BUILDEX CALGARY
NOVEMBER 8 & 9, 2017
BMO CENTRE, CALGARY

T01 – Living and Learning – Passive House Style

Thursday, November 9 8:30AM-10:00AM
QUARTER HORSE A/B

Speakers:
Trevor Butler, PEng CEng LEED AP
Brett Sichello, CPHD, LEED AP BD+C, B. Arch. Sci.

PASSIVEHOUSE CANADA

#BUILDEXCALGARY

PASSIVEHOUSE CANADA

Build better.
Feel better.

Overview

- Introduction
- Principles of Multifamily Passive Houses
  - Superinsulation
  - Airtight Building Envelope
  - Thermal Bridge Free - Balconies, Vent Stacks, RWL's
  - High Performance Windows & Doors
  - Heat Recovery Ventilation Systems
  - Multifamily Challenges
    - Kitchen Exhaust, Laundry Exhaust, Domestic Hot Water
  - Supplementary Heating and Cooling
  - Elevators
  - Component Sourcing
  - Education and Training
  - Building Codes & the growth of Passive House
- Example Projects

Introduction

NIDO.

NIDO Design Inc
203 – 251 Lawrence Avenue
Kelowna, British Columbia, Canada
hello@nido.design
250.448.4307

- Kelowna based Design and Consulting firm specialized in Passive House, Net-Zero and Net-Positive homes and buildings
- Team of 3 (and a half) Certified Passive House Designers
- 100% Committed to redefining that Architecture is only as good as it performs
- 2 Completed Passive Houses and 7 Single Family and Multifamily Passive House Projects in various phases of design and construction

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ASK Wellness 30 Unit Multifamily

- Three storey, 30 unit affordable Housing project for the ASK Wellness Society in association with BC Housing
- Site built, wood frame construction
- Structural Raft Slab Fully Wrapped and Insulated
- VRF Air Source Mini-Split Heat Pumps provide heating/cooling to the suites
- Solar Thermal Pre-Heat Hot Water System with Electric Resistance Top Up Tanks with Drain Water Heat Recovery
- Ventilation Systems are much more challenging in Multifamily Buildings
- Zero-Combustion on Site
- Foam free aside from under slab insulation

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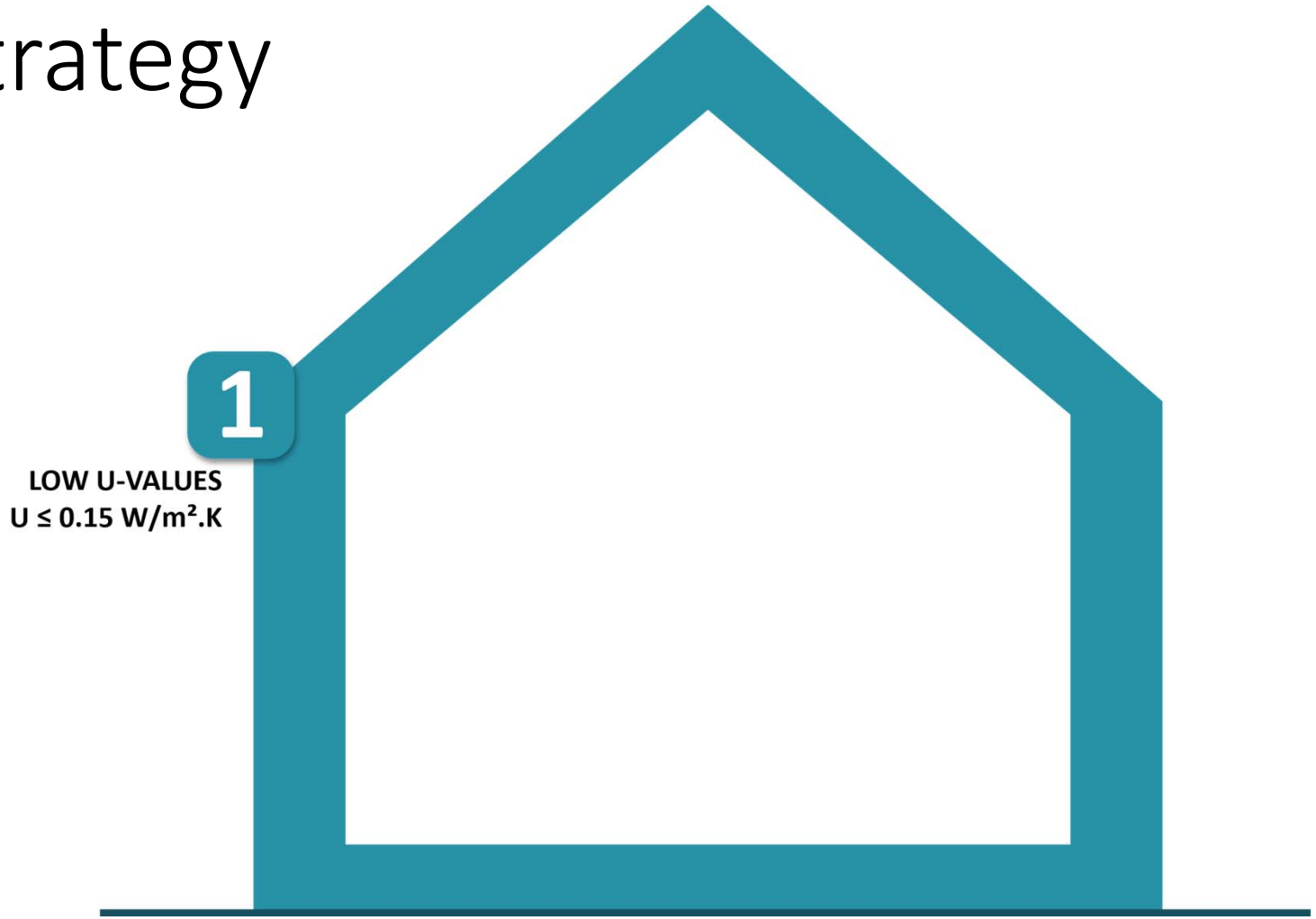
Passive House Strategy



Graphic: Passive House Academy/Passive House Canada

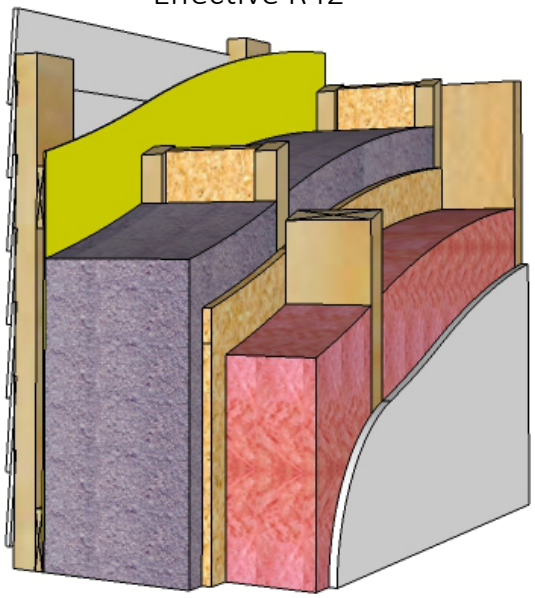
Superinsulation

ASK Wellness, Merritt, BC

Exterior Insulated Vertical I-Joist

U = 0.132 w/(m2k)

Effective R42



- Cladding
- 1x4 vertical rain screen strapping
- 1x4 horiztontal cross strapping
- Proclima Solitex Mento 1000 WRB
- 9-1/2" I-joist with Densepack Cellulose Insulation
- Proclima Intesana
- 1/2" Plywood Sheathing
- 2x6" Wood Studs with Batt Insulation
- Gypsum Wall Board

Advantages:

- Conventionally framed platform construction
- Air/vapour sealing is via an exterior membrane over plywood sheathing with taped seams
- As soon as air/vapour retarder is wrapped around building, plumbing, HVAC and electrical can start while exterior work proceeds
- Vertical I-joists create 9-1/2" cavity for densepack cellulose insulation with marginal reduction in thermal performance due to chords of I-joists and support weight of cladding
- Exterior WRB resists force of densepack and is extremely breathable
- Exterior shades/roofs/balcony can be fixed to vertical I-joists for thermal bridge free connections

Disadvantages:

- Densepack cellulose installation is still fairly new to trades
- Windows require plywood boxes to line rough opening and form stop for cellulose at I-joists
- Installation of exterior WRB and cross strapping requires attention to detail by trades

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Superinsulation

ASK Wellness, Merritt, BC

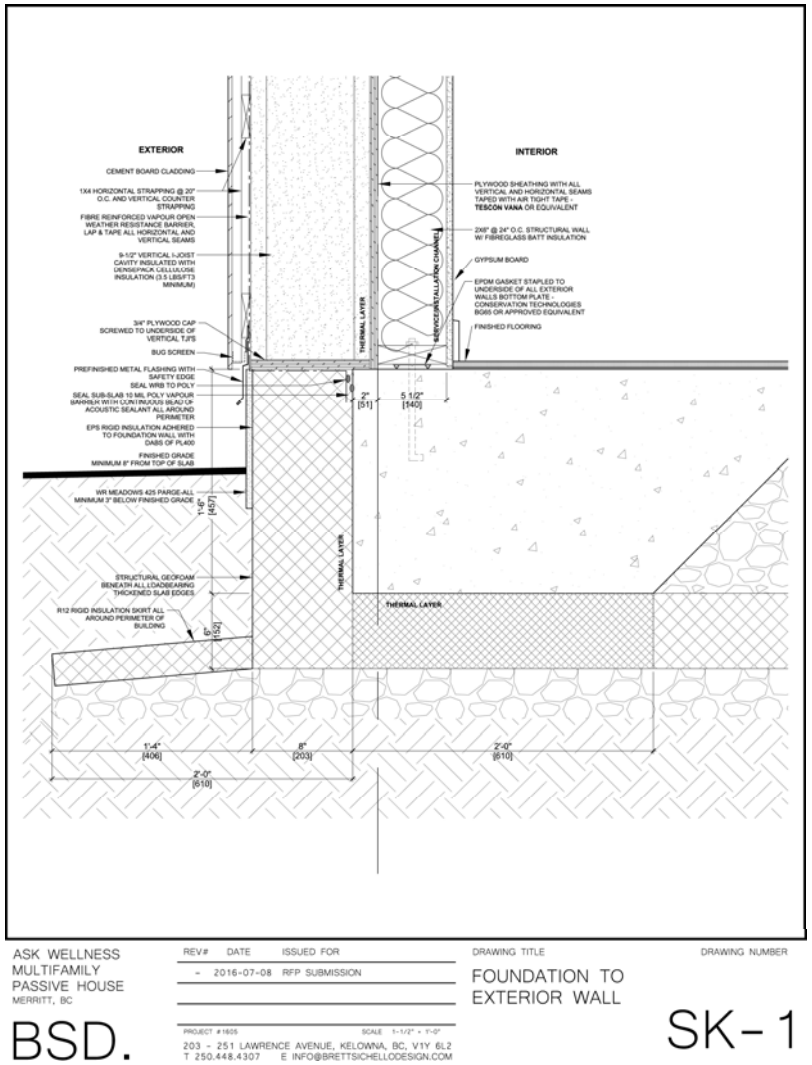
Structural Raft Slab

U = 0.196 w/(m2k)

Effective R29

- Floor Finish
- Underlayment
- Concrete Slab
- 10 mil poly vapour barrier with sealed seams
- Radon rock and levelling sand
- 6” Structural Geofoam beneath all structural loadbearing slab thickenings
- 6” Type IV EPS Rigid Insulation in all other areas
- Prepared sub-base

- 8” EPS Rigid Insulation at slab edge with skirt around perimeter to prevent frost intrusion



ASK WELLNESS
MULTIFAMILY
PASSIVE HOUSE
MERRITT, BC

BSD.

REV#	DATE	ISSUED FOR
-	2016-07-08	RFP SUBMISSION

PROJECT # 1605 SCALE 1-1/2" = 1'-0"

203 - 251 LAWRENCE AVENUE, KELOWNA, BC, V1Y 6L2
T 250.448.4307 E INFO@BRETTSICHELLODESIGN.COM

DRAWING TITLE: FOUNDATION TO EXTERIOR WALL

DRAWING NUMBER: SK-1

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Superinsulation

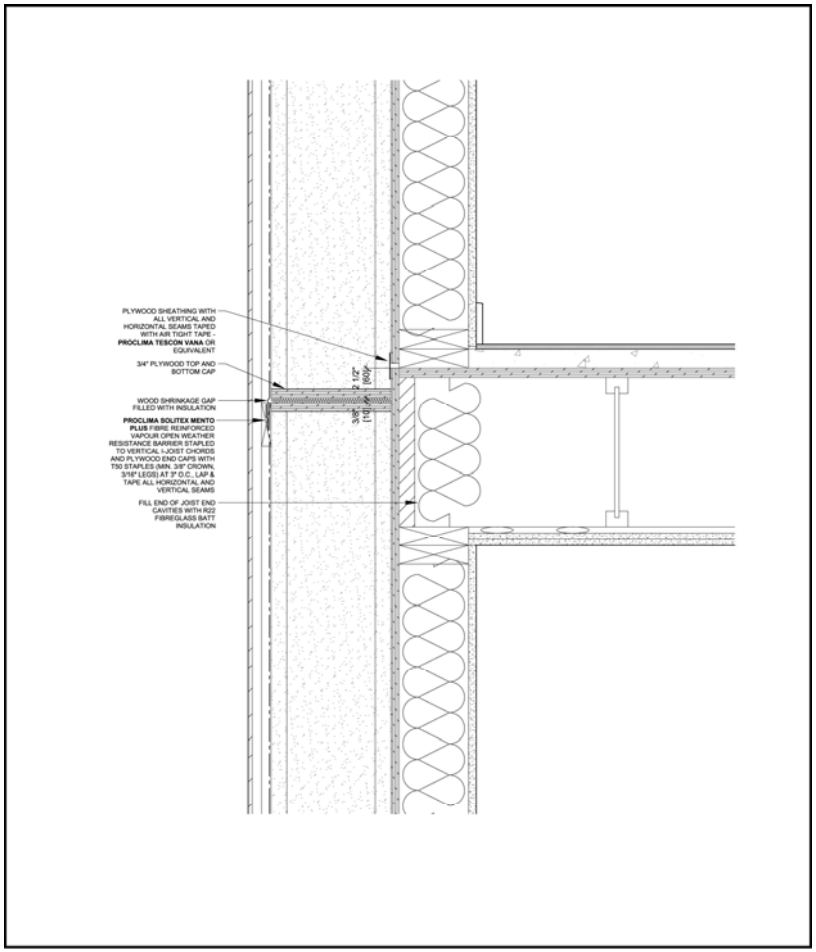
ASK Wellness, Merritt, BC

Exterior Insulated Vertical I-Joist

U = 0.132 w/(m2k)

Effective R42

- Simple, platform construction
- At mid-floors, vertical I-joists are “broken” to allow for expansion joint allowing wood plate shrinkage
- No spray foam required in joist end cavities as air/vapour retarder is located on exterior face of continuous plywood sheathing



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Superinsulation

PASSIVEHOUSE CANADA

Superinsulation

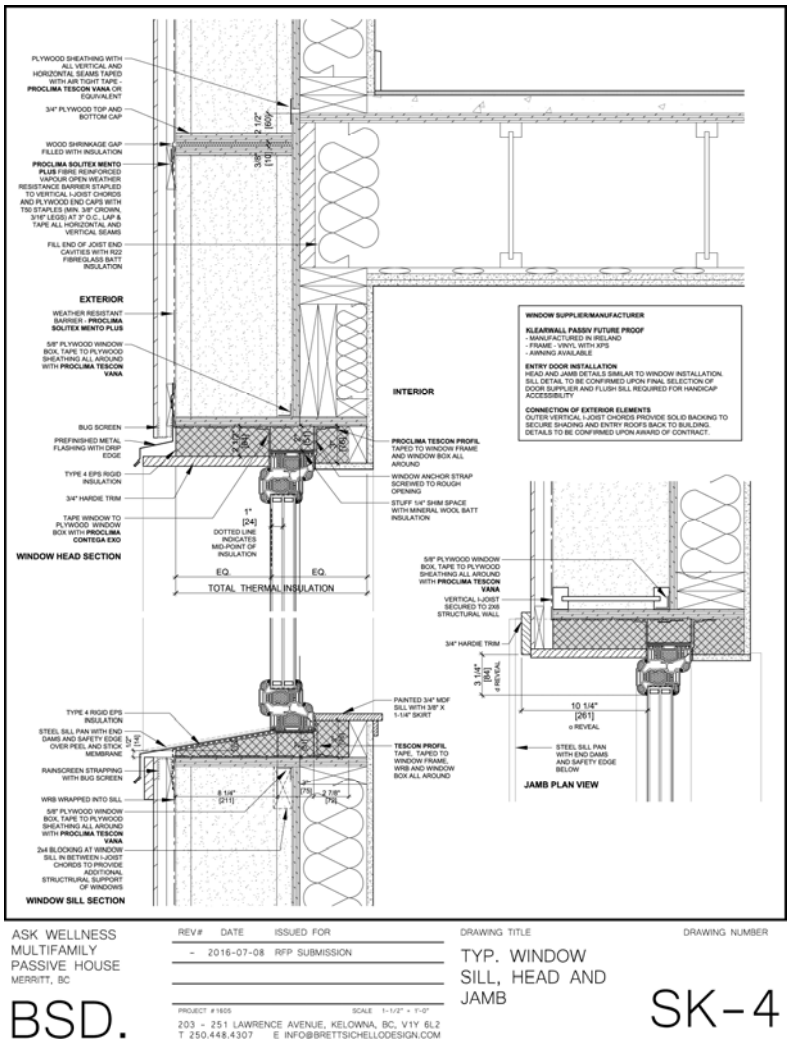
ASK Wellness, Merritt, BC

Exterior Insulated Vertical I-Joist

U = 0.132 w/(m2k)

