

Window Wellness: Energy, Earth, and Human Factors

Course Number: EX 401

Thursday, June 21, 2018; 10:30 AM – 11:30 AM

Learning Units: 1 LU HSW | 1 GBCI CE HOUR

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A'18 AIA Conference on Architecture 2018
June 21-23, New York City



Learning Objectives

Explore history of US building efficiency and impact of fenestration technology

Learn how to measure and compare thermal, airtight, and solar wellness of windows

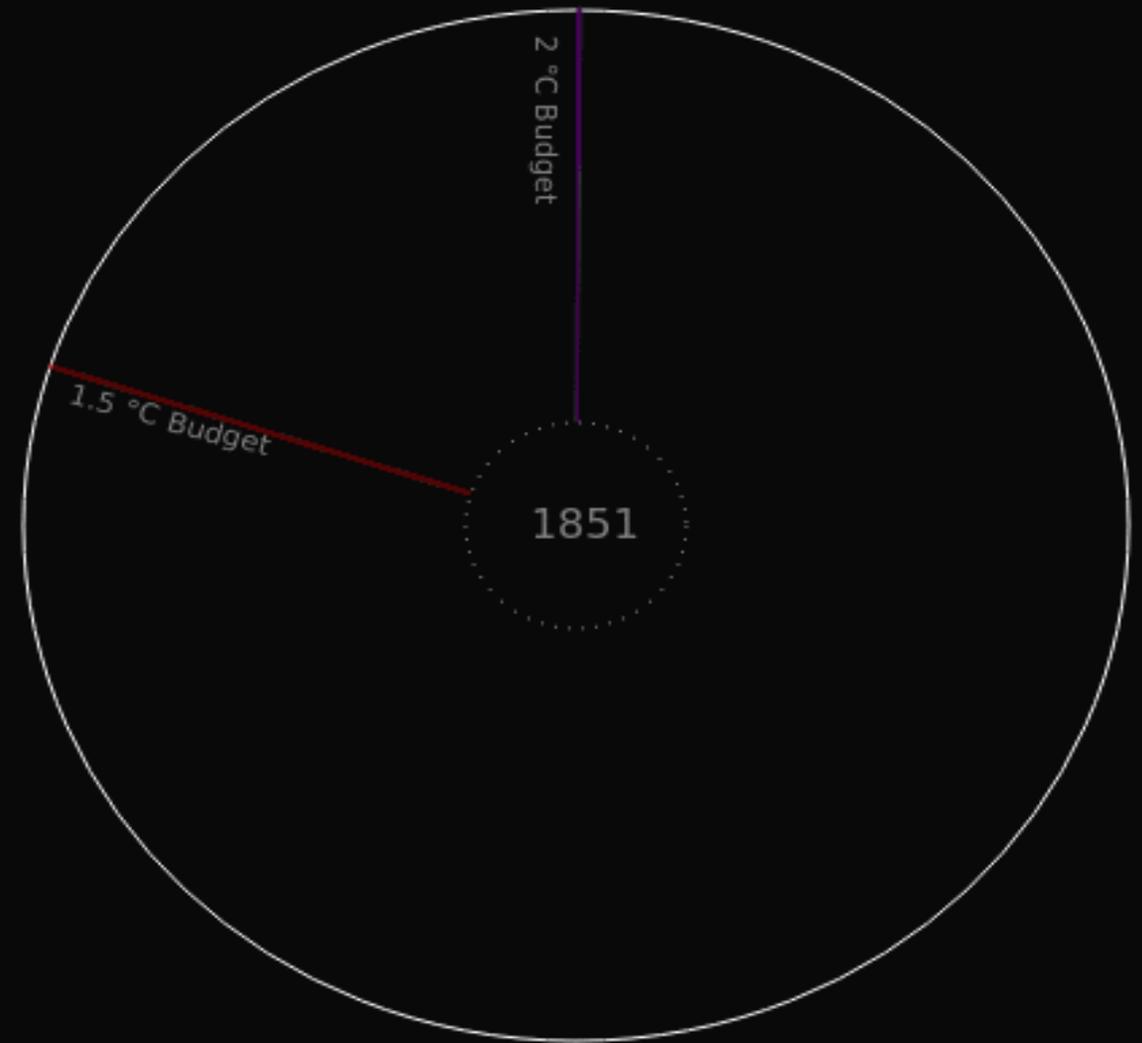
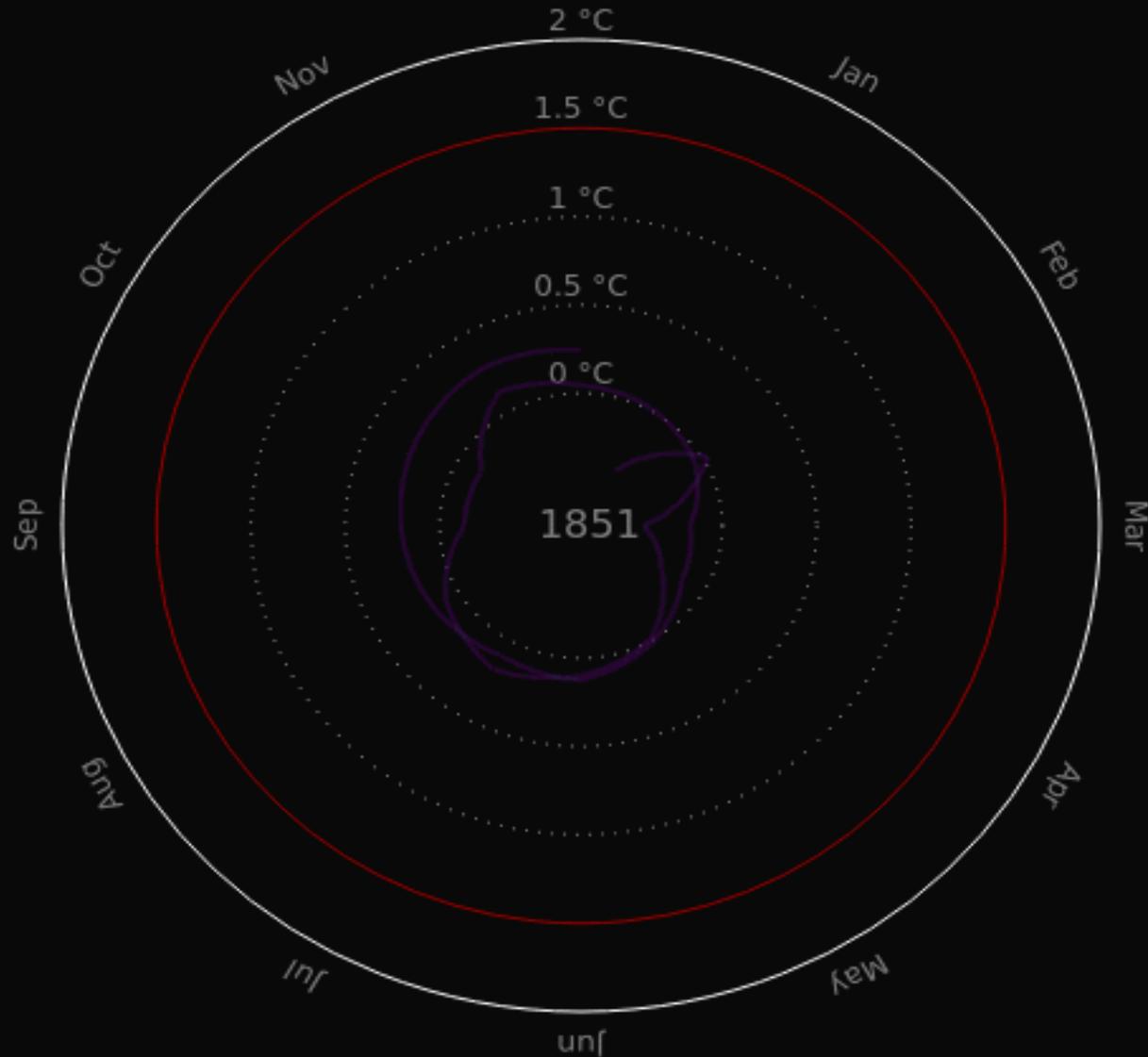
Understand fenestration's potential influence on Indoor Environmental Quality & human health

Evaluate the capabilities and longevity potential of various fenestration materials

Analyze the environmental costs of fenestration manufacturing and lifespan

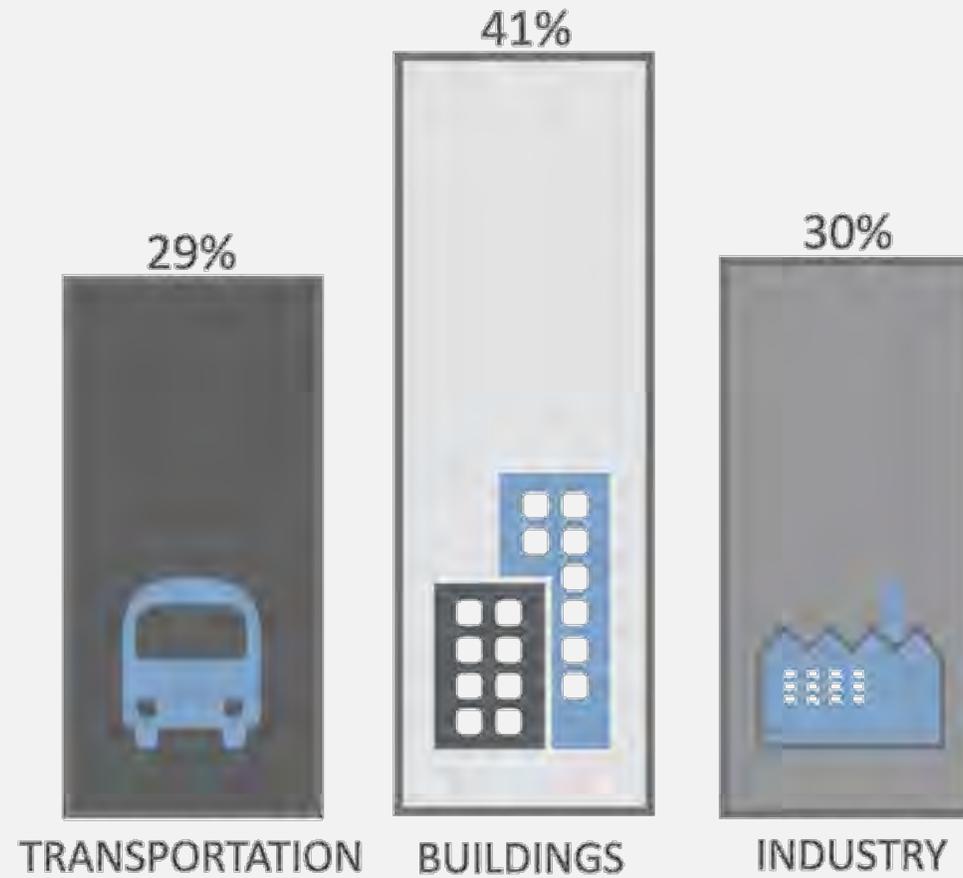
Share emerging window technologies and optimistic solutions

Average Global Temperature Increase

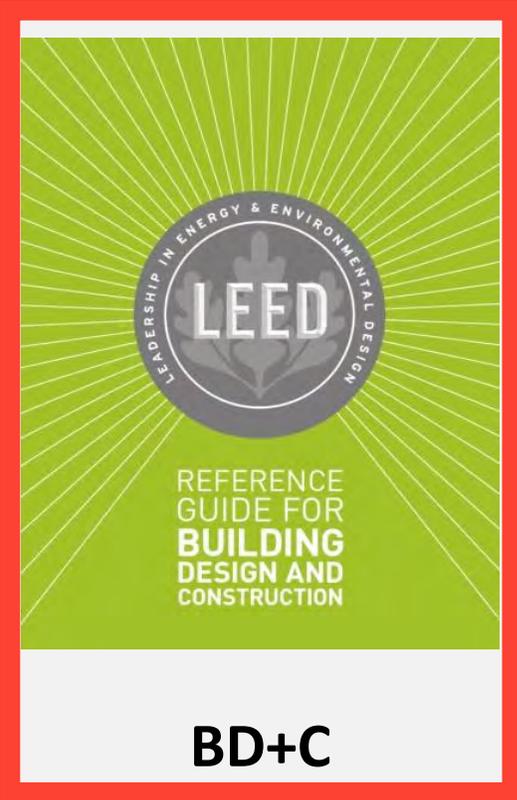


GHG in the USA

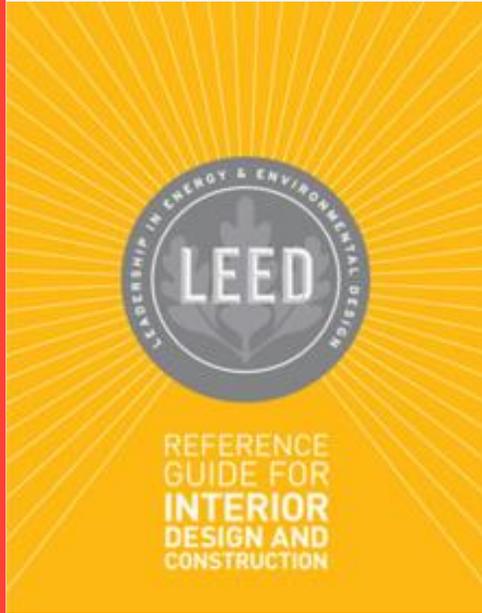
Green House Gas Sources



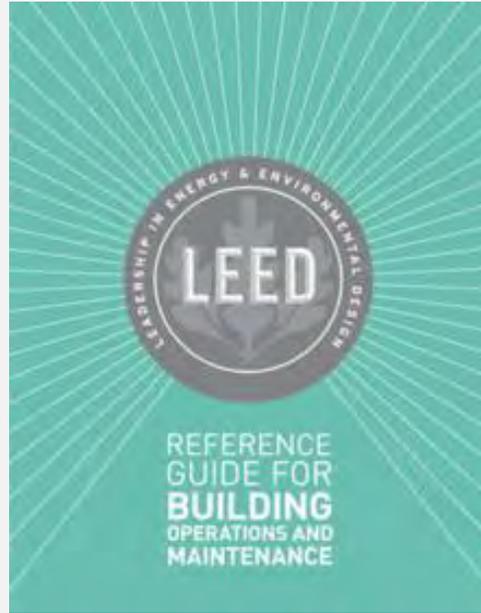
LEED: Leadership in Energy & Environmental Design



