Cost-Effective Code Compliance

Envelope

Seattle City Light

Lighting Design Lab

January 26, 2021

Before we Begin…

During the Webinar

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions periodically.
- Please participate in the online polls.

Following the Webinar

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

Seattle City Light

lighting design lab

Brought to you by:

lighting® design lab

Seattle Department of Construction & Inspections

Customer Care & Energy Solutions Division

Powered by

Seattle City Light

Seattle City Light

lighting® design lab

2018 Construction Code Changes

- Building code
- Residential code
- Mechanical code
- **Energy code**
- Fuel gas code
- Plumbing code
- Fire code
- Electrical code
- Boiler code

2018 Seattle Energy Code

for “Commercial Buildings” – *not* single-family or low-rise multifamily

“2018” Code Timeline

- Nov 2017: IECC published
- Nov 2019: WSEC approved
- ~~July 2020: WSEC goes into effect~~
- **Feb 1, 2021: WSEC effective date**
- Jan – Sept: Seattle public meetings
- Sept – Oct: Review by CCAB
- Dec – Mayoral approval
- Jan – City Council approval
- **March 15, 2021: SEC effective date**

It's not *whether* we're going to do this, it's *how*

Washington state:
70% less building energy use by 2030

- Zero-carbon buildings
- …or by 2027?

Washington state:
45% reduction in GHG emissions by 2030

- 95% reduction by 2050

Seattle: Carbon-neutral buildings & vehicles by 2050

- …or sooner with Green New Deal?

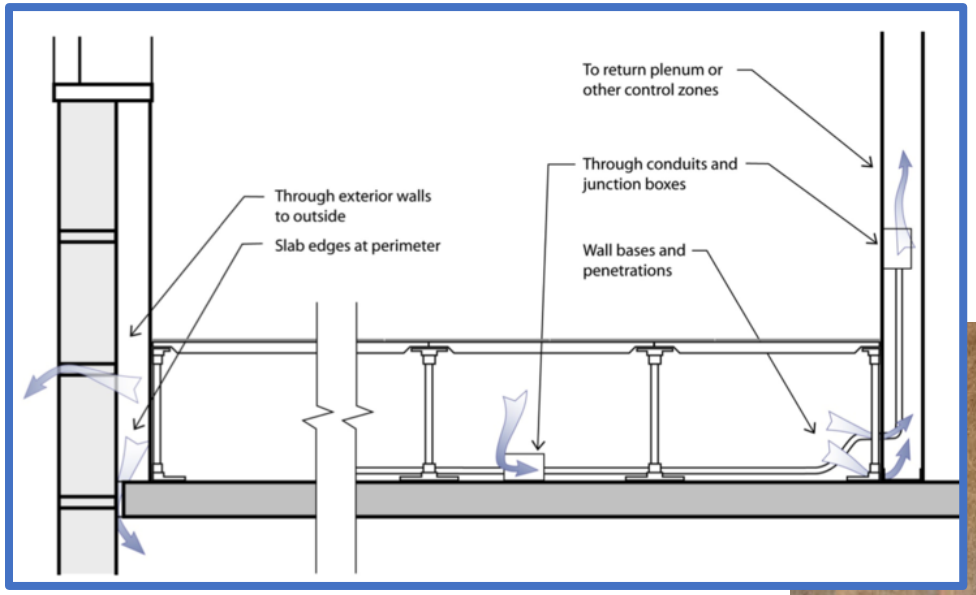
Seattle amendments: 4 Guiding Principles

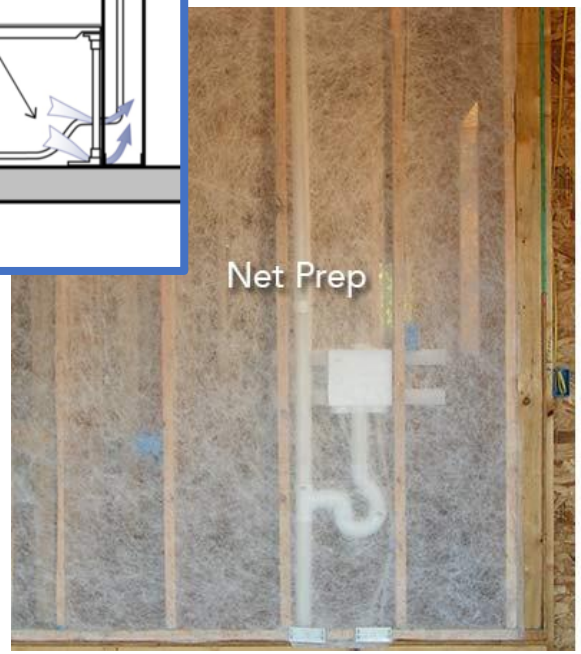
1. Envelopes meet our “2050” standard
   - We have to decide what that 2050 standard is
2. No “internal combustion buildings”
   - Electrical infrastructure for exceptions
3. Efficient use of electricity
   - Typically heat pumps for space heating & water heating
   - Highly efficient systems & controls
4. Increased on-site renewables
   - Options for off-site purchase
   - Plus “solar readiness” for bigger future system

Today:
Envelope

New buildings must be *capable of* meeting Seattle’s 2050 targets
(without major surgery)

Thermal envelope is boring – and effective



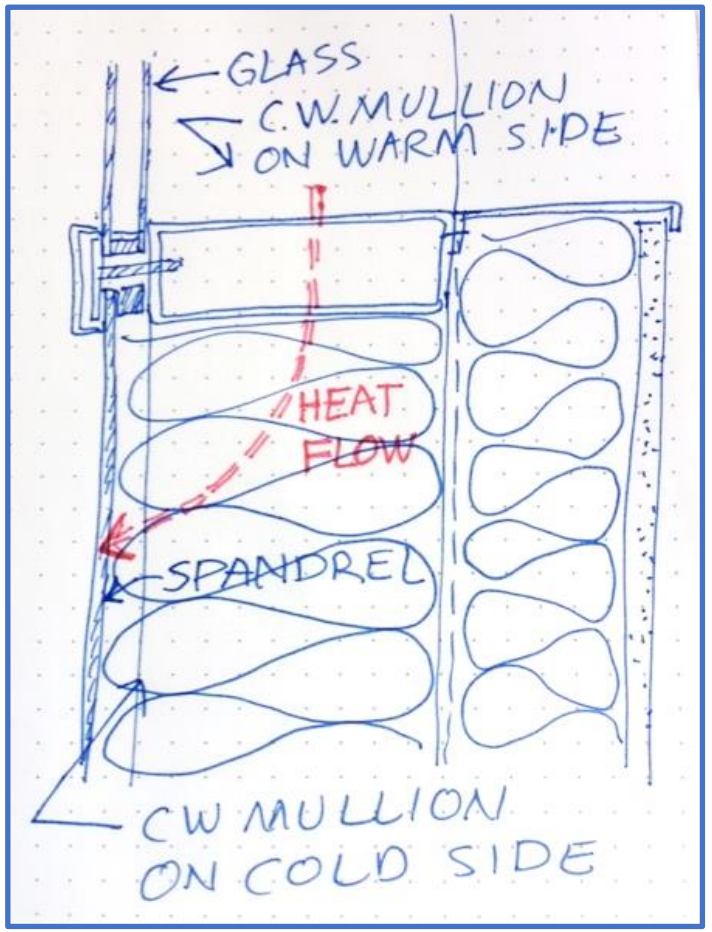


- Reliable energy savings
- Lasts for generations
- …but invisible

Chapter 3 – Even less exciting than Chapter 2

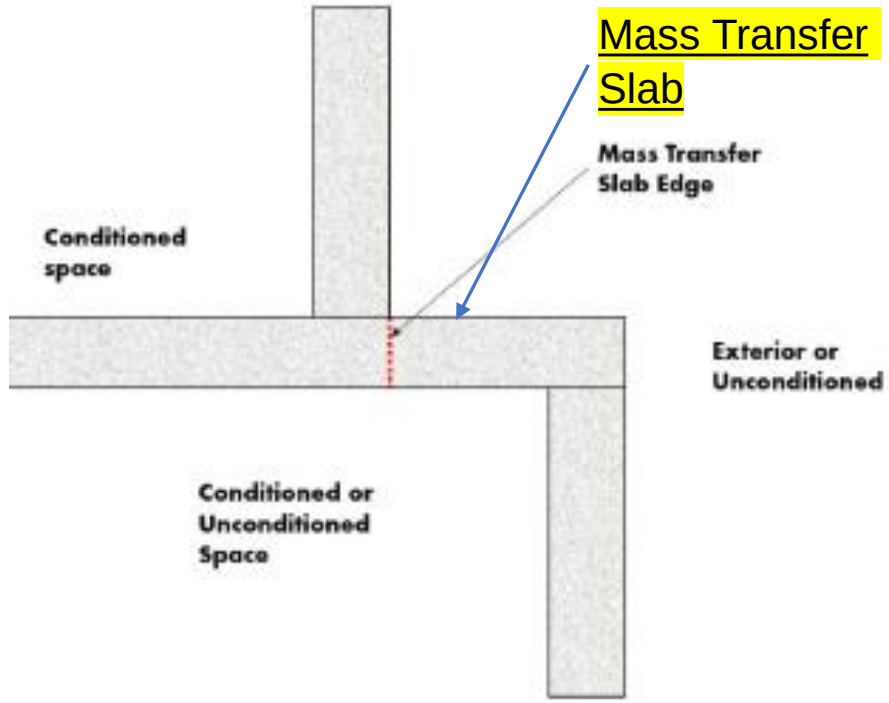
- Rules for installing and labeling insulation & fenestration
- Default U-values for fenestration
  - Don’t use these if you can help it
- Default spandrel panel table and equations
  - Usually better to use manufacturer’s values
- Curtain wall & window wall performance are really much worse than this

- Definitions in Chapter 2 not always obvious
  - Steel-framed wall, single rafter roof, roof recover, opaque door, mass transfer deck slab…



And talking about mass transfer decks…

MASS TRANSFER DECK SLAB ((~~EDGE~~)). ~~That portion of the *above-grade wall* made up of the concrete slab where it extends past the footprint of the floor above.))~~ A concrete slab designed to transfer structural load from the building perimeter wall or column line above, laterally to an offset wall or column line below, and which has conditioned or semi-heated space on the inside of the upper wall and exterior or unconditioned space on the outside of the upper wall. The area of the slab edge shall be defined as the thickness of the slab multiplied by the ((~~perimeter~~)) length of the edge condition. Examples of this condition include, but are not limited to, the transition from an above-grade structure to a below-grade structure or the transition from a tower to a podium. A cantilevered concrete balcony does not constitute a mass transfer deck slab.



Seattle: Bonus U-value prizes

h. Intermediate concrete floor slabs penetrating the *building thermal envelope* shall comply with Section C402.2.9. The area of such penetrating concrete floor slabs shall be defined as the thickness of the slab multiplied by the length of the penetration. The "exposed concrete" row in Table A103.3.7.2 shall be used for typical default *U*-factors for the penetrating concrete slab.

i. Value applies to concrete columns and concrete walls that interrupt mass floor insulation, but not to perimeter walls or columns separating interior *conditioned space* from exterior space.

Walls, Above Grade		
Mass[g,k]	((~~U-0.104[d]~~)) U-0.057	((~~U-0.078~~)) U-0.057
Mass transfer deck slab ~~edge[i]~~	U-0.20	U-0.20
Slab penetrating thermal envelope wall[h]	U-0.10	U-0.10
Metal building[k]	U-0.052	U-0.052
Steel framed[k]	U-0.055	U-0.055
Wood framed and other[k]	((~~U-0.054~~)) U-0.051	U-0.051
Floors		
Mass[e]	U-0.031	U-0.031
Joist/framing	((~~U-0.029~~)) U-0.029 steel joist U-0.025 wood joist	((~~U-0.029~~)) U-0.029 steel joist U-0.025 wood joist
Concrete column or concrete wall penetrating thermal envelope floor[i]	U-0.55	U-0.55
Concrete slab floor directly above an electrical utility vault	N.R.	N.R.

Wood-framed Walls: § C402.1.3 – Insulation Component R-value Method

2015 WSEC-C/ SEC-C

Table C402.1.3

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
Walls, Above Grade		
Mass	R-9.5[c] ci	R-13.3ci
Metal building	R-19ci	R-19ci
Steel framed	R-13 + R-10ci	R-19 + R-8.5ci
Wood framed and other	R-21 int	R-21 int

2018 WSEC-C

Table C402.1.3

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
Walls, Above Grade		
Mass[h]	R-9.5ci[c]	R-13.3ci
Mass transfer deck slab edge	R-5	R-5
Metal buildings	R-19ci or R-13 + 13ci	R-19ci or R-13 + 13ci
Steel framed	R-13 + R-10ci	R-19 + R-8.5ci
Wood framed and other	R-21 int or R-15 + 5ci std	((~~R-21 int~~)) R-13 + 7.5ci std or R-20 + 3.8ci std or R-25 std

Wood-framed Walls: § C402.1.4– Assembly U-factor Based Method

2015 WSEC-C/SEC-C	2018 WSEC-C Group R	Proposed 2018 SEC-C
Group R, Wood framed and other: U-0.054	Reduced to U-0.051 for Group R. Achieved via: - 2x6 advanced framing (24" OC) with R-21 batt, OR - 2x8 standard framing with R-25 batt, OR - 2X6 standard framing with R-21 batt and continuous 1" mineral wool - 2x6 Flash and Batt?	U-0.051 required for both Group R and other occupancies

Air Barrier Testing

- Test standard reduced to 0.25 cfm/sf of envelope

- Passing test now mandatory
  - …at the old std: 0.40 cfm/sf
  - (between 0.25 & 0.40 cfm, just fix what leaks you can)

THE 3 KEYS TO AIRTIGHT BUILDINGS

1. DESIGN

2. BUILD

3. CONFIRM

RDH

Design

- Define/identify assemblies
- Define air barrier boundary
- Identify key interfaces
- Draw details (think in 3D)
- Continuity

Build

- Pre-installation meetings
- Mock-ups
- Full time QC from GC

Confirm

- Visual review
- Qualitative testing
- Quantitative testing

Seattle (vs. WA): Heat pumps don't qualify for "semi-heated"

C402.1.1.2 Semi-heated buildings and spaces. The building envelope of *semi-heated* buildings, or portions thereof, shall comply with the same requirements as that for conditioned spaces in Section C402, except as modified by this section. The total installed output capacity of mechanical space conditioning systems serving a *semi-heated* building or space shall comply with Section C202, except as modified by this section. (…)

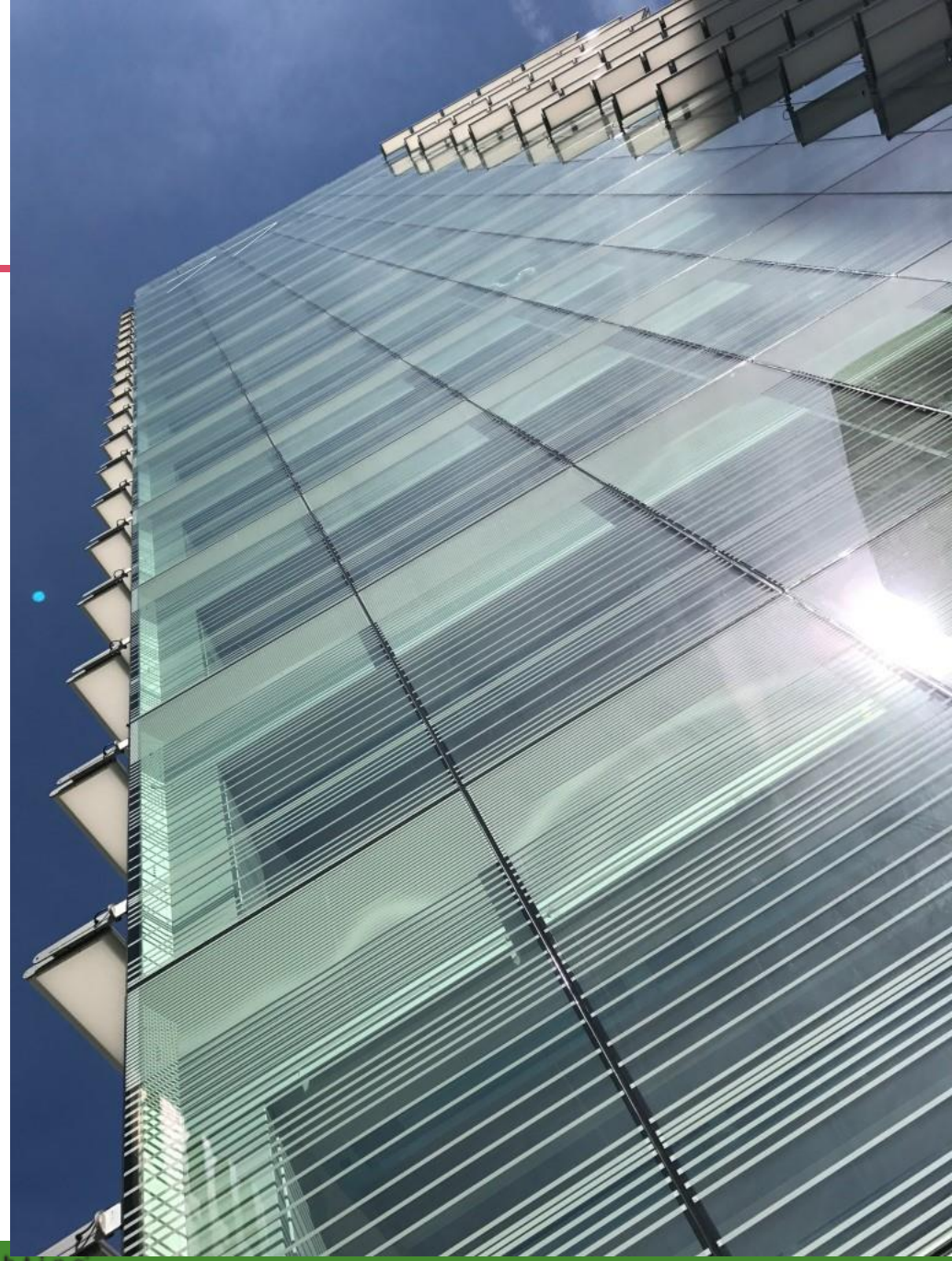
Exception: Building or space may comply as *semi-heated* when served by ((~~one or more of~~)) the following system ((~~alternatives~~)) alternative:

1. Electric infrared heating equipment for localized heating applications, but not for general area heating, insulated in compliance with Section C402.2.8 and controlled by occupant sensing devices in compliance with Section C403.11.1.

((~~2. Heat pumps with cooling capacity permanently disabled, as pre-approved by the jurisdiction.~~))

Allowable glazing percentage

- **Prescriptive** path: ~~30%~~ 35% wall area
  - Works fine for low-rise buildings
  - 40% if half of floor area in daylight zone
  - 40% with low U-value glazing
- **Modeling** path: Varies
  - 40% large office
  - 22% School
  - 7% grocery…
  - List in Appendix G Table G3.1.1-1
- **Modeling "Other"** (incl multifamily)
  - 40%…or proposed, if smaller



Fenestration U-values

- All frame mtrls use same values
  - WA: U-0.38 for curtain wall, storefront, Class AW windows
  - WA: U-0.30 for “all other”
    - Includes most typical windows
- **Lower U-values in Seattle**
  - Sea: U-0.34 (vs. 0.38) for curtain wall, storefront, Class AW windows
  - Sea: **U-0.26** (vs. 0.30) for “all other”
    - Includes most typical windows
  - Sea: **U-0.28** for operable windows

Fenestration U-value examples -Class AW, site built, and curtain wall

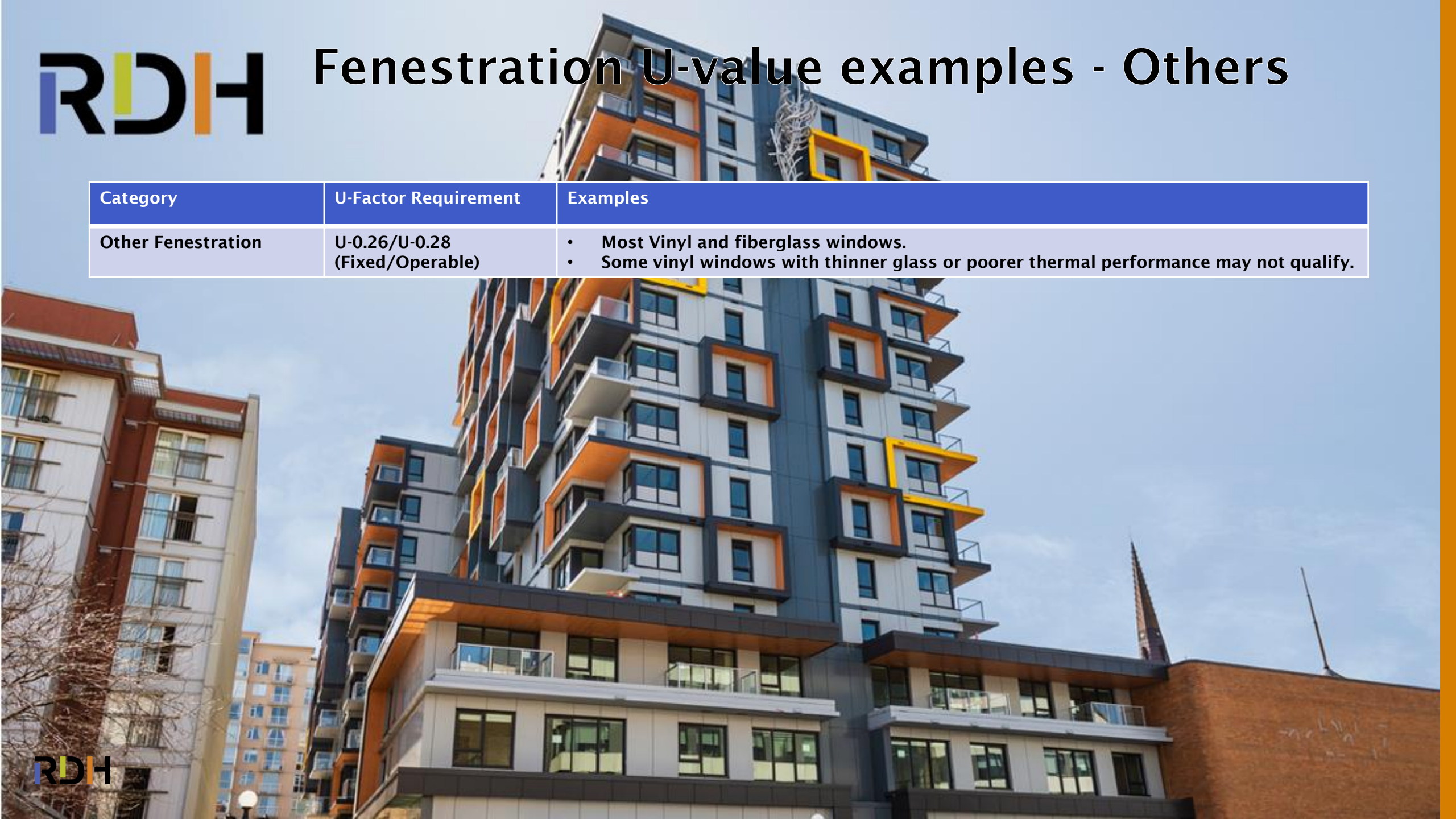
Category	U-Factor Requirement	Example 1	Example 2
Class AW, site built, and curtain wall	U-0.34/U-0.36 (Fixed/Operable)	"Ultra Thermal" Storefront (2 thermal breaks)	• Unitized SSG curtain wall • Many stick-built curtain wall systems • Conventional Window Wall?

