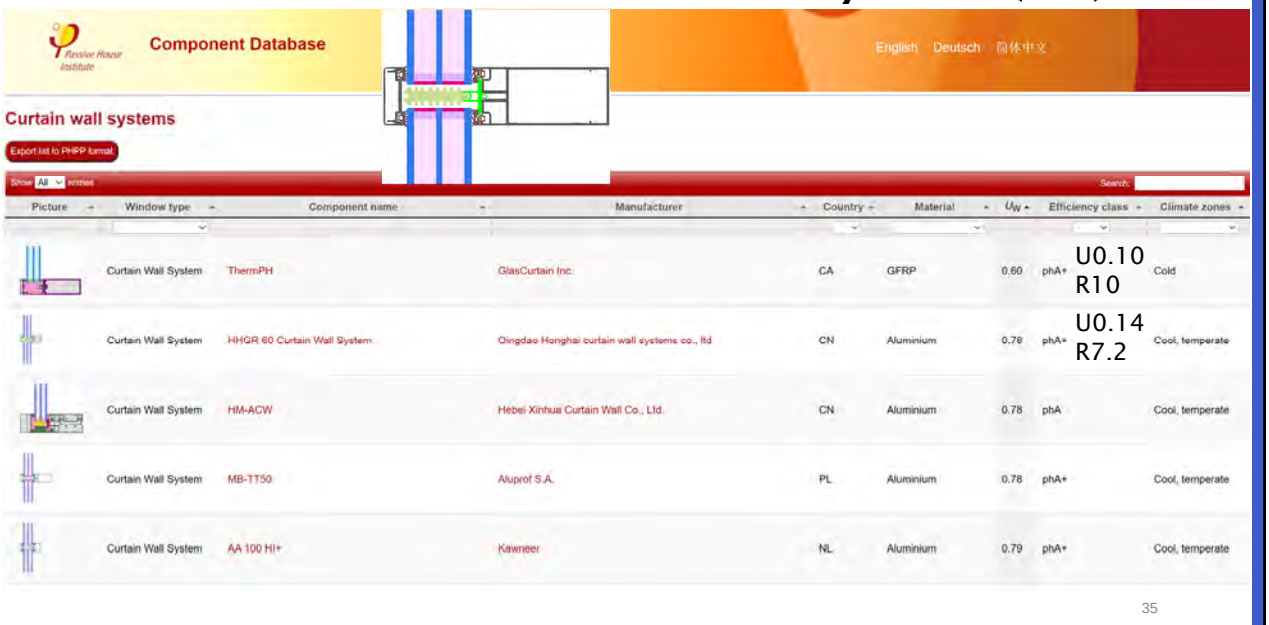


32


33


Curtain Wall

4 Best Passive House Curtain Wall Systems (Uw)



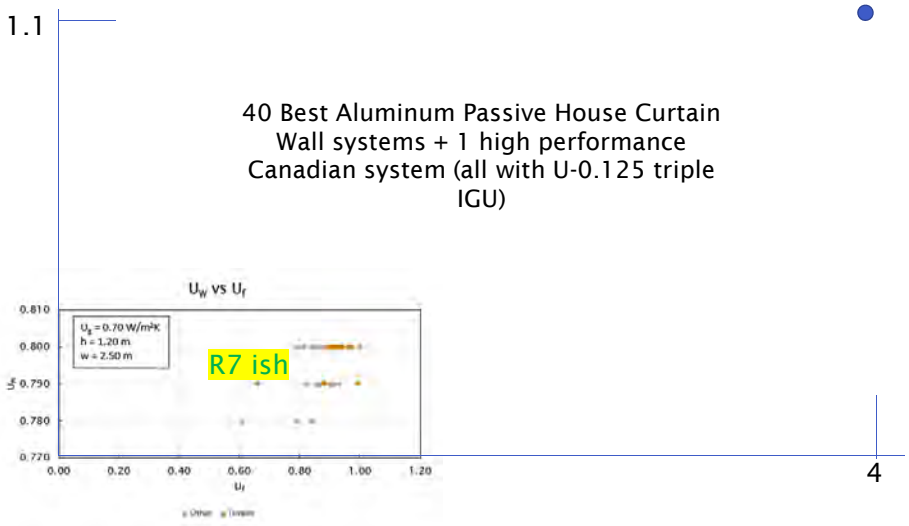
U0.10
R10

U0.14
R7.2

35

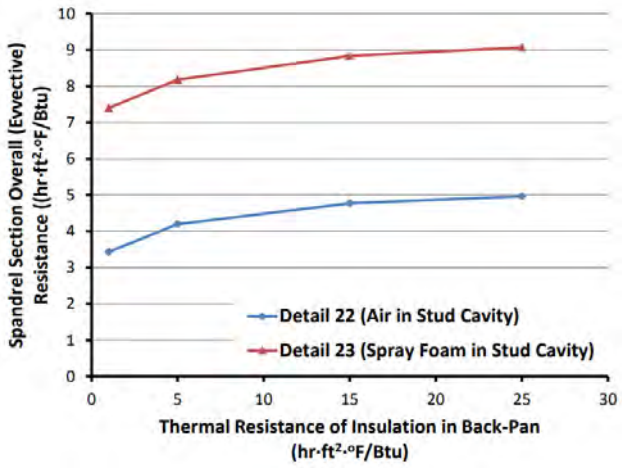
Just Make the Frames Better? U-window vs. U-frame

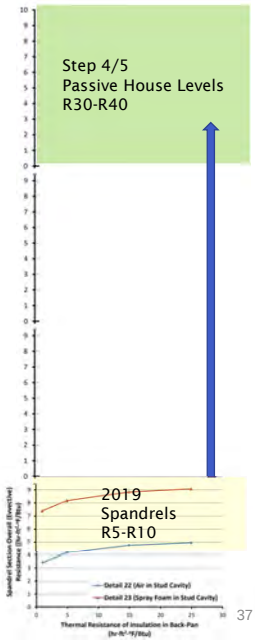
R5 ish



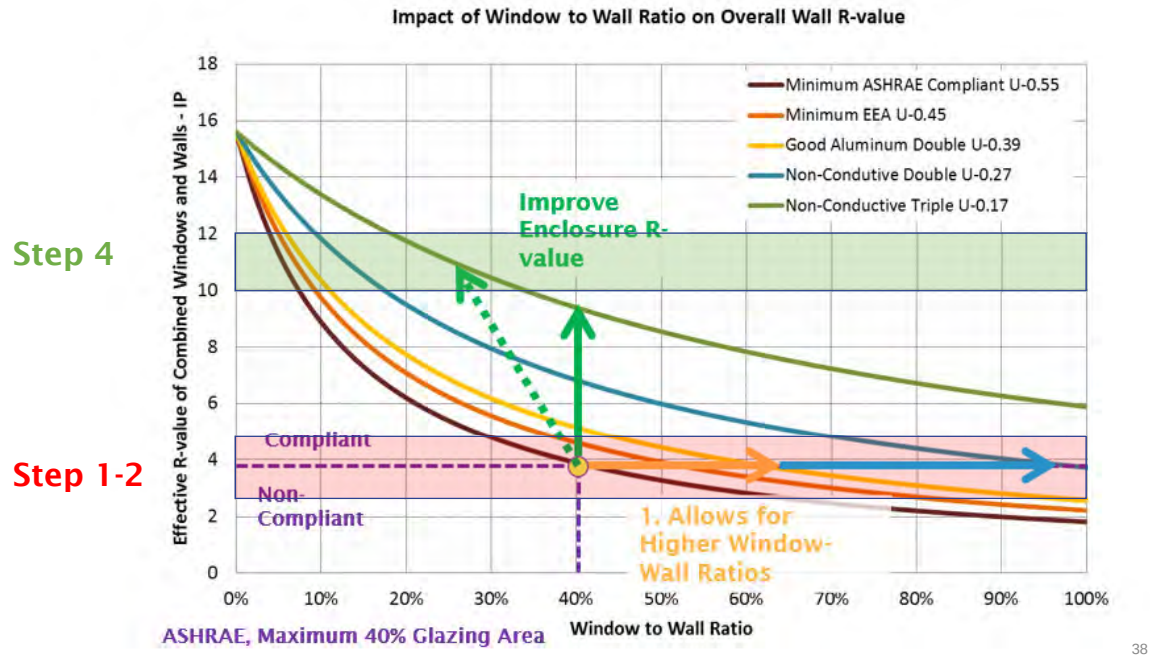
36

Can't we just add more insulation to the backpans?