Effective R42

- Rough opening is lined with plywood sheathing to create window box
- Rigid EPS insulation lines the rough opening which provides great installation Psi value
- Klearwall Windows were selected due to availability of casement/awning windows rather than tilt and turn (security concerns from client and bug screen questions)



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Superinsulation

ASK Wellness, Merritt, BC

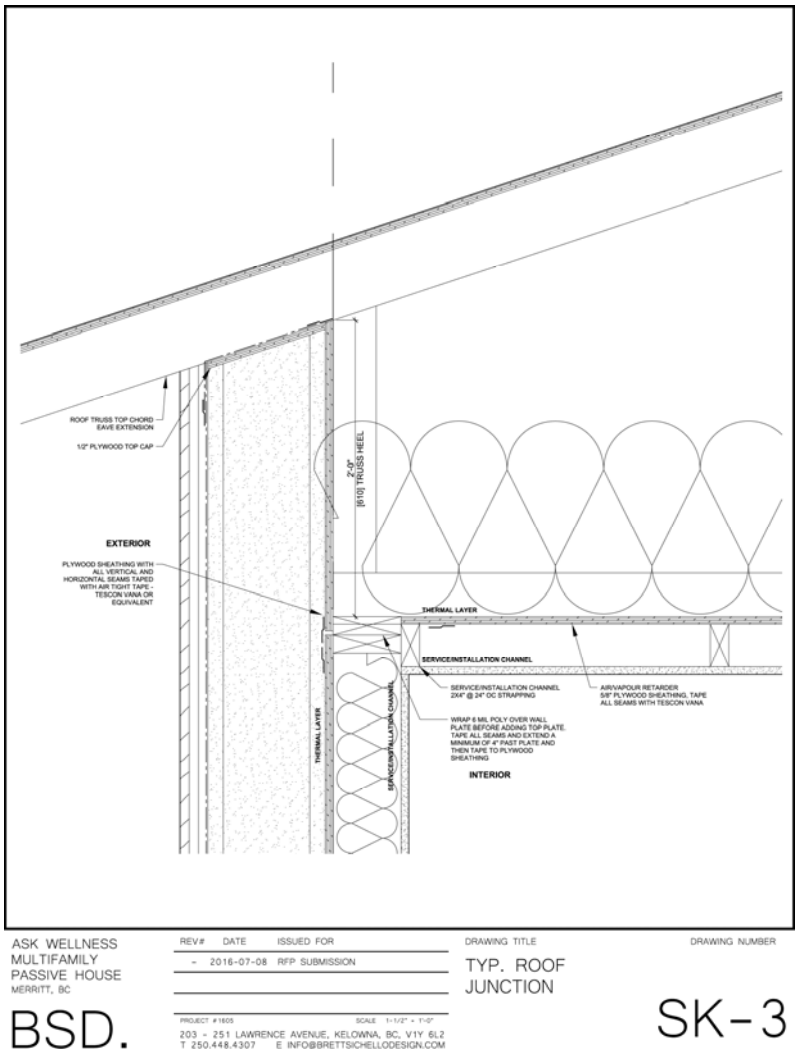
Conventional Vented Truss Roof

U = 0.067 w/(m2k)

Effective R85

- Asphalt Shingles
- Plywood Decking
- Roof Truss with 24” blown-in fiberglass insulation
- ½” Plywood sheathing
- Proclima Intensana Air/Vapour Retarder with sealed seams
- 2x4 service channel for lighting, plumbing, etc.
- Gypsum Wall Board

- Simple, conventionally framed roof
- Air/vapour sealing from underside of truss to exterior wall junction is a bit tricky but easily overcome
- Sloped roof provides angle for photovoltaics and solar thermal collectors



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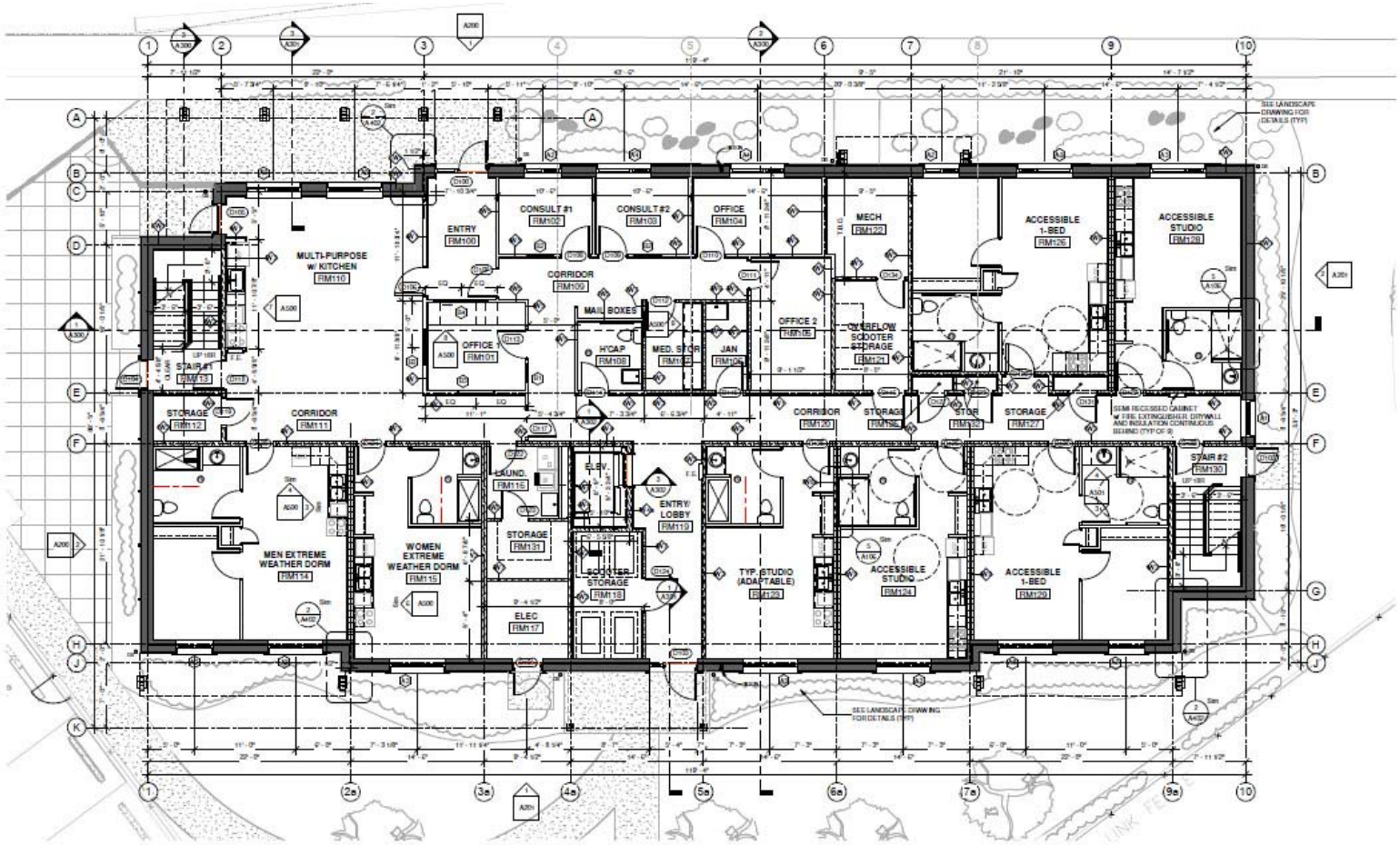
Superinsulation – Compact Form



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Superinsulation

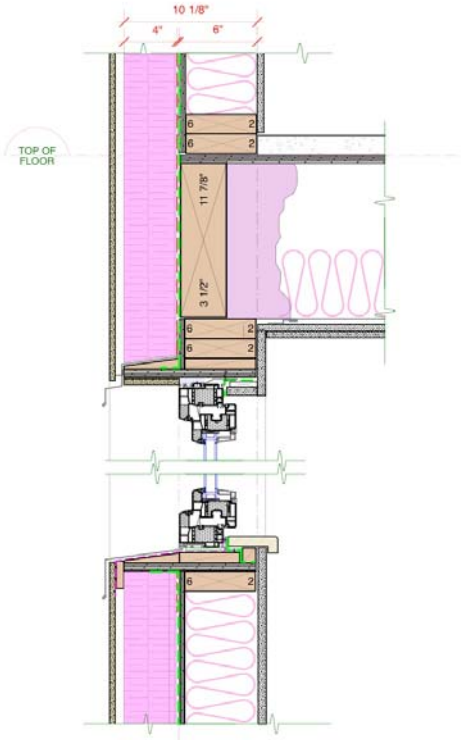
Smithers Multifamily Passive House

- Independent Living Facility
- 19 residential units with common and program spaces
- Intended to be easily adaptable to a variety of climates
- Designed as a template for repeatable social housing Passive House developments across BC

SOURCE: CORNERSTONE ARCHITECTURE

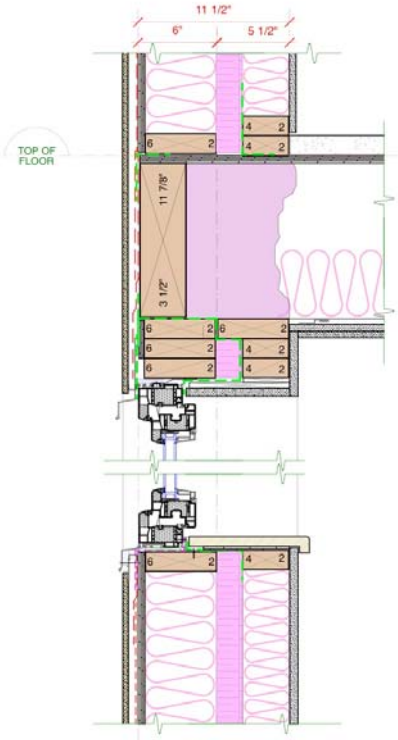
PASSIVEHOUSE CANADA

Superinsulation



EPS EXTERIOR INSULATED

ROXUL EXTERIOR INSULATED



INTERIOR INSULATED

SOURCE: CORNERSTONE ARCHITECTURE

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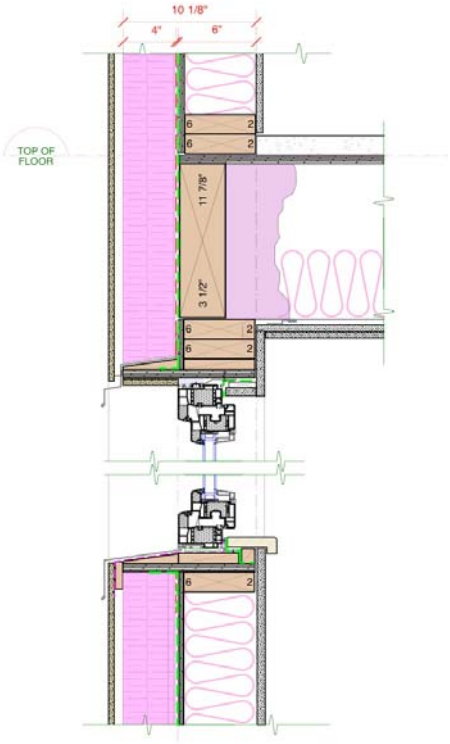
Superinsulation

Exterior Insulated with Rigid Foam:



Advantages:

- Typical interior trades sequencing
- Cost effective

Disadvantages:

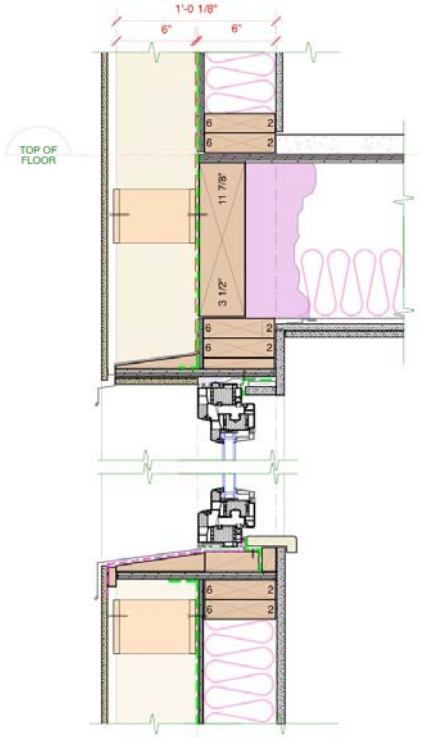
- Fire spread (Code restrictions)
- Zero lot-line construction challenges
- Long screw paths to the wood studs
- Difficult to hang heavier claddings
- Concerns over drying potential for wood
- Where is the moisture barrier:
  - *On the surface of the sheathing?*
  - *On the exterior side of the insulation?*

SOURCE: CORNERSTONE ARCHITECTURE

PASSIVEHOUSE CANADA

Superinsulation

Exterior Insulated with Roxul:



Advantages:

- Best Building Science for drying

Disadvantages:

- Cost
- Installation in wet weather
- Not common knowledge for wood-frame trades
- Window details more complex
- Difficult to install sunshades and handrails
- Zero lot-line construction challenges

SOURCE: CORNERSTONE ARCHITECTURE

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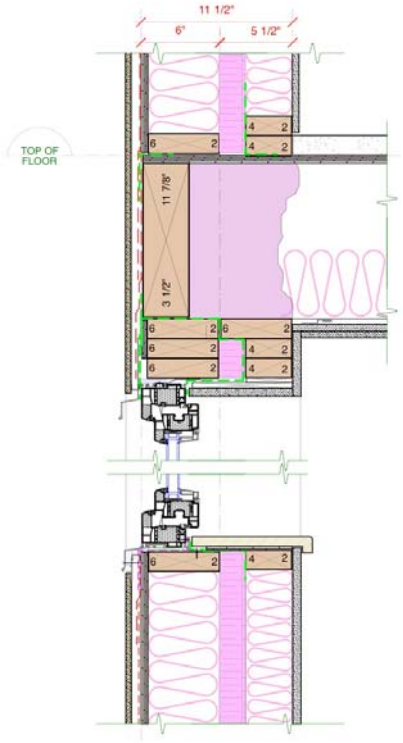
Superinsulation

Interior Insulated:



Advantages:

- Most of the air sealing is one trade working in dry conditions
- Conventionally framed (except*)
- Conventional siding installation
- Simplified window installation
- Simplified attachments (railings, sunshades, etc.)