FENESTRATION PRODUCT, SITE-BUILT. A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory-formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls, and atrium roof systems.

products is expected.

Fenestration U-value examples - Others

Category	U-Factor Requirement	Examples
Other Fenestration	U-0.26/U-0.28 (Fixed/Operable)	• Most Vinyl and fiberglass windows. • Some vinyl windows with thinner glass or poorer thermal performance may not qualify.



C402.4.1.1.2 High-performance fenestration

All of the following requirements shall be met:

WA 0.34, Seattle **0.30** (operable 0.36)

- Class AW windows, fixed
- Vertical curtain walls
- Site-built fenestration, fixed;

WA 0.28, Seattle **0.22** (operable 0.24)

- *"A*ll other" vertical fenestration
  - Mostly punched windows

SHGC 0.35

- adjusted for projection factor

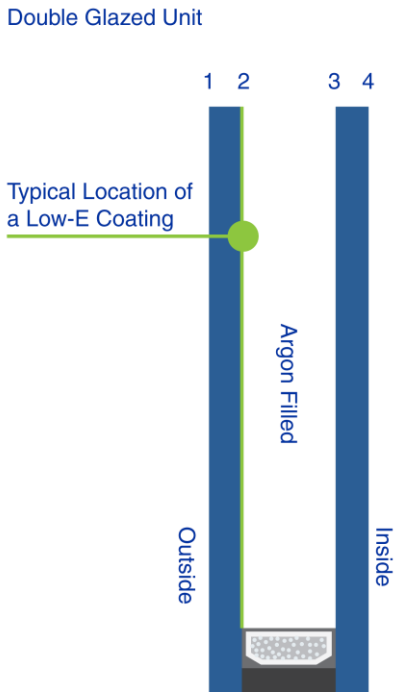
High performance Fenestration U-value examples

Category	U-Factor Requirement	Example 1	Example 2
High-Performance Class AW	U-0.30/U-0.36 (Fixed/Operable)	2-pane stick built curtain wall with surface 4 coating. Reduced u-value from: U-0.32→ U-0.27.	• Fiberglass 2-pane window wall →U-0.24 • "Thermally-Enhanced" window wall →U-0.30

Photo Credit: Cascadia Windows

High performance Fenestration U-value examples

Category	U-Factor Requirement	Example 1	Example 2
High Performance Others	**U-0.22/U-0.24 (Fixed/Operable)**	**2-pane Vinyl Window with surface 4 coating. Reduced u-value from: U-0.26→ U-0.22.**	**2-pane to 3-pane vinyl window U-0.26→ U-0.16.**



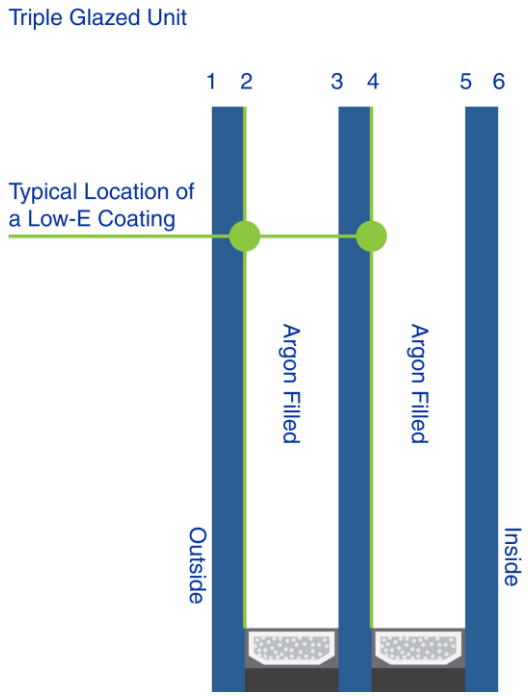


Image Credit: Vitrum

Fenestration Cost Anecdotes

- High rise apartment retrofit. Switching from 2-pane to 3-pane aluminum sliding glass door
  - 35% Cost increase
- Apartment tower window wall new construction. Upgrade from standard window wall to thermally improved aluminum window wall
  - Approx. $10/sq. ft cost increase (10%-15%)
- <$7/ sq. ft. for interior surface low-e coating
- Punched vinyl windows

Size		Cost % (double)	Cost % (triple)
Small (<20sf)	< 4'x5'	Baseline	35%
Medium (20-30SF)	4'x5' to 5'x5'	Baseline	35%
Large (30-40sf)	6'x5' to 8'x5'	35%	55%
Extra Large (>40SF)	>8'x5'	50%	75%

Thank You Walsh Construction!

RDH

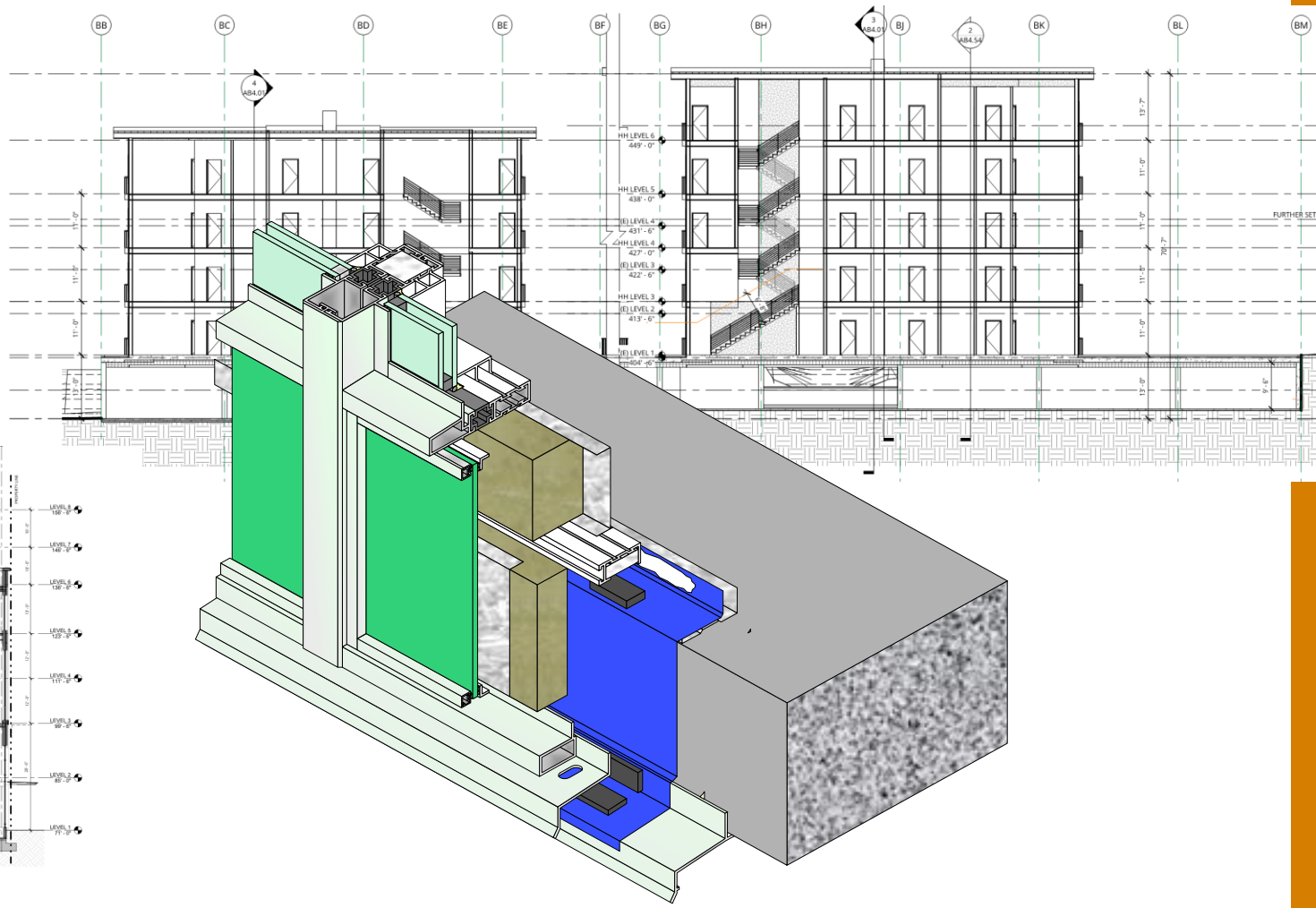
Takeaways on glazing changes

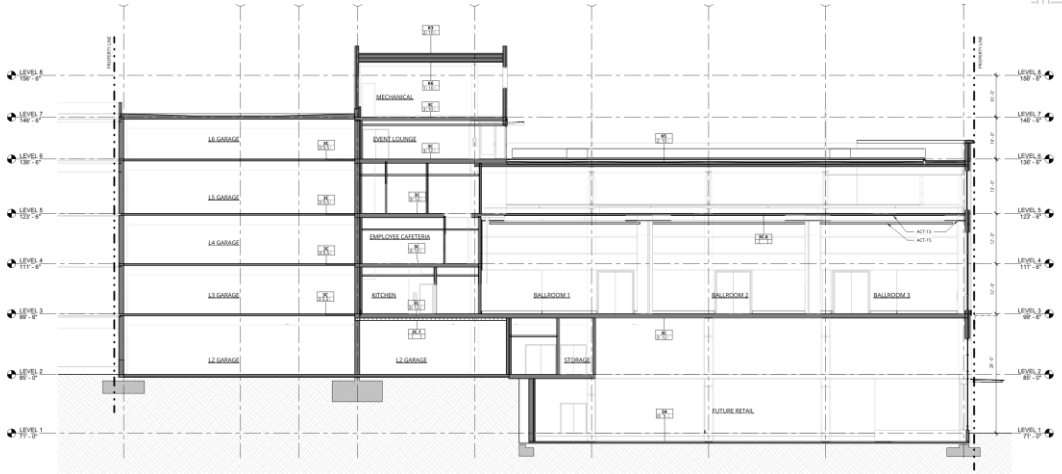
- Code changes weed out worst performers
- High Performance Glazing Options:
  - Double-paned fiberglass glazing systems
  - Thermally-improved products from aluminum glazing system manufacturers
  - More interest in interior surface low-e coatings
  - Triple pane windows will start to be more common, but workarounds are available
- In previous code cycles, over-performing windows were traded off against underperforming assemblies or thermal bridges to meet code. The math is now more difficult

RDH

Typical Underperforming Assemblies

- Mass Transfer Slabs
- Window Wall slab bypasses
- Concrete Curbs
- Spandrel panels
- -PTACs?
- Concrete balconies?





Maximum fenestration area, prescriptive

C402.4.1 Maximum area. The total building vertical fenestration area (not including opaque doors and opaque spandrel panels) shall not exceed ((~~30~~)) 35 percent of the total building gross *above-grade wall* area. The skylight area shall not exceed 5 percent of the total building gross roof area (skylight-to-roof ratio).

C402.4.1.1 Vertical fenestration maximum area with high performance alternates. For buildings that comply with Section C402.4.1.1.1 or C402.4.1.1.2, the total building vertical fenestration area is permitted to exceed ((~~30~~)) 35 percent but shall not exceed 40 percent of the gross above grade wall area for the purpose of prescriptive compliance with Section C402.1.4.

NFRC: Manufactured Windows

- (Seattle) CPD numbers for manufactured windows required at permit submittal *only* if better than code *and* used for UA tradeoff or modeling
  - Otherwise, CPD number not required
- Values shown on the window stickers must be at least as good as the values shown on plans
- Never use the default table values unless there's no NFRC value

NFRC: Curtain Wall, Storefront...

- NFRC “CMA Bid Report” OK instead of “simulation report”
  - But not AAMA reports, mfr’s simulation reports, or product literature
- NFRC Label Certificate *must* be available on site before the first stick of curtain wall goes up
  - … Certificate values must at least equal Bid Report values

PRODUCT LISTING:

ID	Qty	Total Area	Name	EnergyPlus Report File	Fenestration Performance at Actual Size*				
					Width	Height	U-factor	SHGC	VT
		ft^2	ft^2		in.	in.	Btu/ $hr \cdot ft^2 \cdot {}^\circ F$	-	-
P-PL-010	2	48.00	PL-2200 / PL-2210	www.nfrc.org/CMAST/pl2200-2210.txt	48.00	72.00	0.48	0.59	0.66
P-PL-010	5	88.89	PL-2200 / PL-2210	www.nfrc.org/CMAST/pl2200-2210.txt	40.00	64.00	0.50	0.56	0.64
P-PL-005	6	192.67	PL-3400 / PL-3401	www.nfrc.org/CMAST/pl3400-3401.txt	68.00	68.00	0.49	0.58	0.65
P-PL-005	3	54.00	PL-3400 / PL-3401	www.nfrc.org/CMAST/pl3400-3401.txt	72.00	36.00	0.51	0.55	0.62

NFRC Labeling 101

- NFRC label certificate requires thermal simulation + physical testing. It's a time-consuming process
- Specify that an NFRC label certificate must be provided.
- Be upfront in bid review meetings. A lot of manufacturers don't take the NFRC label certificate requirement seriously, let them know that Seattle does.
- CMA – Component Modeling Approach. Utilized by many large manufacturers so that they can quickly provide a CMA bid report. The CMA bid report is not a label certificate.

NON-RESIDENTIAL FENESTRATION CALCULATION REPORT / BID REPORT ACCORDING TO NFRC CMA PROCEDURES – NFRC STANDARD SIZE

NOTE: This is NOT an NFRC Label Certificate. This document can NOT be used in place of NFRC Label Certificate and can be used only for Bid and Design Purposes

PRODUCT LISTING:

					Performance at NFRC Standard Size		
ID	Name	Framing Ref	Glazing Ref	Spacer Ref	U	SHGC	VT
					Btu/h·ft²·F	-	-
P-KAW-42470	KAW 1600UT Sys 2 FGPP, 1" IG Optiwhite VE-2M #2, 90%AR, TGI Wave	FA-KAW-53298	GA-VIR-11242	SA-TCN-3958	0.31	0.38	0.65
P-KAW-41157	KAW AA250 Pair, Viracon 1" IG VE-2M #2, 90% AR, TGI Wave	FA-KAW-42348	GA-VIR-10603	SA-TCN-3958	0.43	0.25	0.43

Seattle Department of Construction and Inspections

Tip 403

Seattle Permits

— part of a multi-departmental City of Seattle series on getting a permit

NFRC Labeling Requirements 2015 Seattle Energy Code

Updated December 18, 2017

fewer than 50 employees, you may use the small business tables to comply with the commercial or residential energy code. (See Tables R303.1.3(5) and C303.1.3(5).

Where to Find These Requirements in the 2015 Seattle Energy Code

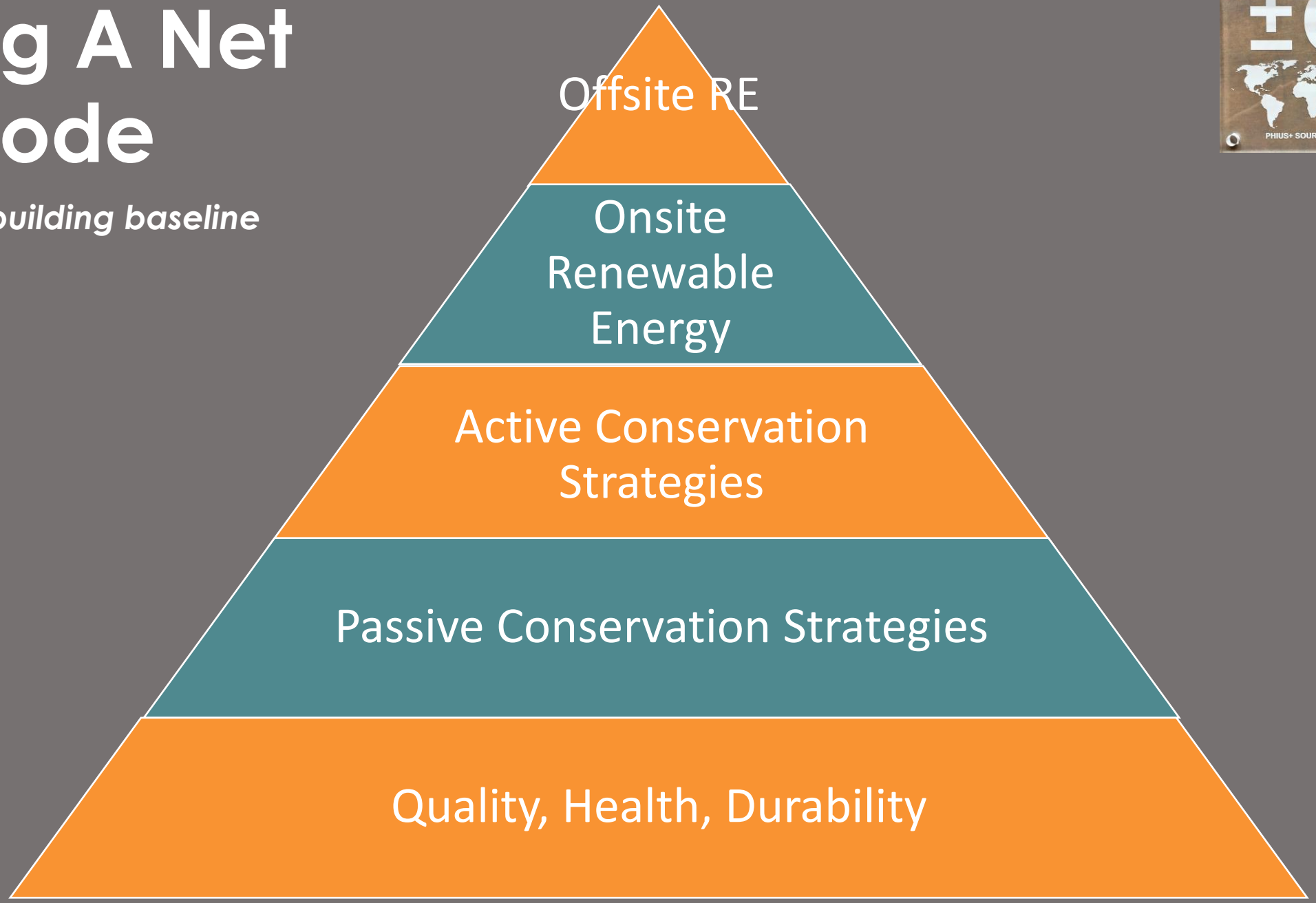
Residential Buildings – Windows and other fenestration, Section R303.1.3

Vestibules C402.5.7

- Vestibules required at all building entrances for public or occupants, except smaller than 3000 SF
- So *not* required at service doors, exit doors, small storefronts, outdoor dining
- Required for swing doors next to revolving doors
- Exception for air curtain!