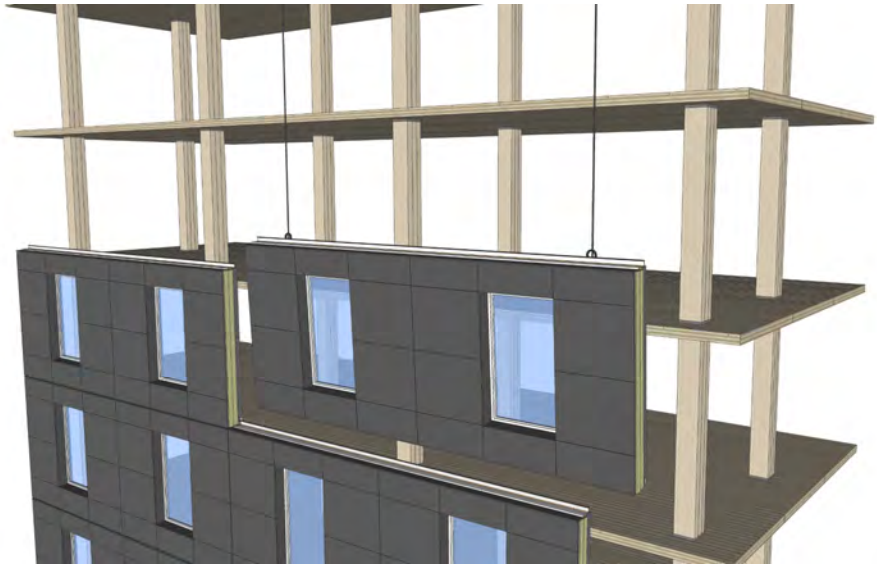


37



38

Unitized Curtain Wall – Circa 2032

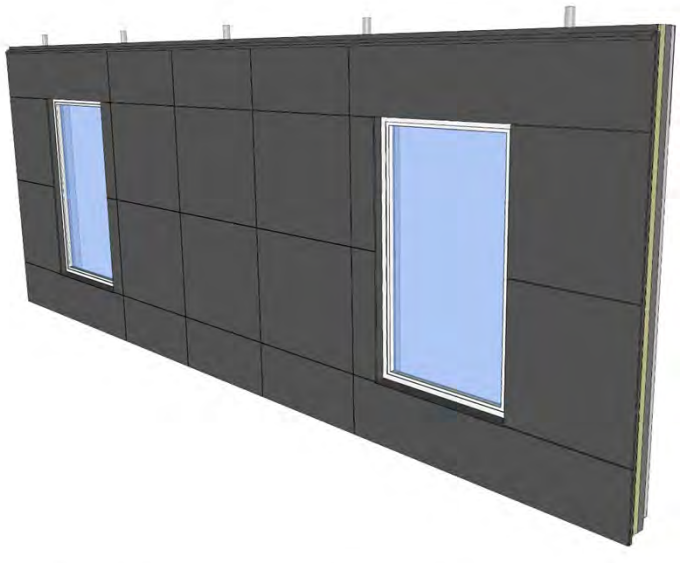


39

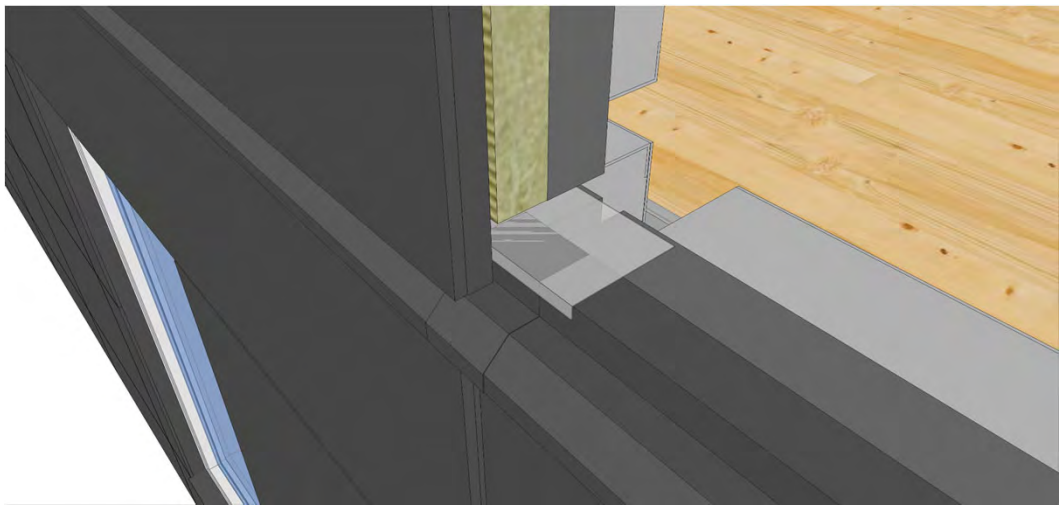
40

Types of Panelized Systems – Steel Stud

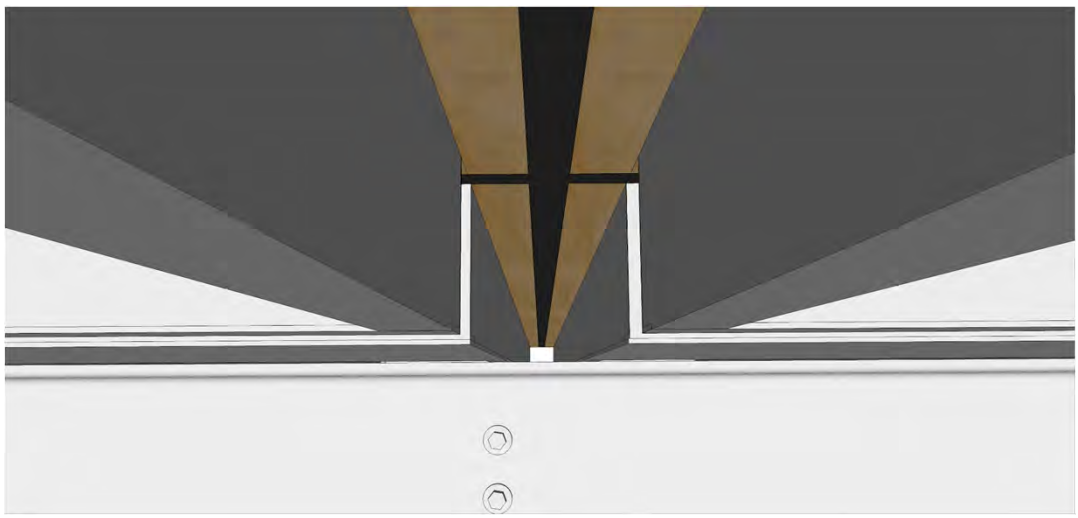
41



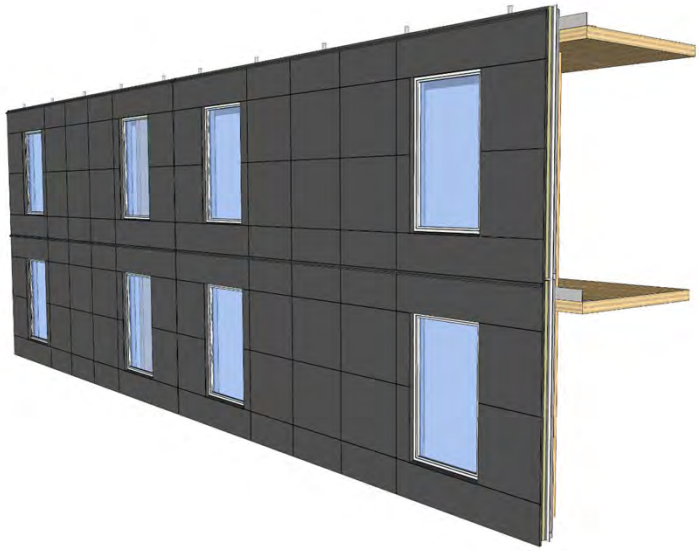
42



43



44



45

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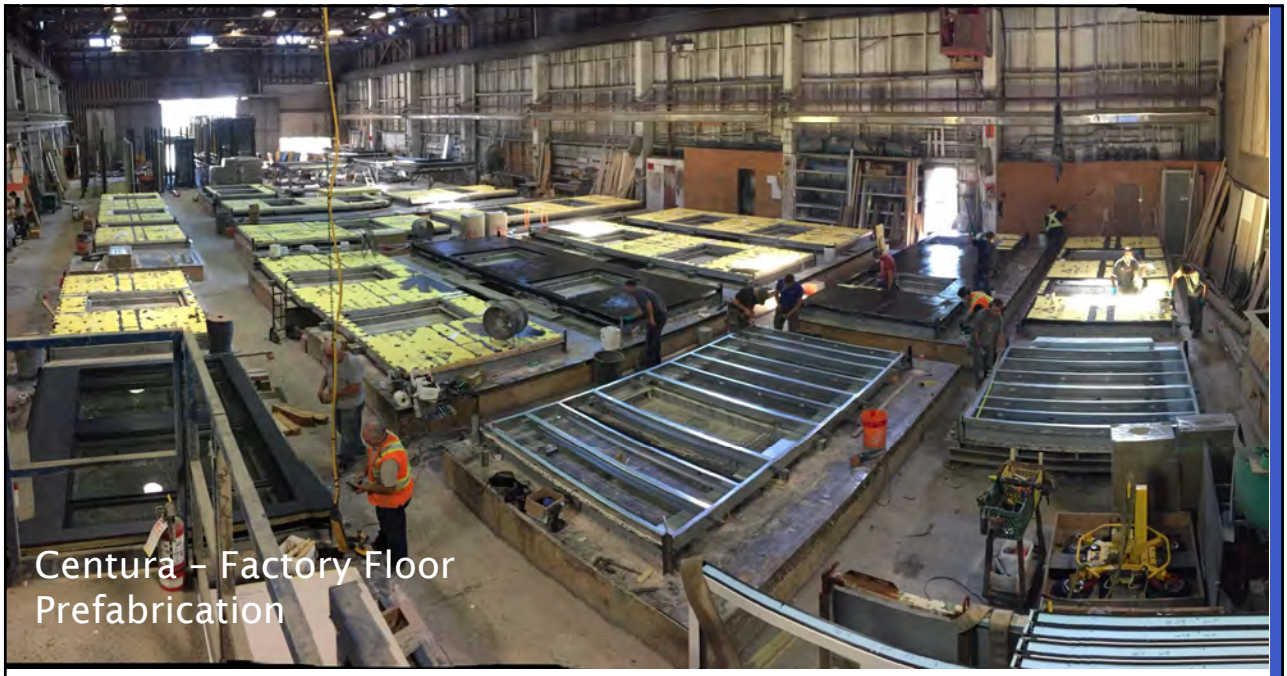


Centura – Factory Floor Prefabrication

47

Site Installation – at Pace with Structure – 1 floor/day

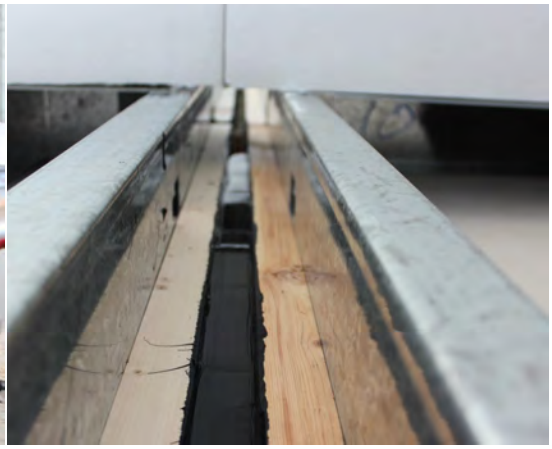
48

49

Site Installation and Sealing

50

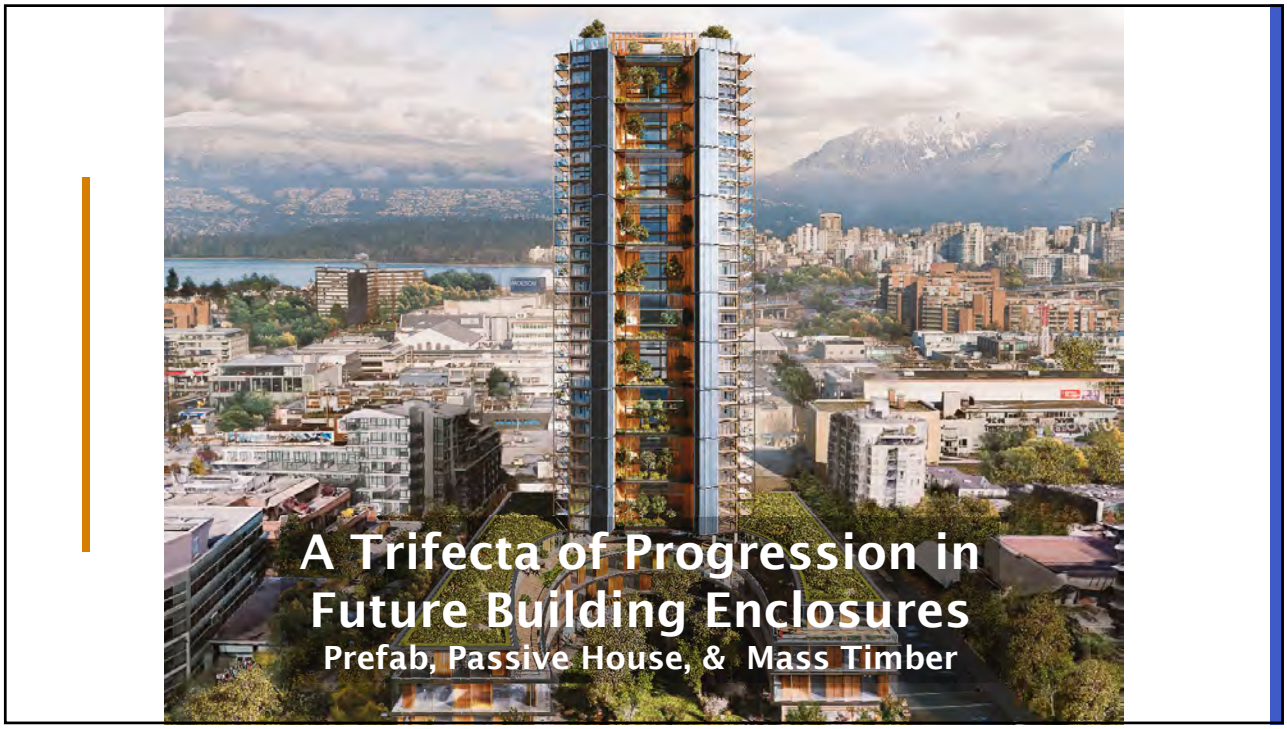
Site Installation and Sealing Considerations



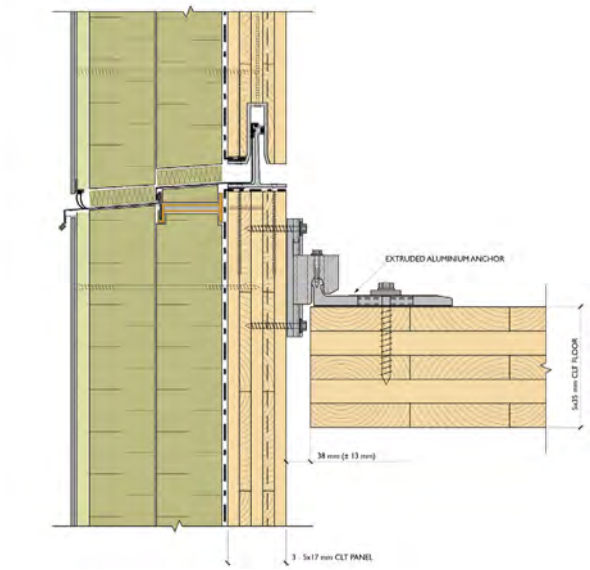
51

52


WEEK: 1
TIMELAPSE
UBC
BROCK COMMONS
WOOD
CONSTRUCTION
STARTS
JUNE/6
WOOD
53


A Trifecta of Progression in Future Building Enclosures
Prefab, Passive House, & Mass Timber

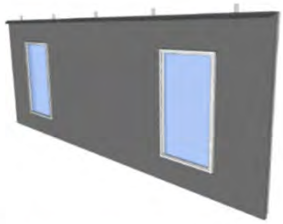
Where Next? “Curtainwood” for Tall Buildings



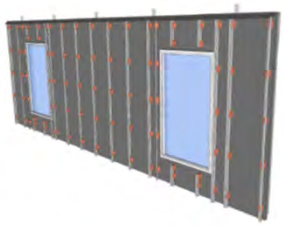
CLT Panel Fabrication Process

1 Mass timber back-up wall structure. 3 or 5-ply CLT.

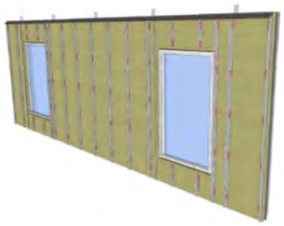
2 Vapour permeable and WRB. Multiple products available but self-adhered membrane recommended for ease of install.