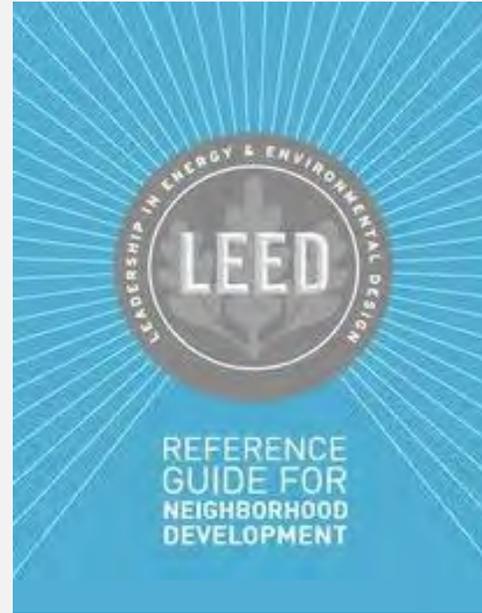
BD+C



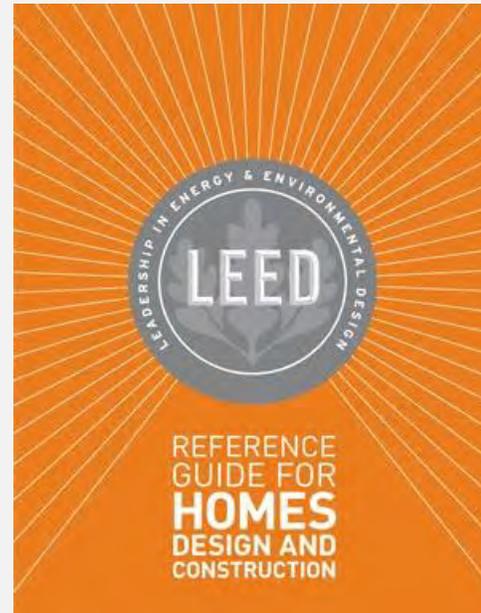
ID+C



O+M

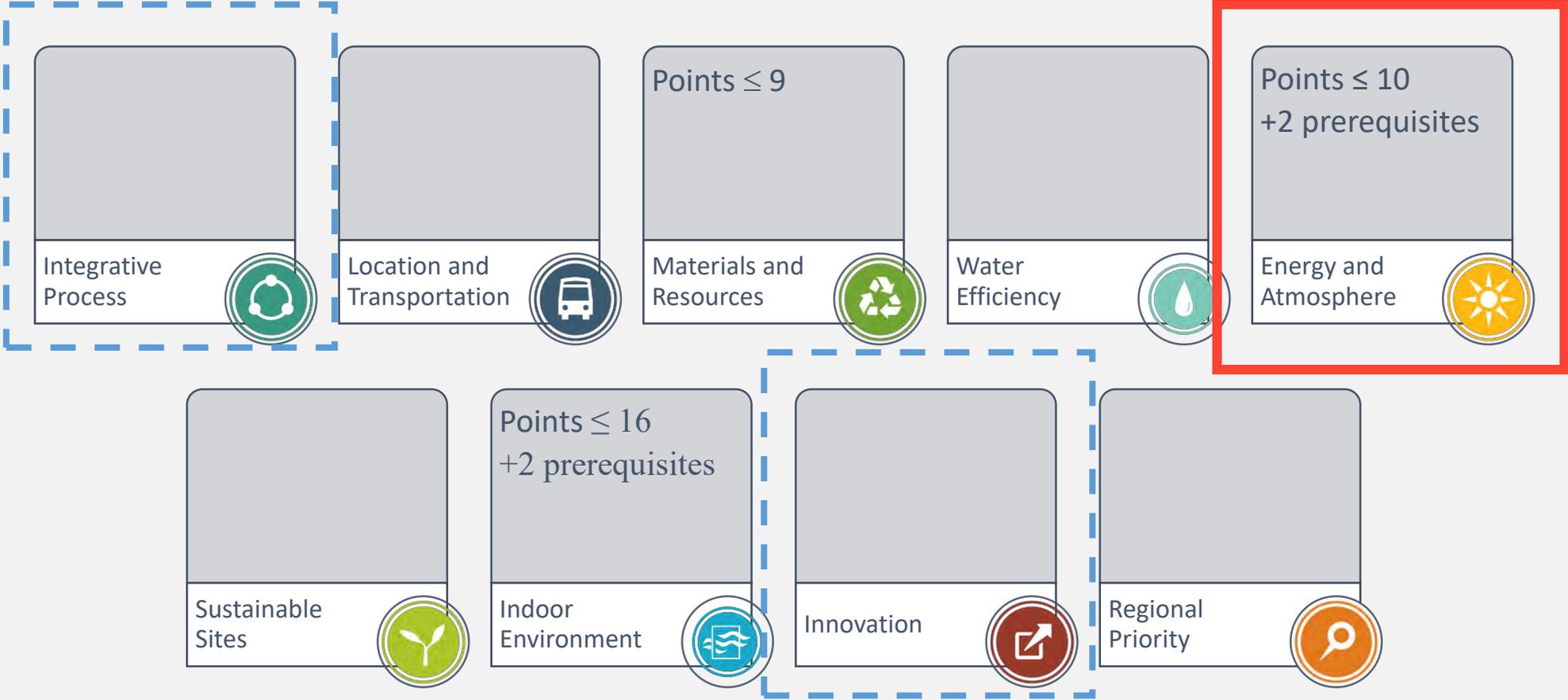


ND



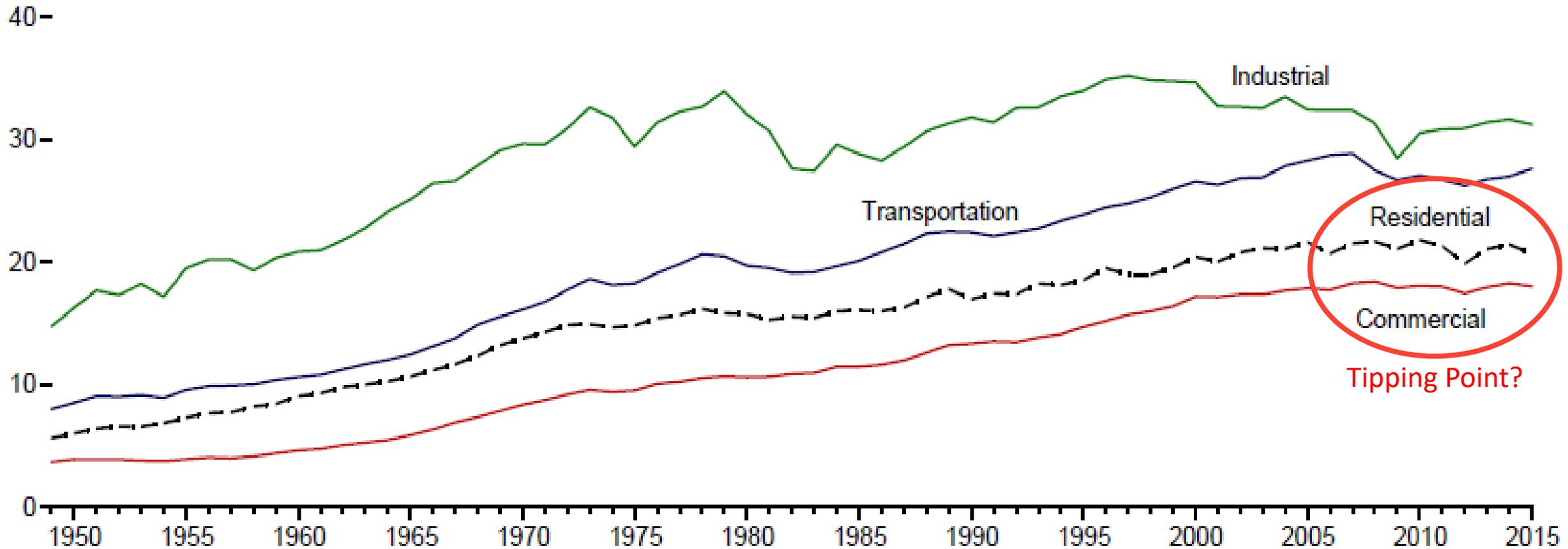
HOMES

LEED BD+C : Credit Categories

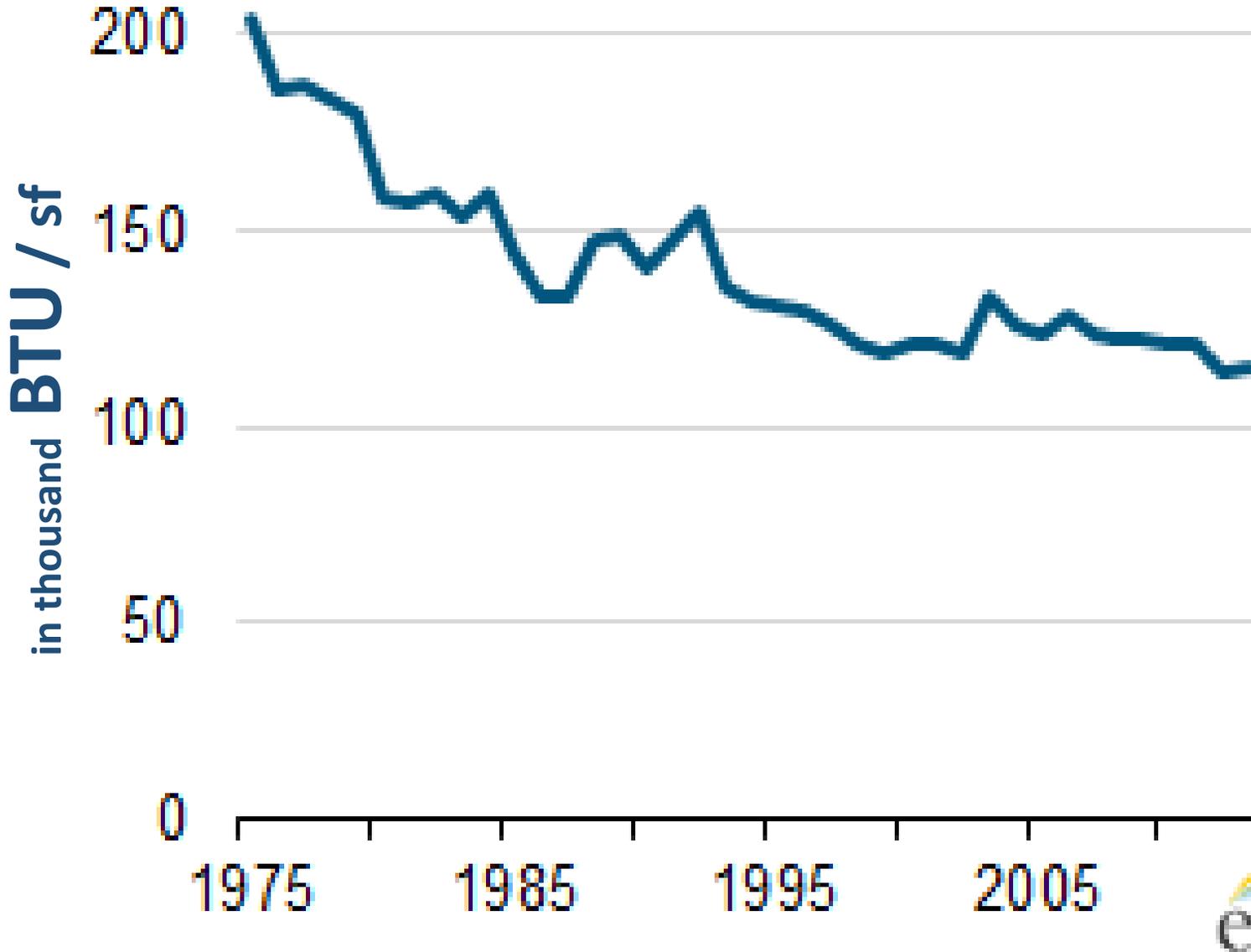


Total US Energy Consumption

(in quadrillion BTUs, since WWII)



Building Energy Intensity Since 1975



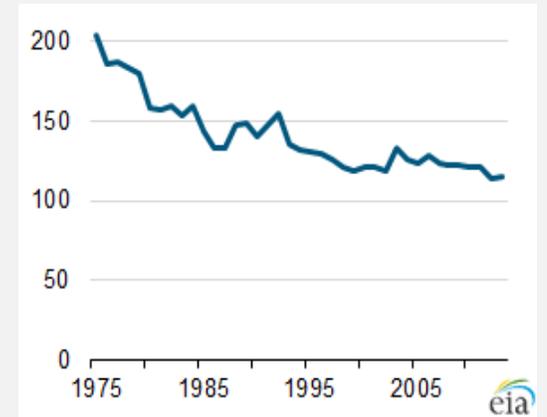
BTU/square foot =
The “MPG” of Buildings



+40% of improvement
due to advancements in
window technology

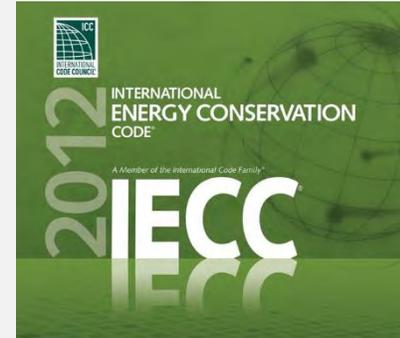
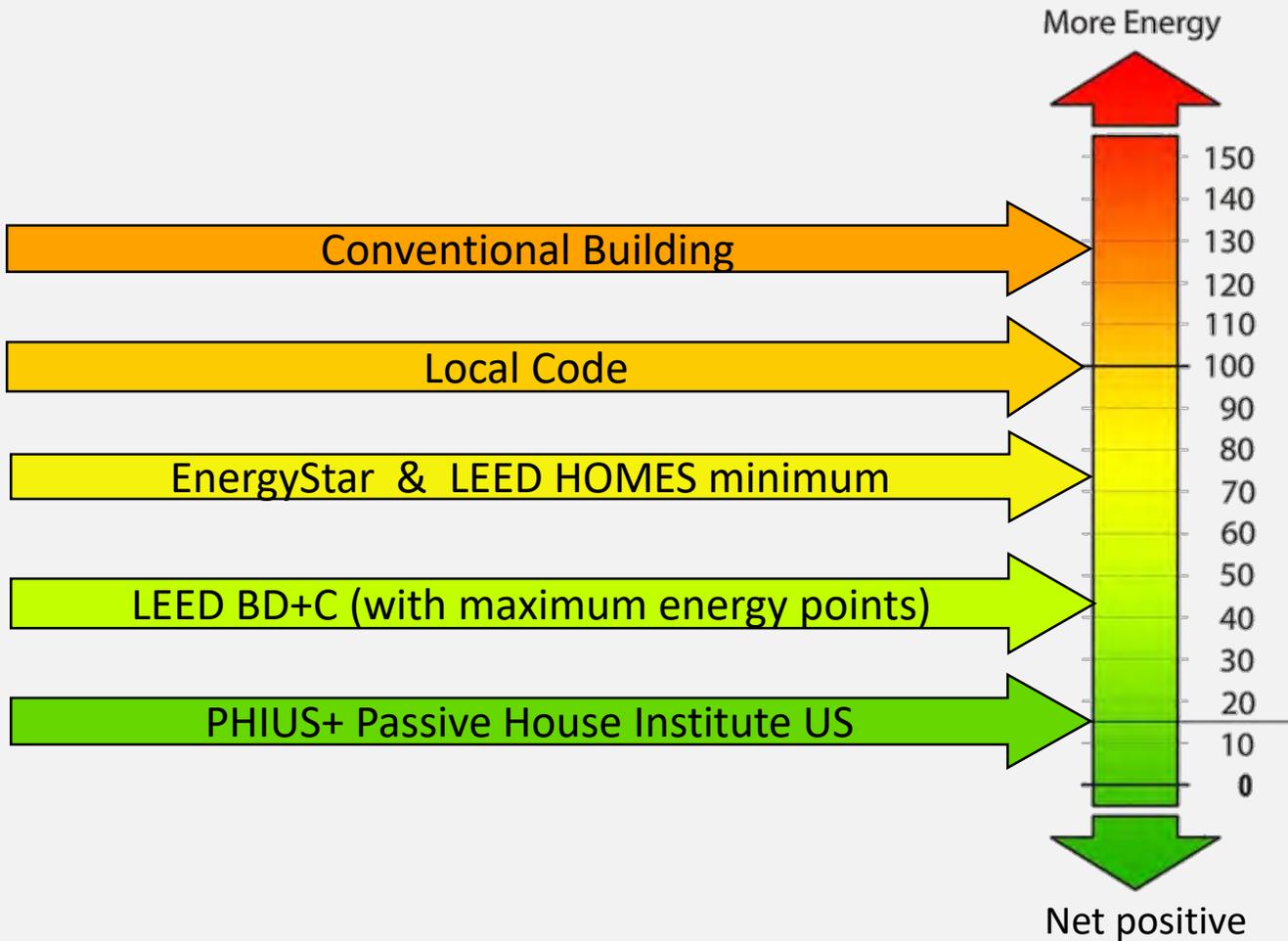


+40% of US building **Energy Intensity** improvement since 1975 due to advancements in window technology:

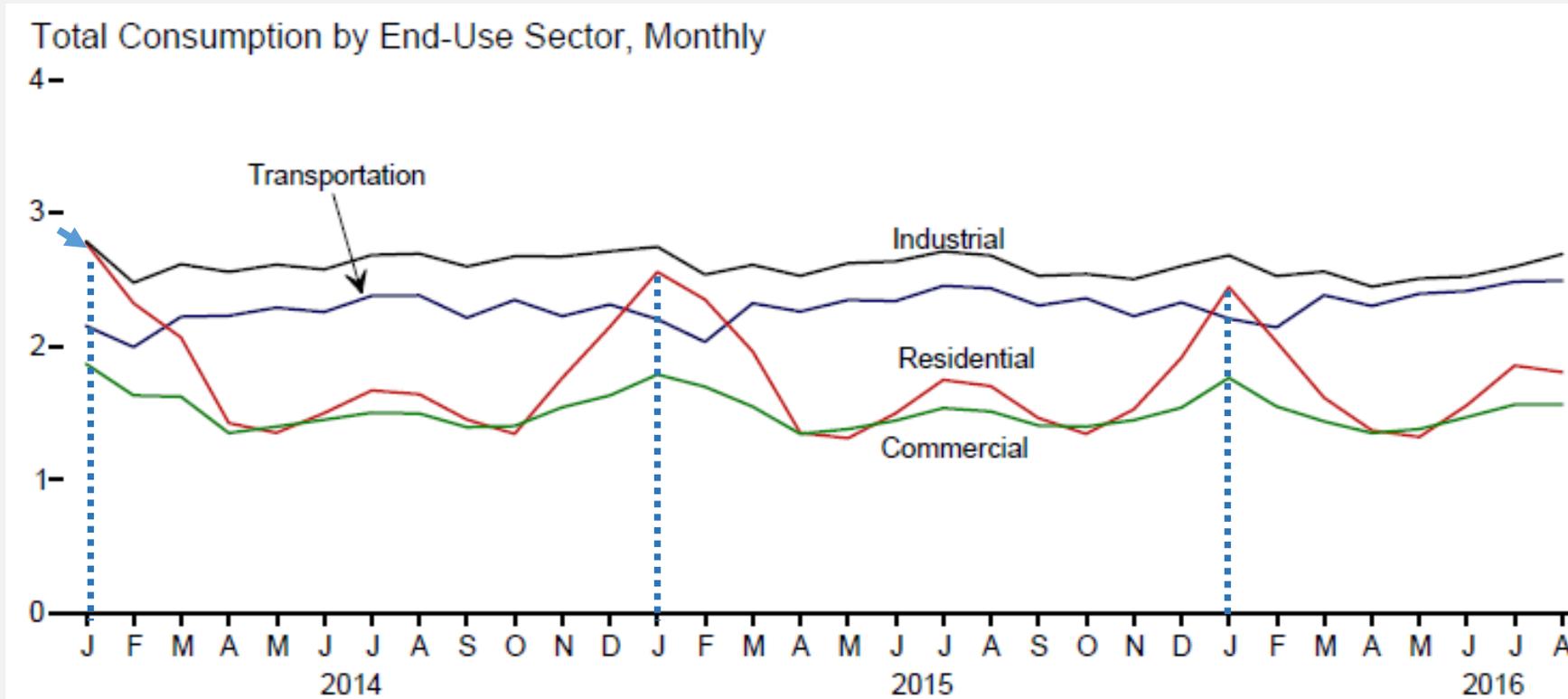


- Adoption of insulated dual pane glazing (IG: insulated glass)
- Sputtered coatings on glass (silver molecules, etc.)
- Enhanced air-tight-ness and “thermally broken” window designs
- Newer, stronger, healthier, more lasting window material adoption

HERS: Home Energy Rating System



When do buildings ~~use~~ the most energy?