Building A Net Zero Code

with a passive building baseline

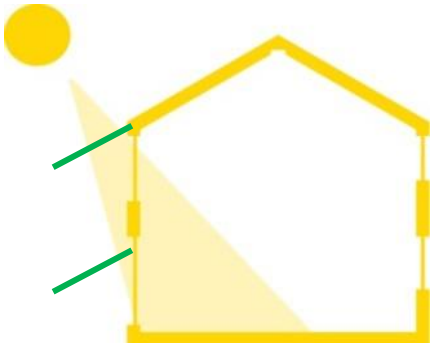


PASSIVE BUILDING PRINCIPLES

Thermal Control

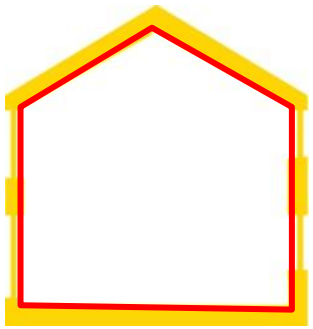
CONTINUOUS INSULATION

Radiation Control



OPTIMIZED WINDOWS & SOLAR GAINS

Air Control



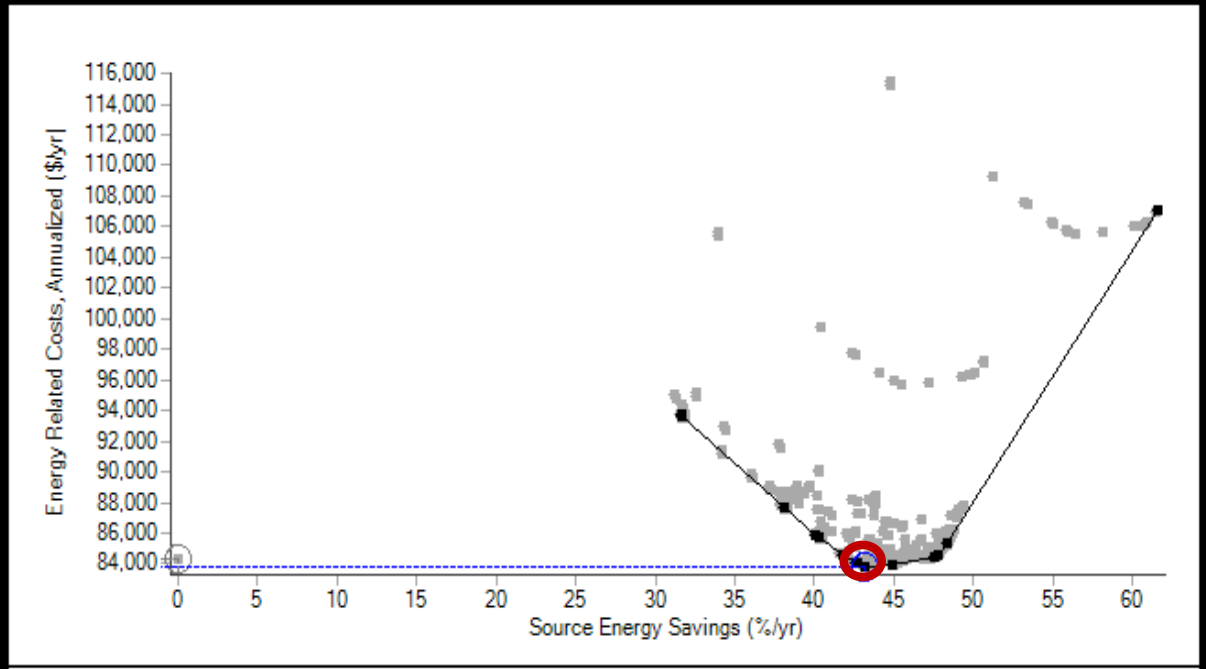
AIR-TIGHT CONSTRUCTION

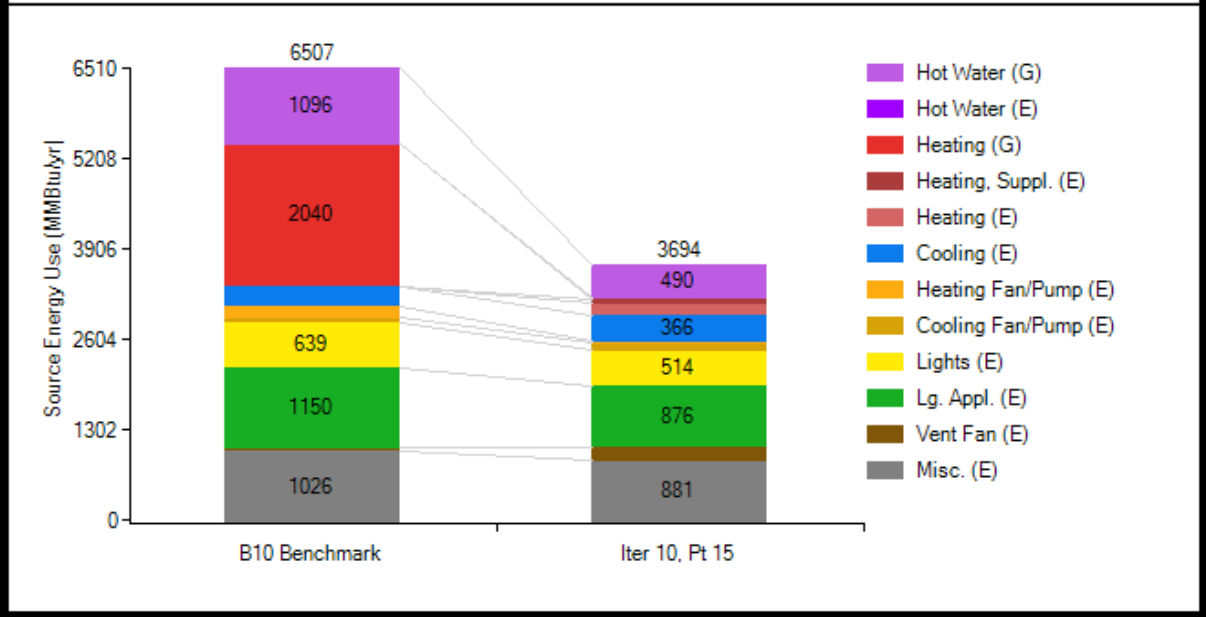
BALANCED VENTILATION WITH HEAT RECOVERY

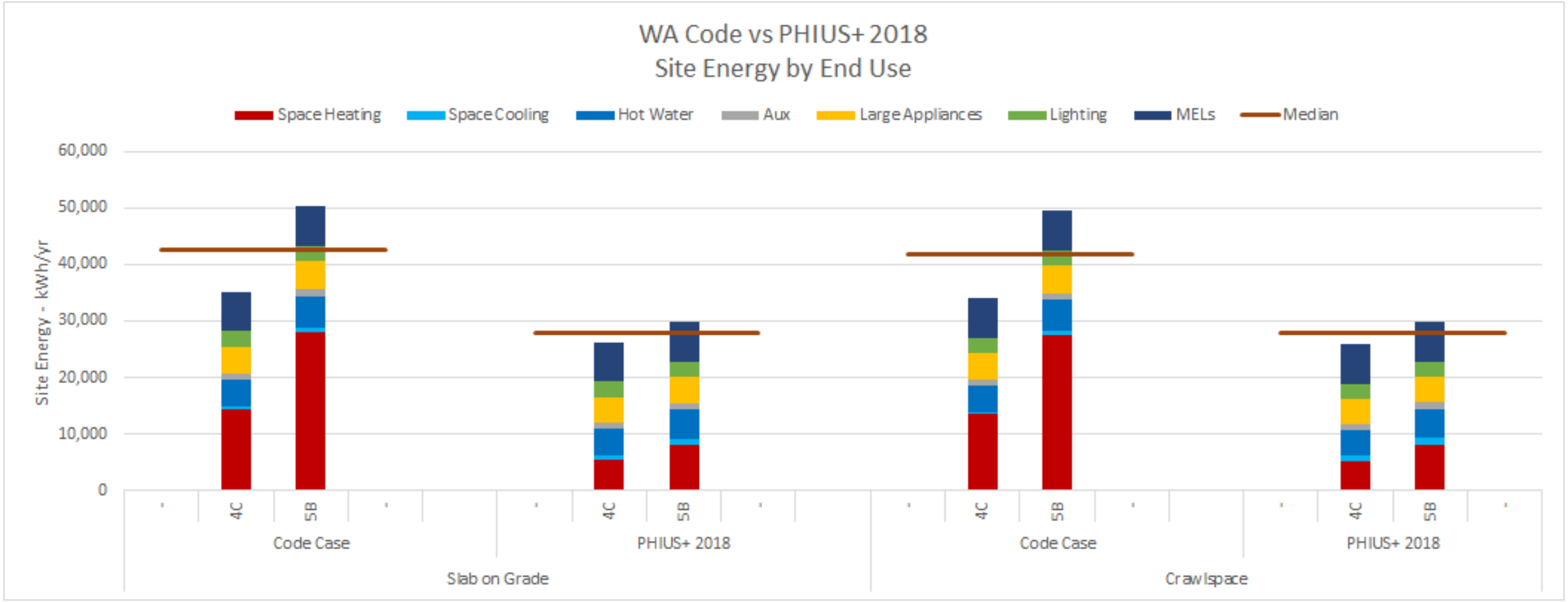
MINIMIZED, EFFICIENT MECHANICAL SYSTEMS

Cost optimal sweet-spot for investment in conservation

- *Window selections constrained based on comfort*
- *Air-tightness set based on PHIUS+ target (durability)*



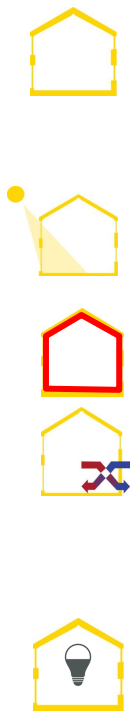




- 3-bdrm Single family, 2 story, 40 x 30 ft, WWR 15%, Seattle & Spokane
- PHIUS performance would still squeeze more out of space heating.

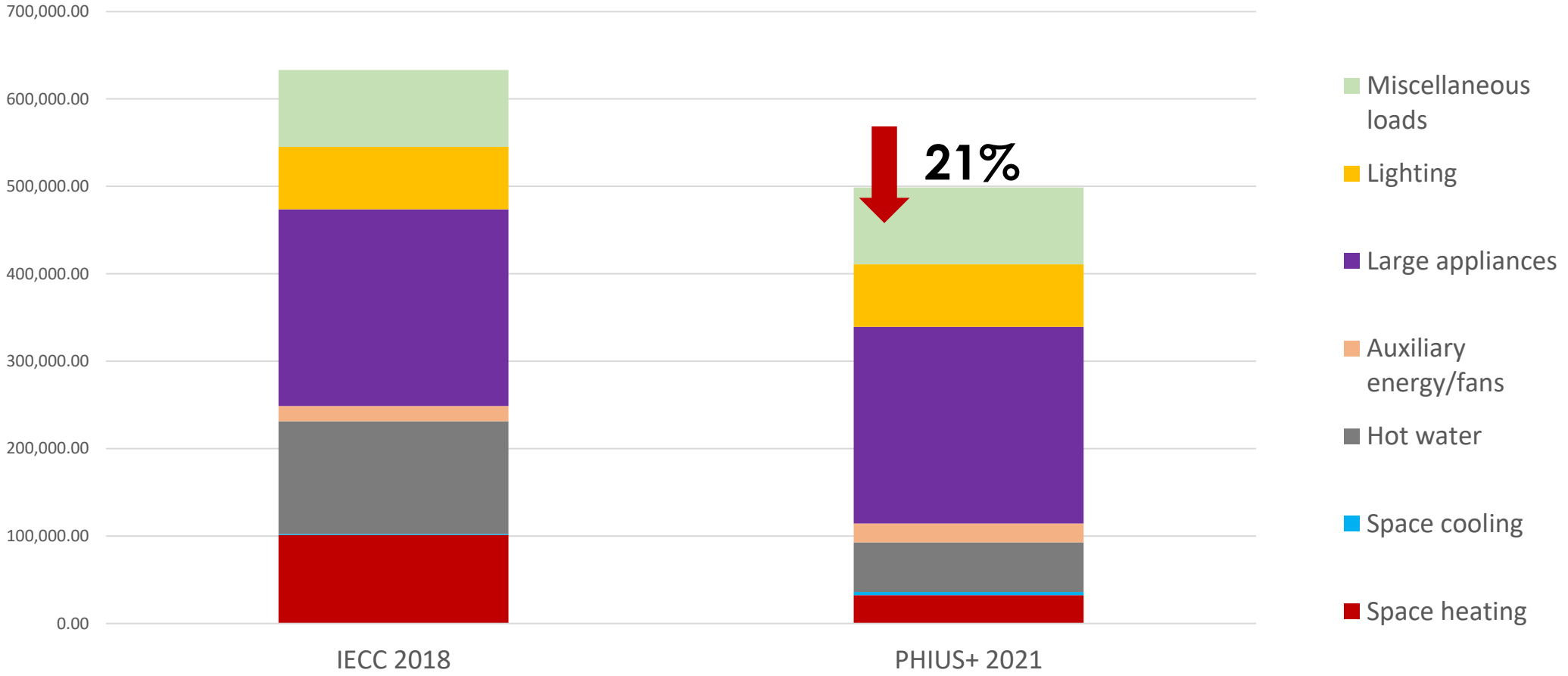
IECC 2018 vs PHIUS+ Comparison

Seattle (Climate Zone 4C) DOE MF Hi-Rise Case Study



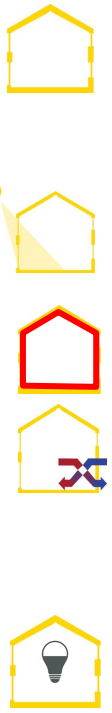
	IECC 2018	PHIUS+ 2021
Walls	R 13+5	R 13+5
Roof	R 30	R 30
Slab	R 5 (15 at Perimeter)	R 5 (15 at Perimeter)
Window U Value	U 0.45	U 0.3
Window SHGC	0.38 / 0.51	0.38 / 0.51
Airtightness/Infiltration	3 ACH50	0.26 ACH50 *(0.060 cfm50/ft2)*
Ventilation Recovery Eff	0	60%
Ventilation Strategy	Exhaust Only	Balanced
Heating COP	3	3
Cooling COP	5	5
Water Heater EF	0.96	3.93
Appliances	Energy Star	Energy Star
Site EUI Before Renewables	**19.47 kBTU/ft2.yr**	**13.9 kBTU/ft2.yr**
Renewable Energy Production for Zero	**469,658 kWh/yr**	**335,217.8 kWh/yr**

High Rise Residential Comparison, Climate Zone 4C, Seattle, WA



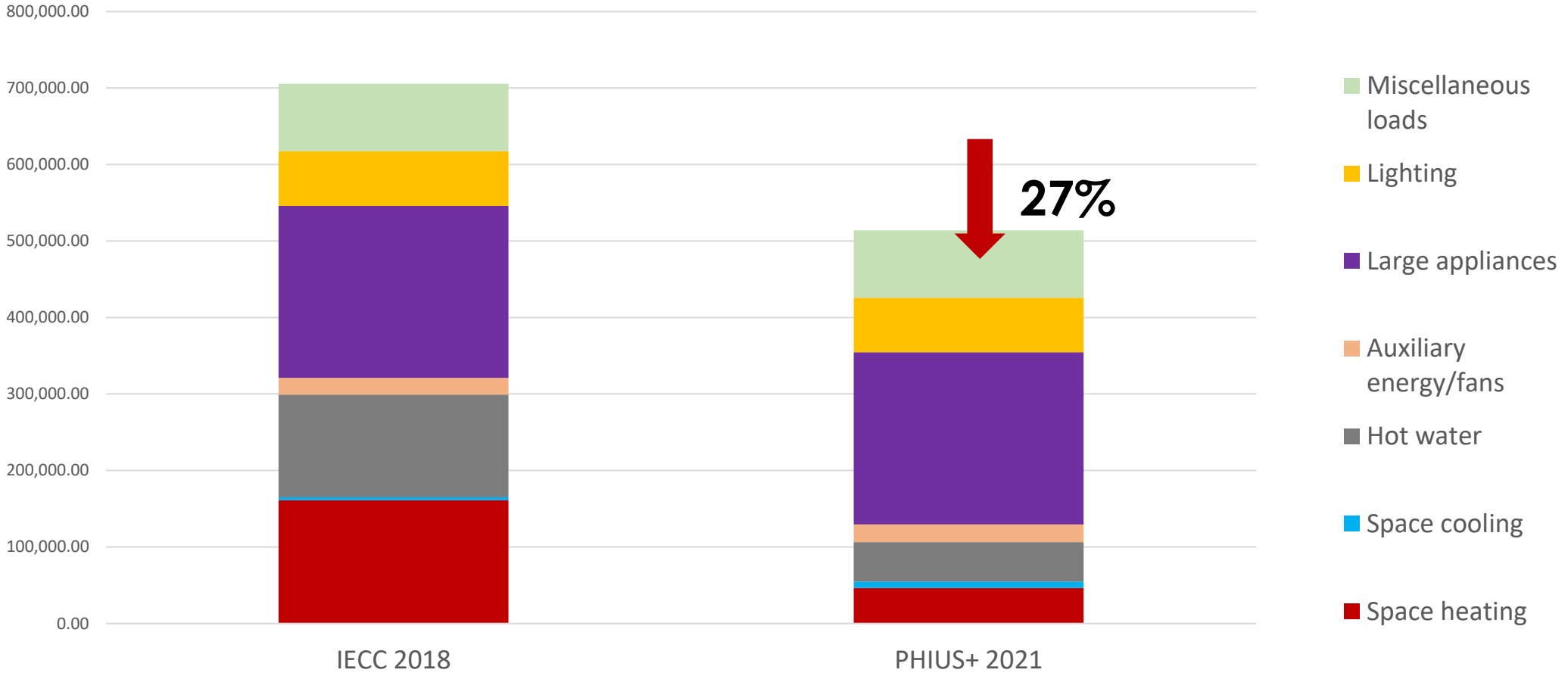
IECC 2018 vs PHIUS+ Comparison

Spokane (Climate Zone 5B) DOE MF Hi-Rise Case Study



	IECC 2018	PHIUS+ 2021
Walls	R 13+5	R 20+10
Roof	R 30	R 60
Slab	R 5 (15 at Perimeter)	R 5 (15 at Perimeter)
Window U Value	U 0.45	U 0.3
Window SHGC	0.38 / 0.51	0.38 / 0.51
Airtightness/Infiltration	3 ACH50	0.26 ACH50 *(0.060 cfm50/ft2)*
Ventilation Recovery Eff	0	75%
Ventilation Strategy	Exhaust Only	Balanced
Heating COP	3	3
Cooling COP	5	5
Water Heater EF	0.96	3.93
Appliances	Energy Star	Energy Star
Site EUI Before Renewables	**22.47 kBTU/ft2.yr**	**14.53 kBTU/ft2.yr**
Renewable Energy Production for Zero	**541,906 kWh/yr**	**350,443 kWh/yr**

High Rise Residential Comparison, Climate Zone 5B, Spokane, WA



Affordable Housing Successes

In 2015, PHFA (Pennsylvania Housing Finance Agency) wrote Passive Building certification into their LIHTC Application.

In **2015**, the passive building projects came in **+2%** in up-front costs vs the other buildings.

In **2016** **-2%**

In **2018** **-2%**

This sparked 15 additional states to include Passive building in their LIHTC application, and 16 additional in process.

https://passivehouseaccelerator.com/articles/2019-new-gravity-housing-conference-july-1st-2nd

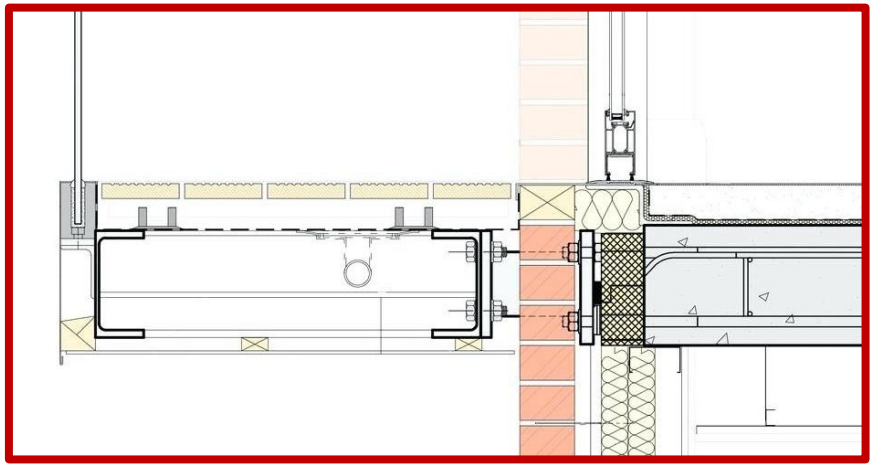
Thermal bridging - Seattle

- Concrete balcony
  - Provide R-10 thermal break –stainless steel re-bar penetrations OK
  - Or component performance (target UA)
  - Seattle 2015 baseline is mass wall insulation value (U-0.057)
  - 2018 value will be *less* stringent (U-0.10)
- Fenestration frame
  - Align continuous insulation & thermal break within 2” of glass plane
  - Insulate “exposed” rough opening to R-3

C402.2.9 Concrete balconies

Above-grade concrete slabs that penetrate the *building thermal envelope*, including but not limited to decks and balconies, shall each include a minimum **R-10 thermal break**, aligned with the primary insulating layer in the adjoining wall assemblies. Stainless steel reinforcing bars are permitted to penetrate the thermal break.

