
CASCADIA
WINDOWS & DOORS
BUILDER: Blue Water Concepts
PHOTO: Kristen McGaughey
CASCADIAWINDOWS.COM

CASCADIA – EDUCATIONAL PRESENTATION

AN ACTIVE APPROACH TO PASSIVE HOUSE WINDOWS

Understanding Passive House window modelling and impacts of real-world design details

WEBINAR ADMIN

WEBINAR TECHNICAL SUPPORT -

- Technical support is available for any issues during the webinar

CONTINUING EDUCATION CERTIFICATES -

- Will be automatically emailed after the presentation
- AIA & AIBC are automatically submitted (no need to self-report)
- All other association learning credits can be claimed via self-reporting

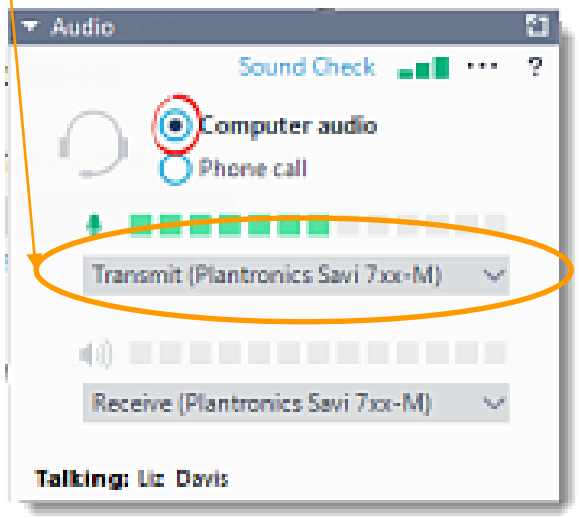
QUESTIONS -

- Feel free to post questions at any point during the presentation

AUDIO -

- We recommend using your computer audio to listen to the presentation. Calling into the presentation may incur long-distance charges from your phone provider.

Remember to select your audio source (headsets vs speakers)



AGENDA: WHAT ARE WE LOOKING AT TODAY?

- Intro to Cascadia Windows & Doors
- Impact of windows on building envelope performance
- Understanding the Passive House window standard
- Meeting the Passive House windows standard
- Window U-values in the real world
- Selecting Passive House windows
- Fiberglass for commercial Passive House projects

INTRO TO CASCADIA WINDOWS & DOORS

INTRO TO CASCADIA WINDOWS & DOORS

COMMERCIAL & MULTI-FAMILY
Windows & Window Wall
Storefront Glazing

RESIDENTIAL
Fixed & Operable Windows
Swing & Sliding Doors

THERMAL SPACER
Exterior Cladding Assemblies
Low-sloped Roofs & Soffits

PASSIVE HOUSE PRODUCTS

FIXED WINDOW

HOPPER WINDOW

CASEMENT / TILT & TURN

SLIDING DOOR

SWING DOOR

COMPONENT AWARD 2019
Passive House Institute

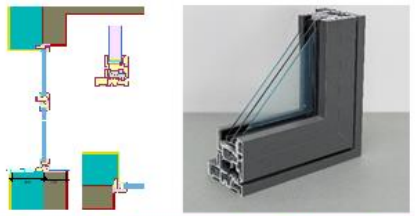
Windows for the Future

Special Prize Aesthetic and Innovation

Universal Series

by

Cascadia Windows Ltd., Canada



Cool, Temperate Climate

2019

ENERGY DEMAND & WINDOW IMPACTS

Understanding high-performance windows & what sets them apart

PASSIVE HOUSE – KEY TERMS

U-VALUE
W / (m²K)

THERMAL CONDUCTANCE

R-VALUE
m²K / W

THERMAL RESISTANCE

Thermal bridging

‘LEAK’ IN THE THERMAL ENVELOPE

PHPP

ENERGY MODEL USED FOR PASSIVE HOUSE PROJECTS

PASSIVE HOUSE PRINCIPLES

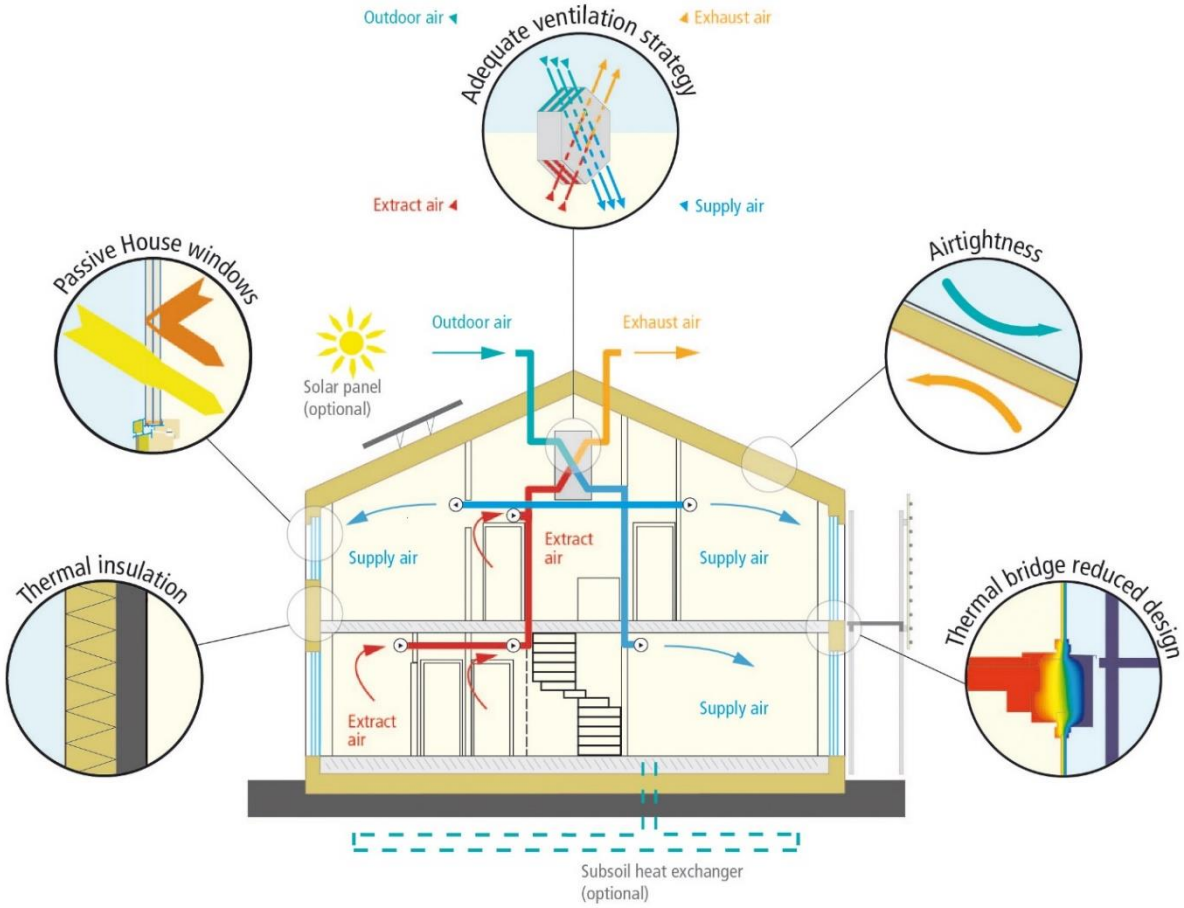
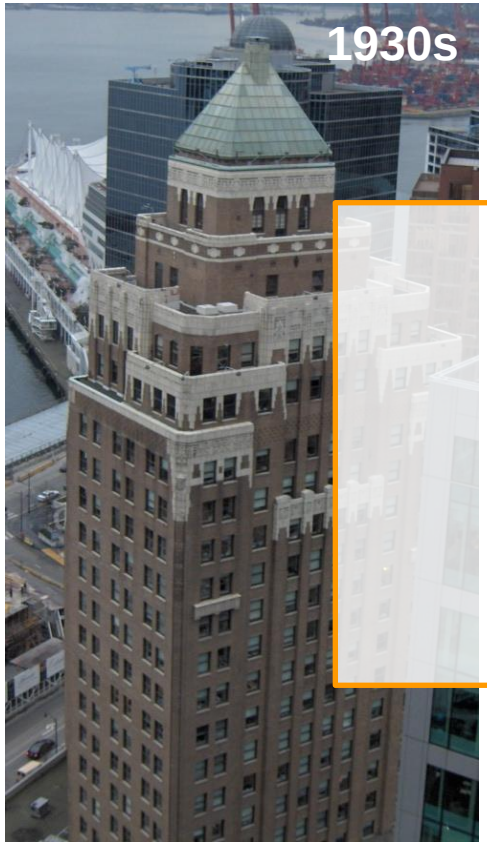
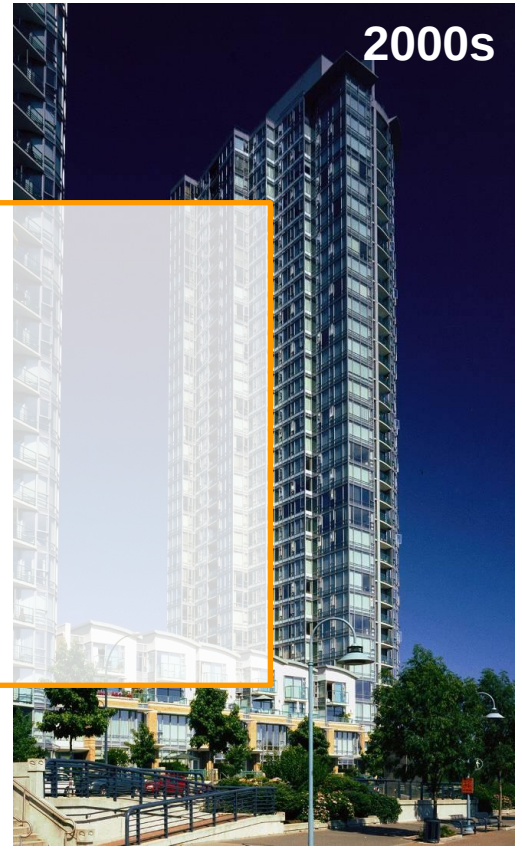


Image courtesy of
Passive House Institute

POLL - WHAT ‘R’ THE VALUES?



