



Performance Glazing & Building Envelope Optimization

GLAZING16

1 AIA LU HSW

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Course Description


The program *Performance Glazing and Building Envelope Optimization* describes how Low E coatings work, both from scientific and applications perspectives. The manufacturing process of applying coatings to glass is shown, and benefits of Low E coatings for energy efficiency are presented.

Learning Objectives

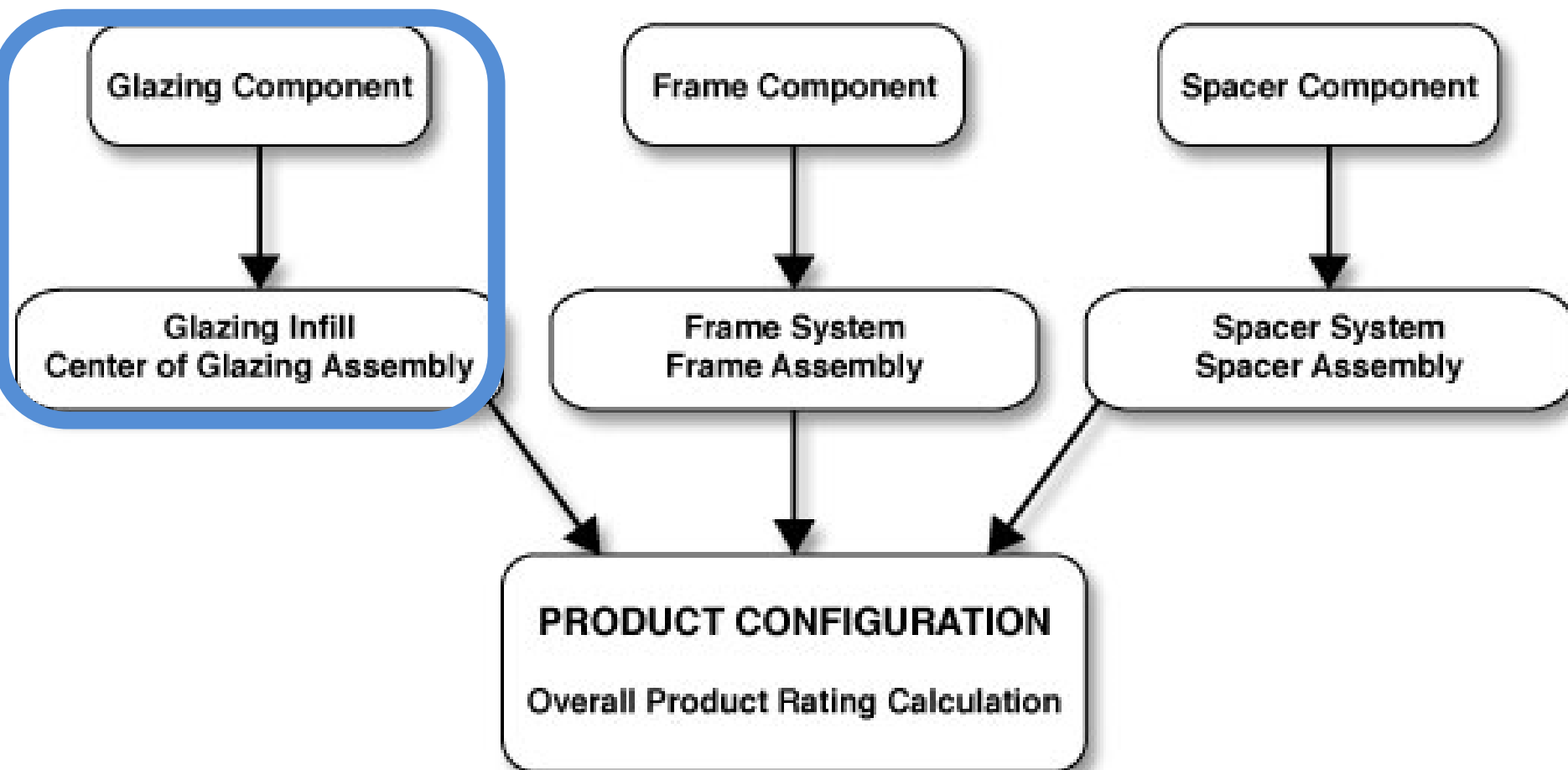
After this presentation you will be able to:

1. Explain NFRC (National Fenestration Rating Council) units and labeling
2. Understand the science of the Light Spectrum
3. Discuss Coating Performance
4. Describe Application Technology
5. Apply Knowledge for Optimization Engineering

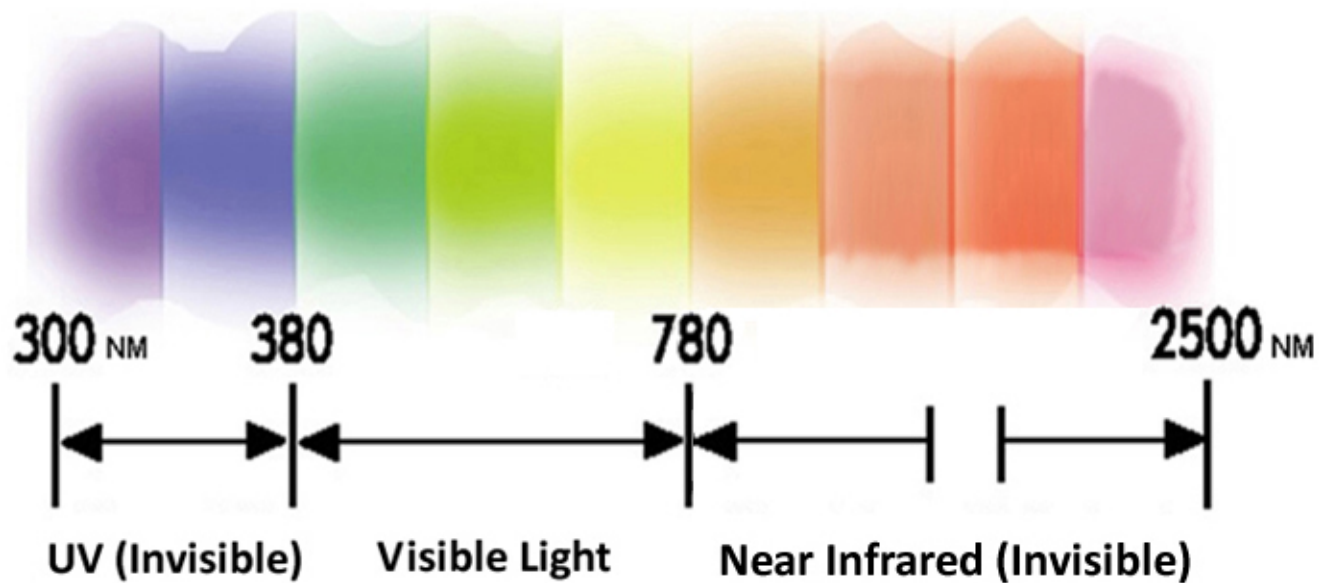
NFRC Label

	World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider	
ENERGY PERFORMANCE RATINGS		
U-Factor (U.S./I-P) 0.35	Solar Heat Gain Coefficient 0.32	
ADDITIONAL PERFORMANCE RATINGS		
Visible Transmittance 0.51	Air Leakage (U.S./I-P) 0.2	
Condensation Resistance 51	—	
<p>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.</p> <p>www.nfrc.org</p>		

