SUN CERTIFIED BUILDERS
COOPERATIVE LIMITED

High Efficiency Building Techniques for Cold Climates

Training logistics

Agenda Review

Group Learning Agreement

Ice Breaker & Personal Introductions

Learning agreement/ground rules

Everyone has wisdom

We need everyone's wisdom for the wisest results

There are no wrong answers

The whole is greater than the sum of the parts

Everyone will hear and be heard

Suffering is optional

Introductions & Ice Breaker

Give your name
Your interest in being here today (3 to 5 words)

Question?

Constructing & Retrofitting High Performance Buildings in Alaska is like a

_____

Because……

We Live in Cold Climates

Fairbanks AK Jan. 2019
min -43.8 F

Wasagaming MB Jan. 2019
min -48.4 F

SUN CERTIFIED BUILDERS
COOPERATIVE LIMITED

Who are we?

Our Multi-stakeholder Worker Cooperative represents three generations of construction knowledge

We design and construct high performance buildings

We retrofit existing structures to high performance standards

SUN CERTIFIED BUILDERS
COOPERATIVE LIMITED

The 7 Cooperative Principles:

1. Voluntary and Open Membership
2. Democratic Member Control
3. Member Economic Participation
4. Autonomy and Independence
5. Education, Training and Information
6. Co-Operation Among Co-Operatives
7. Concern for Community

We use *Passive House International* (PHI) to guide our design and construction.

It is an international performance based construction standard.

Our goal is that new construction and retrofits be built to the highest standards of Energy Efficiency, Thermal Comfort, Health Structures and Low Carbon embodiment because:

- It saves you money!
- It ensures buildings are comfortable and pose limited future health or financial risks
- It achieve buildings that store carbon

What is Passive House?

A voluntary Building Standard and Design/modeling method that results in:

- Energy savings (75-90% reduction)
- Long Term Affordability
- Superior Comfort
- Verified Performance

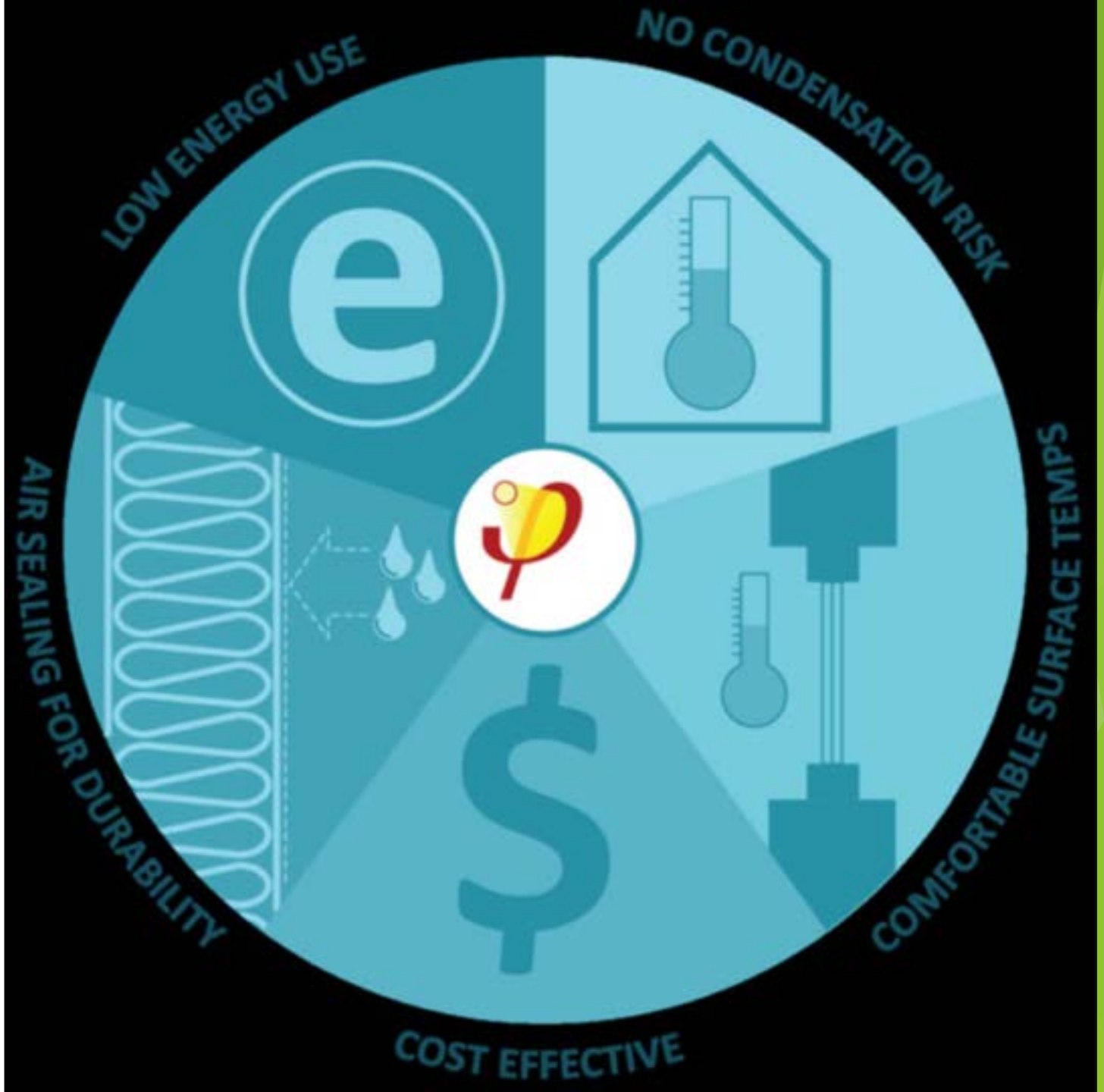
Passive House International certification standards are the most stringent at this time.

(With the exception of some energy targets now being developed by cities)

We are always looking for ways to improve performance with Design, Modelling, Materials and Technology.

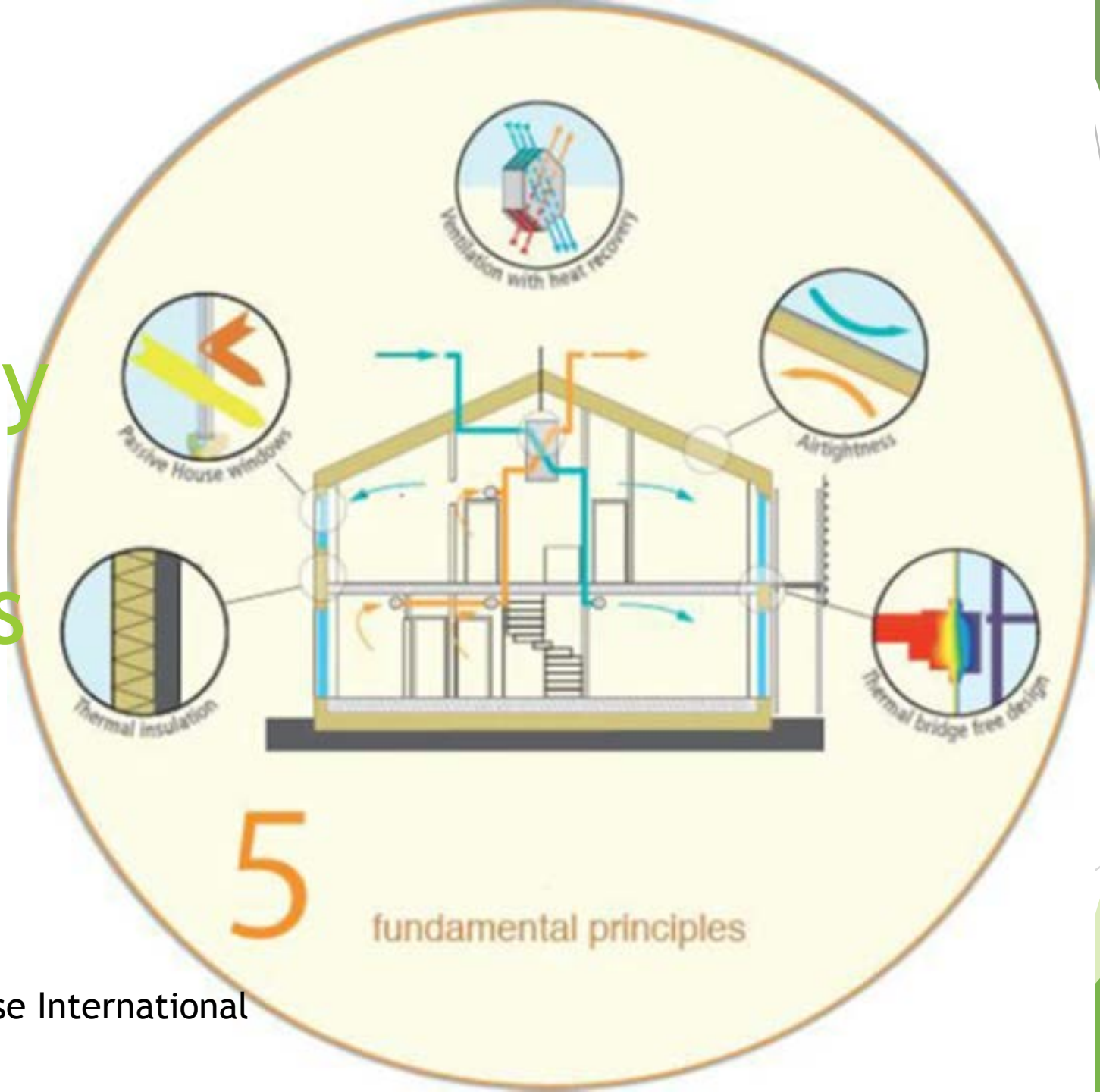
We are now looking for Net Positive Carbon

Passive House Key Qualities



Source Passive House International

Passive House Key Principles



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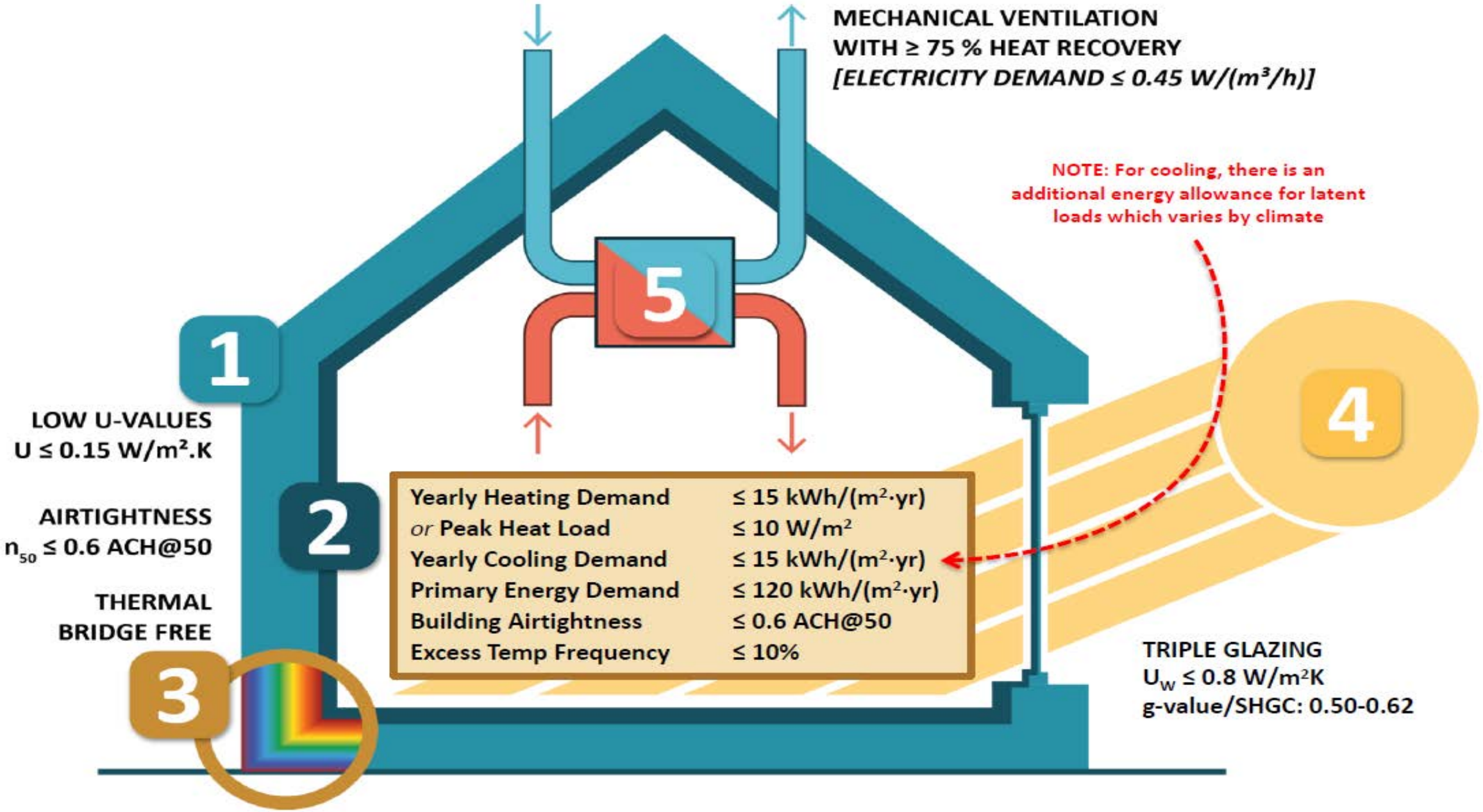