If the component performance alternative in Section C402.1.5 is utilized and the thermal break required by this section is not provided where concrete slabs penetrate the building thermal envelope, the sectional area of the penetration shall be assigned the **default U-factors** from the "exposed concrete" row of Table A103.3.7.2. *(**U-0.741** for 8" slab)*



Balconies & Exposed Slabs

Results from thermal modeling using calibrated finite element 3-dimensional software

R-values for 8’8” High Wall - No Balcony or slab (Center of Wall)

Insulation Strategy	Effective R-value
1” XPS (R-5) + R-12 batts/steel studs	**R-14.3**
2” XPS (R-10) + R-12 batts/steel studs	**R-19.7**
3” XPS (R-15) + R-12 batts/steel studs	**R-24.7**

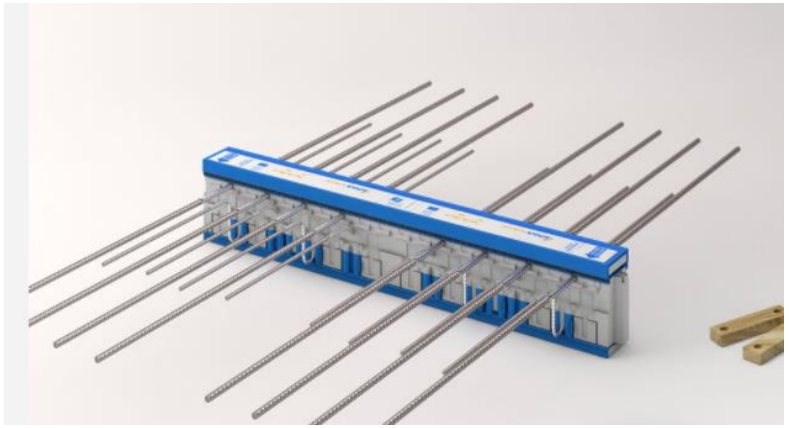
R-values for 8’8” High Wall <u>with Balcony Slab</u>

Insulation Strategy	Effective R-value
1” XPS (R-5) + R-12 batts/steel studs	**R-7.5 (-48%)**
2” XPS (R-10) + R-12 batts/steel studs	**R-8.9 (-55%)**
3” XPS (R-15) + R-12 batts/steel studs	**R-10.0 (-60%)**

RDH

Insulated Balcony Approaches

- Steel bolt-on balconies
- Structural thermal break
  - How much extra do they cost anyway?
- Custom Approaches
  - Supported by exterior columns with discrete attachments to slab edge



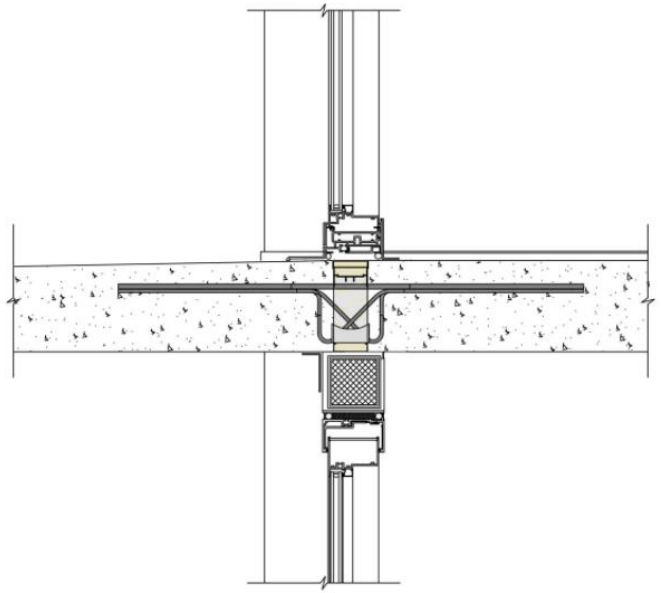
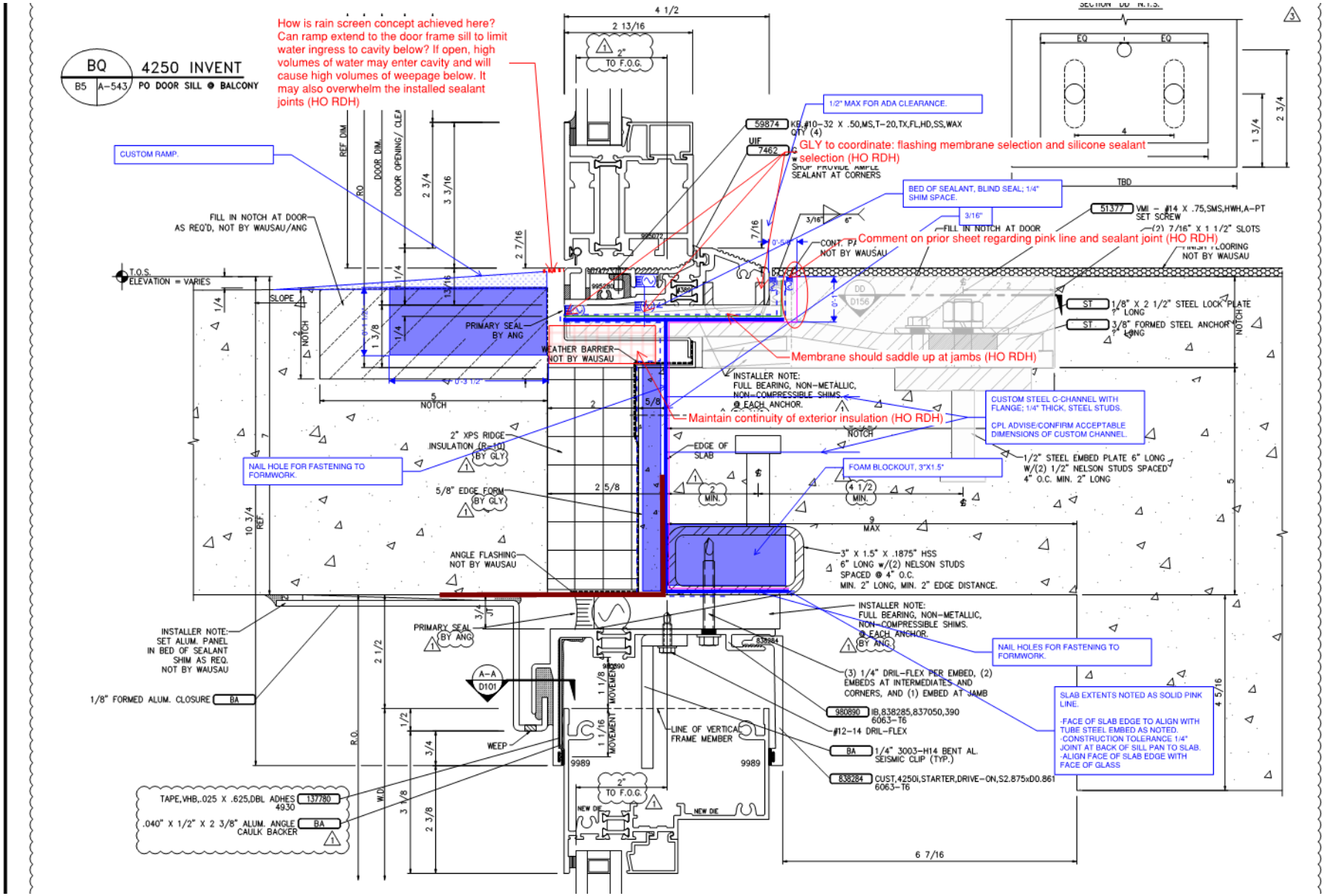
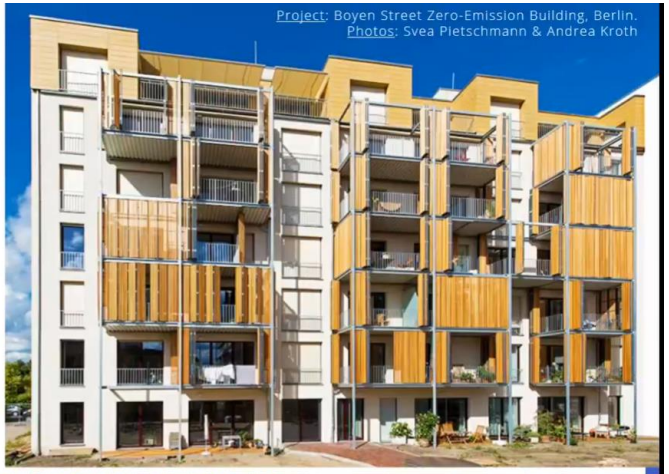


Image Credit: Shock

RDH


How is rain screen concept achieved here? Can ramp extend to the door frame sill to limit water ingress to cavity below? If open, high volumes of water may enter cavity and will cause high volumes of weepage below. It may also overwhelm the installed sealant joints (HO RDH)
BQ
B5 A-543
4250 INVENT
PO DOOR SILL @ BALCONY
CUSTOM RAMP.
FILL IN NOTCH AT DOOR AS REQ'D, NOT BY WAUSAU/ANG
T.O.S. ELEVATION = VARIES
SLOPE
PRIMARY SEAL BY ANG
WEATHER BARRIER NOT BY WAUSAU
NOTCH
2" XPS RIDGE INSULATION (R=10) BY GLY
NAIL HOLE FOR FASTENING TO FORMWORK.
5/8" EDGE FORM BY GLY
ANGLE FLASHING NOT BY WAUSAU
INSTALLER NOTE: SET ALUM. PANEL IN BED OF SEALANT SHIM AS REQ. NOT BY WAUSAU
1/8" FORMED ALUM. CLOSURE BA
TAPE,VHB,.025 X .625,DBL ADHES 4930 137780
.040" X 1/2" X 2 3/8" ALUM. ANGLE CAULK BACKER BA
WEEP
LINE OF VERTICAL FRAME MEMBER
1/2" MAX FOR ADA CLEARANCE.
59874 KB,#10-32 X .50,MS,T-20,TX,FL,HD,SS,WAX QTY (4)
UIF 7462
GLY to coordinate: flashing membrane selection and silicone sealant selection (HO RDH)
BED OF SEALANT, BLIND SEAL; 1/4" SHIM SPACE.
CONT. PT NOT BY WAUSAU
Comment on prior sheet regarding pink line and sealant joint (HO RDH)
51377 VMI - #14 X .75,SMS,HWH,A-PT SET SCREW
(2) 7/16" X 1 1/2" SLOTS
FINISH FLOORING NOT BY WAUSAU
Membrane should saddle up at jambs (HO RDH)
INSTALLER NOTE: FULL BEARING, NON-METALLIC, NON-COMPRESSIBLE SHIMS @ EACH ANCHOR.
Maintain continuity of exterior insulation (HO RDH)
CUSTOM STEEL C-CHANNEL WITH FLANGE; 1/4" THICK, STEEL STUDS.
CPL ADVISE/CONFIRM ACCEPTABLE DIMENSIONS OF CUSTOM CHANNEL.
EDGE OF SLAB
FOAM BLOCKOUT, 3"X1.5"
1/2" STEEL EMBED PLATE 6" LONG W/(2) 1/2" NELSON STUDS SPACED 4" O.C. MIN. 2" LONG
1/8" X 2 1/2" STEEL LOCK PLATE 7" LONG
3/8" FORMED STEEL ANCHOR 7" LONG
3" X 1.5" X .1875" HSS 6" LONG w/(2) NELSON STUDS SPACED @ 4" O.C. MIN. 2" LONG, MIN. 2" EDGE DISTANCE.
INSTALLER NOTE: FULL BEARING, NON-METALLIC, NON-COMPRESSIBLE SHIMS @ EACH ANCHOR BY ANG.
NAIL HOLES FOR FASTENING TO FORMWORK.
(3) 1/4" DRIL-FLEX PER EMBED, (2) EMBEDS AT INTERMEDIATES AND CORNERS, AND (1) EMBED AT JAMB
980890 IB,838285,837050,390 6063-T6
#12-14 DRIL-FLEX
BA 1/4" 3003-H14 BENT AL. SEISMIC CLIP (TYP.)
838284 CUST,4250I,STARTER,DRIVE-ON,S2.875xD0.861 6063-T6
SLAB EXTENTS NOTED AS SOLID PINK LINE.
-FACE OF SLAB EDGE TO ALIGN WITH TUBE STEEL EMBED AS NOTED.
-CONSTRUCTION TOLERANCE 1/4" JOINT AT BACK OF SILL PAN TO SLAB.
-ALIGN FACE OF SLAB EDGE WITH FACE OF GLASS
TBD
6 7/16

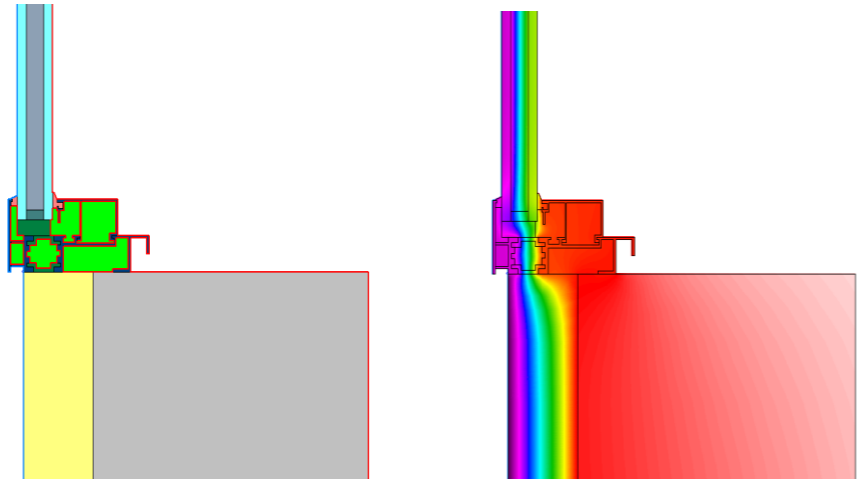

Project: Boyen Street Zero-Emission Building, Berlin.
Photos: Svea Pietschmann & Andrea Kroth


A2M Bureau d'Architecture

C402.2.10 *Vertical fenestration* intersection w/ opaque walls

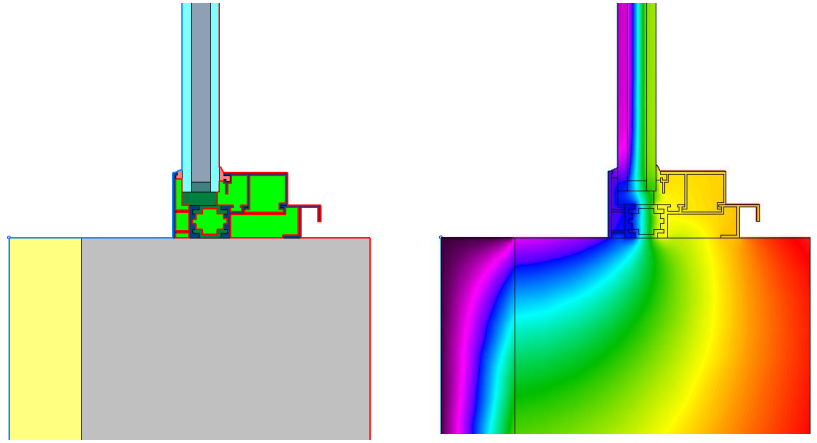
- Where wall assemblies include *continuous insulation*, the exterior glazing layer of *vertical fenestration* and any required thermal break in the frame shall each be aligned within 2 inches (50 mm) of either face of the *continuous insulation* layer.
- Where wall assemblies do not include *continuous insulation*, the exterior glazing layer of *vertical fenestration* and any required thermal break in the frame shall each be aligned within the thickness of the *wall* insulation layer and not more than 2 inches (50 mm) from the exterior face of the outermost insulation layer.
- Where the exterior face of the *vertical fenestration* frame does not extend to the exterior face of the opaque wall rough opening, the exposed exterior portion of the rough opening shall be covered with either a material having an *R-value* not less than R-3, or with minimum 1.5-inch (38 mm) thickness wood.