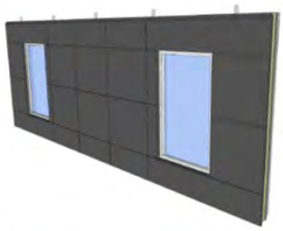
3 Punched windows installed to specifications. Step is omitted if curtain or window walls are specified.



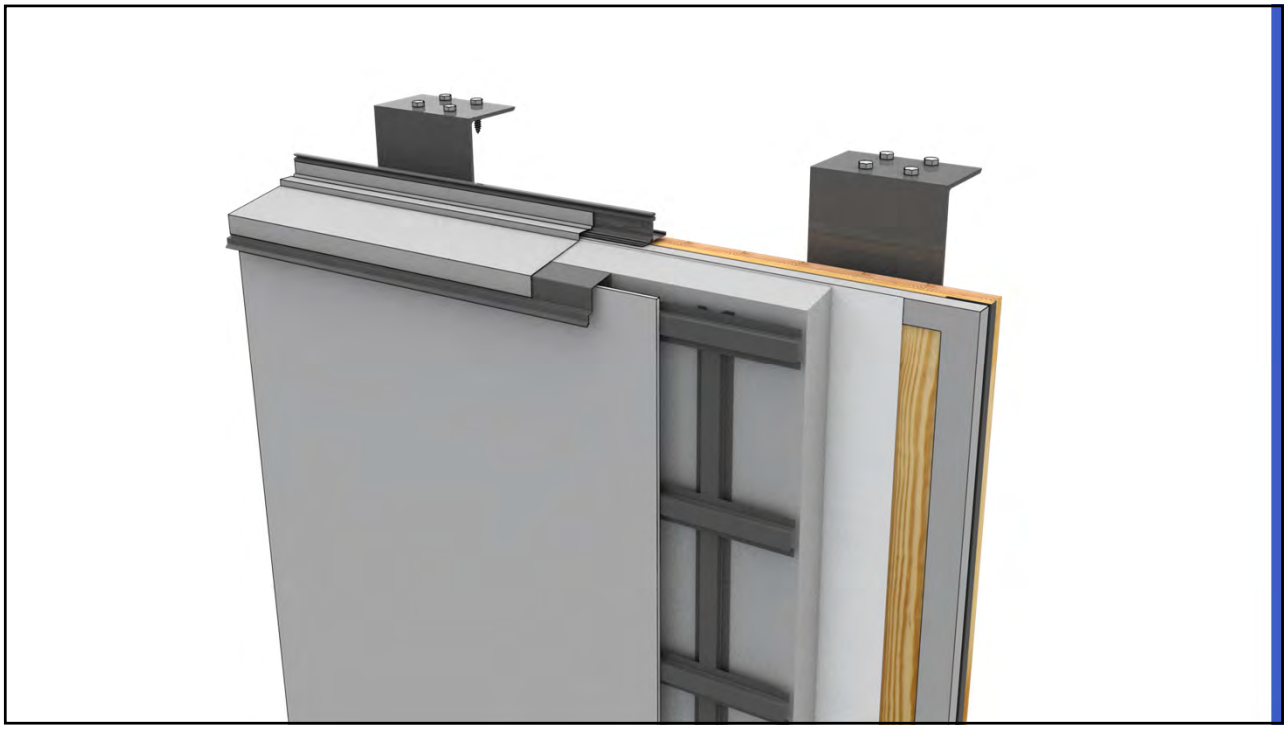
4 Thermal clip and rail cladding attachment. Cheaper option to install hat tracks or Z-girts pinned through insulation with long screws. Cladding is to include an exterior air gap for rainscreen cavity.



5 Exterior mineral insulation of required thickness.



6 WSS. Cladding of choice must be durable as it experiences frequent wetting and drying cycles. Flashing detail is critical where panels join.



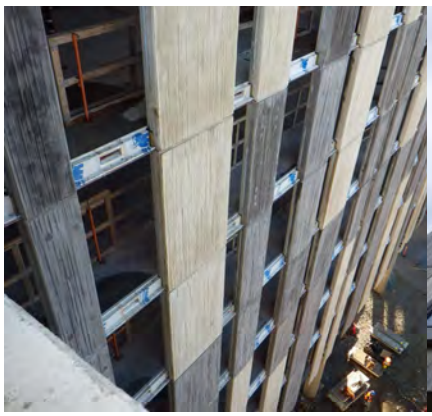
Prefabricated Passive House CLT Wall Panels

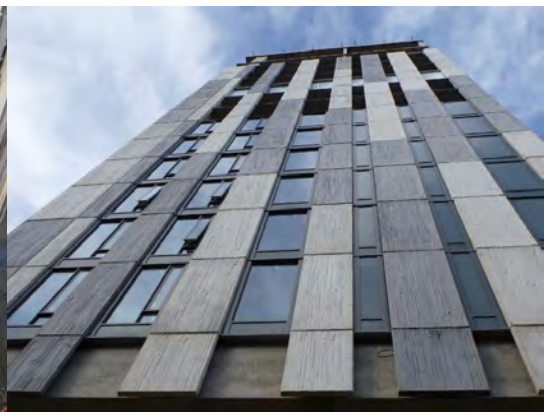
59

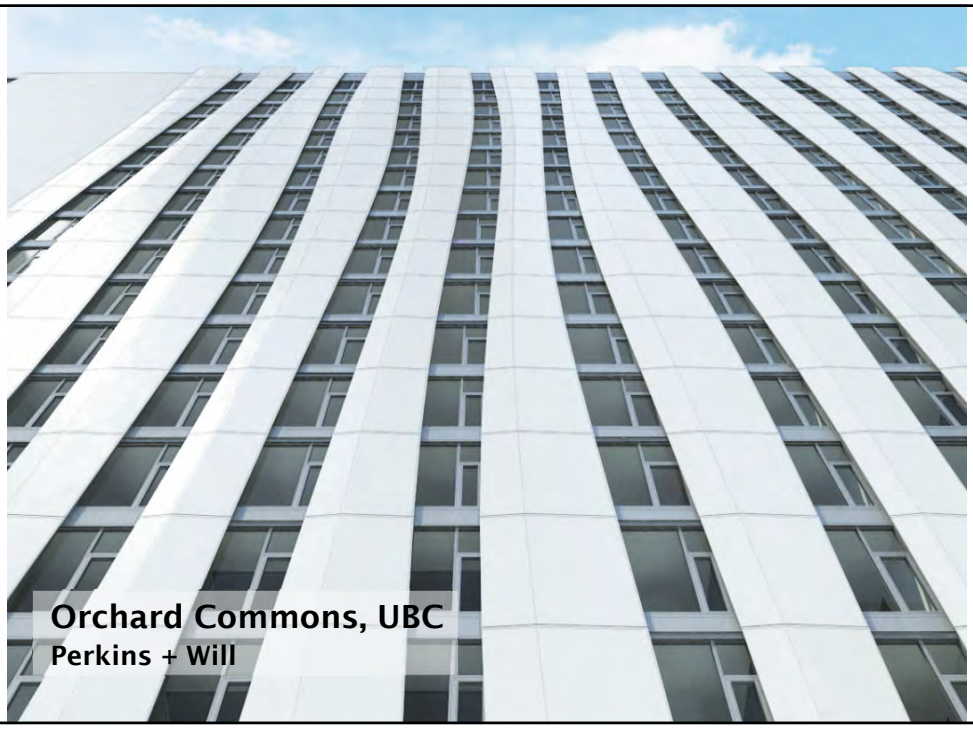
Design team led by Achim Charisius at GBL Architects for Vancouver Native Housing Society.

60

Highly Insulated Precast Panelized Enclosures

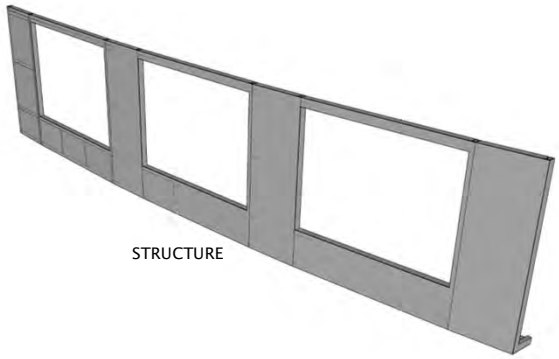






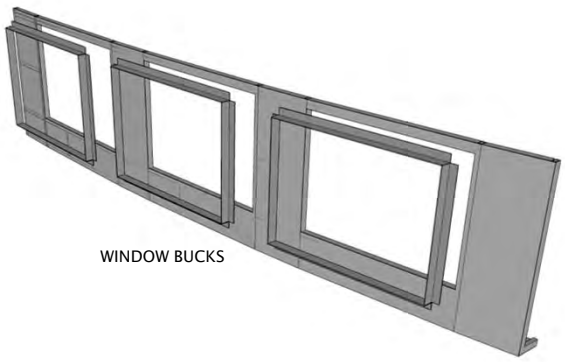

1075 Nelson
WKK Architecture
Tallest Passive House in the World!


→ ~60-storeys tall
→ Balconies
→ Target 50% WWR
→ Pool amenity space
→ Passive House
→ Architectural significance