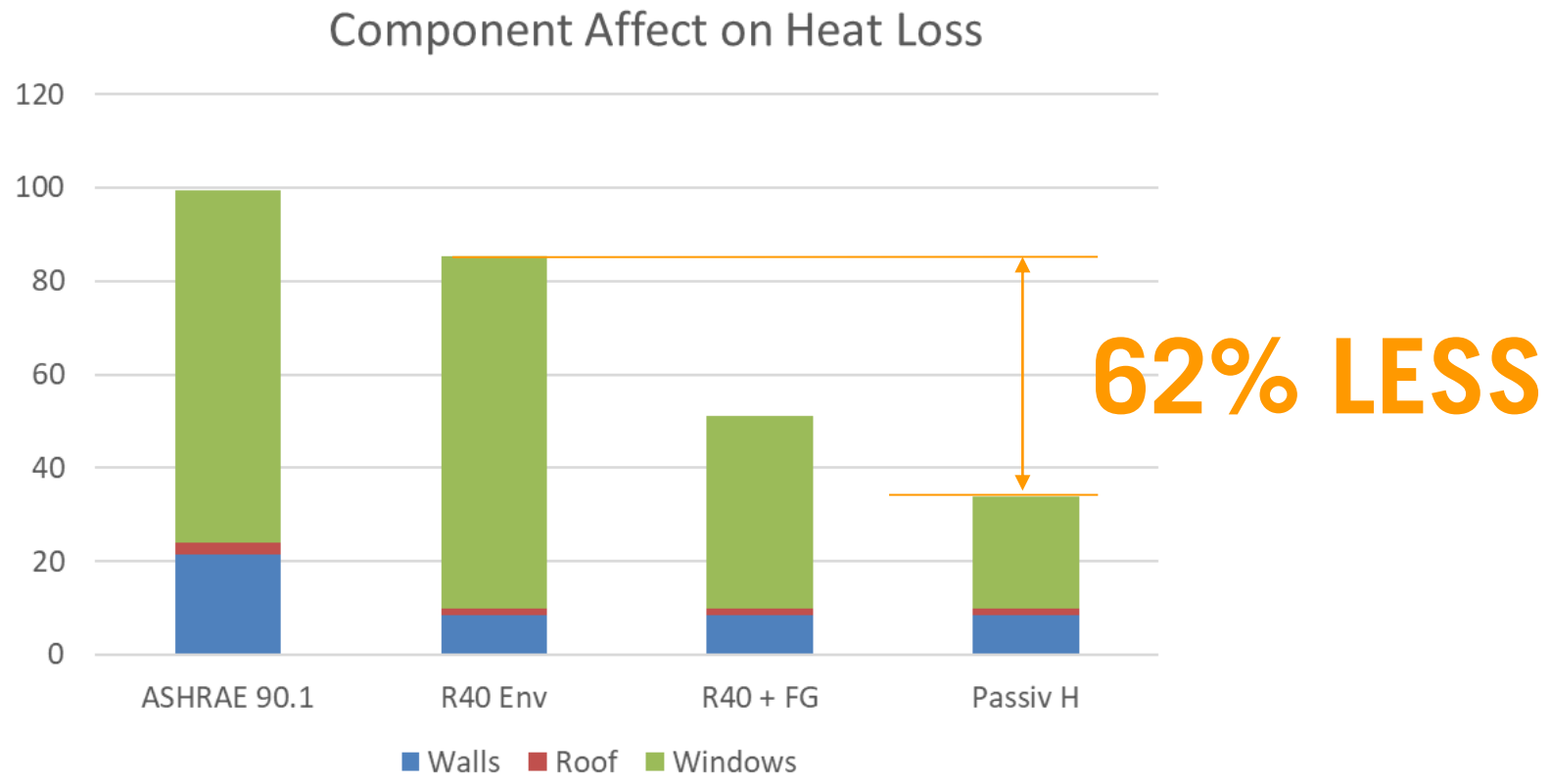


ALL THREE BUILDINGS ARE SOMEWHERE BETWEEN R-2 & R-3.5

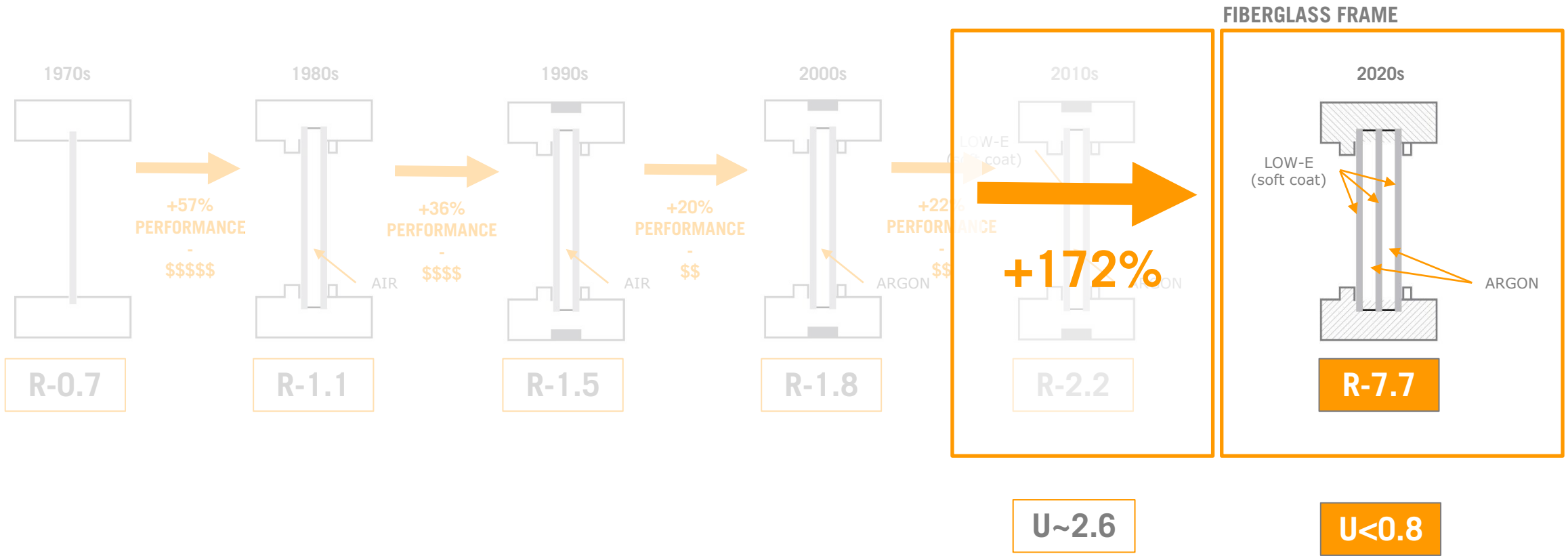
THE IMPACT OF HIGH-PERFORMANCE

Jervis Street
Vancouver, BC

THE IMPACT OF HIGH-PERFORMANCE



A HISTORY OF WINDOW PERFORMANCE



THERMAL PERFORMANCE

30-50%

of a building's heating & cooling energy is lost through windows

20-30%

of a typical window areas is represented by the window frame

BY IMPROVING THE FRAME, YOU IMPROVE THE OVERALL PERFORMANCE OF THE ENTIRE WINDOW

Broeckx-Smith, S., Suh, S., 2019

DICTATING BETTER PERFORMANCE

CA.GOV

CITY of BOSTON

CITY OF VANCOUVER

Minneapolis
City of Lakes

Connecticut

NYC Buildings

Delaware

NEW YORK STATE

ILLINOIS.GOV

IDAHO

ADOPTION OF PASSIVE HOUSE (THANKS TO INNOVATION)

CONSERVATION HOUSE

REGINA, SASKATCHEWAN

1977

Image courtesy of ecohome.net

ADOPTION OF PASSIVE HOUSE (THANKS TO INNOVATION)

CLARK ROAD

SQUAMISH, BC

2020

Image courtesy of
Blue Water Concepts

ADOPTION OF PASSIVE HOUSE (THANKS TO INNOVATION)

825 PACIFIC STREET

VANCOUVER, BC

2021

Image courtesy of
ACDF Architecture /
IBI Group / Grosvenor Americas

ADOPTION OF PASSIVE HOUSE (THANKS TO INNOVATION)

NELSON AVENUE

VANCOUVER, BC

EST. 2023

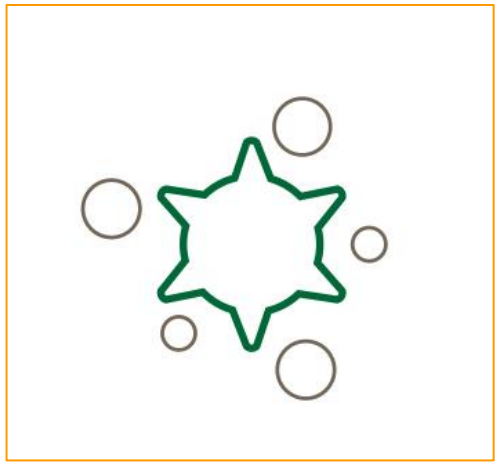
Image courtesy of
WKK Architects /
IBI Group /
Henson Developments

POLL – PASSIVE HOUSE PROJECTS

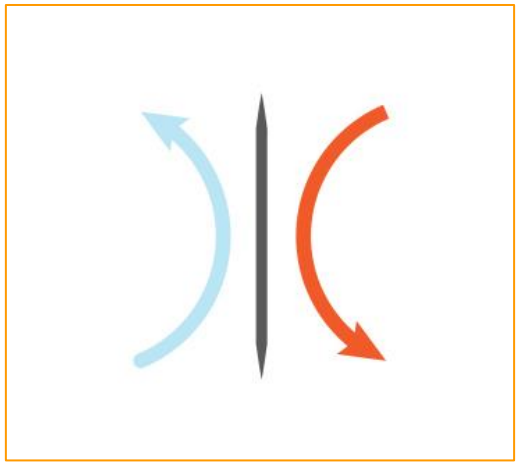
HOW MANY PASSIVE HOUSE PROJECTS HAVE YOU BEEN A PART OF?