Alignment of Glazing and Insulation



Aligned with insulation layer

Ψ = 0.013 BTU/hr.ft.F

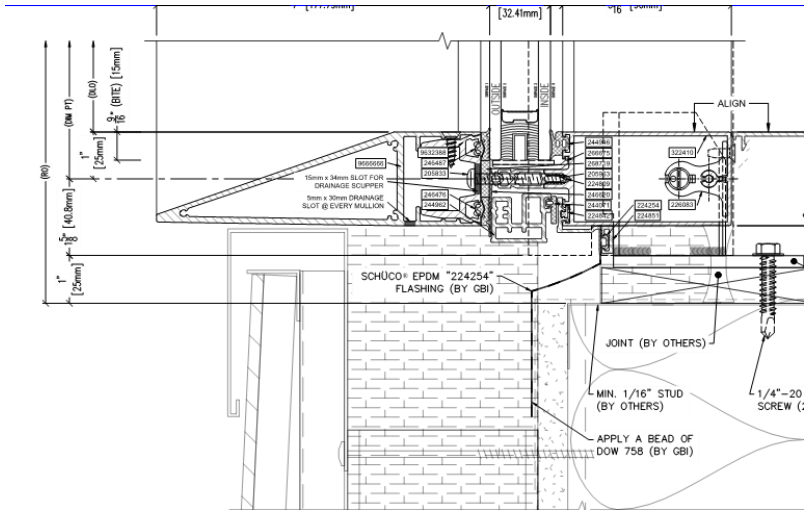


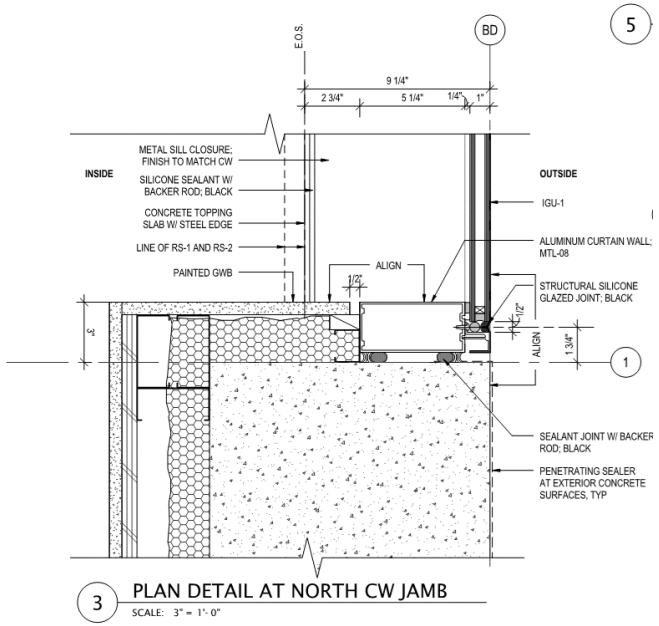
Aligned with concrete

Ψ = 0.241 BTU/hr.ft.F

RDH

Alignment of Glazing and Insulation

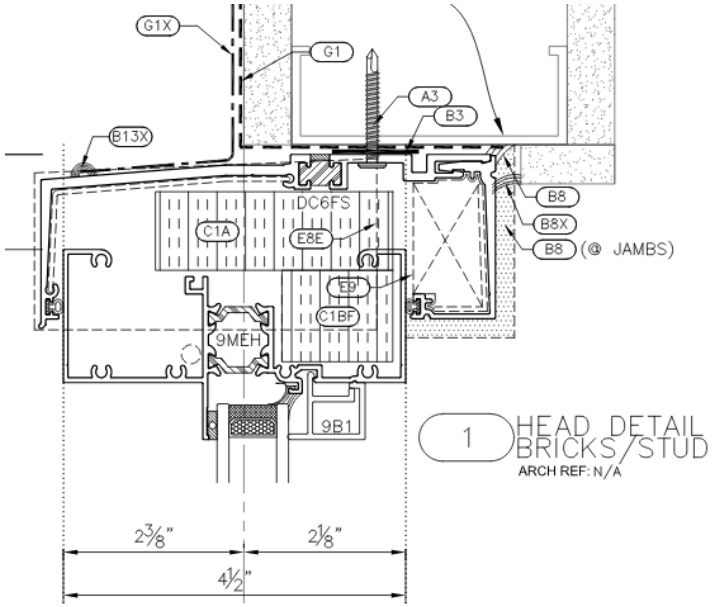


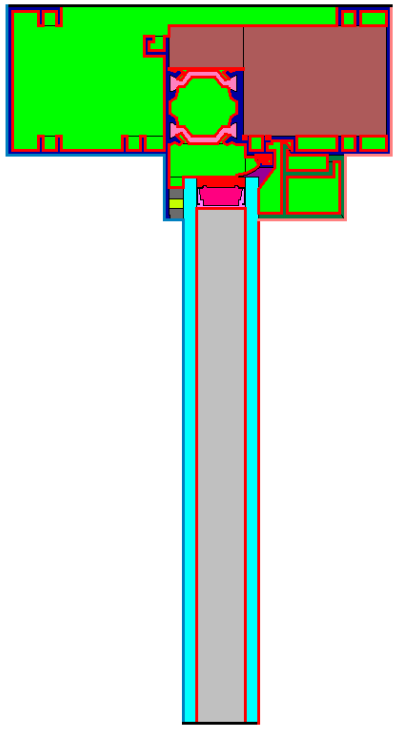


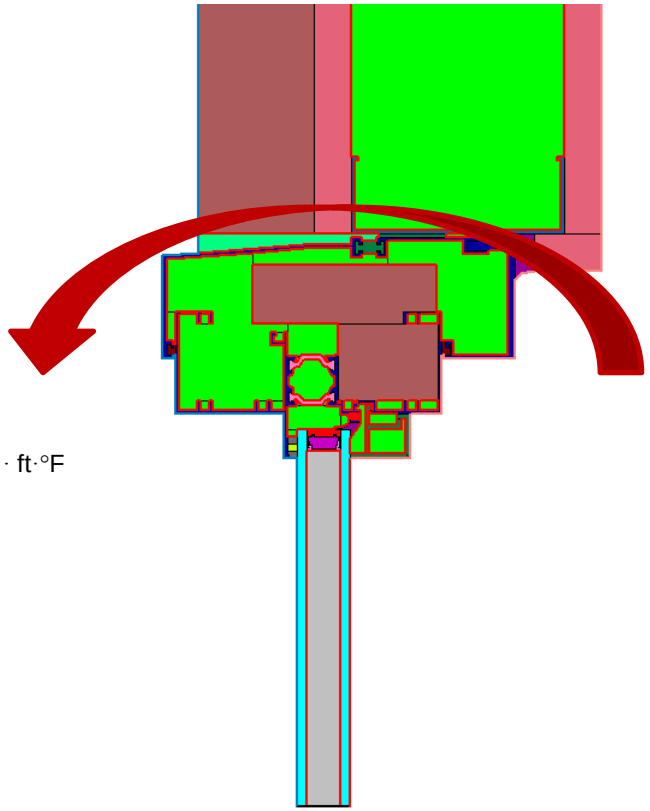
RDH

Windows

Getting back to reality







Reality

Label

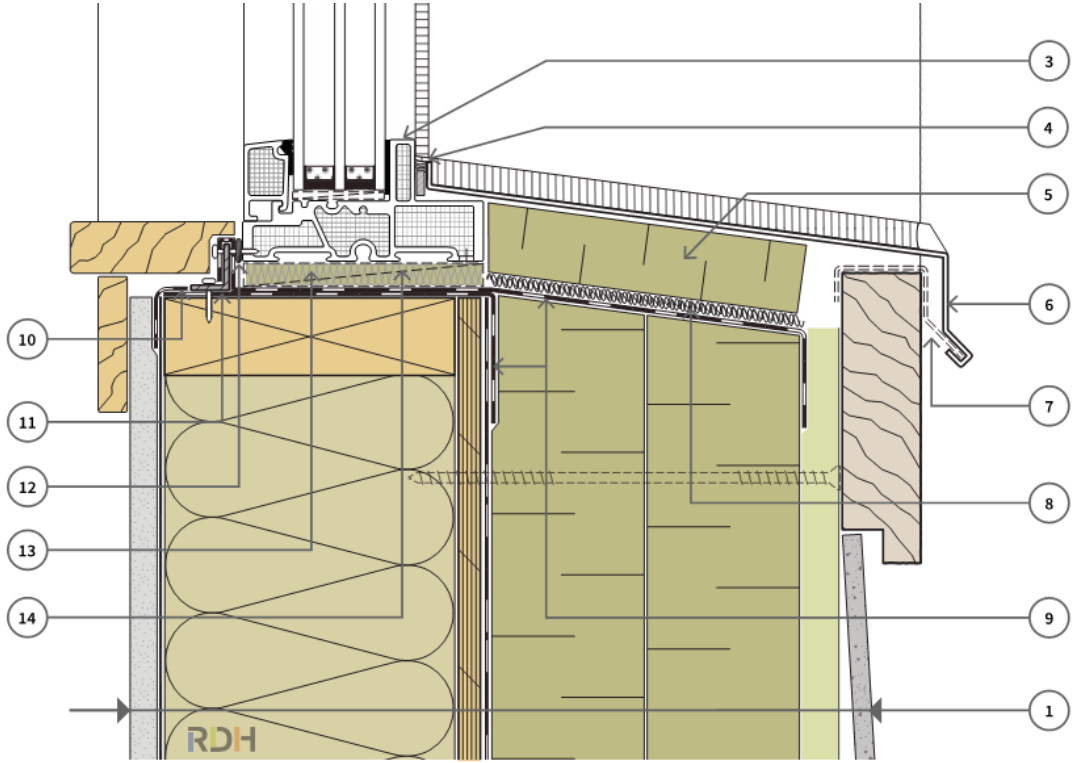
U-0.35

Installed

U-0.47 (33% ↑)

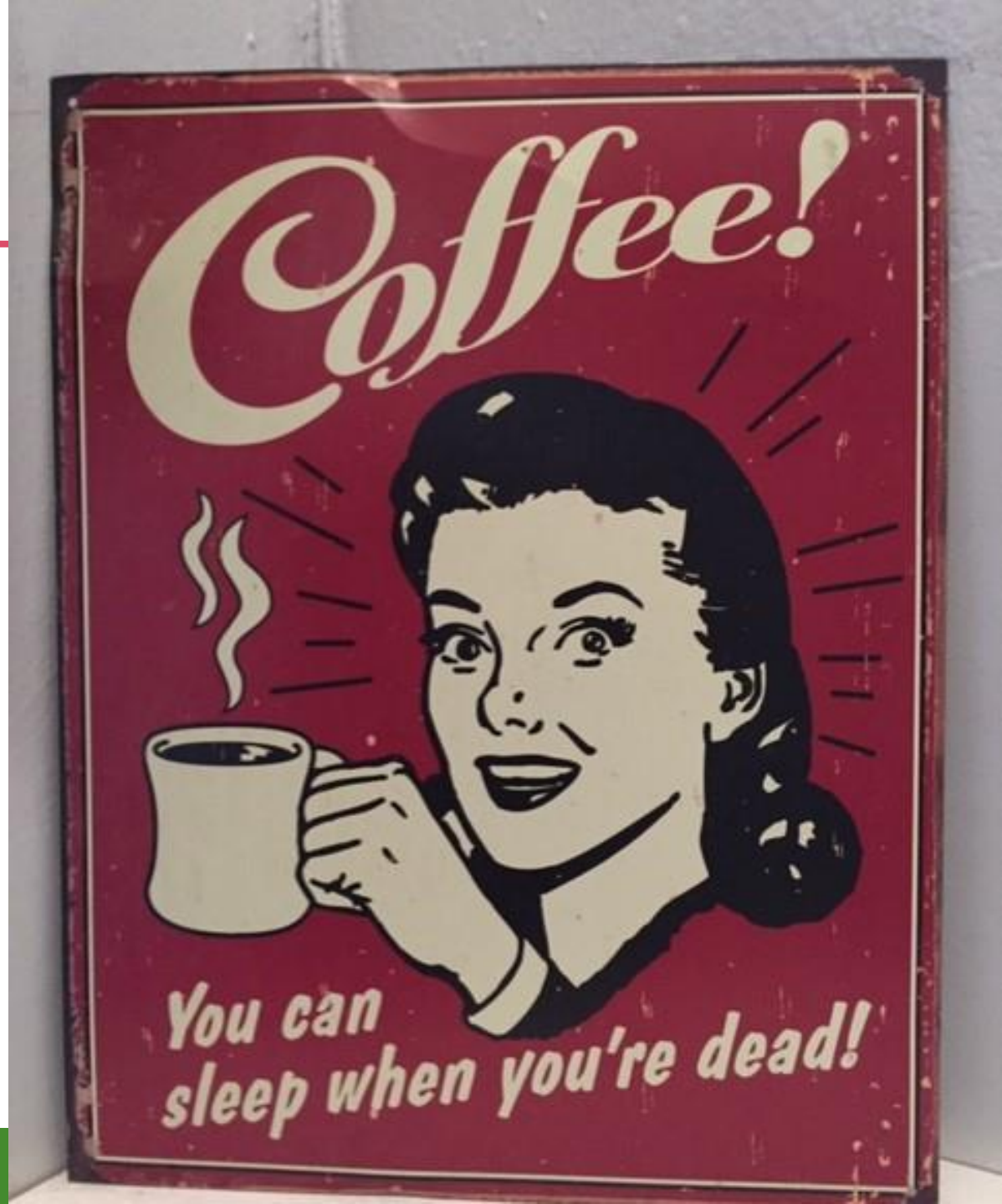
Window Installation

"Over-insulated" Frames



Drawing: RDH Building Science

Break Time!



HB 1112: Propellants & Polyurethane Foams

It's not the foam type…

…it's the blowing agent.

2020

- Rigid polyurethane
- Flexible polyurethane
- Integral skin polyurethane
- Polyolefin
- Phenolic insulation board

2021

- Polystyrene board
- Rigid polyurethane spray foam

Above dates are *install,* not permit date

Available Foam Products – low GWP

- Spray Foam
  - Demilec HeatLok HFO Pro
  - BASF Spraytite Comfort
  - GacoOnePass
  - DuPont Froth-Pak is transitioning.

- XPS Foam Board
  - Owens Corning Foamular NGX
  - DuPont Styrofoam
    - Beginning in the 4th quarter of 2020, with a complete Canadian conversion ready by January 1, 2021, DuPont will transition its heritage Blue Styrofoam™ Brand XPS Boardstock family of products to a new Grey, reduced GWP product line.

Seattle: Space heating

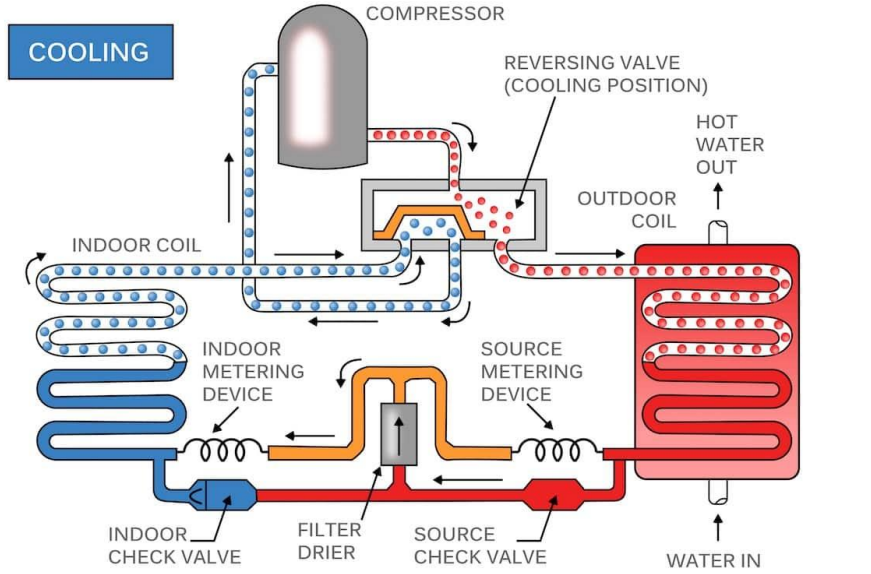
No electric resistance or fossil fuel combustion for space heating

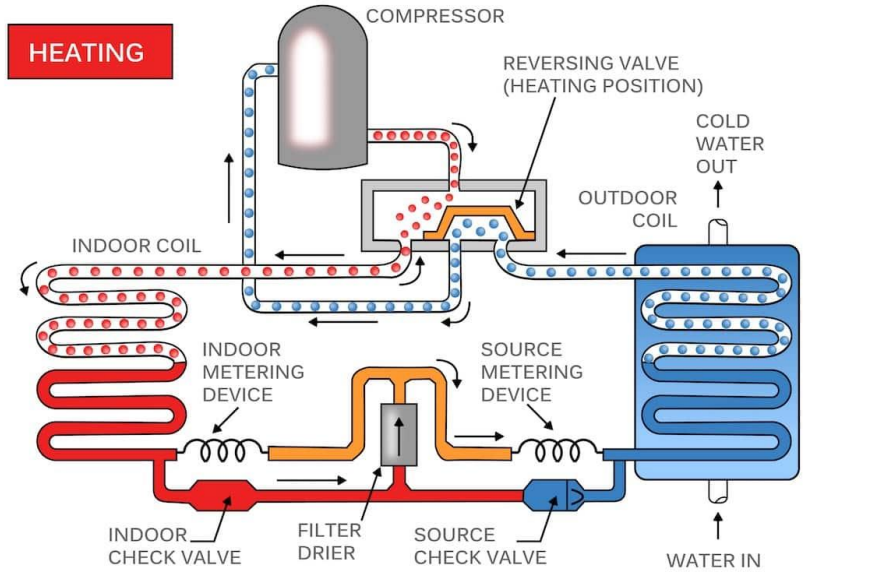
(Usually means “Heat with heat pumps”)

Exceptions allow electric resistance heat for:

1. ~~**Permits applied for before 1/1/22**~~
2. Dwelling units: Max **750 W** per habitable room (**1000 W** for corner room)
3. Other space types: Max 2.5 W/sf total installed heating (The “Passive House” rule)
4. Heat pump auxiliary heat in cold weather
5. Buildings smaller than 2,500 sf

So, how do you design envelopes to do this?

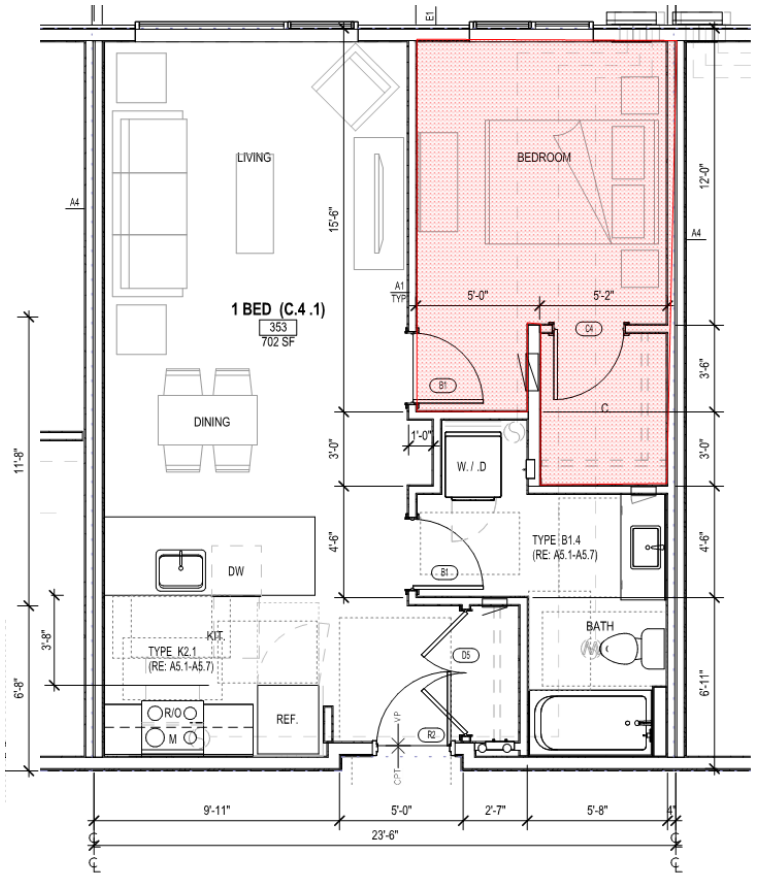




Heat pumps squeeze warmth out of cold air

Electric Resistance Case Studies

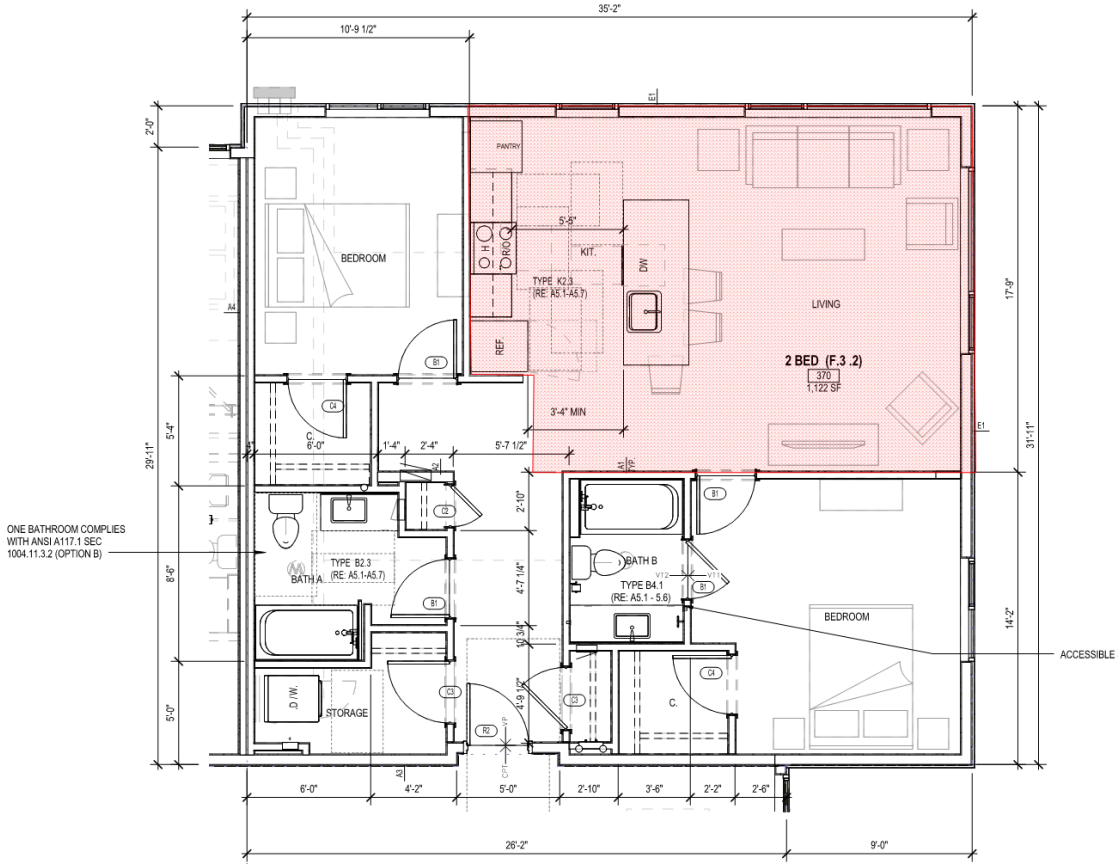
- Typical Bedroom <750W.
- One large (6'x7') sliding glass door (40% glazing).
  - Wood-Framed Construction with punched windows
    - Heat Capacity ≈ 400W
  - Steel-Framed Construction with unitized glazing
    - Heat Capacity ≈ 475W
- Takeaway: Large glazing percentages still possible for small rooms with approximately 10-12 feet of exterior wall



Electric Resistance Case Studies

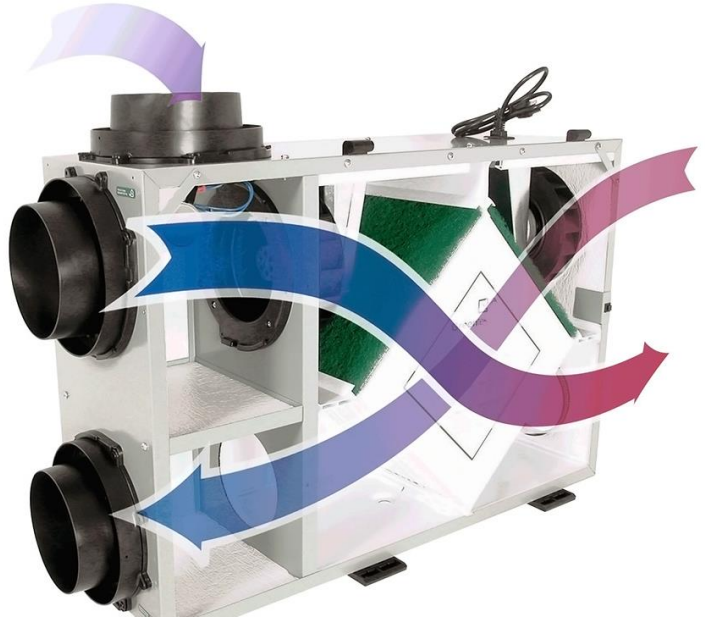
- Corner Living Room
- 24’x18’ living room
- 35% glazing
  - Wood-Framed Construction with punched windows
    - Heat Capacity ≈ 1000W
  - Steel-Framed Construction with unitized glazing
    - Heat Capacity ≈ 1200W
    - Decrease glazing u-value to U-0.30 to reduce heating capacity to 1kW

- Takeaway: It may be challenging to meet loads in corner units due primarily to higher enclosure areas. Close review required
- These are small capacities!