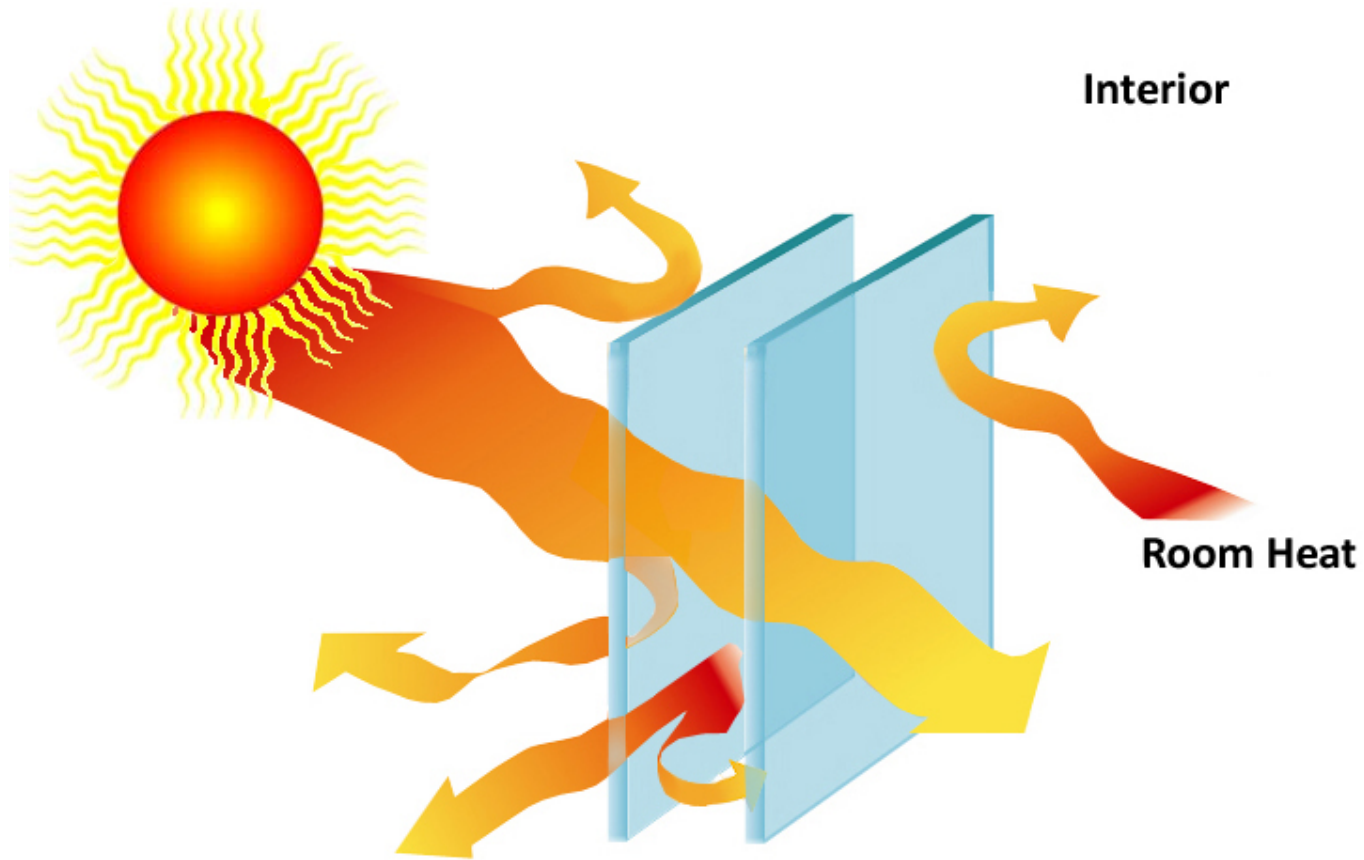
NFRC ratings are derived from the **Component Modeling Approach**



Solar Light Spectrum



Glazing and the Solar Spectrum



Windows reflect, absorb, and transmit ultraviolet light, visible light, and heat.

Why Low E Coatings?

1. Energy Savings
2. Code Compliance
3. Indoor Environmental Quality
 - a) Thermal Comfort
 - b) Less Condensation
 - c) Reduced Fading
 - d) Daylight Control
 - e) Sound Buffering

Energy Codes & Rating Systems

ASHRAE 90.1 (American Society of Heating, Refrigerating, and Air-Conditioning Engineers)

Three path options for compliance

1. Window-to-Wall Ratio Method
2. Sunlight v. Electricity Trade-off
3. Holistic Building Envelope Energy

IECC (International Energy Conservation Code)

- Referenced by ASHRAE 90.1
- Used by PHIUS & LEED
- Divides US into eight climate zones

Energy Codes & Rating Systems

PHIUS (Passive House Institute US)

- Recommends U-factors & SHGC
- Based on holistic building performance prescriptions, not windows alone
- Utilizes IECC's 8 part map

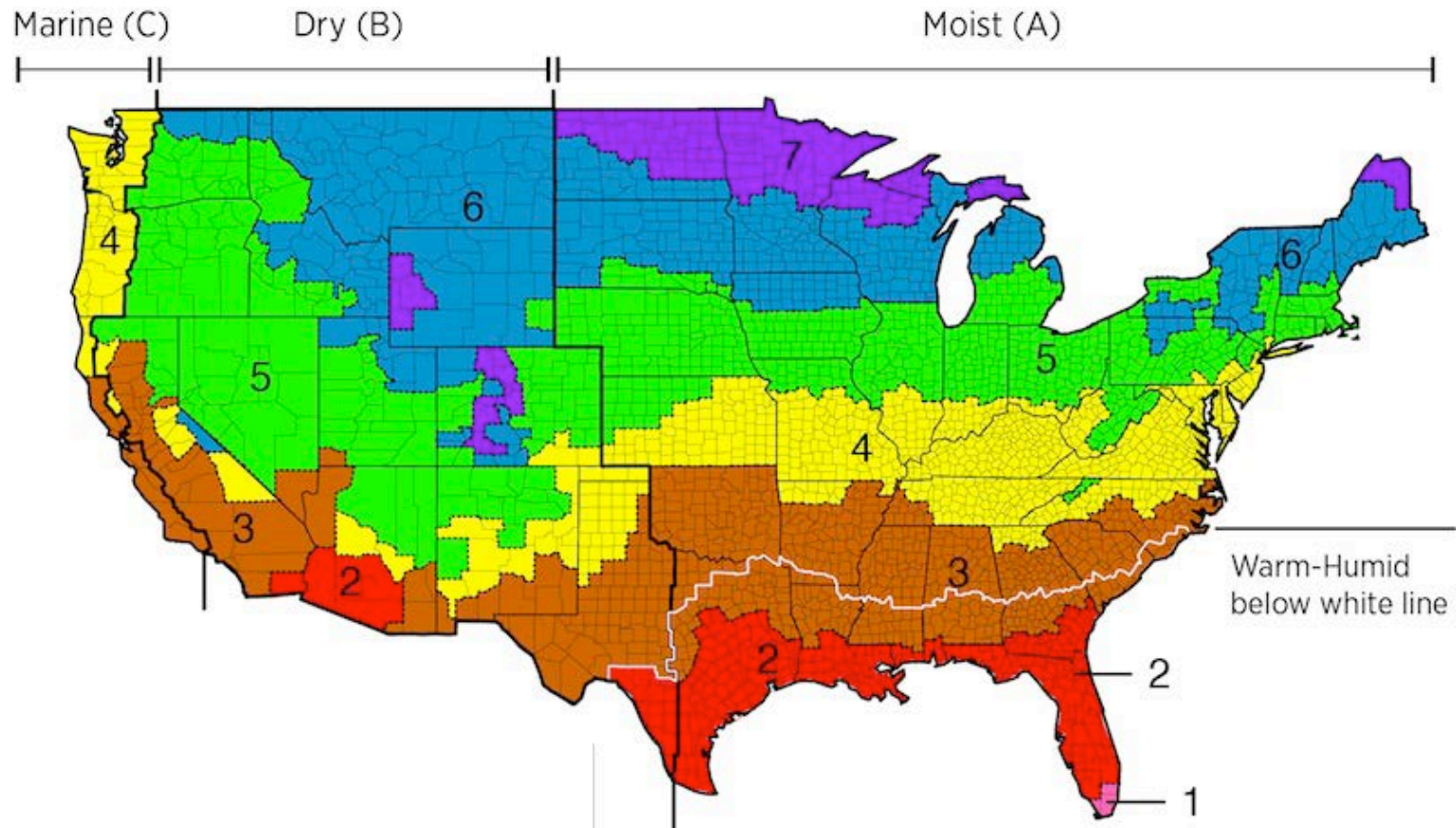
EnergyStar

- Voluntary EPA U-Factor prescriptions
- Based on four US climate zone map
- In response to 'Clean Air Act' (1992) & 'Energy Policy Act' (2005)