Disadvantages:

- Interior wall awaits install of exterior moisture barrier for drying
- Wiring will commence before the exterior wall is ready
- Air barrier sequenced with framing at floors*

SOURCE: CORNERSTONE ARCHITECTURE

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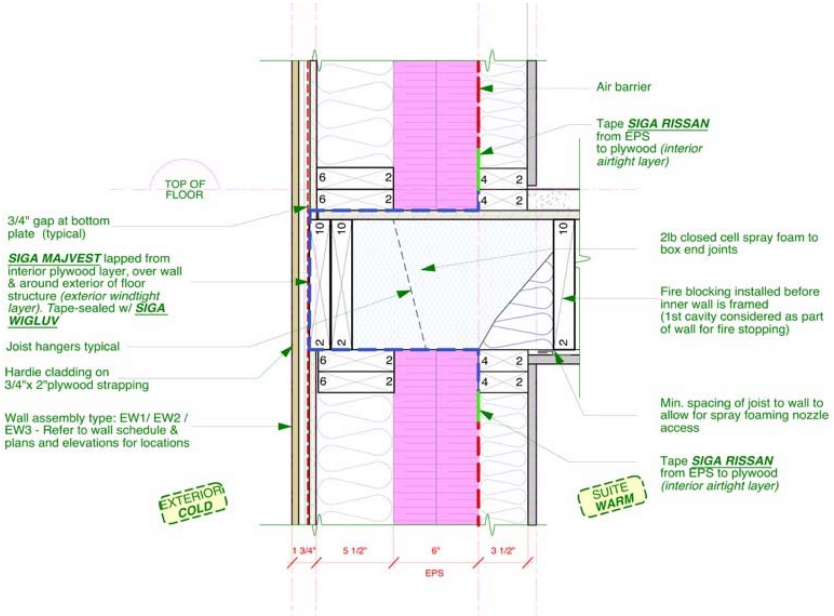
Superinsulation

Smithers Multifamily Passive House

Exterior Wall Assembly

U = 0.104 w/(m2k) Effective R55

- 2x6” structural exterior wall c/w batt insulation
- 6” EPS Type 2 insulation (taped polymer skin air barrier)
- 2x4” service wall c/w batt insulation



SOURCE: CORNERSTONE ARCHITECTURE

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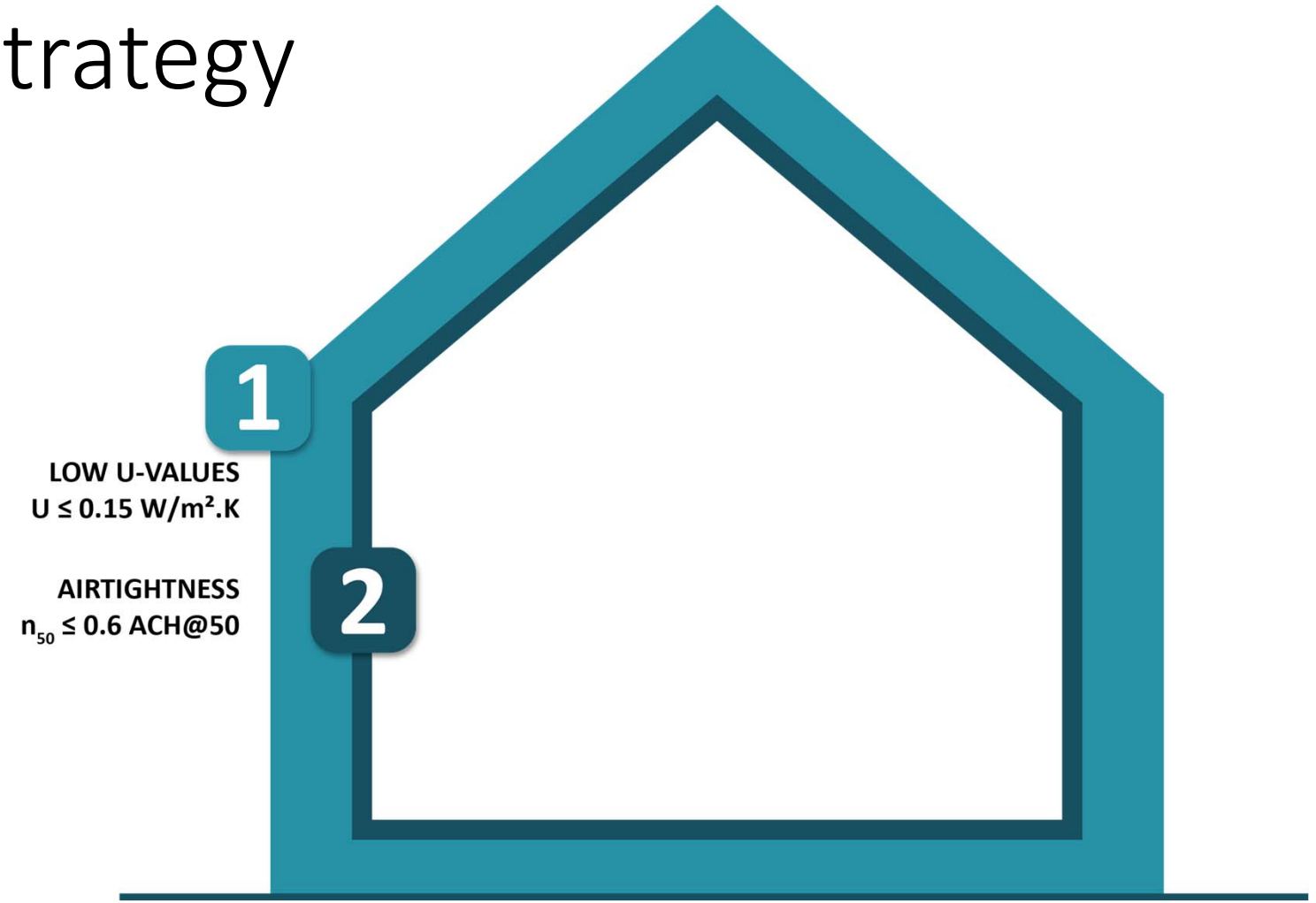
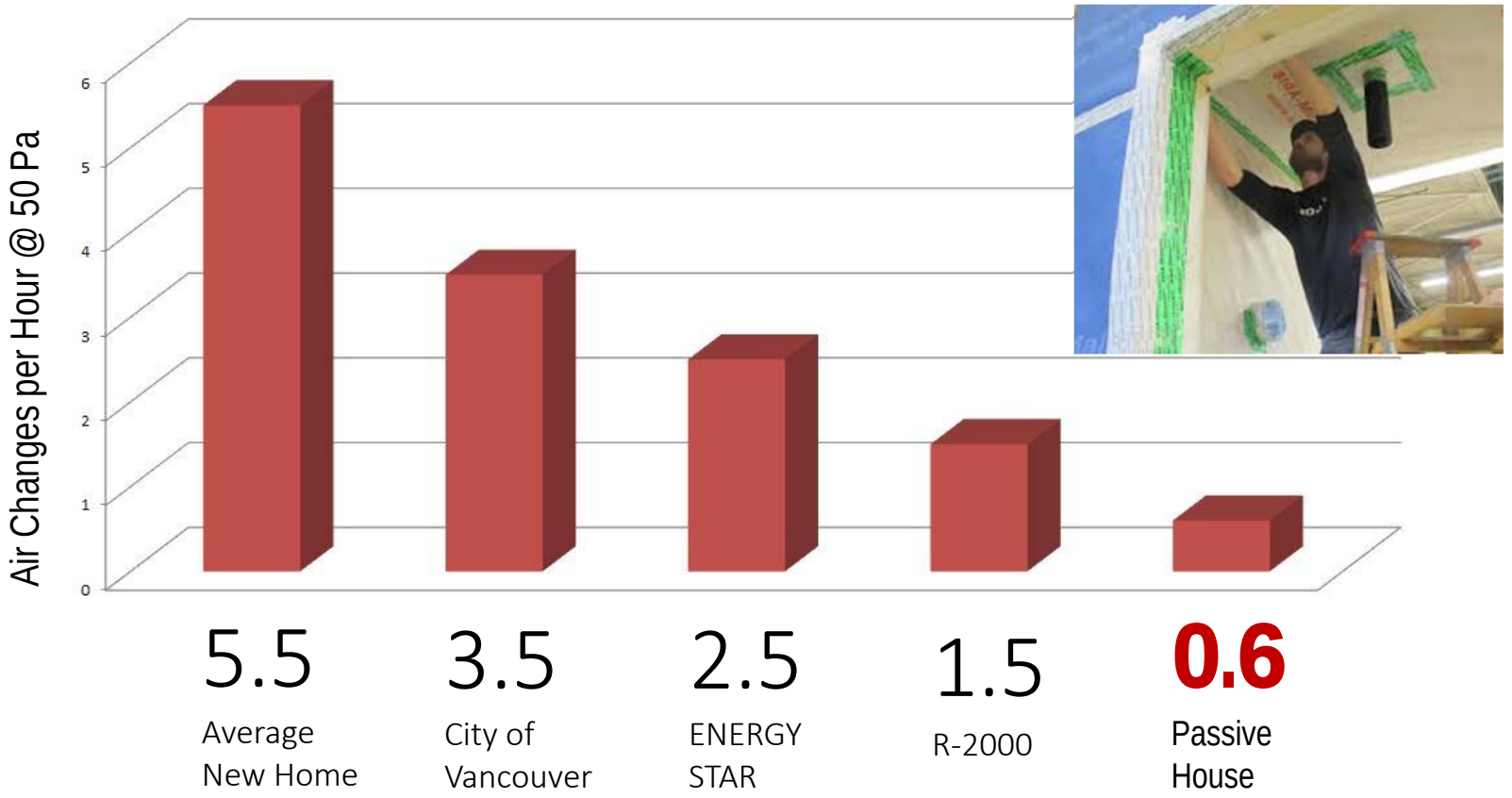
Passive House Strategy



Graphic: Passive House Academy/Passive House Canada

2. Airtight Building Envelope



- Low air changes means less risk of Building Envelope Condensation damage
- For the contractor this will be the most challenging issue
- For the designer a great deal of detailing and product specification is required

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2. Airtight Building Envelope

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2. Airtight Building Envelope

Airtight Building Envelope

Multifamily Blower Door Testing Considerations

- Testing individual units or compartments within the building can be challenging depending on how the airtight layer was constructed
- Testing whole buildings will require multiple blower door fans to pressurize/depressurize a large volume of space
- All HRV penetrations are to be sealed as they will technically be open 24/7/365 so should not be accounted for in the test

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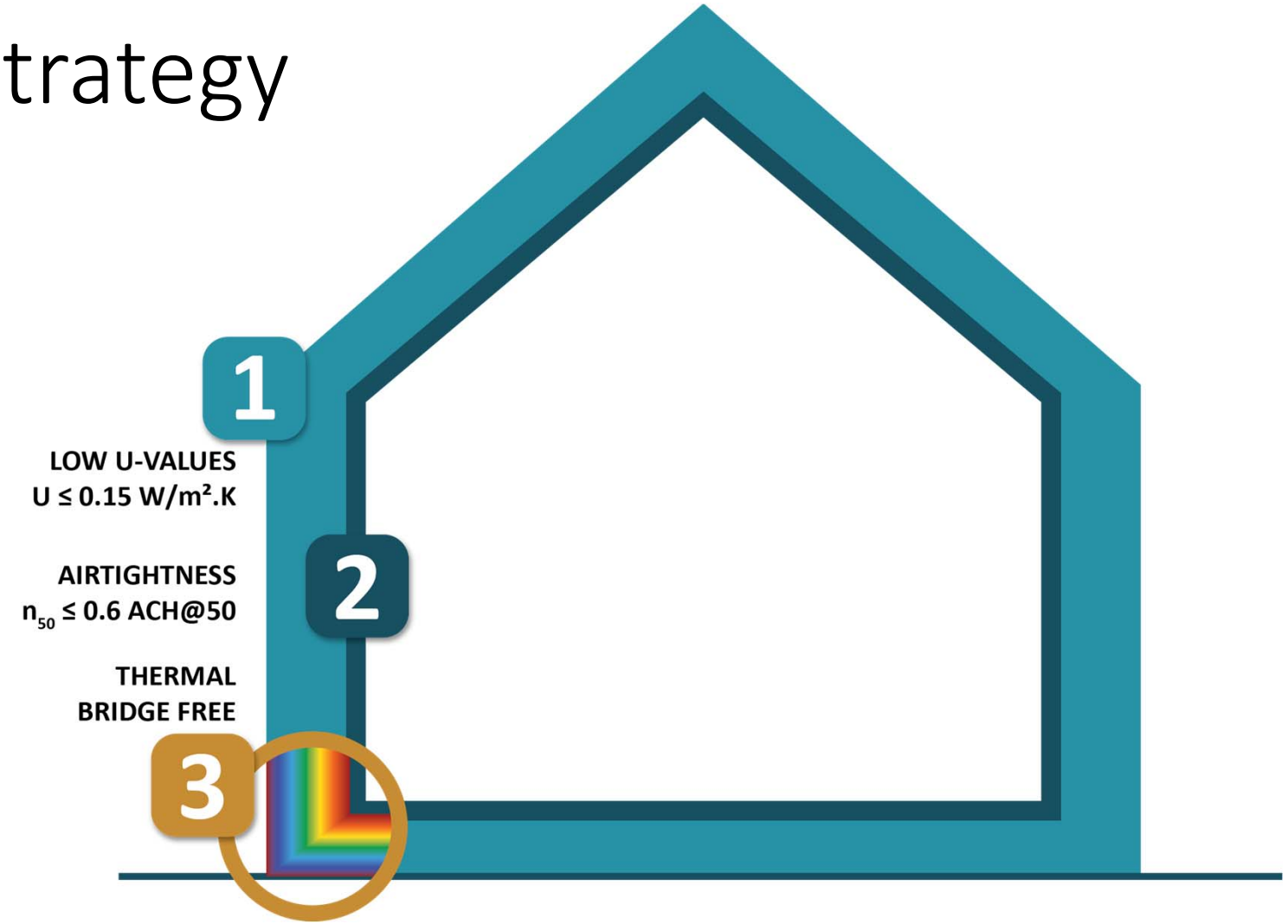
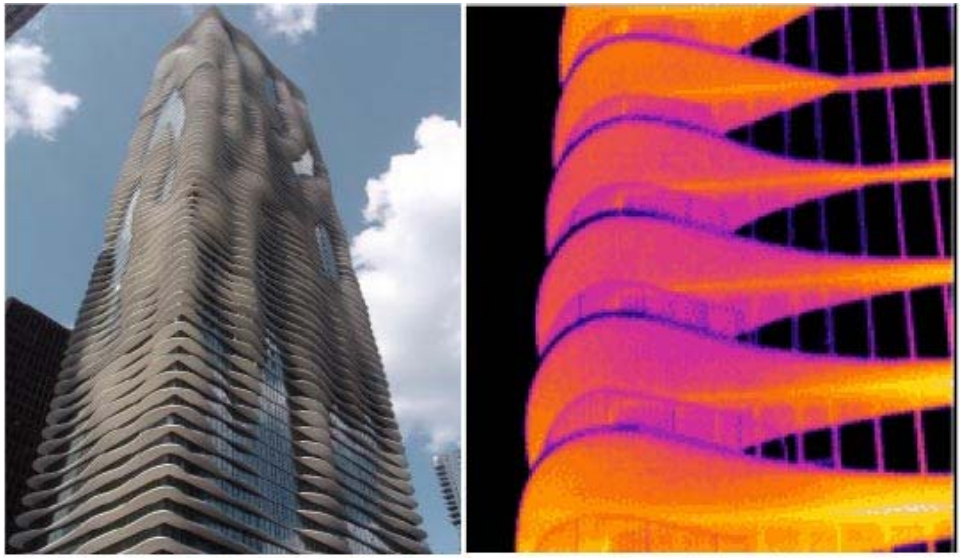
Passive House Strategy



Graphic: Passive House Academy/Passive House Canada

Thermal Bridge Free

MOTORCYCLE ENGINE WITH COOLING FINS
DESIGNED TO COOL OFF THE ENGINE



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3. Thermal Bridge Free???

- With the challenges facing the world today, the question we need to ask, “is it still good architecture if it performs like a Hummer?”

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Thermal Bridge Free Balconies

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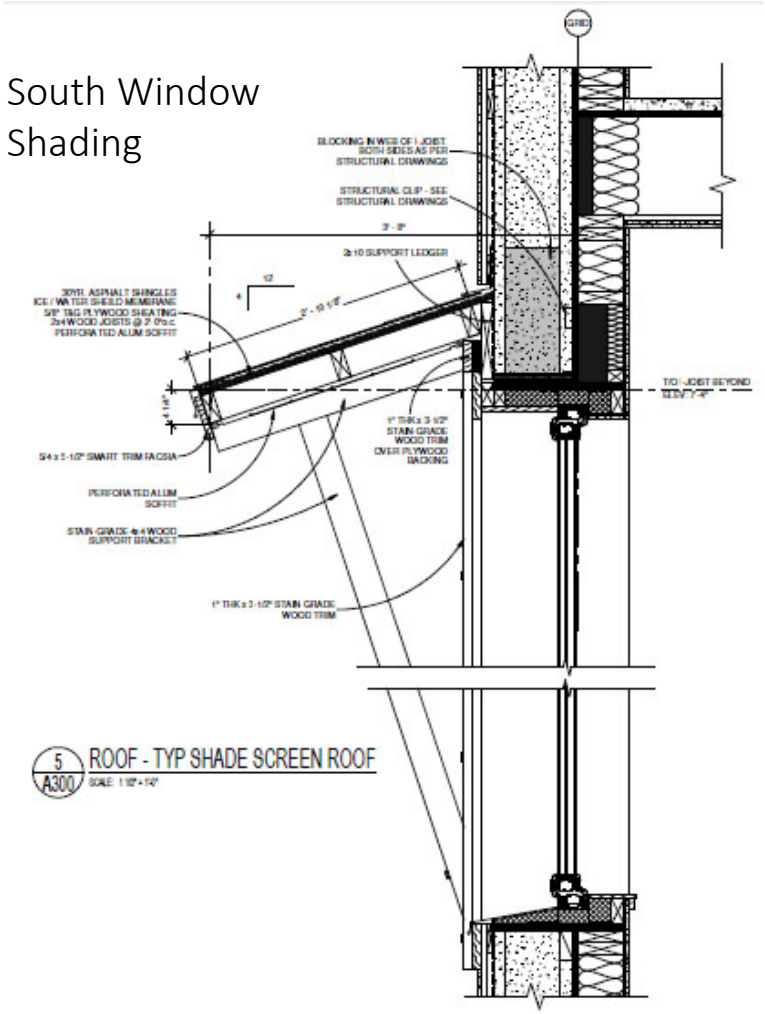
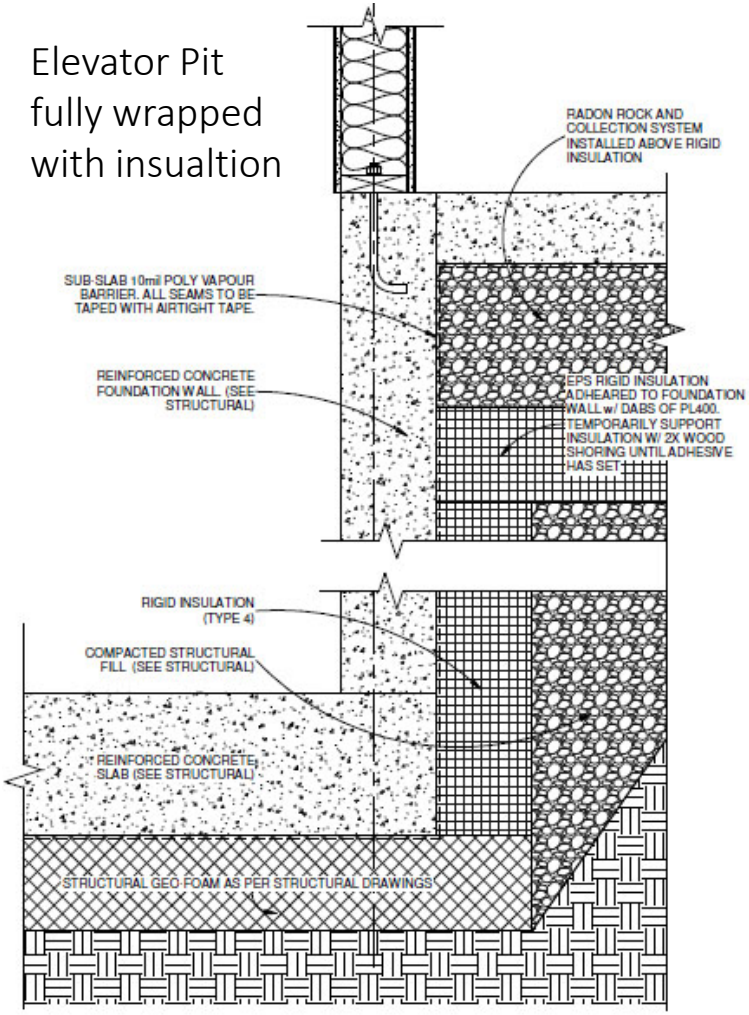
Thermal Bridge Free Connection Details

