


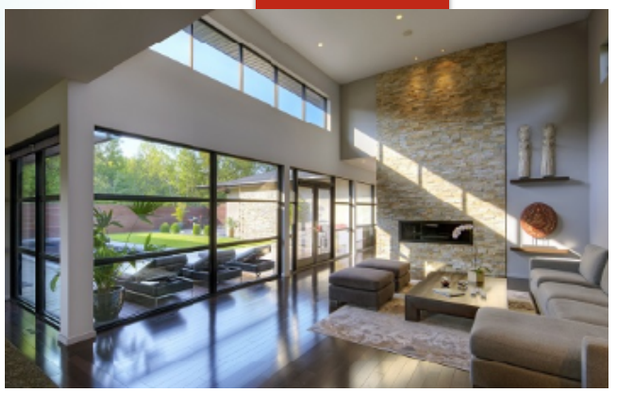

High Performance Glazing

Technologies, Applications & Resulting Performance

Presented by Al & Aynsley Dueck, DUXTON Windows & Doors

DUXTON
Windows & Doors

Continuing Education Credits

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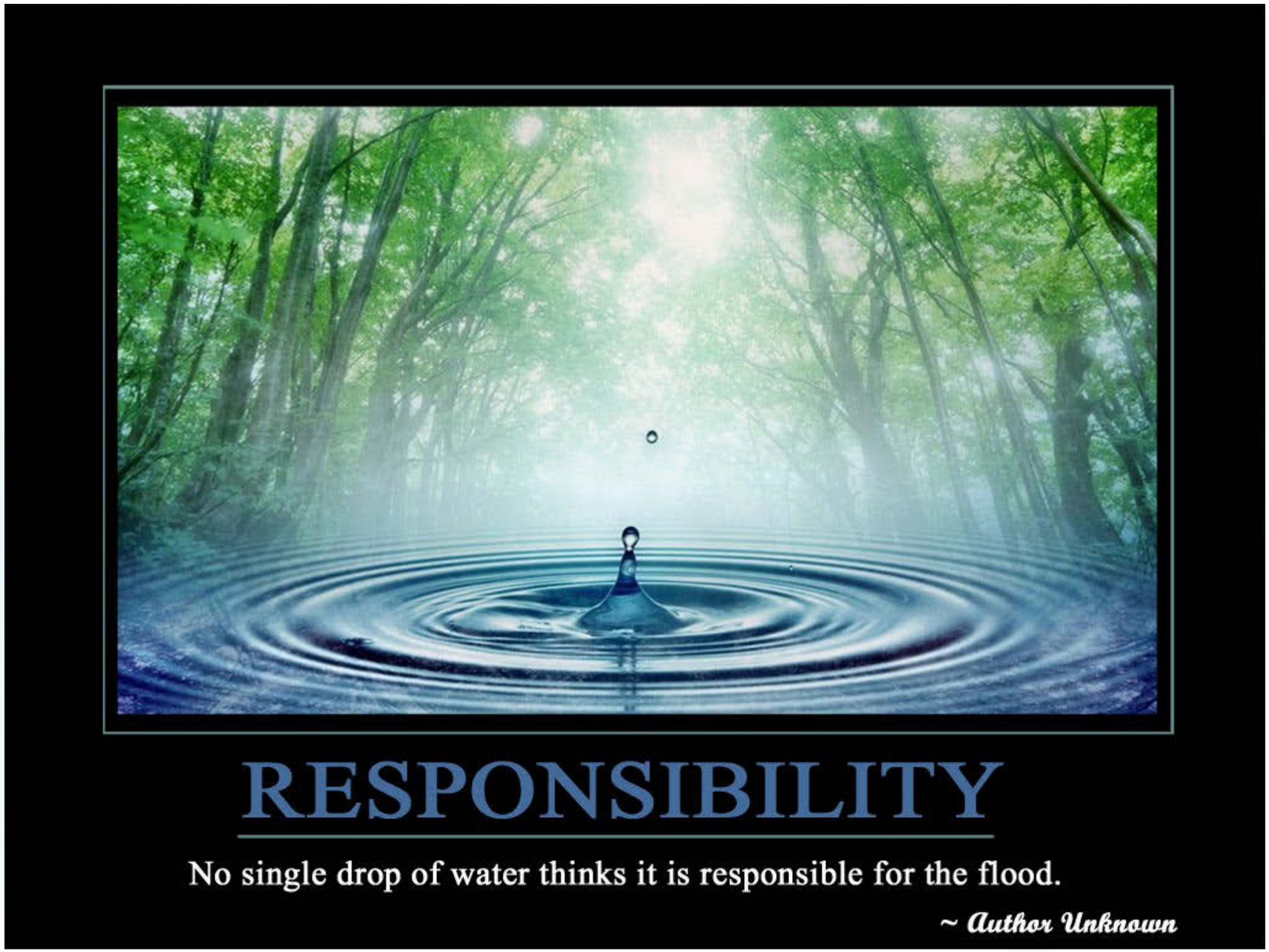
Presentation Overview

- Window vs. Overall Wall Performance
- Performance Specifications
  - Insulating low conductivity frames
  - Insulating glass coatings and spacers
  - Operable window types
  - Durability
  - Installation details
- Selective Glazing by Orientation
- Occupant Considerations
- Emerging Technologies

Food for Thought

Responsibility towards our environment

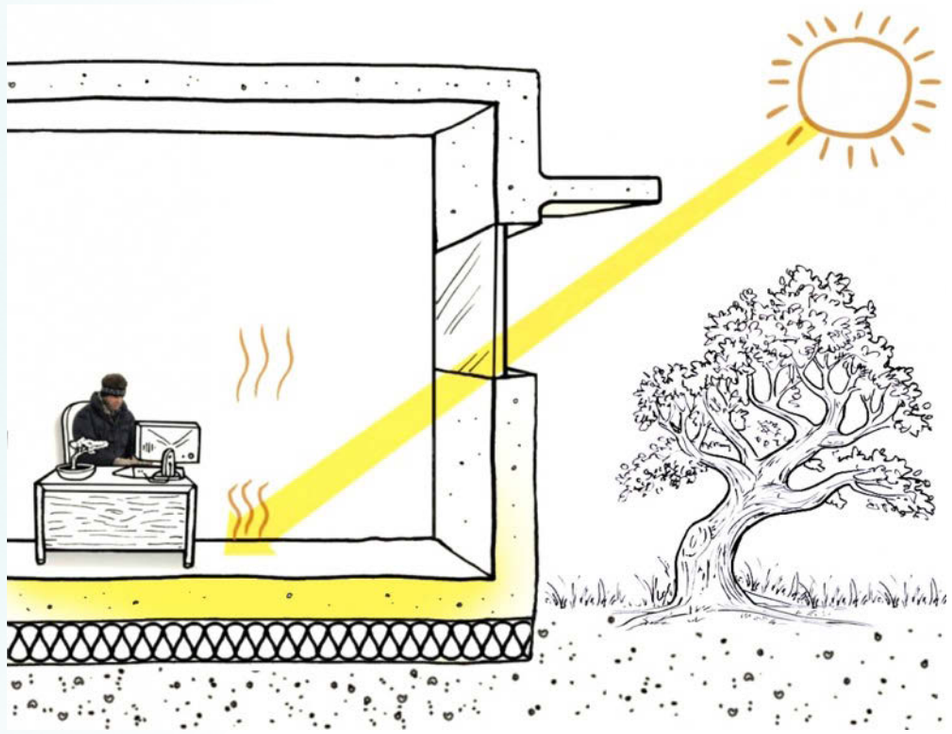
Design Respon-sibility



How do Windows Contribute to Overall Building Performance?

Building Envelope

- Windows in the U.S. consume 30% building heating and cooling energy
- Focus on the building envelope 1st – heating & cooling 2nd
- Windows can be "net energy gainers"
  - Windows with high solar heat gain coefficients (SHGC) can admit more useful solar gain than the conductive energy lost



SOURCE: Dariush Arasteh, Steve Selkowitz, Josh Apte Lawrence Berkeley National Laboratory (Zero Energy Windows), Marc LaFrance U.S. Department of Energy

Net Zero Home – Passive Solar Gain Application

Habitat Studio, Edmonton, AB

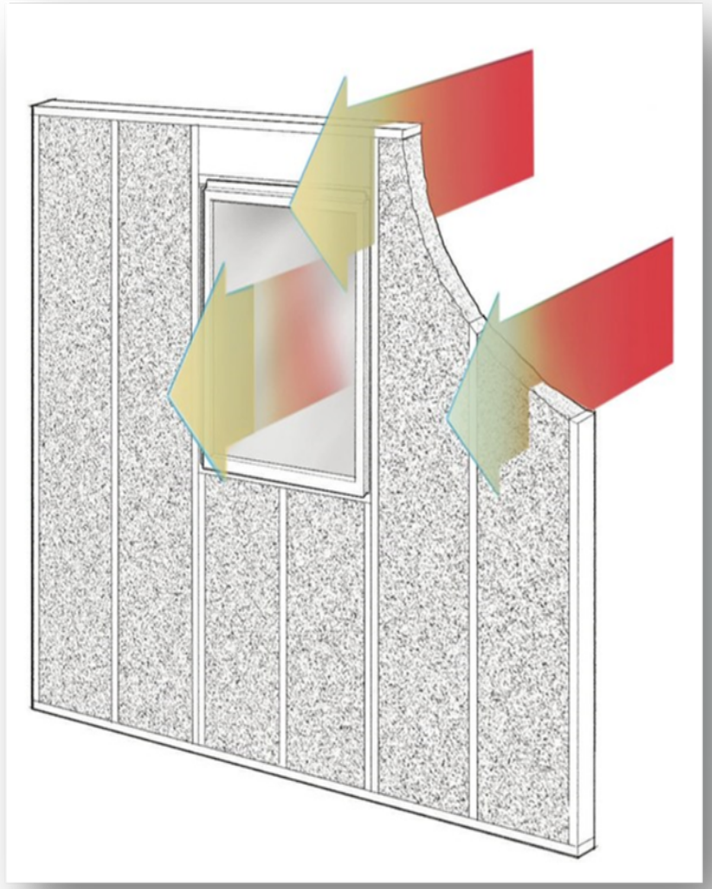
Building Envelope

"One of the reasons this house has such a simple mechanical system is because **it is getting over 50 per cent of its energy just from the sun coming through those south-facing windows**," says Amerongen. "So once you reduce your total heating load it's small enough we can get all of the energy we need from those solar panels."

Overall Wall R-Values

Impact of Window R-Value on Overall Wall R-Value

Window 15% of Wall Area	Wall R-Value with Windows w/Varied Wall Insulation Levels			
U-Value	R-0	R-18	R-39	R-60
0.30	R-5	R-11	R-15	R-17
0.20	R-5	R-13	R-19	R-23
0.15	R-5	R-14.5	R-23	R-28
0.10	R-5.5	R-16	R-27	R-34



Sources:

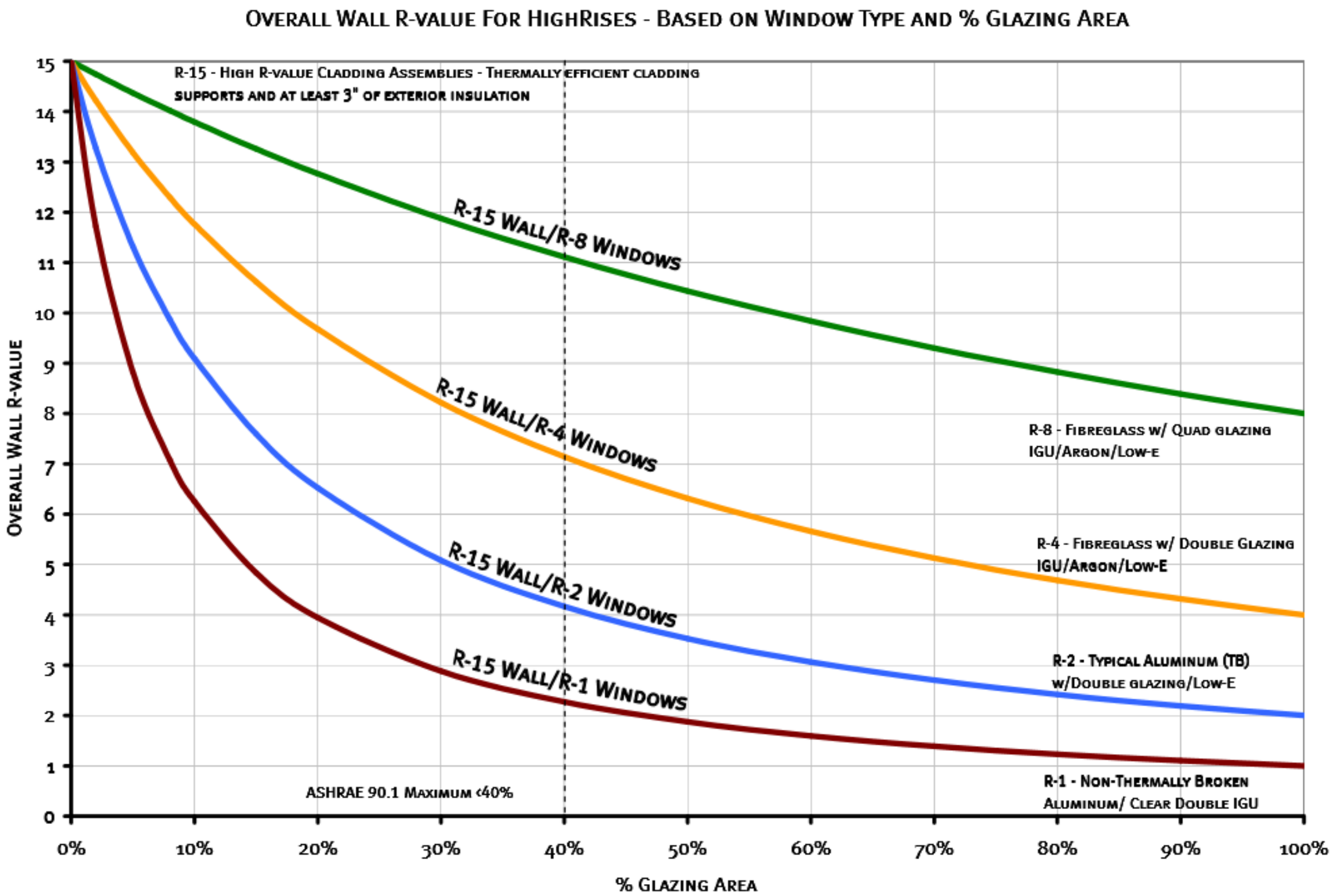
"Holes in the Wall: To Improve the Energy Performance of Walls, Look at the Total R-Value," Journal of Light Construction, February 2014;

Multi-Assembly R-Value / U-Value Calculator – Cascadia Windows and Doors;

Michael Blasnik Presentation, 2014 ACI Conference

Overall Wall R-Values

Impact of Window R-Value on Overall Wall R-Value



- The more glazing, the bigger the impact of window performance

U-Values

Keeping Heat In (or Out)

U-Value (U-Factor)

The measure of a window's **rate of non-solar heat loss or gain** (Btu/hr.-sq. ft.-°F in imperial).