PASSIVE HOUSE WINDOW STRATEGY

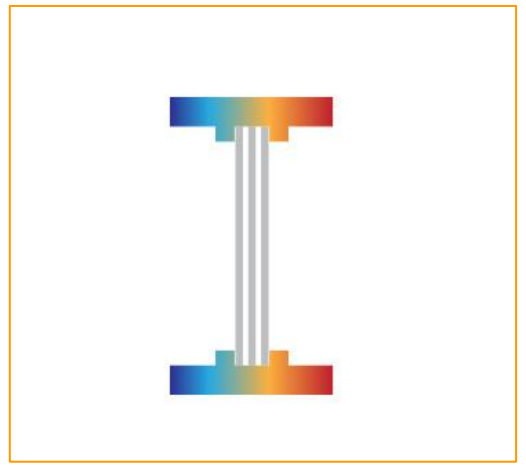
THERMAL COMFORT & DRAUGHT PREVENTION



HYGIENE



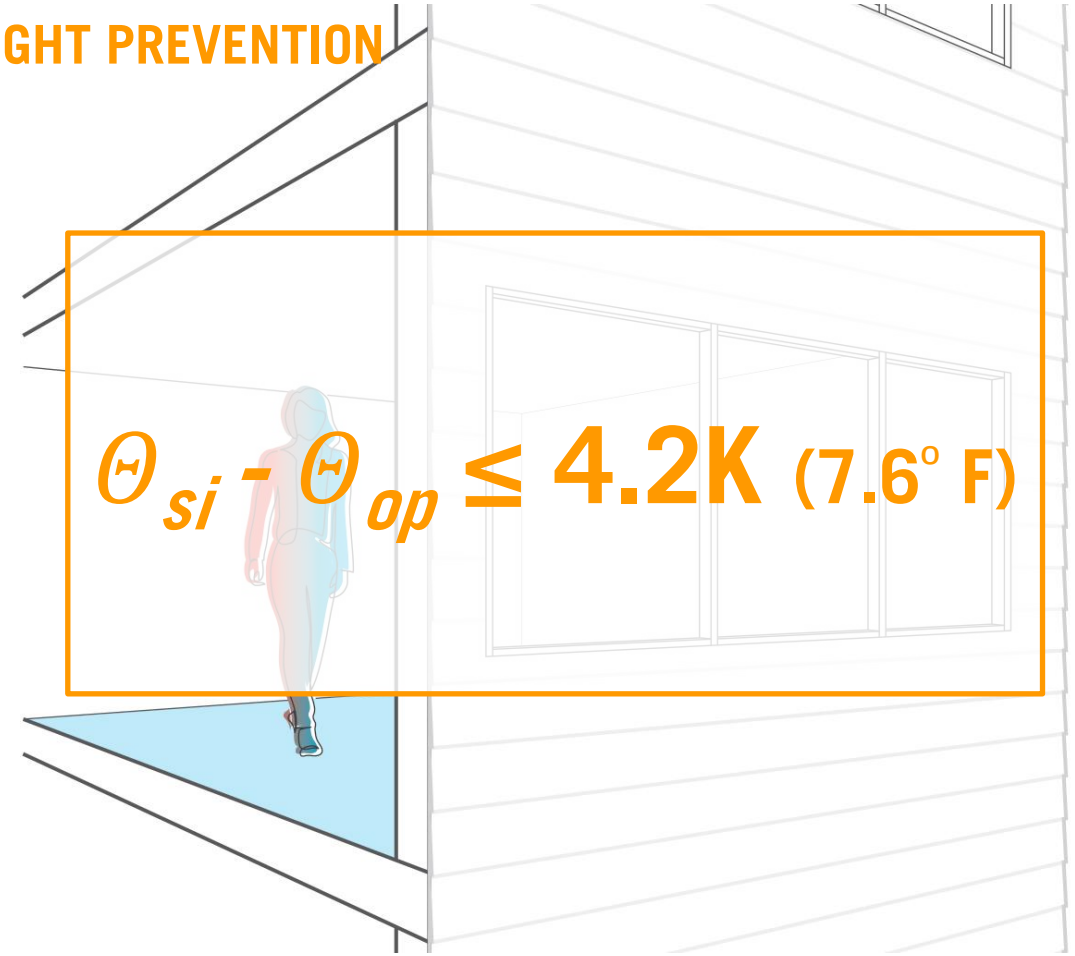
AIR TIGHTNESS



THERMAL PERFORMANCE

PASSIVE HOUSE WINDOW STRATEGY

THERMAL COMFORT & DRAUGHT PREVENTION



PASSIVE HOUSE WINDOW STRATEGY

THERMAL COMFORT & DRAUGHT PREVENTION

$\Theta_{si} - \Theta_{op} \leq 4.2K$

PASSIVE HOUSE WINDOW STRATEGY

THERMAL COMFORT & DRAUGHT PREVENTION

$\Theta_{si} - \Theta_{op} \leq 4.2K$

PASSIVE HOUSE WINDOW STRATEGY

HYGIENE

Image courtesy of
Saga Magazine

PASSIVE HOUSE WINDOW STRATEGY

HYGIENE

AW ≤ 0.80

RELATIVE HUMIDITY AT SURFACE

PASSIVE HOUSE WINDOW STRATEGY

HYGIENE

AW ≤ 0.80

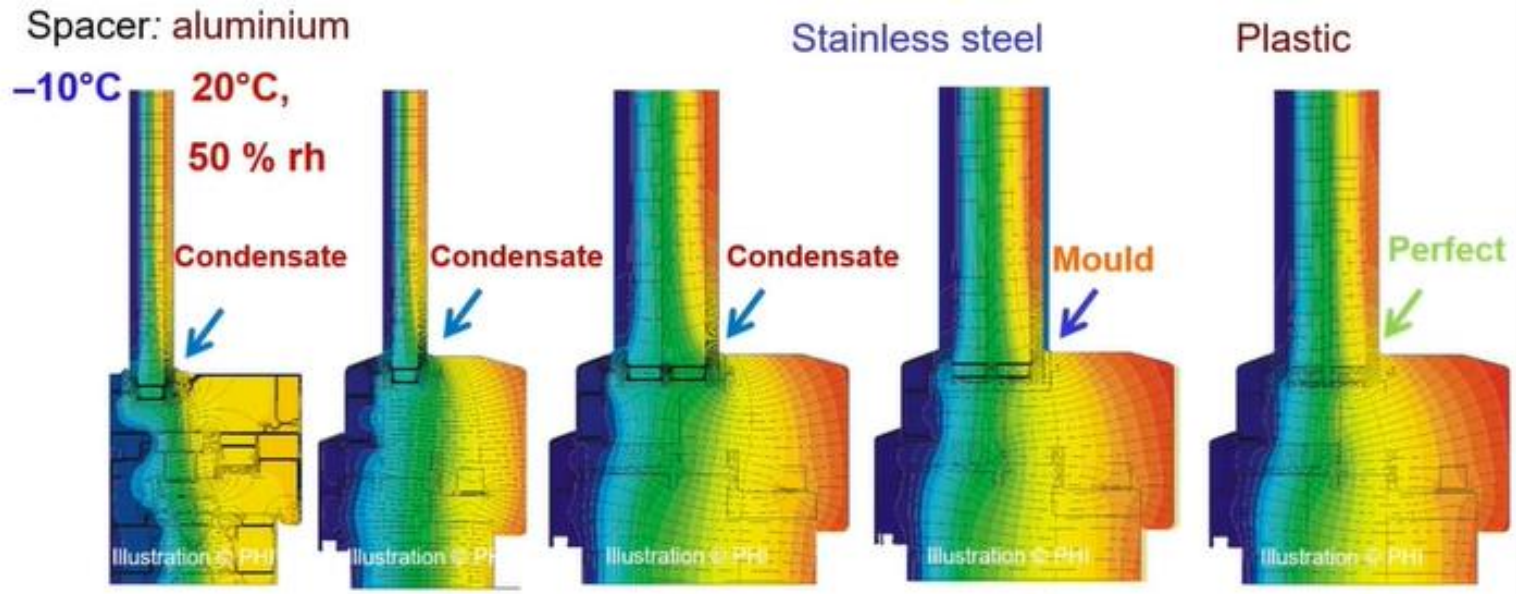
RELATIVE HUMIDITY AT SURFACE

$$f_{Rsi} = \frac{\Theta_{si} - \Theta_e}{\Theta_i - \Theta_e}$$

PASSIVE HOUSE WINDOW STRATEGY

HYGIENE

*COLD CLIMATE



A_W [-]	1	1	1	0.83	0.74
$f_{Rsi=0.25}$ [-]	0.51	0.43	0.54	0.68	0.75
$\theta_{si,min}$ [°C]	7.73	5.84	8.53	12.00	13.61
Ψ_g [W/(mK)]	0.093	0.078	0.103	0.071	0.028

Image courtesy of Peel Passive House

PASSIVE HOUSE WINDOW STRATEGY

THERMAL COMFORT & HYGIENE GO HAND-IN-HAND

Climate zone	Hygiene criterion $f_{Rsi=0.25\ m^2K/W} \geq$	Component U-value[1] [W/(m²K)]	U-value installed [W/(m²K)]	Reference glazing [W/(m²K)]
1 Arctic	0.80	0.40	0.45	0.35
2 Cold	0.75	0.60	0.65	0.52
3 Cool-temperate	0.70	0.80	0.85	0.70
4 Warm-temperate	0.65	1.00	1.05	0.90
5 Warm	0.55	1.20	1.25	1.10
6 Hot	None	1.20	1.25	1.10
7 Very hot	None	1.00	1.05	0.90

PASSIVE HOUSE WINDOW STRATEGY

AIR TIGHTNESS

0.6 ACH

MEASURED AT 50 PA

PASSIVE HOUSE WINDOW STRATEGY

AIR TIGHTNESS

0.6 ACH

MEASURED AT 50 PA

AIR LEAKAGE RESISTANCE

Air test data is indicated in the following table:

Property	Area m^2 (ft^2)	Infiltration Rate $L/s*m^2$ (cfm/ft^2)	Exfiltration Rate $L/s*m^2$ (cfm/ft^2)	Compliance US (CAN)
Overall Assembly @ 75 Pa	3.84 (41.28)	0.00 (0.00)	0.00 (0.00)	Pass (A3)
Overall Assembly @ 300 Pa	3.84 (41.28)	0.00 (0.00)	0.00 (0.00)	Pass (A3)
Allowable Leakage Rates				
Maximum allowable air leakage rate (US):		1.5 $L/s*m^2$, 0.3 cfm/ft^2		
Maximum allowable air leakage rate (CAN – A3):		0.5 $L/s*m^2$, 0.1 cfm/ft^2		

The overall system **met** the US and Canadian performance requirements as reported above when evaluated under NAFS-08, NAFS-11, A440S1-09 and A440S1-17.