- South Window Shading



- Elevator Pit fully wrapped with insualtion



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Thermal Bridge Free Balconies

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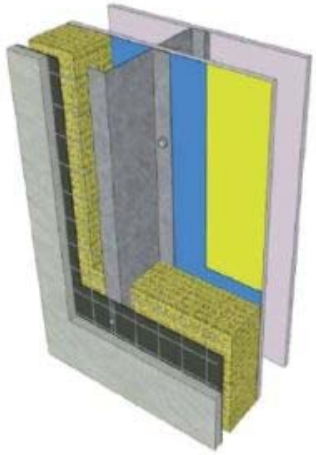
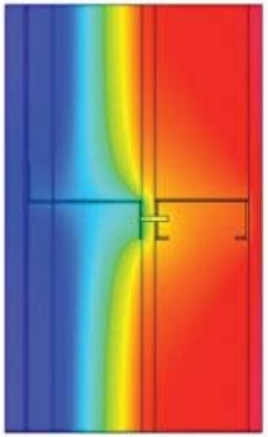
Thermal Bridge Free

Z-girts are significant thermal bridges in exterior mineral wool insulation



100mm (4in)
mineral wool



Z-girts, R7
Effective

Fibreglass clips,
R15 Effective

Double the effective R-value!

Source: Cascadia Windows and Doors

For more information, refer to Technical Bulletin 11 from RDH -
Cladding Attachment Solutions for Exterior Insulated Commercial Walls

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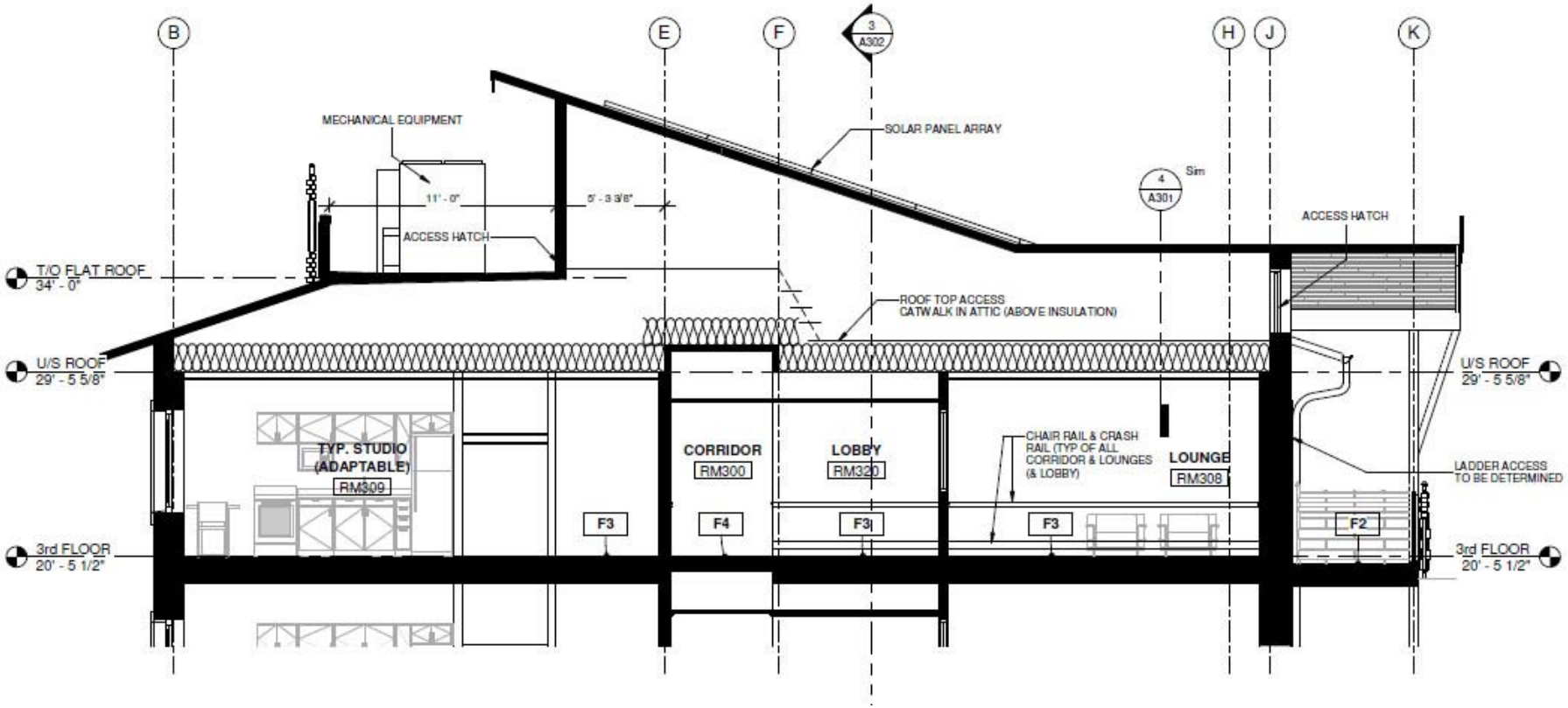
Thermal Bridge Free – Attic Access



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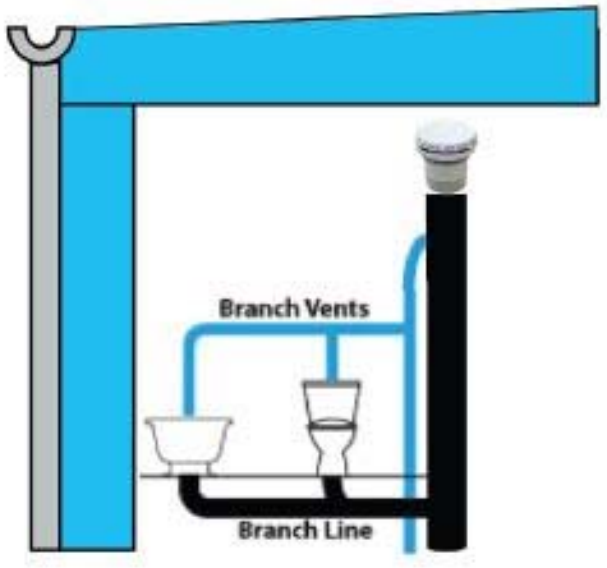
Thermal Bridge Free – Vent Stacks

Plumbing Vent Stacks and Rain Water Leaders running through a building represent large Thermal Bridges

- Step one – don't run rain water leaders through the building!
- Although the Building Code and industry are not up to speed on Air Admittance Valves, they have been used successfully in Europe for years. By using Air Admittance Valves and a Positive Air Pressure Attenuator, it is possible to eliminate all thermal bridges through the building envelope.
- Note that Alternative Compliance Report may need to be prepared for the Local Authority with Jurisdiction



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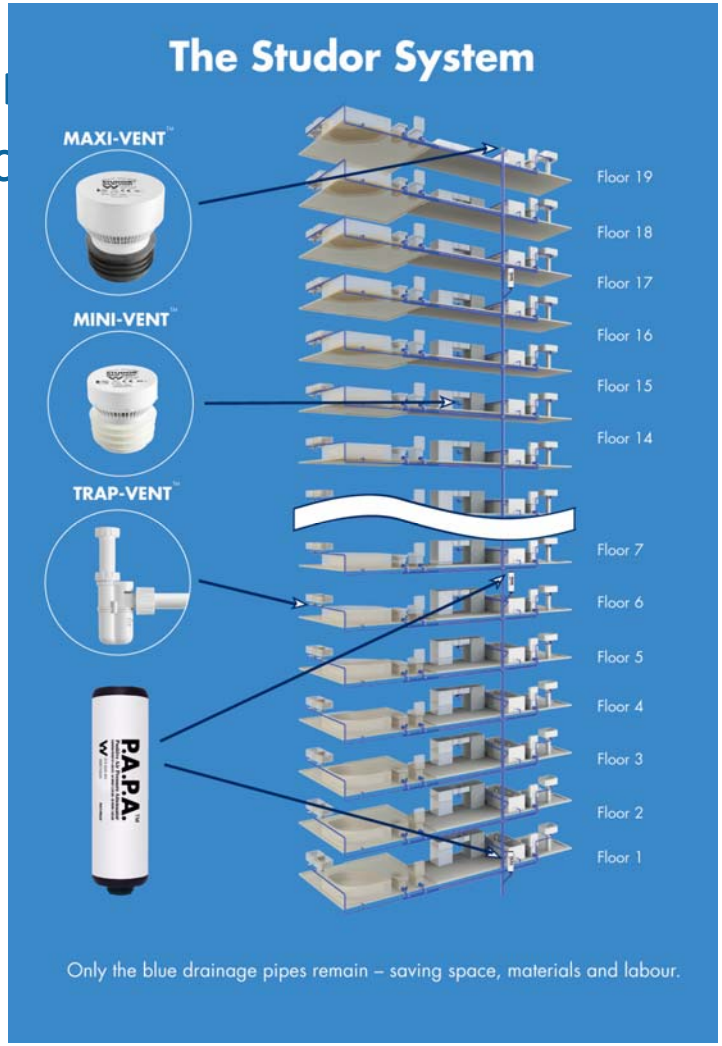

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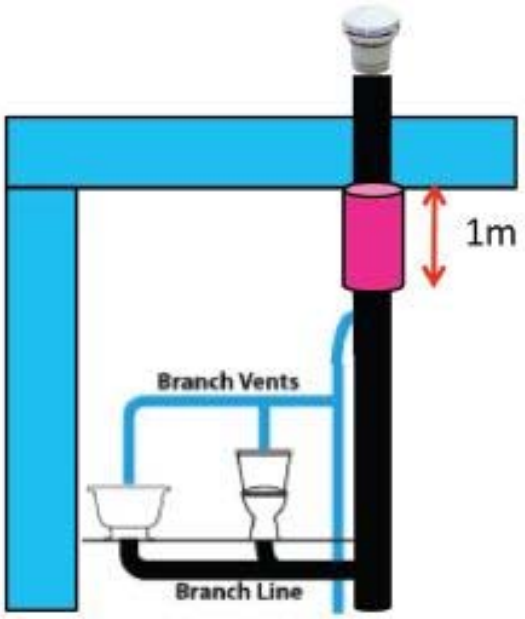
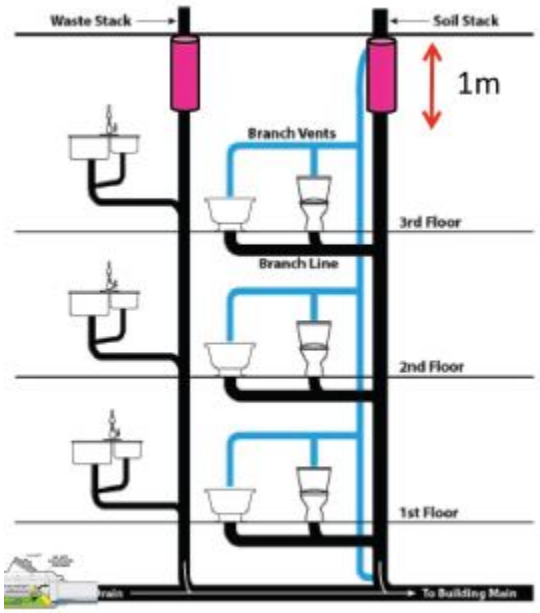
Thermal Bridge Free – Vent Stacks

Plumbing Vent Stack Alternative Options

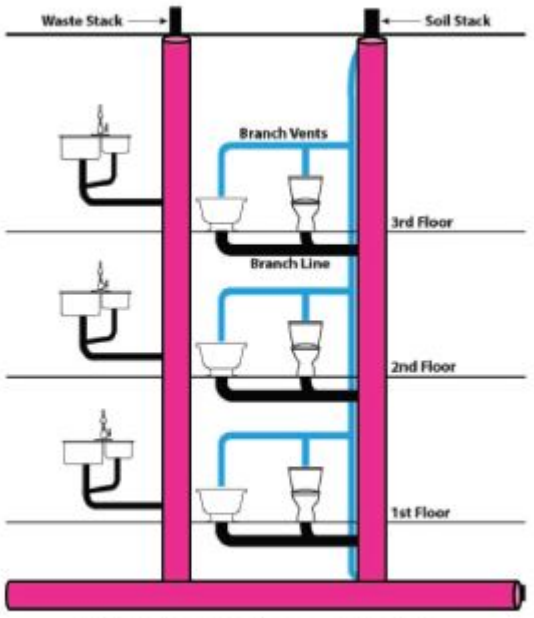


- 1m of Insulation on Pipe
- P-trap below roof penetrationg
- AAV outside of thermal envelope



Multi-story Drainage and Venting

- 1m of Insulation on Pipe
- Backwater valve



Multi-story Drainage and Venting

- Insulate the entire pipe
- $$$

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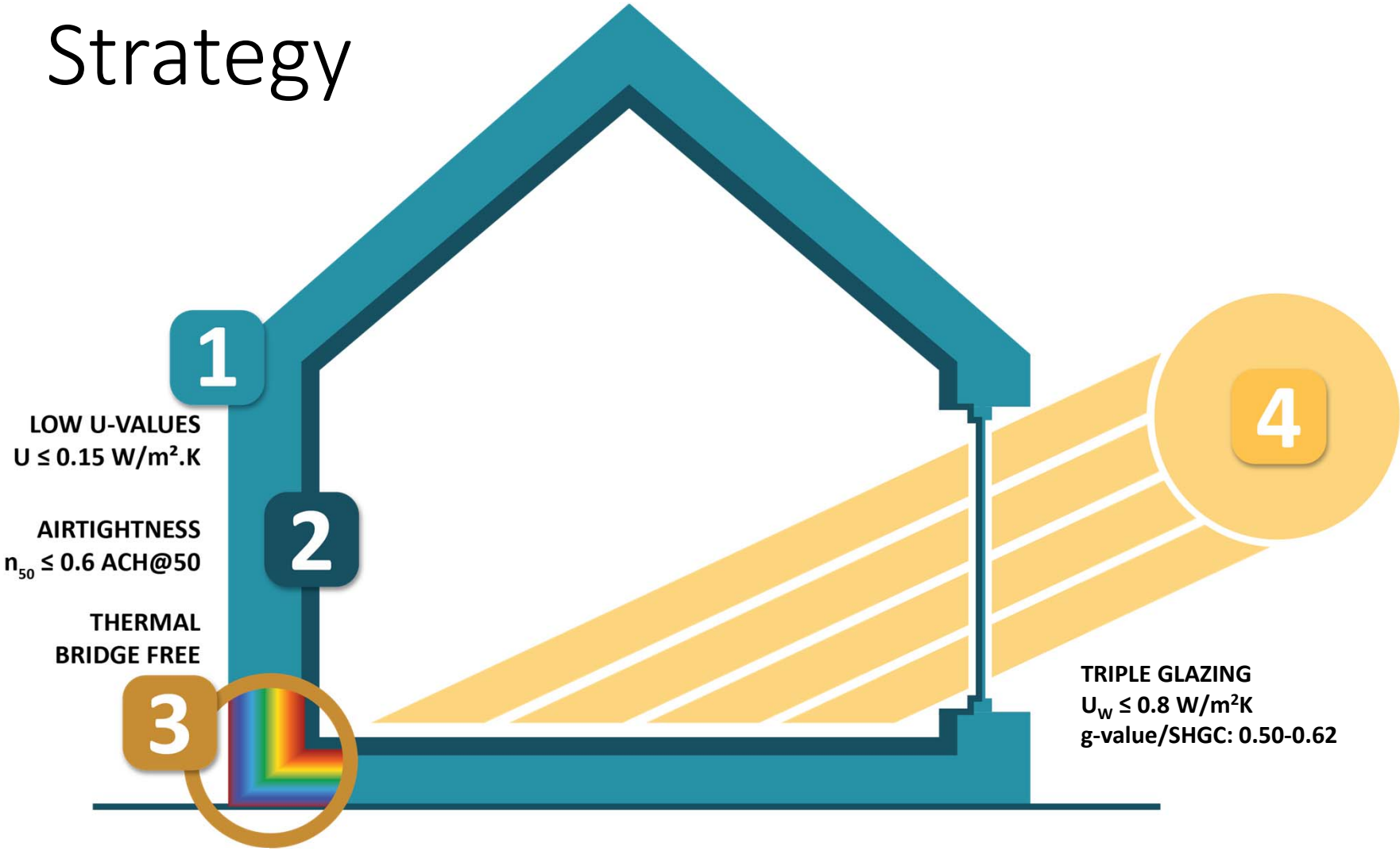