- Consider *overall* u-value

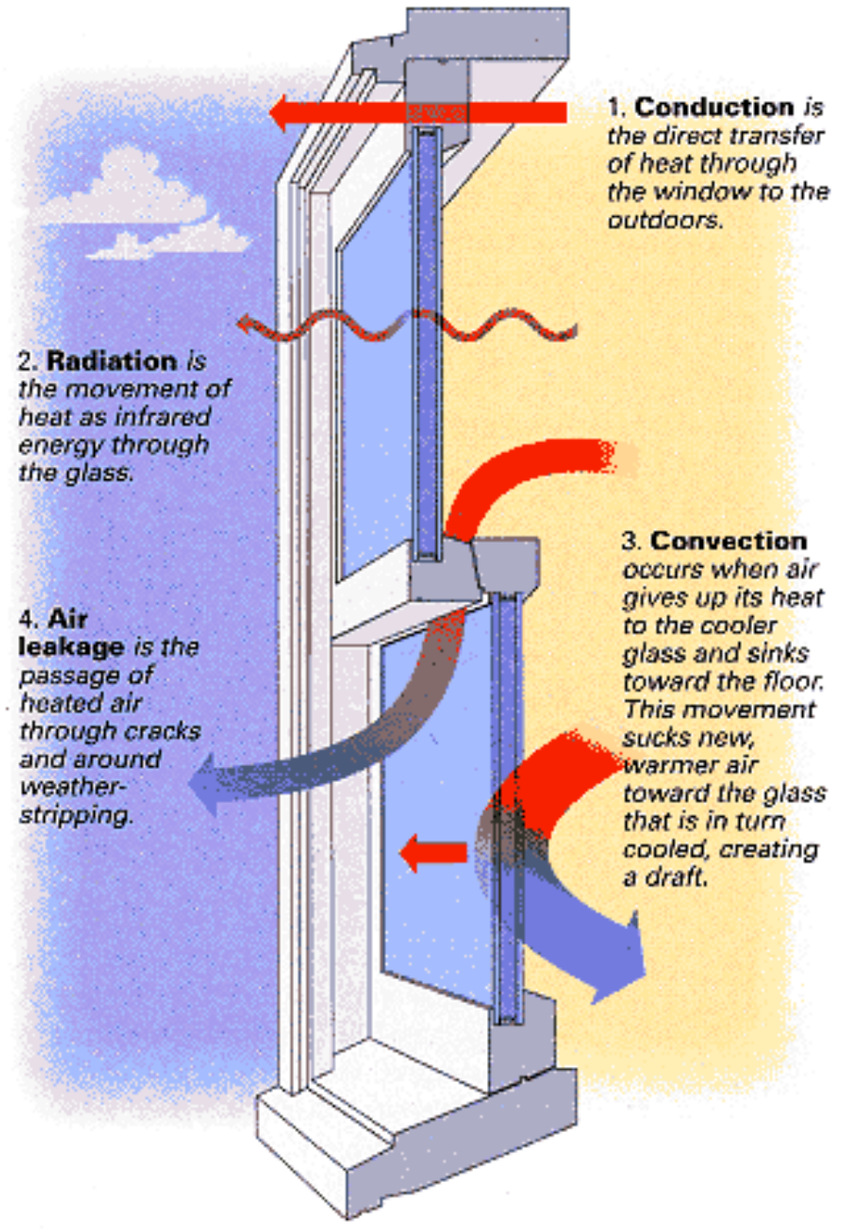
R-Value:

The measure of a window's **resistance to heat flow**.

- The inverse of U-value, or R = 1/U.

Windows lose and gain heat by:

- Conduction
- Convection
- Radiation
- Air Leakage

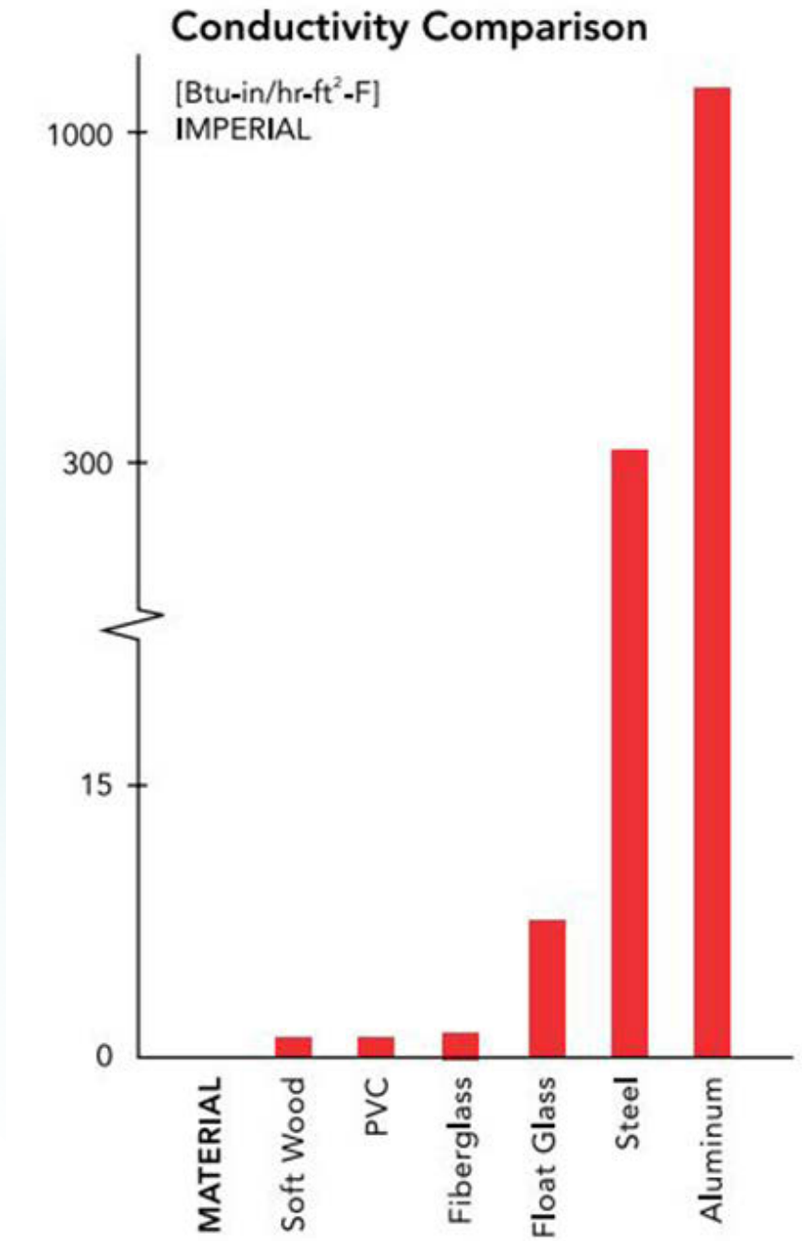


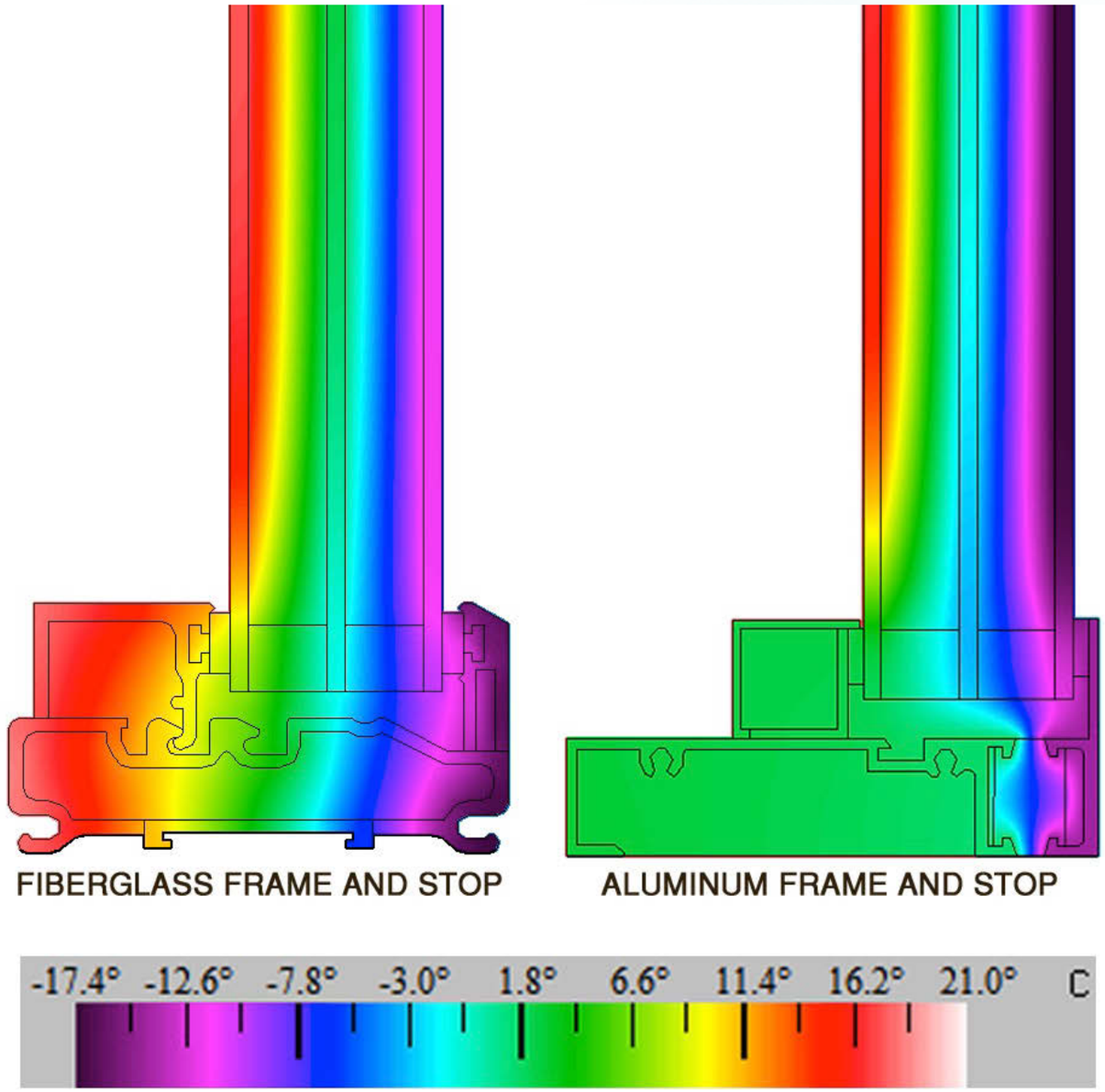
U-Values

Conduction

Definition: Movement of heat through a solid material – like touching a hot skillet

- *Aim for a less conductive frame material*



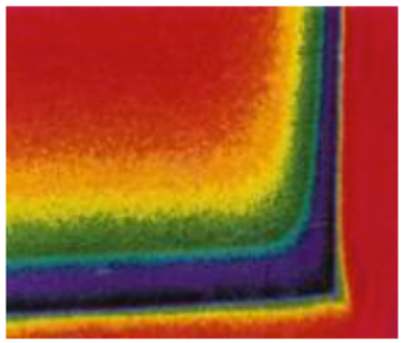


Both simulated with a Tripane 2 Low-E Silver Coatings (2&5), Argon, Warm Edge Space

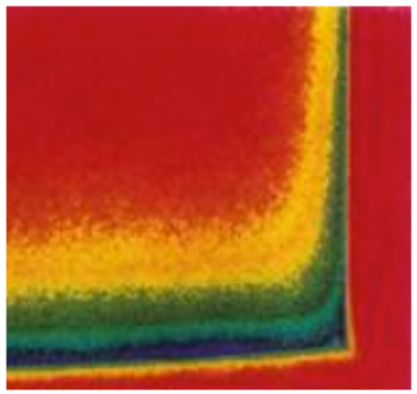
Conduction

Definition: Movement of heat through a solid material – like touching a hot skillet