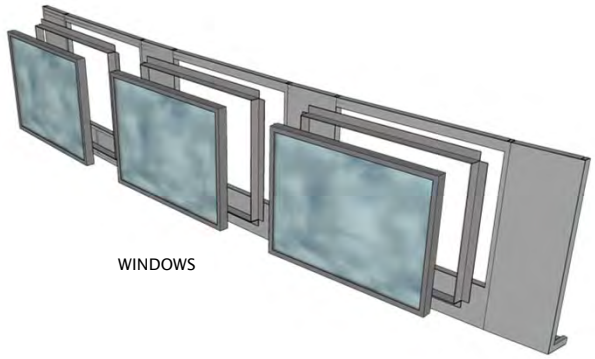
STRUCTURE

65



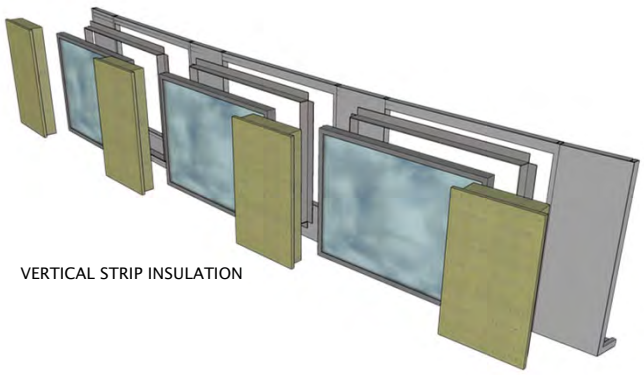
WINDOW BUCKS

66



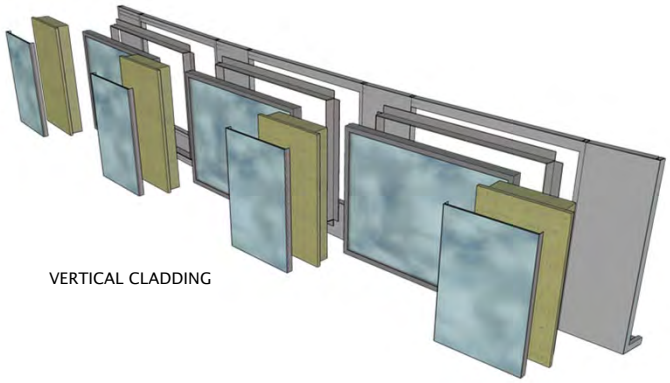
WINDOWS

67



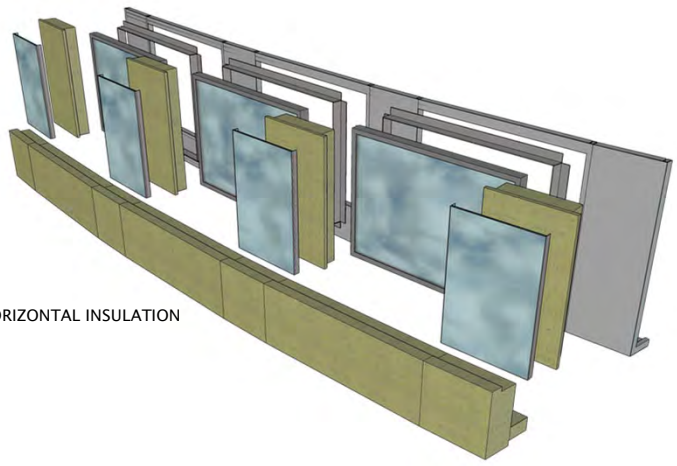
VERTICAL STRIP INSULATION

68



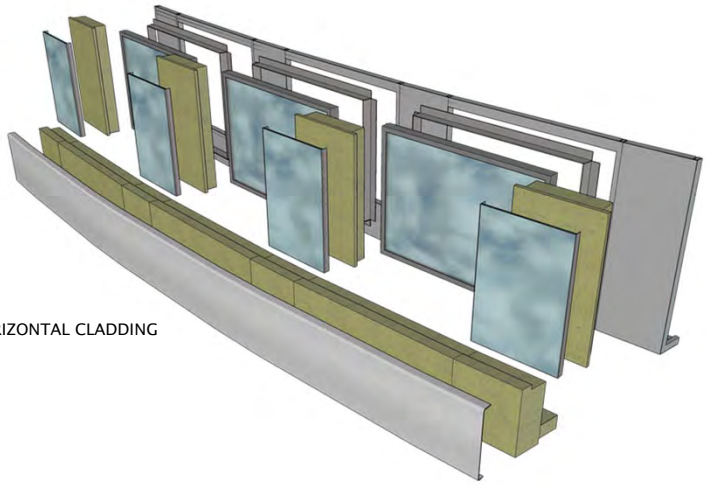
VERTICAL CLADDING

69



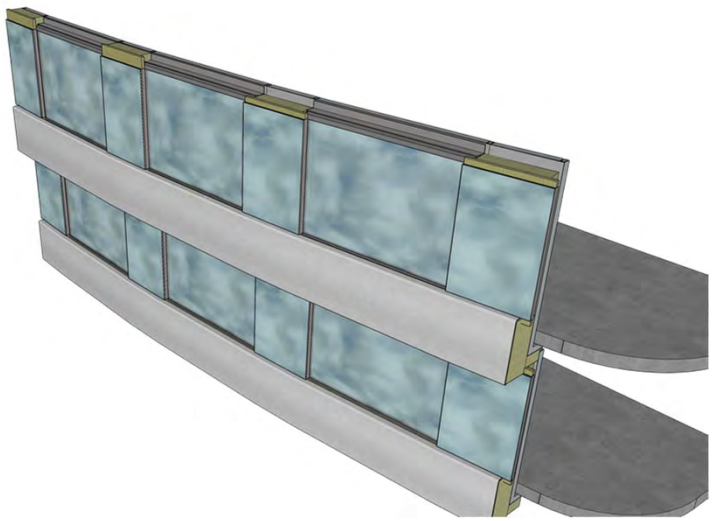
HORIZONTAL INSULATION

70



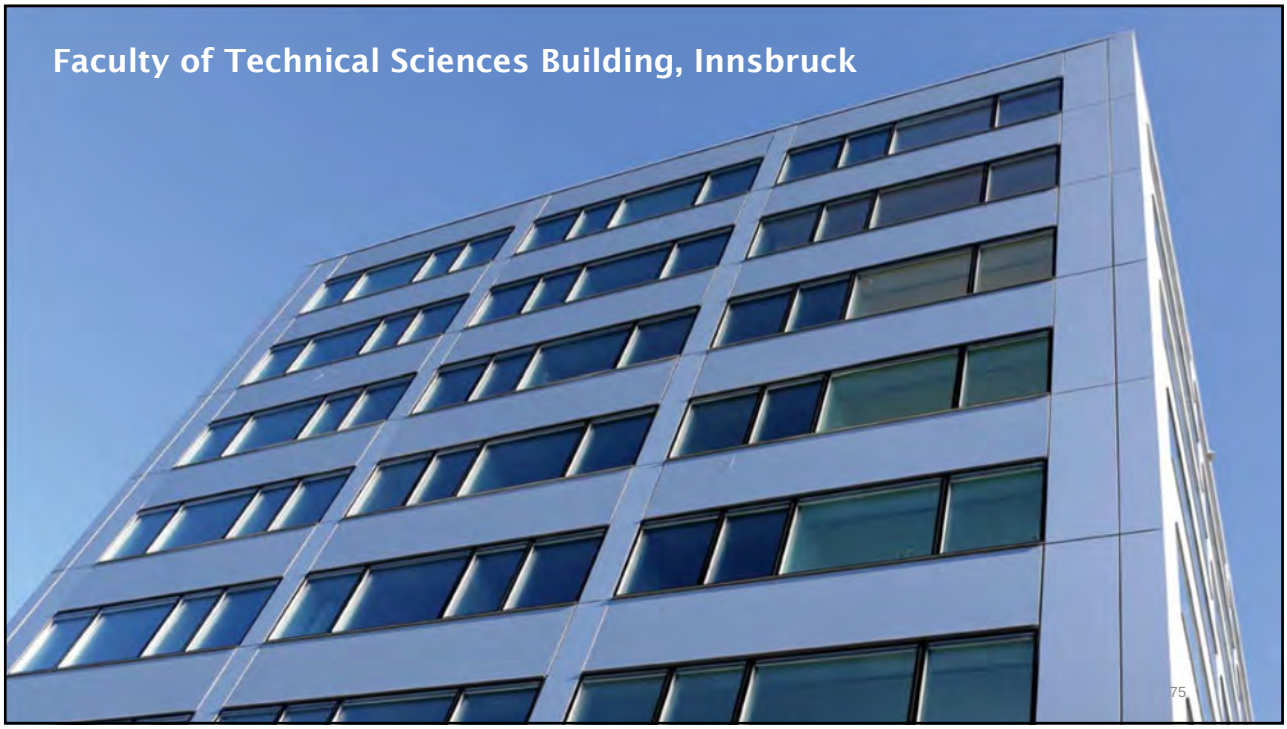
HORIZONTAL CLADDING

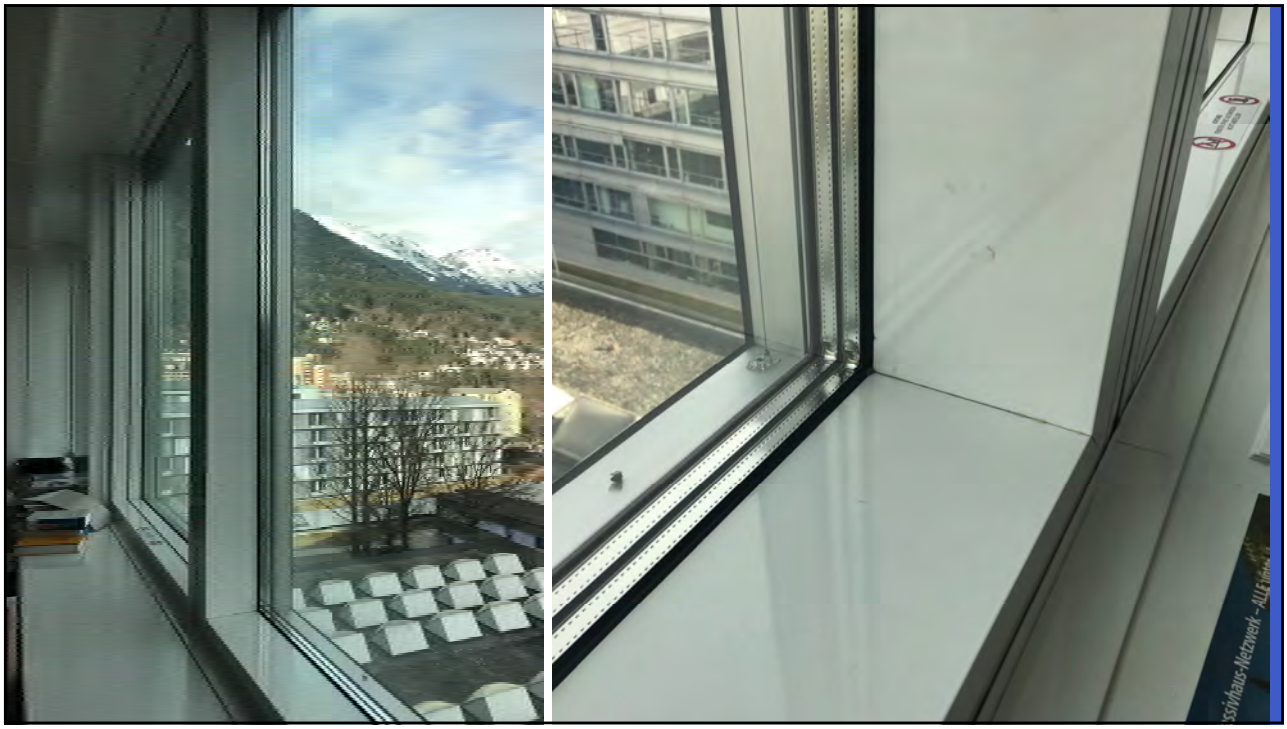
71



72


Highrise Passive House/Net Zero Façade Patterns


Faculty of Technical Sciences Building, Innsbruck
75



Schuco AWS 120

77


Project: Boyen Street Zero-Emission Building, Berlin.
Photos: Svea Pietschmann & Andrea Kroth

RHW Bank Tower 2

- Vienna, Austria
- Completion in 2012
- 21 stories
- ARGE Atelier Hayde Architekten
- Office building
- TFA ~ 21,000 m2
- Overall effective façade R-value ~ R-10

RHW Bank Tower 2

Walls

- Spandrel panels ~ R-15 effective
- Double façade system
  - » Ventilation air within cavity
  - » Double pane
  - » Values ranging R-3 to R-9
- Conditioned cavity
- Shading in cavity

Ventilation

- Centralised ventilation

RHW Bank Tower 2

Costs

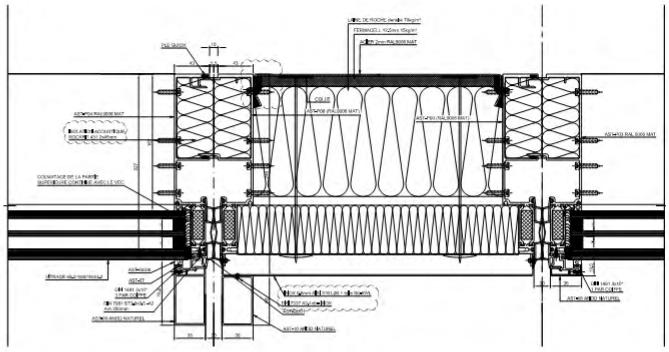
- CAD $148 million
- CAD $4.8 million cost premium ~ 3%
- 14-year payback

PHPP Values

- Annual Heating Demand: 14 kWh/m^2.year < 15
- Primary Energy: 117 kWh/m^2.year < 120

Astro Tower

- Brussels, Belgium
- 1974, Refurbishment in 2013-2015
- 33 stories
- Altiplan Architects, Estudio Lamela
- Commercial Office
- TFA ~ 35,000 m2



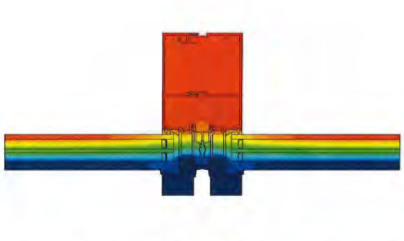
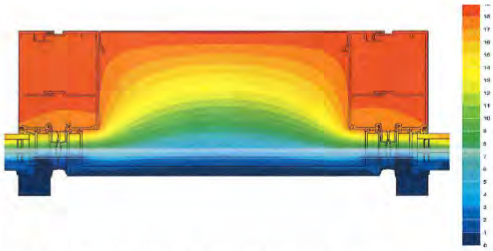
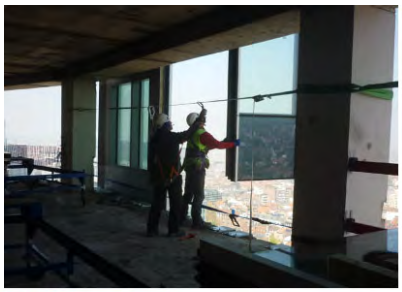


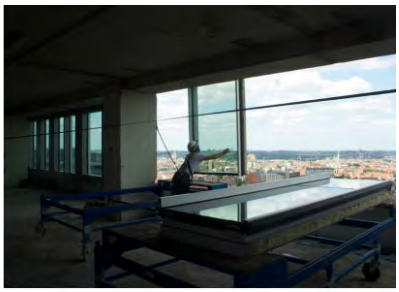
Figure 4 - Coupe 1: modèle géométrique, matériaux & distribution de la température (température intérieure 20°C, extérieure 0°C).



ure 5 - Coupe 2: modèle géométrique, matériaux & distribution de la température (température intér 20°C, extérieure 0°C).