More Energy



150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

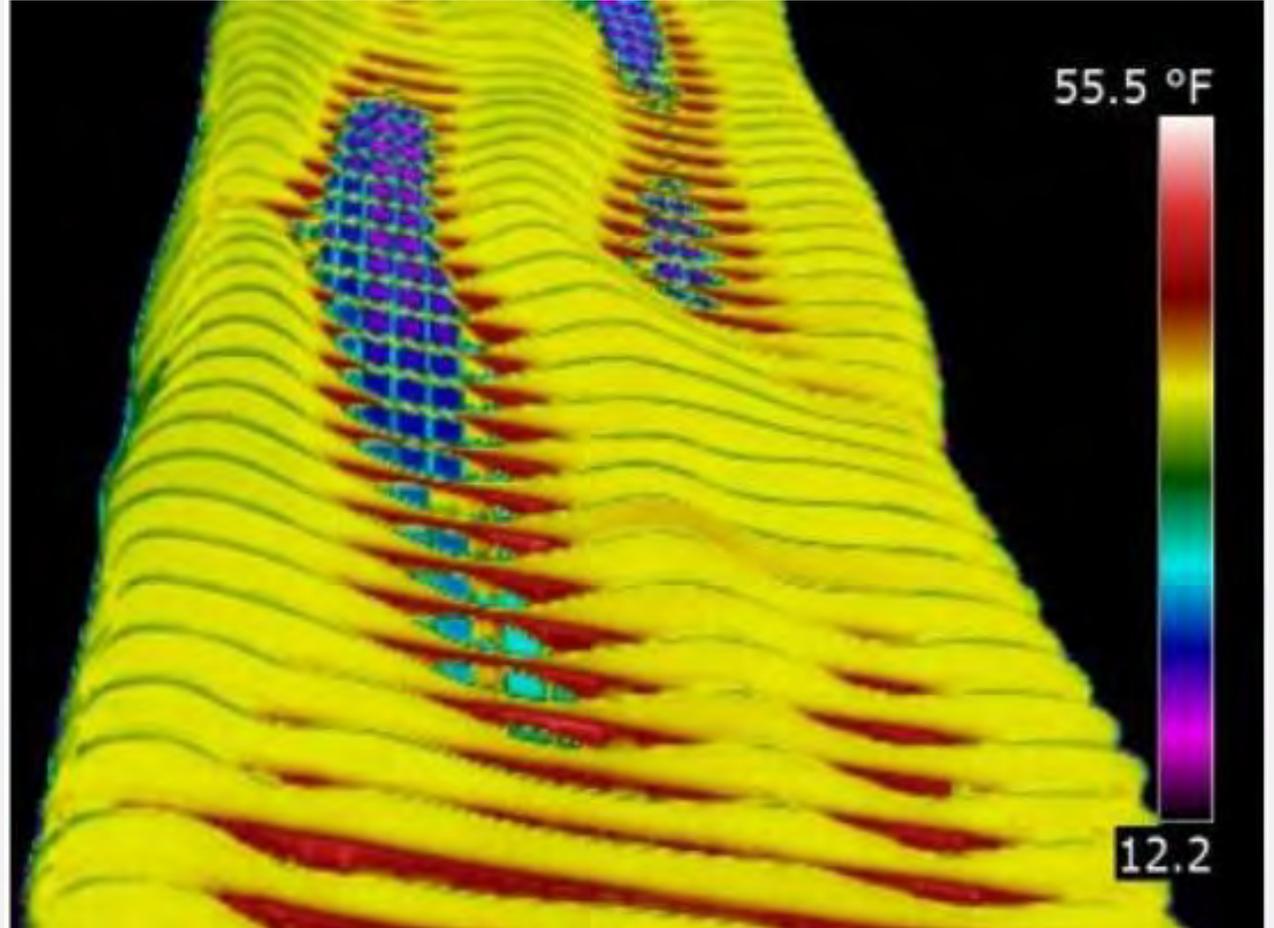


Learning Objective Two

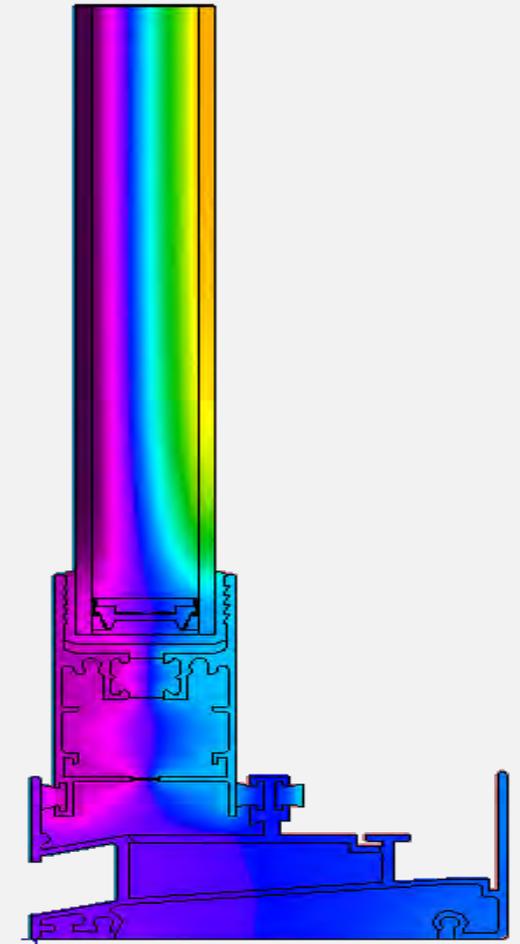
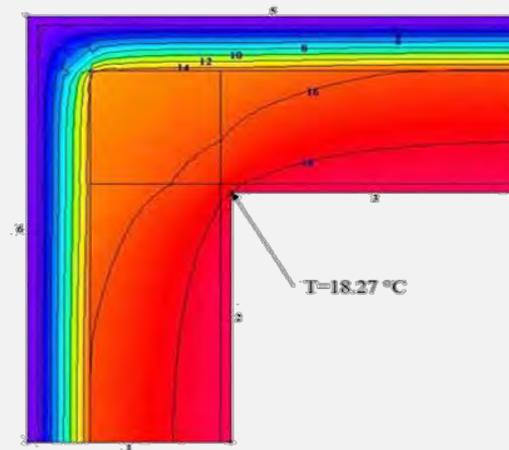
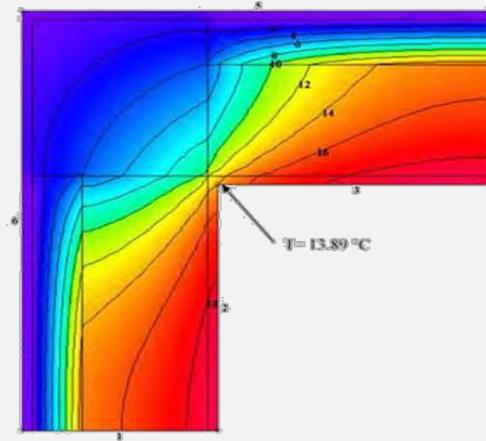
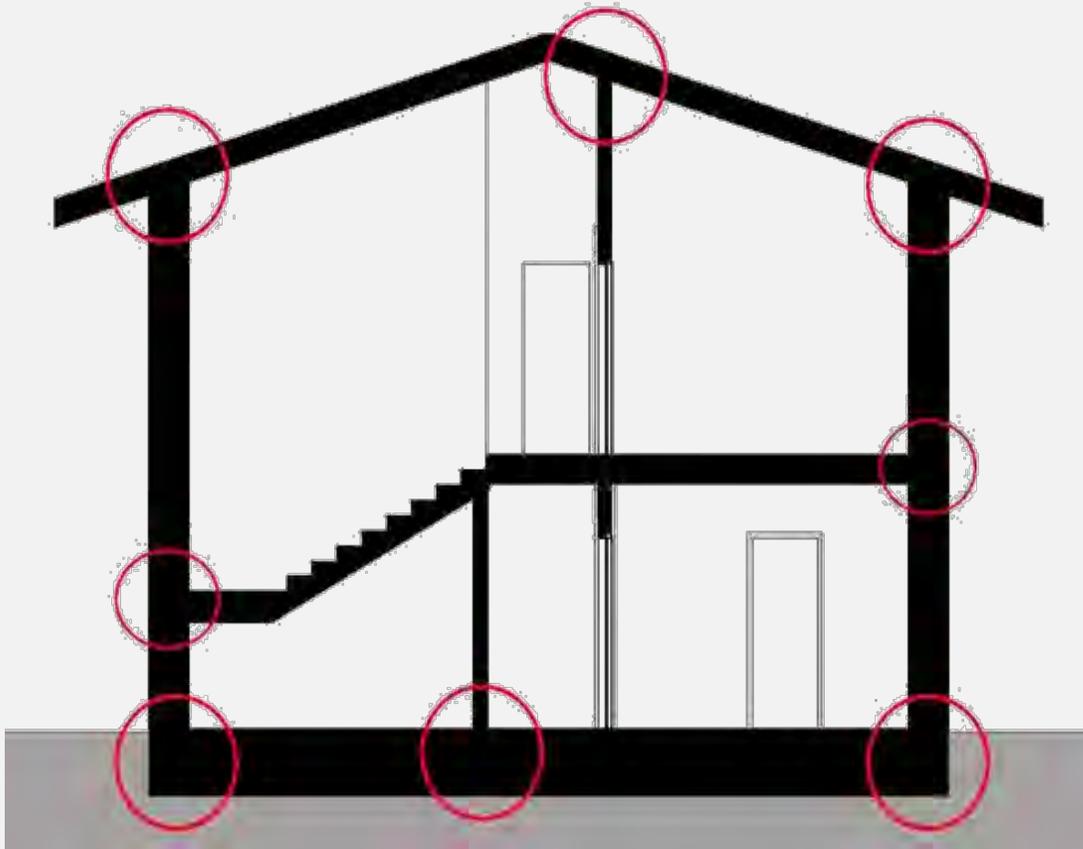
Learn how to measure the thermal and solar wellness of windows.



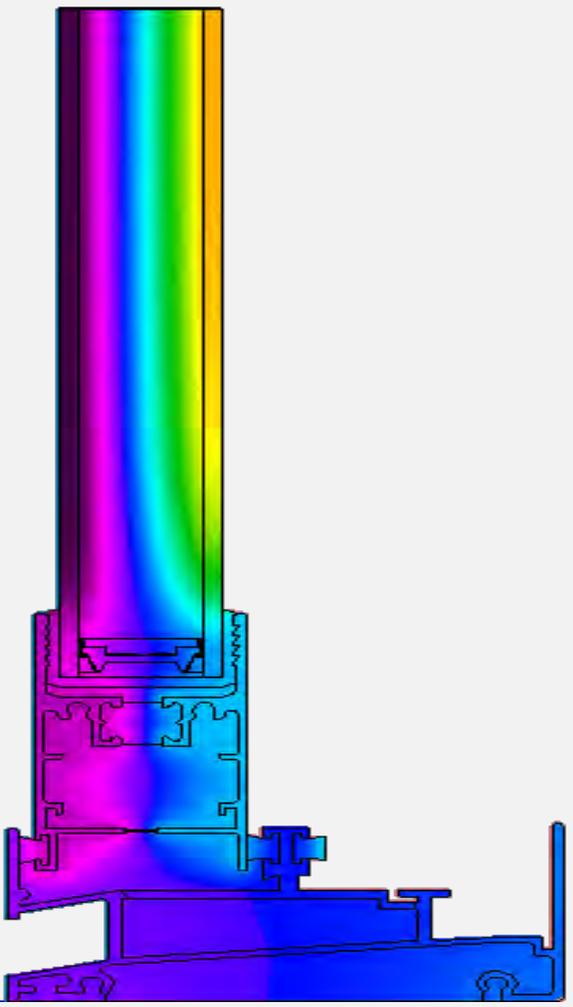
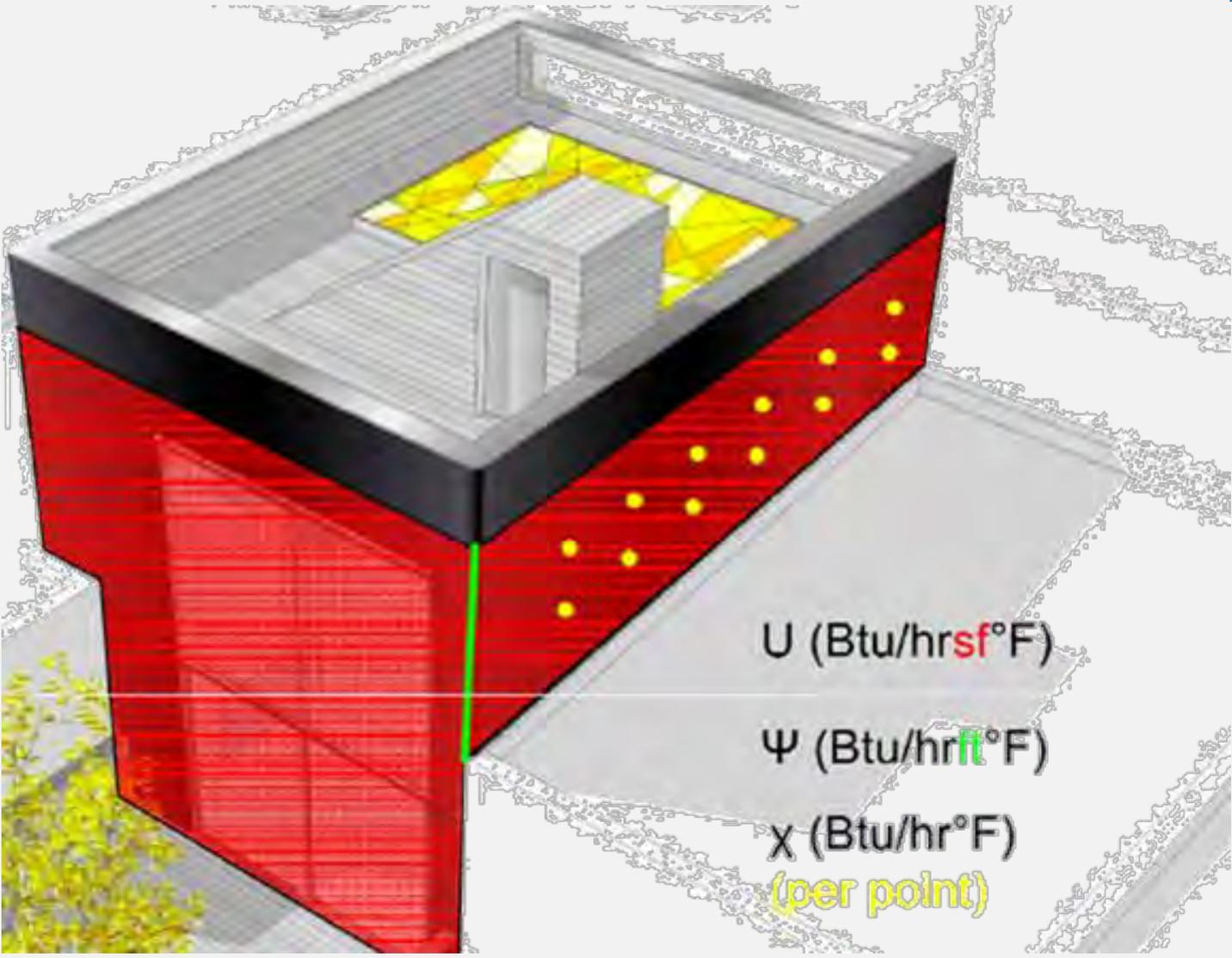
Thermal Bridges



Thermal Bridges



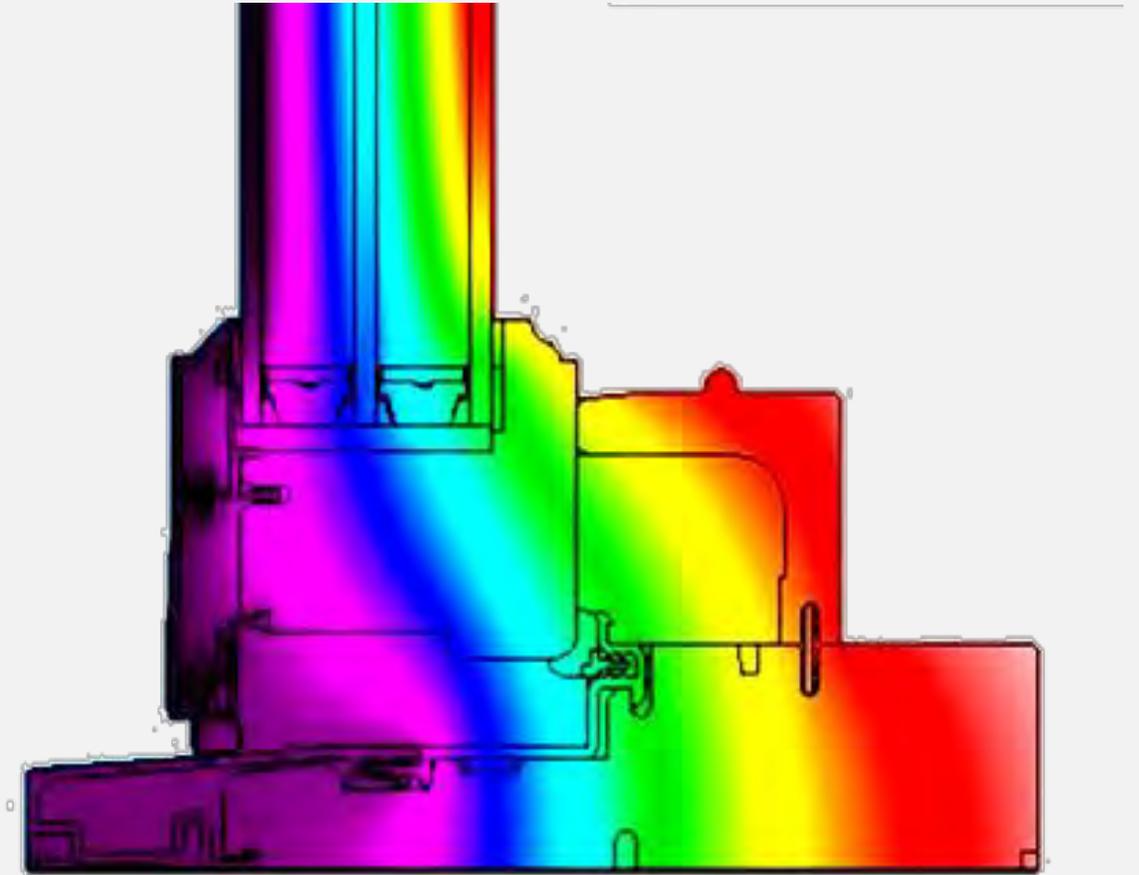
Thermal Bridges



U Value = **BTU** / hour / square foot (°F)



BTU = **B**ritish **T**hermal **U**nit



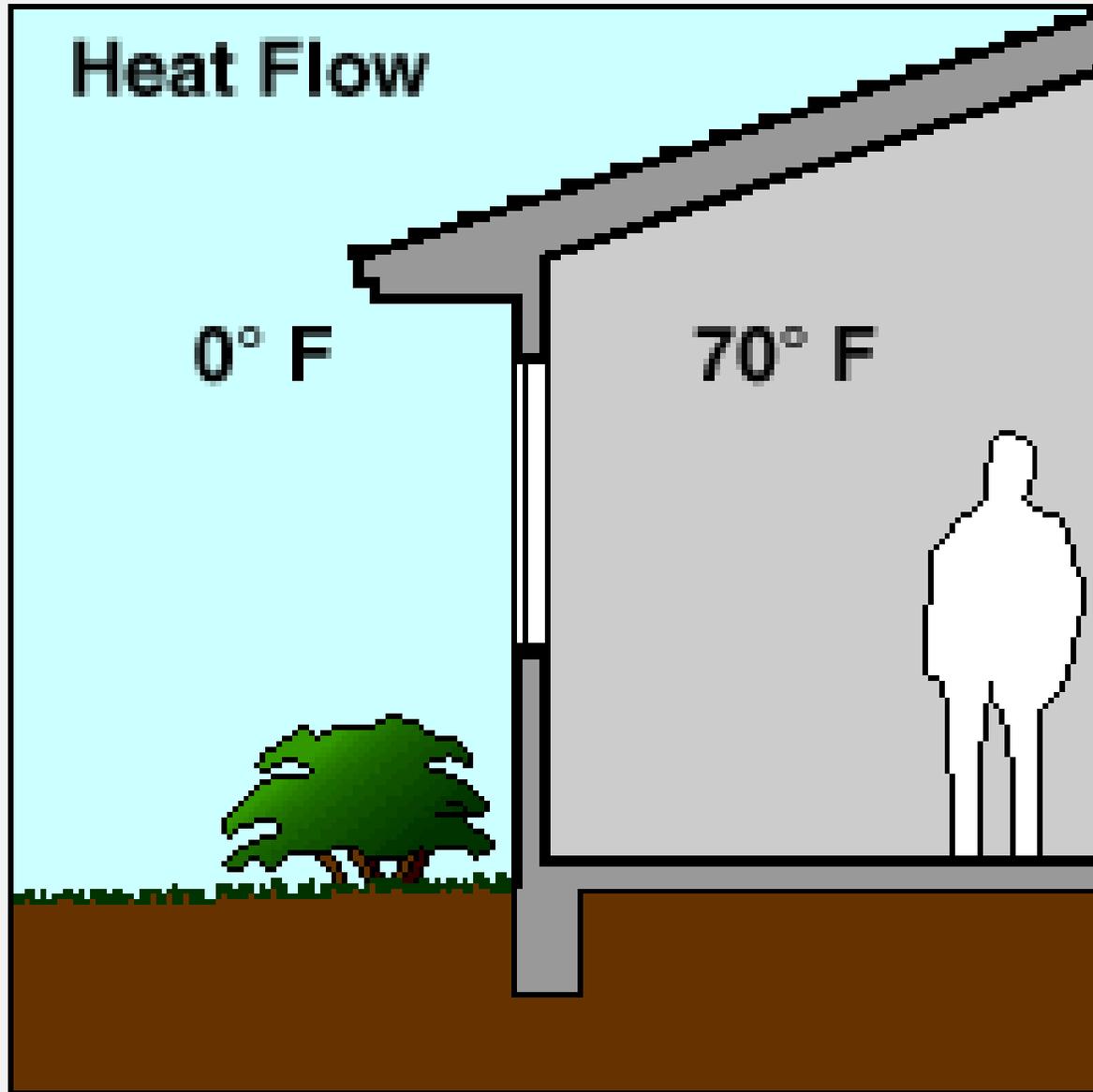
U Value = **BTU** / hour / square foot (°F)