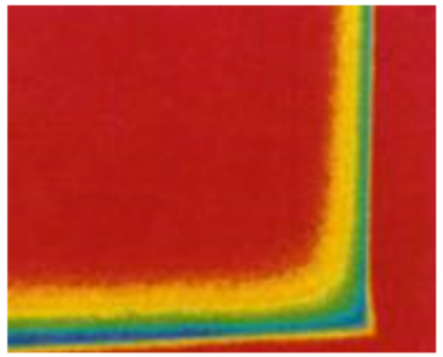
- *Aim for a less conductive spacer*



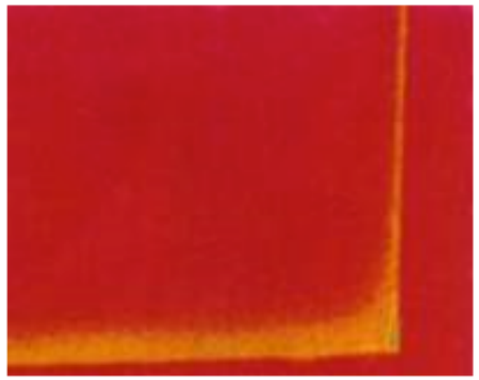
Double Glazed Aluminum Spacer



Double Glazed SuperSpacer ™ (Silicone Foam)



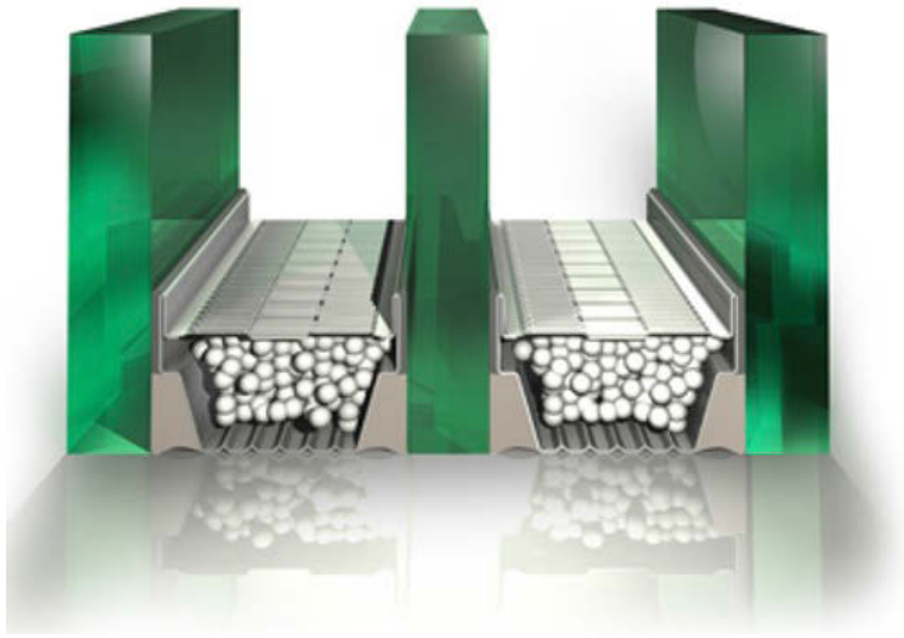
Triple Glazed Aluminum Spacer



Triple Glazed SuperSpacer ™ (Silicone Foam)

The difference between spacers is less meaningful in triples.

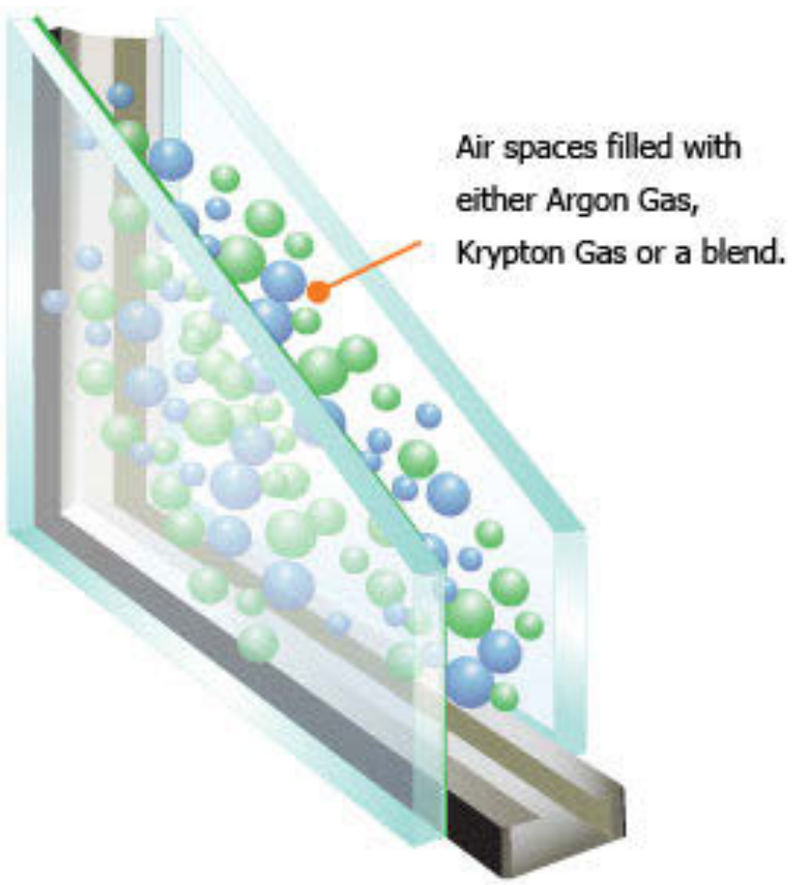
- Typical warm edge triple is at least 8°F warmer than dual equivalents
- Lowest performing spacers in a triple will be equal or better than the best performing double pane.



Convection

Definition: Heated indoor air contacts the interior window surface, the air cools, drops, warm air takes its place, and creates a loop recognized like a draft.

- *Use a gas fill to reduce the convection within the Insulating Glass (IG) unit.*
- Same process between layers of glass and in frame cavities



Insulating Glass Unit	U-Factor (Btu/hr/ft²/°F)	
	Air	Argon
2-Pane Clear	0.48	0.46
2-Pane with 1-Low E 272	0.30	0.25
3-Pane Clear	0.31	0.29
3-Pane with 1-Low E 272	0.22	0.19

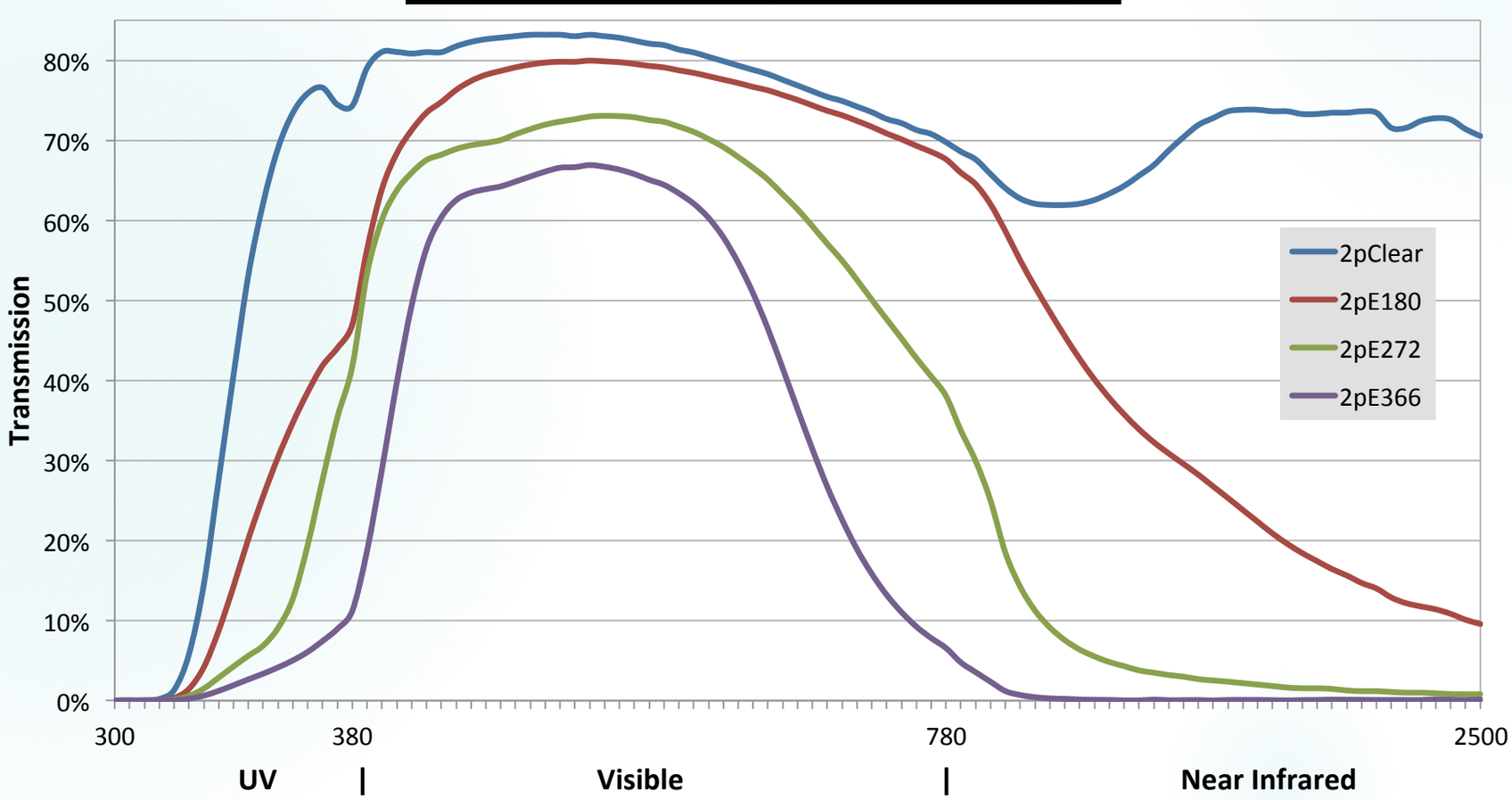
Radiation

Definition: Movement of heat – like standing near a woodstove

- *Consider the most appropriate type of low emissivity (Low E) coating to reduce radiation.*

- Types of Soft Coat Low E's:
  - 1 coat of Silver – High solar gain, High visible light
  - 2 coats of Silver – Mid-to-low solar gain, Low U-value
  - 3 coats of Silver – Low solar gain, Low U-value, Low visible light

Spectrally Selective LoĒ Coatings
% Transmission per Wavelength



Selective Glazing by Orientation

Customizing Low E Coatings by Elevation

Selective Glazing

Typical Objectives in North America

North:

Minimize U-value (Maximize R-value) for reduced heat loss.

South:

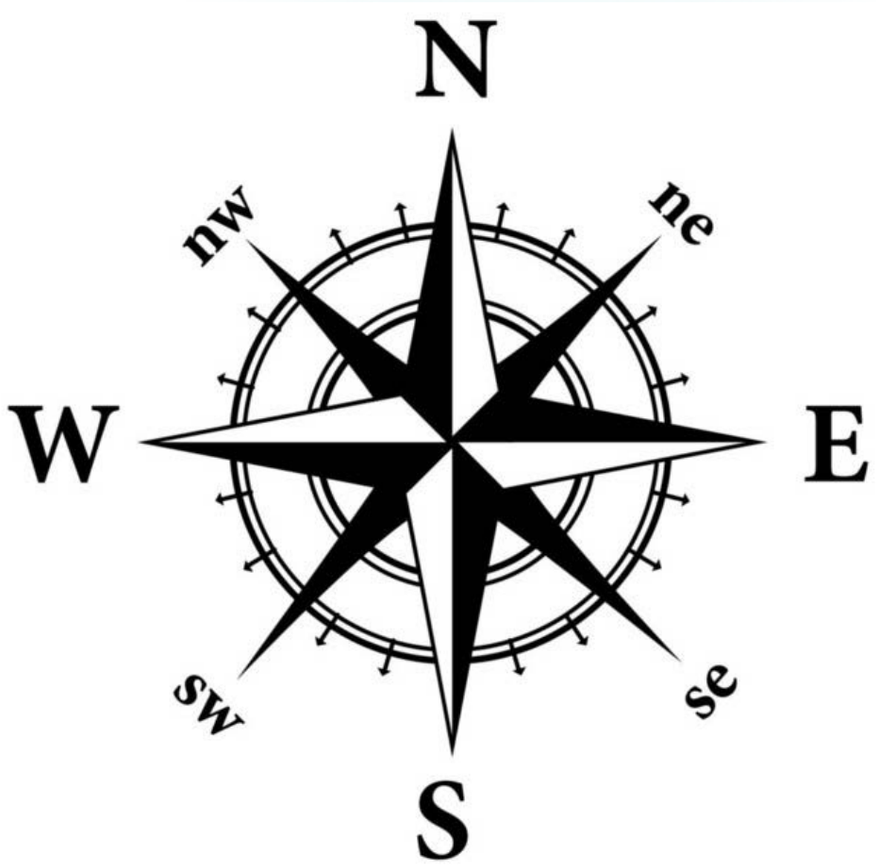
Take advantage of optimal solar heat gain and visible light.

East:

Aim for a mid-range product.

West:

Control solar heat gain.