PHPP
Passive House Planning Package
Version 9 (2015) © Passive House Institute

The goal is to get

- 1/3 of the energy free from the sun,
- 1/3 from activity in the building and
- 1/3 from a small heating device.

A typical 2000 sq. ft. building will require 3000 watts of additional heat at design temperature of -33C (2 hair dryers)

3000 watts of additional heat
at design temperature of -33C
/-27F (2 hair dryers)

RBC Erickson, Mold remediation requiring major renovations

High performance buildings are comfortable and reduce future health or financial risks.

Our interest is to prevent new constructions or renovations that look like this

Ice dam on the Onanole Post Office addition

Poor design and construction

Major Financial Risk

Daycare building showing Thermal Bridging on the rafters due to poor design.

Major Health and Financial Risk

This project achieved LEEDS Platinum

Our Design Process Begins by Setting Performance Targets

Without Performance Targets

YOU DON'T KNOW WHAT YOU ARE DESIGNING


PZM 025

What will impact your design performance?

Site Orientation
Site Shading
Building Shape & Size
Materials
Equipment
Local Bylaws

Site orientation dictates the amount of sunlight
you can use.

Site Shading

- Trees,
- Landforms,
- Existing buildings

What kind of building layout do clients desire?

- Vaulted ceilings/high ceilings
- Bungalow vs 2 Story
- Single unit vs multi-unit

Materials

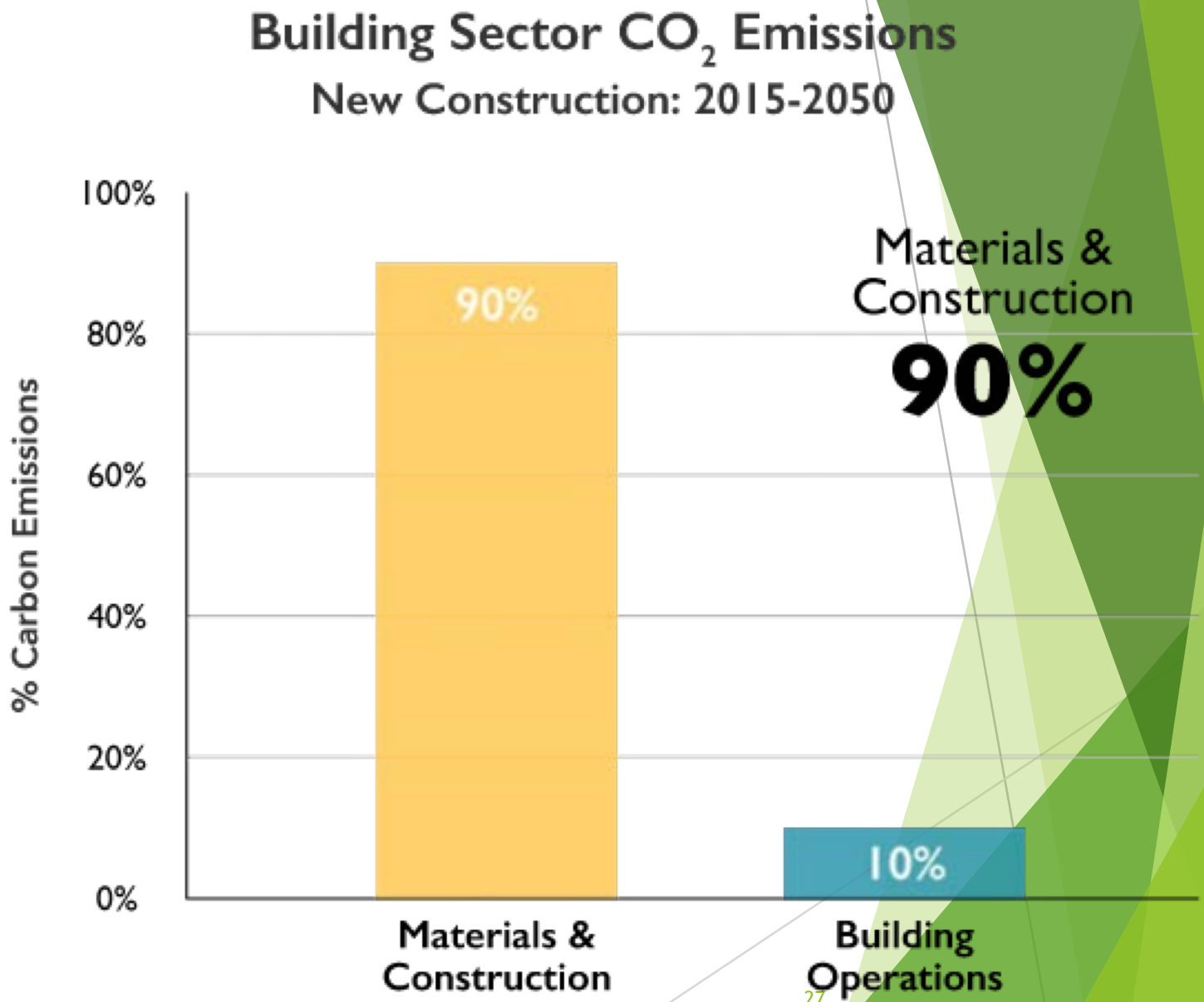
Buildings and Embodied Carbon

We Cannot “Net Zero Energy” Our Way Out of the Carbon Crisis

There is 1 more factor to consider

Embodied Carbon

Embodied carbon is the ***emissions associated with the harvesting, transportation and manufacturing of building materials.***
These emissions occur before the building begins operation…
And represent the majority of emissions that will occur between now and the climate change tipping point.



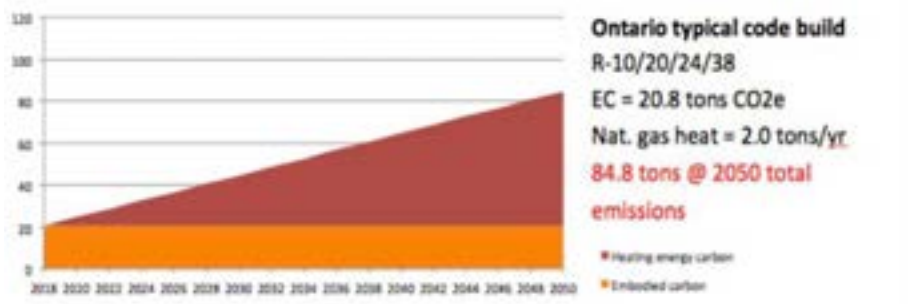
As Builders Why Should We Care

19 major cities in the world have pledged to make new buildings carbon neutral by 2030

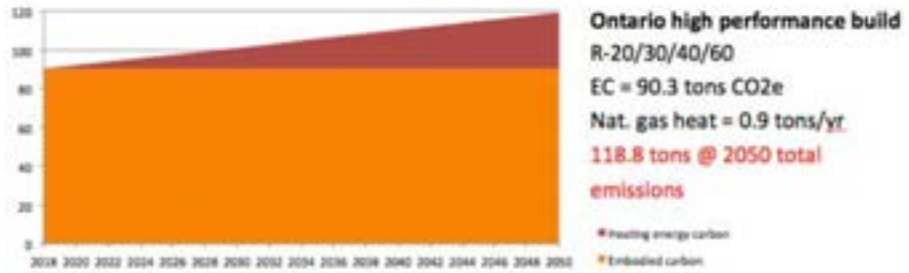
REDUCING EMBODIED CARBON REQUIRES US TO PAY ATTENTION TO MATERIAL CHOICES…

RESULTS FROM SOME EMBODIED CARBON MODELS…

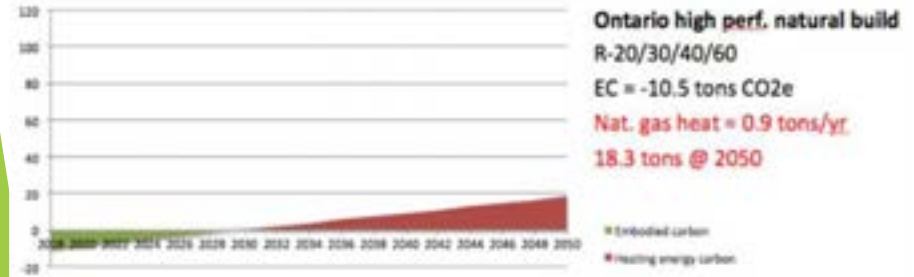
…with natural gas heating



Ontario typical code build
R-10/20/24/38
EC = 20.8 tons CO2e
Nat. gas heat = 2.0 tons/yr
84.8 tons @ 2050 total emissions

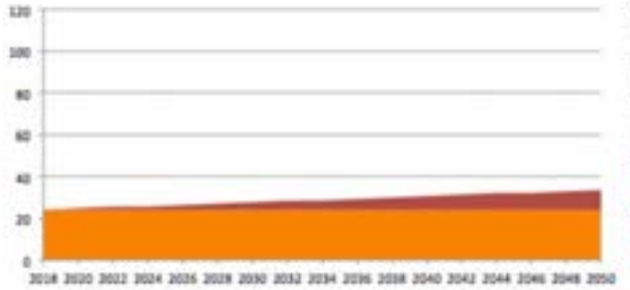


Ontario high performance build
R-20/30/40/60
EC = 90.3 tons CO2e
Nat. gas heat = 0.9 tons/yr
118.8 tons @ 2050 total emissions

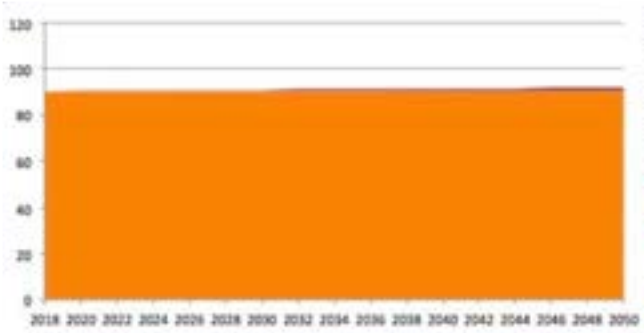


Ontario high perf. natural build
R-20/30/40/60
EC = -10.5 tons CO2e
Nat. gas heat = 0.9 tons/yr
18.3 tons @ 2050

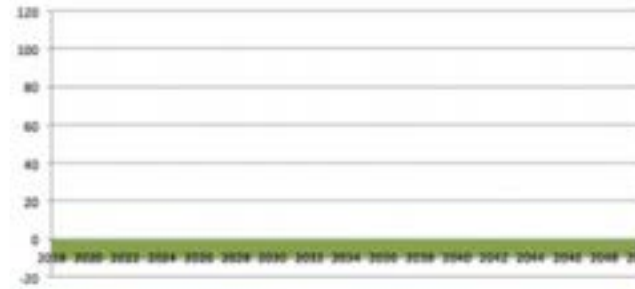
…with air source heat pump heating



Ontario typical code build
R-10/20/24/38
EC = 20.8 tons CO2e
Heat pump (COP2.5)= 0.3 tons/yr
33.7 tons @ 2050 total emissions



Ontario high performance build
R-20/30/40/60
EC = 90.3 tons CO2e
Heat pump = 0.1 tons/yr
91.9 tons @ 2050 total emissions



Ontario high perf. natural build
R-20/30/40/60
EC = -10.5 tons CO2e
Heat pump = 0.1 tons/yr
-8.9 tons @ 2050

ENDEAVOUR

ZERO CARBON BUILDING IS POSSIBLE NOW!