BTU = British Thermal Unit
= energy of a 4" match
burnt top to bottom



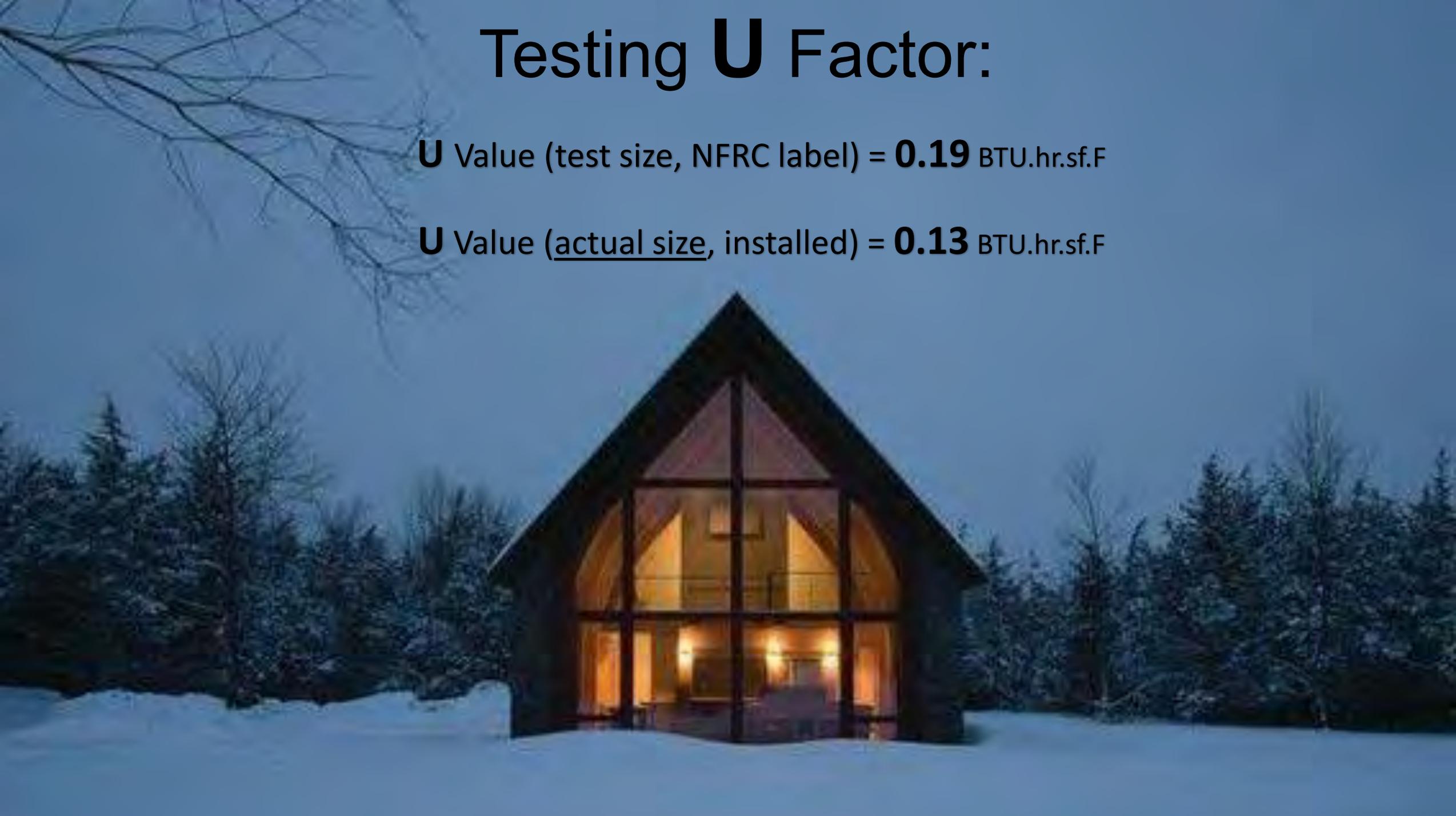
Testing U Factor:



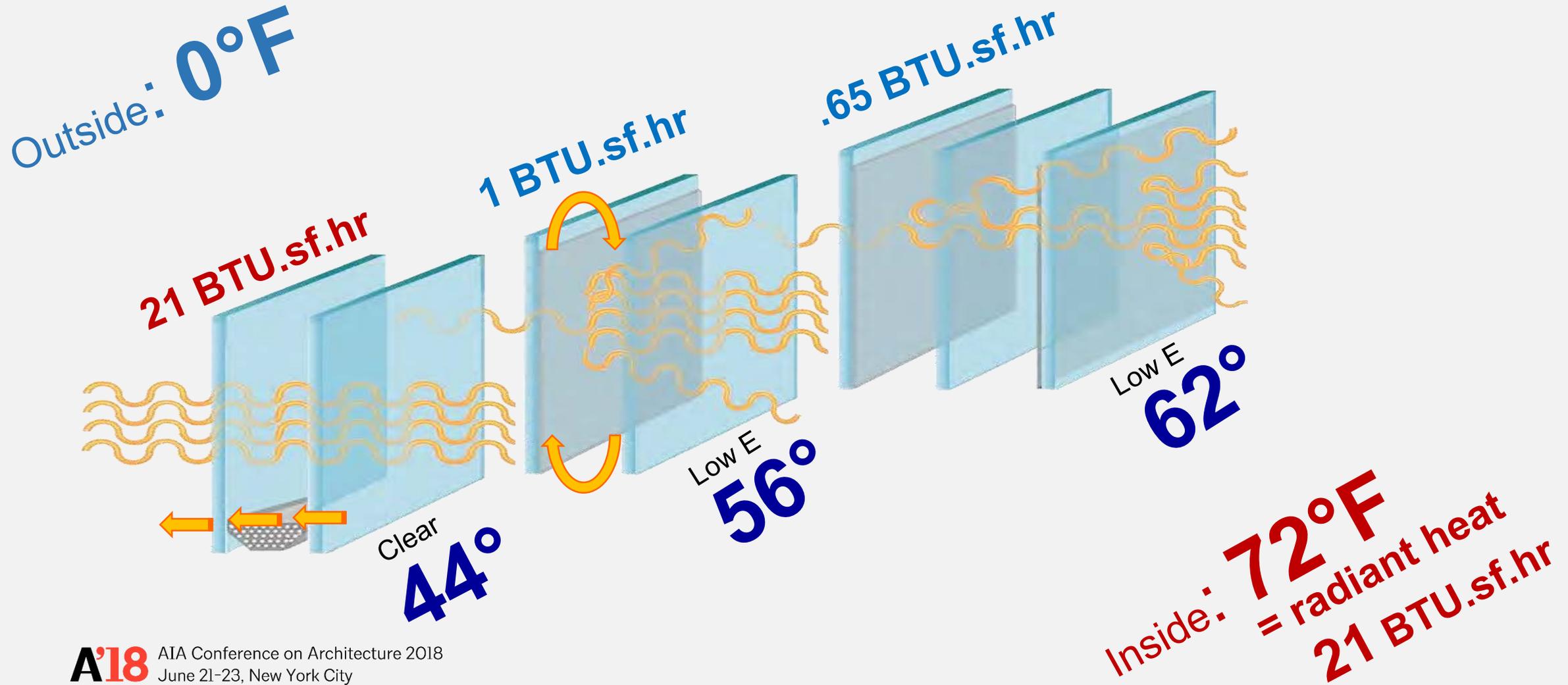
Testing **U** Factor:

U Value (test size, NFRC label) = **0.19** BTU.hr.sf.F

U Value (actual size, installed) = **0.13** BTU.hr.sf.F

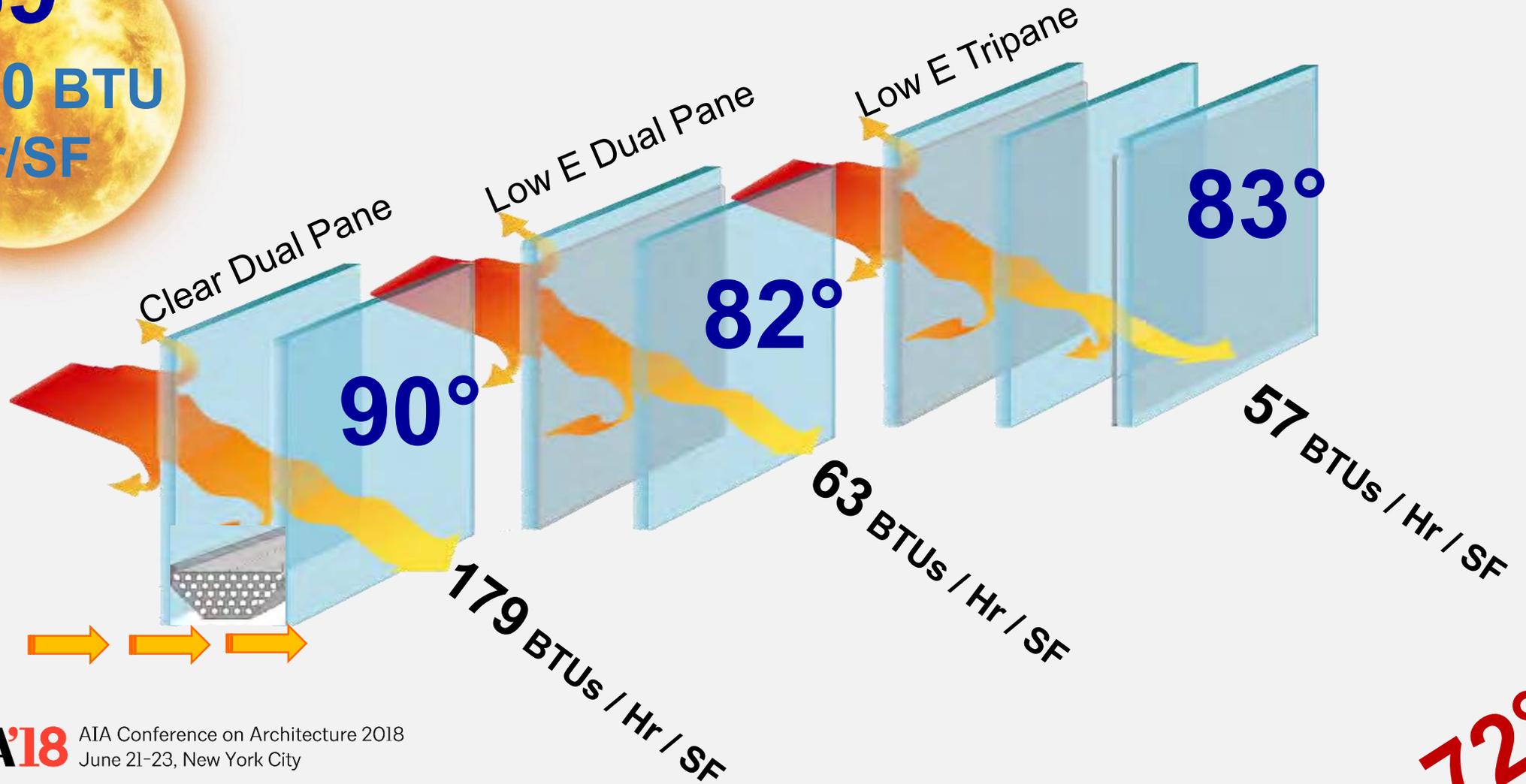


Sputtered Low E (emissivity) Coatings



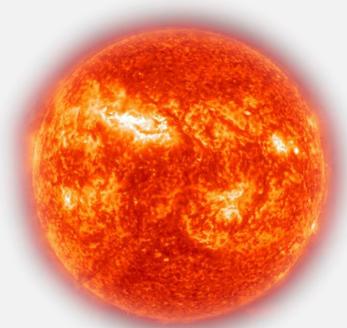
Sputtered Low E (emissivity) Coatings

89°
= 230 BTU
/Hr/SF





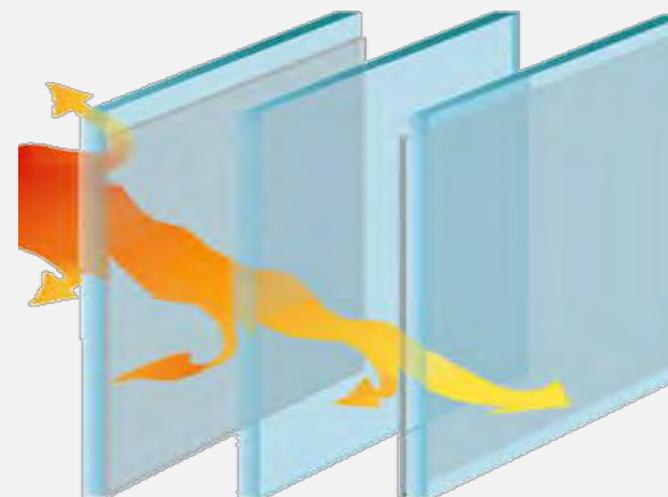
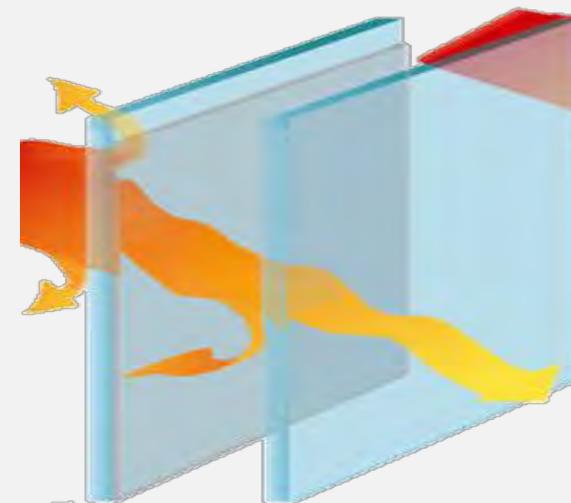
SHGC



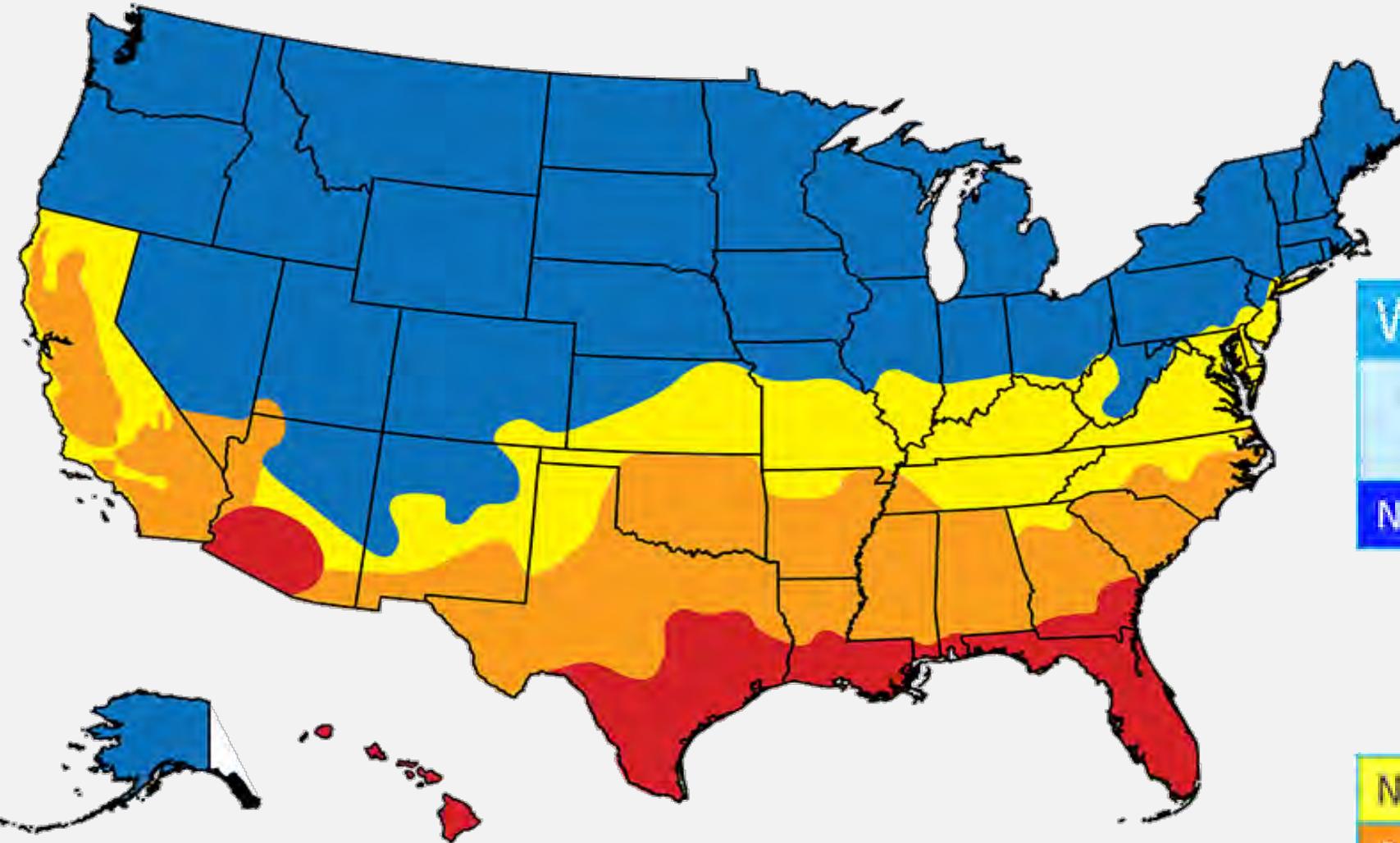
SHGC: Solar Heat Gain Coefficient

Glass Type	Coating	SHGC
Double Pane	(none)	.78 = 78%
Double Pane	LoE 1 80	.64 = 64%
Double Pane	LoE 2 72	.41 = 41%
Double Pane	LoE 3 40	.18 = 18%
Double Pane	LoE 3 66	.27 = 27%