Image courtesy of
Cascadia Windows & Doors

PASSIVE HOUSE WINDOW STRATEGY

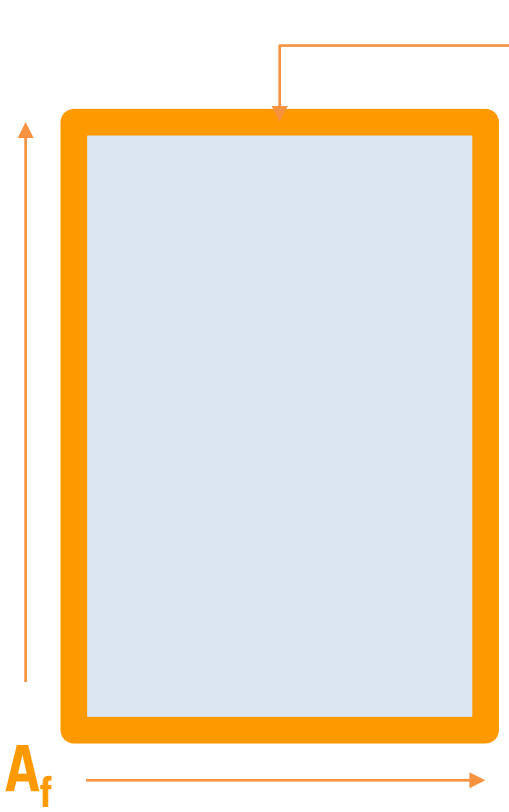
THERMAL PERFORMANCE

U_g = U-value of the glass
A_g = Glazing surface area

$U_g \times A_g$

PASSIVE HOUSE WINDOW STRATEGY

THERMAL PERFORMANCE



U_g = U-value of the glass
A_g = Glazing surface area

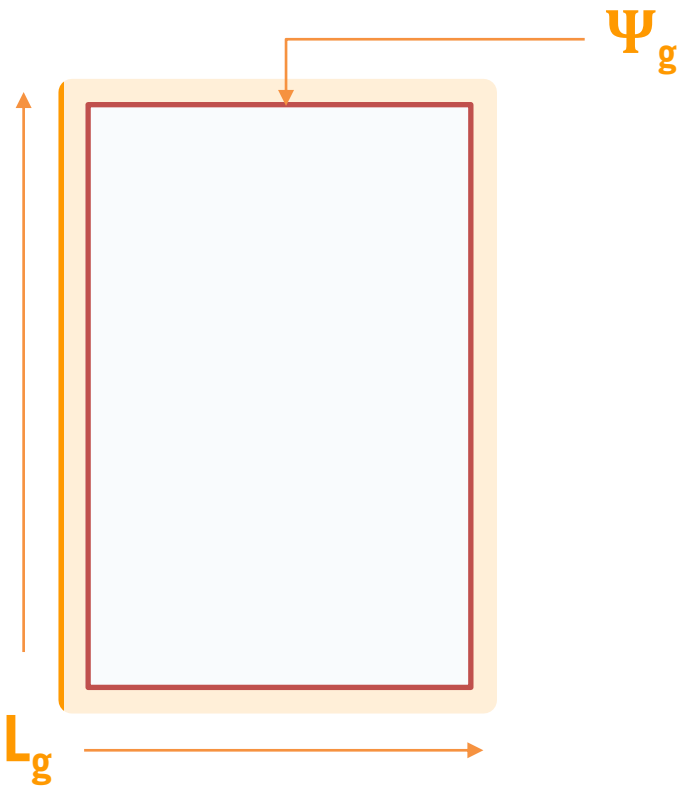
$U_g \times A_g$

U_f = U-value of the frame
A_f = Window frame surface area

$U_f \times A_f$

PASSIVE HOUSE WINDOW STRATEGY

THERMAL PERFORMANCE



U_g = U-value of the glass
A_g = Glazing surface area

$U_g \times A_g$

U_f = U-value of the frame
A_f = Window frame surface area

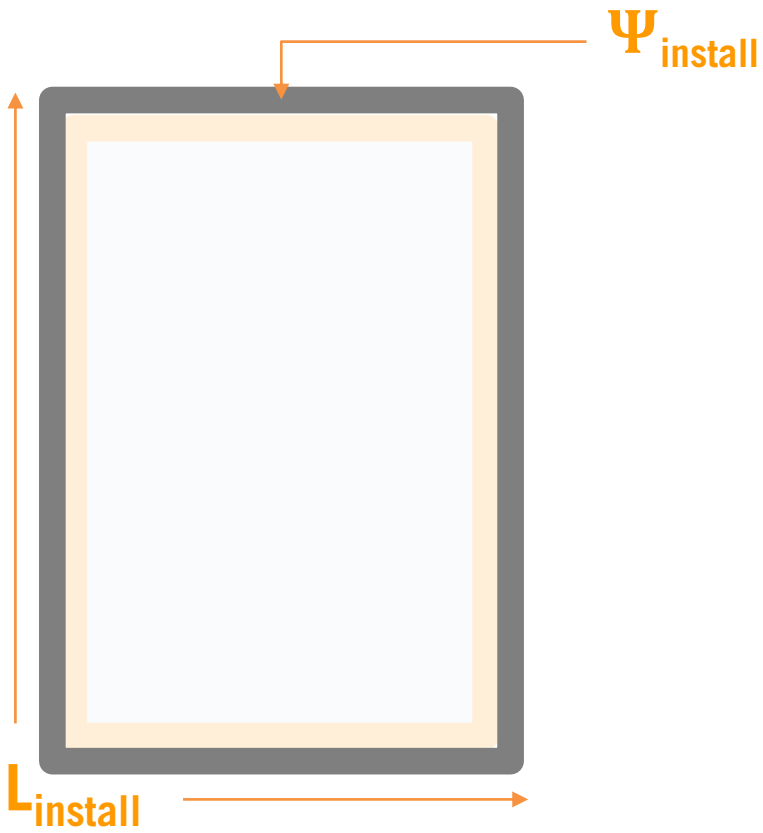
$U_f \times A_f$

Ψ_g = Glass edge coefficient
L_g = Glass edge length

$\Psi_g \times L_g$

PASSIVE HOUSE WINDOW STRATEGY

THERMAL PERFORMANCE



U_g = U-value of the glass
A_g = Glazing surface area

$U_g \times A_g$

U_f = U-value of the frame
A_f = Window frame surface area

$U_f \times A_f$

Ψ_g = Glass edge coefficient
L_g = Glass edge length

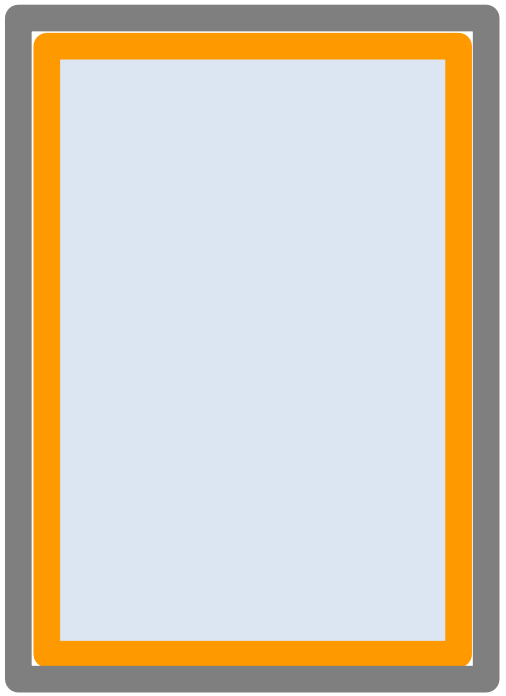
$\Psi_g \times L_g$

$\Psi_{install}$ = Installed edge coefficient
$L_{install}$ = Installed edge length

$\Psi_{install} \times L_{install}$

PASSIVE HOUSE WINDOW STRATEGY

THERMAL PERFORMANCE



$$\frac{U_g \times A_g + U_f \times A_f + \Psi_g \times L_g + \Psi_{install} \times L_{install}}{A_g + A_f} = U_{w\text{-}install}$$

$U_{w\text{-}install}$ (W / m²K)

PASSIVE HOUSE WINDOW STRATEGY

THERMAL PERFORMANCE

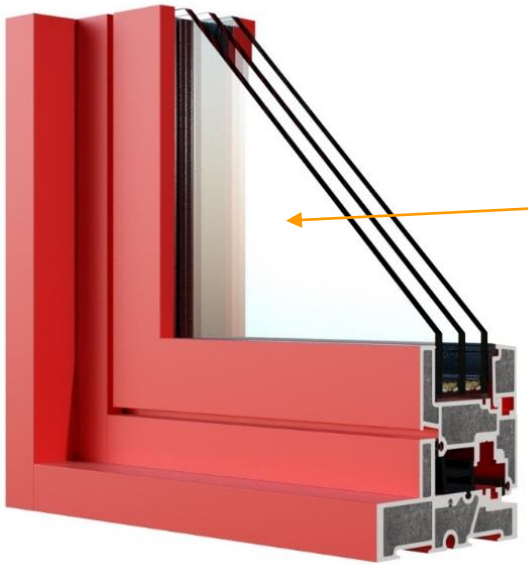
$$U_{w\text{-}install} = \frac{U_g \times A_g + U_f \times A_f + \Psi_g \times K_g + \Psi_{install} \times L_{install}}{A_g + A_f}$$

0.85 W/m²K

$U_{w\text{-}install}$ (W / m²K)

PASSIVE HOUSE WINDOW STRATEGY

SUMMARY OF GOOD WINDOW DESIGN



TRIPLE PANE
(GAS-FILLED
& LOW E-COATINGS)

PASSIVE HOUSE WINDOW STRATEGY

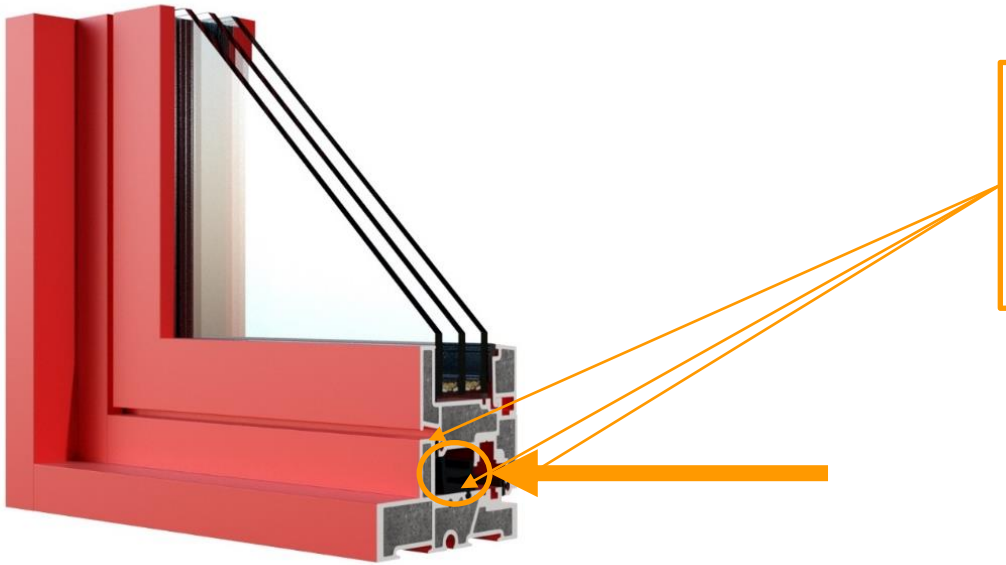
SUMMARY OF GOOD WINDOW DESIGN

WARM
EDGE SPACERS

TRIPLE PANE
(GAS-FILLED
& LOW E-COATINGS)

PASSIVE HOUSE WINDOW STRATEGY

SUMMARY OF GOOD WINDOW DESIGN



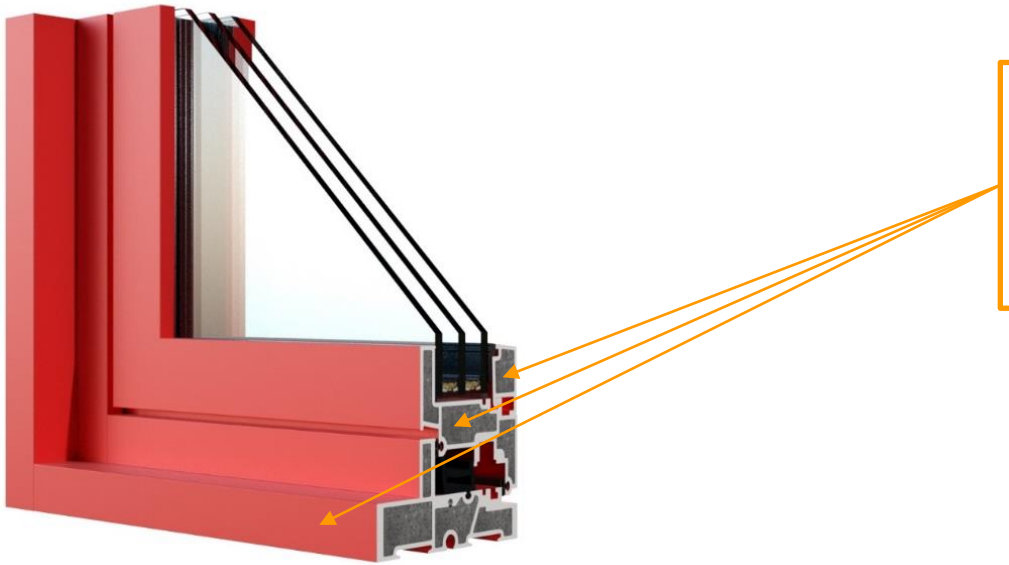
MULTIPLE GASKETS

TRIPLE PANE
(GAS-FILLED & LOW E-COATINGS)