This model building is made with entirely off-the-shelf and cost-competitive materials.

Any designer/contractor/builder can make this house today.

ENDEAVOUR

Embodied Carbon and Technology

Wood, for example, has the lowest **embodied energy** of common building materials; plastic has approximately six times as much **embodied energy** by weight, glass 16 times as much, steel 24 times as much, and aluminum a whopping 126 times as much **embodied energy** as wood.

Top five materials

1. FSC-certified wood (Forest Stewardship Council)
2. Natural building materials (straw/hemp/wool/bamboo)
3. Cellulose insulation
4. Cross-laminated timbers
5. Wood fiberboard insulation

Bottom five materials

1. Aluminum
2. Concrete
3. Steel
4. Refrigerants
5. Spray foam

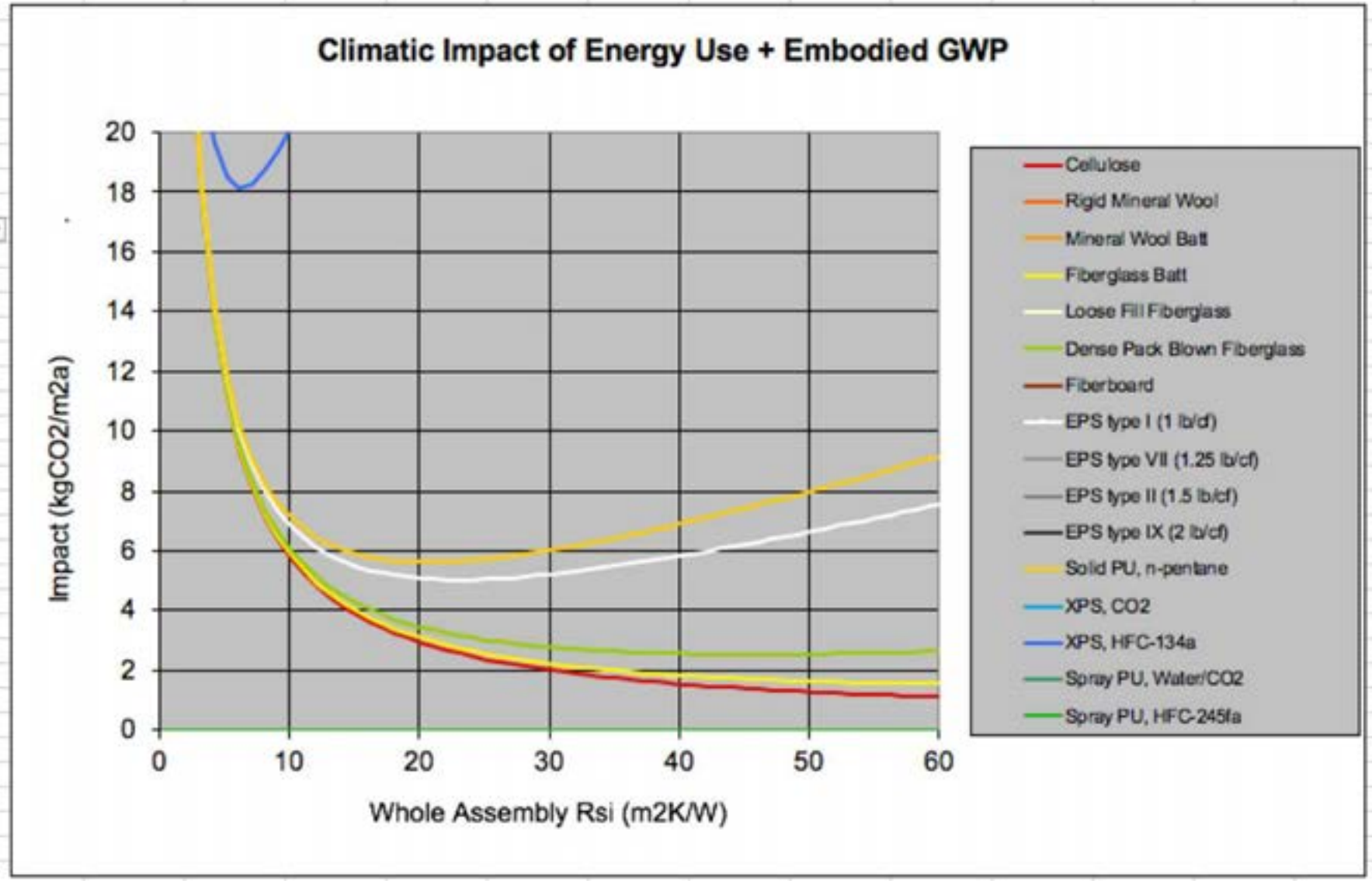
Do your research then make your material decisions

						Net Impact (kgCO2eq/sfyr)
Material Data		Mnfr CO2 (kg/m3)	BA CO2 (kg/m3)	Total CO2 (kg/m3)	R-value per inch	Whole Assembly R Value R-62
Cellulose		3.1	0	3.1	3.7	0.20
Rigid Mineral Wool		176.1	0	176.1	3.9	0.33
Mineral Wool Batt		37.1	0	37.1	4.1	0.22
Figerglass Batt		11.0	0	11.0	3.3	0.21
Loose Fill Fiberglass		11.0	0	11.0	2.3	0.21
Dense Pack Blown Figerglass		41.1	0	41.1	4.2	0.23
Fiberboard		202.0	0	202.0	2.6	0.42
EPS type I (1lb/cf)		130.8	7	137.5	3.6	0.31
EPS type VII (1.25lb/cf)		163.4	7	170.5	3.8	0.33
EPS type II (1.5lb/cf)		196.1	7	203.6	4.0	0.34
EPS type IX (2lbs/cf)		261.5	8	269.4	4.2	0.38
Solid PU, n-pentane		282.1	3	285.3	6.0	0.33
XPS, CO2		183.9	2	185.5	4.4	0.32
XPS, HFC-134a		183.9	2323	2507.1	5.0	1.63
Spray PU, Water/CO2		446.9	1	447.5	5.0	0.45
Spray PU, HFC-245fa		349.7	721	1070.3	6.0	0.70

Total Climatic Impact of Insulation

Inputs	
Climate HDD (Kd)	4,000
Reference Rsi	0.18
Heating Fuel	Electricity
Heating Efficiency/COP	1.00
Life Span of Insulation (Years)	50
BA Release Rate	High
Chart Type	R Value
R Value Chart x-axis maxiumum	60
Thickness Chart x-axis maximum	30
Chart y-axis maximum	20

Displayed in Graph (mark with "x")	
Cellulose	x
Rigid Mineral Wool	
Mineral Wool Batt	
Fiberglass Batt	x
Loose Fill Fiberglass	
Dense Pack Blown Fiberglass	x
Fiberboard	
EPS type I (1 lb/cf)	x
EPS type VII (1.25 lb/cf)	
EPS type II (1.5 lb/cf)	
EPS type IX (2 lb/cf)	
Solid PU, n-pentane	x
XPS, CO2	
XPS, HFC-134a	x
Spray PU, Water/CO2	
Spray PU, HFC-245fa	



David White, Brooklyn, New York, [Right Environments](),

Design & Construction Process

1. Set embodied carbon & energy consumption goals for the space,
2. Model and design the space,
3. Calculate the projected energy use using an energy modelling tool,
4. Construct the project,
5. Test the structure to ensure goals are met.

Construction Process must address:

-Thermal Bridging

-Airtightness

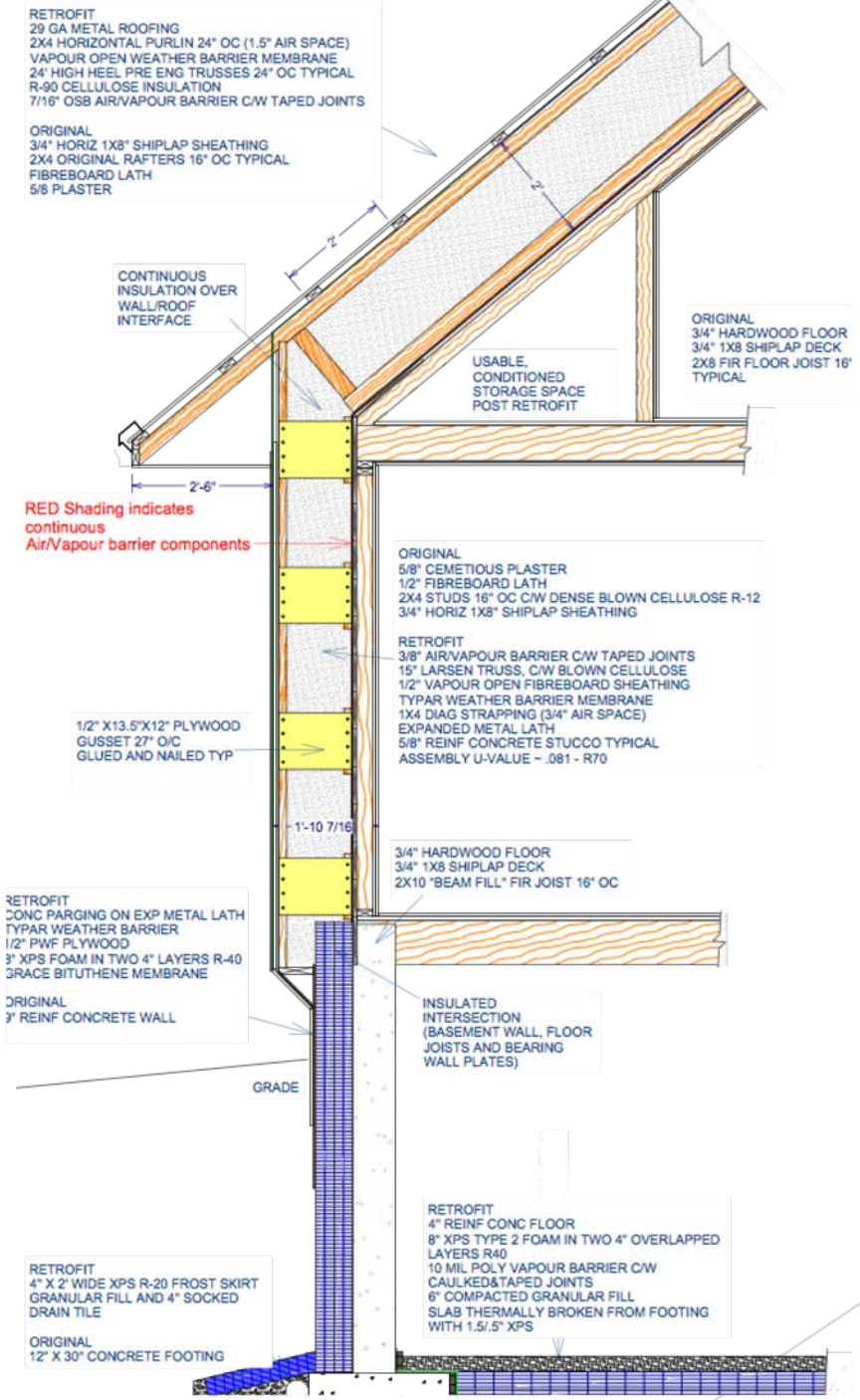
-Fenestration (Windows and Doors)