Glass Type	Coating	SHGC
Triple Pane	LoE 2 & 1	.56 = 56%
Triple Pane	LoE 2 & 2	.36 = 36%
Triple Pane	LoE 2 & 3	.24 = 24%

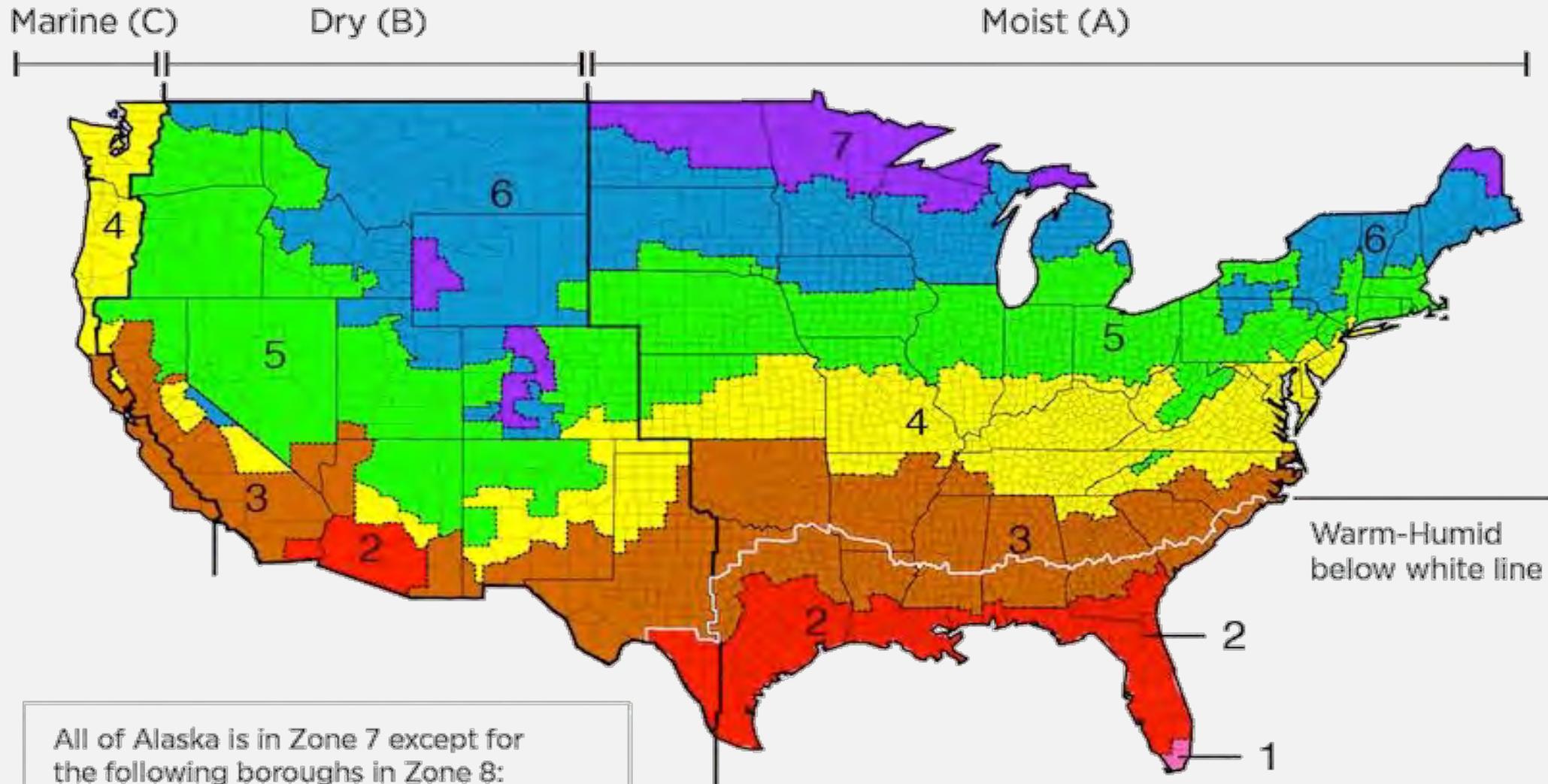


EnergyStar and EPA Map



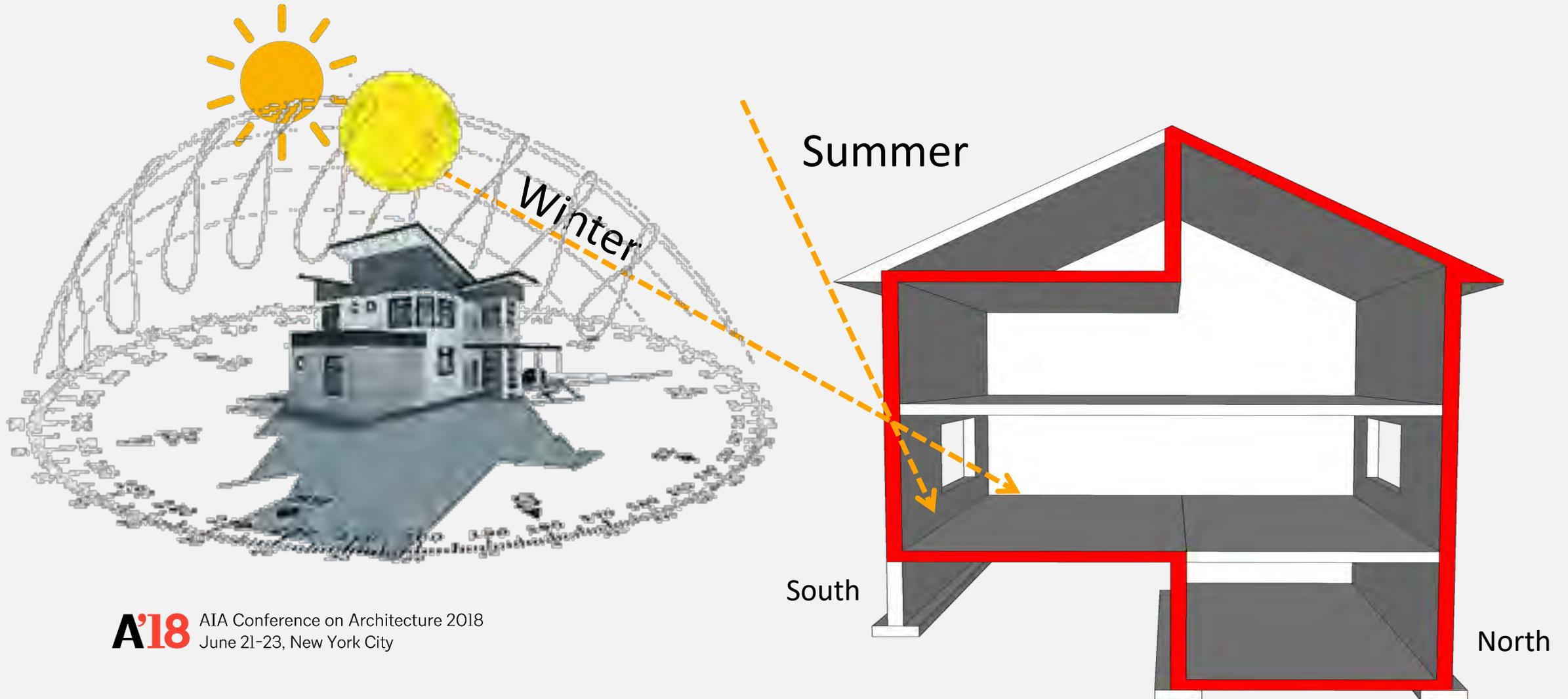
WINDOWS		
CLIMATE ZONE	U-FACTOR ¹	SHGC ²
Northern	≤ 0.27	Any
	≤ 0.28	≥ 0.32
	≤ 0.29	≥ 0.37
	≤ 0.30	≥ 0.42
North Central	≤ 0.30	≤ 0.40
South Central	≤ 0.30	≤ 0.25
Southern	≤ 0.40	≤ 0.25

IECC Climate Zones

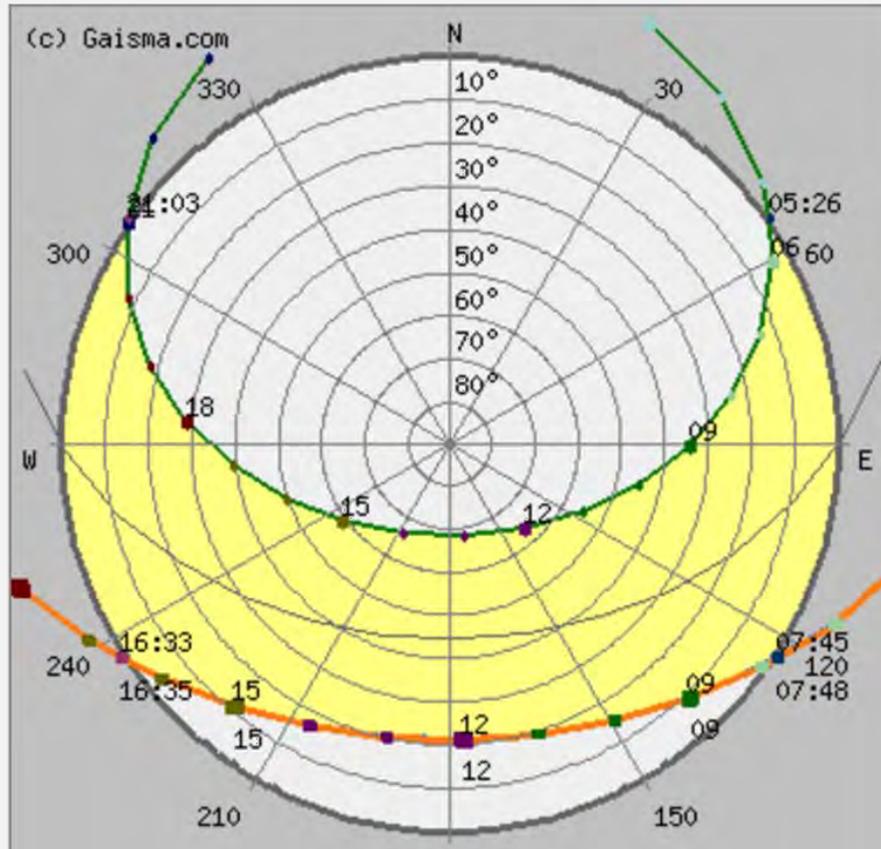


All of Alaska is in Zone 7 except for the following boroughs in Zone 8:

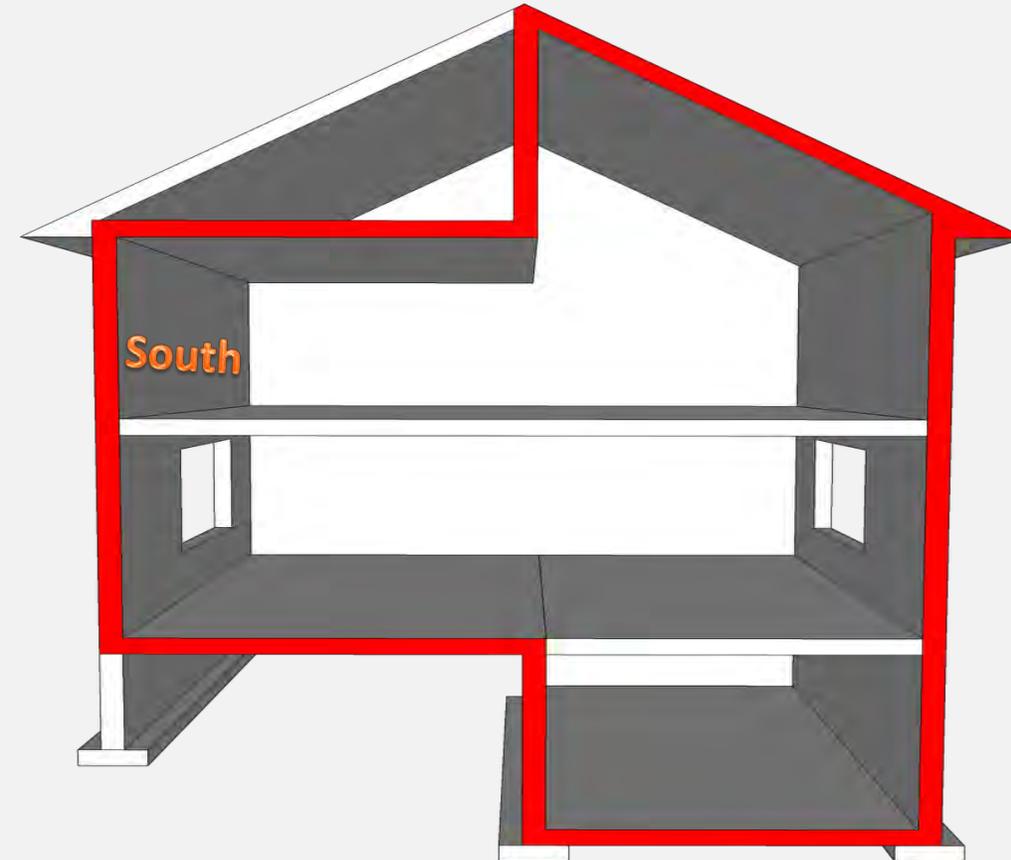
Sun Path & SHGC Risks



Sun Path & SHGC Risks



- Sun path**
- Today
 - June solstice
 - December solstice
 - Annual variation
 - Equinox (March at
- Sunrise/sunset**
- Sunrise
 - Sunset
- Time**
- 00-02
 - 03-05
 - 06-08
 - 09-11
 - 12-14
 - 15-17
 - 18-20
 - 21-23



16 December 2016, Minneapolis

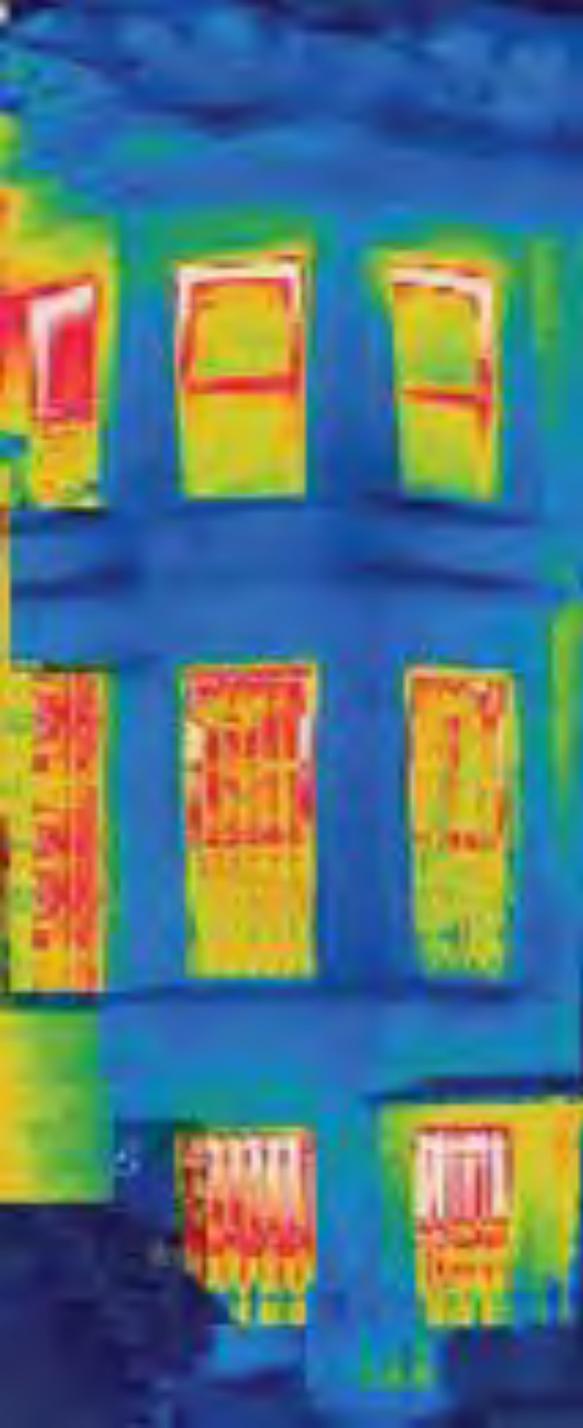


Learning Objective Three

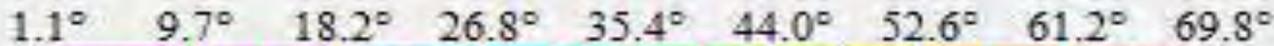
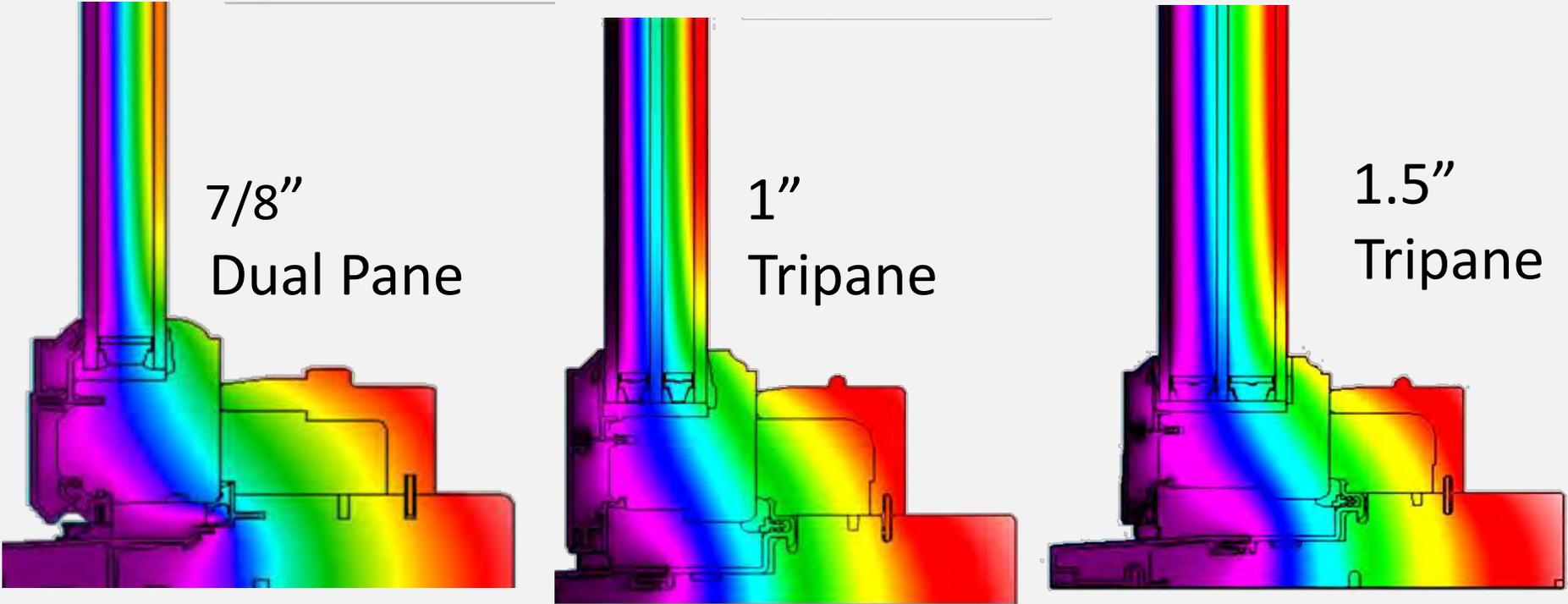
Evaluate the capabilities and
longevity of various fenestration
materials