WARM EDGE SPACERS

PASSIVE HOUSE WINDOW STRATEGY

SUMMARY OF GOOD WINDOW DESIGN



INSULATED FRAME
(LOW CONDUCTIVITY
&/OR THERMAL BREAKS)

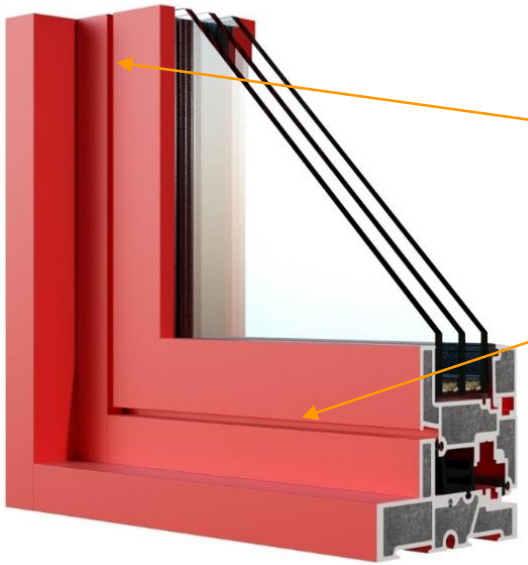
TRIPLE PANE
(GAS-FILLED
& LOW E-COATINGS)

WARM EDGE SPACERS

MULTIPLE GASKETS

PASSIVE HOUSE WINDOW STRATEGY

SUMMARY OF GOOD WINDOW DESIGN



MULTI-POINT LOCKING

TRIPLE PANE
(GAS-FILLED & LOW E-COATINGS)

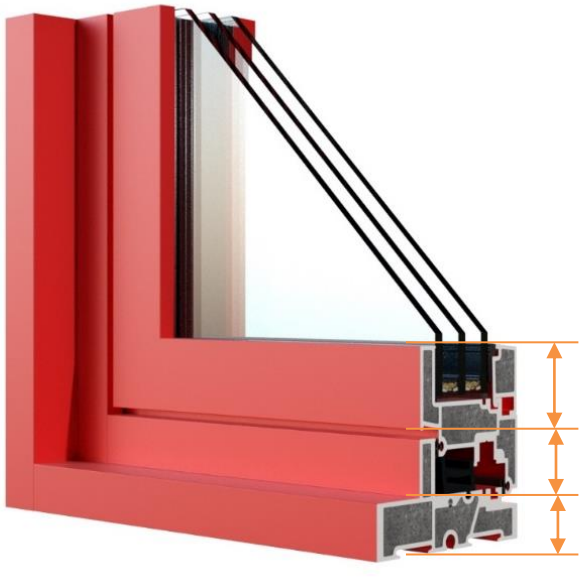
WARM EDGE SPACERS

MULTIPLE GASKETS

INSULATED FRAME
(LOW CONDUCTIVITY &/OR THERMAL BREAKS)

PASSIVE HOUSE WINDOW STRATEGY

SUMMARY OF GOOD WINDOW DESIGN



MINIMIZED FRAME AREA

TRIPLE PANE
(GAS-FILLED & LOW E-COATINGS)

WARM EDGE SPACERS

MULTIPLE GASKETS

INSULATED FRAME
(LOW CONDUCTIVITY &/OR THERMAL BREAKS)

MULTI-POINT LOCKING

MINIMIZED FRAME AREA

MEETING THE PASSIVE HOUSE STANDARD

Understanding ways to meet performance criteria in real projects

UNDERSTANDING ‘CERTIFIED’ PRODUCTS

WINDOWS & DOORS - DOUBLE GLAZED										
LOW-E OPTIONS	CENTER-OF-GLASS DATA			U_w (U-VALUE OF WINDOW) PER NFRC METHOD [W / M²-K]						
CARDINAL (90% ARGON FILL, UNO)	U_g	SHGC	VT	FIXED	CASEMENT	AWNING	TILT & TURN	HOPPER	SWING DOOR	SLIDING DOOR
STANDARD DOUBLE GLAZED (ONE LOW-E ON SURFACE #2 OR #3 / STAINLESS STEEL SPACER)										
180 (#3)	1.48	0.68	0.79	1.48	1.42	1.42	1.40	1.37	1.33	1.39
272 (#2)	1.42	0.41	0.72	1.42	1.36	1.39	1.36	1.34	1.29	1.35
270 (#2)	1.42	0.37	0.70	1.42	1.36	1.38	1.35	1.34	1.28	1.35
366 (#2)	1.36	0.27	0.65	1.36	1.36	1.36	1.33	1.32	1.26	1.32
452 (#2)	1.36	0.22	0.51	1.36	1.36	-	-	-	1.28	1.32
340 (#2)	1.36	0.18	0.39	1.42	1.36	1.37	1.34	1.33	1.27	1.33

UNDERSTANDING ‘CERTIFIED’ PRODUCTS

LOW-E 366 (#2)

U_W-1.36

STANDARD DOUBLE-GLAZED IGU /
STAINLESS STEEL SPACER

FIXED WINDOW

LOW-E 366 / 180

U_W-0.79

STANDARD TRIPLE-GLAZED IGU /
TRISEAL SUPER SPACER

FIXED WINDOW

UNDERSTANDING ‘CERTIFIED’ PRODUCTS

STANDARD DOUBLE → **STANDARD TRIPLE**

≈ 40%

IMPROVEMENT

U-1.36 → **U-0.79**

UNDERSTANDING ‘CERTIFIED’ PRODUCTS

LOW-E 366 (#2)

U_W-1.36

STANDARD DOUBLE-GLAZED IGU /
STAINLESS STEEL SPACER

FIXED WINDOW

LOW-E 366 / 180

U_W-0.79

STANDARD TRIPLE-GLAZED IGU /
TRISEAL SUPER SPACER

FIXED WINDOW

LOW-E 366 / 180 / i89

U_W-0.74

PREMIUM TRIPLE-GLAZED IGU /
TRISEAL SUPER SPACER

FIXED WINDOW

UNDERSTANDING ‘CERTIFIED’ PRODUCTS

LOW-E 366 (#2)

U_W-1.36

STANDARD DOUBLE-GLAZED IGU / STAINLESS STEEL SPACER

FIXED WINDOW

STANDARD TRIPLE → **PREMIUM TRIPLE**

LOW-E 366 / 180

U_W-0.79

STANDARD TRIPLE-GLAZED IGU / TRISEAL SUPER SPACER

FIXED WINDOW

≈ **7%**

IMPROVEMENT

LOW-E 366 / 180 / i89

U_W-0.74

PREMIUM TRIPLE-GLAZED IGU / TRISEAL SUPER SPACER

FIXED WINDOW

U-0.79 → **U-0.74**

AVAILABLE IN NON-CERTIFIED & PASSIVE HOUSE CERTIFIED

UNDERSTANDING ‘CERTIFIED’ PRODUCTS

LOW-E 366 (#2)

U_W-1.36

STANDARD DOUBLE-GLAZED IGU /
STAINLESS STEEL SPACER

FIXED WINDOW

LOW-E 366 / 180

U_W-0.79

STANDARD TRIPLE-GLAZED IGU /
TRISEAL SUPER SPACER

FIXED WINDOW

LOW-E 366 / 180 / i89

U_W-0.74

PREMIUM TRIPLE-GLAZED IGU /
TRISEAL SUPER SPACER

FIXED WINDOW

AVAILABLE IN NON-CERTIFIED
& PASSIVE HOUSE CERTIFIED

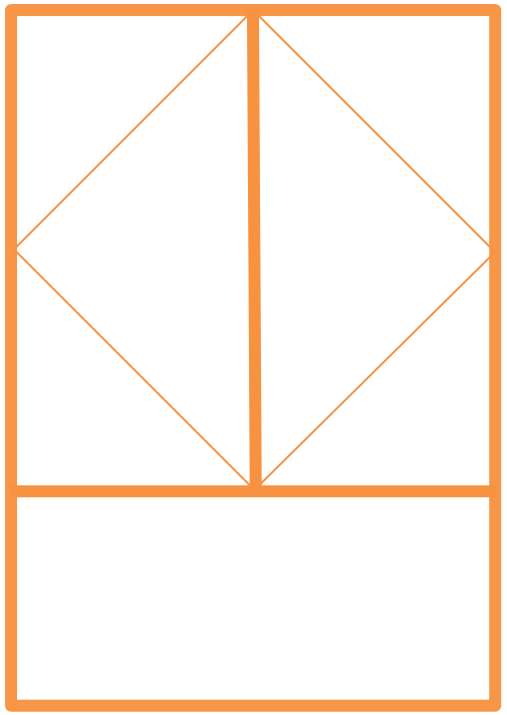
PASSIVE HOUSE MODELLING

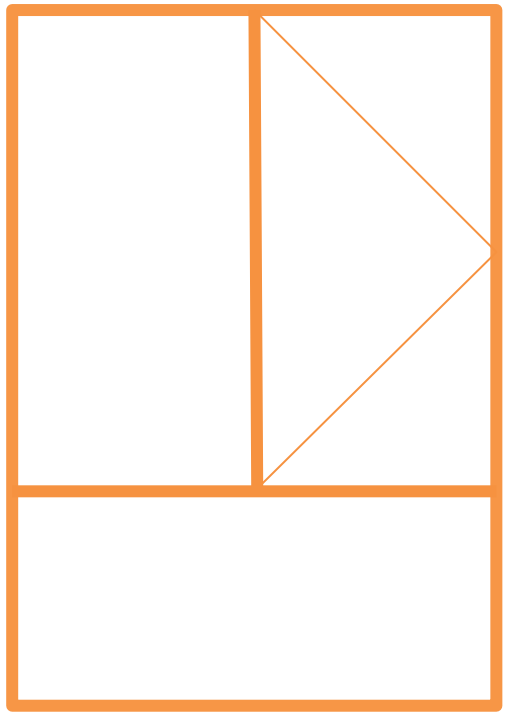
HOW DOES PHPP MODEL A WINDOW?