-Heat Recovery Ventilators (HRV)

-Heating and Cooling

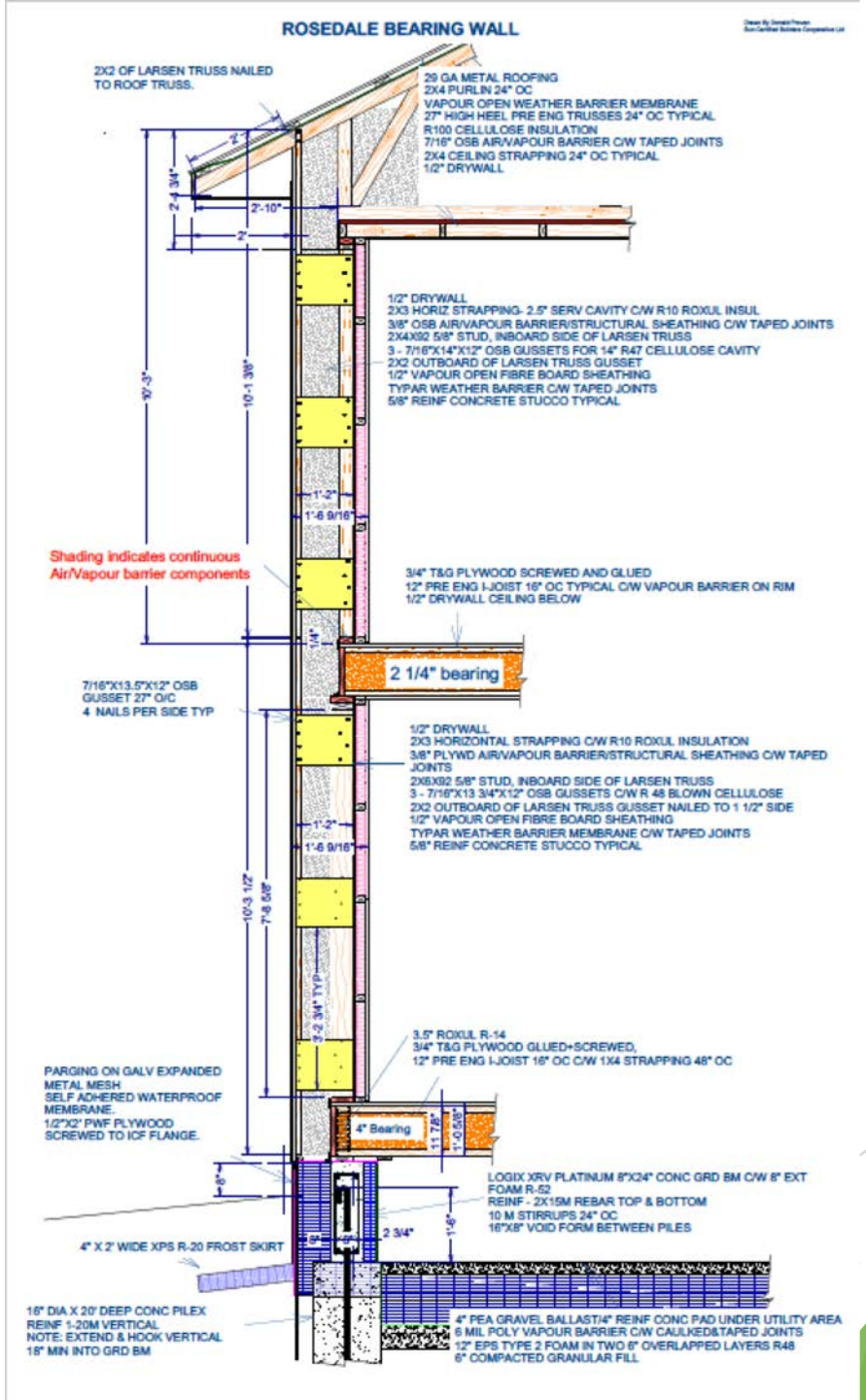
Our Wall System

Retrofit



Our Wall System

New Build



Passive House Basics: Thermal Bridges

Part of the building envelope where the otherwise uniform thermal resistance is significantly reduced by:

a)full or partial penetration of the insulating layers by materials with a different thermal conductivity

and/or
b) a change in thickness of the insulating layers

and/or
c)a difference between internal and external areas, such as occurs at wall/floor/ceiling junctions.

Two kinds of Thermal Bridges

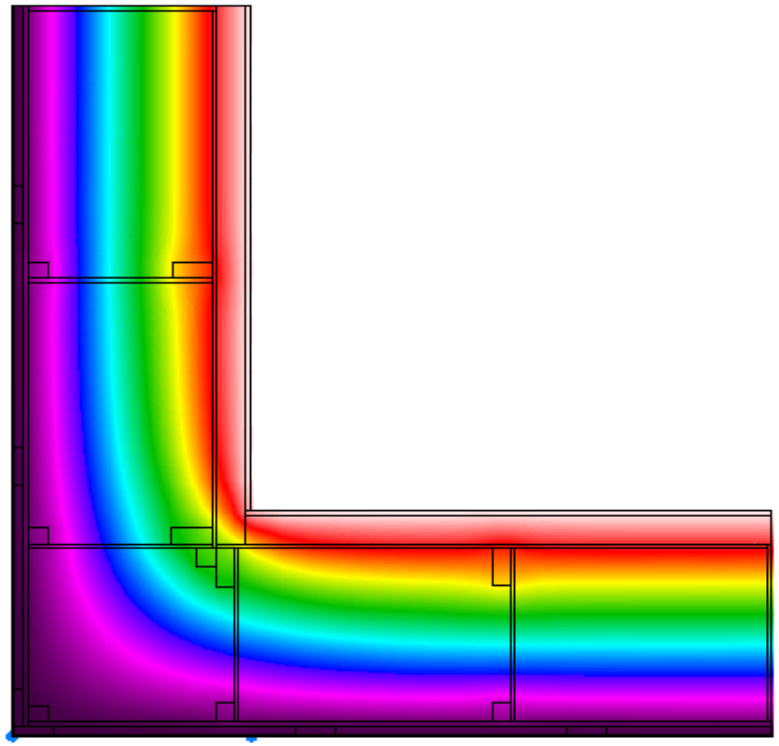
Linear thermal bridges

- Found at connections between different planes of the envelope (example, wall to roof)
- Magnitude of a linear thermal bridge is determined by its '**Psi Value**', denoted by ψ_e, measured in **W/mK**

Point thermal bridges

- Found at point penetrations of the envelope (example, wall ties through insulation layer)
- Magnitude of a point thermal bridge is determined by its '**Chi Value**', denoted by χ, typically reported in **W/m²K***

THERM graphic of 16” Modified Larson Truss wall corner



Passive House Basics: Insulation

1. How much insulation is enough?
2. What to use?
3. How to use it?

Dense Packing Cellulose

Airtightness: So what does 0.6 ACH@50 mean?

EPDM rubber (**ethylene propylene diene monomer rubber)** gaskets

anges per hour – 0.31

umber is better.

Mani
Hydr
POWER

*Manitoba Hydro is a licensee of the Trad

Doors

Passive House Certified door section

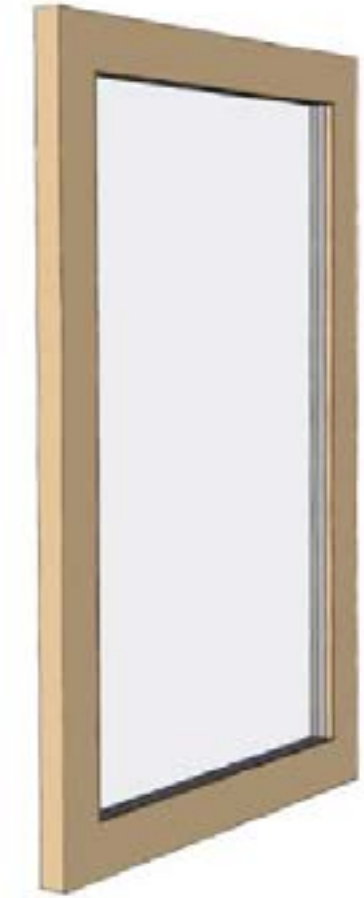
Passive House Certified door section

cool, temperate climate

CERTIFIED COMPONENT

Passive House Institute

Passive House Basics: Windows



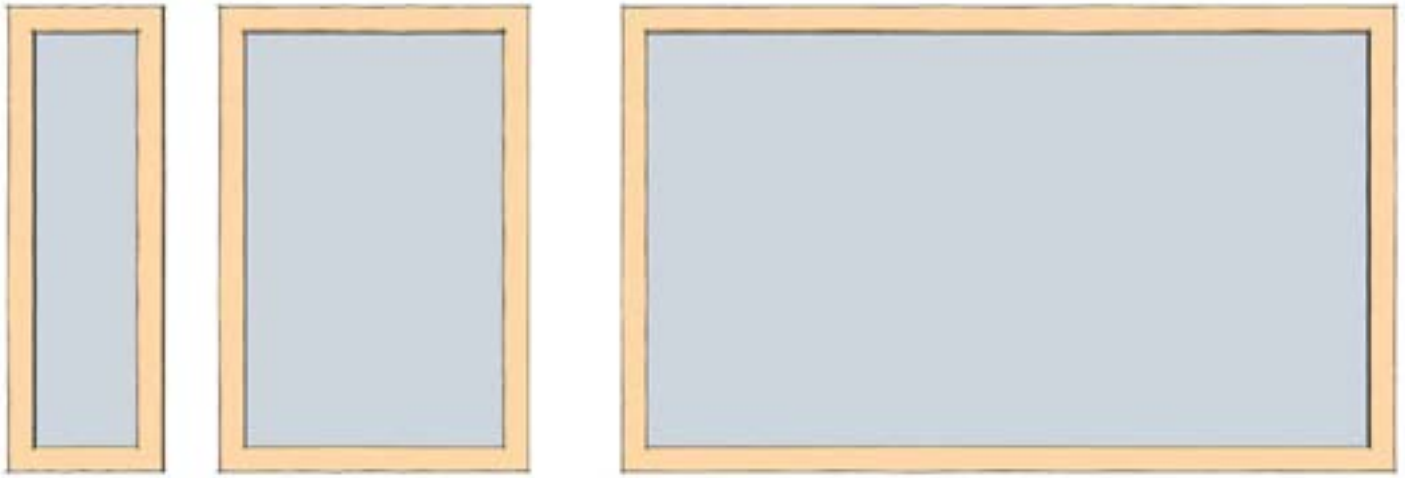
- Heat is LOST through
  - Frame
  - Glass
  - Glass-Spacer
  - Where the window touches the building
- Heat is GAINED through
  - Glass

Source PHI

Basic Geometry

U_f: 0.80 W/(m²·K)

U_g: 0.55 W/(m²·K)