“Balanced ventilation” for R-2 dwelling units

- Deliver ventilation air directly to each “habitable space”
  - Living room, bedrooms
  - **Trickle vents with bathroom exhaust won’t work anymore**
- Heat recovery required
  - w/ 60% sensible heat recovery effectiveness



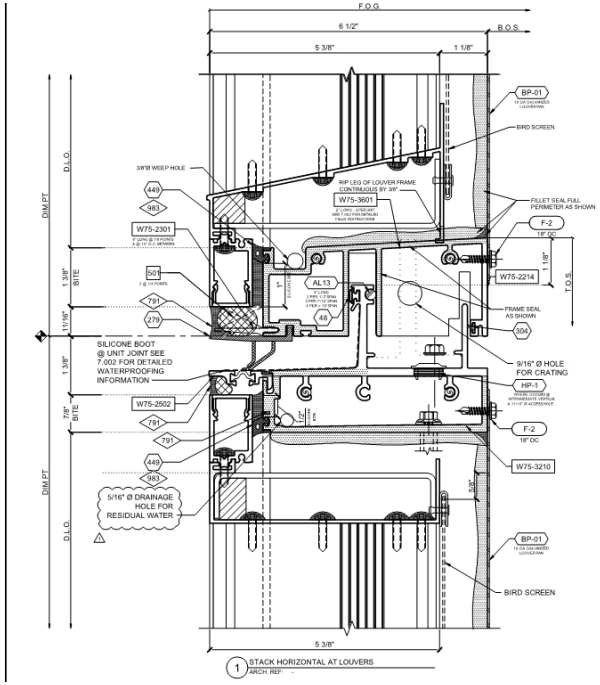
- Individual HRVs in apartments?
  - Many small penetrations
- Rooftop units with vertical shafts?
  - Eats up some rentable floor area

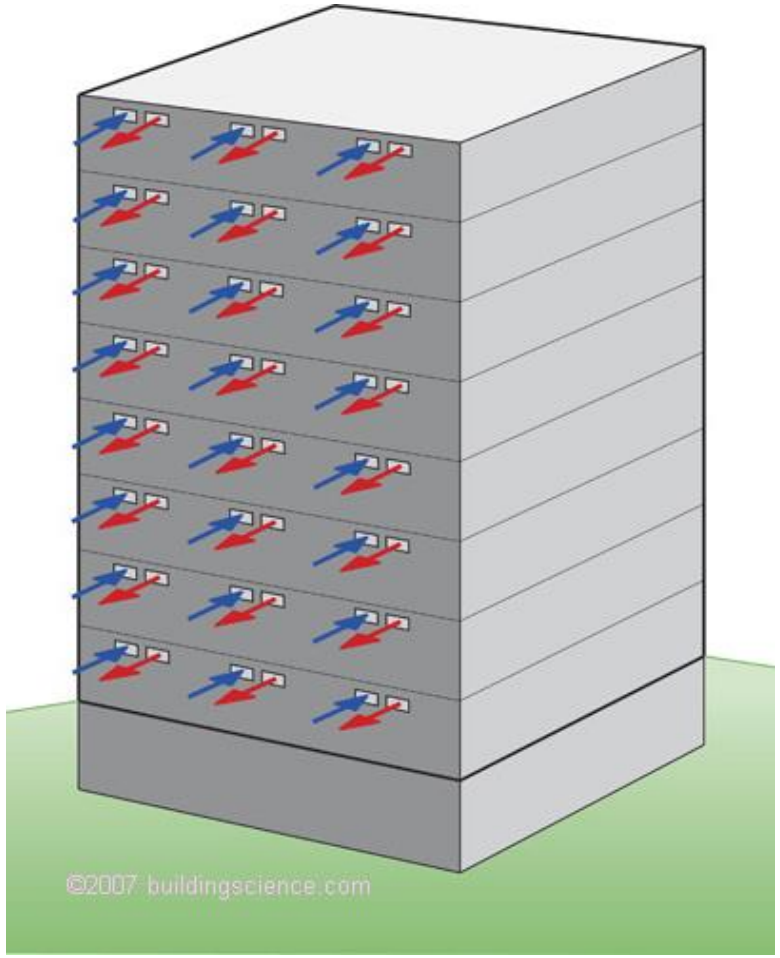
- Floor-by-floor HRVs?
  - Each serving 6 – 8 units
  - Fewer penetrations

Balanced Ventilation and the Envelope

Pros and Cons

- Decentralized Maintenance
- More Penetrations
  - Reduce penetrations with recirculating range hoods and condensing dryers →balanced ventilation
- Less Area, ducts and equipment located in bulkheads



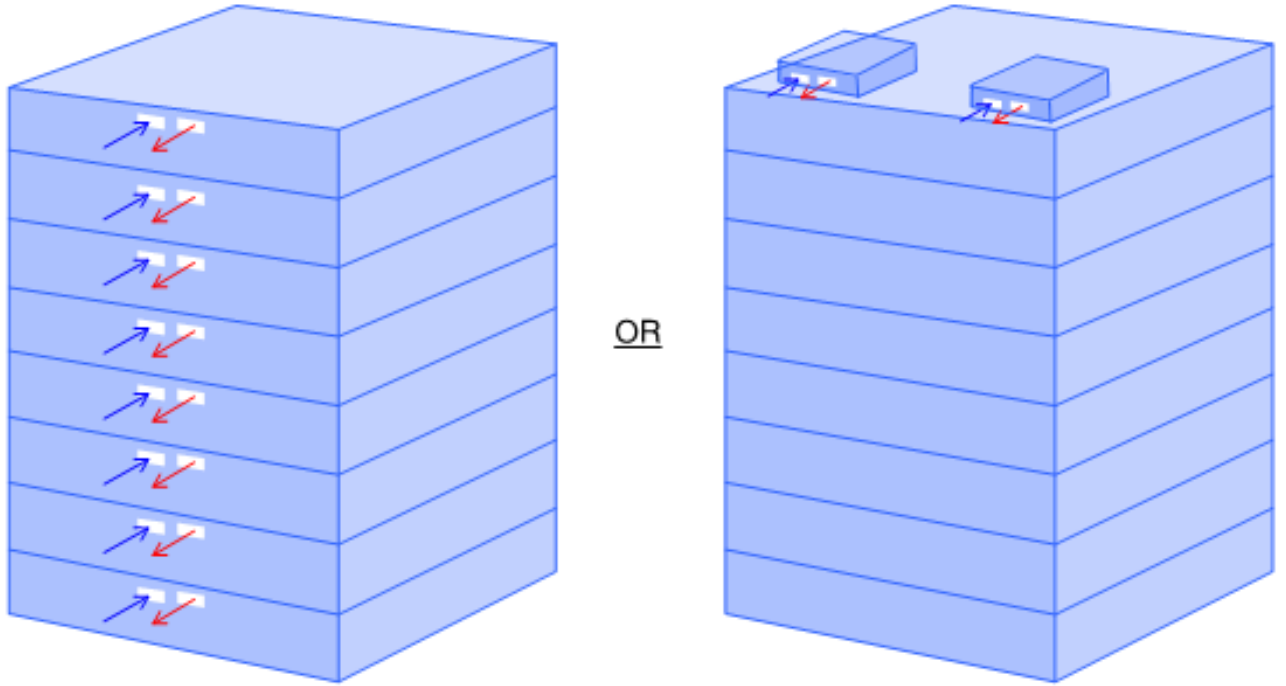


Balanced Ventilation and the Envelope

→1 HRV unit per floor or stacked Roof Top Units

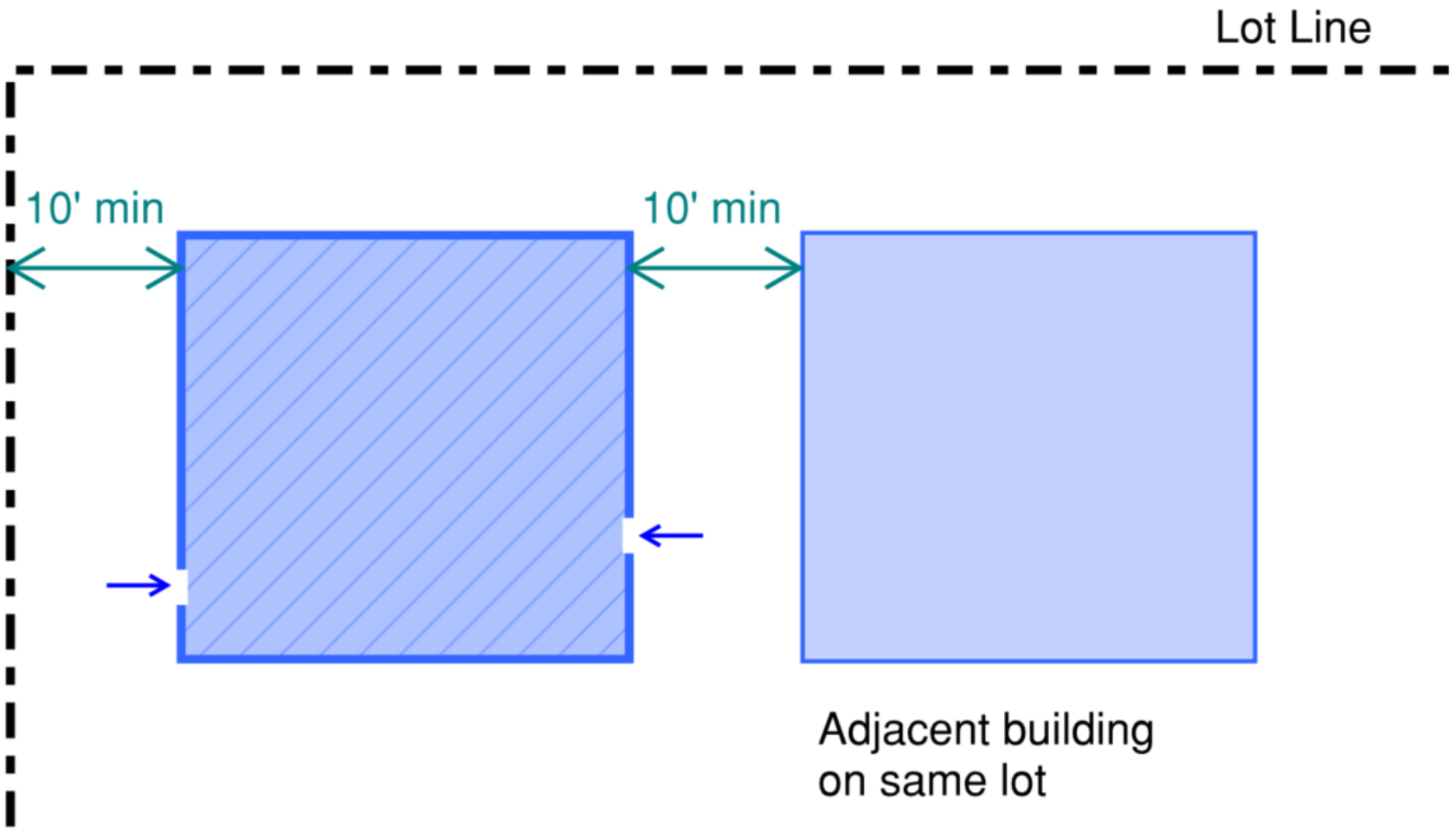
Pros and Cons

- Floor Area!
  - Shafts
- Rooftop Area!
  - Amenity and Solar Space
- Corridor Height
- Extra effort to maintain unit compartmentalization due to ductwork penetrations
  →fire dampers and duct routing
- Difficult to balance through varying wind and stack effect pressures
  →fancy controls ($)
- Easier Maintenance
  - Affordable and student housing



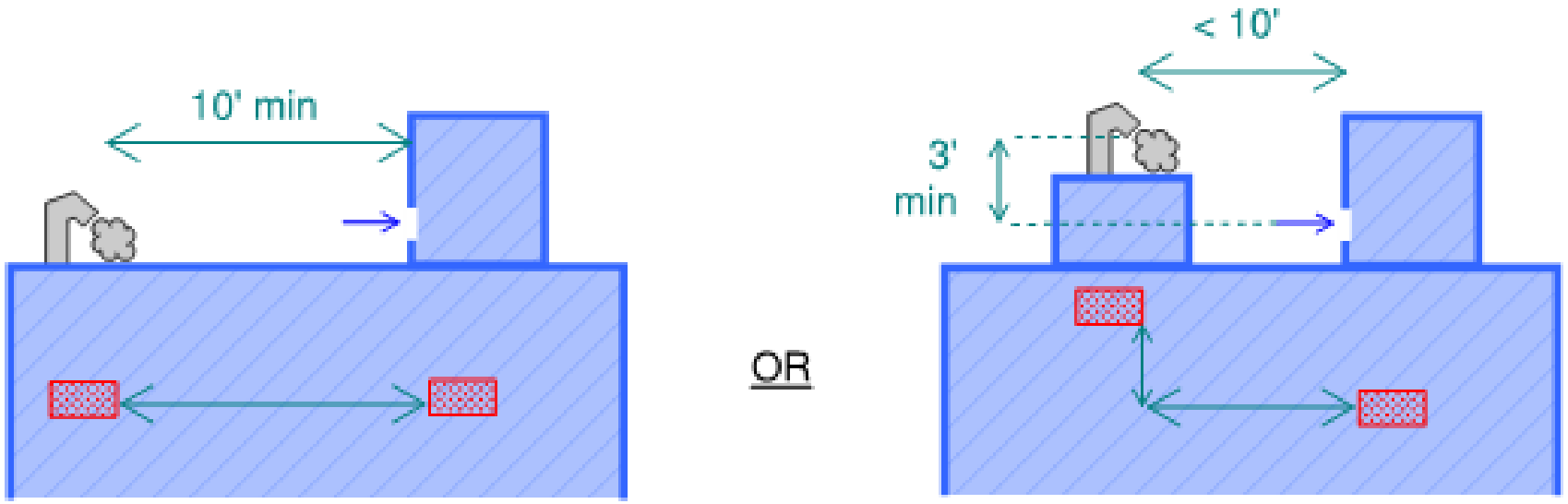
Balanced Ventilation and the Envelope

- Spacing of intake and exhaust (WMC Section 401.4)



Balanced Ventilation and the Envelope

- Spacing of intake and exhaust (WMC Section 401.4)
  - Proximity to hazardous or noxious contaminant source



Exception: factory-built intake/exhaust combination termination fitting is used to separate the air streams

RDH

PTAC: recognize heat loss through wall

C402.1.4.2 Thermal resistance of mechanical equipment penetrations. When the total area of penetrations from through-wall mechanical equipment or equipment listed in Table C403.3.2(3) **exceeds 1 percent** of the opaque *above-grade wall* area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a **default U-factor of 0.5**…

Exception: Where mechanical equipment has been tested in accordance with *approved* testing standards…

Through-wall mechanical equip (PTAC/PTHP)

Table C402.1.4: Add new footnote k to above-grade wall types:

Walls, Above Grade		
Mass[g,k]	((~~U-0.104[d]~~)) U-0.057	((~~U-0.078~~)) U-0.057
Mass transfer deck slab edge[i]	U-0.20	U-0.20
Slab penetrating thermal envelope wall[h]	U-0.10	U-0.10
Metal building[k]	U-0.052	U-0.052
Steel framed[k]	U-0.055	U-0.055
Wood framed and other[k]	((~~U-0.054~~)) U-0.051	U-0.051

k. Through-wall mechanical equipment subject to Section C402.1.4.2 shall be calculated at the U-factor defined in Section C402.1.4.2. The area-weighted U-Factor of the wall, including through-wall mechanical equipment, shall not exceed the value in the table

Renewable energy

- Seattle: **0.25 W/sf**, based on conditioned area of *all* floors
- WA: Appendix E was the 2015 Seattle renewable requirement – 0.07 W/sf
  - If any jurisdictions adopt it!
- Seattle C406.5 is also 0.25 W/sf

Solar readiness

- Solar-ready zone 40% of *net* roof
- Seattle: now includes multifamily
- Solar zone: 4 psf add'l dead load
- Roof sleeve 2"@ 2,500 sf

How big is 0.25w/sf?

- Any size tower floor area
  - If all floors same size
- Area includes space between PV rows

Chart courtesy FSI Engineers

Building Floors	Roof Area Required
1	1.8%
2	3.6%
4	7.2%
6	10.9%
8	14.5%
10	18.1%
12	21.7%
14	25.4%
16	29.0%
18	32.6%
20	36.2%

Solar PV and Roofing

- Ballasted vs. Attached
  - Potential movement for ballasted systems
  - Weight
  - Number of Penetrations
  - Roof access for servicing
  - Roof replacement

- Solar Readiness (Section C411)
  - Structural Load – Dead Load and Wind Load (C411.7)
  - Review roof warranty terms
  - Avoid roof ballast
  - Coverboard and insulation compressive strength
  - PV system vs roof membrane longevity

C406 Credits, Popularity Contest

Table C406.1
Efficiency Package Credits

Code Section	Commercial Building Occupancy					
	Group R-1	Group R-2	Group B	Group E	Group M	All Other
	Additional Efficiency Credits					
1. More efficient HVAC performance in accordance with Section C406.2	2.0	3.0	3.0	2.0	1.0	2.0
2. Reduced lighting power: Option 1 in accordance with Section C406.3.1	1.0	1.0	2.0	2.0	3.0	2.0
3. Reduced lighting power: Option 2 in accordance with Section C406.3.2[a]	2.0	3.0	4.0	4.0	6.0	4.0
4. Enhanced lighting controls in accordance with Section C406.4	NA	NA	1.0	1.0	1.0	1.0
5. On-site supply of renewable energy in accordance with C406.5	3.0	3.0	3.0	3.0	3.0	3.0
6. Dedicated outdoor air system in accordance with Section C406.6[b]	4.0	4.0	4.0	NA	NA	4.0
7. High performance dedicated outdoor air system in accordance with Section C406.7	4.0	4.0	4.0	4.0	4.0	4.0
8. High-efficiency service water heating in accordance with Sections C406.8.1 and C406.8.2	4.0	5.0	NA	NA	NA	8.0
9. High performance service water heating in multi-family buildings in accordance with Section C406.9	7.0	8.0	NA	NA	NA	NA
10. Enhanced envelope performance in accordance with Section C406.10[c]	3.0	6.0	3.0	3.0	3.0	4.0
11. Reduced air infiltration in accordance with Section C406.11[c]	1.0	2.0	1.0	1.0	1.0	1.0
12. Enhanced commercial kitchen equipment in accordance with Section C406.12	5.0	NA	NA	NA	5.0	5.0 (Group A-2 Only)

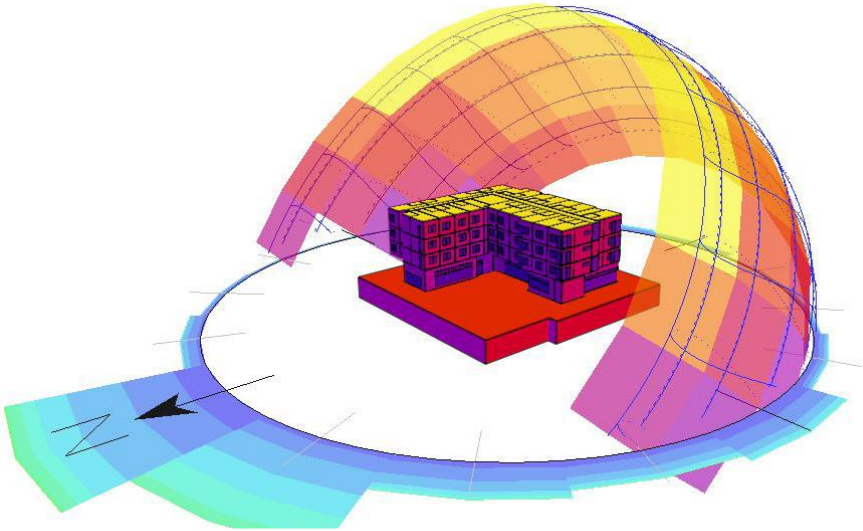
[a] Projects using this option may not use Item 2.
[b] This option is not available to buildings subject to the prescriptive requirements of Section C403.3.5.
[c] Buildings or building areas that are exempt from the thermal envelope requirements in accordance with Sections C402.1.1 and C402.1.2, do not qualify for this package.

Envelope UA
Infiltration

Image credit Ben Roush, FSI Engineers, Seattle

Modeling – Welcome to ASHRAE Appendix G

- Carbon emissions compared with 2004 ASHRAE 90.1 standard
- Seattle: 10% *lower* than WA code
- BPF: Building Performance Factor



SEATTLE 10% lower									
Building Area Type	Multi family	Health care	Hotel	Office	Rest.	Retail	School	Ware house	Others
Building Performance Factor	~~0.56~~ 0.50	~~0.54~~ 0.49	~~0.64~~ 0.58	~~0.54~~ 0.49	~~0.73~~ 0.66	~~0.47~~ 0.42	~~0.36~~ 0.32	~~0.48~~ 0.43	~~0.54~~ 0.49

Modeling: Limits on sub-standard envelope

- WA: Modeled envelope heat loss cannot be more than **20% worse** than prescriptive
- **Seattle: Modeled envelope heat loss cannot be more than *10%* worse than prescriptive**

Additions C502

- Addition alone can comply
- or (existing + addition)
- Prescriptive projects also follow C502.2 rules
  - Fenestration area, skylight area, etc.
- Additions over 500 sf require C406 options

Alterations: Ground Rules C503

- You don't have to upgrade what you don't touch
  - …if it met code back when it was built
  - …there are a few exceptions
- But new stuff has to meet current code
- "Substantial Alterations" Comply with C503.8
- Don't harm anything protected by Landmarks
- Code official discretion if full compliance is physically or economically "impractical"
  - …so come talk with us

Exceptions to envelope alteration rules:

<u>These *don't* have to meet code:</u>

- Storm windows
- Replacement glass
- Cavities not exposed
- Cavities exposed
  - if filled with insulation
- Roof *recover* (not *replacement*)
- Simple door replacement doesn't require vestibule
- Air leakage testing not required unless substantial alteration

Minimum Energy Performance for "Substantial Alterations" C503.8

- Once in a generation opportunity for "deep green" retrofit
- For major alterations (like complete gut-and-remodel) close to full compliance required

- "*…substantially extend the useful physical or economic life of the building*"
- Vacant for > 24 months
- Four compliance paths
- "Impracticality" clause