IECC

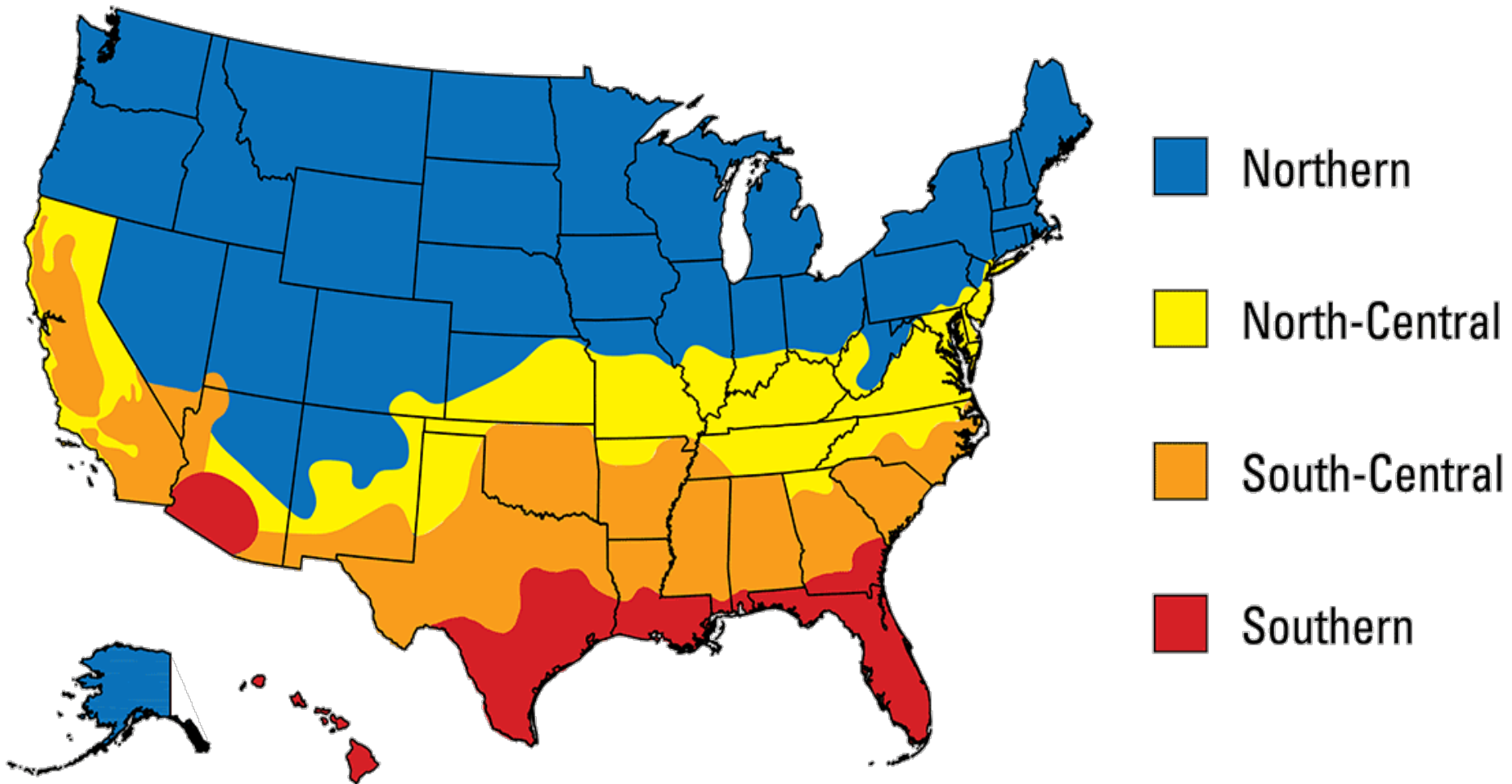
Climate Zone Map

(PHIUS, ASHRAE)