0.6 x 1.8 m

1.2 x 1.8 m

3.0 x 1.8 m

U_w: 0.82

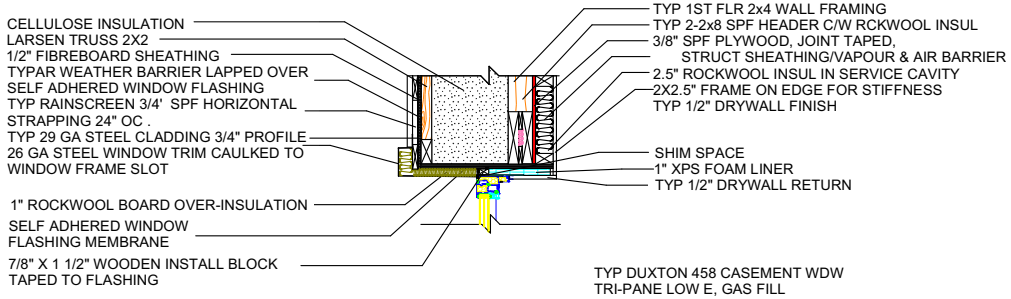
U_w: 0.67

U_w: 0.62

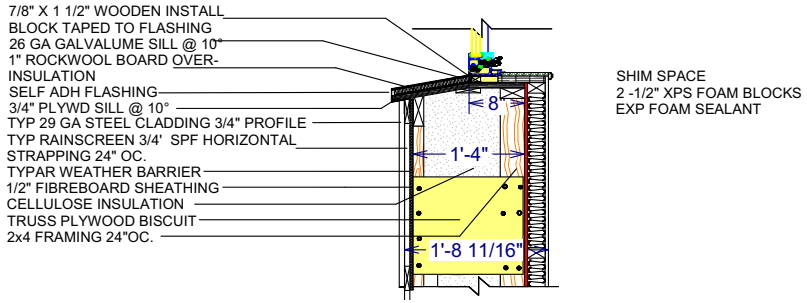
Source PHI

Our window details

TYPICAL OPERATOR WINDOW HEAD



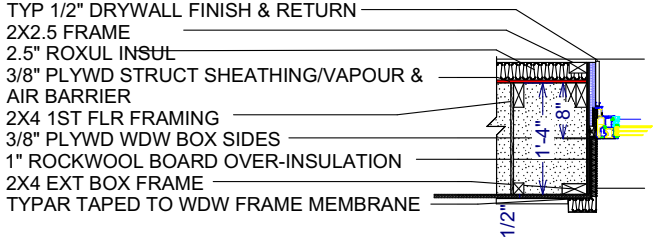
TYP DUXTON 458 CASEMENT WDW
TRI-PANE LOW E, GAS FILL
C/W FACTORY FIBREGLASS MOUNTING FLANGE



SHIM SPACE
2 -1/2" XPS FOAM BLOCKS
EXP FOAM SEALANT

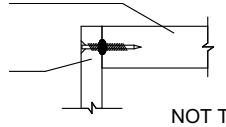
TYPICAL OPERATOR WINDOW SILL

TYPICAL WINDOW JAMB



TYPICAL WINDOW BOX CONSTRUCTION DETAIL: JOINTS AND SILL

19MM (3/4") PLYWD TOP AND BOTTOM
9.5MM (3/8") PLYWD BOX SIDES GLUED&SCREWED (PL400+1.25" #6 WOOD SCREWS) TO TOP AND BOTTOM

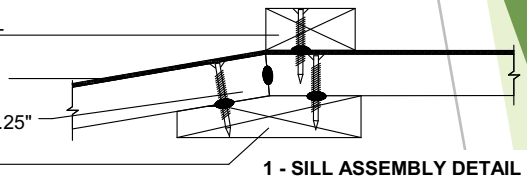


TYP WNW BOX TOP ELEVATION

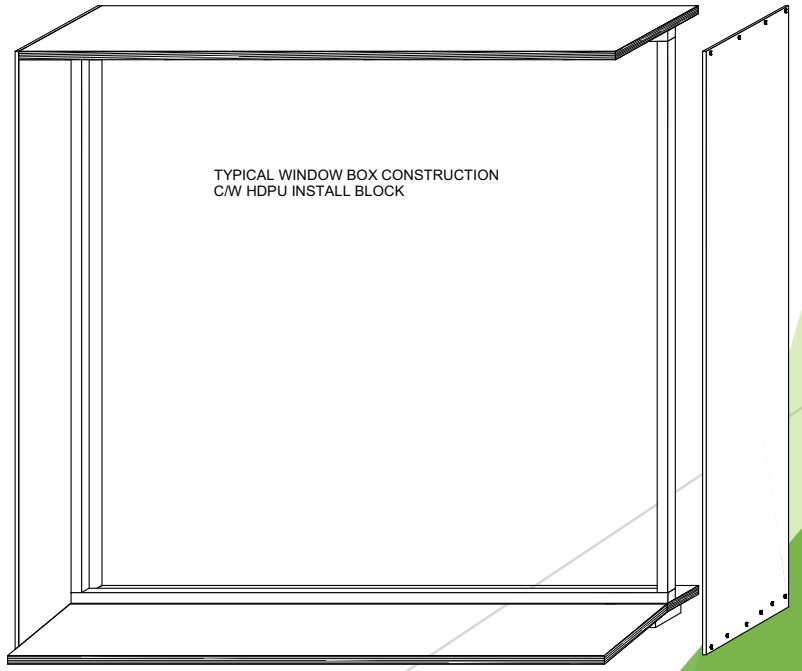
NOT TO SCALE

SILL ASSEMBLY

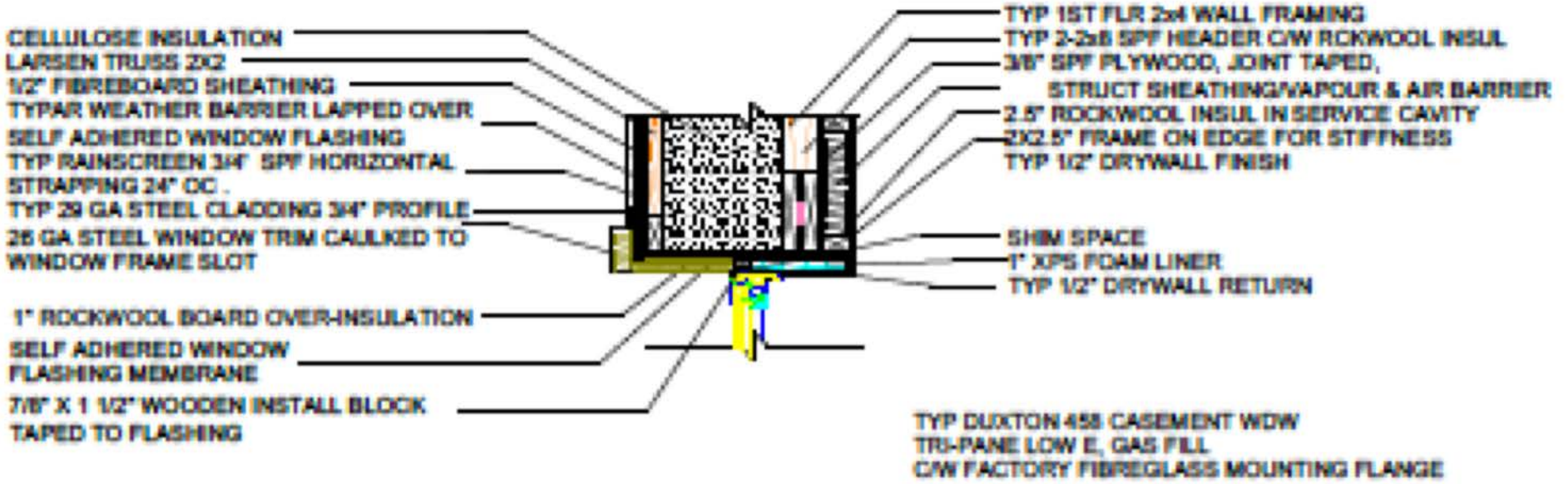
7/8"X 1.5" HDPU WINDOW MOUNT BLOCK CAULKED TO FRAME
SELF ADHERED FLASHING
19MM PLYWD C/W 10° SLOPE GLUED AND SCREWED (PL400+1.25" #6 COATED WOOD SCREWS)TO BEVELED 1X4 BLOCK

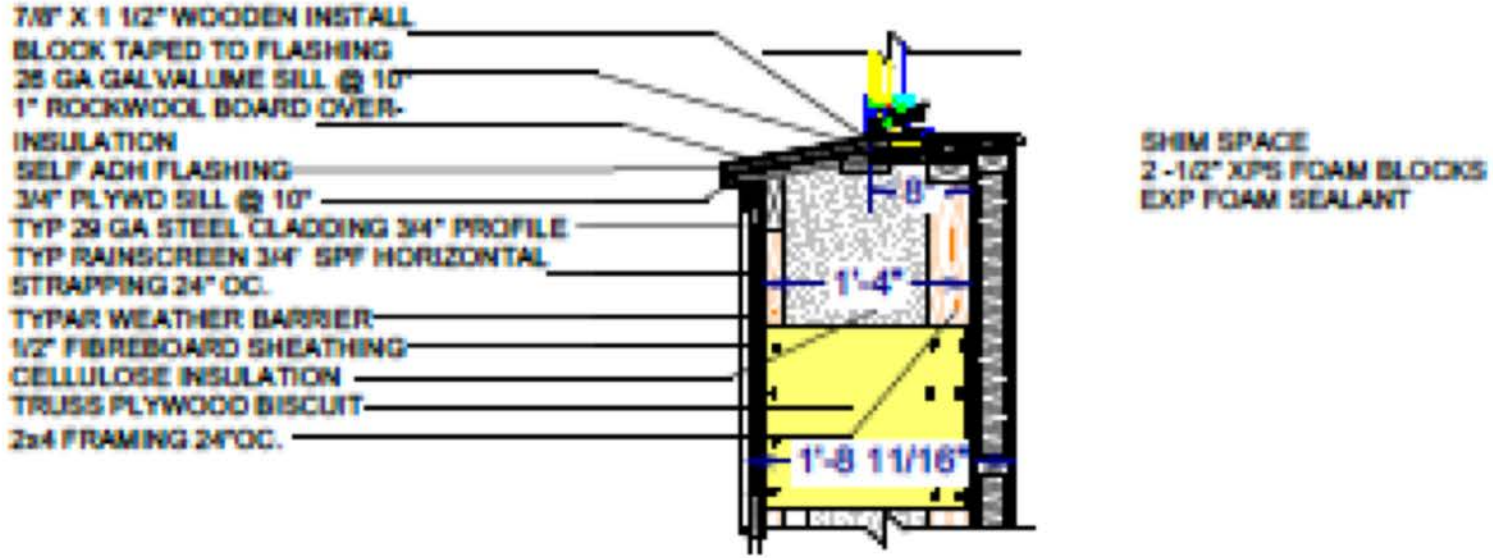


1 - SILL ASSEMBLY DETAIL



TYPICAL OPERATOR WINDOW HEAD

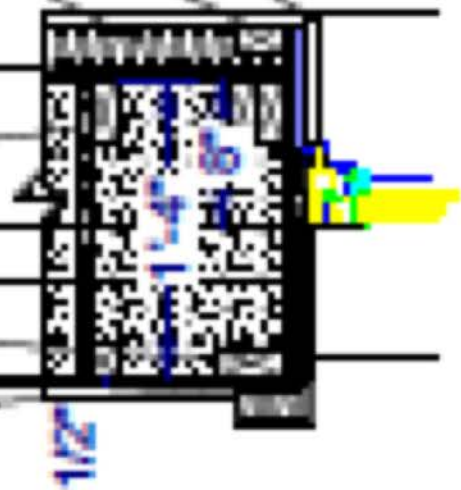




TYPICAL OPERATOR WINDOW SILL

TYPICAL WINDOW JAMB

TYP 1/2" DRYWALL FINISH & RETURN
2X2.5 FRAME
2.5" ROXUL INSUL
3/8" PLYWD STRUCT SHEATHING/VAPOUR & AIR BARRIER
2X4 1ST FLR FRAMING
3/8" PLYWD WDW BOX SIDES
1" ROCKWOOL BOARD OVER-INSULATION
2X4 EXT BOX FRAME
TYPAR TAPED TO WDW FRAME MEMBRANE