1. Area for heat loss – A_w, m^2
2. Area performance – U_w, $W/(m^2K)$
   - Glass (U_g and Ψ_g included)
   - Frame
   - Installation

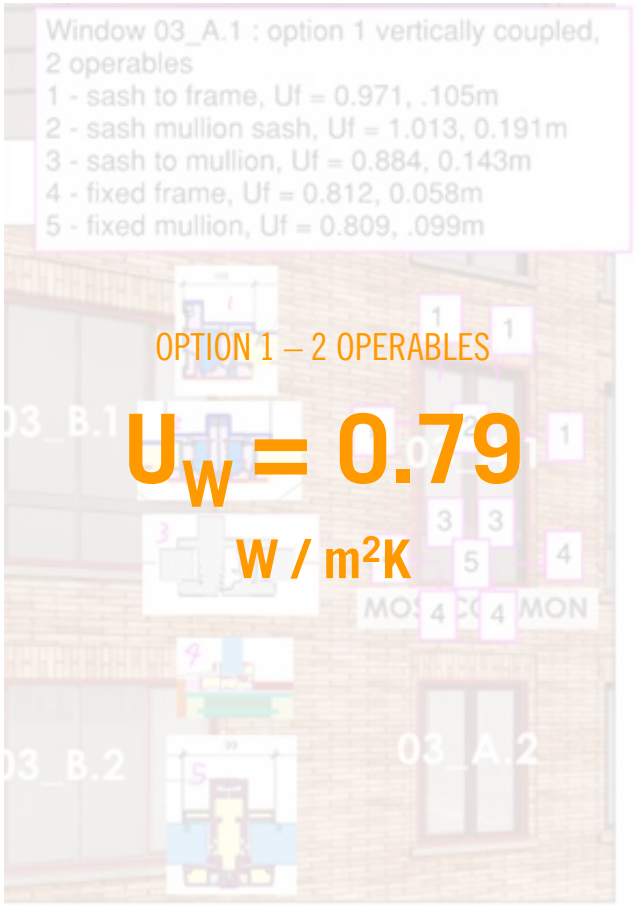
WHAT ABOUT COMPLEX WINDOW CONFIGURATIONS?

MODELLING COMPLEX WINDOWS





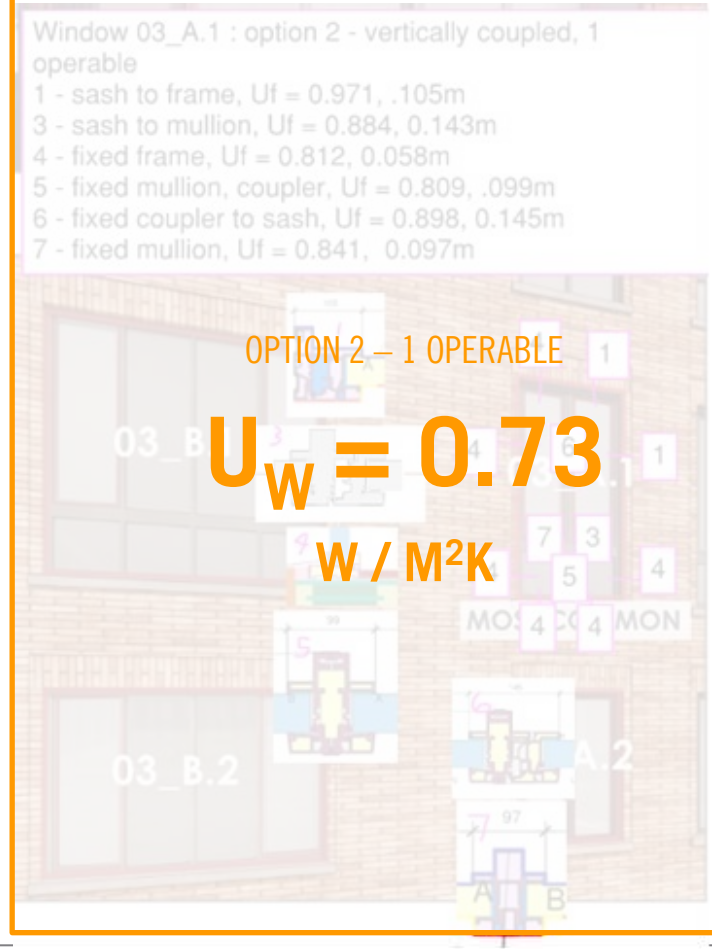
MODELLING COMPLEX WINDOWS



OPTION 1 – 2 OPERABLES

$U_W = 0.79$

W / m²K

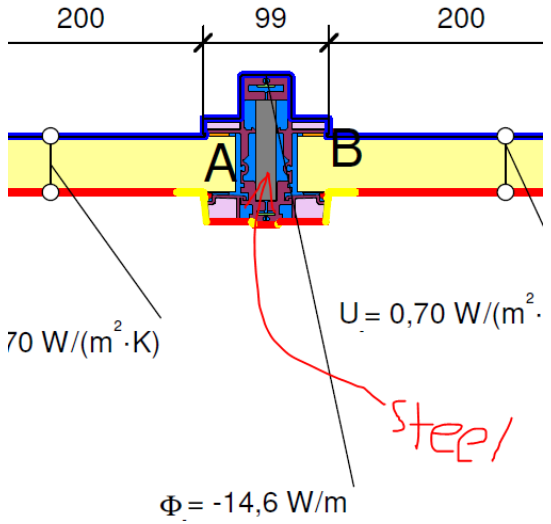


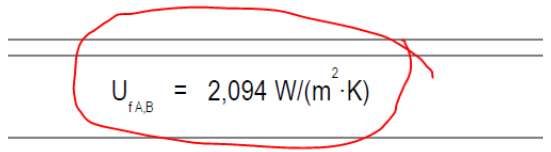
OPTION 2 – 1 OPERABLE

$U_W = 0.73$

W / M²K

MODELLING COMPLEX WINDOWS





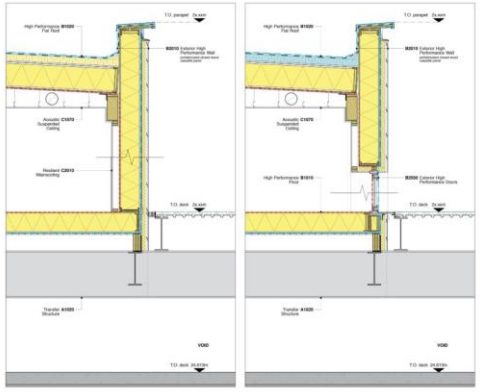
ADDITIONAL PRODUCT PHI INFORMATION

U-VALUES IN THE REAL WORLD

Passive House project examples & the variety of window configurations used to achieve certification

GASTOWN CHILD CARE CENTRE

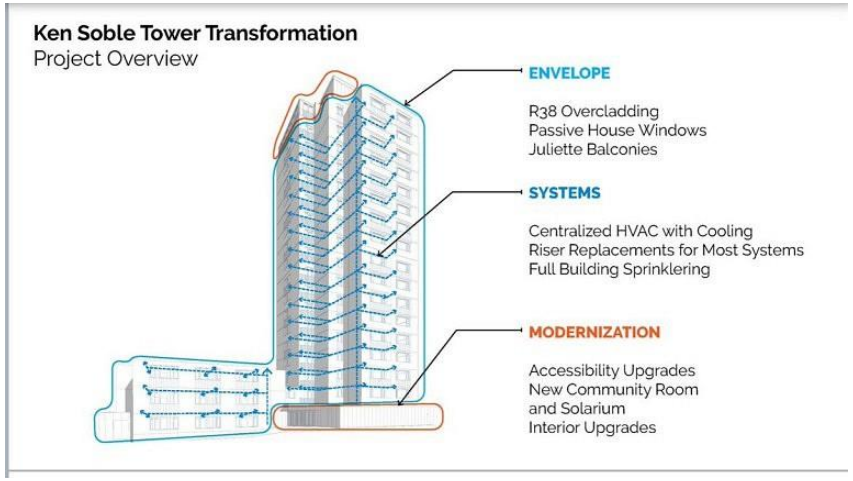
- Vancouver, BC (new construction)
- **PH outswing windows**
- PH certified commercial doors w/ ADA thresholds
- Triple glazed windows (Three Low-E 366 / 180 / **i89**)



Images courtesy of Acton Ostry Architects & Rikur Energy

KEN SOBLE TOWER

- Hamilton, ON (EnerPHit)
- Non-combustible construction
- **PH certified, inswing windows**
- Triple glazed windows (Three Low-E 270 / 180 / **i89**)
- ‘Juliet Balcony’ attached directly to the windows



Images courtesy of ERA Architects

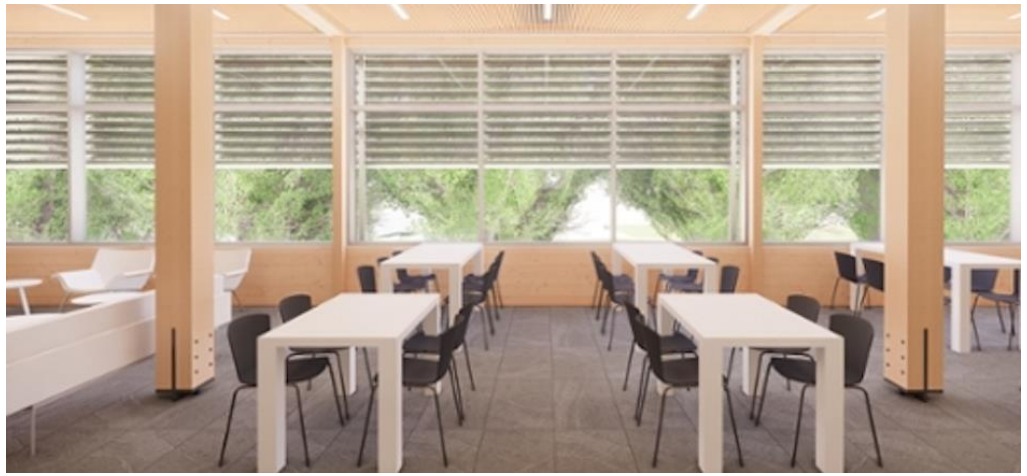
825 PACIFIC

- Vancouver, BC (new construction)
- **PH certified, inswing windows**
- **PH certified commercial doors** w/ ADA thresholds
- Triple glazed windows (Two Low-E 366 / 180)

Images courtesy of ACDF Architecture / IBI Group / Grosvenor Americas

UVIC STUDENT HOUSING

- Victoria, BC (new construction)
- Non-combustible construction
- **PH outswing windows**
- Triple glazed windows (Two Low-E 270 / 180)



Images courtesy of Province of BC

SELECTING A PASSIVE HOUSE WINDOW

Passive House project examples & the variety of window configurations used to achieve certification

POLL – WINDOW CHARACTERISTICS

TYPICALLY, WHAT ARE THE TOP 3 CHARACTERISTICS YOU LOOK FOR IN WINDOWS?

FRAME TYPES & APPLICATIONS

WOOD FRAME

PHOTO CREDIT: NEUFFER WINDOWS

VINYL / UPVC

PHOTO CREDIT: EUROLINE WINDOWS

FIBERGLASS

PHOTO CREDIT: CASCADIA WINDOWS & DOORS

ALUMINUM

PHOTO CREDIT: GLO EUROPEAN WINDOWS

FRAME TYPES & APPLICATIONS

WOOD FRAME

RESIDENTIAL

PHOTO CREDIT: NEUFFER WINDOWS

VINYL / UPVC

RESIDENTIAL
MULTI-FAMILY

PHOTO CREDIT: EUROLINE WINDOWS

FIBERGLASS

RESIDENTIAL
MULTI-FAMILY
COMMERCIAL
HIGH-RISE

PHOTO CREDIT: CASCADIA WINDOWS & DOORS

ALUMINUM

MULTI-FAMILY
COMMERCIAL
HIGH-RISE

PHOTO CREDIT: GLO EUROPEAN WINDOWS

CONSIDERATIONS WHEN SELECTING PH WINDOW TYPE?