Image courtesy Passive House Canada

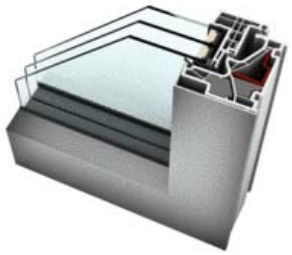
High Performance Windows & Doors

KF 220

UPVC

Thermal insulation (in W/m²K)

U_W up to 0,67



KF 500

UPVC/aluminium

Thermal insulation (in W/m²K)

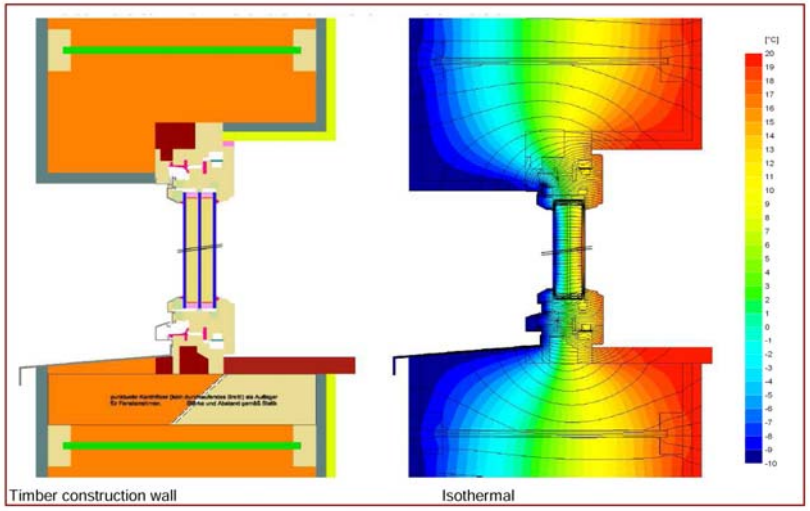
U_W up to 0,61

HF 410

Timber/aluminium

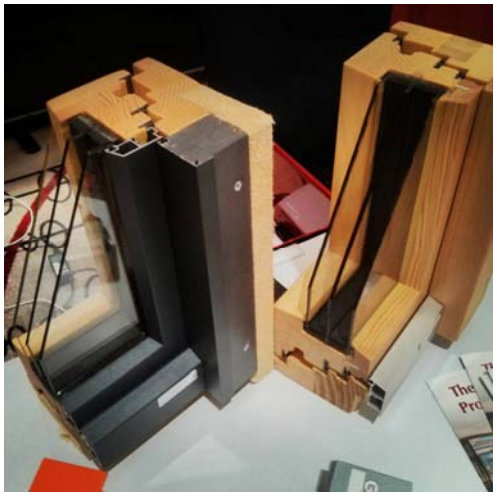
Thermal insulation (in W/m²K)

U_W up to 0,64



Timber construction wall

Isothermal



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High Performance Windows & Doors

Frame, Glass and Installation Specifications

- Uf – Frame Thermal Performance
  - Thinner frames result in more glass which leads to better performance
- Ug – Sealed unit thermal performance
  - Argon vs. Krypton, etc.
- G-value – Solar heat gain coefficient
- Spacer Psi Value – Thermal Conductivity of spacer material
- Installation Psi Value – where the window is installed in the rough opening has a major impact on the performance of the overall installation

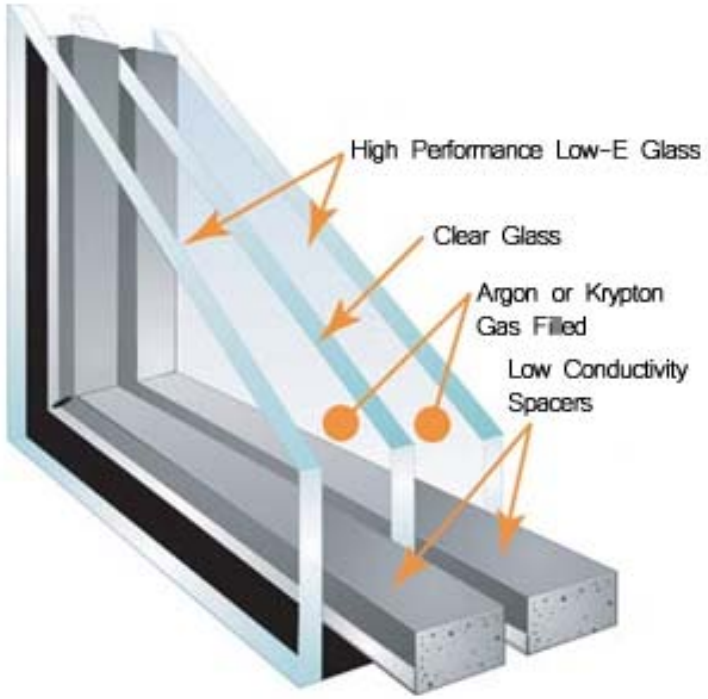

Fig. 3 – High Quality Window Components

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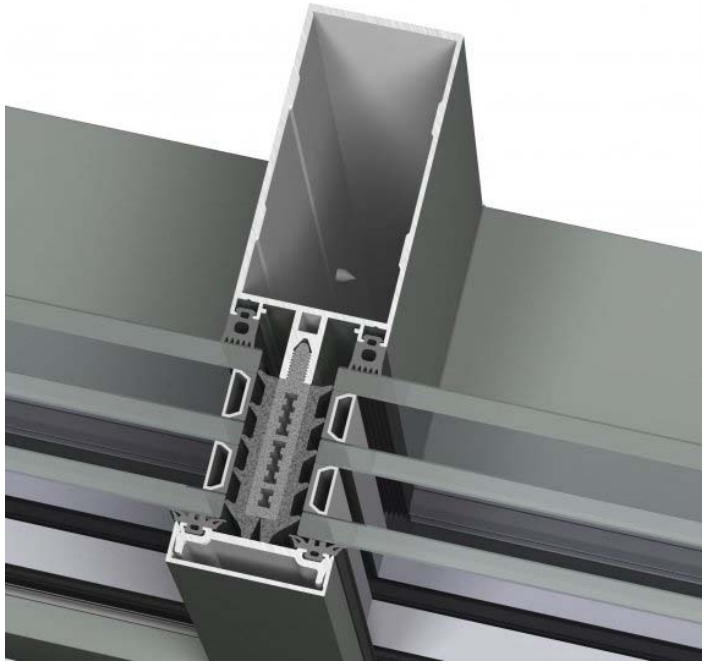
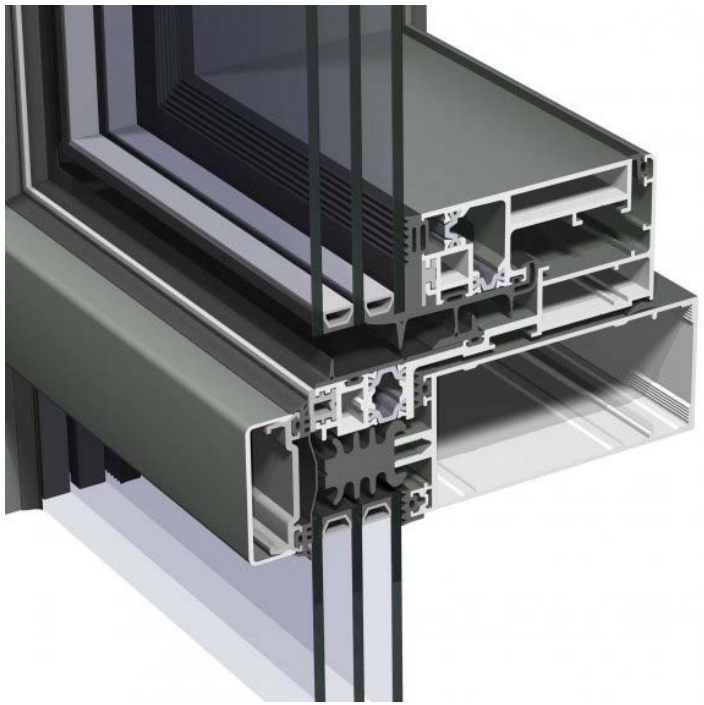
High Performance Windows & Doors

- Many different combinations from uPVC, uPVC/alum, wood, wood-alum, fiberglass and now aluminum framed curtain wall systems





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High Performance Windows & Doors

Multifamily Considerations

- Limited North American Manufacturers – Euroline, Cascadia, Casa Grande
- Tilt and Turn bug screen integration can be challenging and if screens are not removed in the winter this will impact Passive Solar Gains, alternatively in the summer, screens will provide some shading
- Casement/Awning windows allow easy integration of bug screens without having to remove in spring/fall but there are limited manufacturers that produce casement/awning windows
- Main Entry Door Hardware - Integration of multipoint locking hardware with panic hardware and electronic door strikes

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High Performance Windows & Doors

Multifamily Considerations

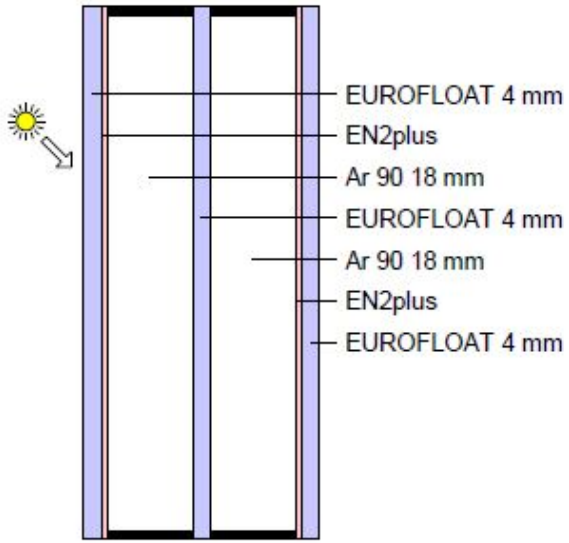
- North American Glass vs. European Glass
  - European U-factors are at least 10% ‘better’ than the equivalent NFRC rating due to the lower delta-T used for European calculations versus the greater delta-T used for North American U-factor calculations
  - European windows are more likely to be fabricated with a thicker glass package (heavier glass with wider airspace)

Source: Green Building Advisor

European Glastroch Glass

Ug Value = 0.50 w/(m2k)

G-value = 0.53



North American Cardinal LoE180 Glass

Ug Value = 0.64 w/(m2k)

G-value = 0.52

22% Difference

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Passive House Strategy

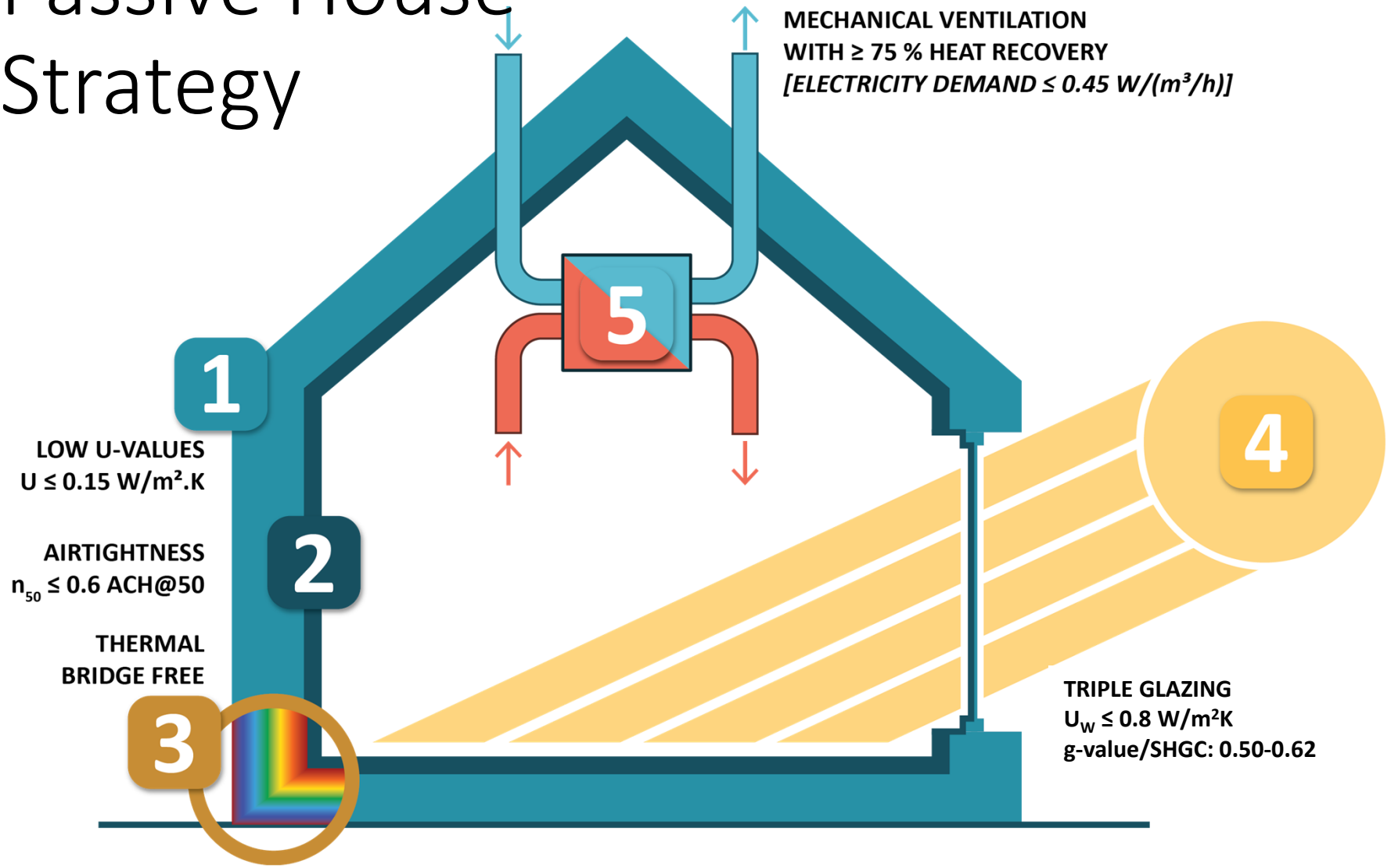

Image courtesy Passive House Canada

Heat Recovery Ventilation

Minimum HRV Efficiency of 75% Required based on PHI Testing Standards

Centralized – Whole Buildings

De-Centralized

Individual Suites

Hybrid/Semi-Central

Multiple HRV's serving 3-6 units and common spaces

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Heat Recovery Ventilation

2 Different Thermal Efficiency Calculations!

PHI's Method

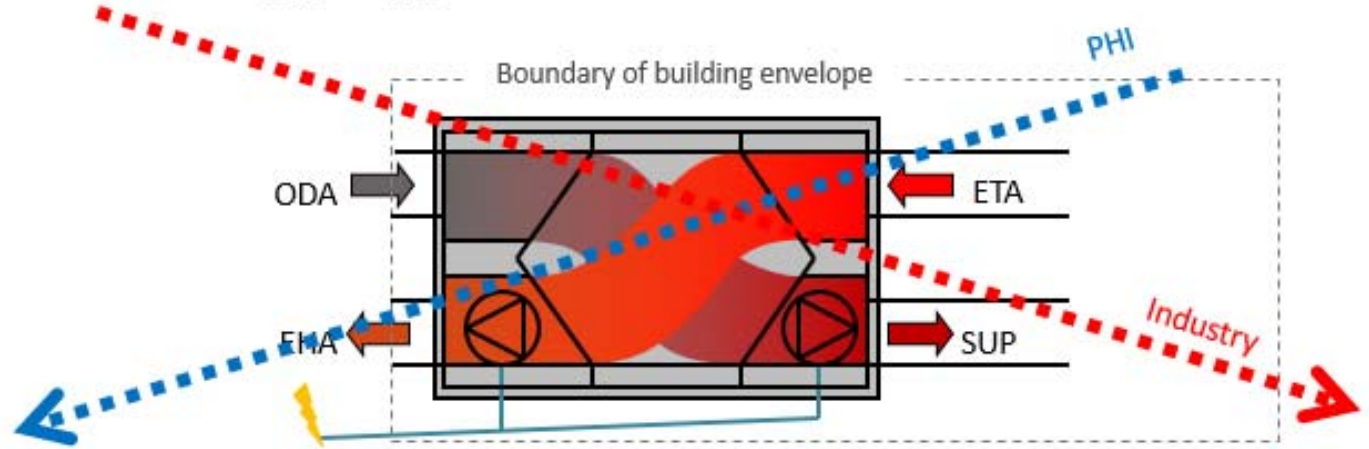
Measures drop-off between extract air and exhaust air

$$= \frac{(\, t_{ETA} - t_{EHA} \,) + \frac{P_{el}}{V \cdot c_{air}}}{t_{ETA} - t_{ODA}}$$