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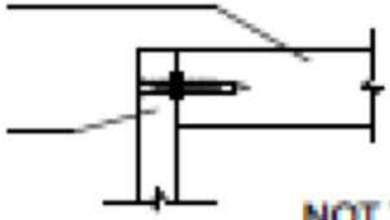

TYP WNW BOX TOP
ELEVATION

NOT TO SCALE

SILL ASSEMBLY

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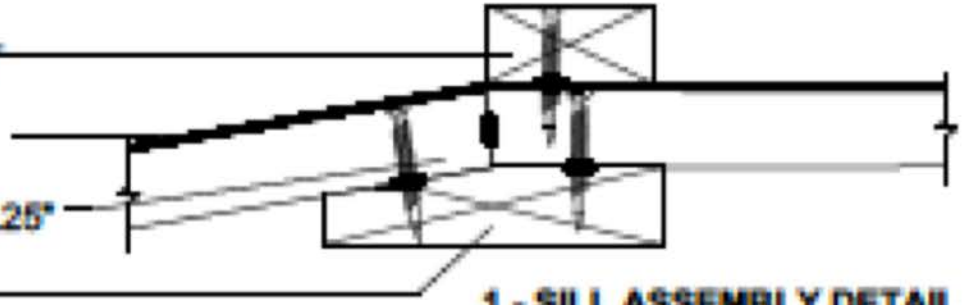

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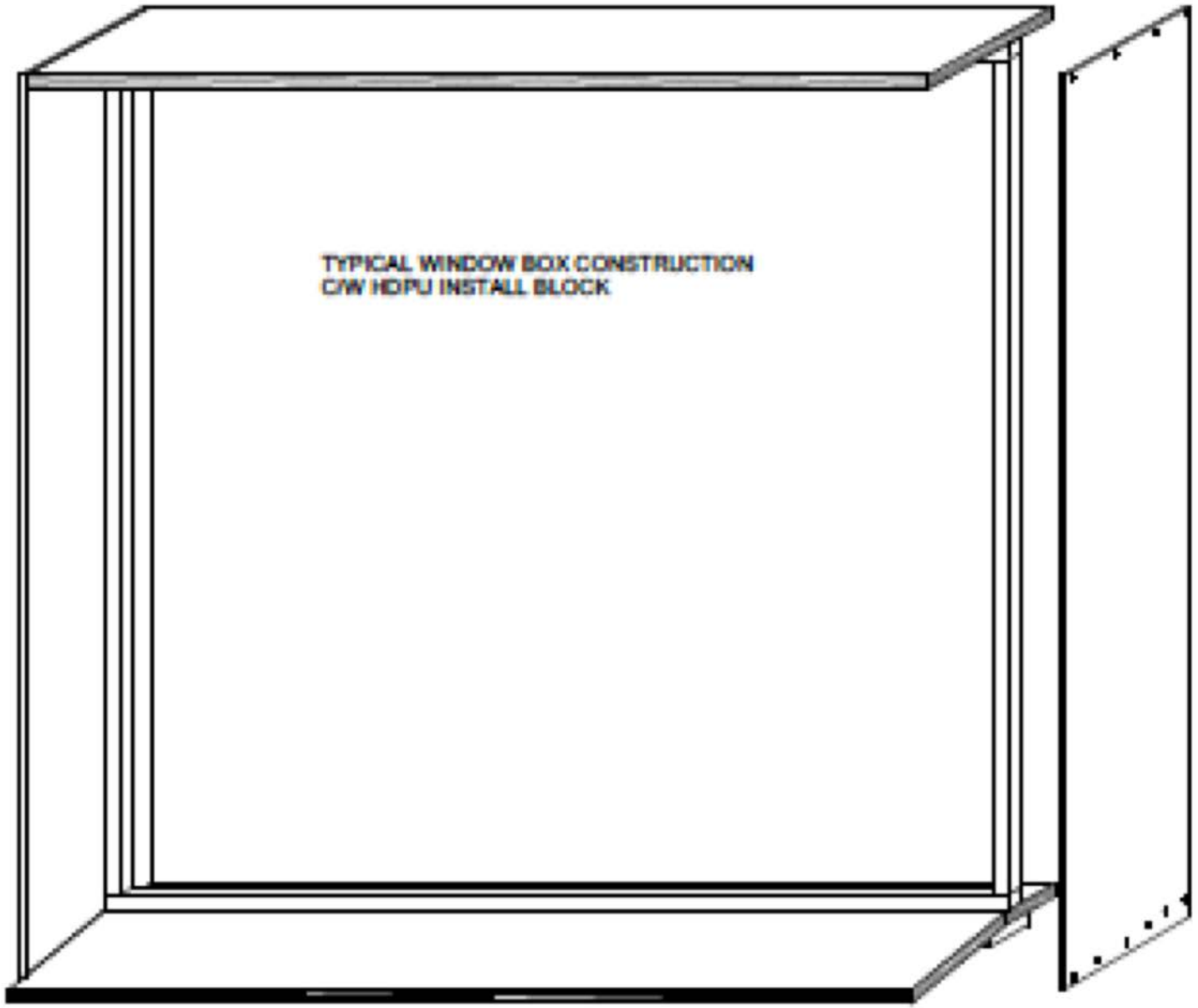
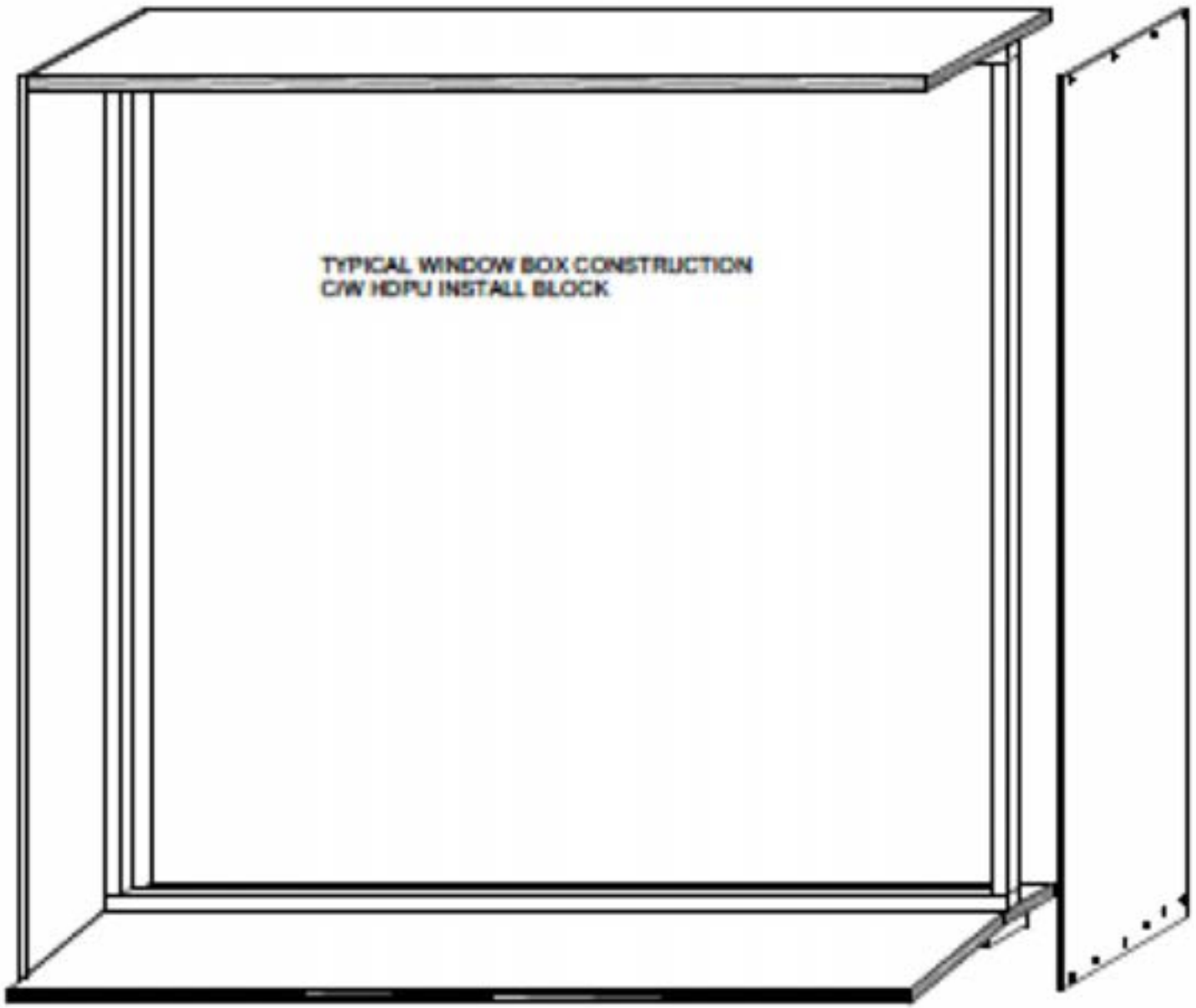

TYPICAL WINDOW BOX CONSTRUCTION
C/W HDPU INSTALL BLOCK


TYPICAL WINDOW BOX CONSTRUCTION
C/W HDPU INSTALL BLOCK

Passive House Basics: Windows


SIGA-Rissan
Blueskin BUTYL FLASH


Blueskin BUTYL FLASH

Showing Roxul, 26 GA metal trim.

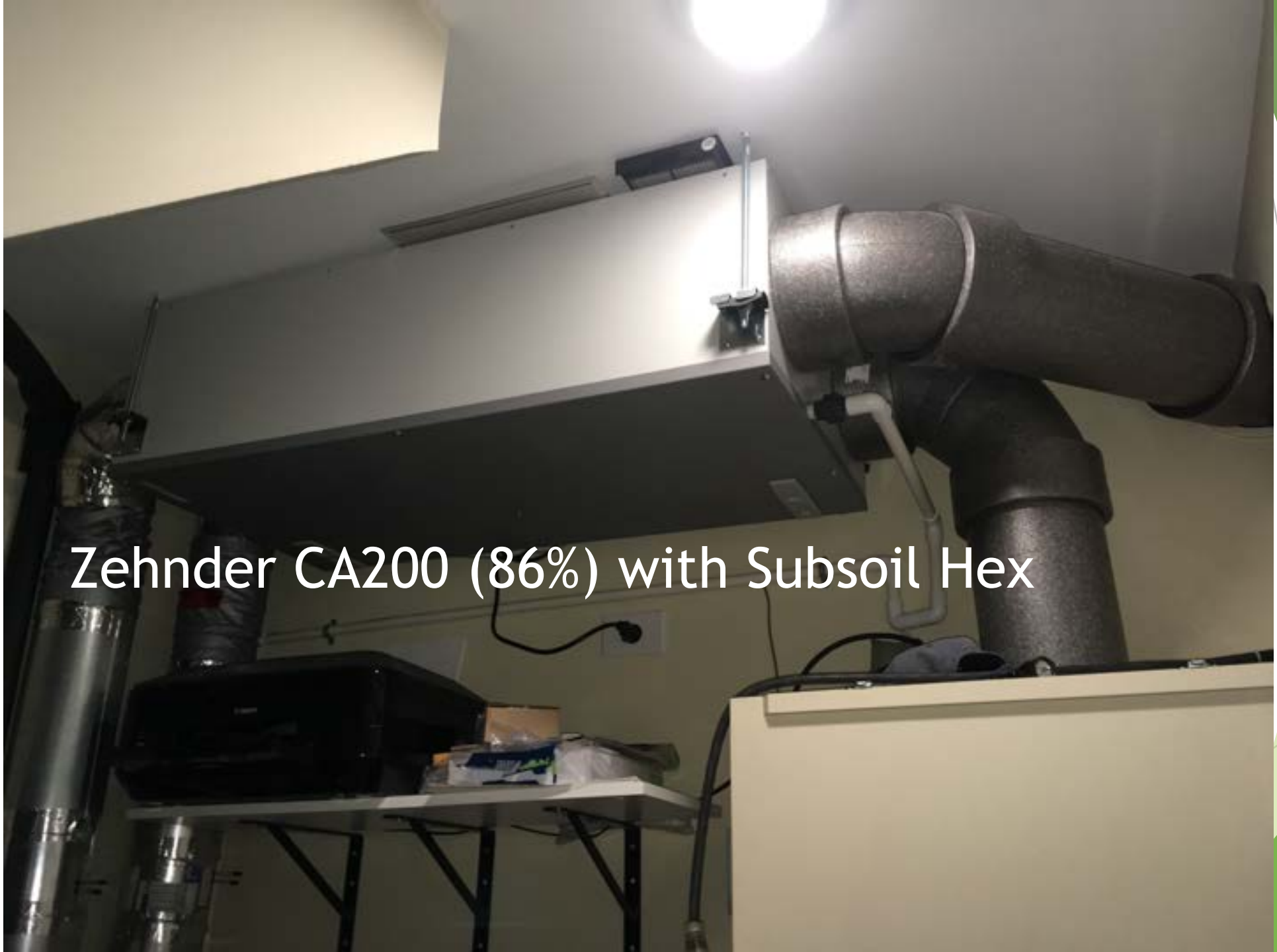
Passive House Basics: Ventilation

VanEE 2400 Gold HECM (HVI Max Rated Sensible Recovery Efficiency (@ 0c),

Lifebreath RNC 155 (155 MAX rating 75%)