Air Leakage

Air Leakage

Definition: Infiltration of outside air into the building

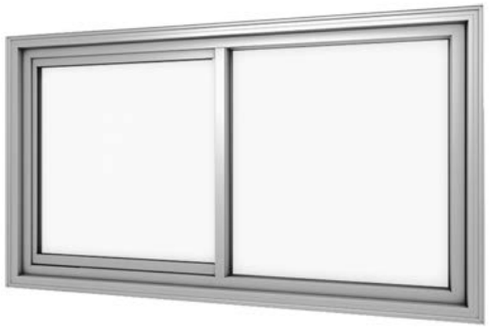
- *Reduced by compression (over sliding) seals and durable multi weatherstripping.*

Best → Worst

Fixed

Casement

Awning



Horizontal Slider

Single/Double Hung

Performance Advancements on Doors

Air Leakage

Insulated Door Slabs

Automotive Weatherstripping

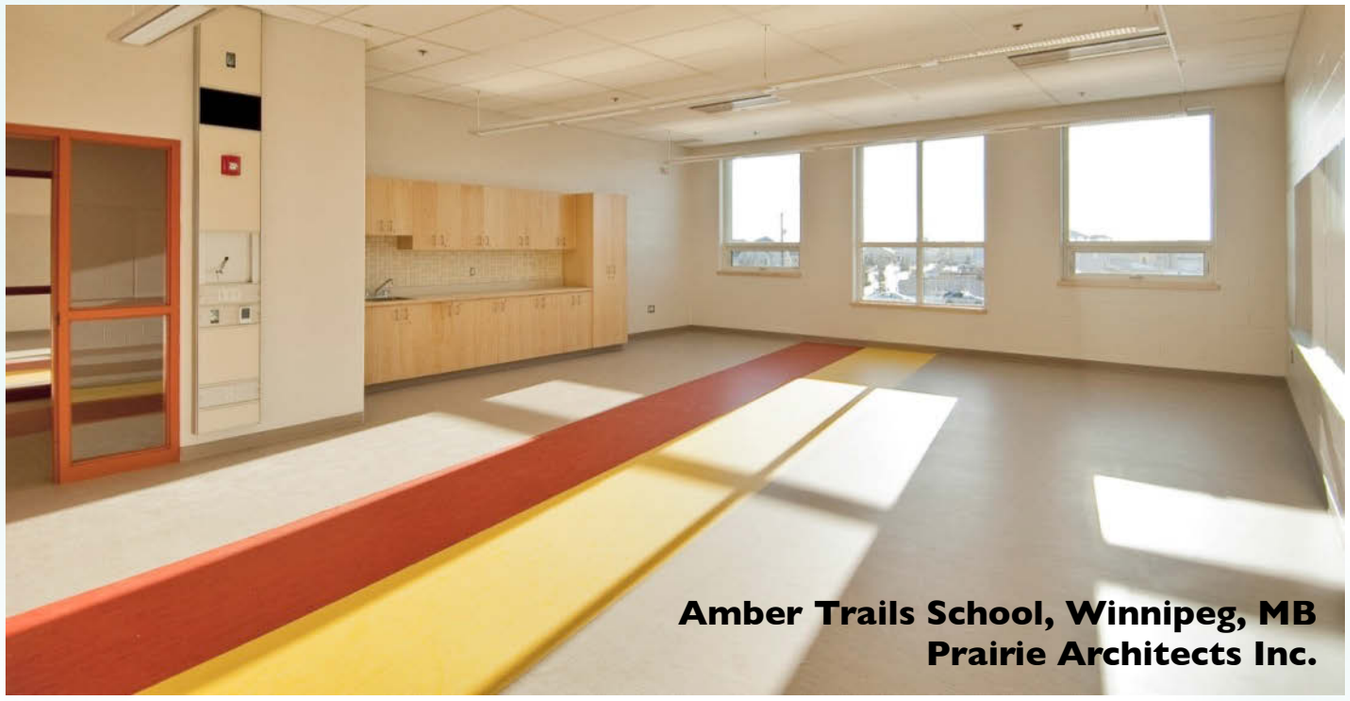
Thermally Broken Adjustable Sills

Multi-Point Locks

Real-World Application:

Window Upgrade Allows for Smaller HVAC System

Overall Wall R-Values



Amber Trails School, Winnipeg, MB
Prairie Architects Inc.

Condensation Resistance

Conden-sation Resistance

Definition: The measure of a window's **resistance to condensation** on the inside surface.

- *Condensation Resistance Factor (CRF) is the AAMA rating, ranging 30 to 80 – measured data*
- *Condensation Resistance (CR) is the NFRC rating, ranging 1 to 100 – simulated data*

- Not directly correlated to U-values which is an area-weighted calculation – more related to thermal bridging
  - Coldest part of most modern windows is the bottom 1/2" of glazing

- Condensation Variables
  - Buildings with high humidity
  - Thermal bridging in the wall construction
  - Installations near the outside of the wall plane reducing interior air flow
  - Blinds / Draperies reducing interior air flow
  - House plants
  - Hobbies

Conden-sation Resistance

Condensation Resistance

- Impact of Reducing the Relative Humidity
  - Increased discomfort
  - Drying of skin – chapping and irritation
  - Increased static electricity

- Factors to Improve Condensation Resistance
  - Triple pane glazing
  - Warm edge spacers
  - Low E coatings and Argon gas fill
  - Insulated frames
  - Placement of the window in the wall assembly

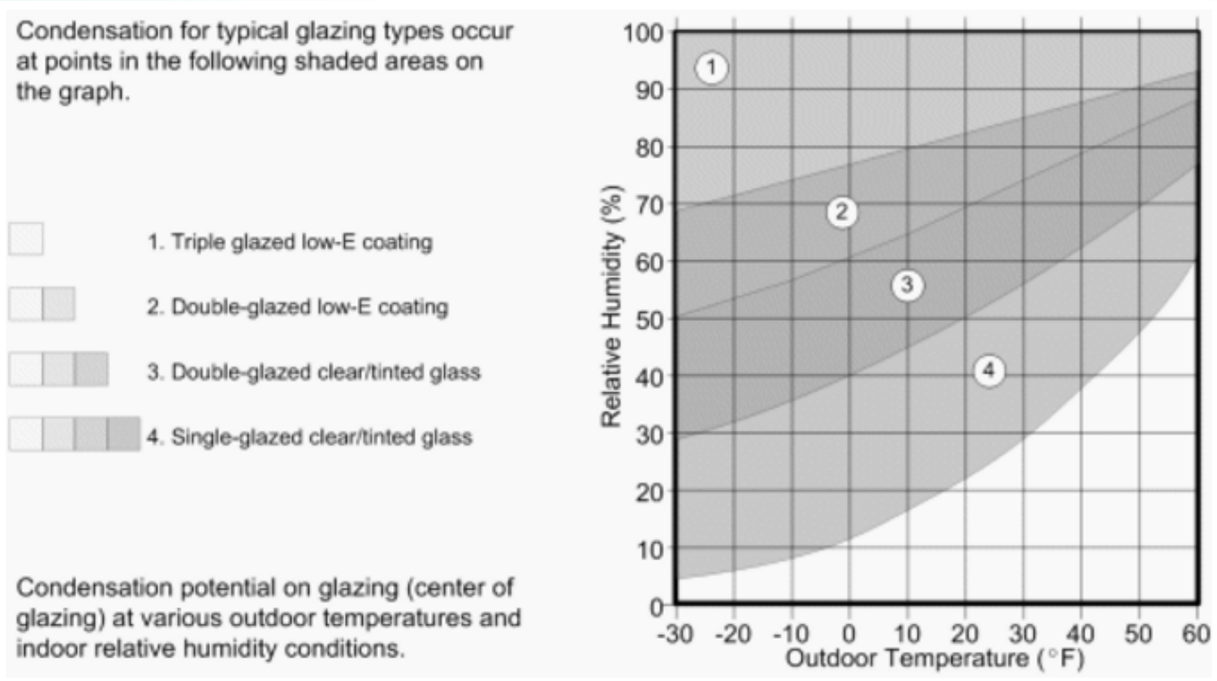


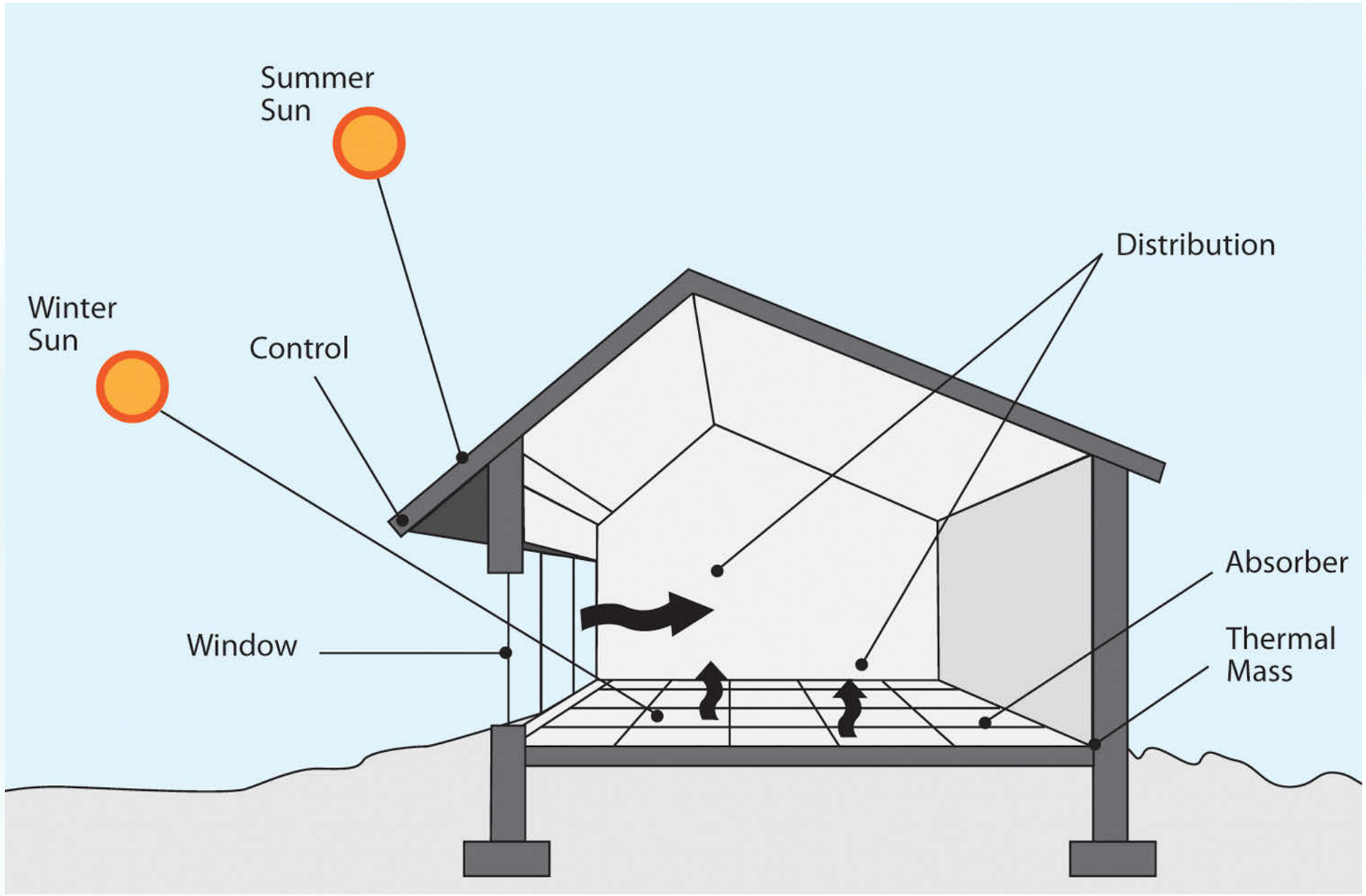
Figure 1a. Window type performance at various humidities and outdoor temperatures. Source: THERM5.2/Windows5.2 NFRC Simulation Manual, Fenestration Heat Transfer Basics, Condensation Resistance

Solar Heat Gain Coefficient (SHGC)

Solar Heat Gain

Definition: The fraction of the **solar radiation admitted** through a window.