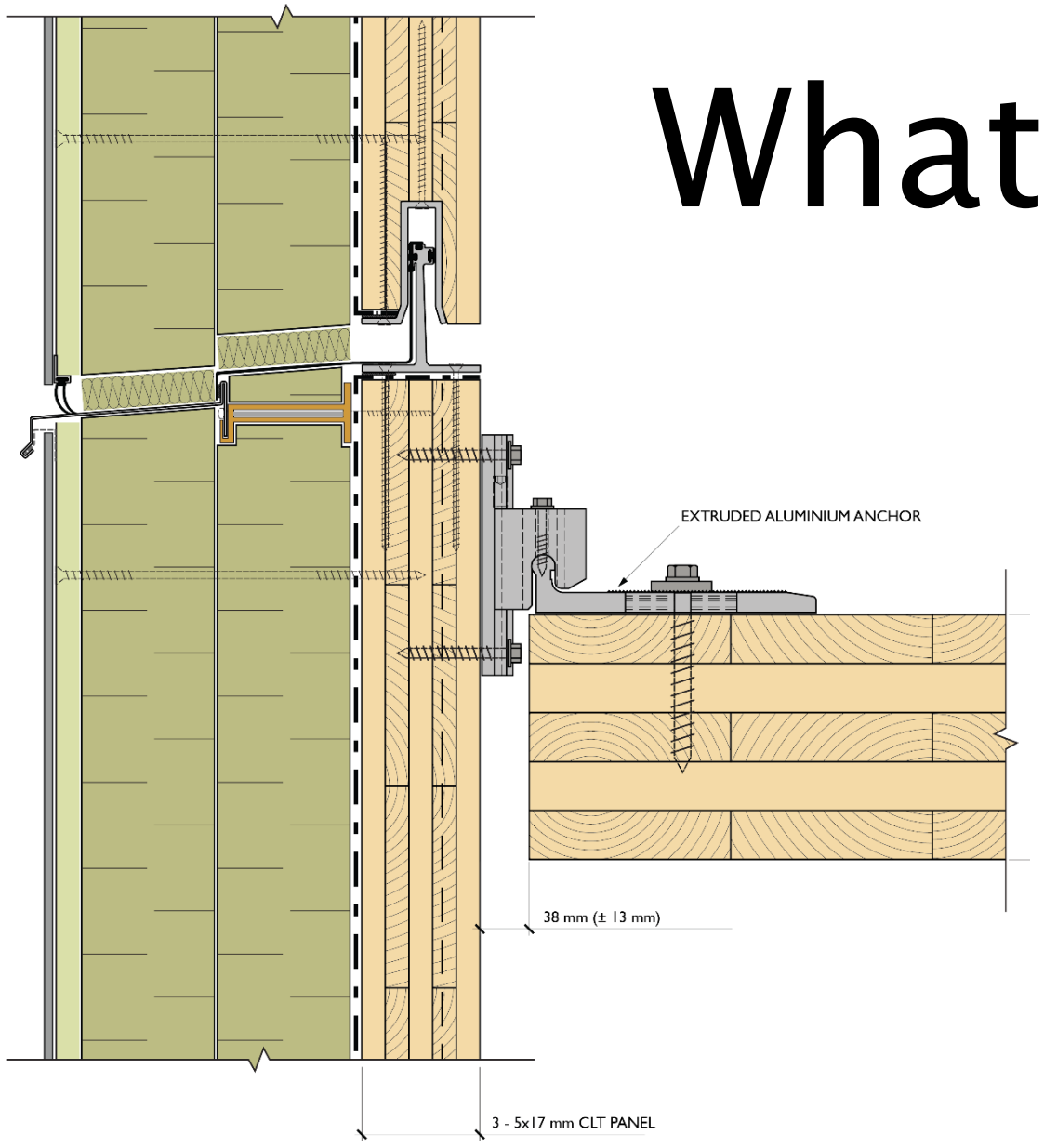
Substantial Alterations Exceptions & Options C503.8

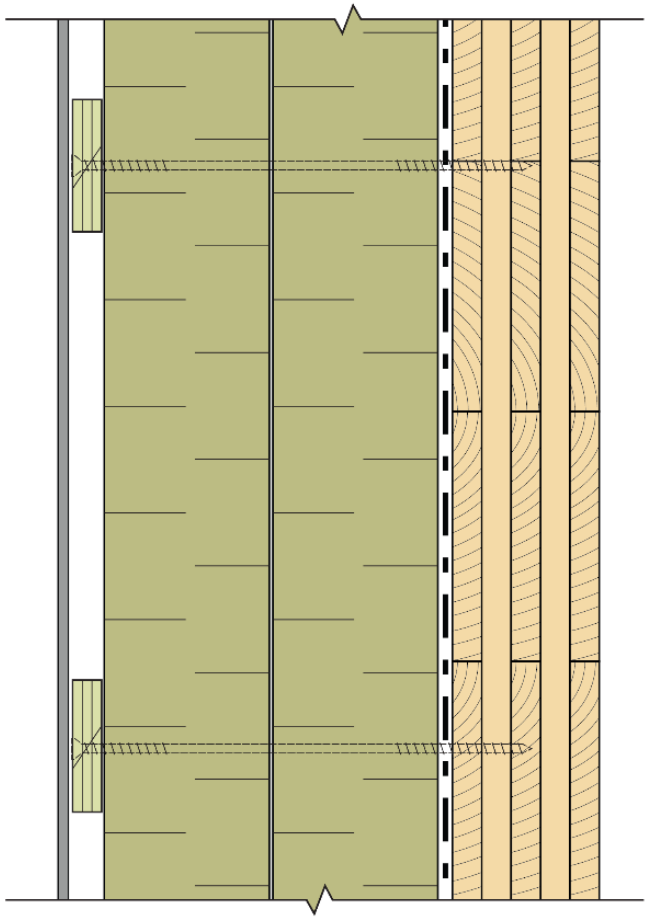
- Exceptions
  - Building features protected by Landmarks
  - URM (only) projects
  - Recently-constructed vacant buildings
  - “Impractical”
- Options
  1. Full prescriptive code compliance
  2. UxA 15% higher than code
  3. TBP 10% more energy use than allowed by code
  4. Target Performance Path option
- Similar rules for change of use & change of space conditioning

How should we build *today* for carbon-neutral city *tomorrow*?

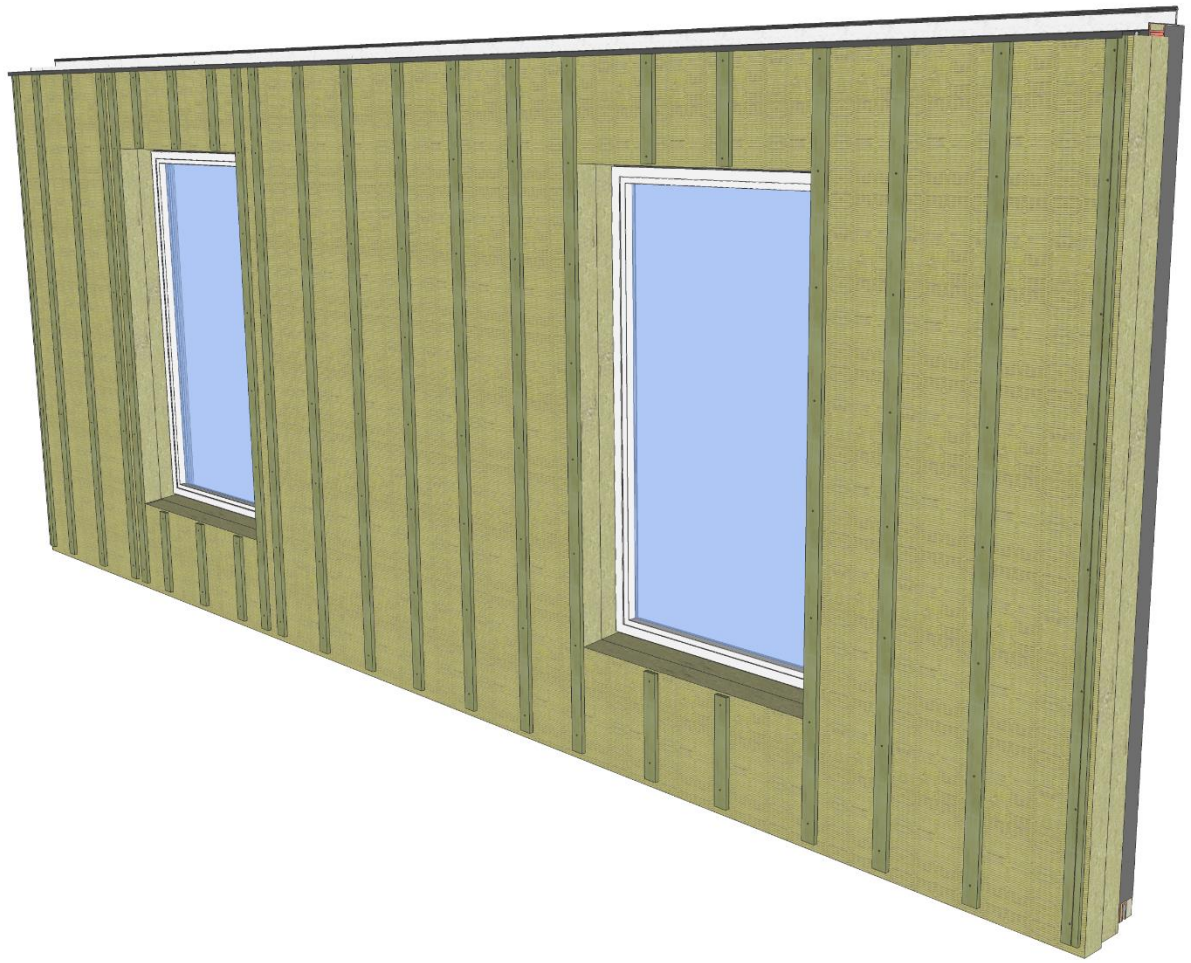
- Buildings last a long time
- Envelope is really hard to upgrade…
- …while other elements will be changed periodically

What's Next?

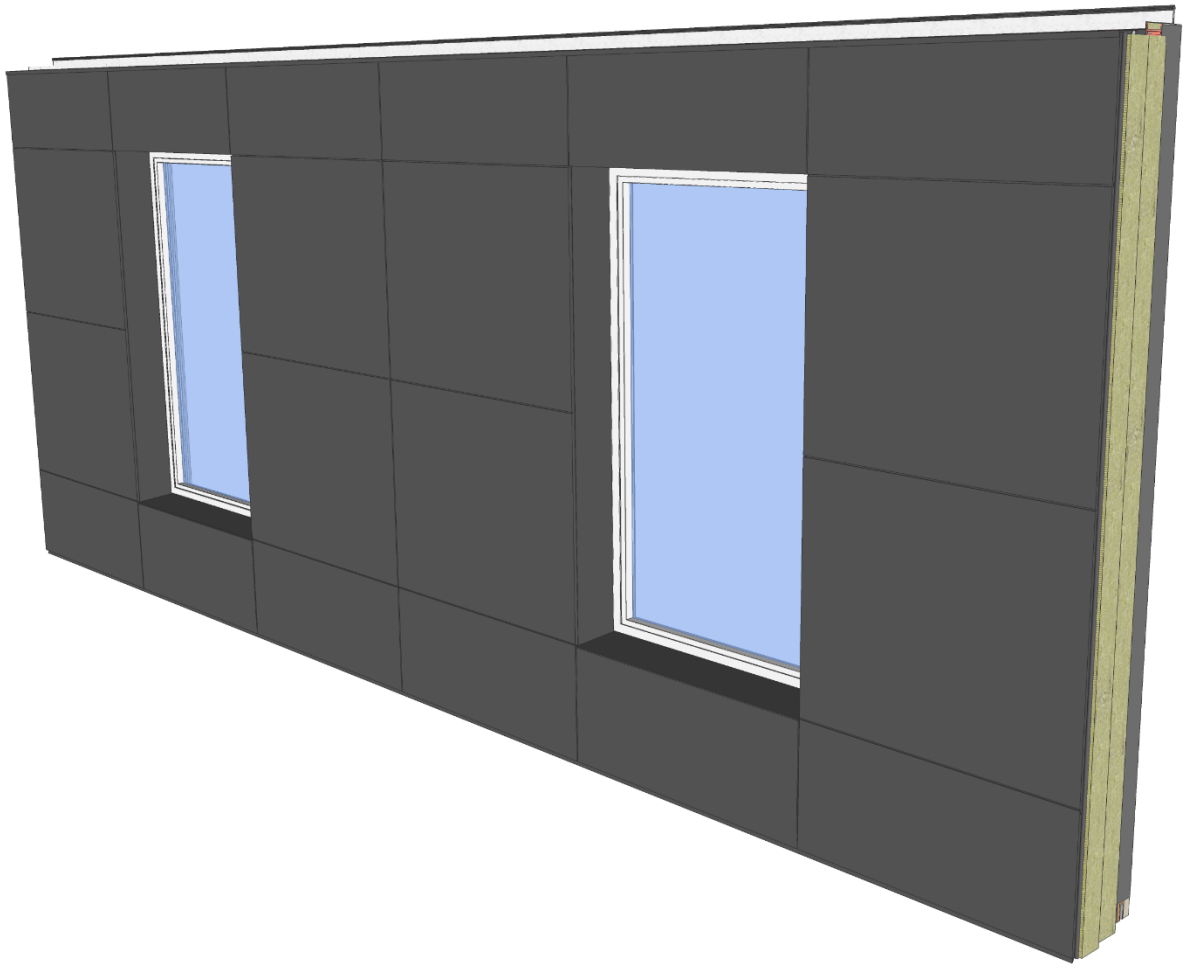




Prefabricated Passive House CLT Wall Panels



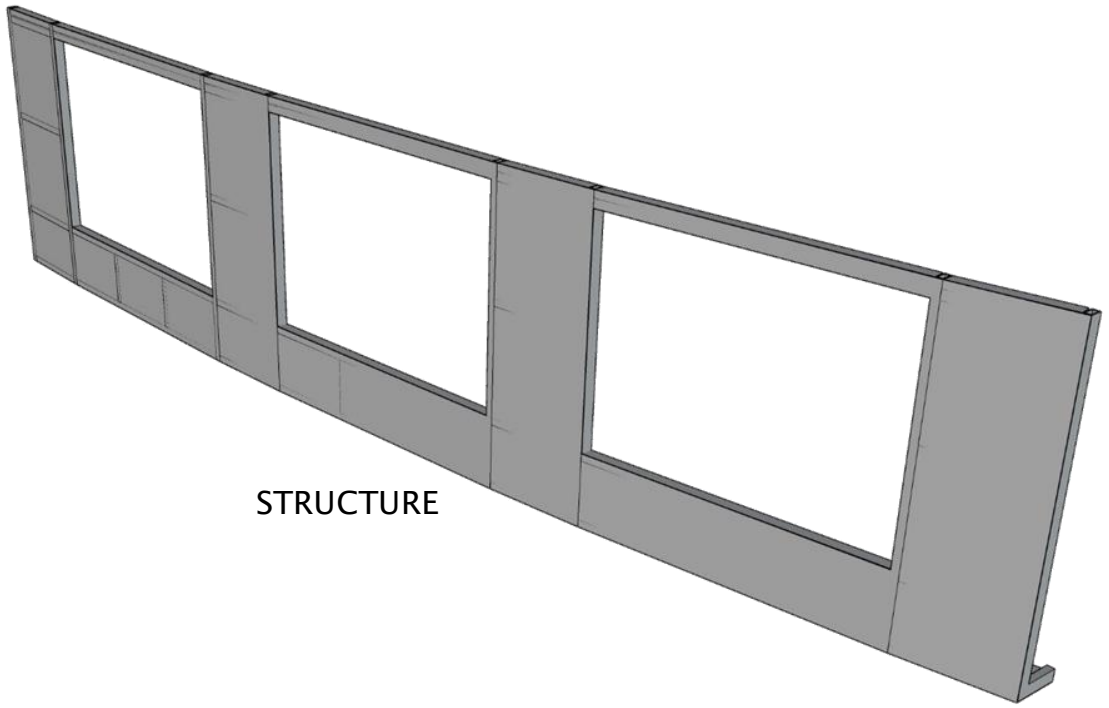
Prefabricated Passive House CLT Wall Panels



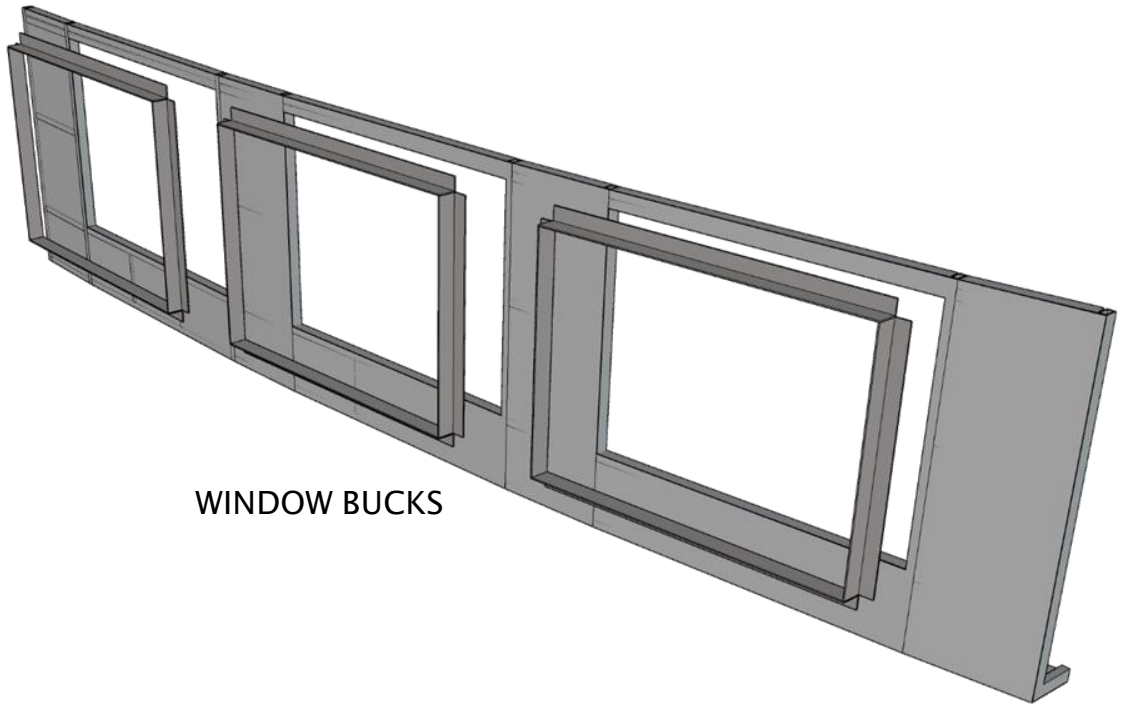
Prefabricated Passive House CLT Wall Panels