87





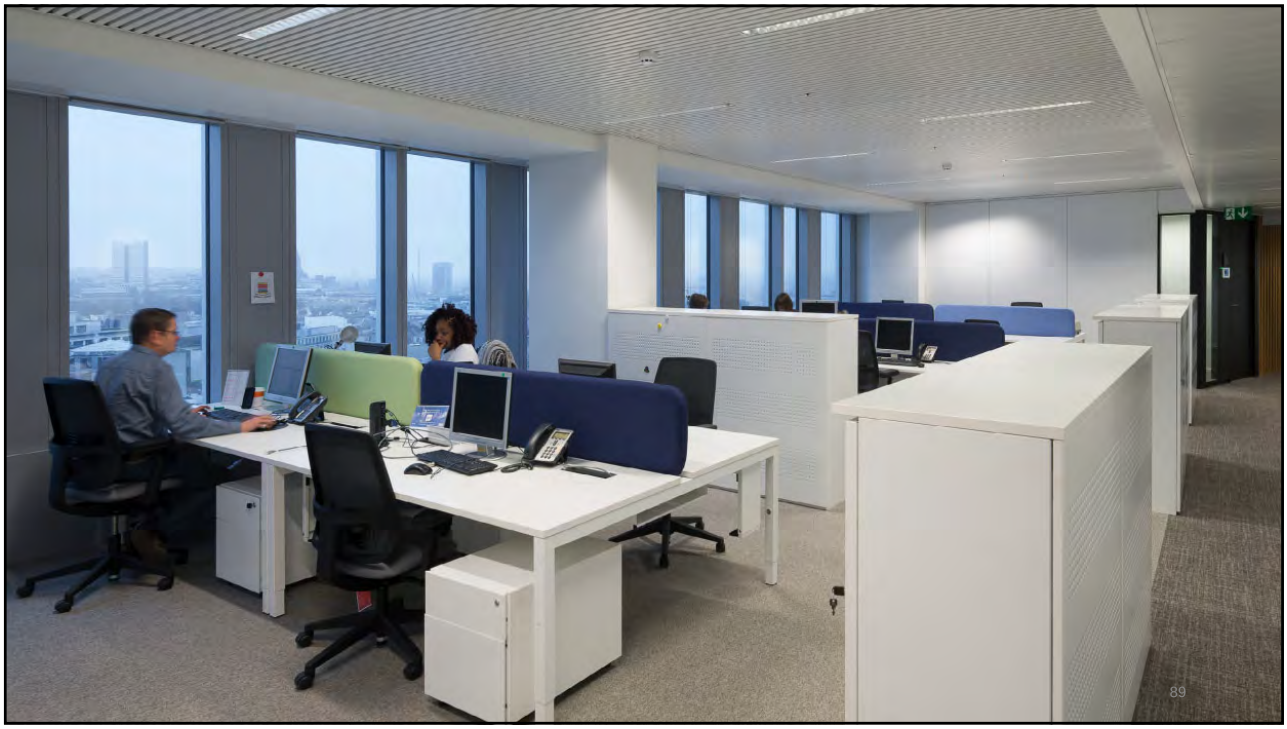
Window-To-Wall Ratio

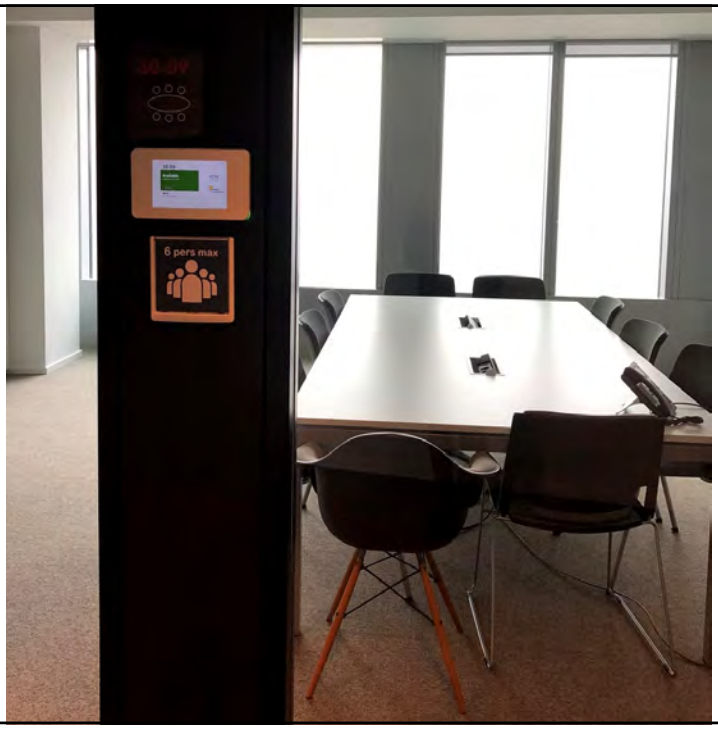
- <45% Window-to-Wall Ratio
- Windows U-0.17

PHPP Values

- Annual Heating Demand reduced from 170 to 15 kWh/m^2.year

88

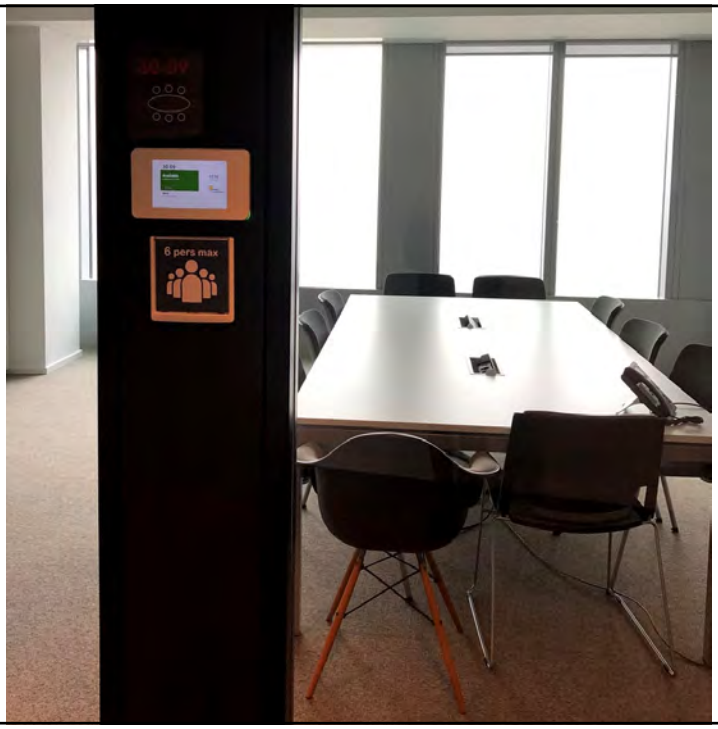




Problem
Ventilation insufficient
No operable windows

Remediation
Limits on occupancy
Turnstiles at entries
Evacuation protocols

90



Q1: What circumstances might have tempted the design team into creating this problem?

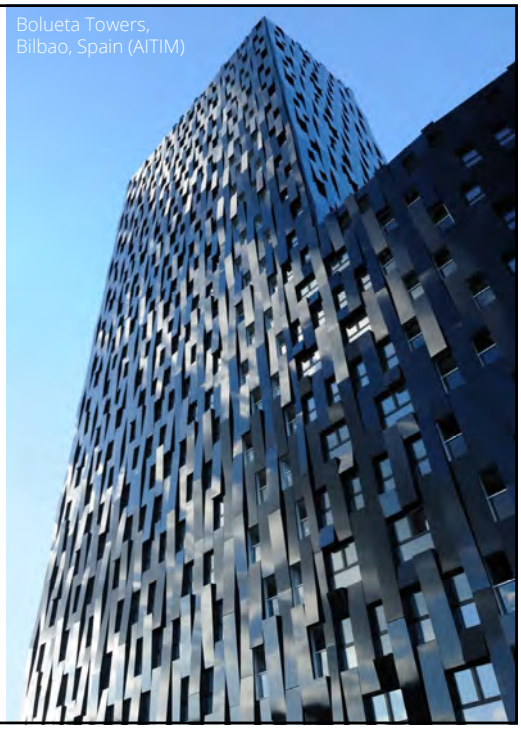
A1: Ventilation is a leading source of heat loss. Its tempting to lower ventilation rates in order to achieve 15 kWh/m²a

Never compromise comfort or safety to achieve a target.

91

Bolueta

- Bilbao, Spain
- Completion in 2017
- 28 stories
- Varquitectos
- Social Housing (361 apartments)
- TFA ~ 27,500 m2


Bolueta Towers,
Bilbao, Spain (AITIM)

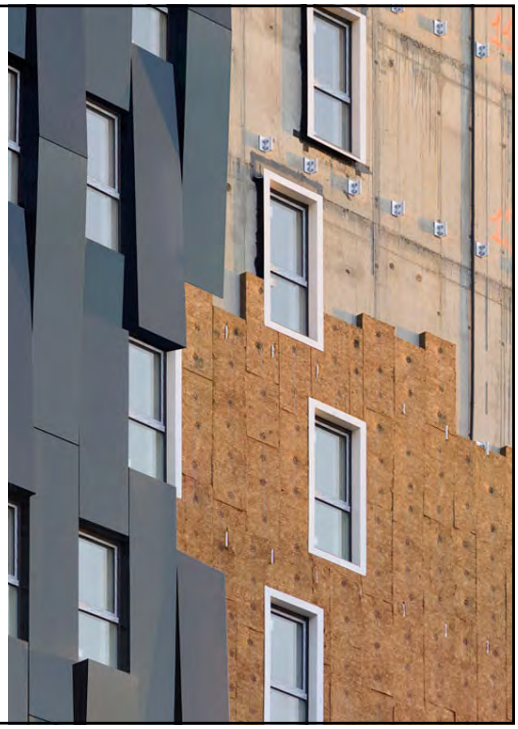
Bolueta

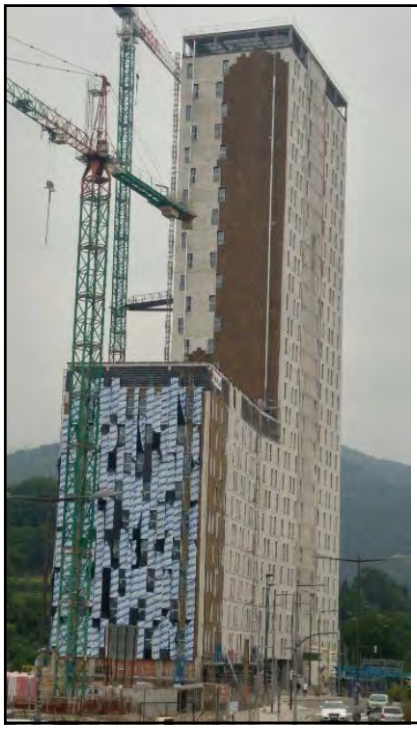
Components

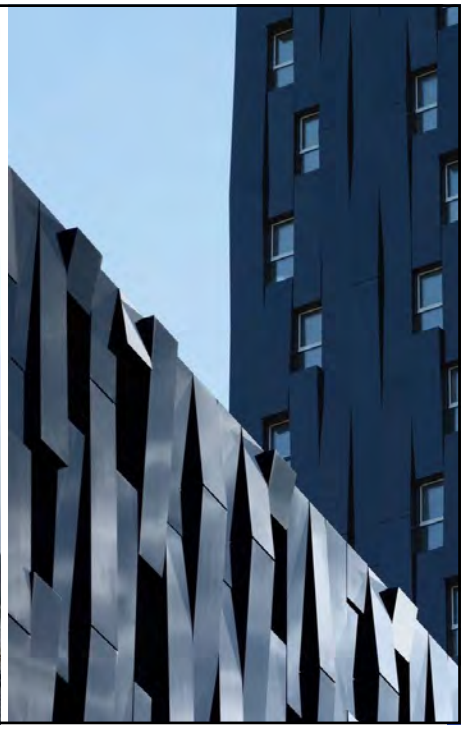
- Walls R-26
  Concrete/CMU structure with external (100mm) and internal (50mm) insulation
- Roof R-27
- Floor R-27
- Operable punch windows (triple pane U-0.15)
- Affordable:180,000 euros for a unit !