Industry Method

Measures uplift between outdoor air and supply air

$$= \frac{t_{SUP} - t_{ODA}}{t_{ETA} - t_{ODA}}$$



If E/HRV is poorly insulated and leaky, industry method will appear to perform better due to raised SUP temperatures

Heat Recovery Ventilation

Ventilation Standards:

- There is debate about the appropriate ventilation rates
  - Provincial Building Codes refer to ASHRAE standards
  - Passive House has slightly different standard which incorporate “normal” and “boost” ventilation flow rates
  - At the end of the day, the Building Code must be adhered to unless an Alternative Solution is prepared
- Over Ventilation
  - higher energy consumption
  - Tends to dry out the air in cold climates in winter months
- Under Ventilation
  - build-up of mold and toxins in the air

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Heat Recovery Ventilation

Multifamily Challenges – Boost (Flow Rate) Controls

Controls

Multi-family: at least 3 settings*

- set-back (54%)
- standard (77%)
- boost (100%)

Non-residential: use-dependent

- Automatic restart after power failure

*Relative to HRV design rate

- Boost controls can trigger the requirement for motorized dampers to control ventilation flow rates when centralized or hybrid / semi-central systems are used
- The greater number of units, the more complex the controls system

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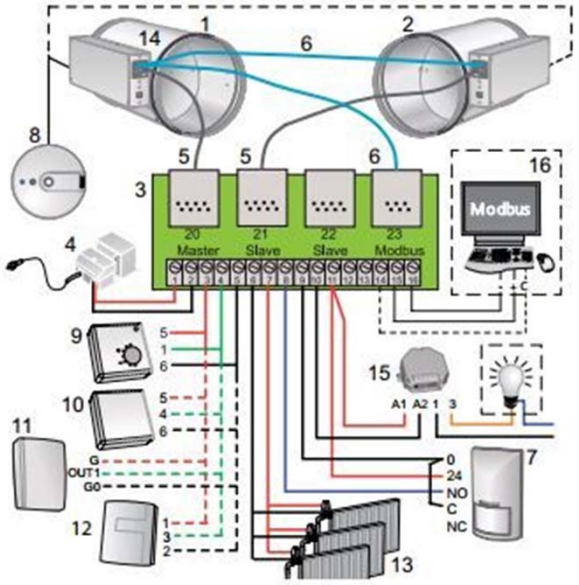
Heat Recovery Ventilation

Multifamily Challenges – Motorized Dampers

- Advantage
  - Can adjust flow rate depending on set points for the desired CO2, humidity, indoor air quality, temperature and/or occupancy detection

- Disadvantage
  - Motorized dampers required on both supply and exhaust ducts into the suites
  - Dampers draw continuous phantom power when not in operation
  - Controls systems are complicated
  - Motors inevitably fail!!!



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Heat Recovery Ventilation

Centralized System

- One HRV to supply the entire building

Swegon Gold RX

- 84% heat recovery
- One unit is easier to maintain
- Operator changes the filters
- Duct fire dampers required into suites
- Longer ducts can lead to pressure losses

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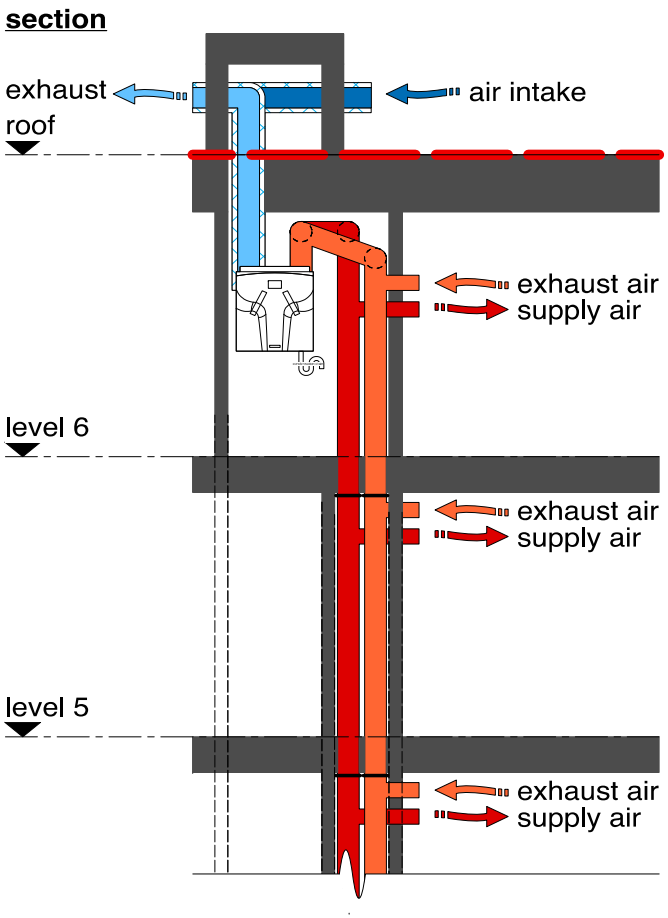
Heat Recovery Ventilation

Hybrid / Semi-Central System

- Multiple HRV's supplying 3-6 suites based on size of units

Zehnder Comfoair 550

- 84% heat recovery
- All suites on HRV boost if tenant in one suite hits "boost"
- Boost switch in kitchen and bathrooms
- Multiple HRV's require multiple filters to maintain



Source: Cornerstone Architecture

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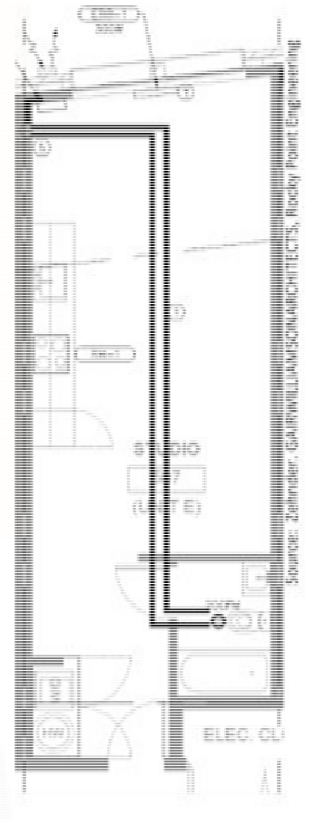
Heat Recovery Ventilation

De-Centralized System

- Individual HRV per Suite

- Advantage
  - 89% heat recovery
  - Homeowner pays for the power
  - Ducts in corridors or shafts are not required which eliminates fire dampers, flow rate dampers and sound attenuators where requi
- Disadvantage
  - Owner must change filters
  - Limited flow rates
  - Significantly more building envelope penetrations as every unit requires insulated supply and exhaust ducts and exterior wall caps
  - If not properly sealed these additional penetrations can compromise the building airtightness requirements



Multifamily Challenge – Kitchen Exhaust

HRV Exhaust vs. Insulated Range Hood Exhaust Duct to Exterior

- Passive House recommend approach is to use a re-circulating extract hood over an electric stove
- This is not common in North America
- Considerably lower flow rate than traditional range hood however exhaust flow is 24/7/365
- If gas range this approach would not be allowed by Code due to additional pollutants created by combustion

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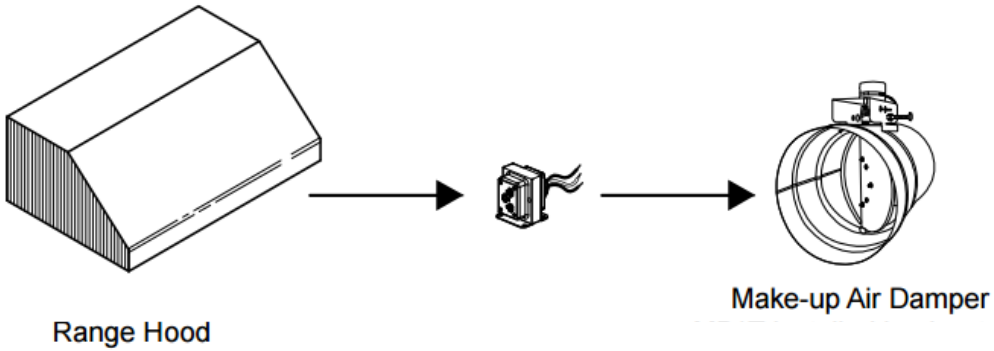
Multifamily Challenge – Kitchen Exhaust

HRV Exhaust vs. Insulated Range Hood Exhaust Duct to Exterior

- If gas range, a traditional but appropriately sized range hood required to exhaust pollutants
- When range hood is turned on, motorized dampers open.
- Dampers are not 100% airtight which can impact building envelope airtightness
- Make up air required to prevent infiltration which adds up to two building envelope penetrations per suite
- Two sets of insulated supply/exhaust ducts, motorized dampers and wall caps - $$$
- More traditional approach that North American's are used too however this should be avoided if possible – think induction or electric resistance cooktops!



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Multifamily Challenge – Laundry Exhaust

Conventional Dryers vs. Heat Pump Condensing Dryers

- If common laundry room, Owner/Operator may prefer traditional dryers
- Make up air required to prevent infiltration which adds up to two building envelope penetrations Two sets of insulated supply/exhaust ducts, motorized dampers and wall caps - $$$
- Laundry room must be isolated from remainder of building as exhaust duct can't have motorized damper on it due to lint build up

- No exhaust duct, make up air ducts, duct insulation, motorized dampers, penetration sealing and wall vent caps required
- Perfect for individual suites
- Considerably more efficient

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Multifamily Challenge – Hot Water

Gas, Electric, Heat Pump, Geothermal, Solar Thermal

Options:

- Central versus Distributed Systems
- Storage Tank versus On-Demand Systems
- Primary Energy: Natural Gas versus Electricity
- Other Choices/Issues:
  - Solar-Thermal
  - Heat Pump Technology
  - Solar-Voltaic

Water Distribution Piping:

- Detailed PHPP input – Internal heat gains accounted for
- Pipe Insulation Critical

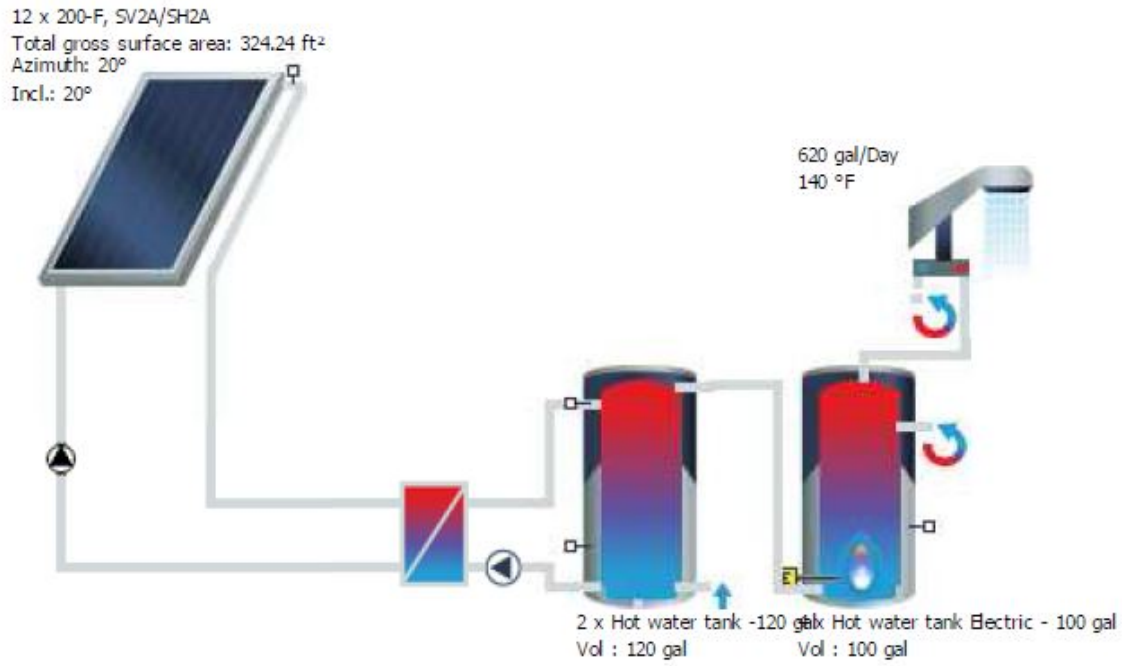
PASSIVEHOUSE CANADA

Multifamily Challenge – Hot Water

Gas, Electric, Heat Pump, Geothermal, Solar Thermal

- BSD's ASK Wellness Multifamily project is proposing to use a solar thermal flat plate roof mounted panels with buffer tanks and electric resistance "top up" tanks to serve the entire building

- Due to superinsulated, airtight building envelope, hot water lines contribute to Internal Heat Gains so all lines should be insulated



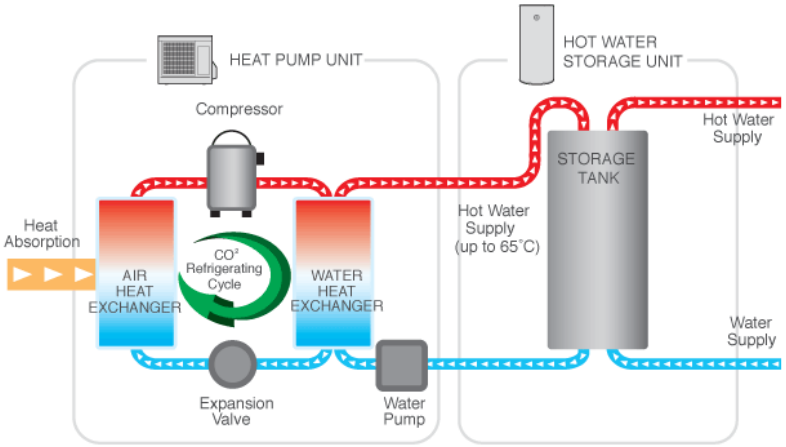
PASSIVEHOUSE CANADA

Multifamily Challenge – Hot Water

Gas, Electric, Heat Pump, Geothermal, Solar Thermal

- Cornerstone's Skeena Multifamily project is using natural gas tanks due to their quick recovery rate however there is a slight Primary Energy Demand penalty due to a combustible fuel

- Cornerstone's Smithers Multifamily is proposing 3 Sanden CO2 Heat Pumps with Electric Resistance Back Ups
  - In how this system is designed the exterior condenser is connected to an internal tank via a water line which raises concerns with power outages and the line freezing



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Multifamily Challenge – Hot Water

Gas, Electric, Heat Pump, Geothermal, Solar Thermal

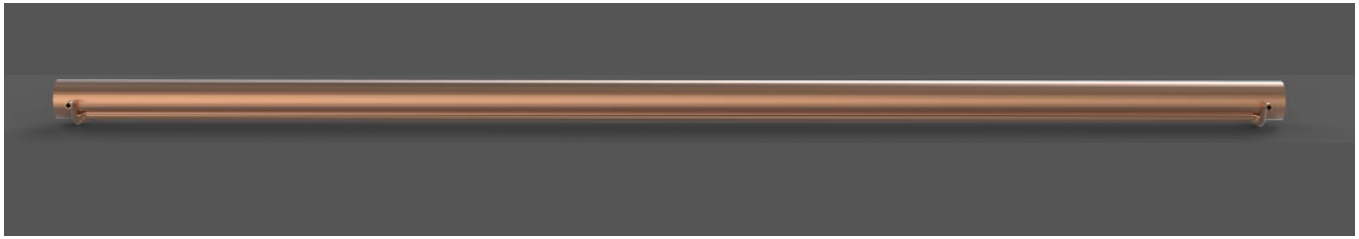
- Residential grade heat pump hot water heaters are available
- Have slow recovery rates often requiring an additional “top up” measures to meet peak demand
- Internal heat pumps “steal” heat from the building in the winter when needed most however in the summer it is advantageous

PASSIVEHOUSE CANADA

Multifamily Challenge – Hot Water

Drain Water Heat Recovery

- Dead simple technology with no moving parts
- One of the best bang for your bucks in our opinion
- Vertical and now horizontal under slab versions available