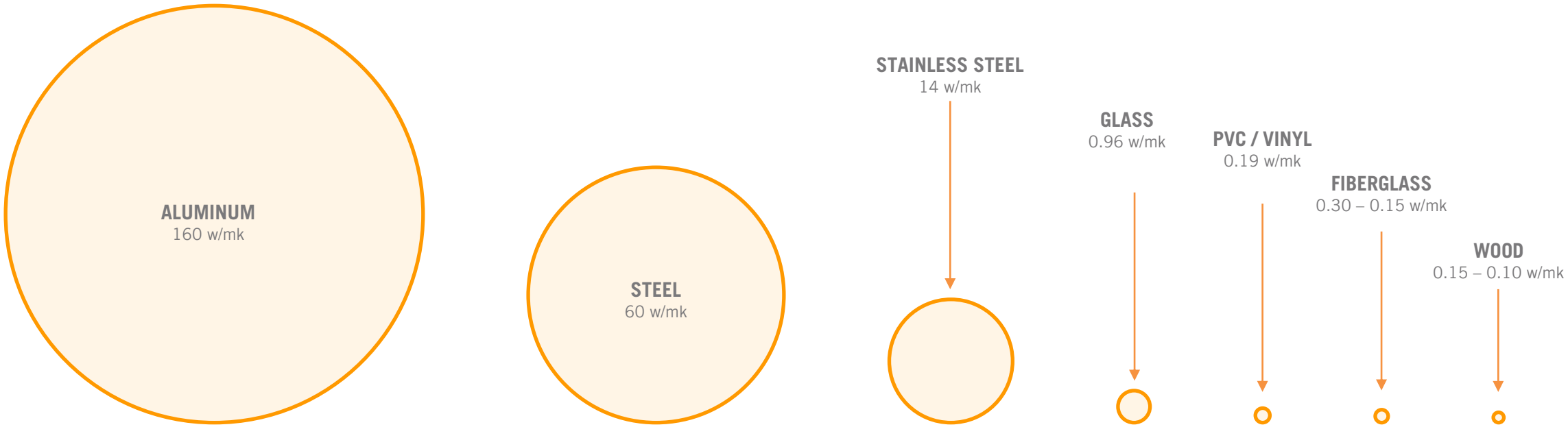
WHAT ARE YOUR DESIGN CRITERIA?

CONSIDERATIONS WHEN SELECTING PH WINDOW TYPE?

PHI/PHIUS CERTIFIED	●	●	●	●
THERMAL PERFORMANCE	●●	●●	●●●	●
LARGE WINDOW SIZE	●	●	●●	●●●
LIFETIME	●●	●	●●●	●●
STRUCTURAL STRENGTH	●	●	●●	●●●
FLEXIBILITY	●●	●●	●	●●●
CURTAIN/WINDOW WALL			●●	●●●
WEATHER RESISTANCE	●	●●	●●●	●●●
COMBUSTIBILITY			●	●
LIFECYCLE COST	$$$	$$$	$$	$$

HIGH-PERFORMANCE CHARACTERISTICS

THERMAL CONDUCTIVITY (W/MK)

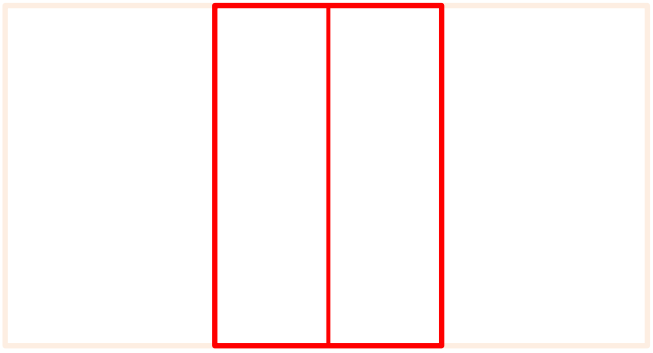


HIGH-PERFORMANCE CHARACTERISTICS

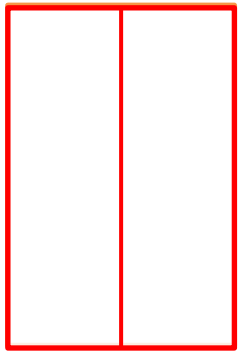
MATERIAL	MODULUS OF ELASTICITY (GPa)
Steel	**200**
Aluminum	69
Fiberglass (polyester resin)	24
Wood, various	7 - 14
PVC/Vinyl	2.4 – 4.1

MATERIAL STRENGTH: YOUNG'S MODULUS

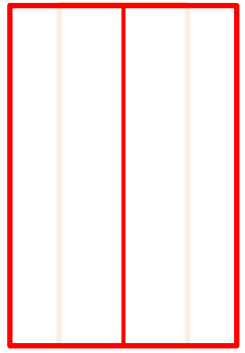
Imagine a theoretical extrusion…..



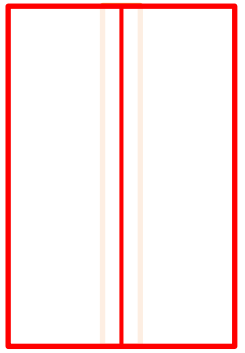
ALUMINUM



FIBERGLASS



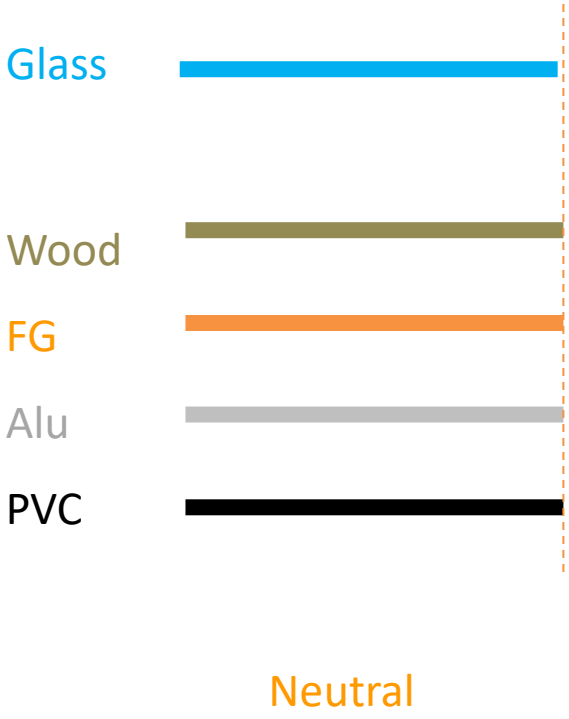
WOOD



VINYL/PVC

HIGH-PERFORMANCE CHARACTERISTICS

THERMAL EXPANSION COEFFICIENT - 10^{-6}M/(M°C)



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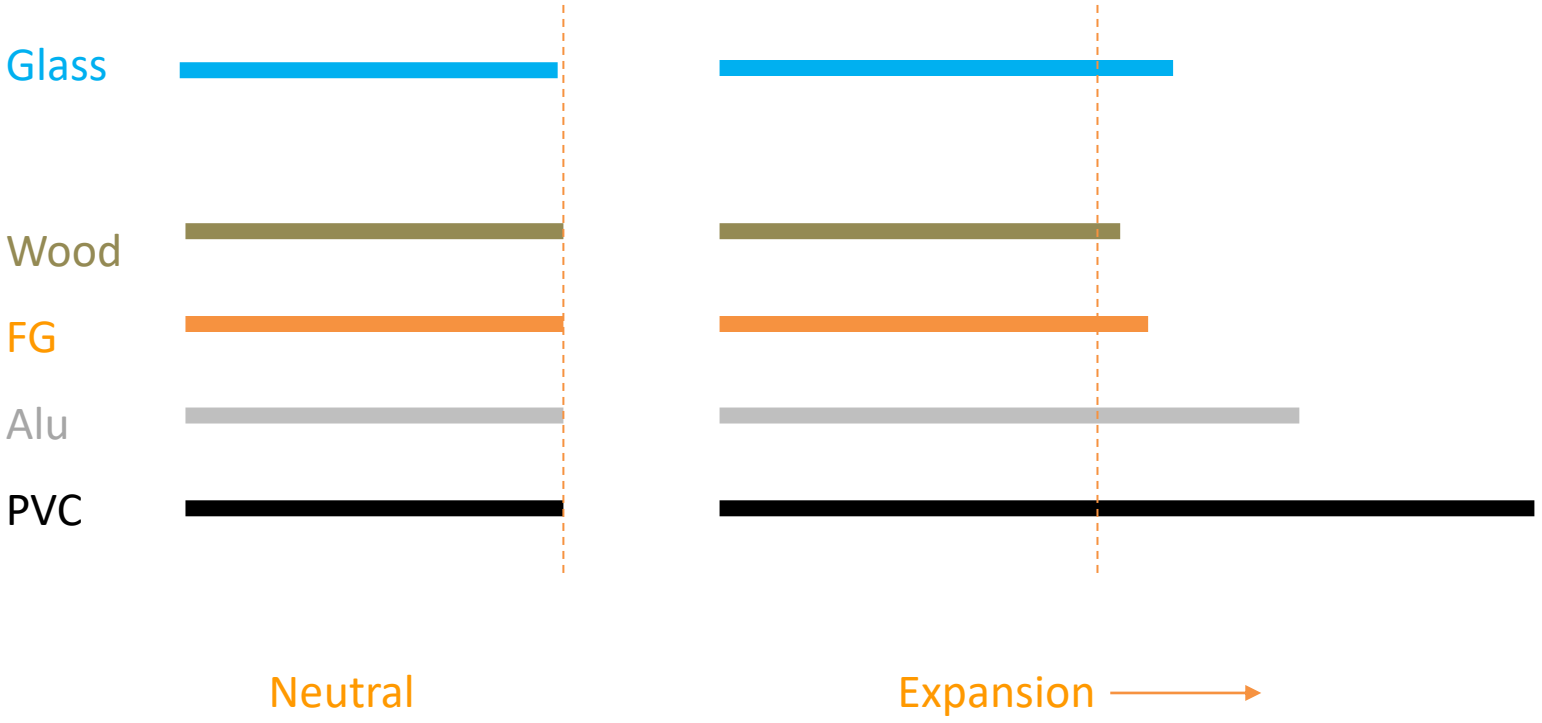