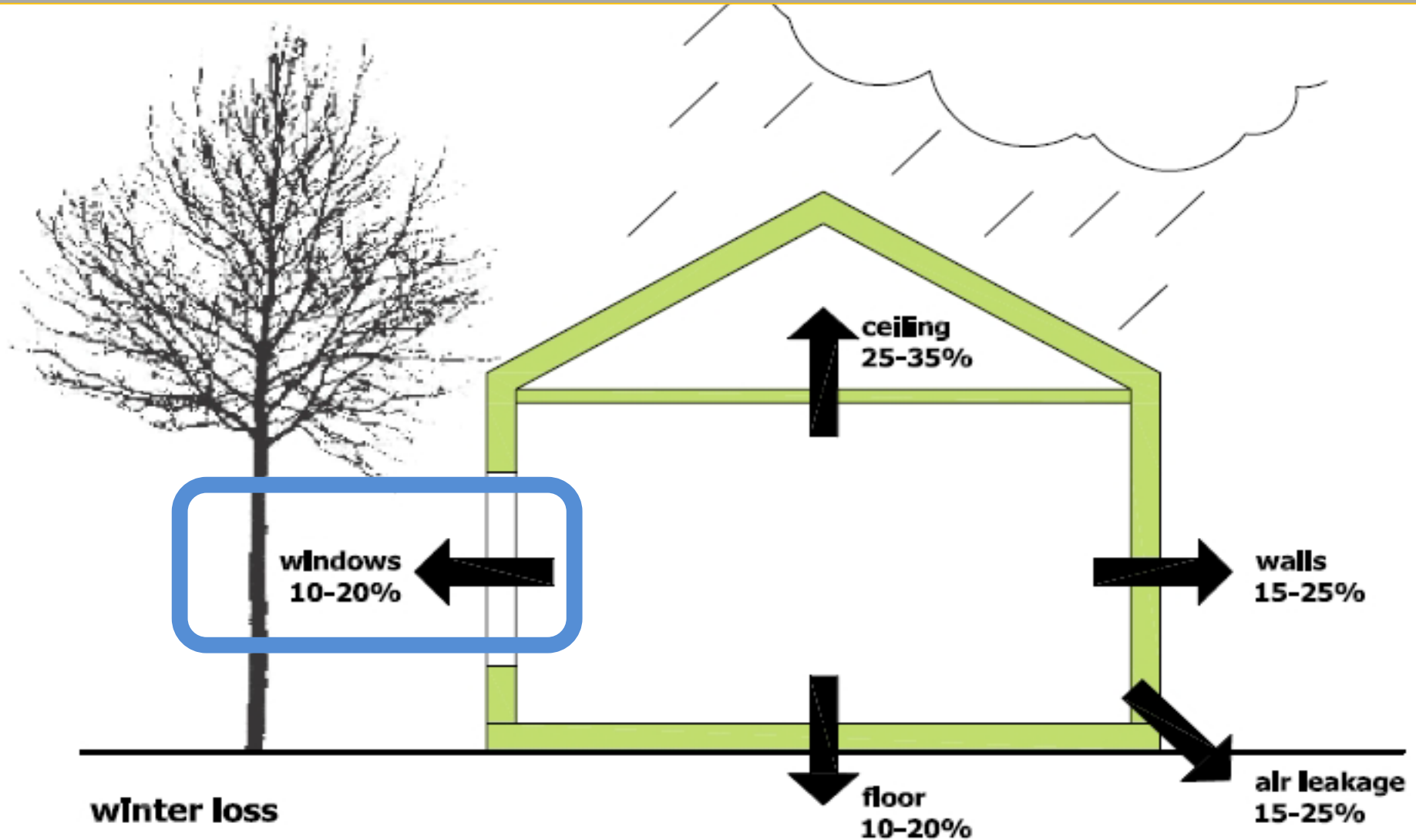


EnergyStar

EPA Map

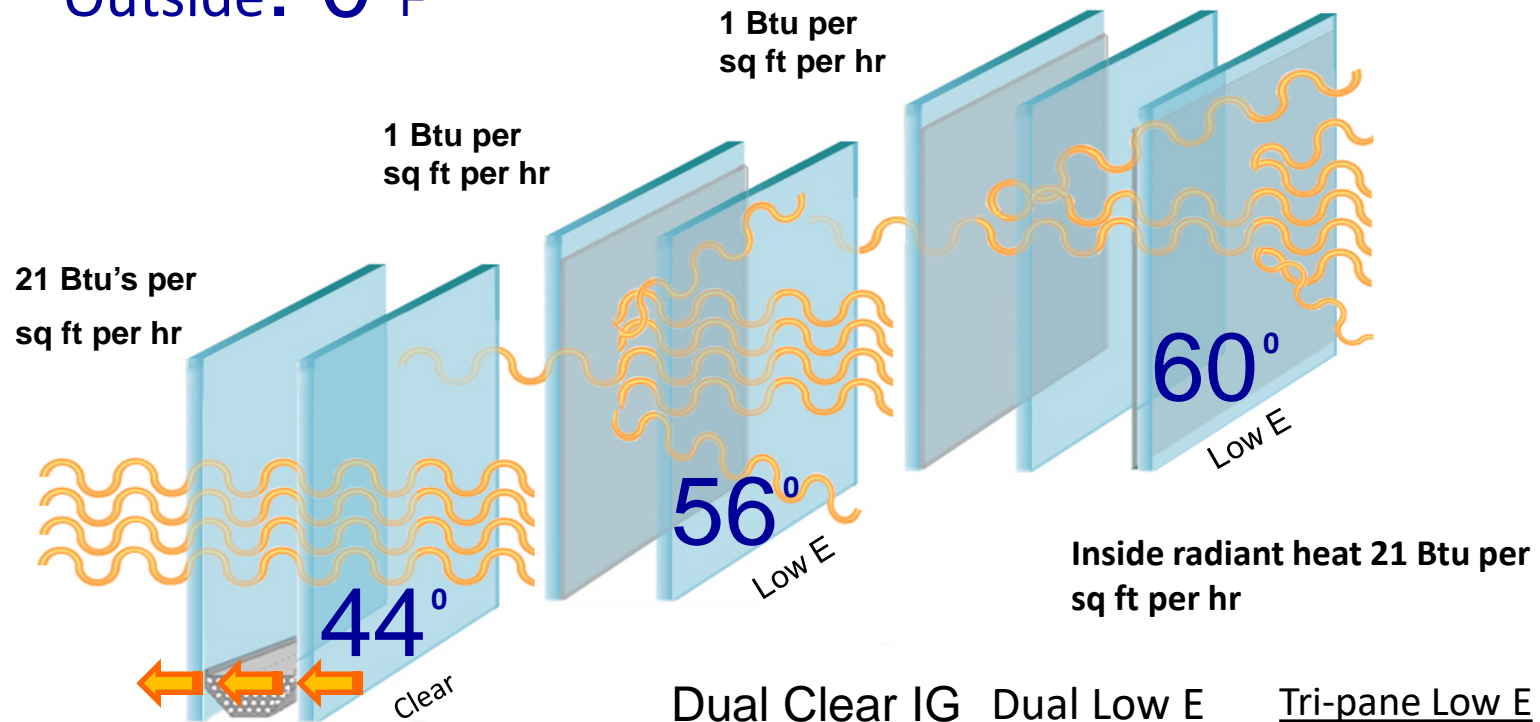


Average Percentages of Heat Loss in Winter



Low E Effect On Winter Nights

Outside: 0°F



Btu of radiant heat loss from the home :

21 Btu

1 Btu

1 Btu

Conduction heat loss through materials:

13 Btu

16 Btu

10 Btu

Inside glass temp at 0 degrees F outside :