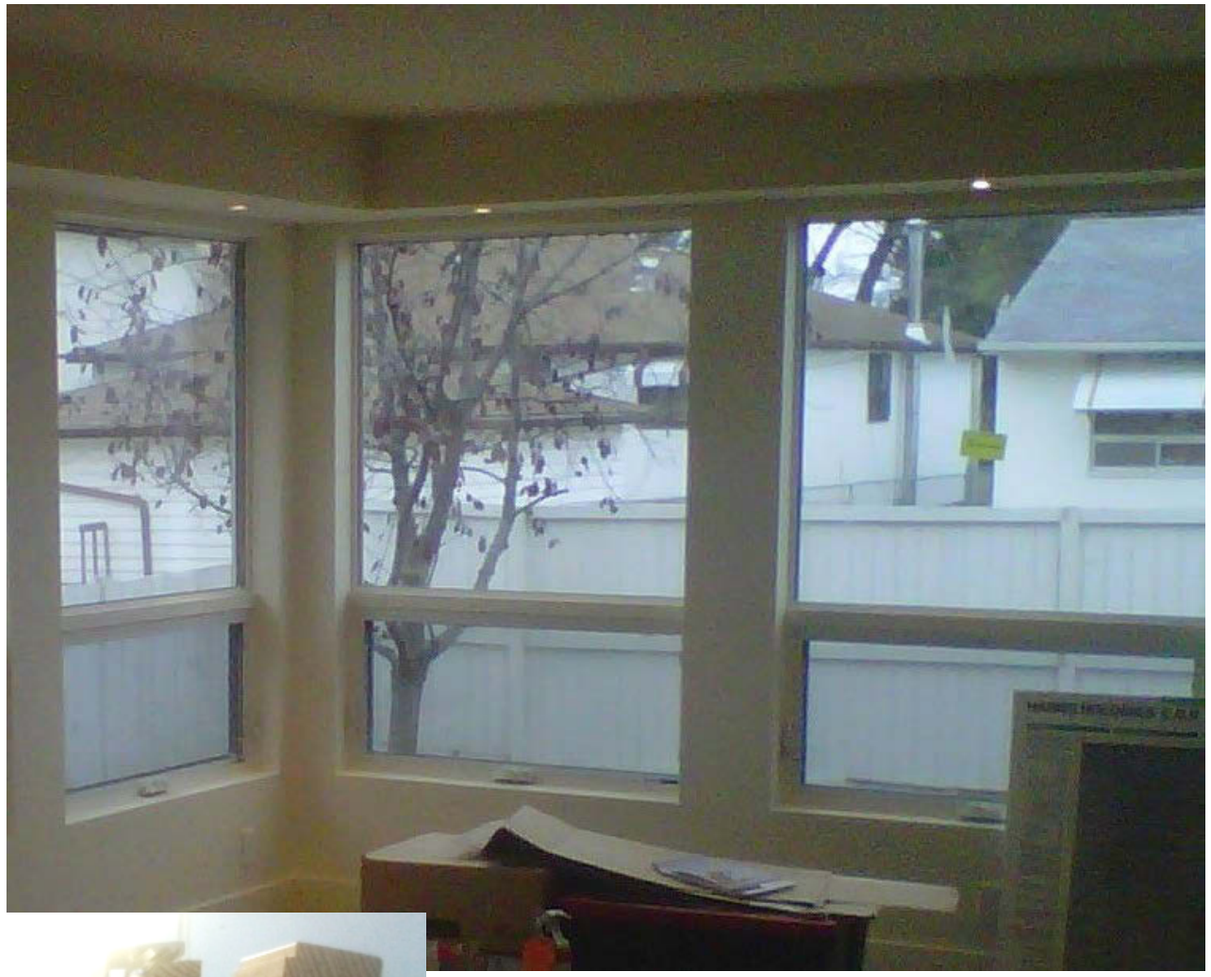
- *Look for passive solar gain opportunities on south elevations and use large glazing*

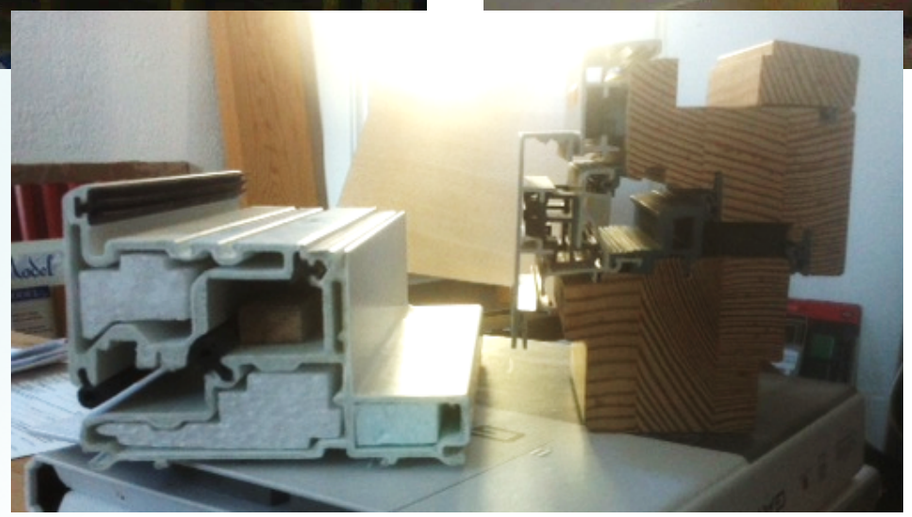


Real-World Application:

Slim Frames for Maximum Gain and Viewing Area

Solar Heat Gain





Solar Heat Gain

Real-World Application:

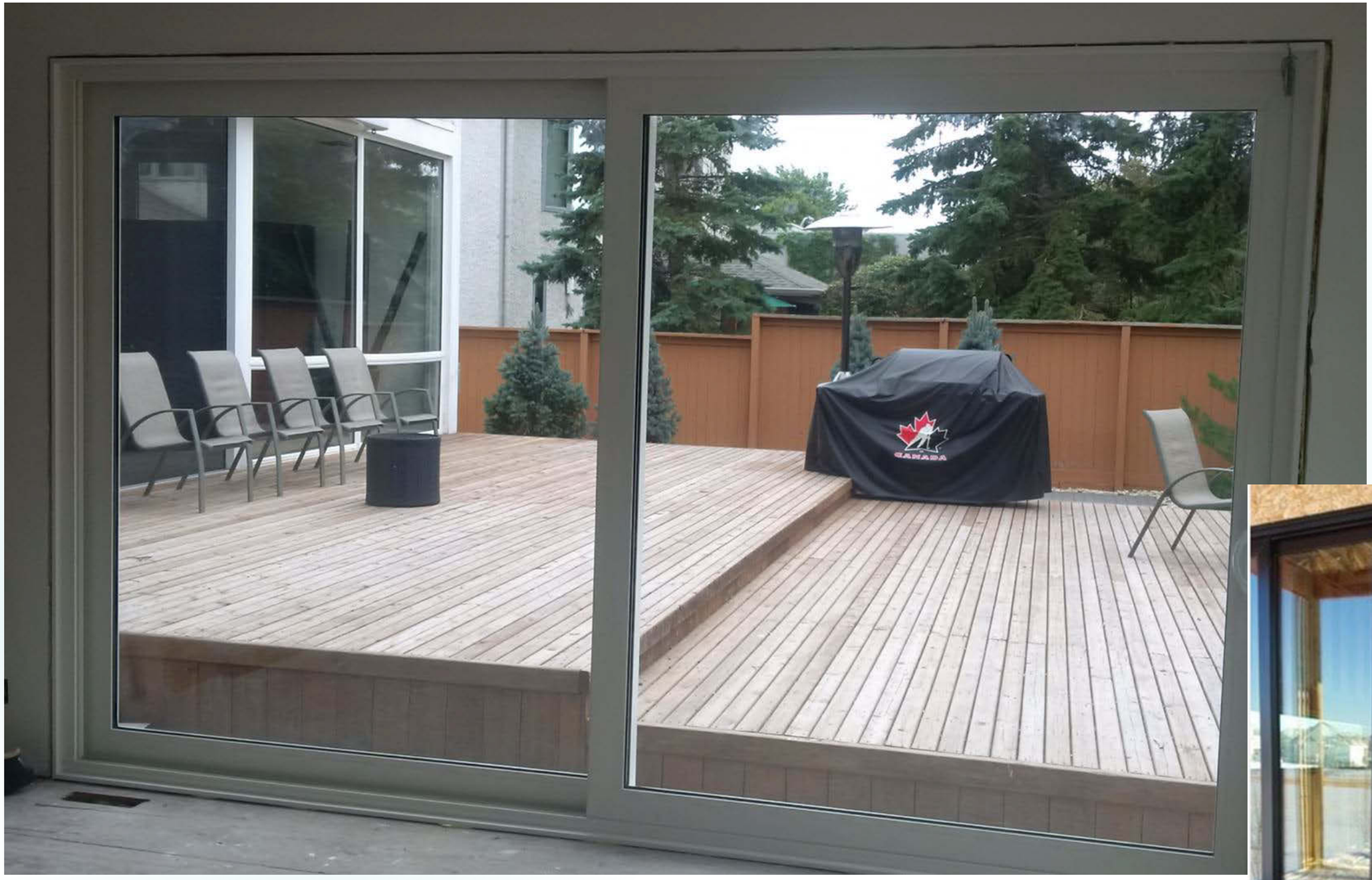
Passive Solar Gain Glazing with Exterior Shading

- ✓ *Design for a few large windows vs. many small windows to give more light and reduce cost.*

Solar Heat Gain

Real-World Application:

Passive Solar Gain with Patio Access



Solar Heat Gain

Real-World Application:

Selective Glazing by Orientation

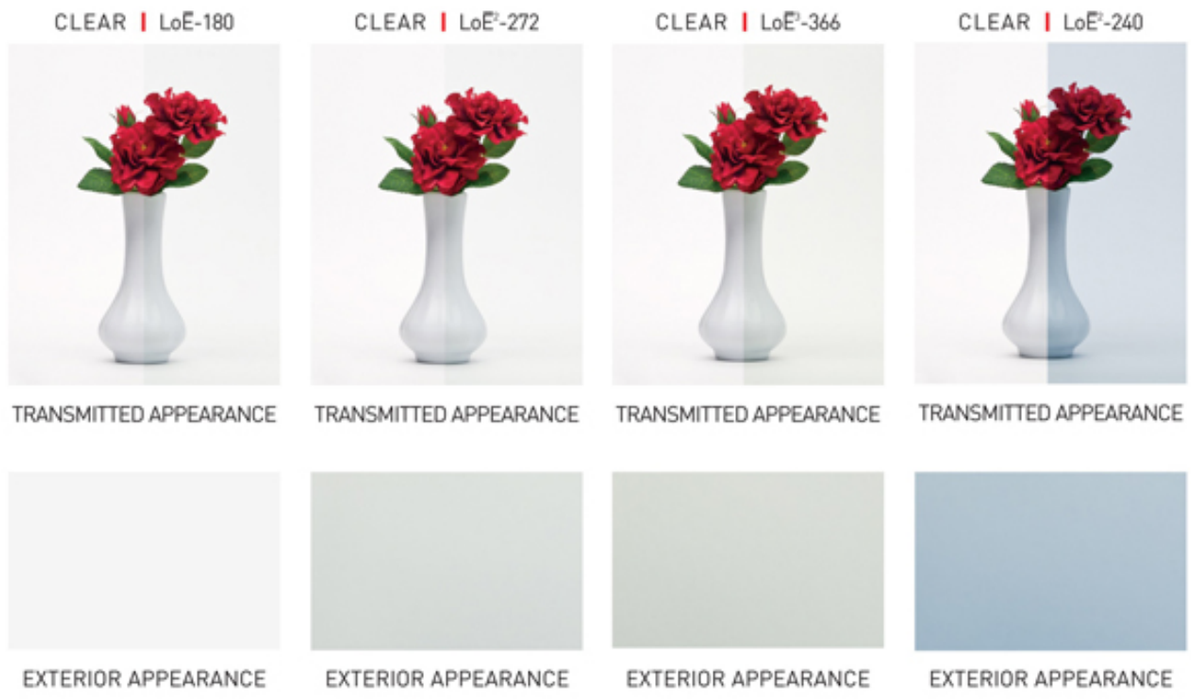
Law Office, Winnipeg, MB
Concord Projects Ltd.

Glass type	LoĒ Surface #	Spacer	Gas	R-Value (cog)	Overall U-Value	S.H.G.C.	Visible Light
Cardinal LoĒ-180							
Tripane 2 Coatings	2 and 5	Warm Edge Stainless Steel	Argon	7.69	0.16	0.56	70%
Cardinal LoĒ²-272							
Tripane 2 Coatings	2 and 5	Warm Edge Stainless Steel	Argon	7.69	0.15	0.35	58%
Cardinal LoĒ³-366							
Tripane 2 Coatings	2 and 5	Warm Edge Stainless Steel	Argon	8.33	0.15	0.24	47%

Visible Light Transmittance (VLT)

Definition: The fraction of **visible light transmitted** through a window.