Expansion & Contraction of Window Materials

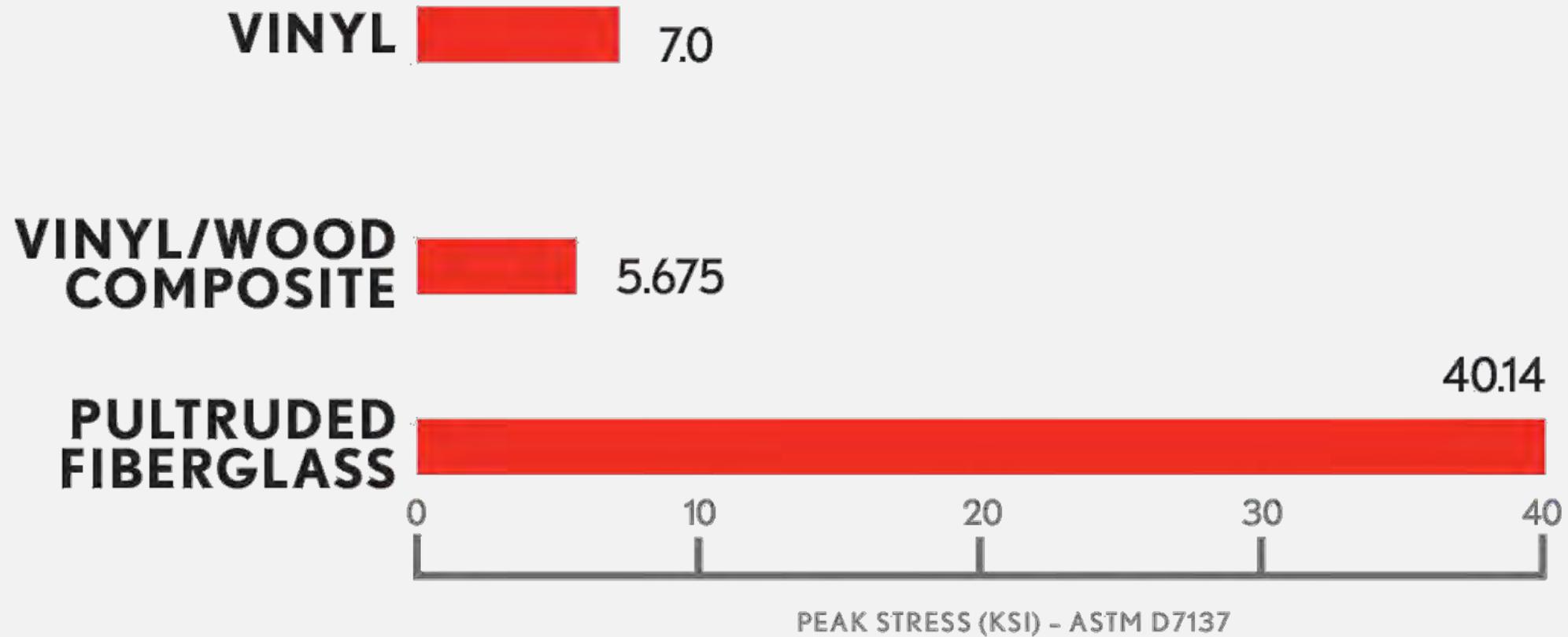




Thermal & Airtightness Retention

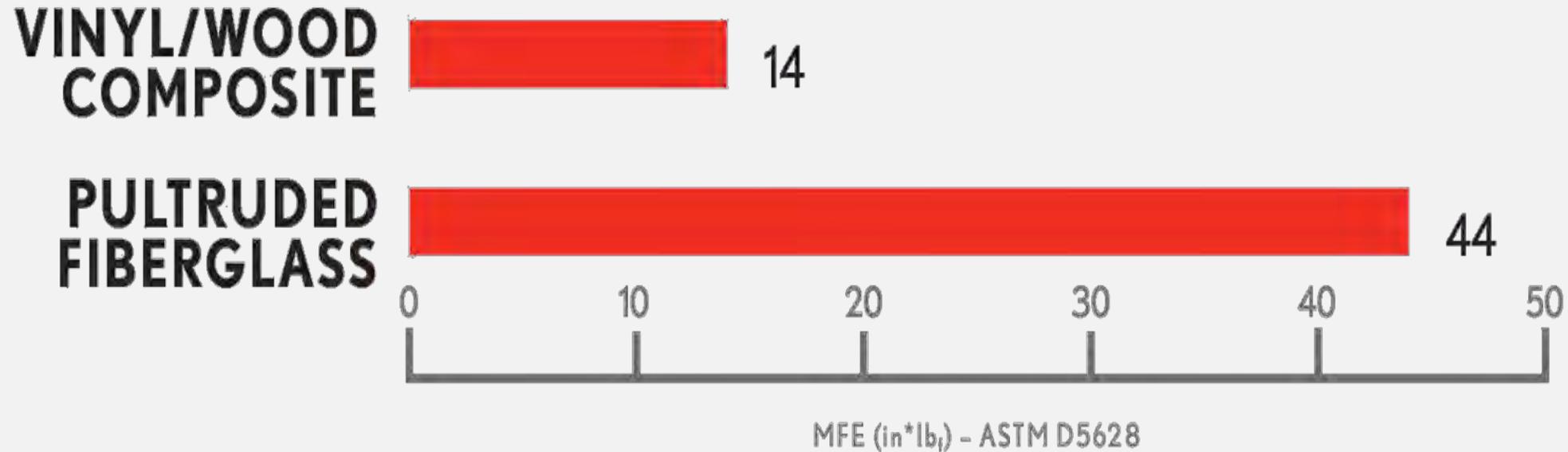


Composite Window Material Performance



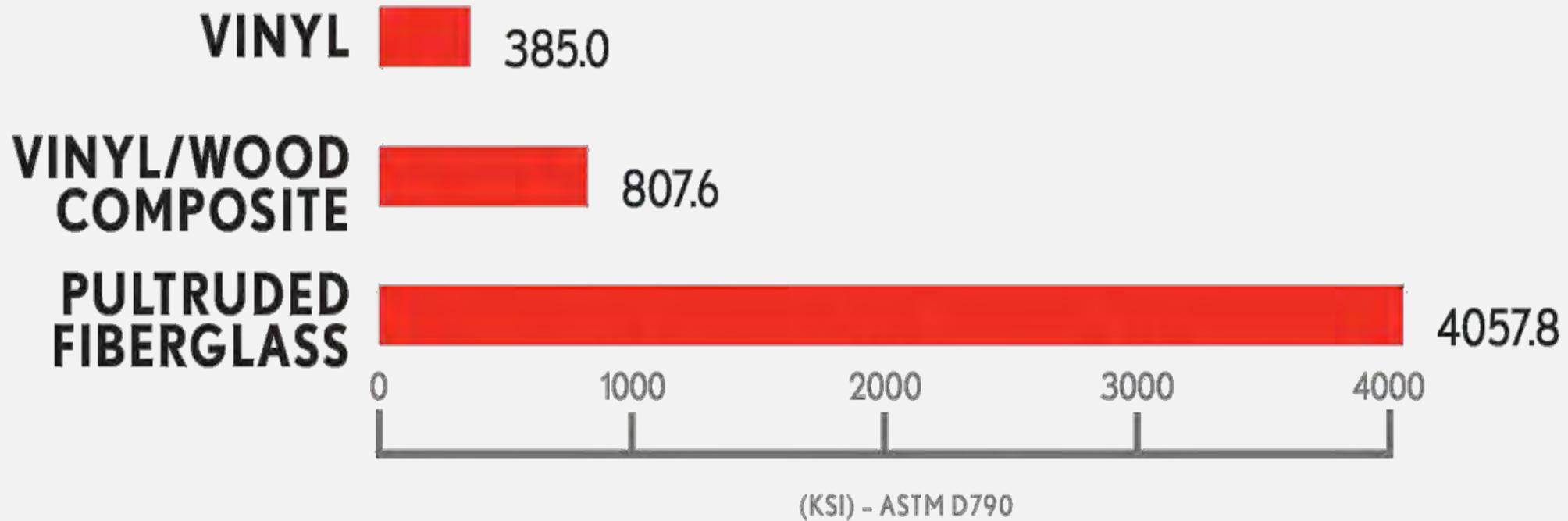
Tensile Strength Chart

Composite Window Material Performance



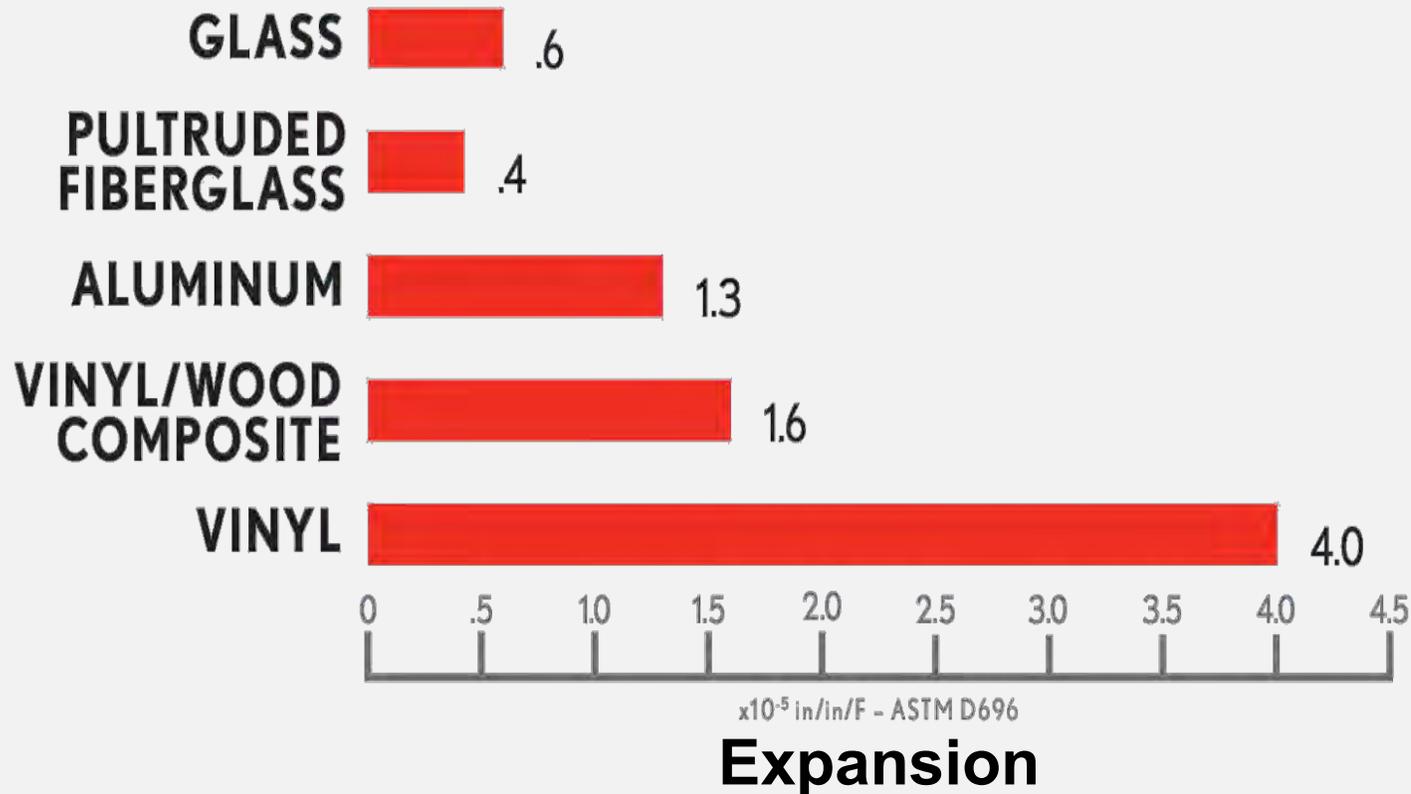
Impact Resistance Chart

Composite Window Material Performance



Flexular Modulus Chart

Composite Window Material Performance





National Fenestration
Rating Council®

CERTIFIED

Diminishing Returns ?

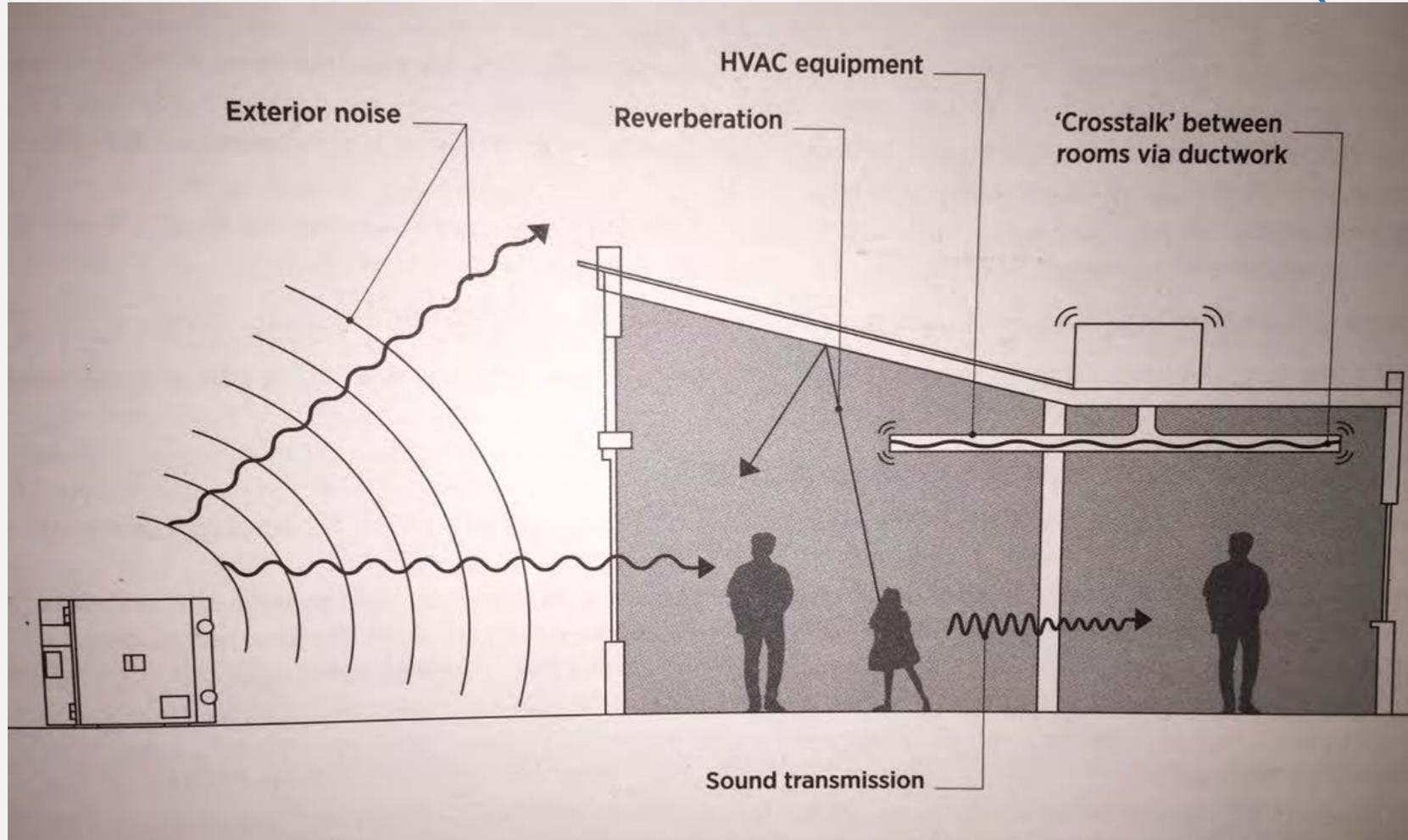
ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.30	0.30
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./I-P)
0.51	0.2

A modern bedroom with large windows and a fireplace. The room features a bed with white and grey bedding, a lamp, and a large window with a view of trees. A dark grey fireplace is visible on the right side of the room.