44 deg

56 deg

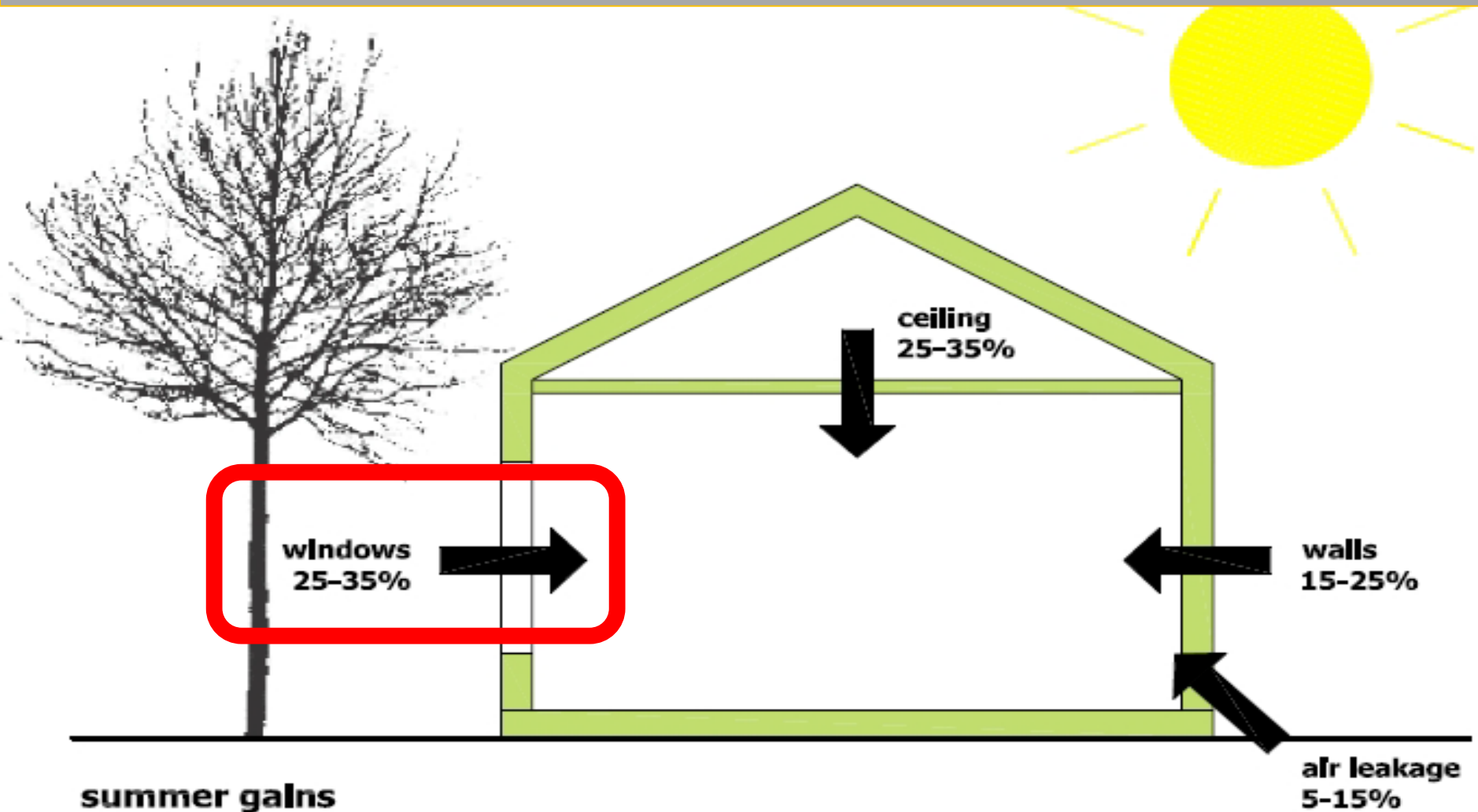
60 degrees

Total Btu exiting through the glazing: 34 Btu

17 Btu

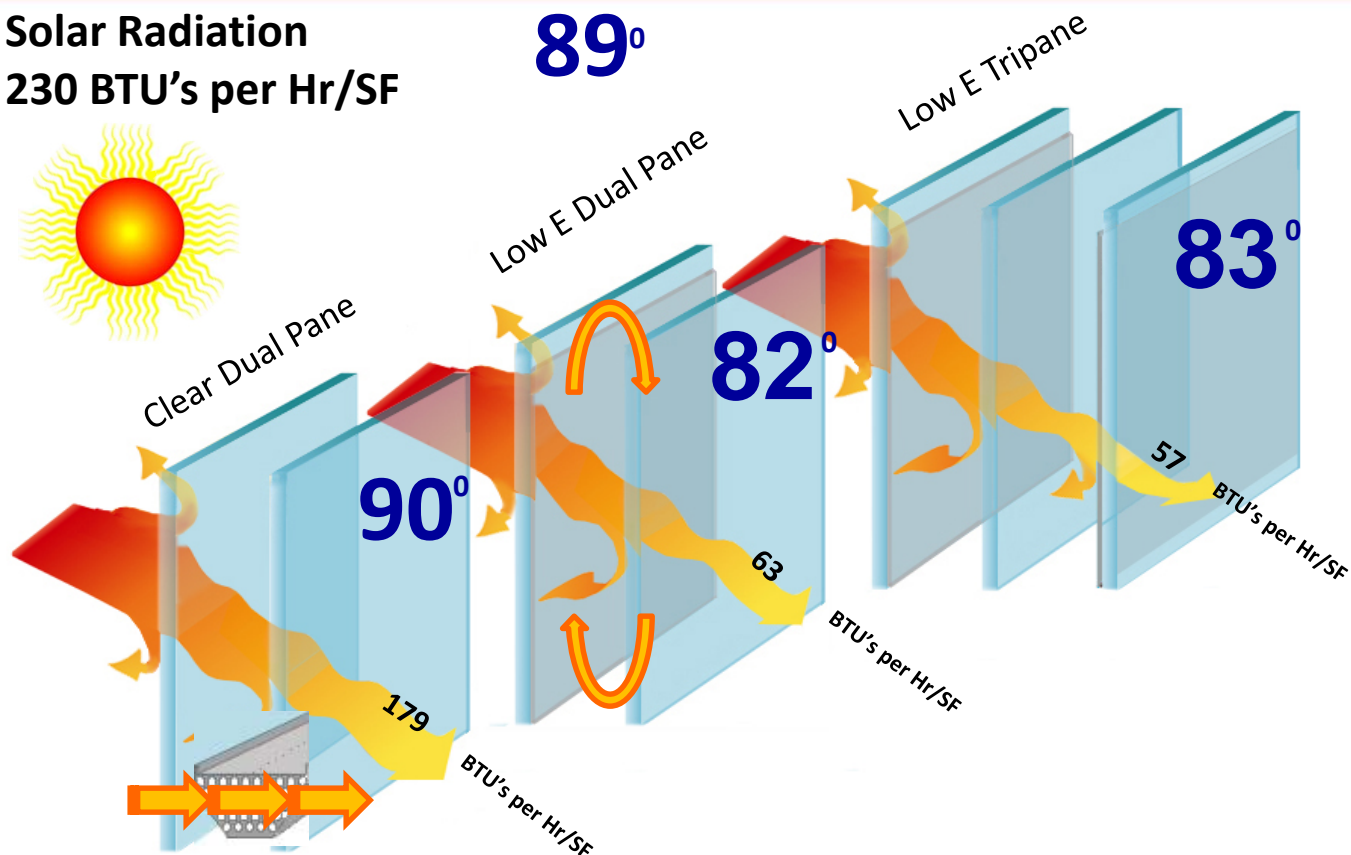
11 Btu

Average Percentages of Heat Gains in Summer



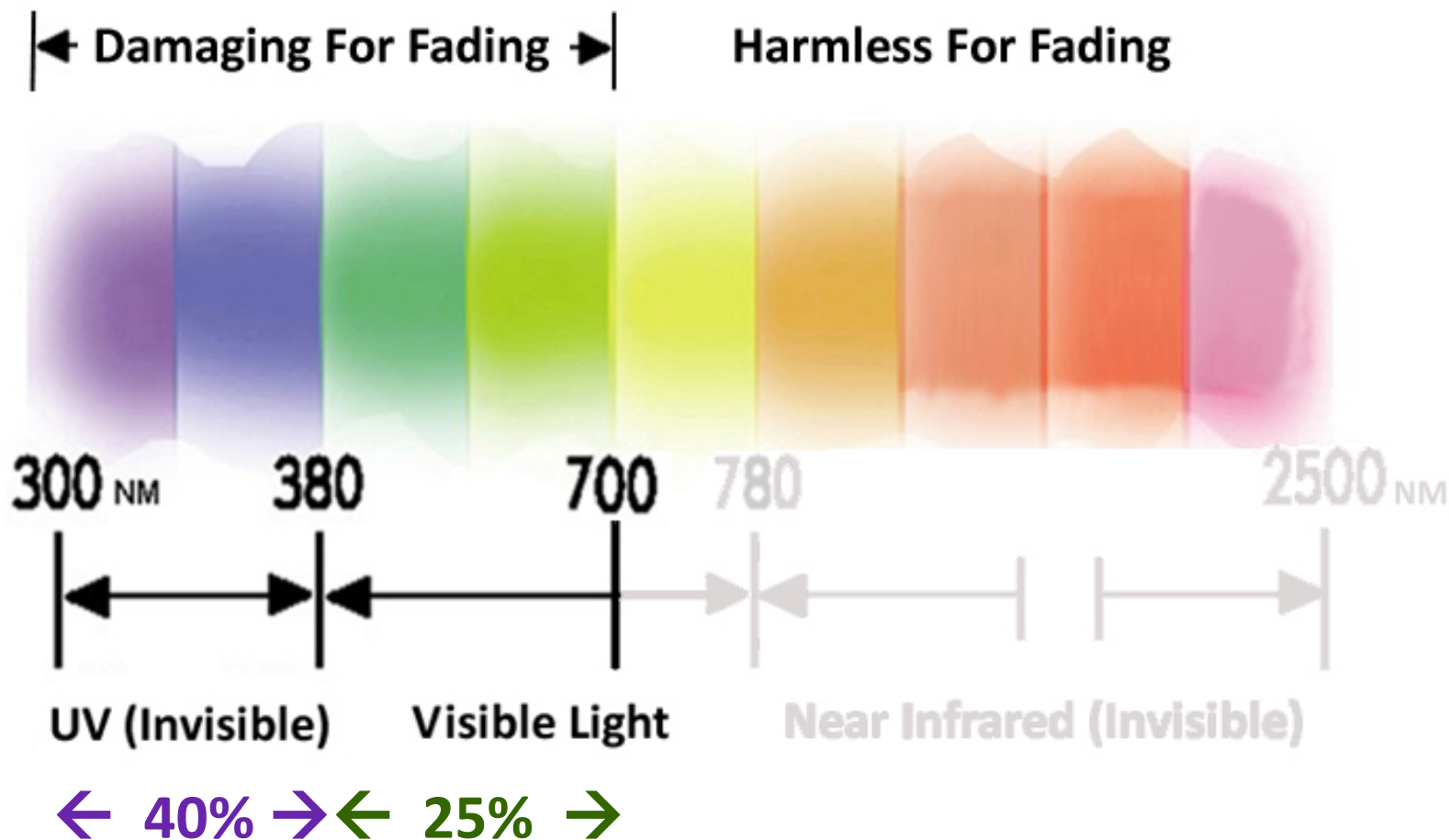
Low E Effect On Summertime Sun

Solar Radiation
230 BTU's per Hr/SF



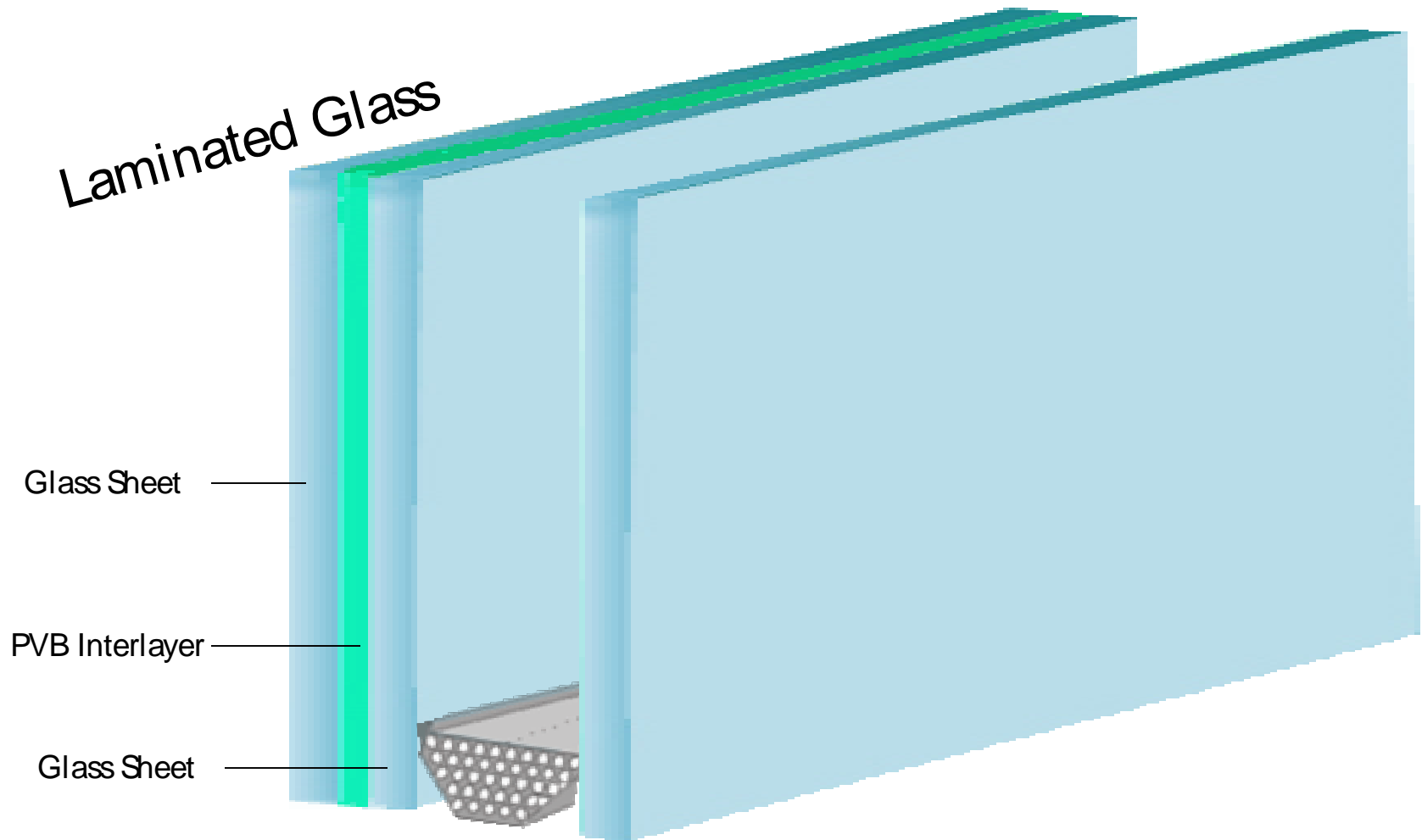
Btu via solar radiation reduction :	22%	73%	75%
Conduction heat entering materials:	7 Btu	3 Btu	2 Btu
Convection heat transferred:	12 Btu	6 Btu	8 Btu
Inside glass temperature:	90 degrees	82 degrees	83 degrees