- *Note the changes in Visible Light with changes in Solar Heat Gain*



Real-World Application:

Changes in Solar Heat Gain vs. Visible Light

Visible Light

Glass type	LoĒ Surface #	Spacer	Gas	R-Value (cog)	Overall U-Value	S.H.G.C.	Visible Light
Cardinal LoĒ-180							
Tripane 2 Coatings	2 and 5	Warm Edge Stainless Steel	Argon	7.69	0.16	0.56	70%
Cardinal LoĒ^2-272							
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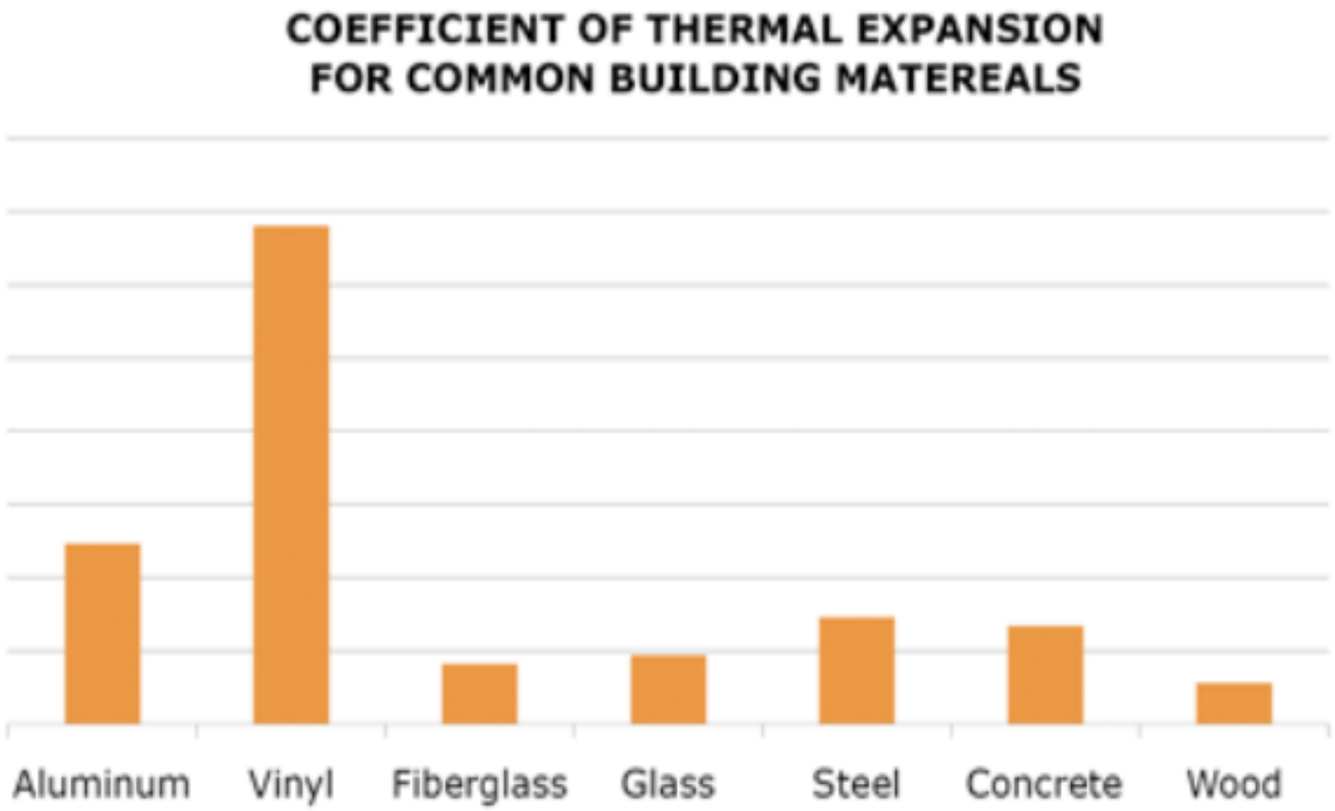
Cardinal LoĒ^3-366							
Tripane 2 Coatings	2 and 5	Warm Edge Stainless Steel	Argon	8.33	0.15	0.24	47%

Real-World Application:

Selecting the Right Glass for the Setting

Visible Light

Durability by Frame Type

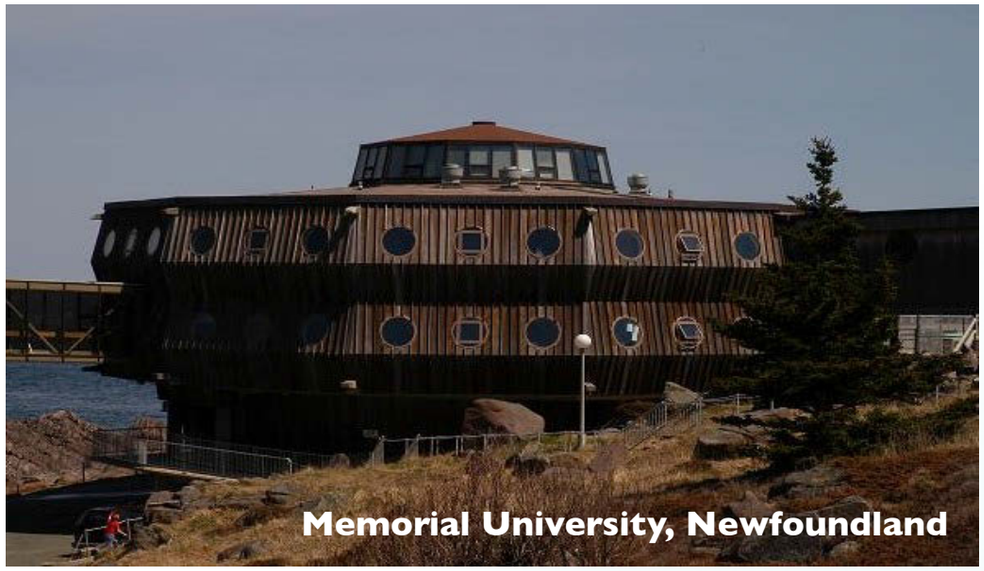


Material	Coefficient of Thermal Expansion (x 10^-6 per degrees Celcius)
Wood (1st generation)	0.0 (Wood expands with changes in humidity)
Aluminium (2nd generation)	23.0
Vinyl (3rd generation)	62
Fiberglass (4th generation)	7.4
Glass	8.7

Real-World Applications:

Window Selections for Longevity and Reduced Maintenance

Durability



Memorial University, Newfoundland

Learning Centre, Rankin Inlet

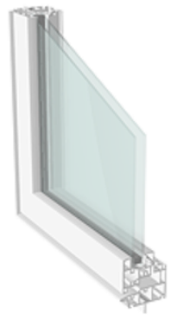
Historical Home, Winnipeg

Characteristics by Frame Type

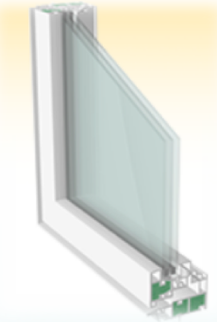
Frame Types

Aluminum

Composite



Vinyl



Fiberglass

Aluminum
- Strong, low maintenance, high conductivity, requiring thermal breaks

Wood
- Good thermal performance, expand/contract in response to weather conditions, require regular maintenance

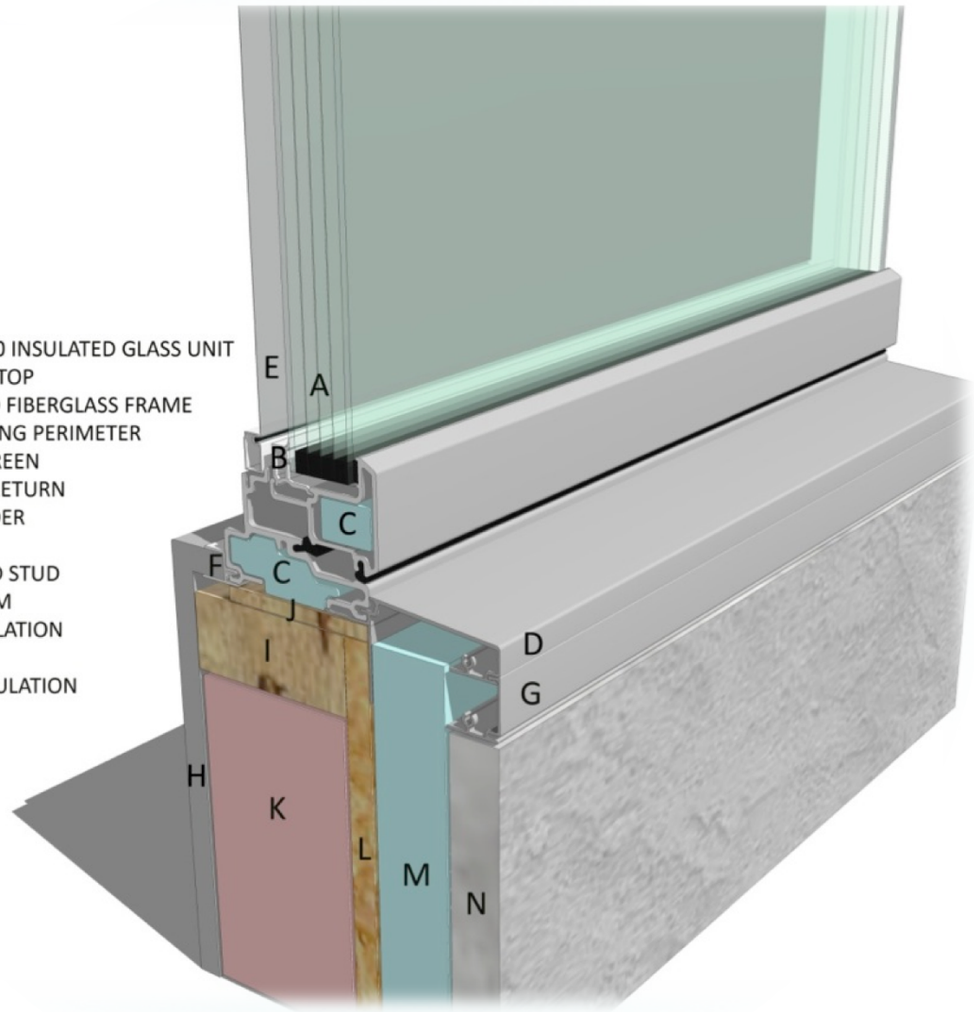
Composite
- Composite wood products / metal clad vinyl / metal clad fiberglass
- Stable, with better resistance to moisture

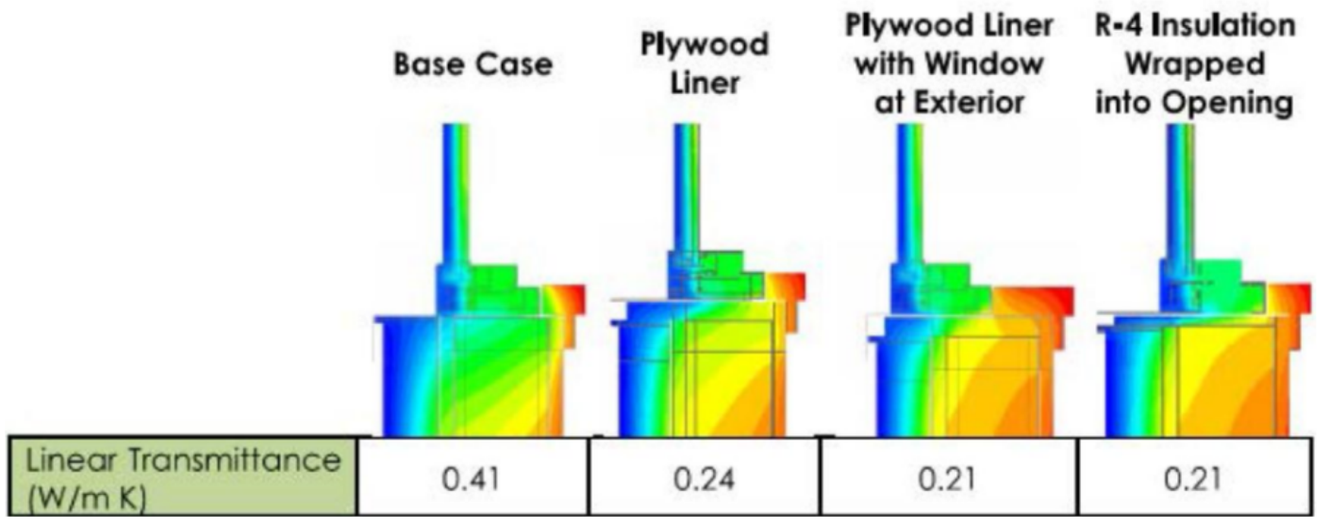
Vinyl
- Low maintenance, good thermal performance, less dimensionally stable / shorter life span

Fiberglass
- Low maintenance, dimensionally stable, with superior thermal performance to aluminum

Impact of Installation

Placement Within the Wall System



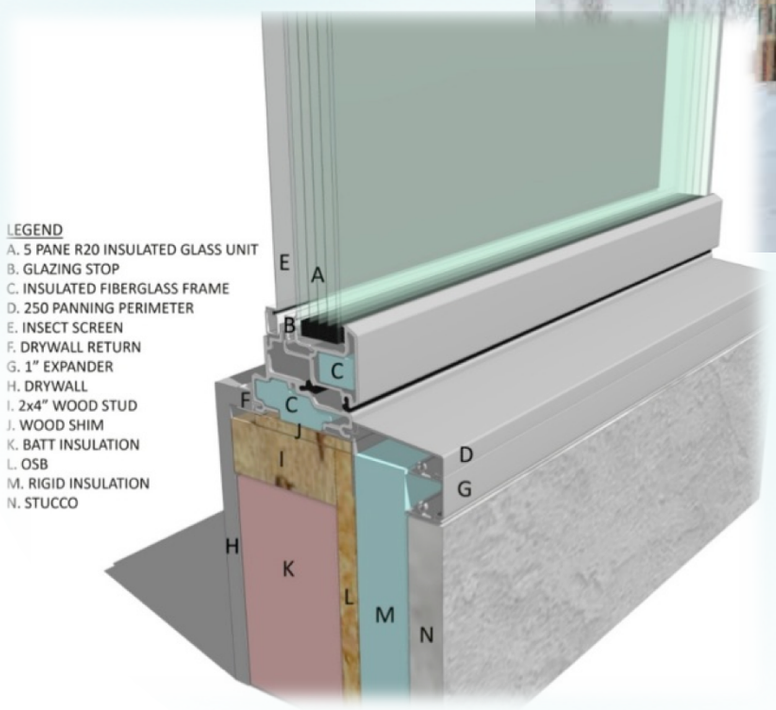


Linear Transmittance (W/m K)	0.41	0.24	0.21	0.21

Real-World Applications:

Careful Consideration of the Building Envelope as a Whole

Installation



Net Zero Projects

The Alberta Sustainable House, Calgary, AB

A *utonomous &*
S *ustainable*
H *ousing Inc.*

Fig. 1: View from S.W.

Fig. 2: Masonary Heater in living room

Fig. 3: Solar Oven on front porch

The total purchased energy requirements per year averages 6% of an ordinary house (0.75 wh/DD/m3).