Learning Objective Four

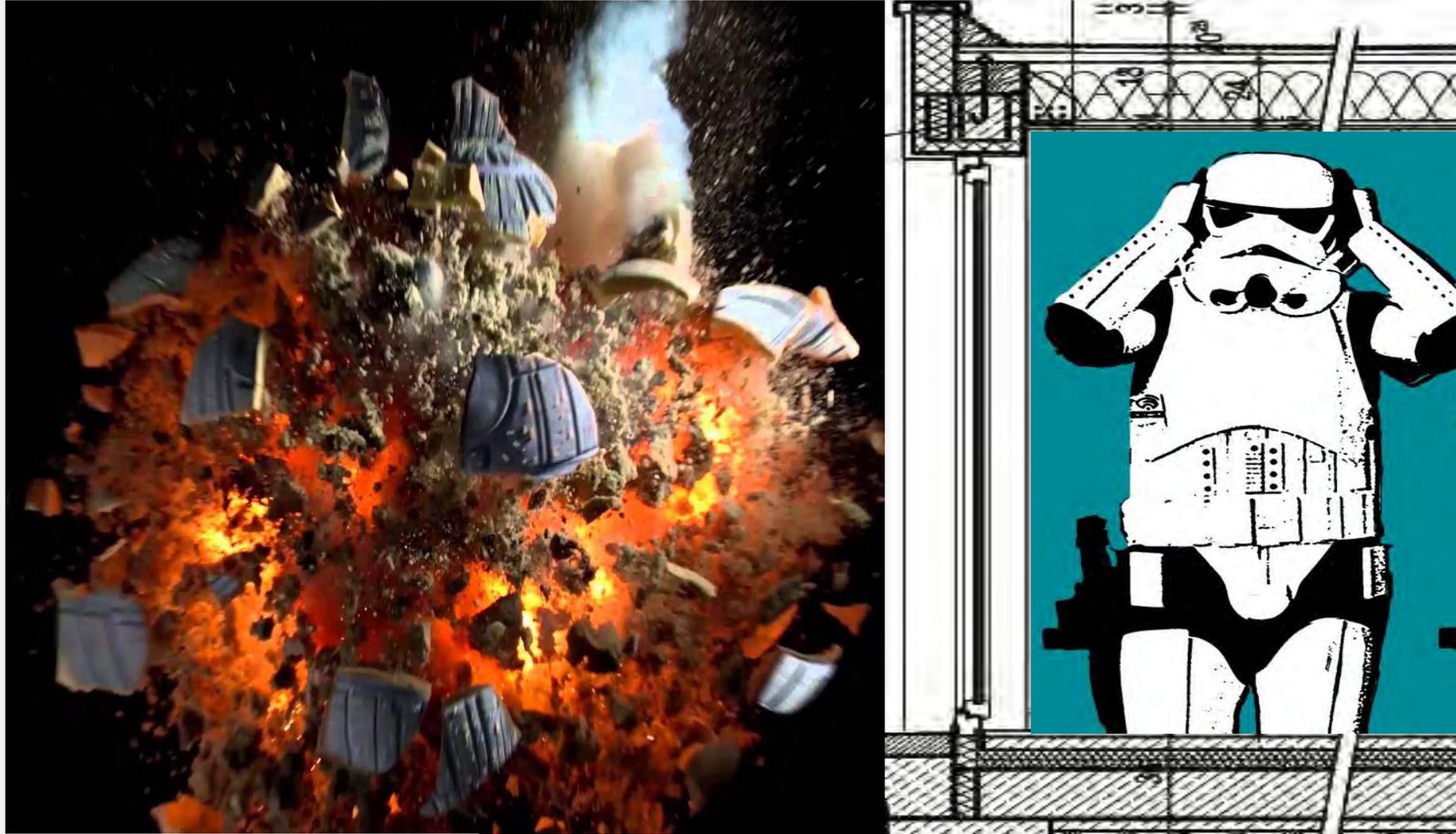
Understand indoor
environmental quality and the
human factor.

LEED IEQ Prerequisite: Minimum Acoustic Performance (schools)



Sound
Transmittance
Class

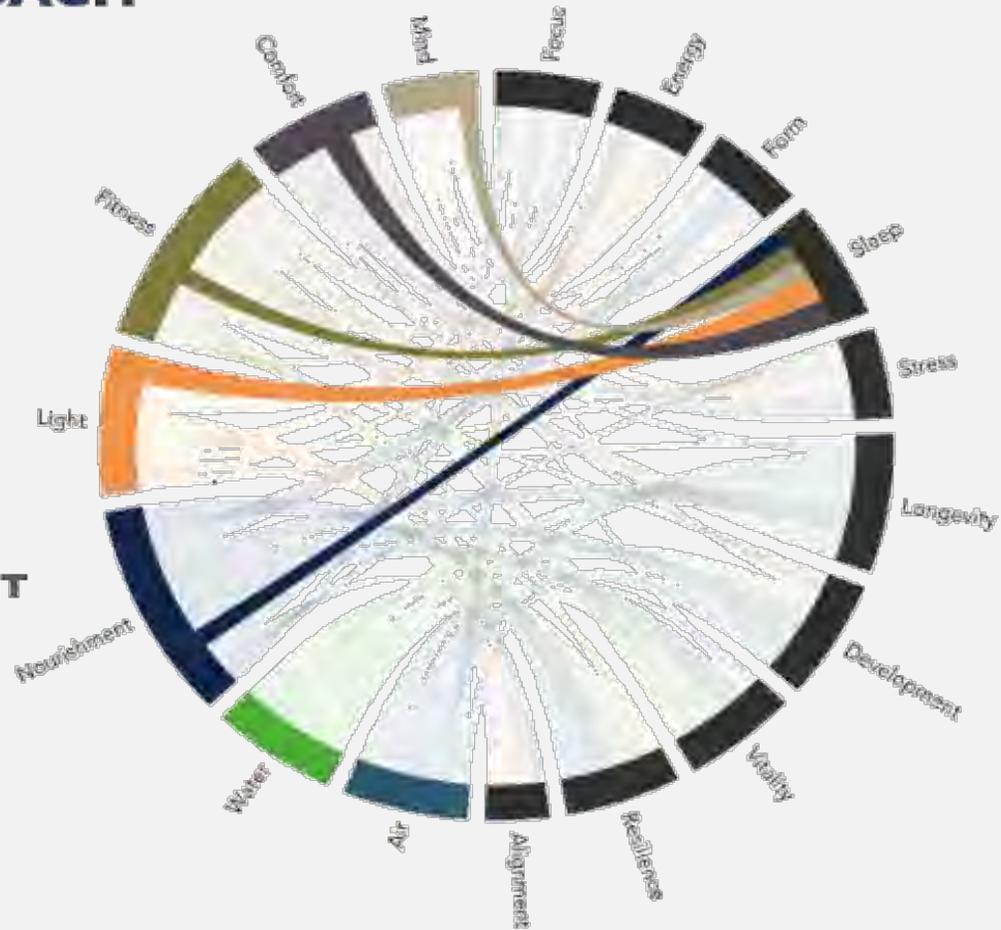
LEED IEQ Credit: Acoustic Performance



100 decibels - STC 20 = 80decibels

WELL Building Standard

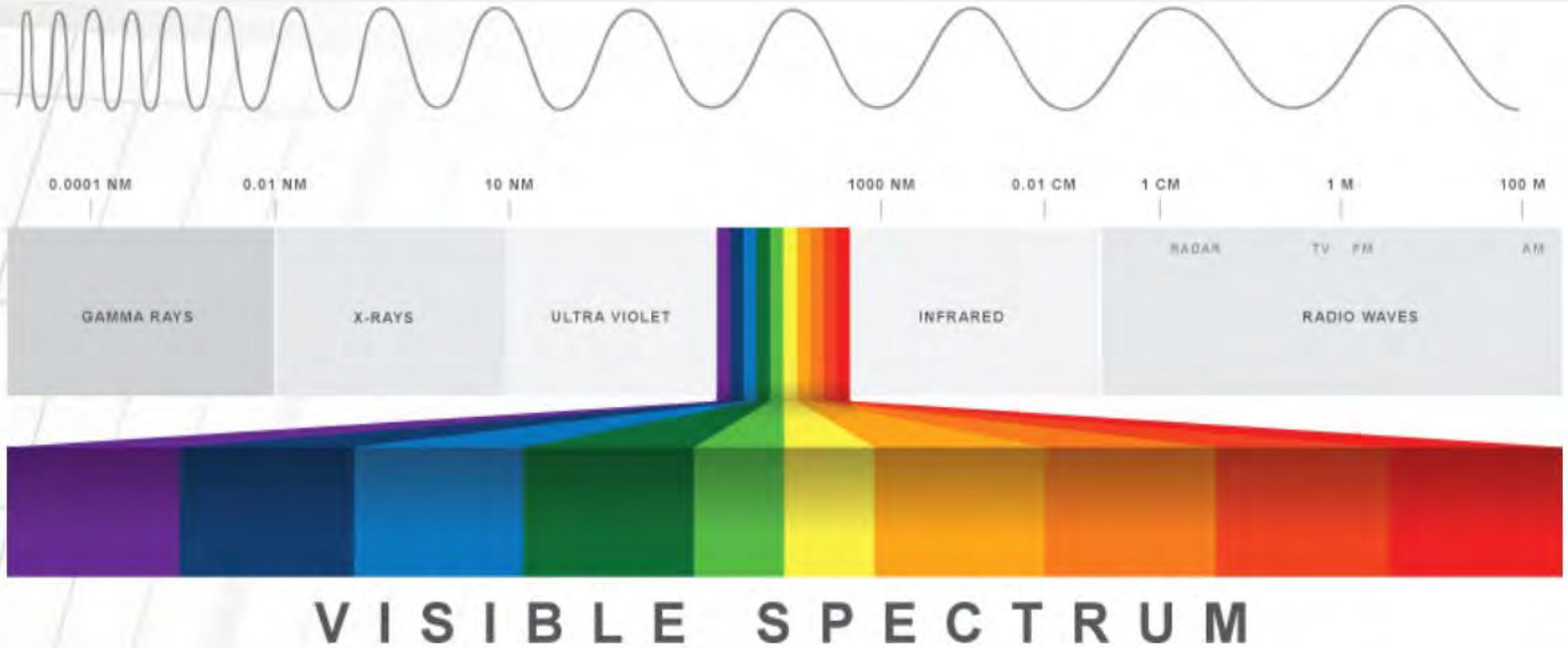
HOLISTIC APPROACH



Natural Light & Nourishment



Natural Light & Nourishment

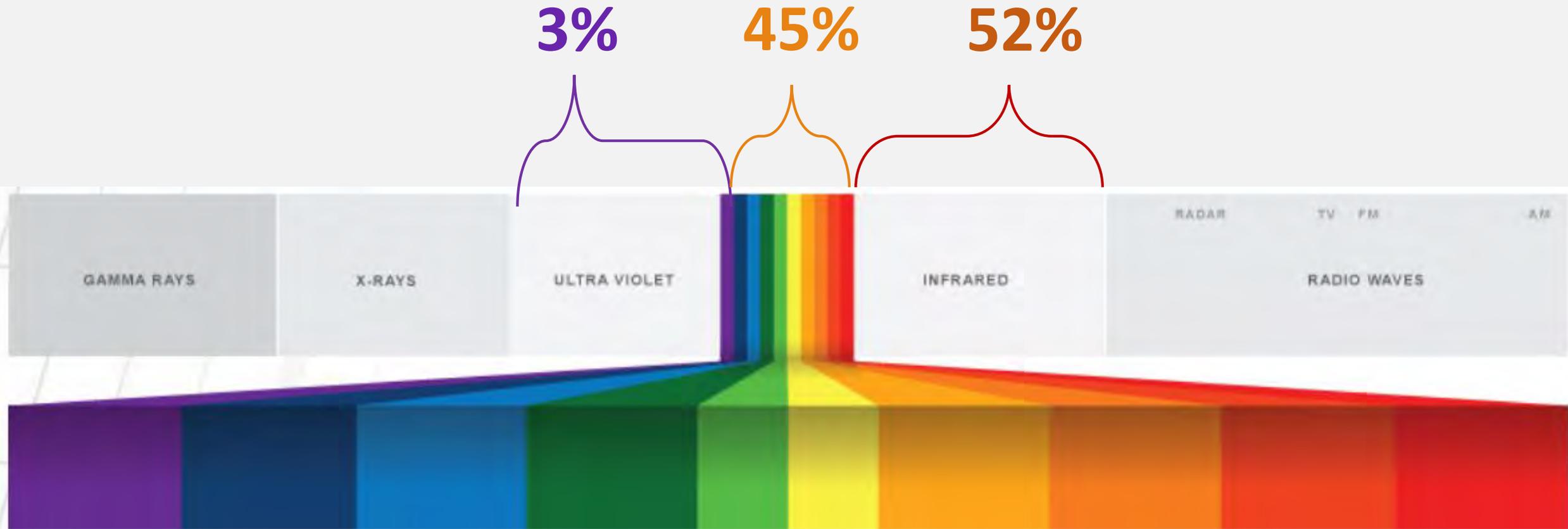


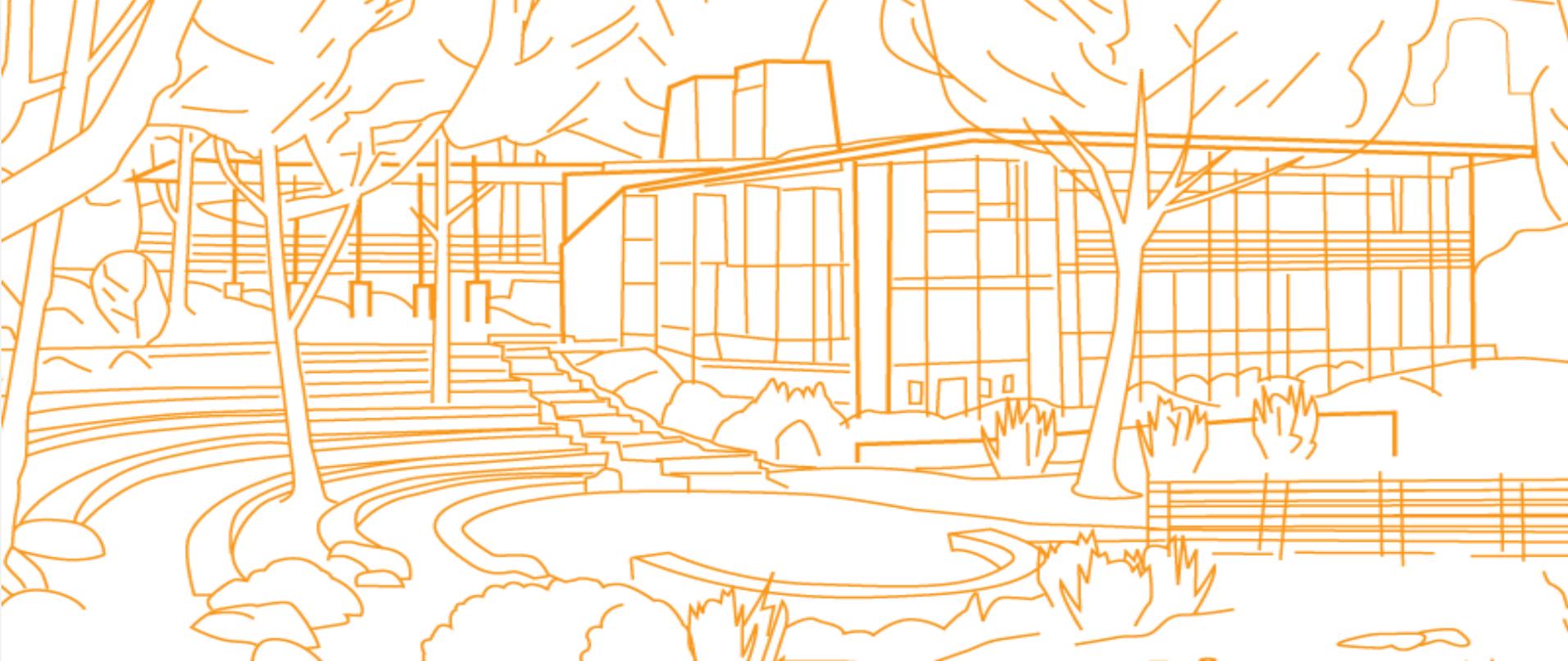
LEED IEQ Credit: Daylight

- NYC office LUX plan in June
- October also needed
- Option:
Prove 300-3000 lux in 75%+ of occupied spaces



Visible Light v. Thermal Comfort

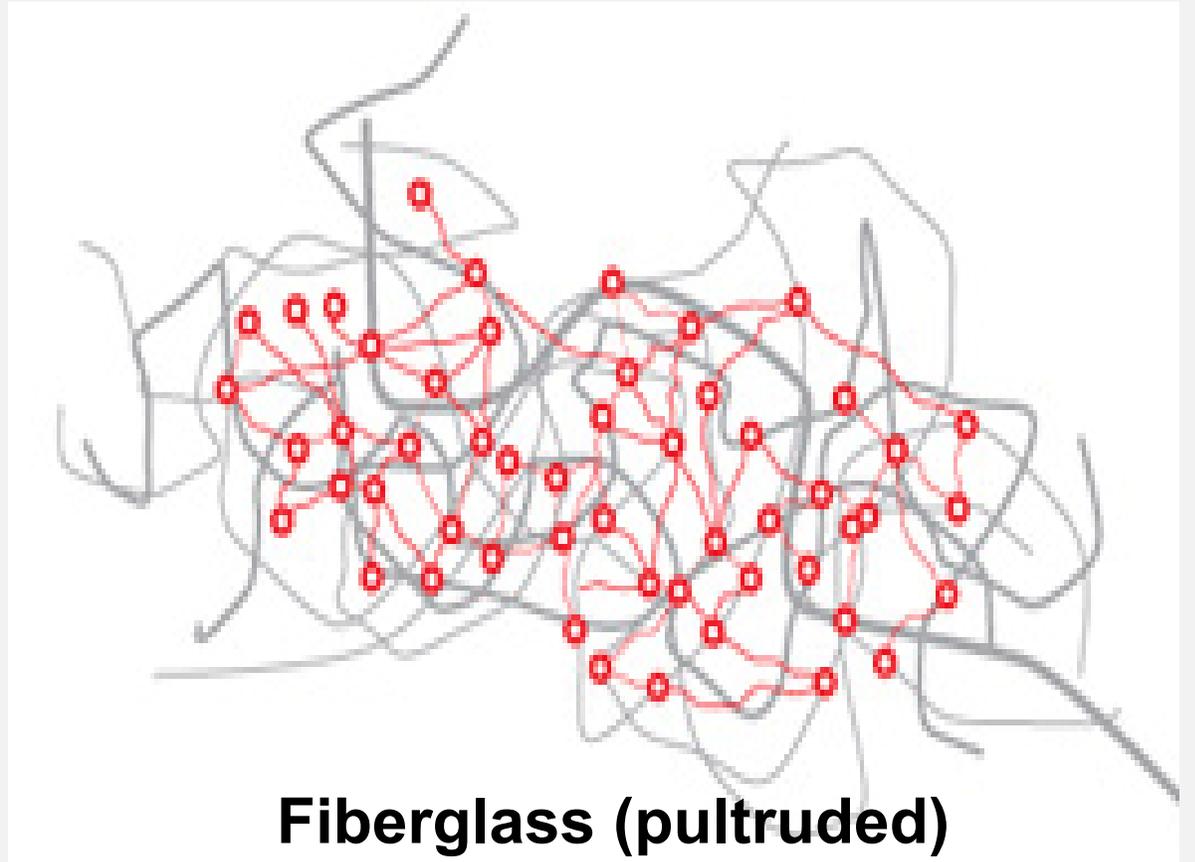
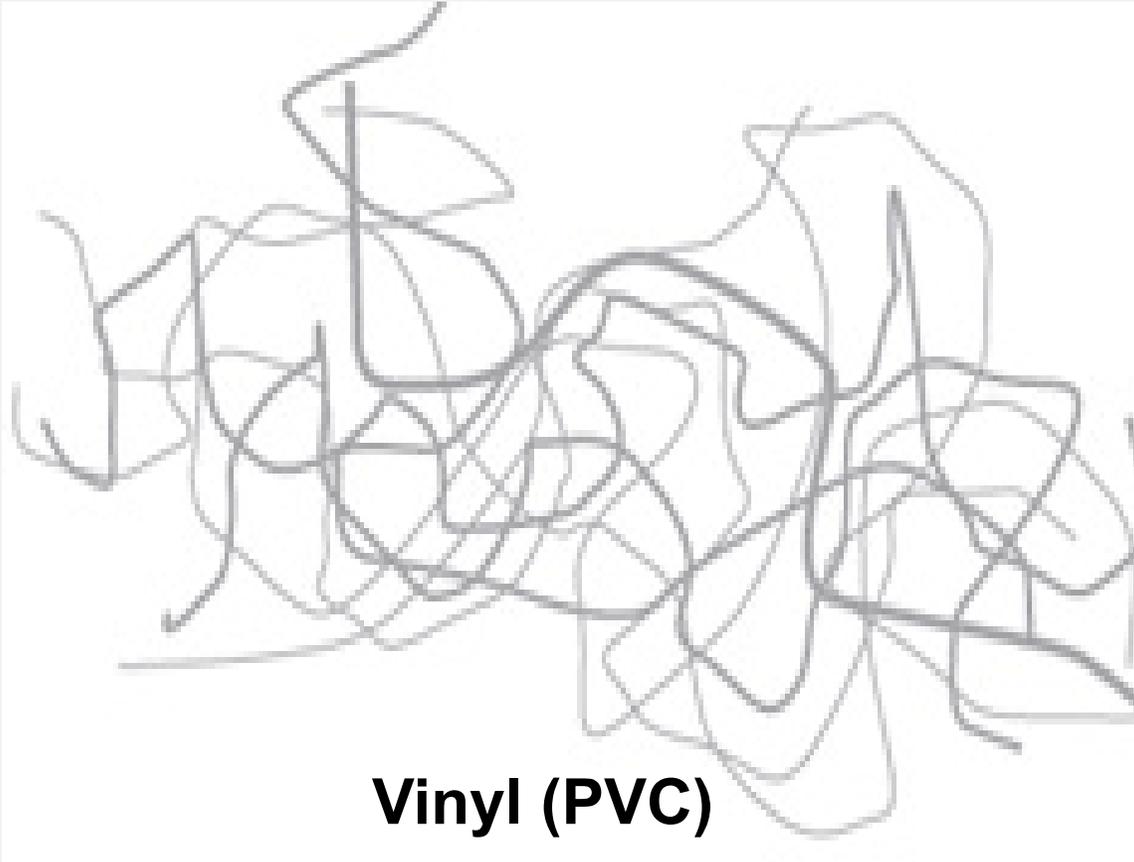