Protection from Sunlight Fading Potential



+25% from heat (infrared+interior)
+10% from interior light & humidity

Laminated Glass Benefits

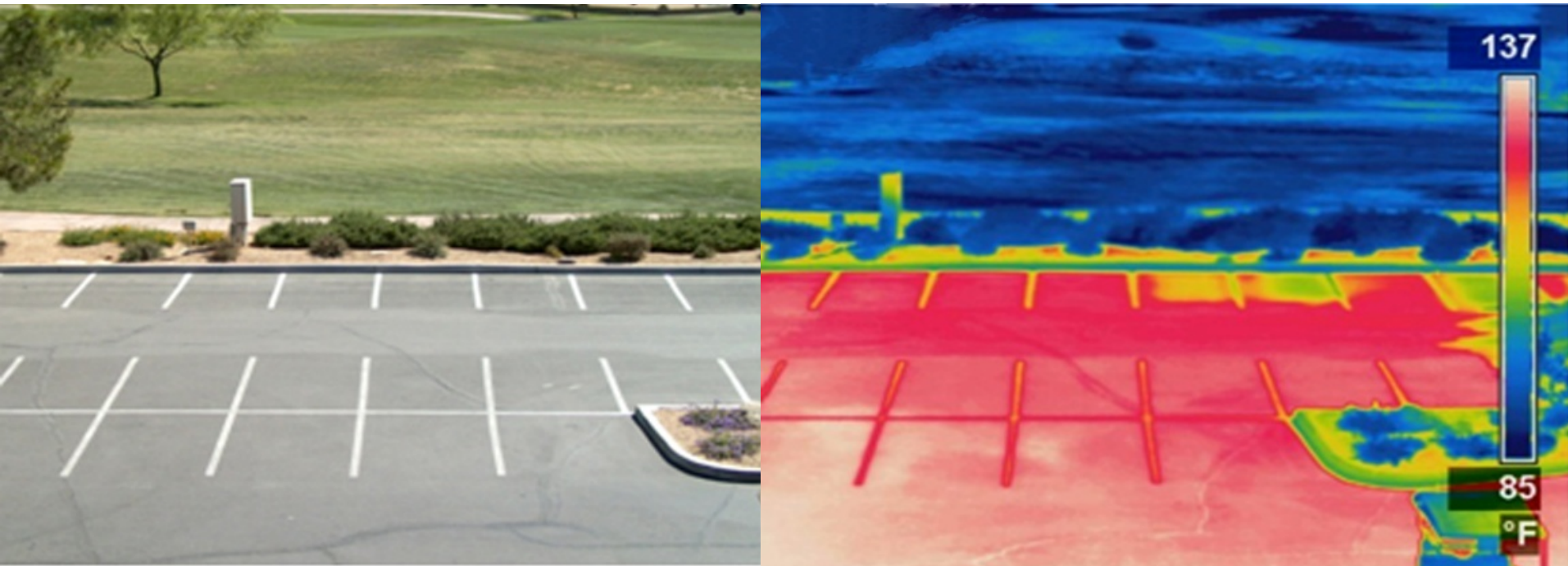


Energy-efficient glazing systems

- 1.) Defining Emissivity (E)
- 2.) Types of Low E
- 3.) Where & How Low E is applied
- 4.) Engineering for Optimized Performance of Building

Emissivity (E)

Measure of a material's ability to emit long wave infrared light and radiation (heat).



Coating Process

Sputtered

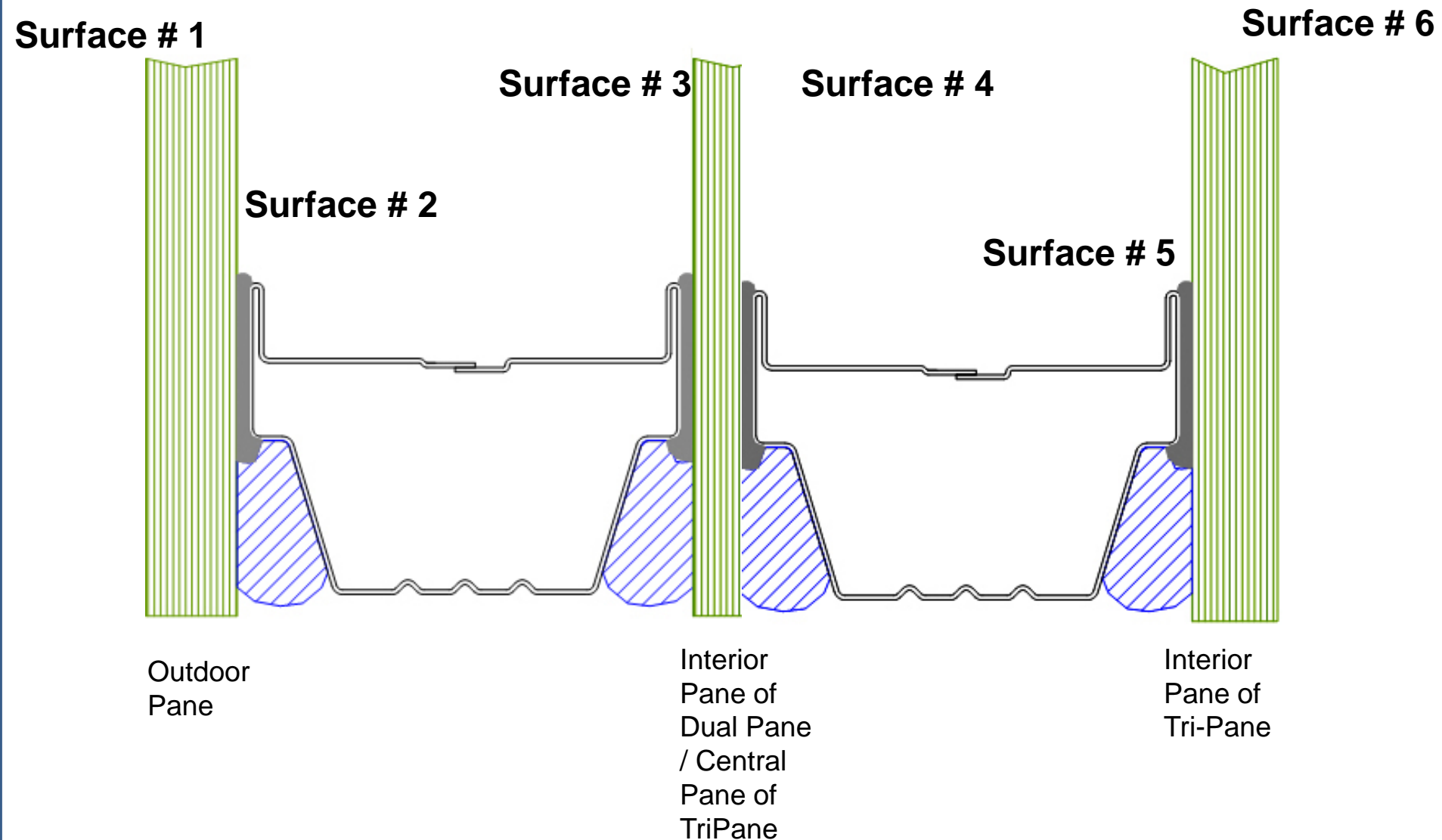
vs.