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Passive House Strategy

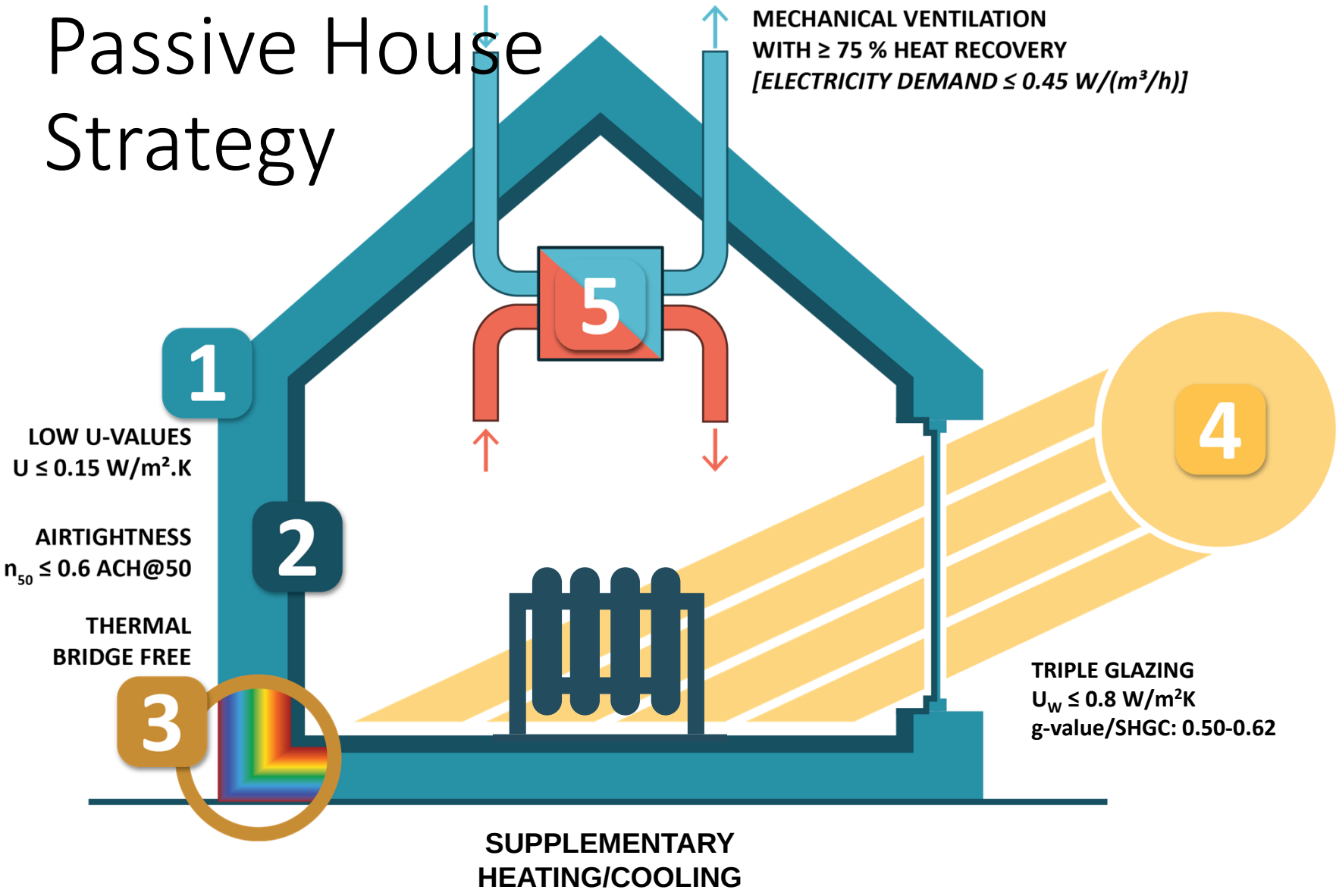


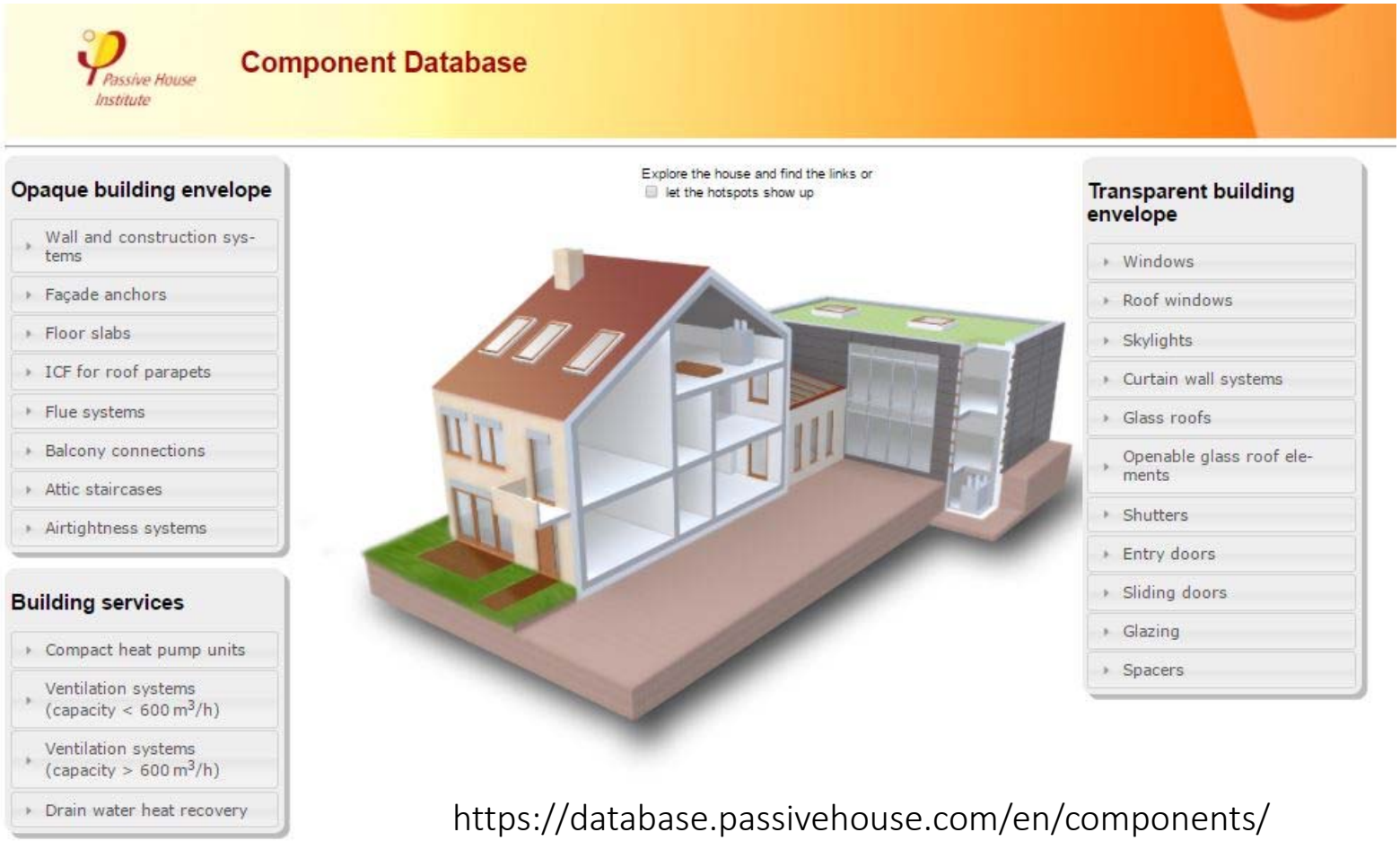
Image courtesy Passive House Canada

Multifamily Challenge – Elevators

- North American elevators are not tested for energy performance
- Although some elevators have been certified to the VDI 4707 (German standard), these models are not available in NA
- There are no conservative energy performance values to use to date so over-estimate and build savings into the energy model elsewhere and evaluate elevators based on the following criteria:
    1. Travel Energy
    2. Standby Power
    3. Number of uses in a 24 hour period
- Electric traction elevators are more efficient than hydraulic elevators but are considerably more expensive for initial costs
- Electric traction elevators uses 1/3 the power of a hydraulic elevator and the difference in motor size also impacts the heat output which contribute to internal heat gains.

PASSIVEHOUSE CANADA

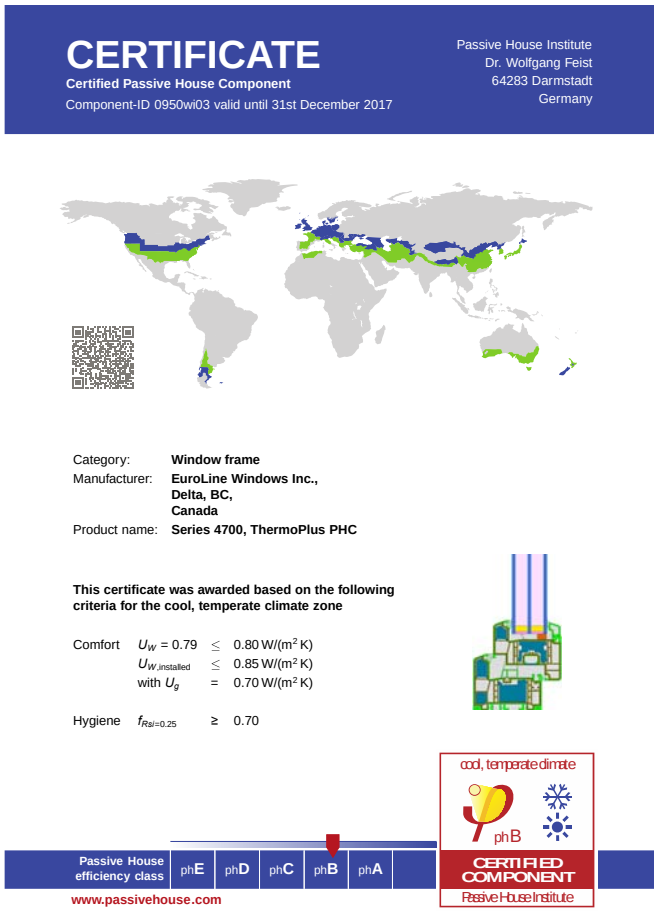
Certified Component Sourcing and Specs



https://database.passivehouse.com/en/components/

PASSIVEHOUSE CANADA

Certified Component Sourcing and Specs



CERTIFICATE

Certified Passive House Component

Component-ID 0950wi03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Category: **Window frame**
Manufacturer: **EuroLine Windows Inc., Delta, BC, Canada**
Product name: **Series 4700, ThermoPlus PHC**

This certificate was awarded based on the following criteria for the cool, temperate climate zone

Comfort $U_W = 0.79$ ≤ 0.80 W/(m² K)
$U_{W,installed}$ ≤ 0.85 W/(m² K)
with U_g = 0.70 W/(m² K)

Hygiene $f_{Rsi=0.25}$ ≥ 0.70

cool, temperate climate

phB

CERTIFIED COMPONENT

Passive House Institute

Passive House efficiency class: phE | phD | phC | phB | phA

www.passivehouse.com

CERTIFICATE

Certified Passive House Component

Component-ID 0302vs03 valid until 31st December 2017

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Category: **Air handling unit with heat recovery**
Manufacturer: **PAUL Wärmerückgewinnung GmbH Germany**
Product name: **novus 300**

Specification: Airflow rate < 600 m³/h
Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate η_{HR} ≥ 75 %
Specific electric power $P_{el,spec}$ ≤ 0.45 Wh/m³
Leakage < 3 %

Comfort: Supply air temperature ≥ 16.5 °C at outdoor air temperature −10 °C

Airflow range
121–231 m³/h
Heat recovery rate
η_{HR} = 93 %
Specific electric power
$P_{el,spec}$ = 0.24 Wh/m³

■ At an airflow of 144 m³/h, a heat recovery of η_{HR} = 94 % is reached.

cool, temperate climate

CERTIFIED COMPONENT

Passive House Institute

www.passivehouse.com

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PH Energy Model Optimization & Design PH

Passive House verification

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

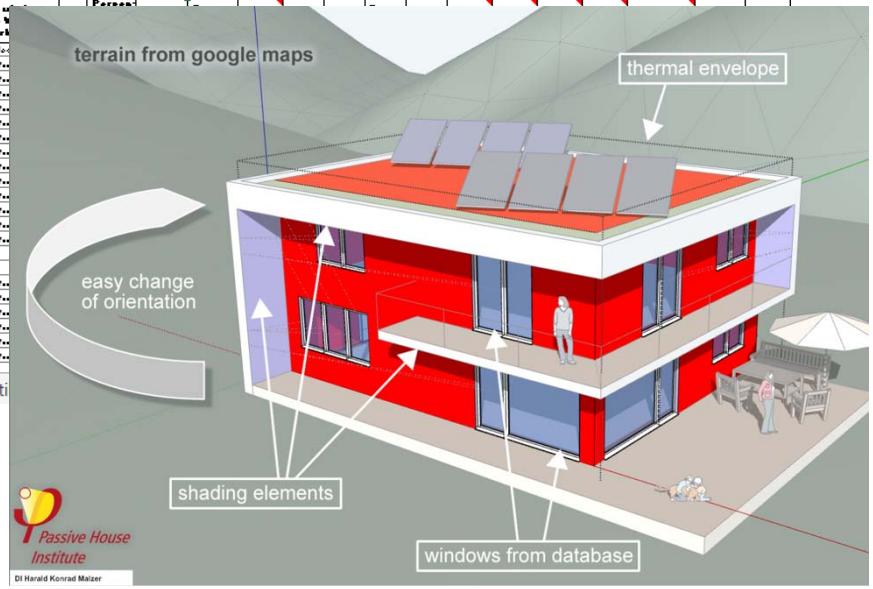
Building: Tan-Kok Passive House — Annual heating demand: 13.66 kWh/(m²a) — Heating degree hours: 105.1

Climate: BC_Nelson

Window area orientation	Global radiation (cardinal points)	Shading	Dirt	Non-perpendicular incident	Glazing fraction	g-Value	Reduction factor for solar radiation	Window area	Window U-Value	Glazing area	Average global radiation	Transmission losses	Heat gains solar radiation	
maximum:	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/m²a	kWh/a	kWh/a	
North	140	0.83	0.95	0.85	0.635	0.53	0.47	7.99	0.69	5.6	169	582	334	-248
East	371	0.27	0.95	0.85	0.601	0.53	0.13	4.06	0.75	2.4	246	319	70	-249
South	672	0.81	0.95	0.85	0.736	0.62	0.48	16.72	0.74	12.3	627	1304	3121	1817
West	378	0.72	0.95	0.85	0.641	0.59	0.37	3.44	0.77	6.1	518	764	1077	312
Horizontal	552	1.00	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	552	0	0	
Total or Average Value for All Windows						0.59	0.41	38.22	0.74	26.4		2969	4602	1632

Quantity	Description	Deviation from north	Angle of inclination from the	Orientation	Window rough openings Width	Height	Installed in Area in the Areas worksheet	Nr.	Glazing: Select glazing from the WinType worksheet	Nr.	Frame: Select u… from the … worksheet	g-Value	U-Value	Ψ-Space	Installation	Res… (unhide cells to ma… from WinType wo…
		Degree	Degree		m	m	Select:		Select:		Sele…	Person…				
1	201A Gym T+T	240	30	West	0.914	1.524	EXWWest	4	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	201B Gym Fixed	240	30	West	0.914	1.524	EXWWest	4	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	202 Kitchen T+T	240	30	West	0.914	1.524	EXWWest	4	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	203 Dining Door	240	30	West	1.017	2.438	EXWWest	4	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	204 Dining T+T	240	30	West	0.914	1.829	EXWWest	4	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	205 Dining Fixed	150	30	South	1.524	1.829	EXW South	3	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	206A Dining/Living T+T	150	30	South	0.914	1.829	EXW South	3	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	206B Dining/Living Fixed	150	30	South	2.133	1.829	EXW South	3	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	207 Living Fixed	150	30	South	1.524	1.829	EXW South	3	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	208 Living Fixed	60	30	East	1.829	0.457	EXW East	2	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	209 Entry	60	30	East	1.118	2.221	EXW East	2	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	210 Bathroom T+T	330	30	North	0.610	1.219	EXW North	1	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	211 Gym - Fixed	330	30	North	1.829	1.524	EXW North	1	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	301 Ensuite T+T	240	30	West	0.914	1.219	EXWWest	4	SAMCO SILVERSTAR TRILLE PRIVACY [4-TRE-18AR-4SATINATO-18	3	Optiwin - AluWo…					
1	302A Office T+T	150	30	South	0.914	1.829	EXW South	3	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	302B Office Fixed	150	30	South	2.133	1.829	EXW South	3	SAMCO SILVERSTAR TRILLE [4EF-TRE-18AR-4EF-18AR-TRE-4EF]	1	Optiwin - AluWo…					
1	303 Stairs T+T	60	30	East	0.609	1.219	EXW East	2	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	304A M. Bedroom T+T	330	30	North	0.914	1.829	EXW North	1	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					
1	304B M. Bedroom Fixed	330	30	North	1.524	1.829	EXW North	1	SAMCO SILVERSTAR EMZPLUS [4-18AR-4-18AR-4]	2	Optiwin - AluWo…					

... | Verification | Areas | U-List | U-Values | Ground | **Windows** | WinType | Shading | Venti