Zehnder CA 350 (88%),

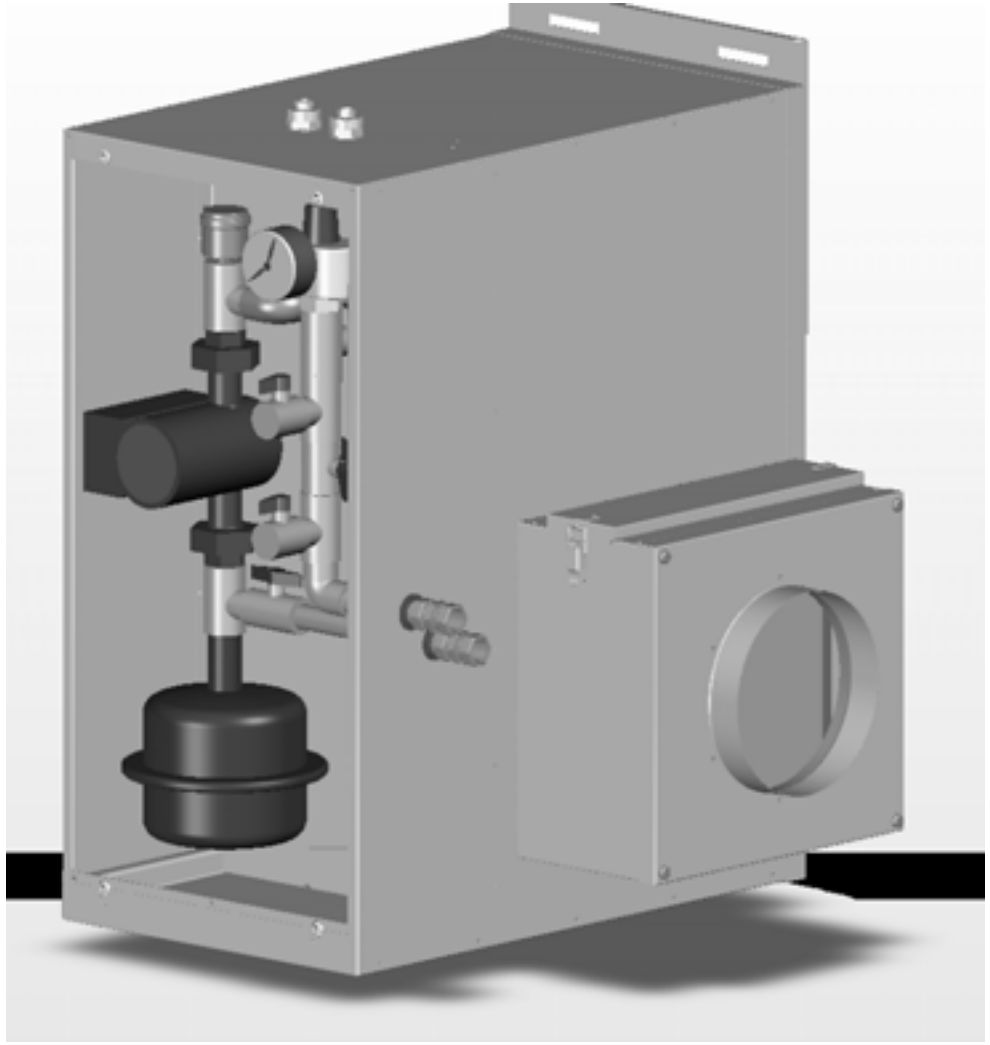
81VanEE 90HV ECM (75%) with Subsoil Hex Case

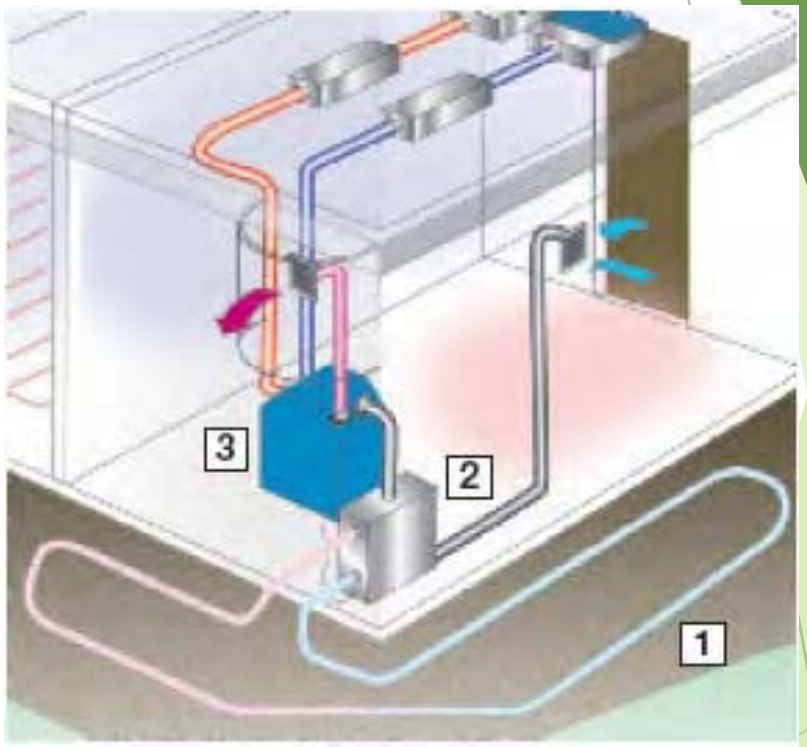


Zehnder CA200 (86%) with Subsoil Hex

Solar HRV Intake,

Zehnder ComfoFond Integrated Ground Source H/ERV preheat unit. Off the Shelf + Plug n Play…





http://www.zehnderamerica.com/

Randy's first HRV installed 1990, still going strong

Site Visit

4905 Newcastle Way

Break into diverse teams

Pick a leader and a recorder

- Leaders make sure everyone on your team has transportation to the site
- Recorders make sure you pick up your site visit worksheet

Site Visit Debrief

What are the challenges facing high performance retrofits?

-Thermal Bridging

-Airtightness

-Fenestration (Windows and Doors)

-Heat Recovery Ventilators (HRV)

-Heating and Cooling

What you find in a Retrofit

A Retrofit Tour


GRACE
Bituthene

How do we know how much we will save?

206 - 848 Allegheny Drive
Winnipeg, MB

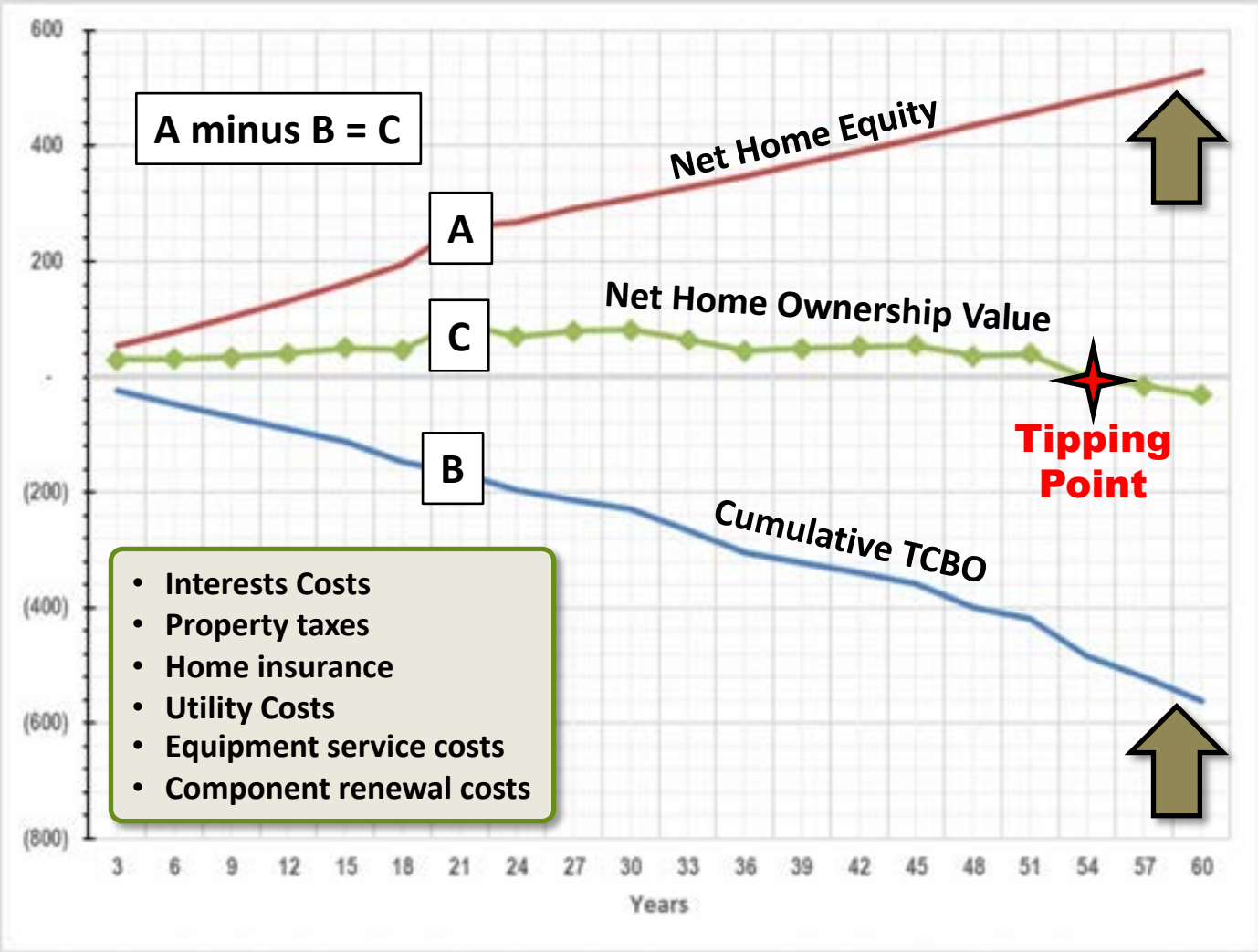
What the SEEFAR-Valuation© does:

- Provides a comparative assessment
- Provides a data repository for investment assessment information (historical)
- Compels designers and builders to answer questions not commonly asked
- Creates a transparent format for accurate comparative analysis
- Clarifies the TCBO design features by focusing on the ‘energy configuration construction design’ and ignoring the aesthetic elements
- Incorporates the importance of TIME into the investment value equation
- Incorporates the costs from a Whole-Building life-cycle perspective
- Evaluates the TCBO and the investment value over time

A Sustainable ‘Investment Optimization’ Approach:

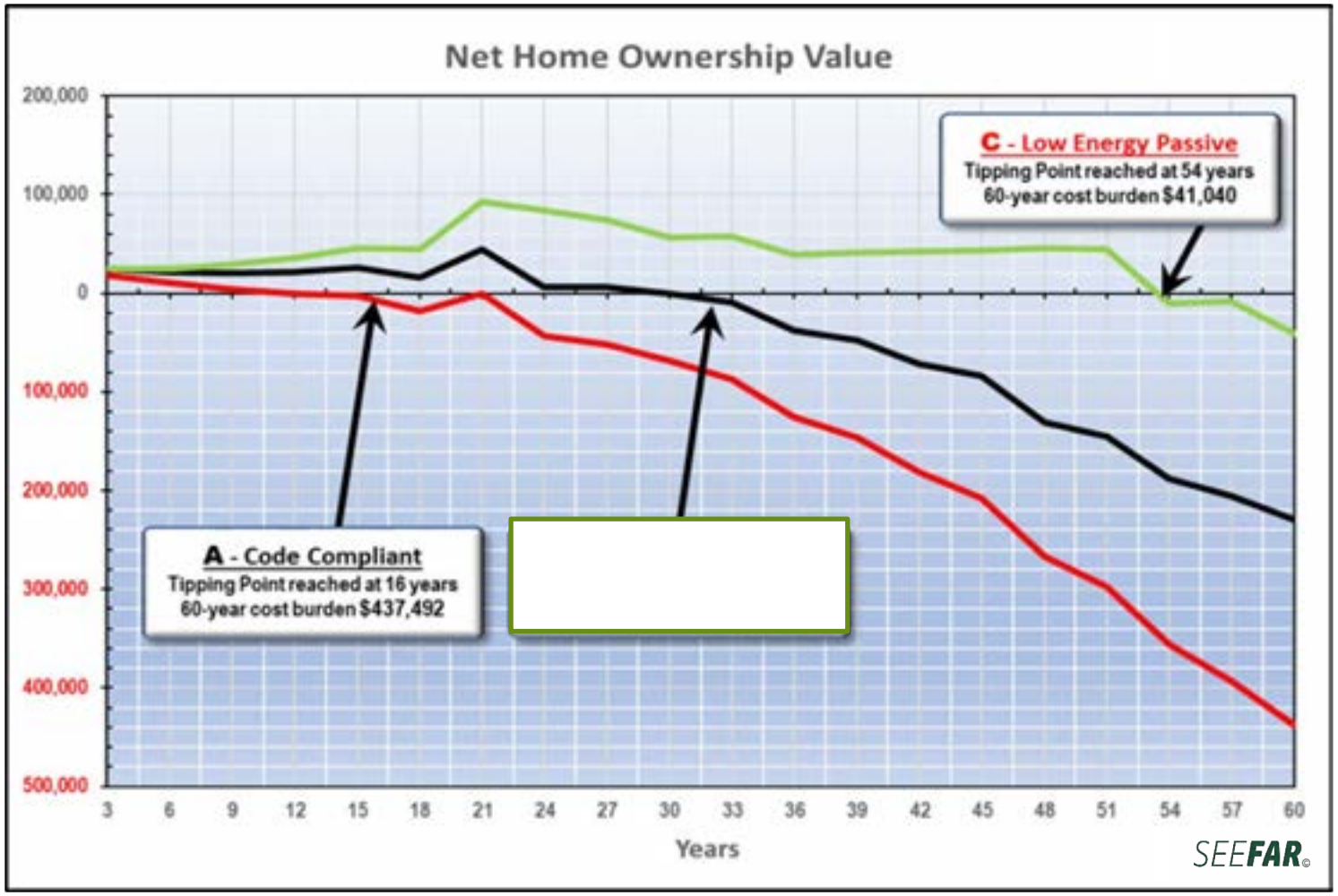
- Evaluate the entire building
- Evaluate over the useful life of the building
- Evaluate the Total Cost of Building Ownership:
  - Mortgage Interest
  - Utilities
  - Insurance
  - Maintenance
  - Carbon Tax
  - Property Tax

60-year Comparative Time/Value Rationale



- Net Home Equity is the current market value less any outstanding mortgage principle
- Cumulative TCBO is the total amount spent for the costs of home ownership and home occupancy
- The difference (equity less TCBO) is the Net Home Ownership Value
- The Tipping Point is reached when the Net Home Ownership Value falls below zero (A minus B = 0)
- The only way to move the Tipping Point is to either increase the home equity, or reduce the TCBO, or both
- The Tipping Point is unique to each home
- Longer tipping points offer more value

Projected 60-year Comparative Building Investment Performance



Estimated Finishing Costs - $182,500

Option A: **(Code Compliant – 189 EUI)**

- Net Market Price – $327,500
- Net lifecycle cost – $437.492
- Cost tipping point - 16 years

Option C: **(Passive Low Energy – 39 EUI)**

- Net Market Price – $356,000
- Net Lifecycle cost – $41,040
- Cost tipping point - 54 years

Option C versus Option A:

- Net purchase cost is $47,930 higher
- Lifecycle cost is $396,452 lower
- 79% energy reduction
- Tipping point is 38 years longer

482 Kylemore Ave, Winnipeg MB

Row	Total Cost of Building Ownership (TCBO)	Building A	Building B	
		Code Built Home	High Performance Passive Home	Total Savings A to B
1	GHG emission (kg) (60 Years)	247,000	-	247,000
2	EUI (kWh/m2/year)	275	18	258
3	TCBO at 12 Years	$ 155,000	$ 141,000	$ 14,000
4	TCBO at 25 Years	$ 342,000	$ 255,000	$ 87,000
5	TCBO at 60 years	$ 960,000	$ 624,000	$ 336,000
6	Home Equity at 60 years	$ 814,000	$ 980,000	$ -166,000
7	Net Cost of Home Ownership	$ -146,000	$ 356,000	$ -502,000
8	Savings/year			$ 8,000
9	Incremental Difference in Capital Cost		$ 49,000	$ 49,000
10	ROI / Year over 60 Years			16%

- Mortgages
- Insurance
- Appraisal Values

"*In researching other areas with more mature green home markets (all studies completed in the United States), the evidence revealed that green homes sell for a premium of 2% to 6%"*

The *Community Preservation Corporation's Handbook, Underwriting Energy Efficiency: A Lender Handbook*, details studies which show that energy efficient homes have lower default rates and reduced risk.

"Instead of developing green mortgages, the industry should consider moving to mortgage qualification based on principal, interest, taxes, and energy (PITE) costs."

PRESTON HARTWIG, M.A., RFPP, AIC CANDIDATE MEMBER, RED RIVER GROUP

Educating the world around you!
Our experience with managing/educating the system

Building Codes

Engineers

Architects

Evolution: SCBC version

Built 1990 2x6 with 2x3 Interior strapping

1990 8” Larsen Truss Retrofit to 100 year old farmhouse moved onto new basement.

1998 12” Modified Larsen Truss Wall R42, 3rd of 5 ending 2009

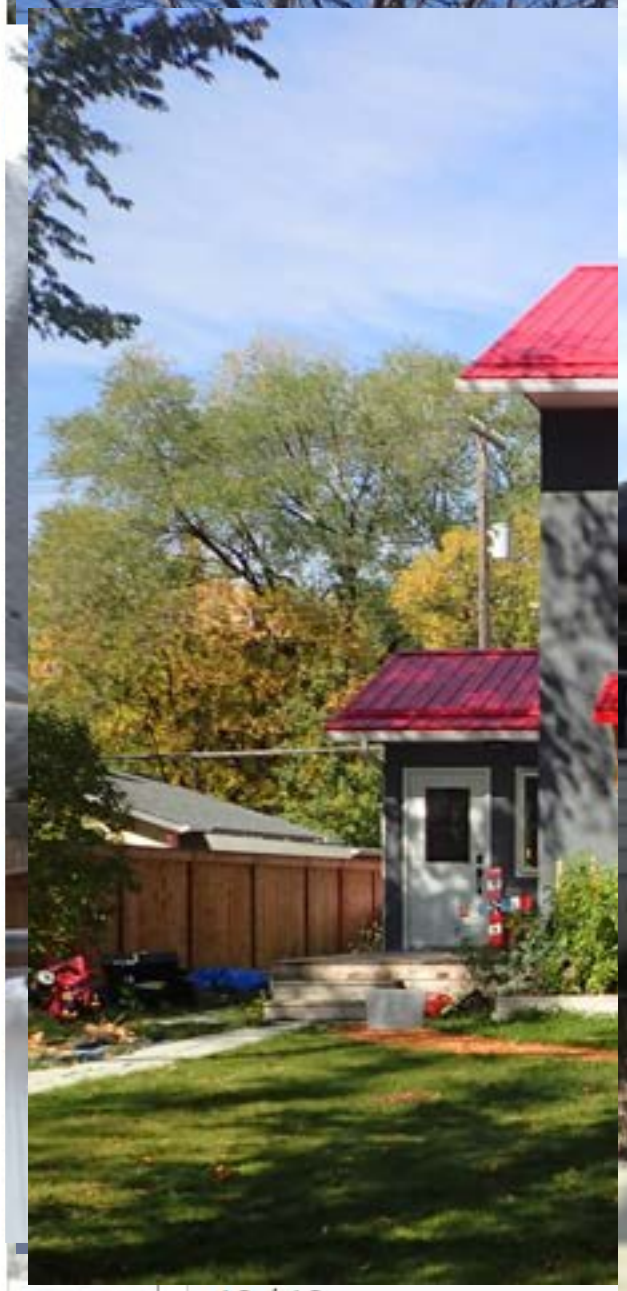
Typar Exterior membrane – no external sheathing. All internal framing protected from cold.

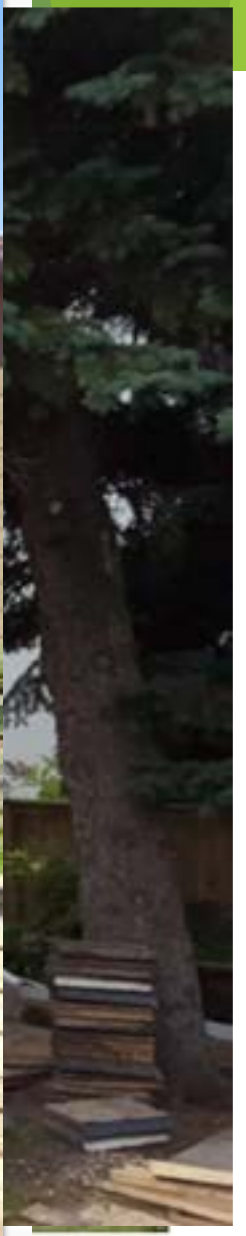
Fibreboard exterior sheathing to contain cellulose and thermally break 2x2 framing

3/8th plywood air/vapour barrier, structural sheathing membrane, prior to taping joints

Installation of 2x3 Service Cavity

5kW Renewable Solar Power = Net Zero





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SUNPOINT


TYPAR
TYPAR


DEWALT

When we build.

When we build, let us think that we build forever.

Let it not be for present delight nor for present use alone.

Let it be such work as our descendants will thank us for;

And let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them,

and that people will say, as they look upon the labour and wrought substance of them, "See! This our ancestors did for us."

Adapted from John Ruskin, Chapter IV: The Lamp of Beauty, section 19

SUN CERTIFIED BUILDERS
COOPERATIVE LIMITED

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