Pyrolytic

- Low emissivity
- Low-Med-High SHG
- Silver based
- Vacuum deposition
- Uniform
- Neutral color
- Low Haze
- Must be insulated

- Medium emissivity
- High SHG
- Metal oxides
- Spray process
- Can be non-uniform
- Can have color
- Can have haze
- Single Glaze

Surface Designation



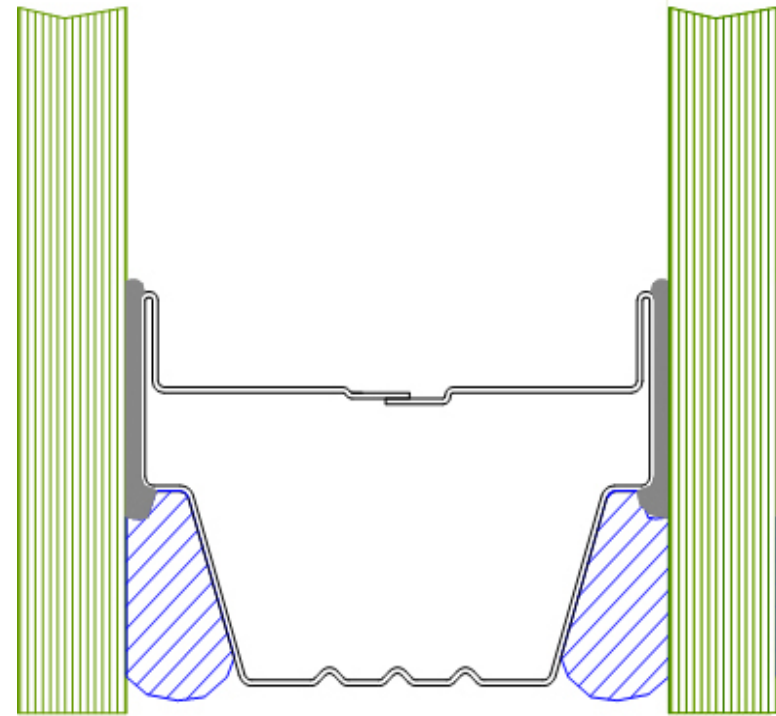
Coating Locations & Their Effects

Surface #2 on Dual Pane (Standard)

- Better overall performance
- Reduces Solar Heat Gain
- Reduces Summer Inside Glass Temp
- Reduces Thermal Bridging in Winter

Surface #3 on Dual Pane

- Increased Solar Heat Gain
- Increased Inside Glass Temperature
- Can assist passive solar design
(if annual effects due to building orientation are measured)



**Winter night time
U-Factors are same
for surface #2
and surface #3**

Coating Locations & Their Effects

Surface #4 (Dual Pane)

- Reflects Heat
- Lowers U Factor
- Reduces Solar Heat Gain
- Decreases Inside Glass Temperature
(Increasing the Risk of Condensation)
- Rivals Tri-Pane Performance

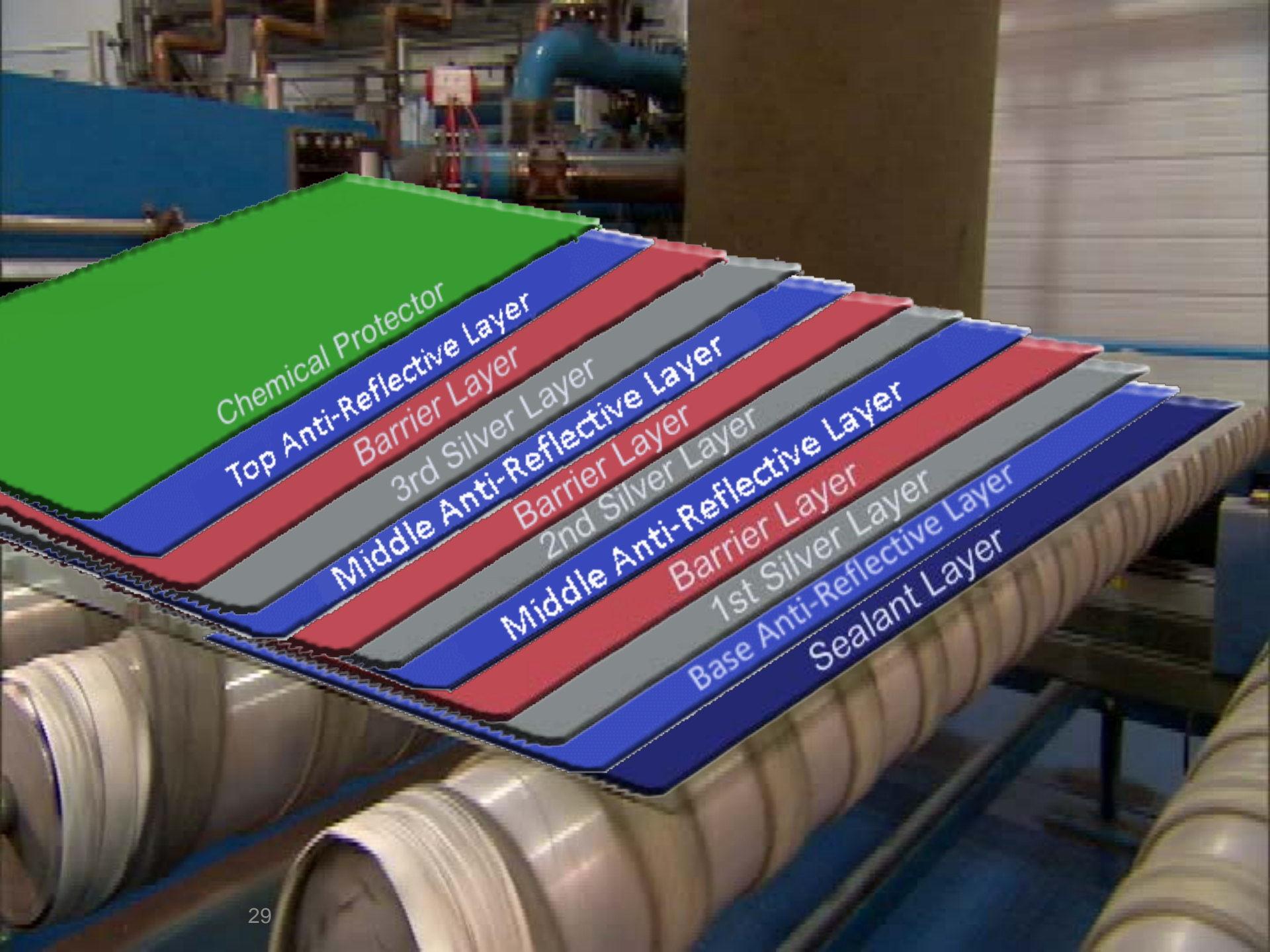
Tri-pane is typically assembled with the coatings on surfaces 2 and 5.

How Coatings are Applied



How Coatings are Applied



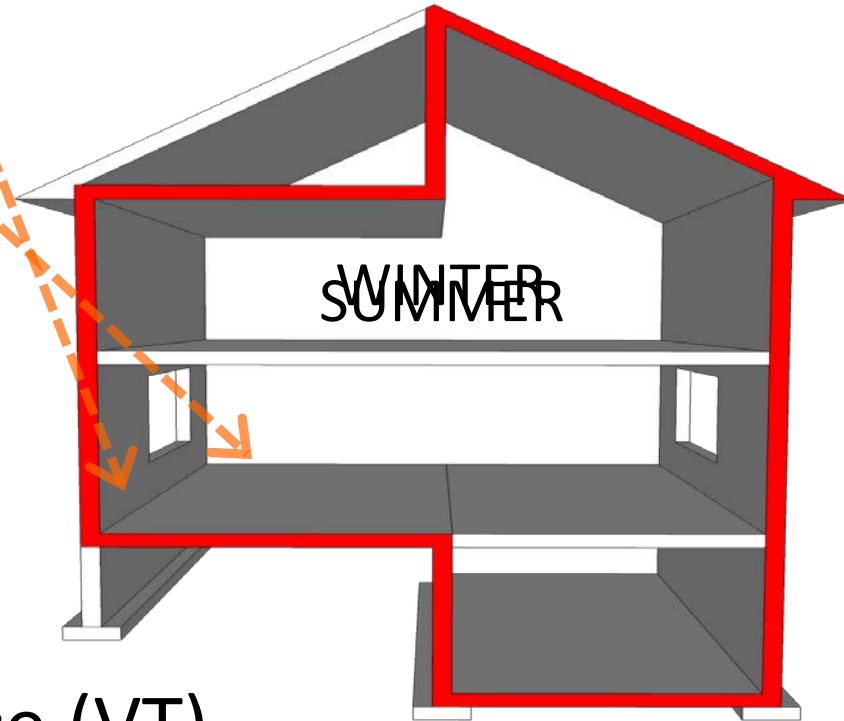


Spectrally Specific Coatings



Adjusting coatings
will cause variations in...