LEED Credits & WELL Optimizations: Low-Emitting Materials



Thermoplastic v. Thermoset





Mmmm...
'New Car
Smell'

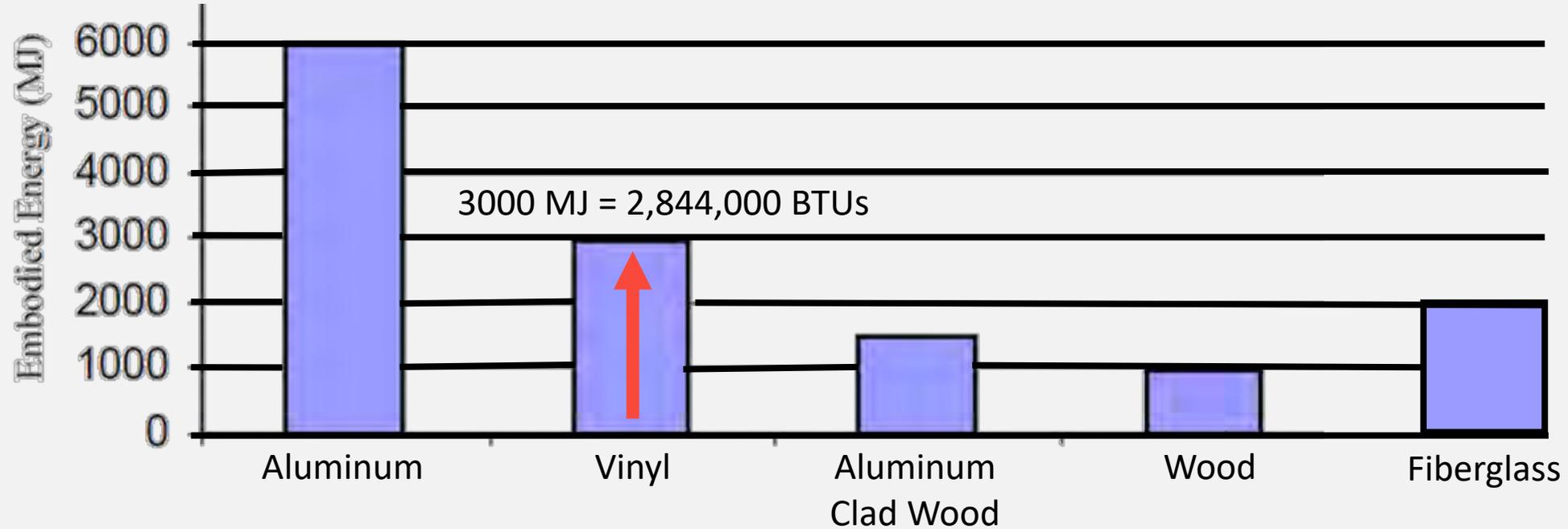
★ GUTTURAL GROANING ★

Learning Objective Five

Analyze the environmental costs of various fenestration materials.

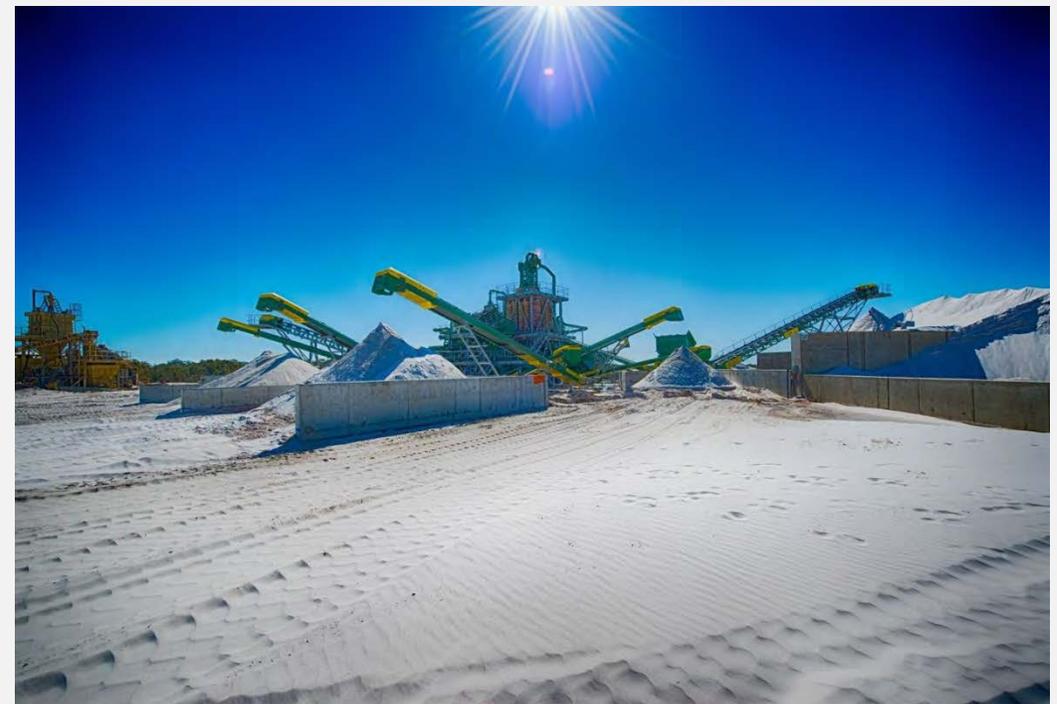


Embodied Energy: 4' x 4' Window

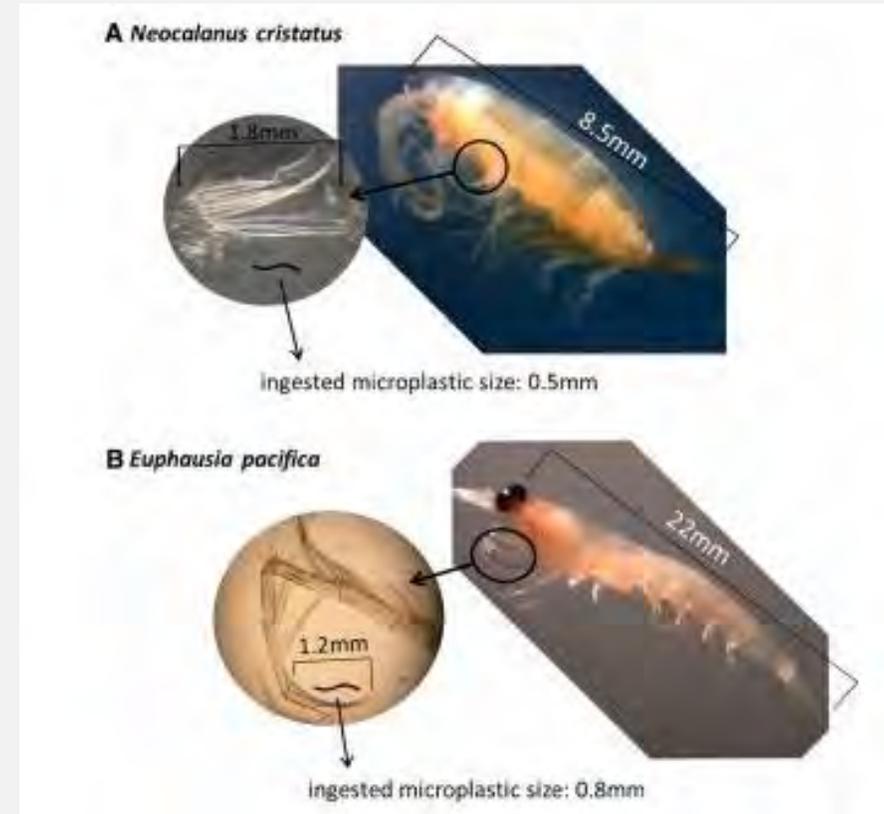


1 MegaJoule = 948 BTUs (British Thermal Units)

Silica Sand Mining Environmental Effects



PVC Environmental Effects of PVC



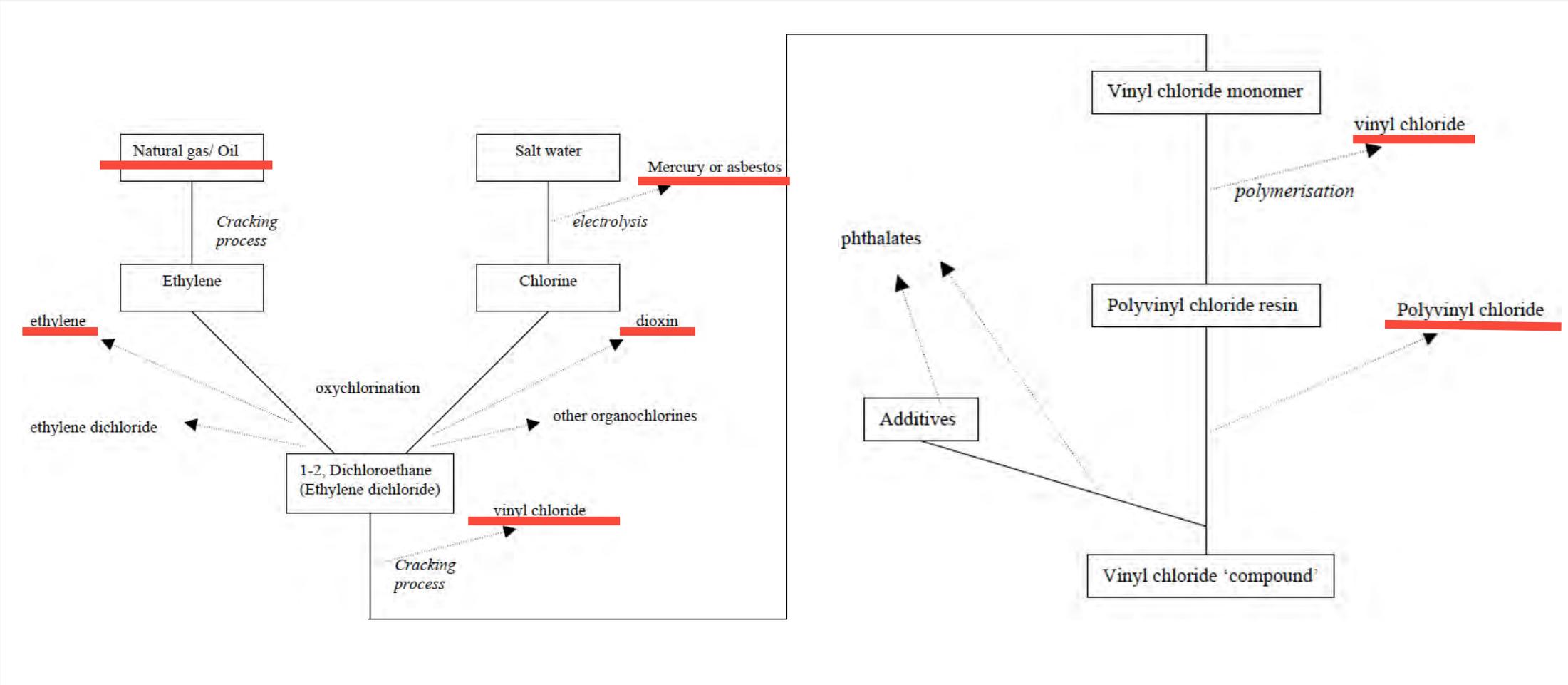
Vinyl Windows' Chemical Makeup



Vinyl → PVC → PolyVinyl Chloride

- 51% Chlorine by weight
- 49% hydrogen + carbon that is derived from
 - Oil, Petroleum
 - Natural Gas

Vinyl Windows' Manufacturing





Learning Objective Six

Share optimistic solutions and
emerging technologies

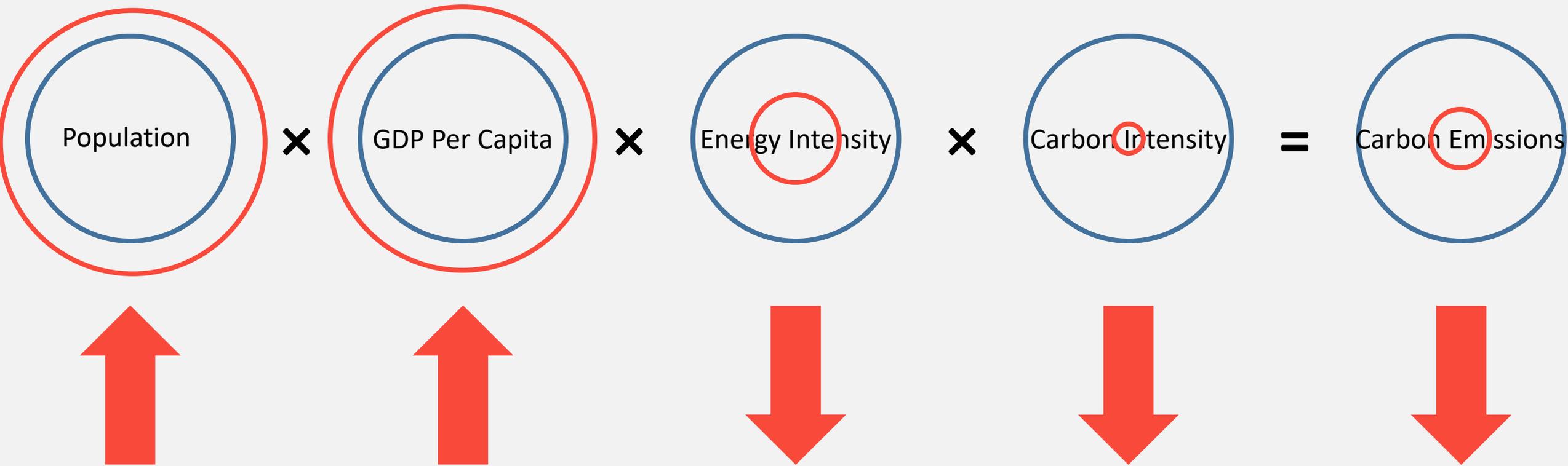
The Kaya Identity:

$$I = P \times A \times T$$

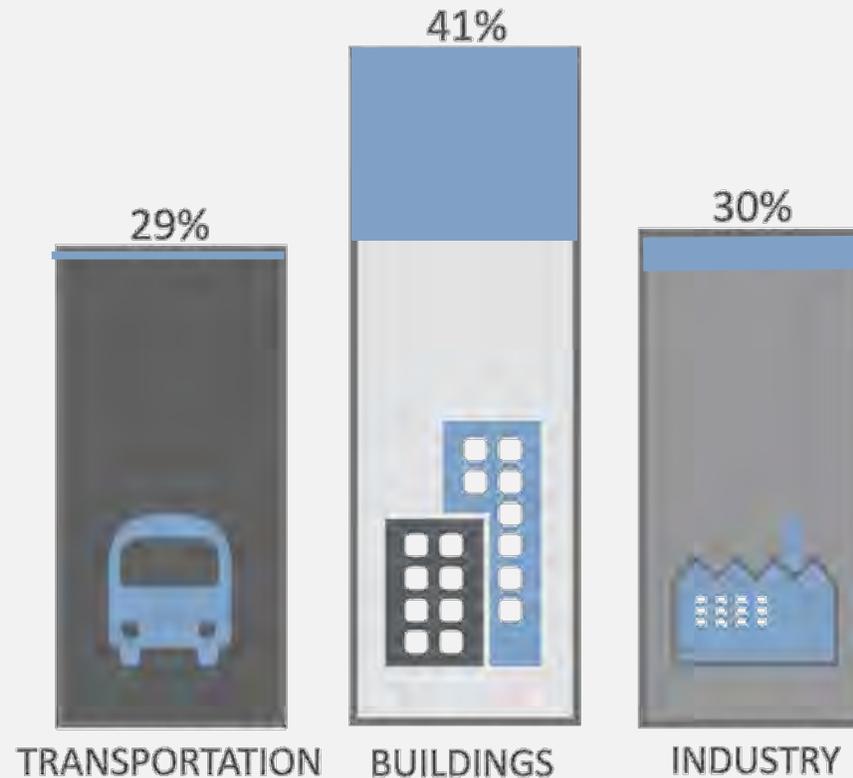
(8%)

Human Impact = Population × Affluence × Technology

The Kaya Identity



Fenestrations' GHG & Energy Impact





HELP

Marco Vincent Assoc.AIA, CPHC®, WELL-AP®, LEED-AP®

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