Net Zero Projects

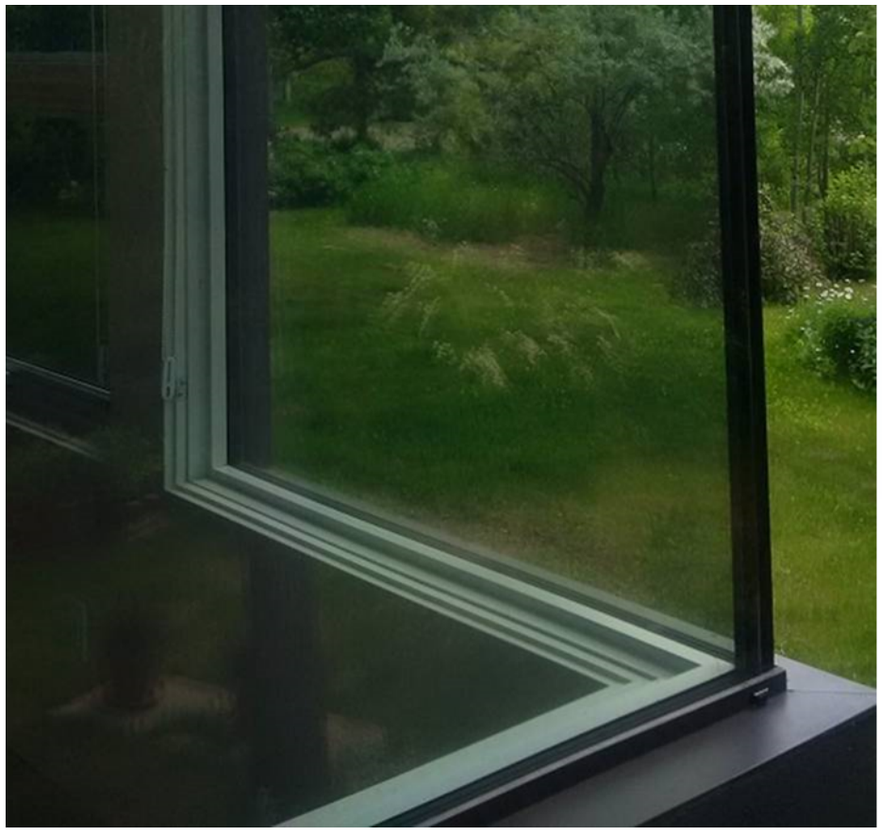
Riverdale by Habitat Studio, Edmonton, AB

Built back in 2007 the Riverdale net-zero home was a 5,000 square foot duplex. It also had a complex space heating system that depended on an over-built solar thermal set-up with a lot of extra engineering bells and whistles.

Net Zero Projects

The House Company, Edmonton, AB

Projects



“A tough blend of large glazing areas, tight venting windows and innovative triple pane glazing configurations."