HIGH-PERFORMANCE CHARACTERISTICS

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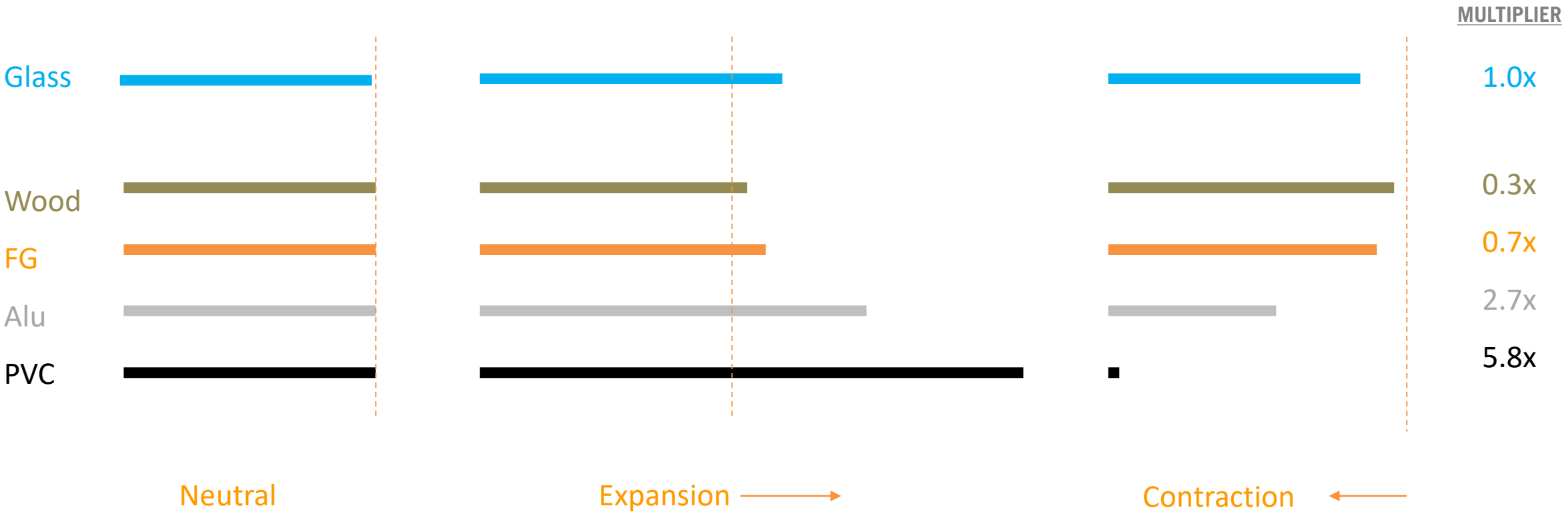


PRIMARY BENEFITS OF FIBERGLASS

THERMAL PERFORMANCE

STRENGTH & STIFFNESS

LOW THERMAL EXPANSION & CONTRACTION COEFFICIENT

DURABILITY

LOWER ENVIRONMENTAL IMPACT

SAVINGS

COMMERCIAL PASSIVE HOUSE PROJECTS

How commercial building requirements impact Passive House window selection.

WHY WAS WINDOW WALL INVENTED?

FIRST, THERE WAS CURTAIN WALL

PHOTO CREDIT: TORO ALUMINUM

PHOTO CREDIT: TORO ALUMINUM

PHOTO CREDIT: TORO ALUMINUM

WHY WAS WINDOW WALL INVENTED?

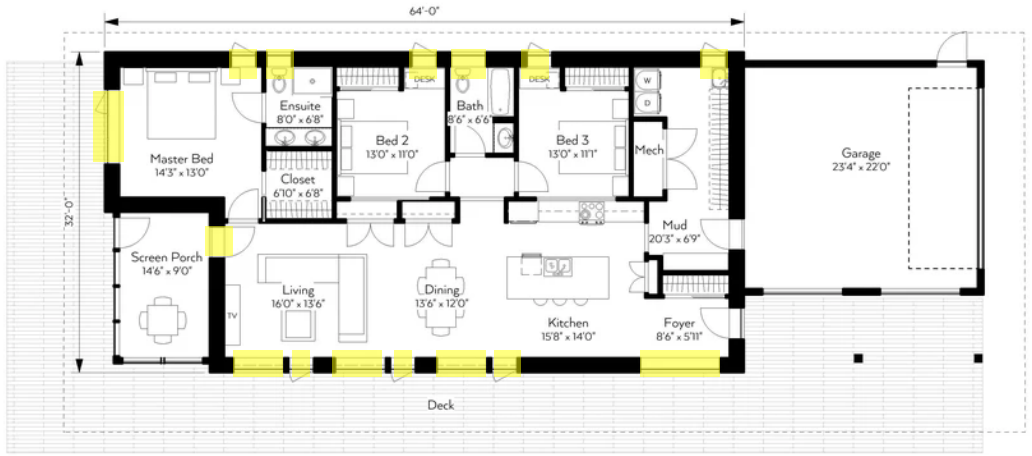


Image courtesy of Passive Design Solutions

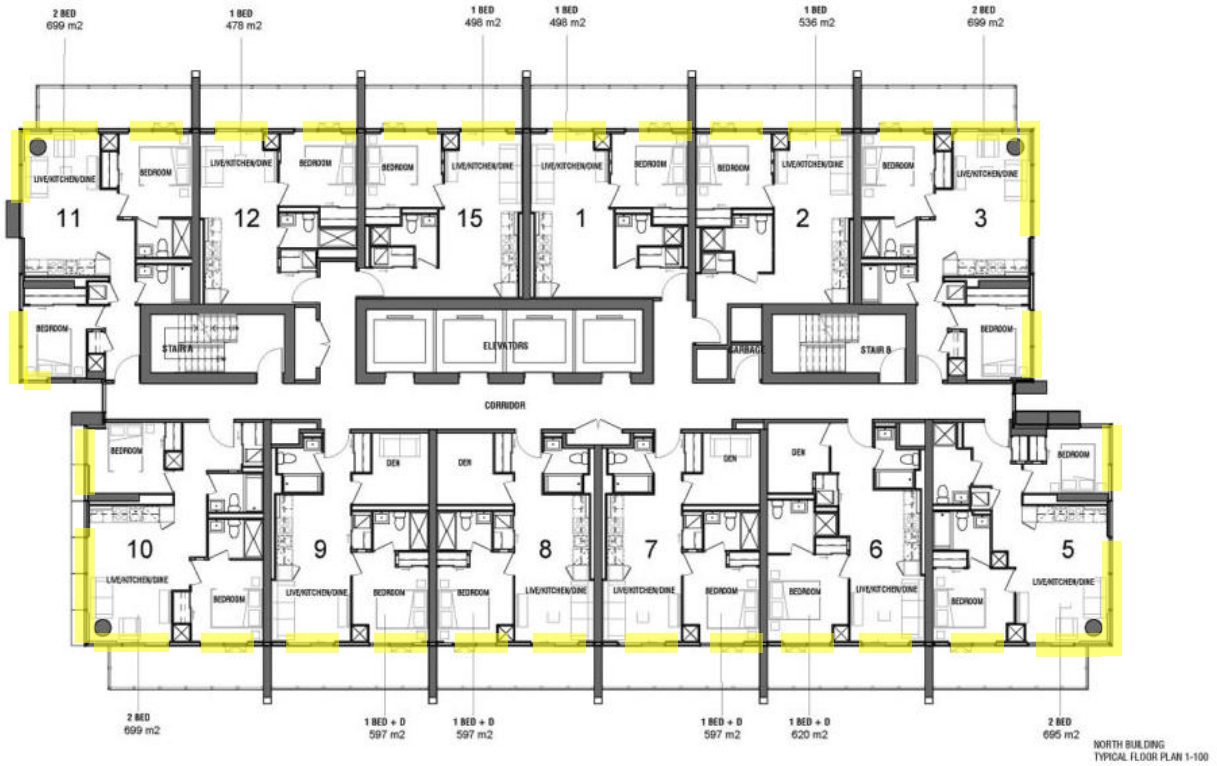


Image courtesy of Transit City Condos

N

WHY WAS WINDOW WALL INVENTED?

THEN CAME WINDOW WALL AS A CHEAPER ALTERNATIVE

PHOTO CREDIT: TORO ALUMINUM

PHOTO CREDIT: TORO ALUMINUM

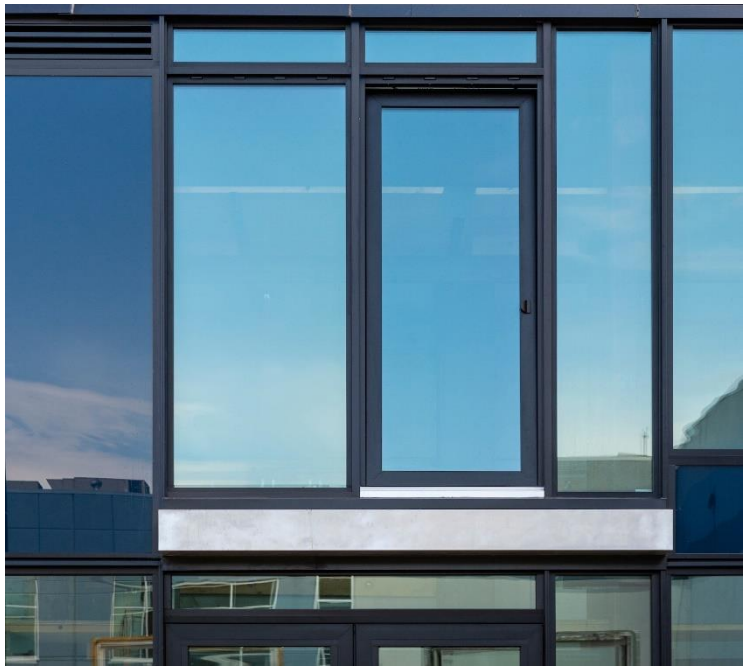
PHOTO CREDIT: TORO ALUMINUM

WHY WAS WINDOW WALL INVENTED?

THEN FIBERGLASS WINDOW WALL WAS INVENTED

MORE EFFICIENT & COMFORTABLE

ALLOW ANY BUILDING TO USE FIBERGLASS



WHY WAS WINDOW WALL INVENTED?

ACHIEVING “COMMERCIAL GRADE” AND PHI CERTIFIED PERFORMANCE

WHAT HAPPENS IN A PMU?

- Large format (full height)
- Withstand high +/- pressure loads with low air leakage
- Withstand wind driven rain with no water leaks
- Withstand extreme temperature ranges, resist condensation
- Withstand building movement, large deflections during service life as well as seismic event
- Extreme hardware durability
- Combustibility
- **All of this and maintain air and water tightness, operability and thermal performance!**

KEY TAKE AWAYS

WINDOWS HAVE HUGE IMPACT

Type I Location I Installation

Often the weakest link in a building's envelope, a little extra attention on windows can have large overall impact

PAY ATTENTION TO PRODUCT DETAILS

Material I Modeled vs Real-World

Ensure you're verifying general product details and performance within the context of your project

PASSIVE HOUSE FOR ALL BUILDINGS

Residential I Multi-Family I High-Rise

Building to Passive House standards offers significant environmental and financial incentives for nearly all stakeholders


CASCADIA
WINDOWS & DOORS
BUILDER: Blue Water Concepts
PHOTO: Kristen McGaughey
CASCADIAWINDOWS.COM