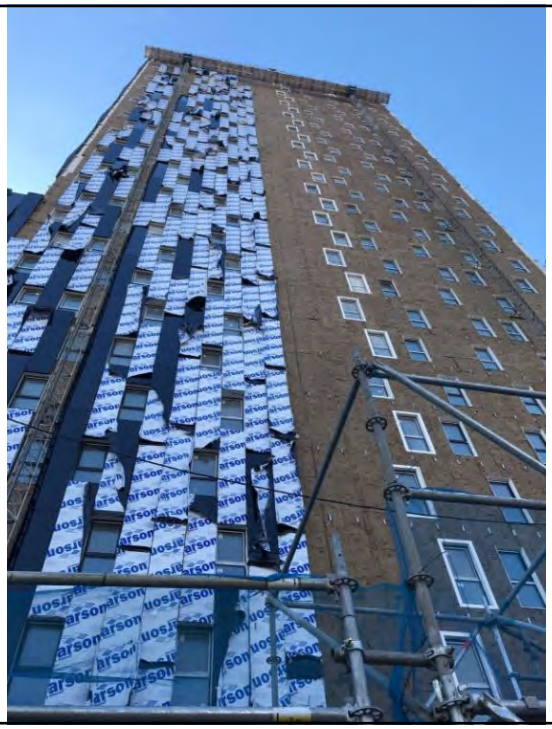
Ventilation

- Decentralised (Zehnder units)

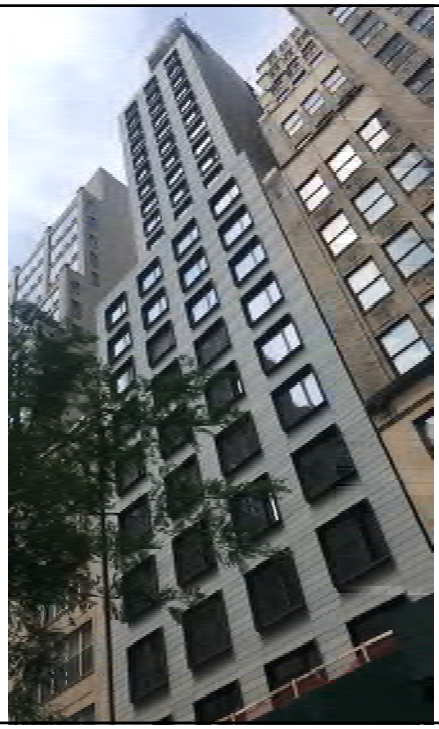








95



211 WEST 29th AVENUE

New York
LOCATION

65,000
SQUARE FEET

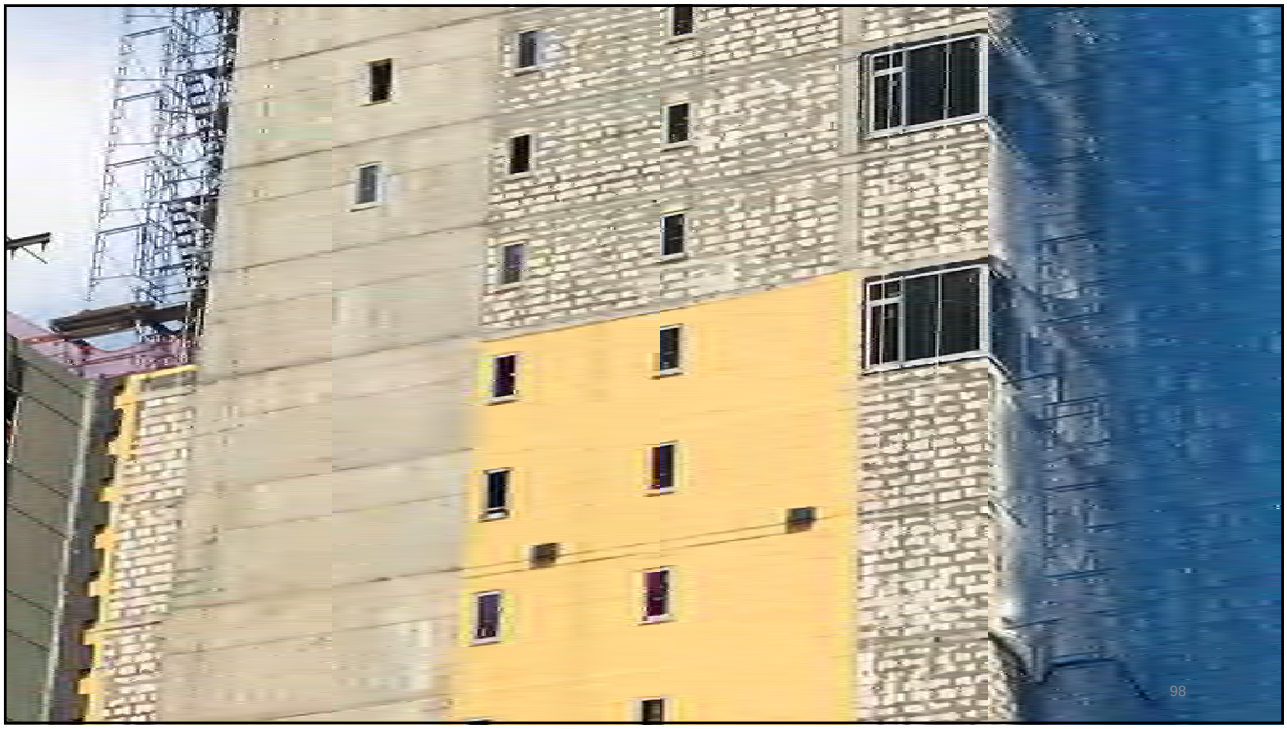
$405
PER SQUARE FOOT
EST. 4% PREMIUM

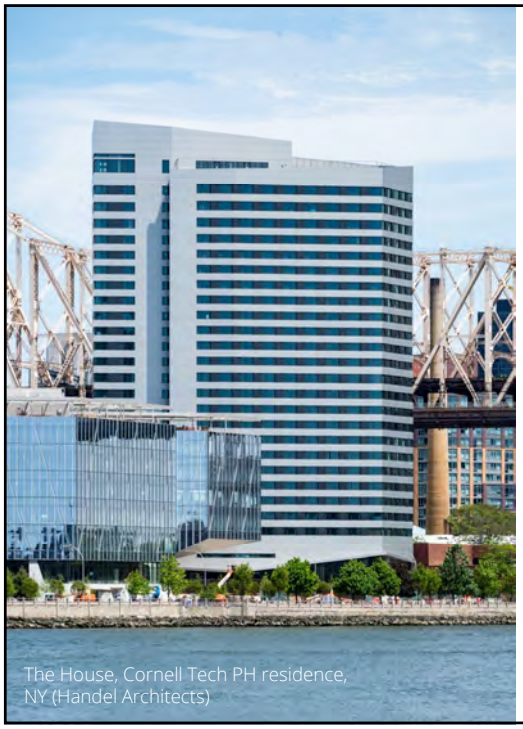
Bernstein Real Estate
DEVELOPER

ZH
ARCHITECT

96


211 West 29 Street
97


98



The House, Cornell Tech

- New York City, U.S.A.
- Completion in 2017
- 26 stories
- Handel Architects, LLP
- Student Residence (351 studios)
- TFA ~ 17,500 m2

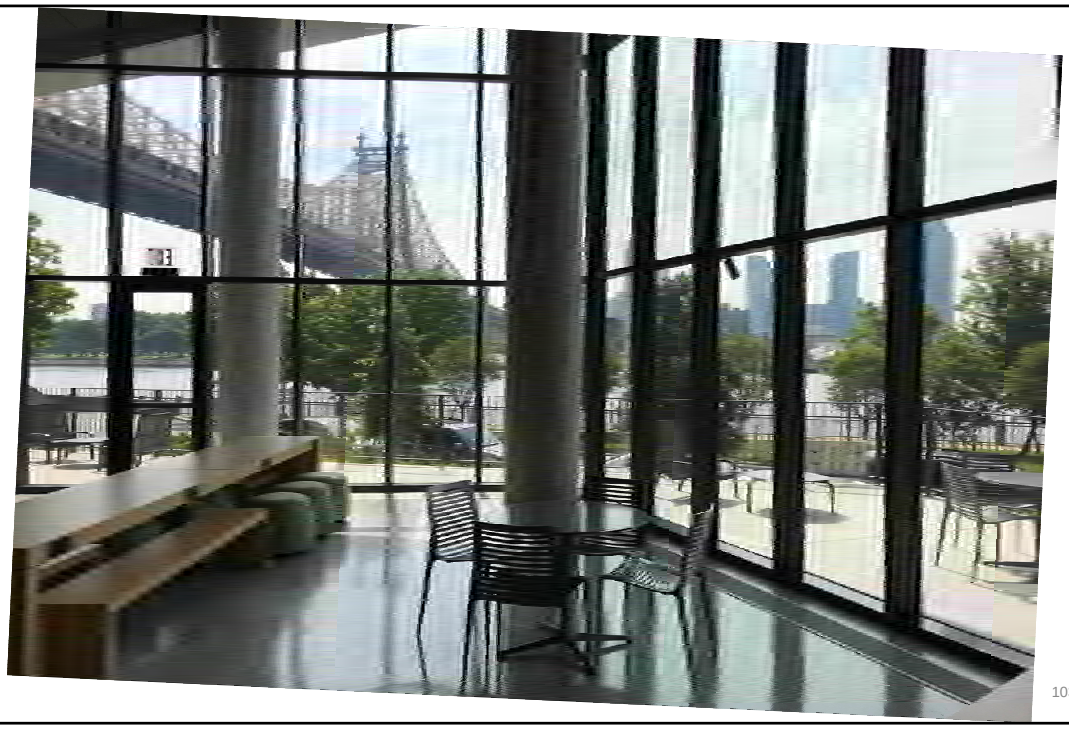
The House, Cornell Tech

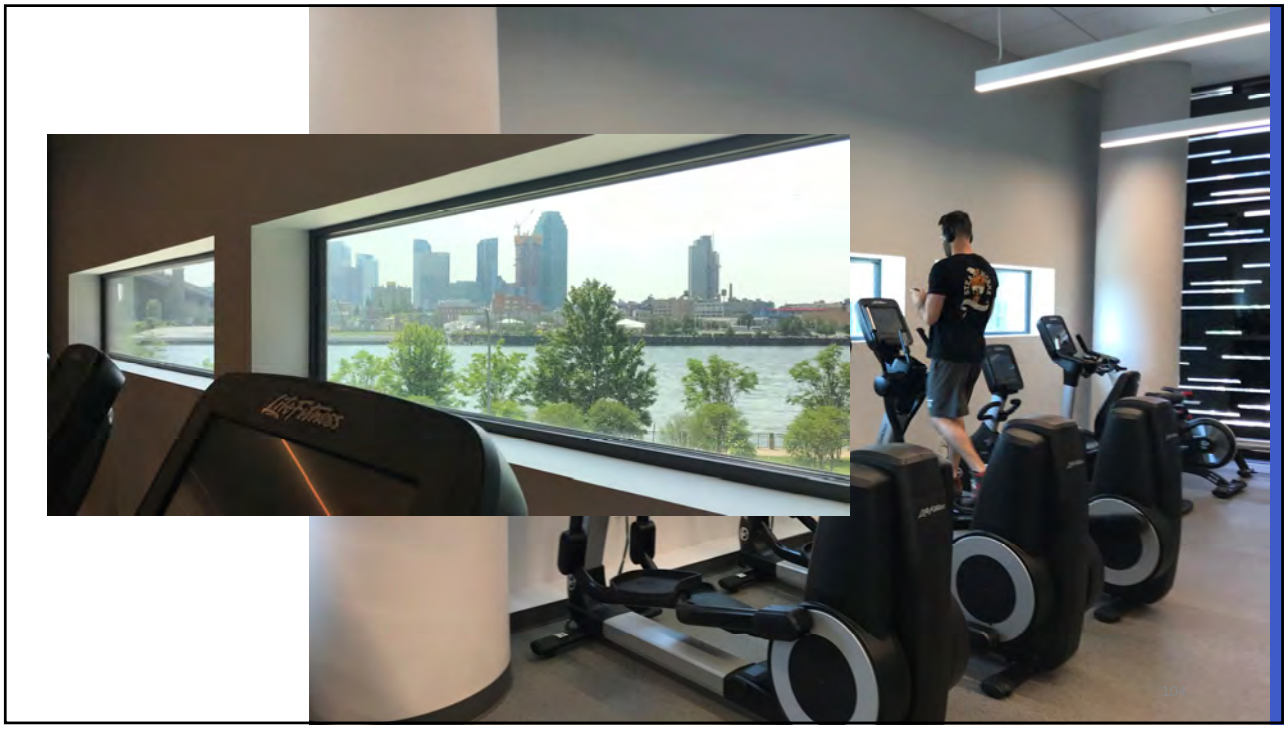
Components

- Roof R-50
- Walls R-19 average (~ R37 effective for panels)
  Panelised steel studs with external insulation
- Slab edge R-10
- Cantilevered floors R-40
- Windows U-0.17
- 23% Window-to-Wall Ratio