Window Walls with Non-Conductive Frames

Projects

Punched Openings with Casements

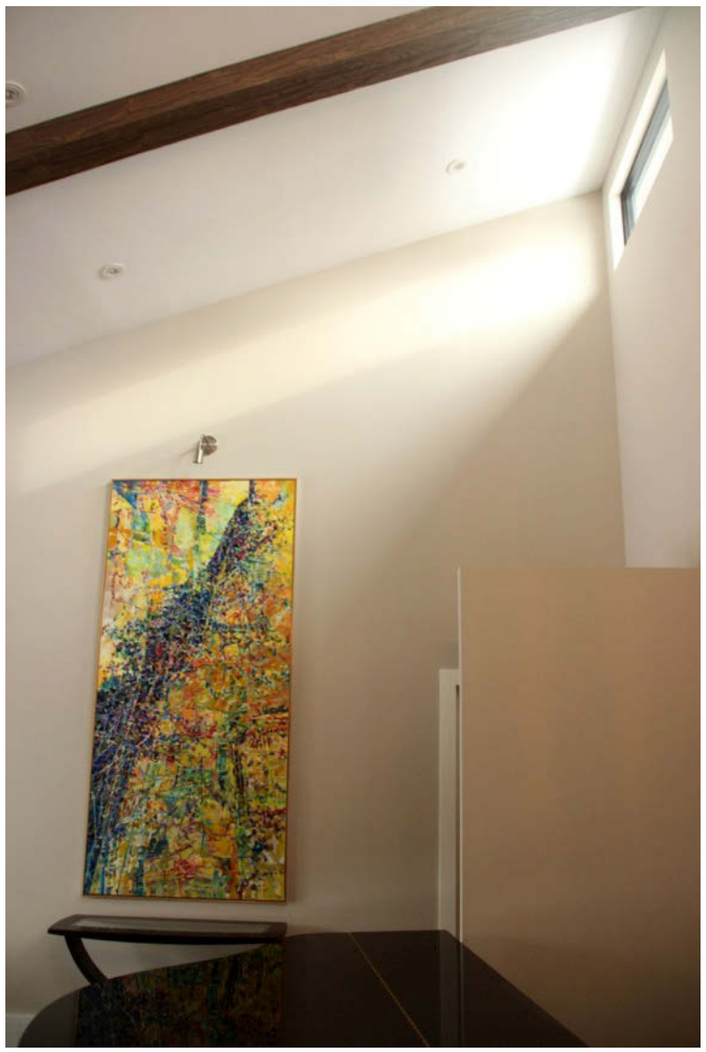
Triple Low E Glazing

Projects

Occupant Considerations

Quality of Living Spaces

Views – Comfort all Year-Round

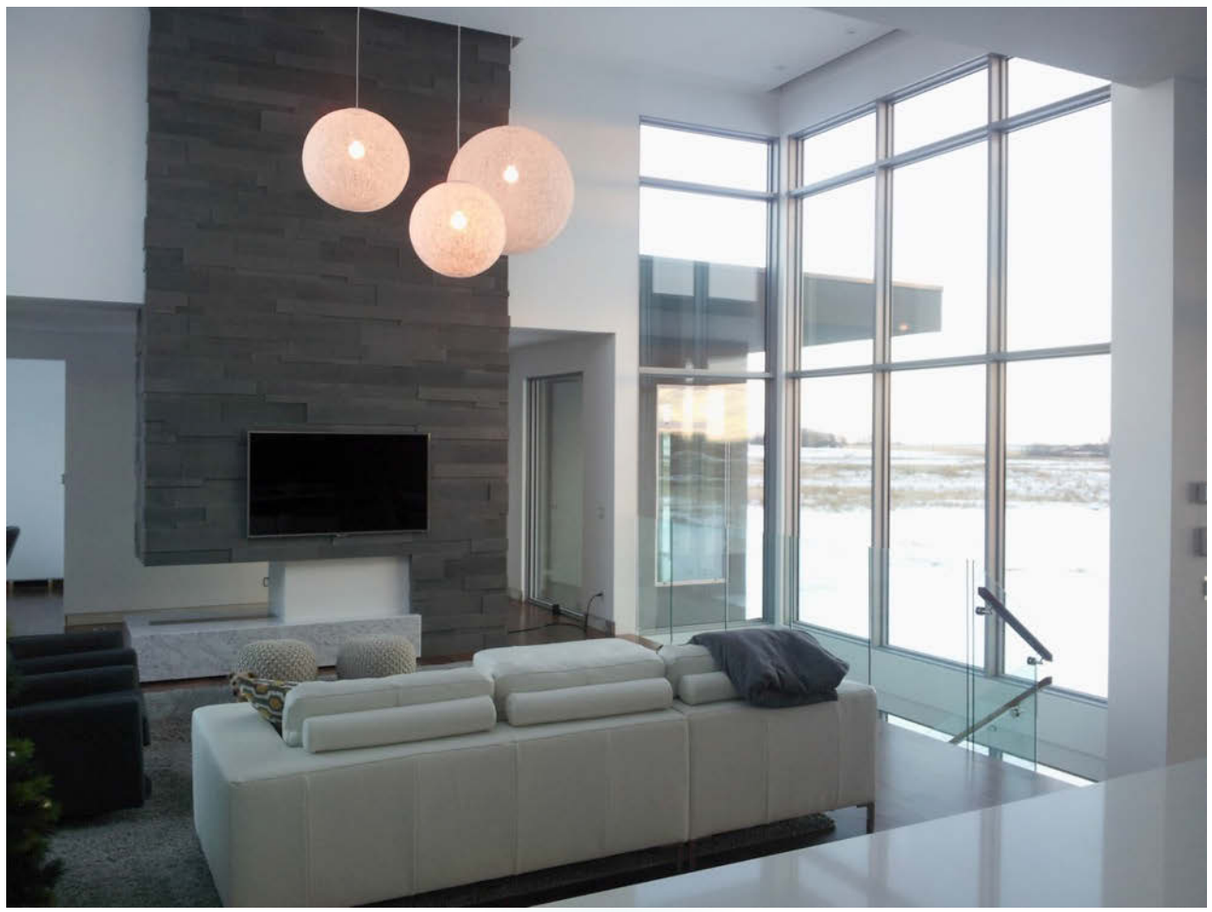


Privacy

Occupant Considerations

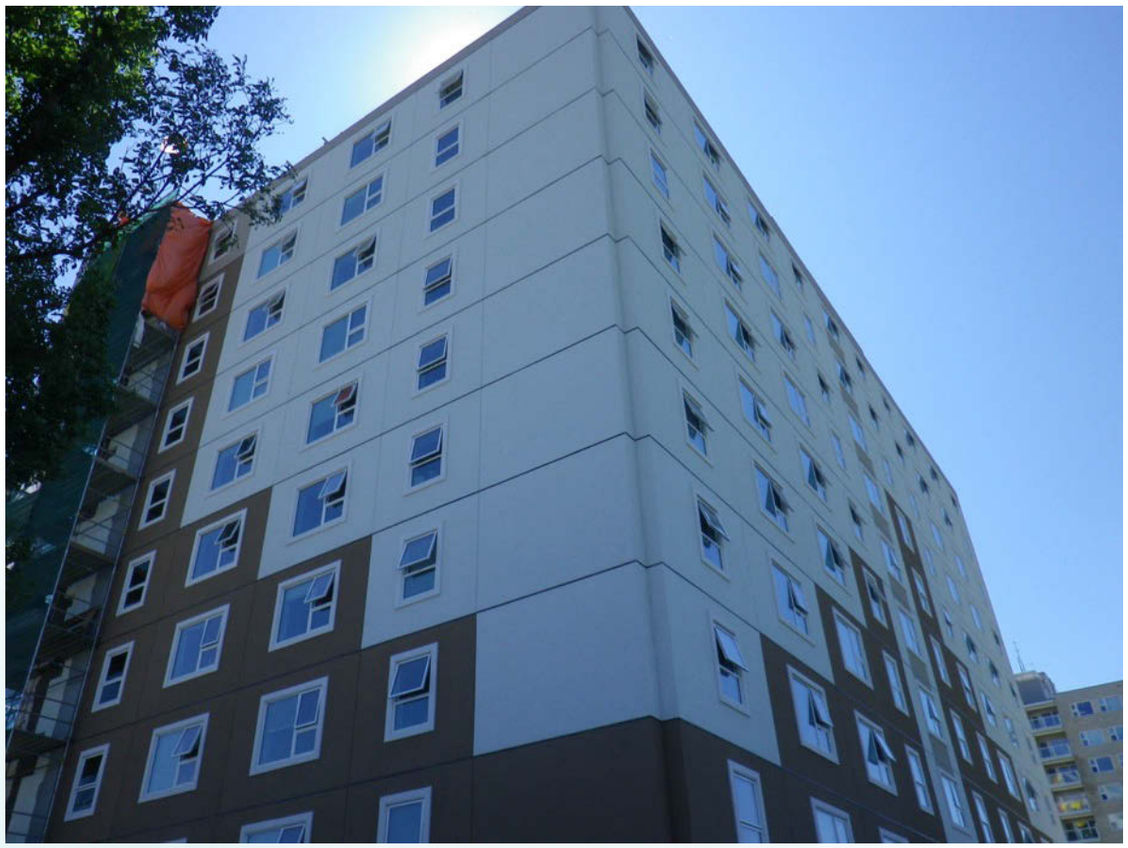
Quality of Living Spaces

Natural Lighting



Occupant Considerations

Quality of Living Spaces



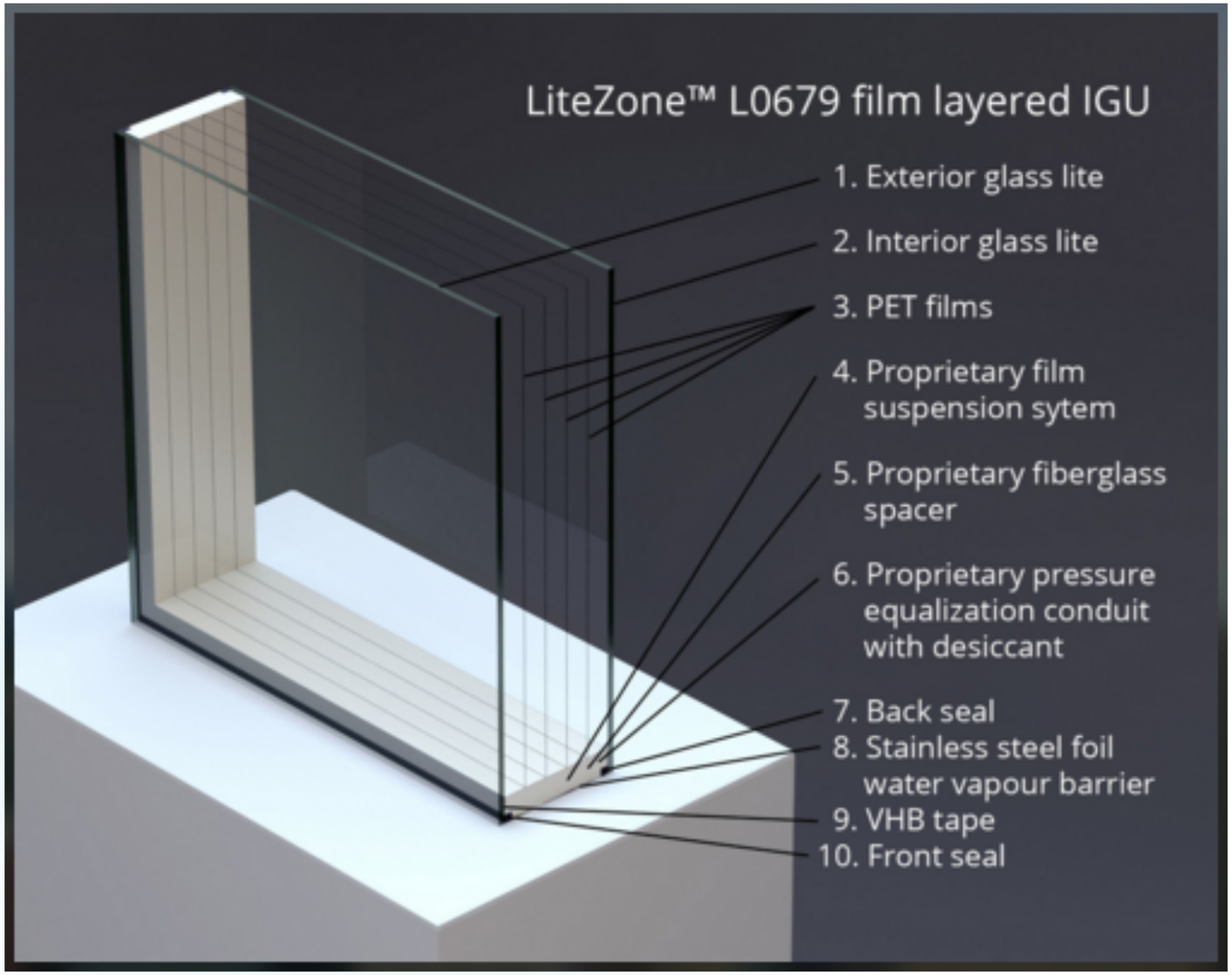
Natural Ventilation

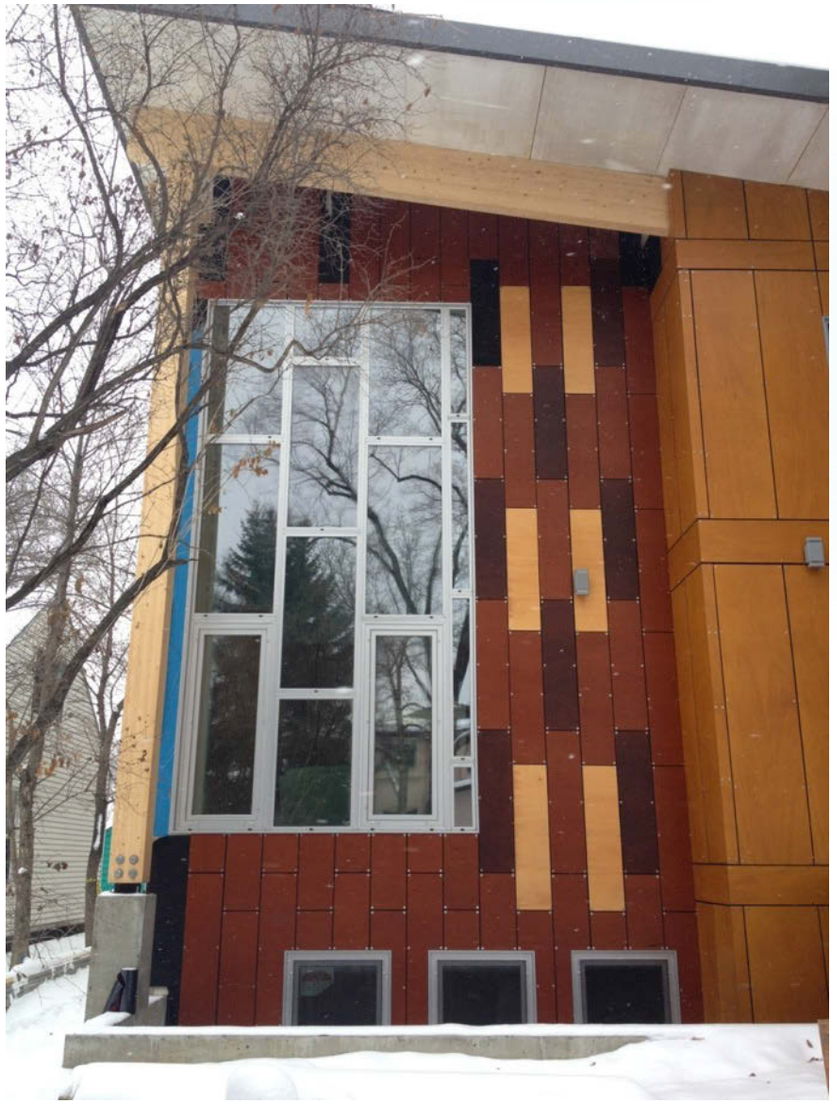
(Dis) Comfort

Emerging Technology

R-20 Centre-of-Glass Sealed Units

New





Emerging Technology

Dynamic Glazing

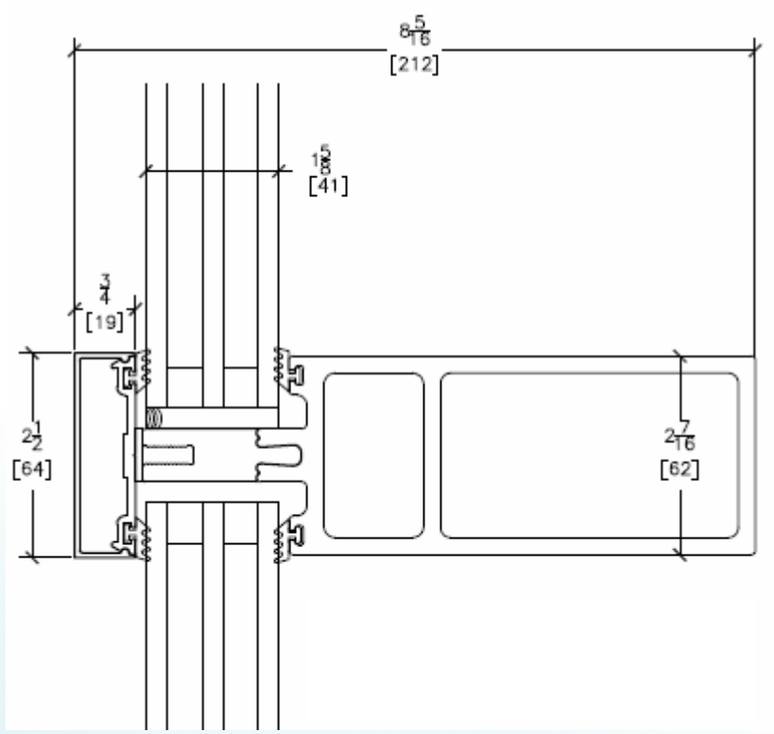
New

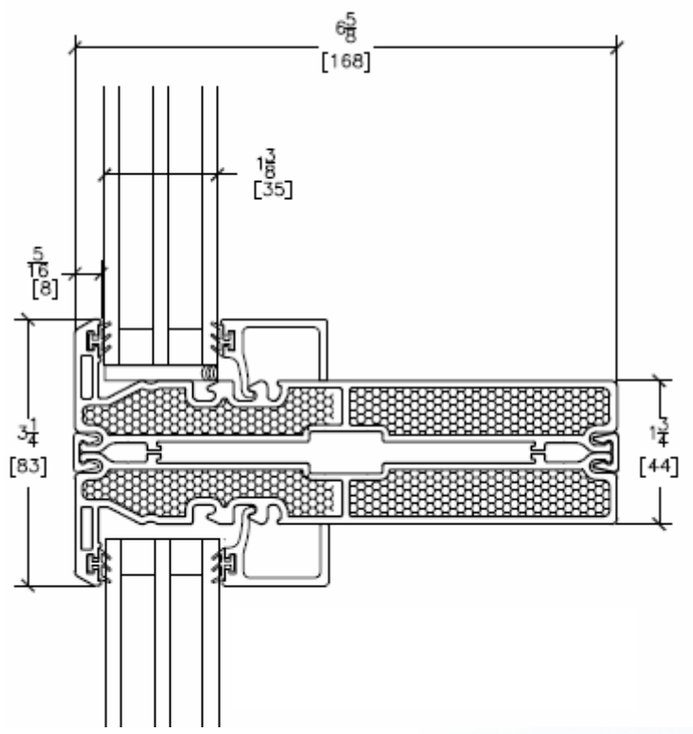
Green Build Toronto

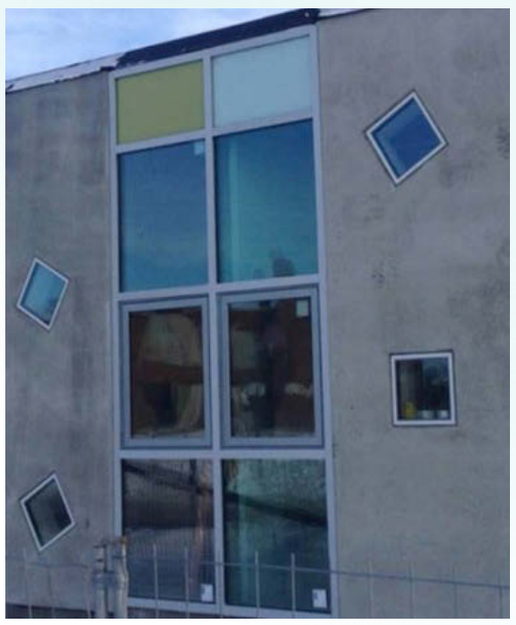
Emerging Technology

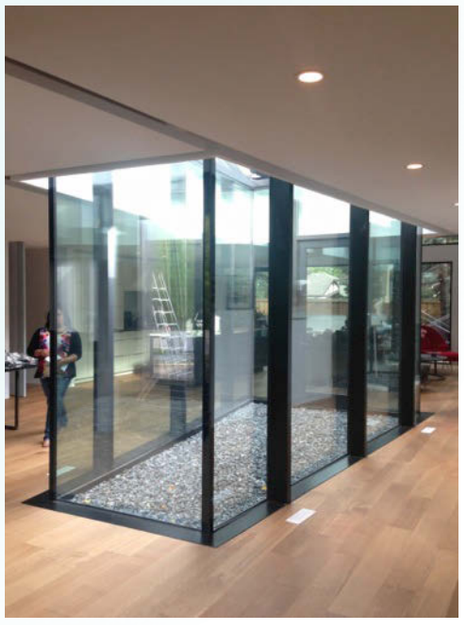
Fiberglass Curtain Wall

New



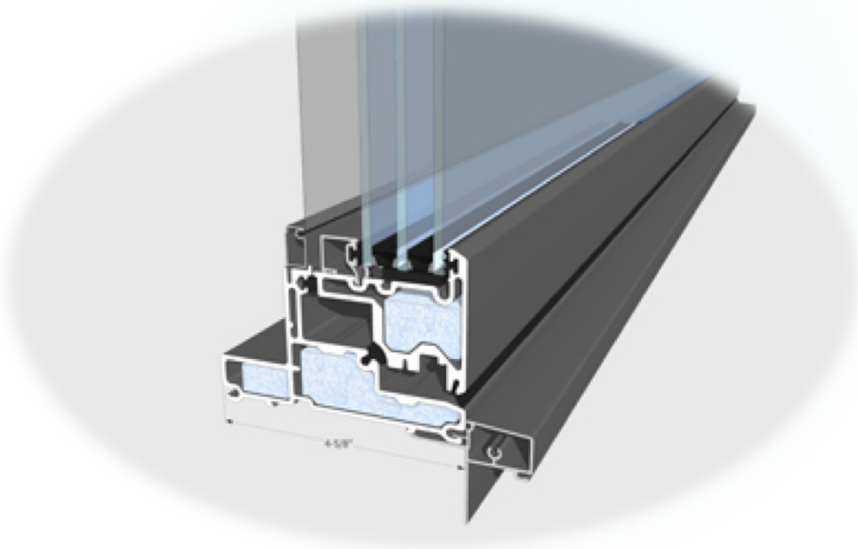






Summarized: Window Shopping Tips

- ✓ Low Overall U-Value
  - Consider low conductivity insulated frames, triple pane glass & warm-edge spacers
- ✓ Good Air Tightness
  - Triple weatherstripping / Compression seal
- ✓ Slim Frames
  - Typically the glass has a better u-value over the frame
- ✓ Solar Gain Opportunities
  - South elevations
- ✓ A Few Large Windows vs. Many Small Windows
  - Use less energy, give more light, and reduce cost
- ✓ Durability
  - A “cheap” investment today can result in expensive operating & replacement costs in the future.



SOURCES: Peter Amerongen, Net-Zero Energy Home Expert, Habitat Studio, Edmonton, AB.