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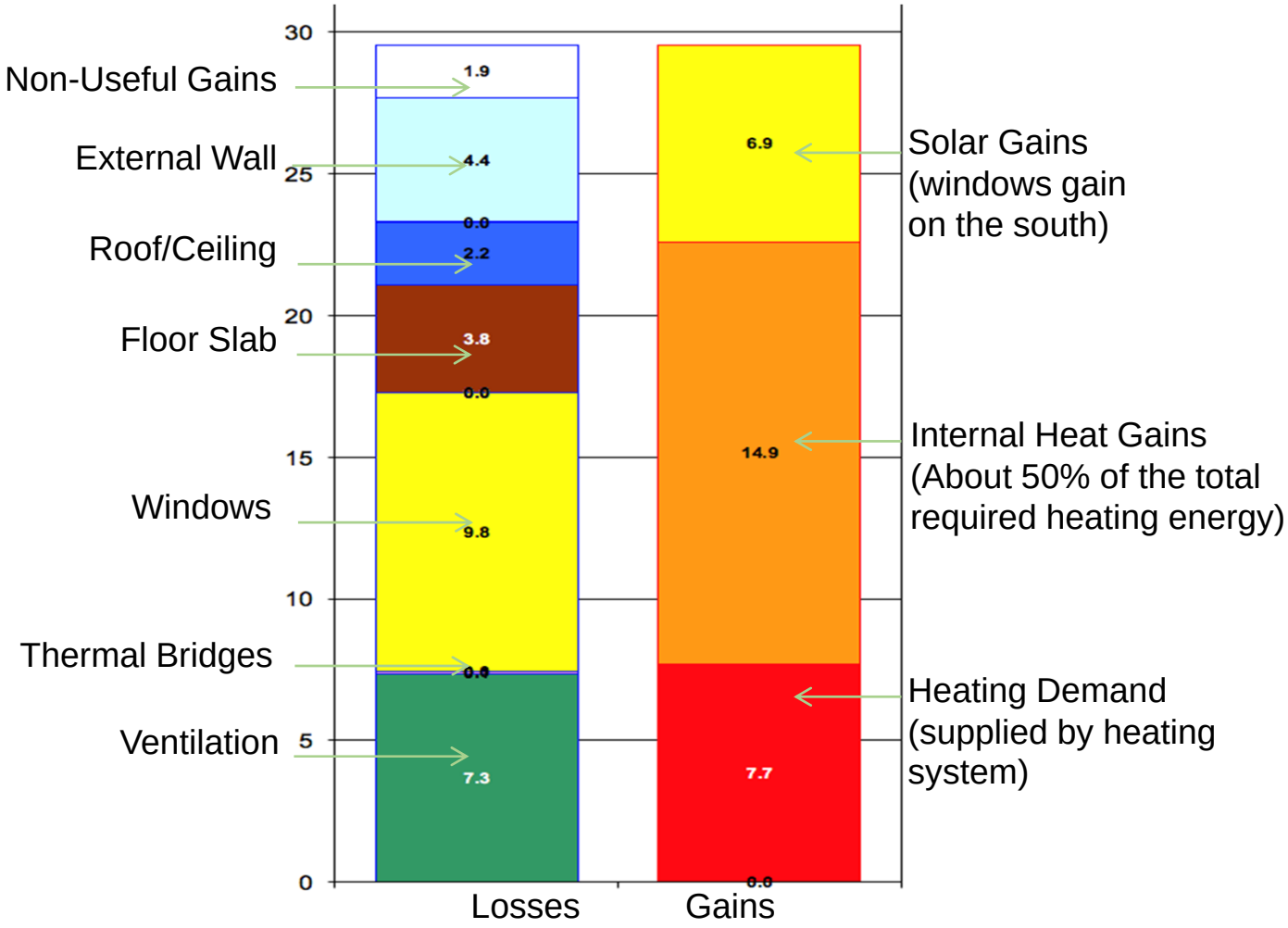
Annual Energy Balance



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Passive House Standards / Minimum Requirements / Specifications

Requirements	Passive House
• Heating Demand	15 kWh/(m²·a)
• Heating Load (or cooling)	10 W/m²
• Primary Energy (PE)	120 kWh/(m²·a)
• Primary Energy Renewable (PER)	60 kWh/(m²·a) (PH classic)
• Air Tightness	0.6 ac/h
• Thermal Bridge Free	

Average heating energy use in Canada (Statistics Canada):

- Existing Buildings: 150 kWh/square metre
- New Buildings: 100 kWh/square metre
- Passive House: 15 kWh/square metre

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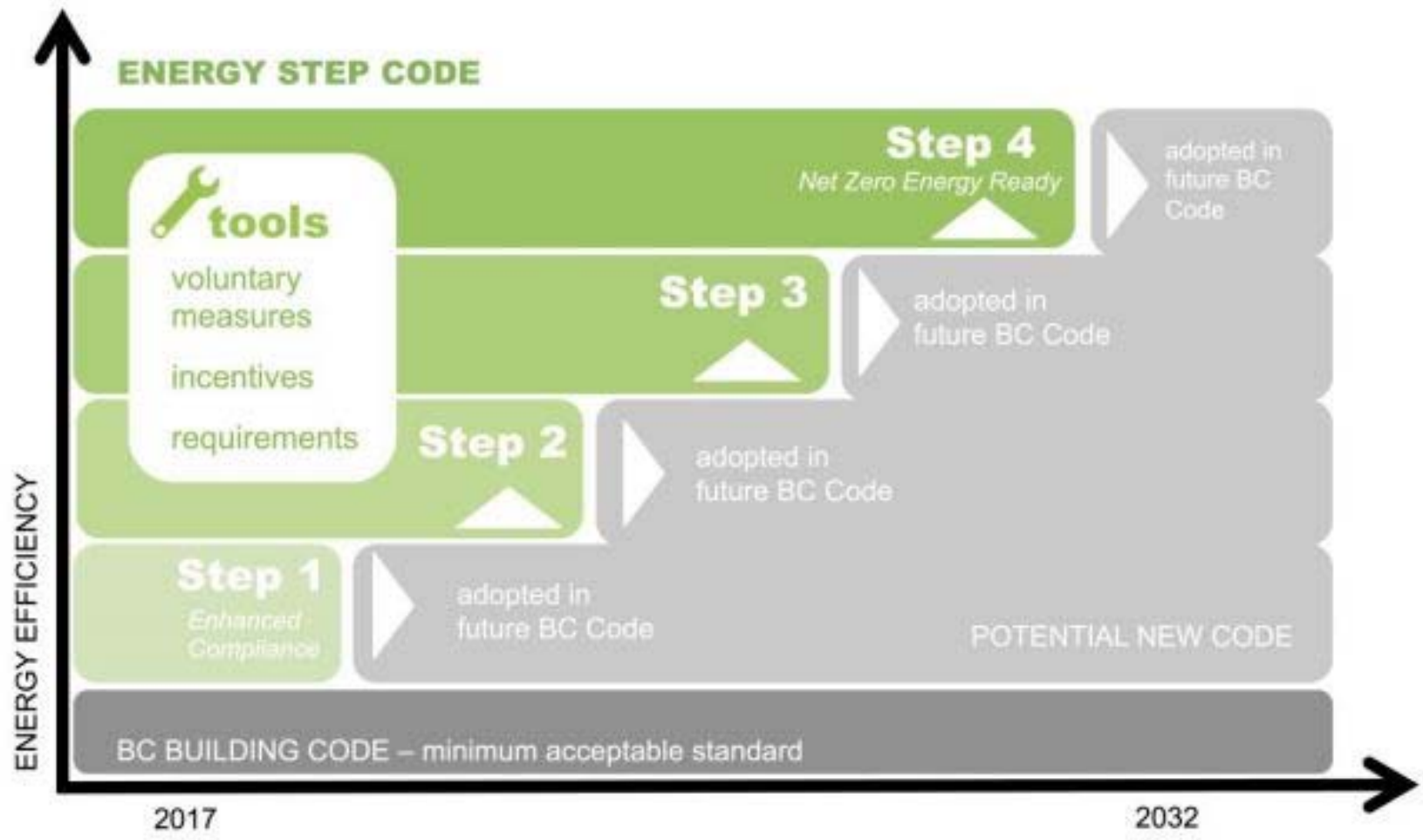
BC Energy Step Code points toward Passive House



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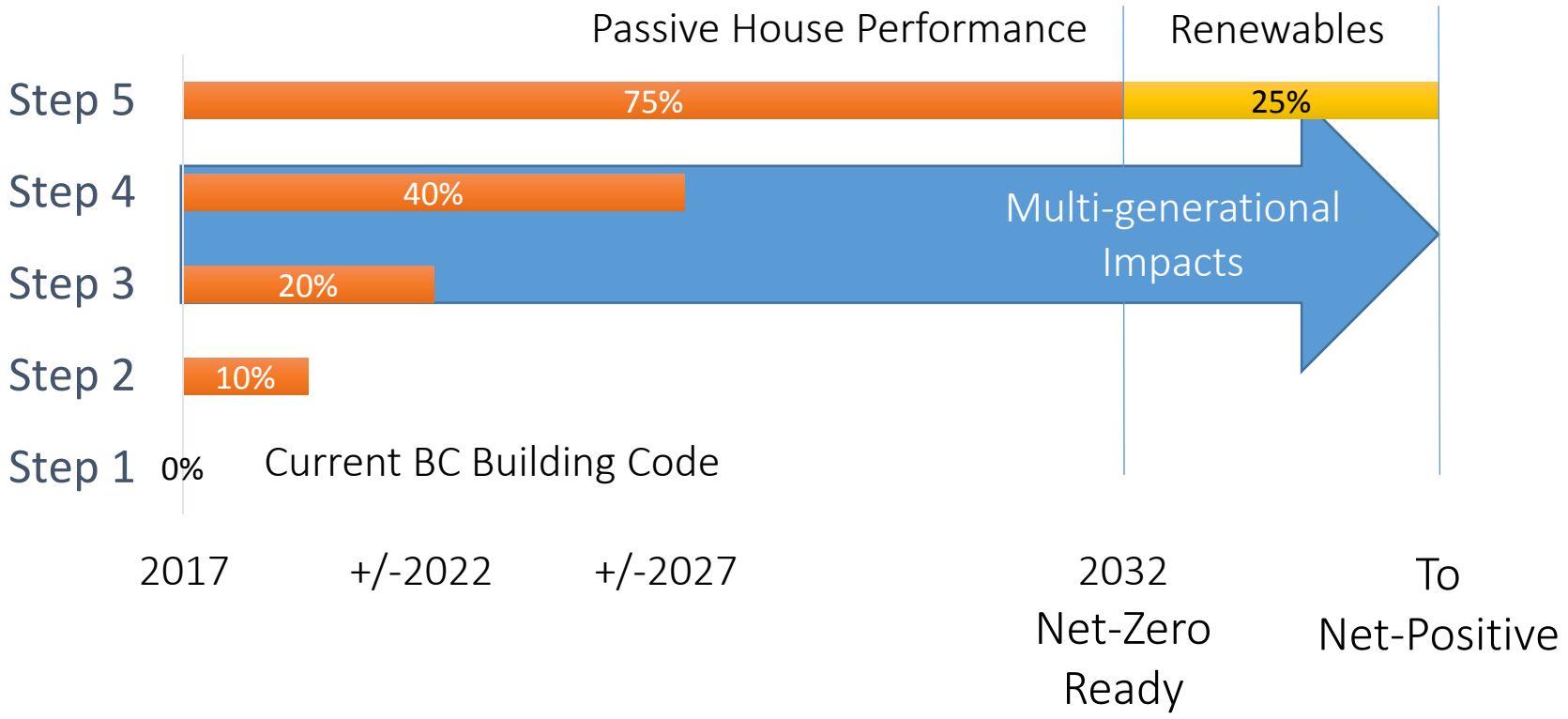
The Big Picture



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Salus Clementine

Four Stories, 42 Affordable Housing Units, Ottawa, Ontario – CSV Architects

PASSIVEHOUSE CANADA

163 Skeena – Canada's Largest Multifamily Passive House

85 Condo Units, Vancouver, BC – Cornerstone Architecture

PASSIVEHOUSE CANADA

Orchards at Orenco

Three story, 57 Unit Passive House, Hillsboro, Oregon

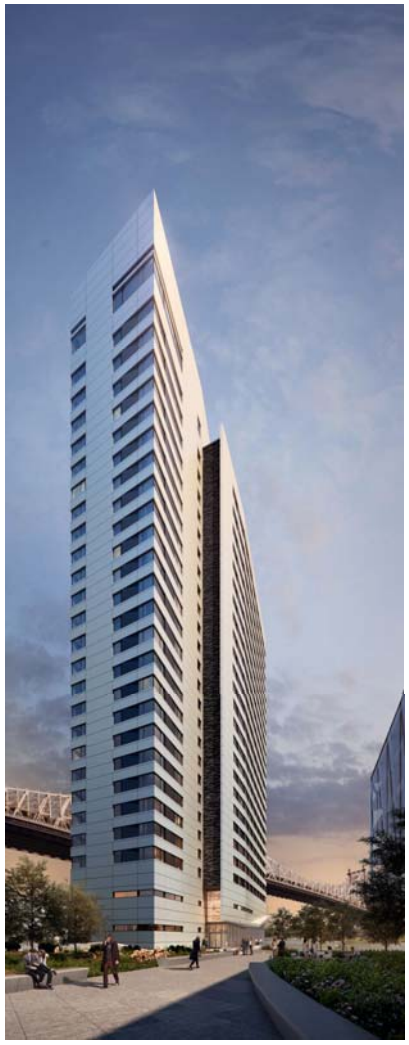
PASSIVEHOUSE CANADA

706 East 57th Avenue

Six Story Rental Building with 95 Units, Vancouver, BC – Cornerstone Architecture

PASSIVEHOUSE CANADA

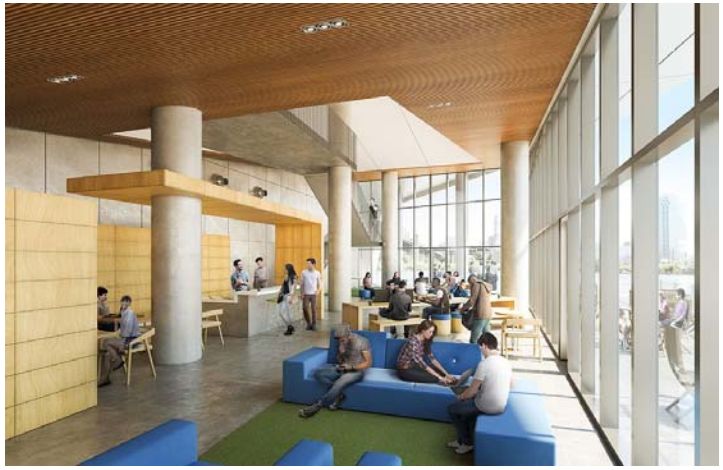
The House at Cornell Tech, New York

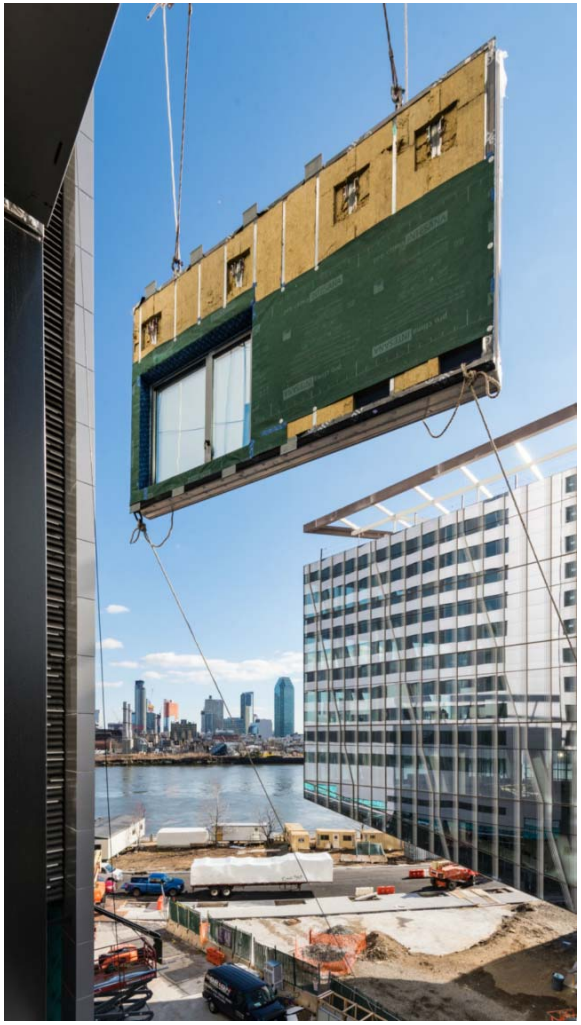


- 26 Story Passive House Tower
- Upon completion in July, this will be world's largest Passive House building.
- 350 units of studios, one, two and three bedrooms

PASSIVEHOUSE CANADA

The House at Cornell Tech, New York





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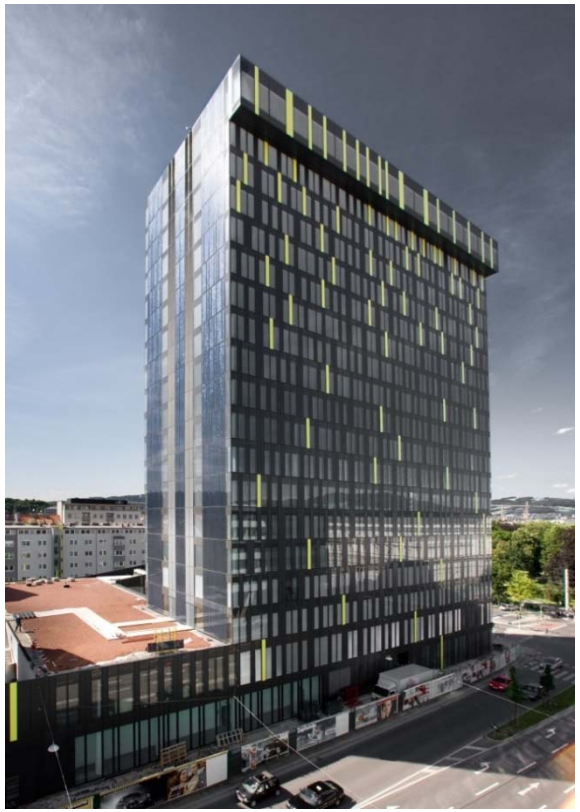
North Park Passive House 6 Unit Townhouse in Victoria, BC

PASSIVEHOUSE CANADA

Passive House Towers around the World



Power Tower, Linz, Austria

RHW2 Tower, Vienna

Cornell Tech Residence, NYC

PASSIVEHOUSE CANADA

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