Ventilation

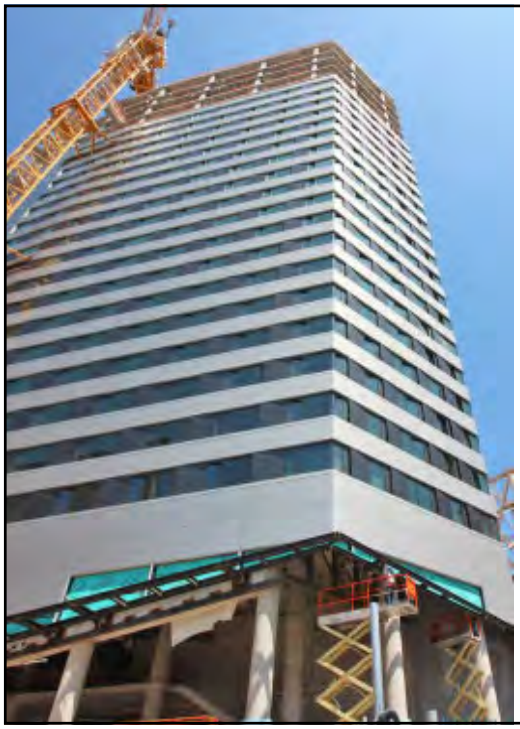
- Central system, with 1 riser per unit






105


106

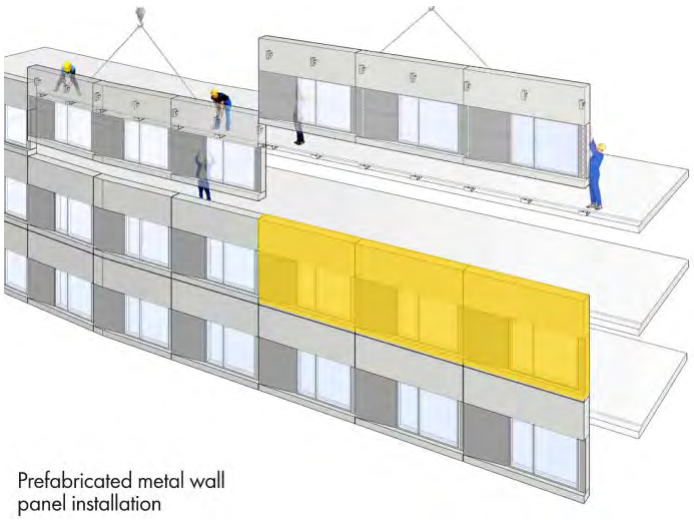


The House, Cornell Tech

PHPP Values

- Annual Heating Demand: 14.2 kWh/m^2.year < 15
- Peak Heat Load: 14 W/m^2 >10
- Primary Energy: 139 kWh/m^2.year > 120

The House, Cornell Tech



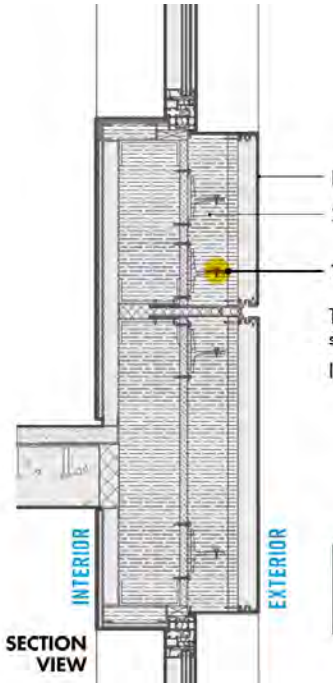
Prefabricated metal wall panel installation

3

ENCLOSURE

EXTERIOR WALL DETAIL

- Thermally broken construction
- Airtight envelope: 0.6ACH@50pa
- Window-to-wall ratio calibrated to maximize performance
- R Value ranges from R19 - R40
- Overall R Value with thermal bridges at panel to panel joints = R19



Rainscreen Metal Cladding System

2"-5" Mineral Wool, R=4.2/inch

Thermally Broken Support Clip

Thermal clip assembly with thermal studs/isolators.

Improves performance by 60 - 90%.

109

Graphic courtesy Handel Architects


111


112
Photo courtesy Handel Architects

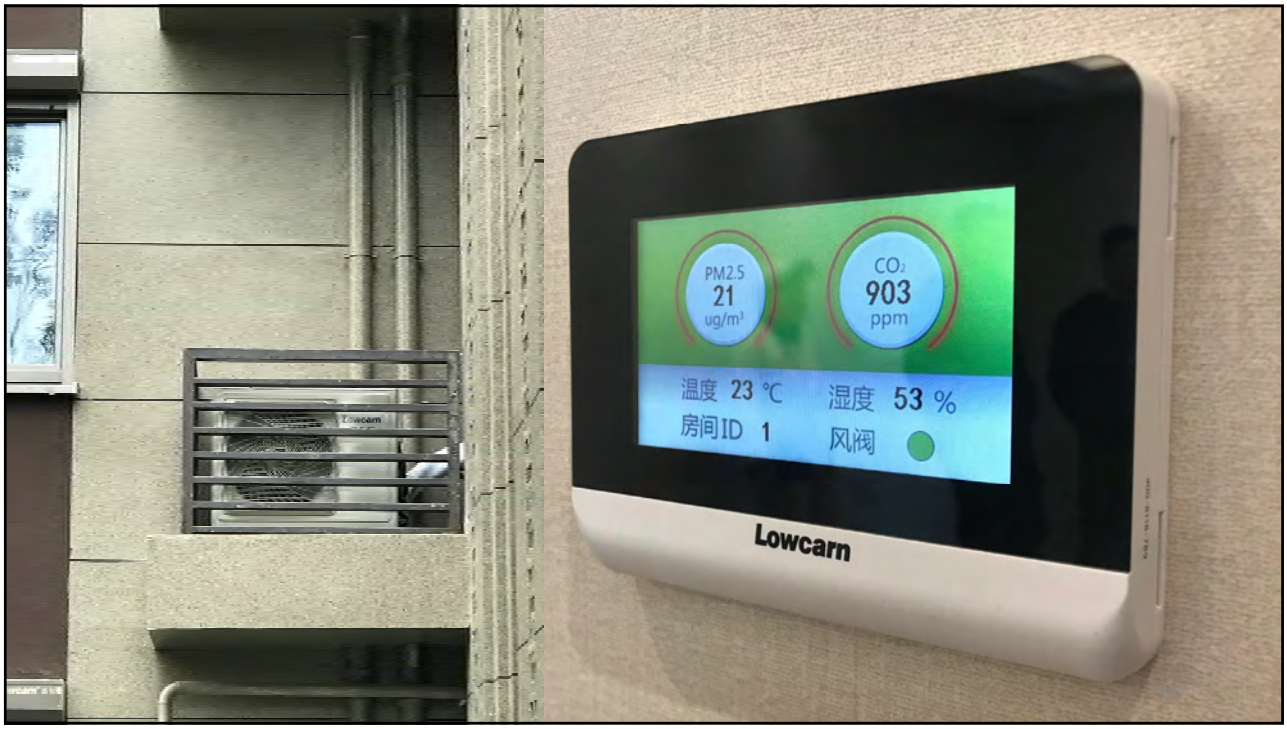
113
Photo courtesy Handel Architects

BAHNSTADT GAOBEIDIAN

Gaobeidian Railway City
(about an hour outside Beijing)
LOCATION

30 high-rise buildings
1 million square meters
SIZE

114


PM2.5
21
ug/m³
CO₂
903
ppm
温度 23 ℃
湿度 53 %
房间ID 1
风阀
Lowcarn


Can every tall building be a Passive House building?

2.2 Performance Limits (Energy Modelling)

2.2.1 Performance Requirements

The performance requirements will vary depending on the Project's ability to secure a City of Vancouver recognized LCES. The performance targets are:

LCES Type	Building Type	TEUI [kWh/m²]	TEDI [kWh/m²]	GHGI [kgCO₂/m²]
Utility-Owned	Hotel	210	25	8
User-Owned	Hotel	210	25	5.36
Not a LCES	Hotel	170	25	8
Utility-Owned	Retail	170	21	3
User-Owned	Retail	170	21	2.01
Not a LCES	Retail	170	21	3

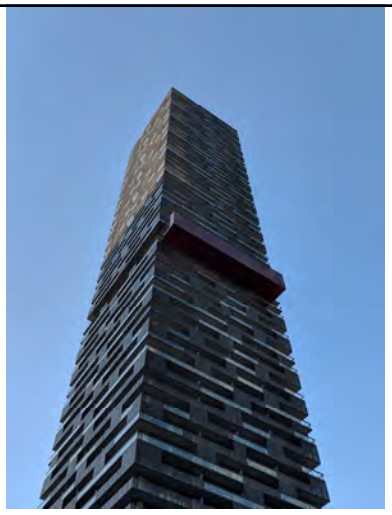
- TEUI: Total Energy Use Intensity
- TEDI: Thermal Energy Demand Intensity
- GHGI: Greenhouse Gas Intensity

2.2.2 Performance Analysis based on Indicative Design

	TEUI [kWh/m²]	TEDI [kWh/m²]	GHGI [kgCO₂/m²]
Project	107.1	7.0	6.8

The indicative design can meet the City of Vancouver rezoning requirements under a non-LCES category.

119



E Condos – 196 m, 58 stories
[image: CC Sikander Iqbal]

Montage at CityPlace West – 153 m, 48 stories
[image: By SimonP - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=7029143]

Tall Residential Buildings?

ICE North Tower – 234 m, 67 stories
[image: CC Terramorphous]

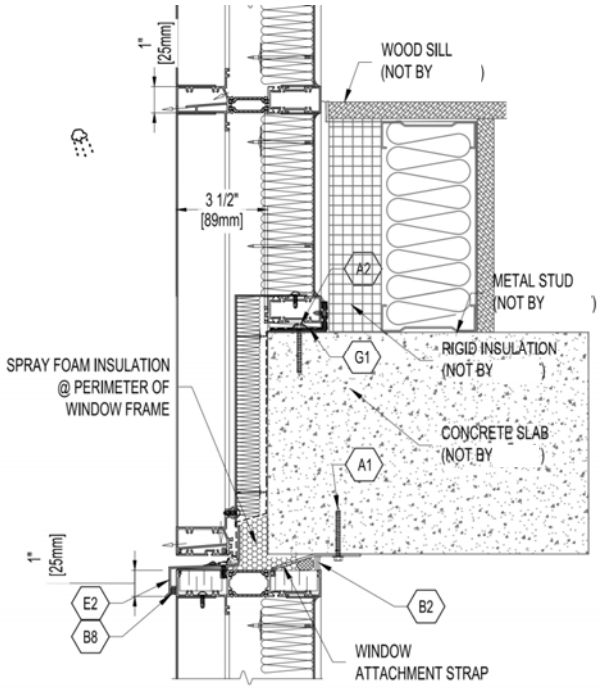
120

ICE North Tower – 234 m, 67 stories
[image: CC Terramorphous]

Tall Residential Buildings?

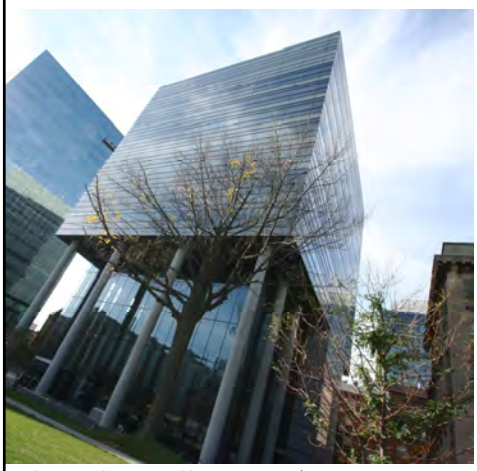
- Balconies
- Elevators and Garbage Chutes
- Parking Garages + Podium Connections
- Window Wall vs Curtain Wall?
- Centralized Ventilation vs Compartmentalized Suites?
- Weight/structure
- Construction speed

121



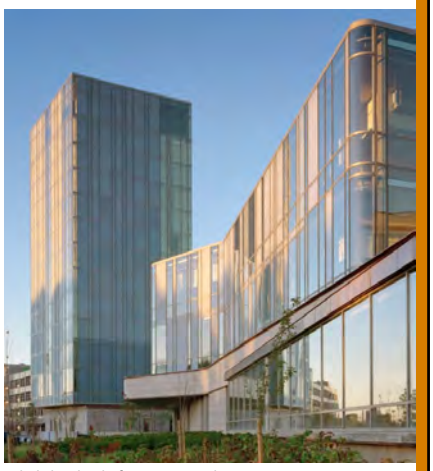
122

Tall Academic Buildings?