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

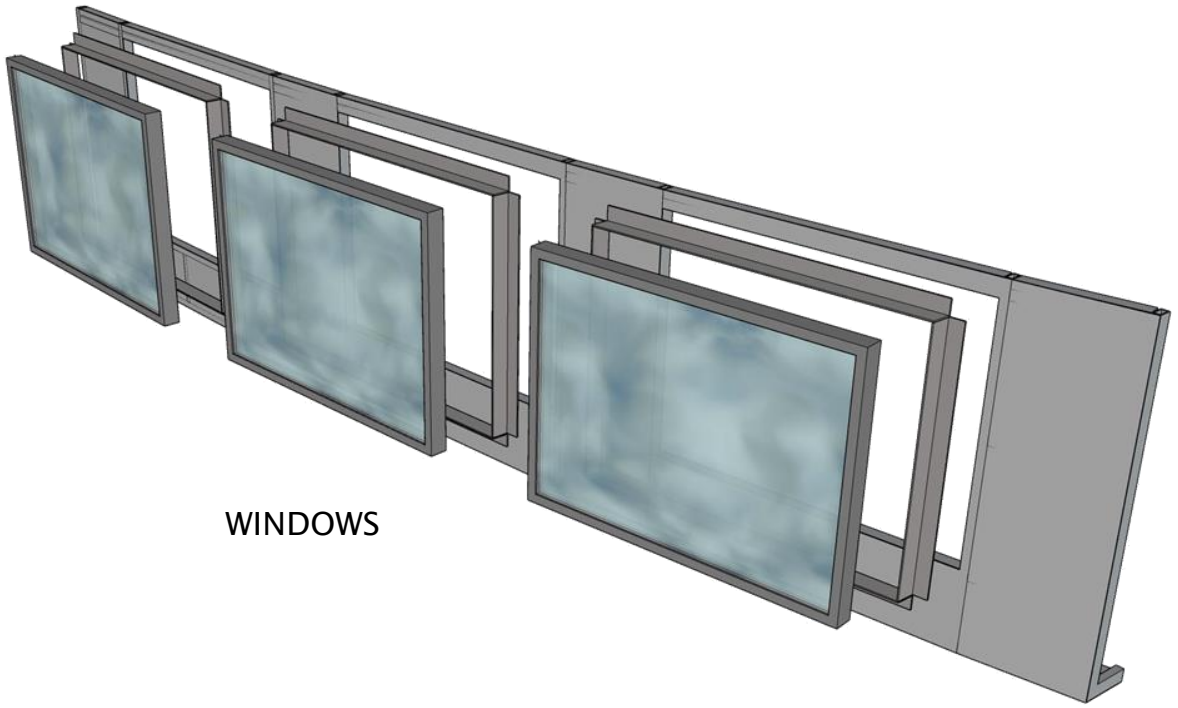
RDH



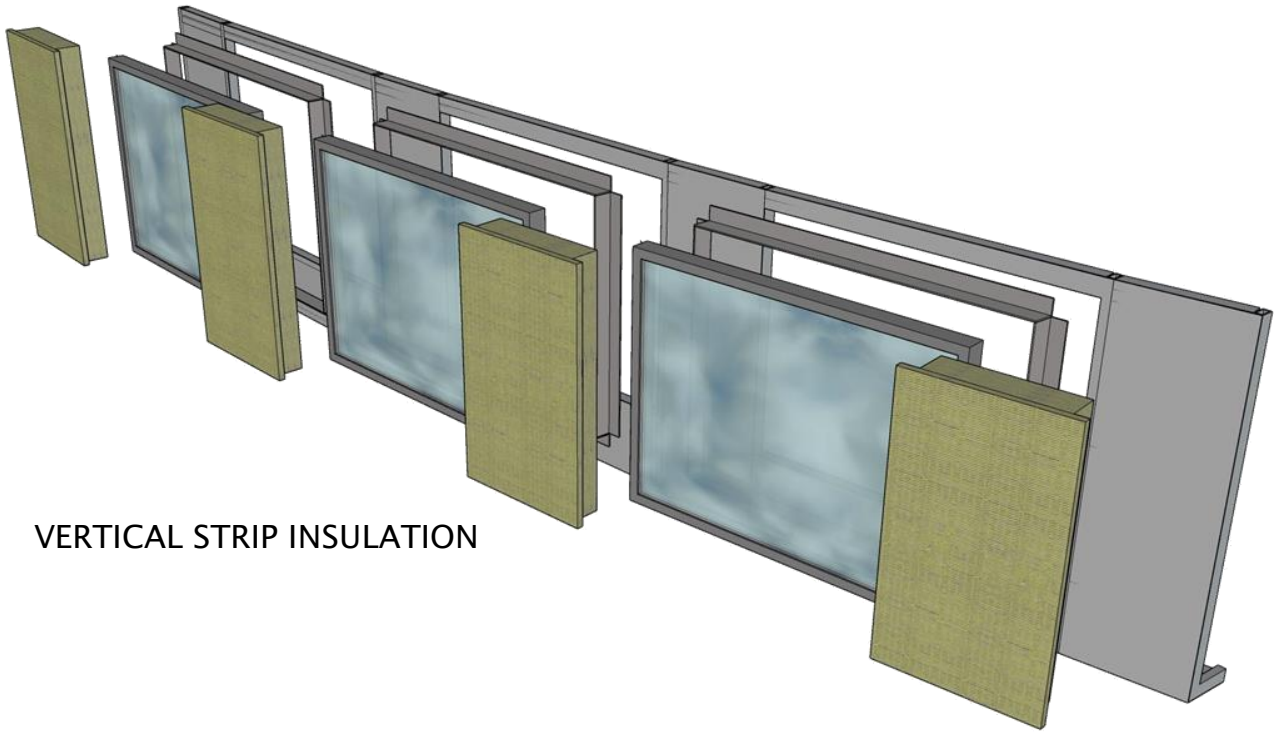
STRUCTURE



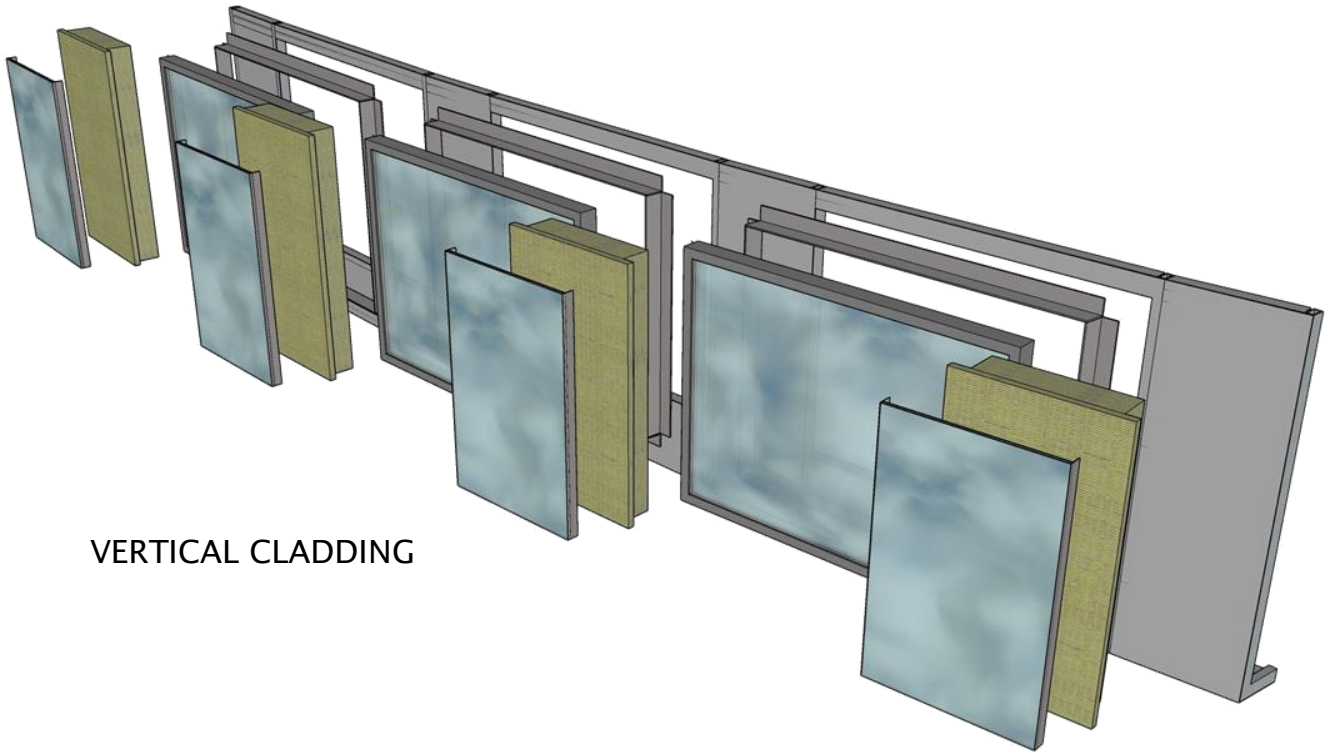
WINDOW BUCKS



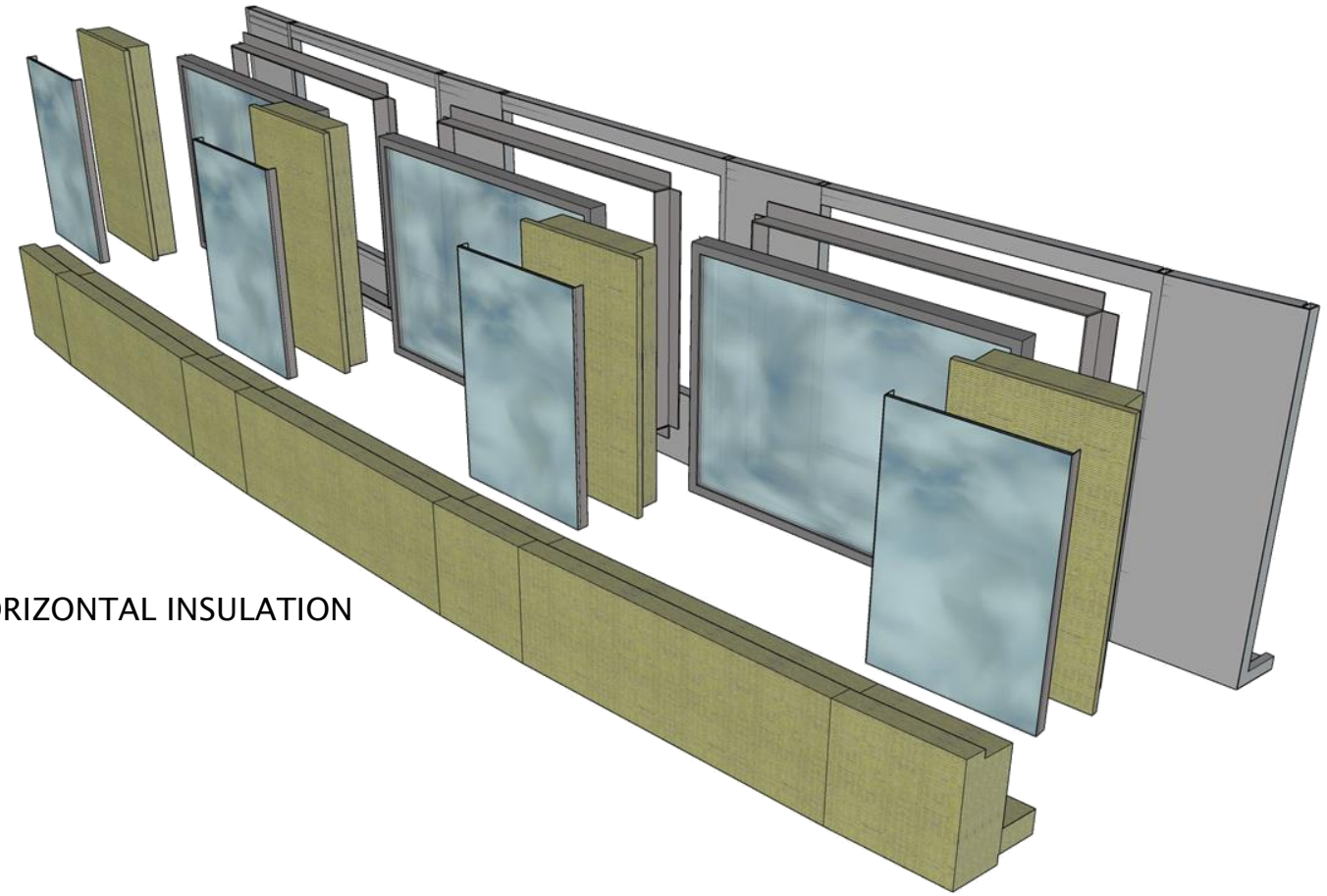
WINDOWS



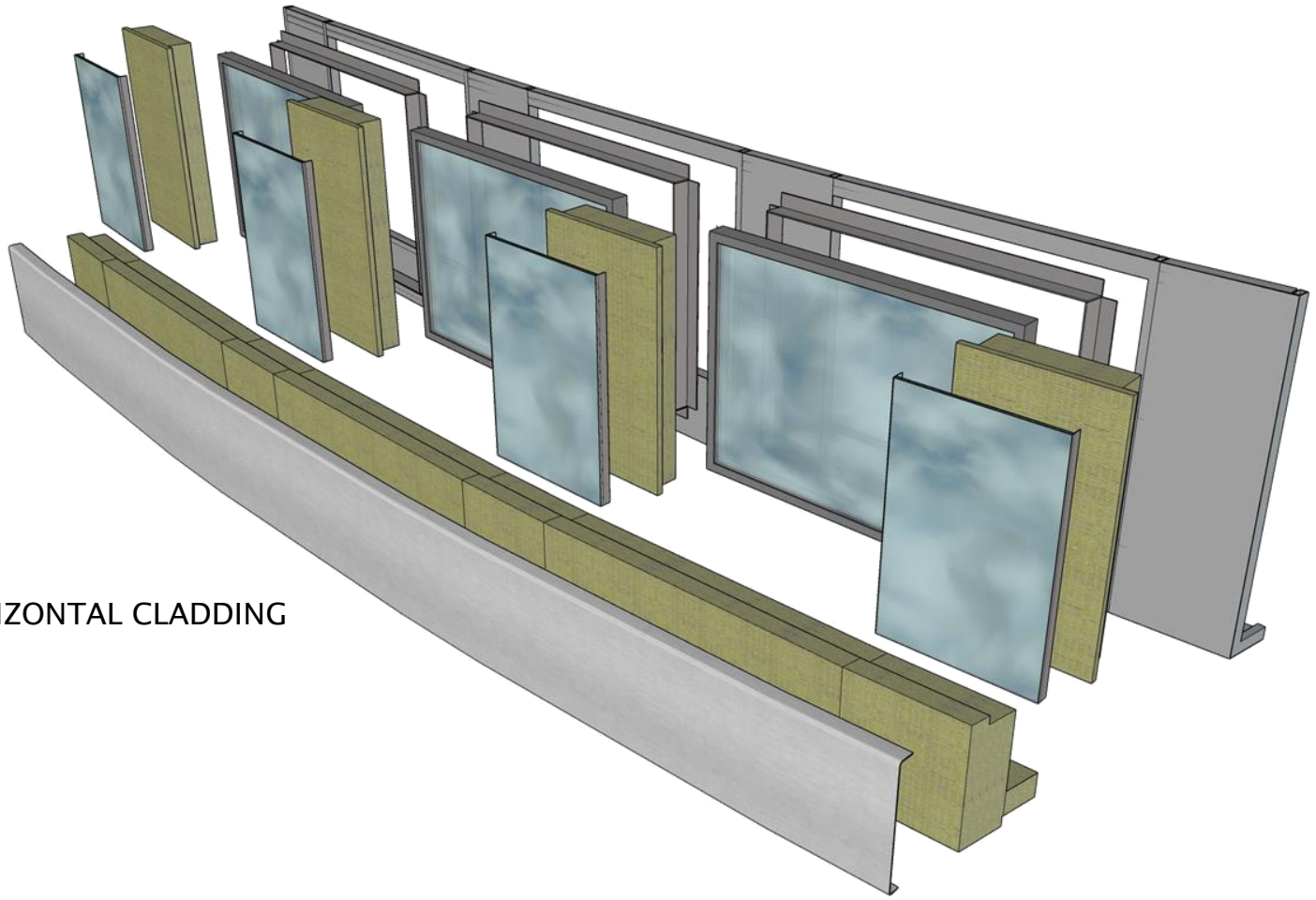
VERTICAL STRIP INSULATION



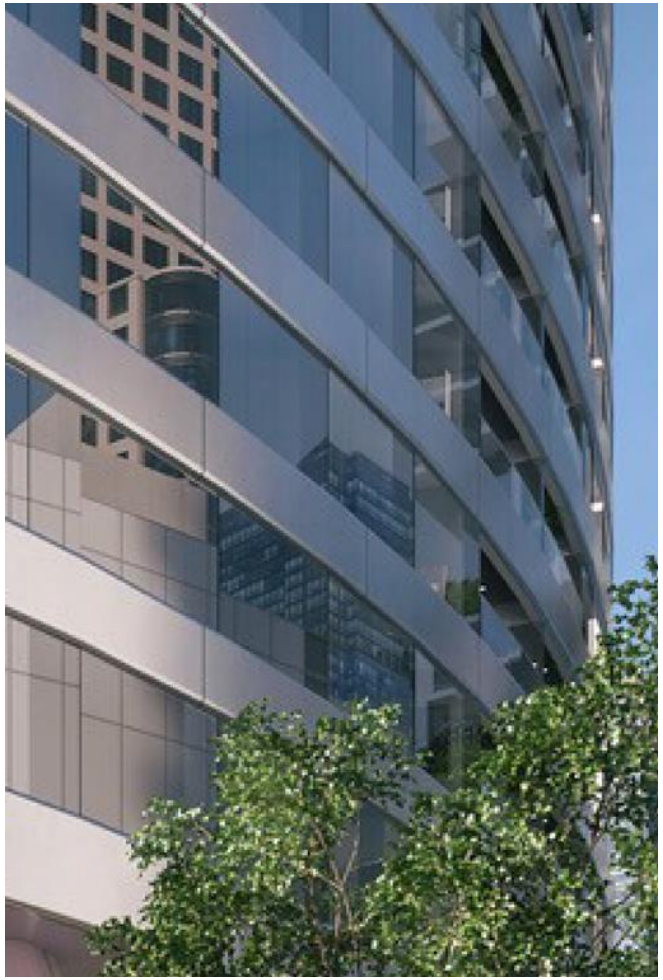
VERTICAL CLADDING

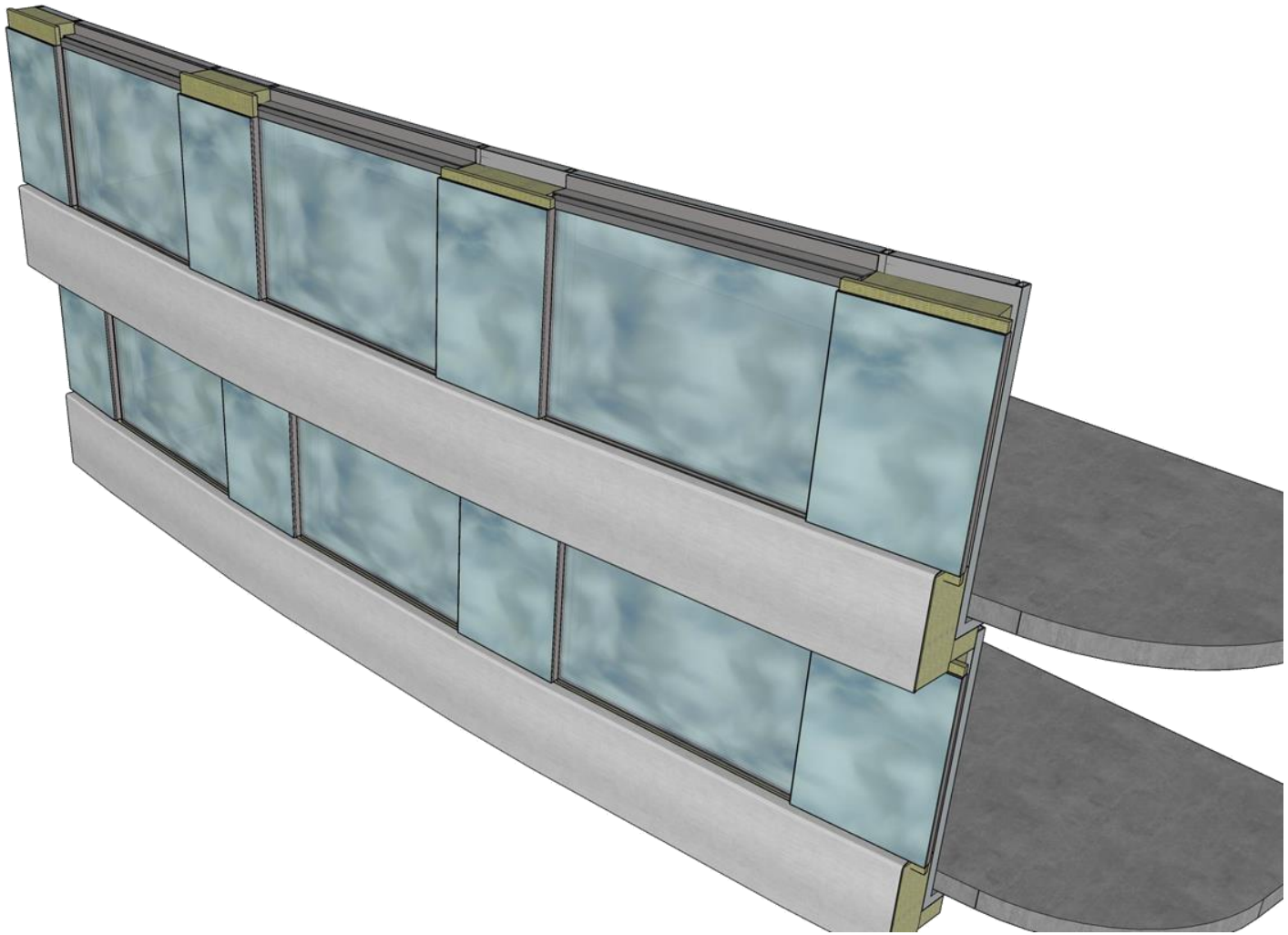


HORIZONTAL INSULATION



HORIZONTAL CLADDING





Duane Jonlin, FAIA
duane.jonlin@seattle.gov
206-233-2781

Jason Acosta, PE jacosta@rdh.com
206-602-3571
Denali Jones , PE djones@rdh.com

Now a Few Words with

Customer Care & Energy Solutions (CCES)

Upcoming 2018 Code Update Deliveries

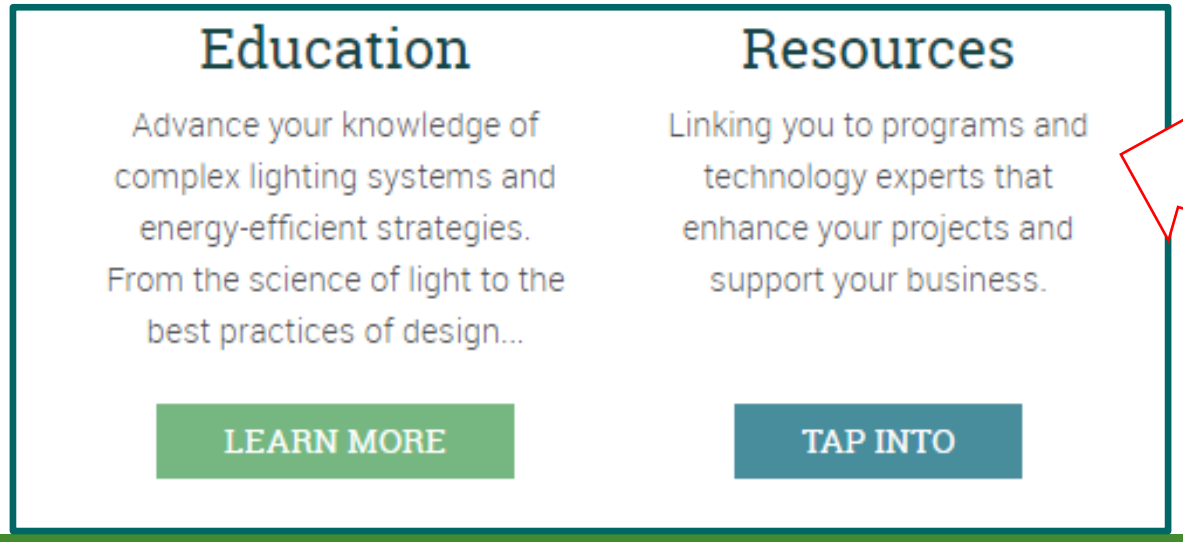
Webinar Topic	Delivery Date	Time
Cost Effective Code Compliance: HVAC	January 19th	10:00 - Noon
Cost Effective Code Compliance: Building Envelope	January 26th	10:00 - Noon
Cost Effective Code Compliance: Lighting	January 2nd	10:00 - Noon
Cost Effective Code Compliance: Water Heating	February 9th	10:00 - Noon

Today's slide deck and video recording can be found on www.lightingdesignlab.com

Click – Call – Connect

- Duane Jonlin, FAIA
  - 206-233-2781
  - Duane.Jonlin@seattle.gov
- Armando Berdiel Chavez, M.Eng., LC.
  - 206-475-2722
  - armando.berdiel@seattle.gov

Visit us online



OR

Email Us

lightingdesignlab@seattle.gov

Todays slide deck will be posted here!

Please take the online survey once you exit the webinar

We'll *SEE* you on the next call… ☺