Leslie L Dan Pharmacy Building, University of Toronto
[image: CC Upload Bot (Magnus Manske)]

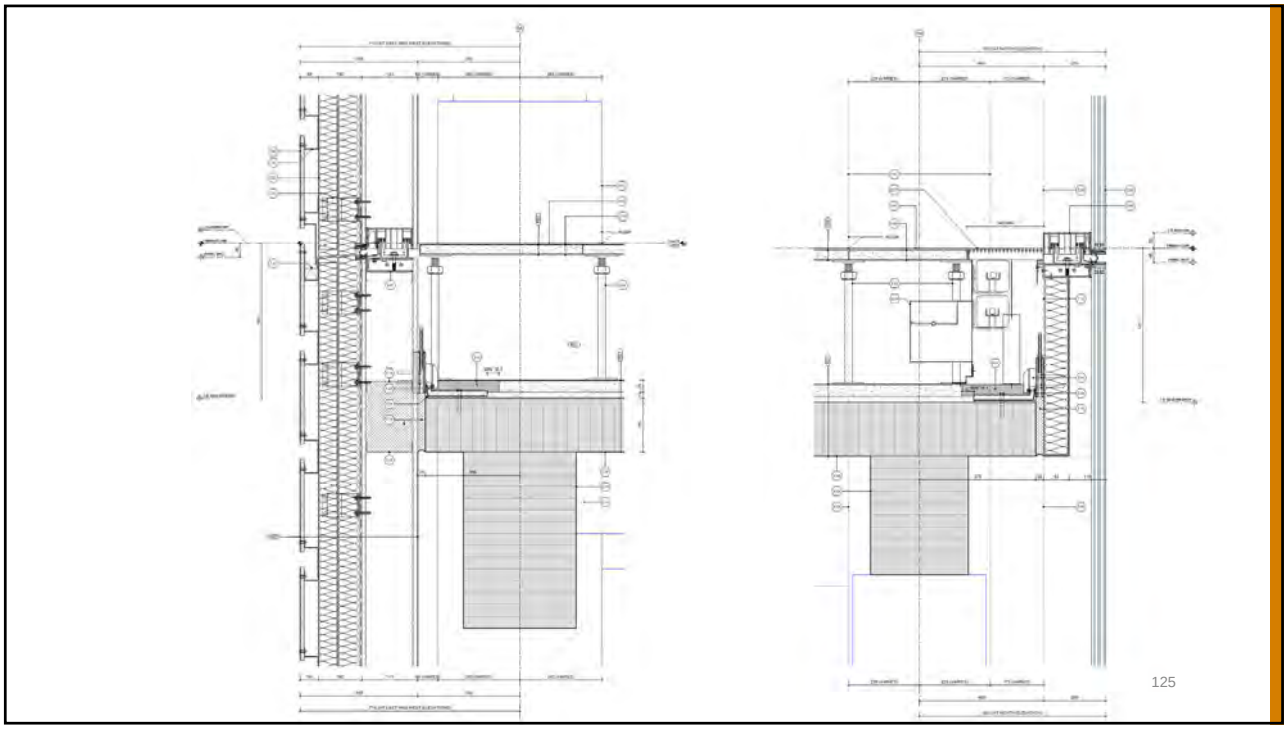
Student Learning Centre, Ryerson University
[image: CC Secondarywaltz]



Schulich School of Business, York University
[image: Schulich.York.ca]

123

124



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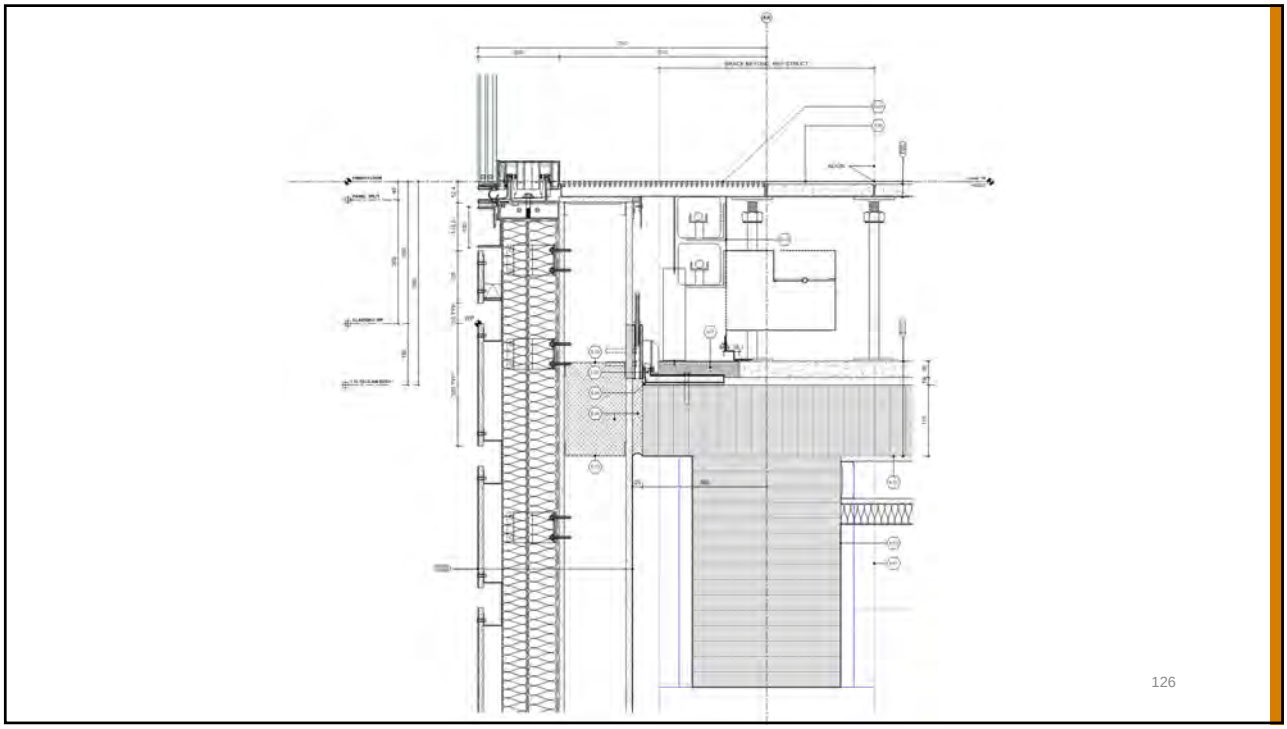

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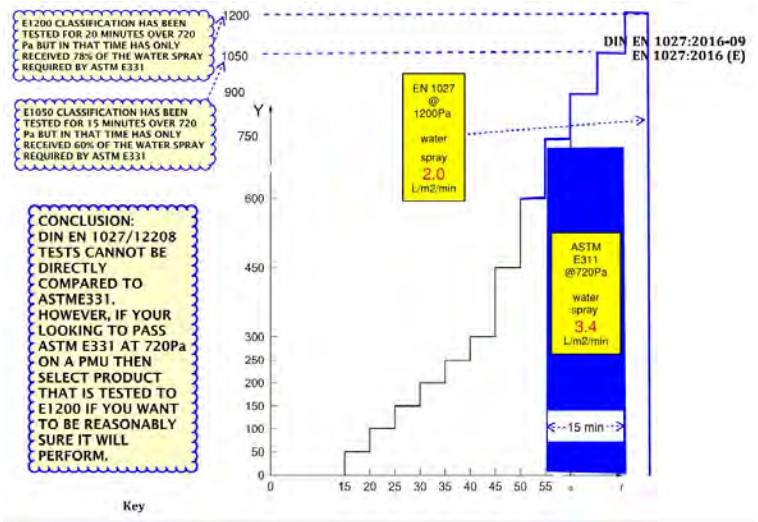
Final Thought - Why do imported products often perform differently than expected?



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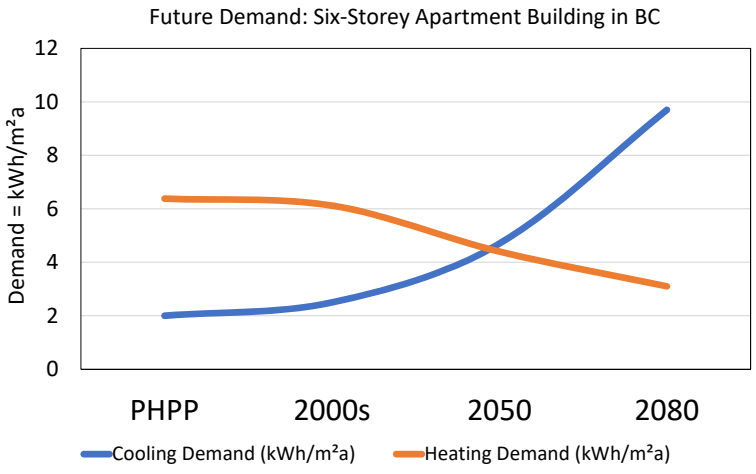
Thank you.



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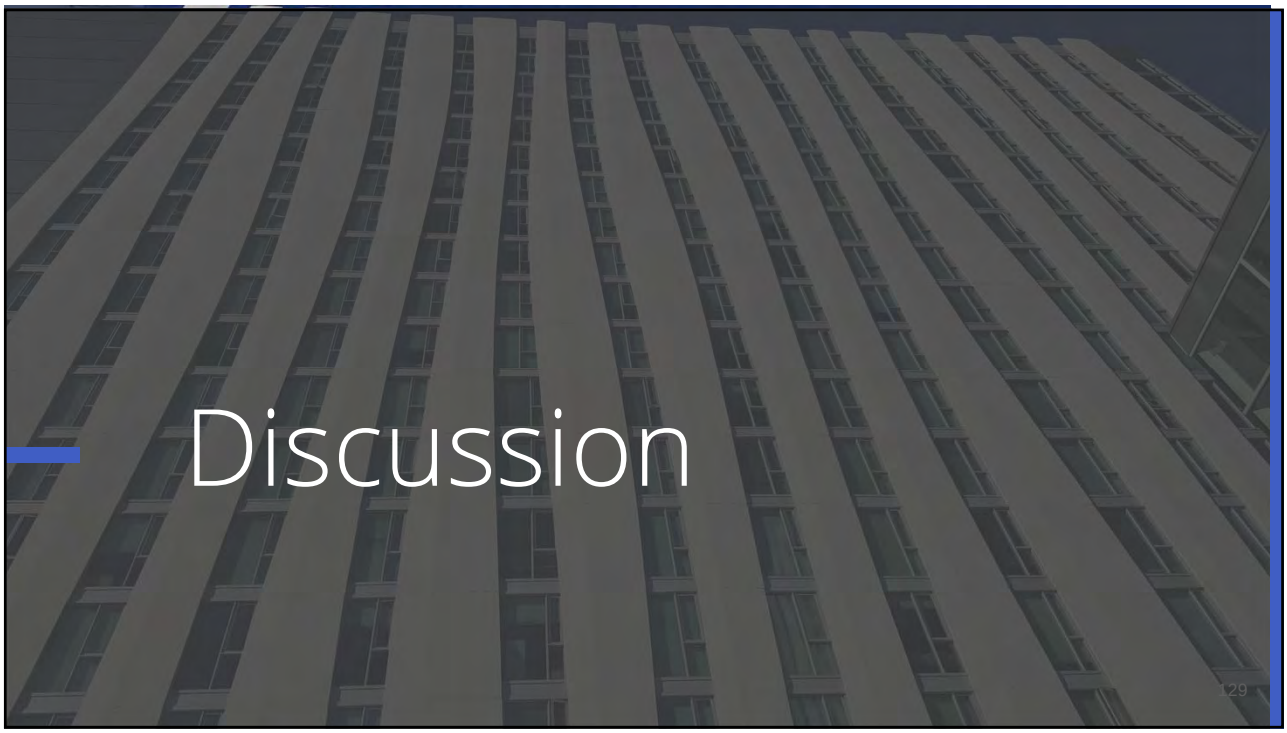
Discussion
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