- U-Value
- Solar Heat Gain (SHGC)
- Visible Light Transmittance (VT)
- Visible Light Reflectance



U FACTOR = $1/R_{\text{value}}$ = BTU / hr.ft₂ .°F

**Measurement of heat transfer
through a material or an assembly**

Center of Glass U-factor

(Btu/hr/ft²F)

0.48

Double-Pane Clear

Double-Pane LoE-180_{tm} 0.26

Double-Pane LoE-180_{tm} Gray Tint** 0.26

Double-Pane LoE -272_{tm} 0.25

Double-Pane LoE -366_{tm} 0.24

Double-Pane LoE -340_{tm} 0.25

Triple-Pane LoE-180_{tm} 0.15

Triple-Pane LoE -366_{tm} 0.14

3mm, ½ "space, 3mm (90% ARGON filled, opposed to air, or KRYPTON)

Coatings on surface #2, except for: Graytint = #3 ; Tripane= #2 and #5

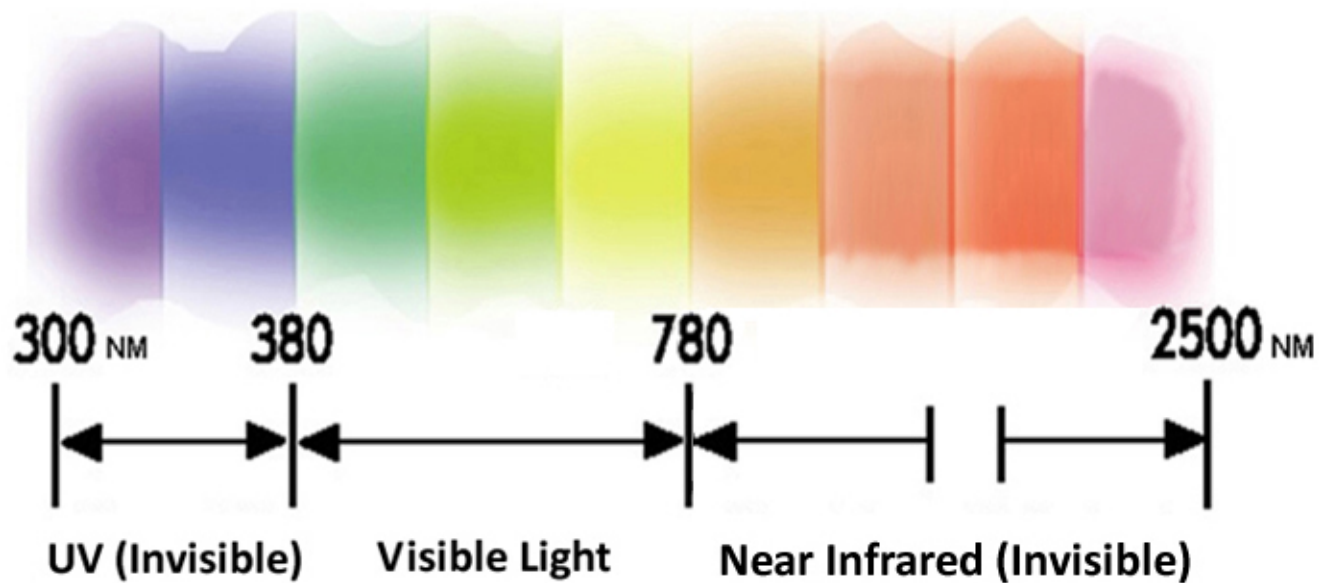
Solar Heat Gain Coefficient (SHGC):



A number between 0 and 1

Lower SHGC = less solar heat transmitted + greater shading ability

Solar Light Spectrum



| 3% | 45% | 52% |
← HEAT GENERATION →

Solar Heat Gain Coefficient (SHGC)

		SHGC	Indoor Glass ⁰ Temp F
Double-Pane	Clear	0.78	90
Double-Pane	LoE-180 _{tm}	0.64	86
Double-Pane	LoE-180 _{tm} Gray Tint**	0.49	93**
Double-Pane	LoE -272 _{tm}	0.41	86
Double-Pane	LoE -366 _{tm}	0.27	82
Double-Pane	LoE -340 _{tm}	0.18	79**
Triple-Pane	LoE-180 _{tm}	0.56	94
Triple-Pane	LoE -366 _{tm}	0.24	91

(Krypton Gas Typically Decreases SHGC by 0.02)

3mm, ½ "space, 3mm (90% ARGON)

**Coatings on surface #2, except for:

Graytint = #3 ; Tripane= #2 and #5**

Visible Light Transmittance (VT):



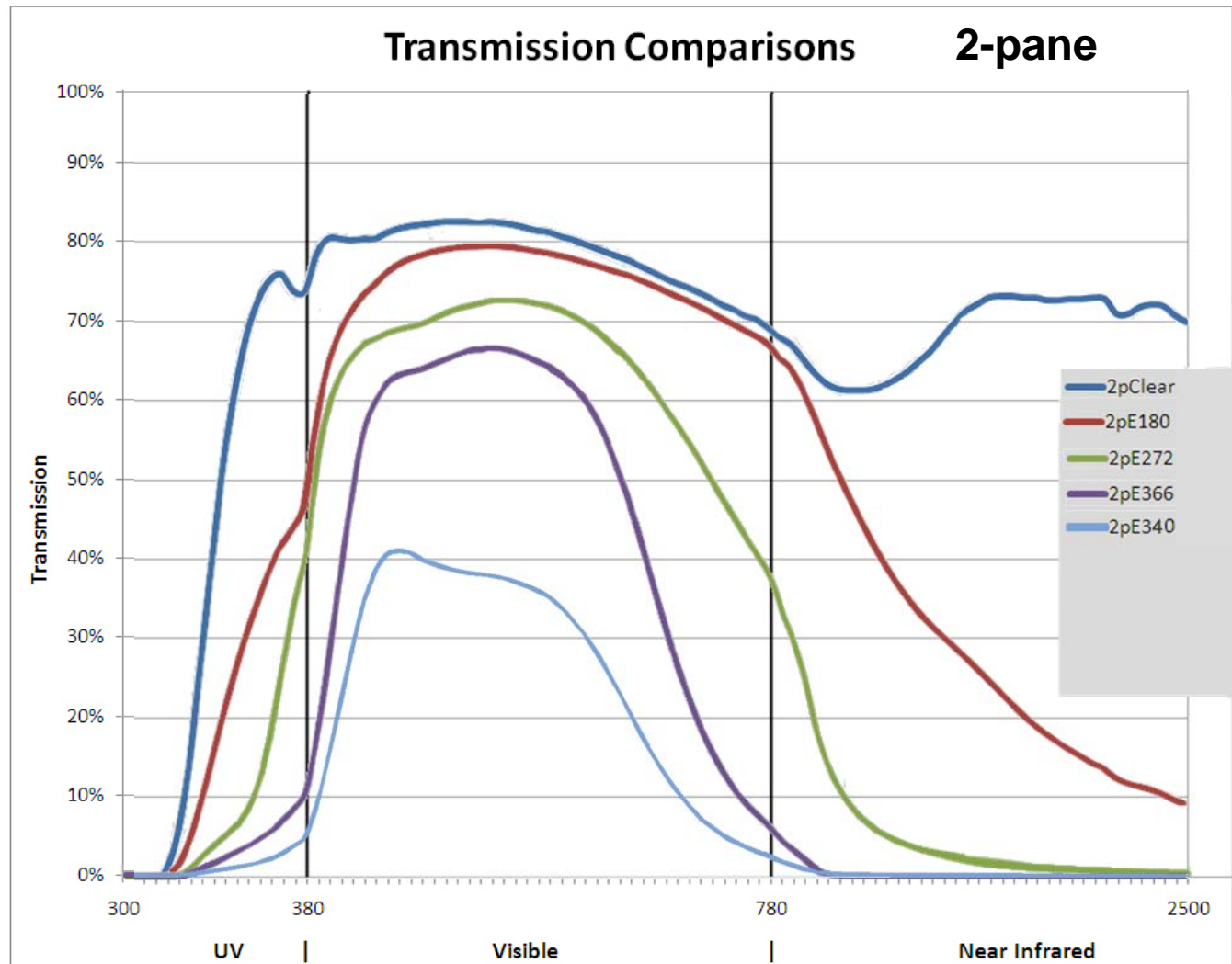
- An optical property for the amount of visible light transmitted.
- A number between 0 and 1, typically between 0.3 and 0.8

VT: Visible Light Transmittance

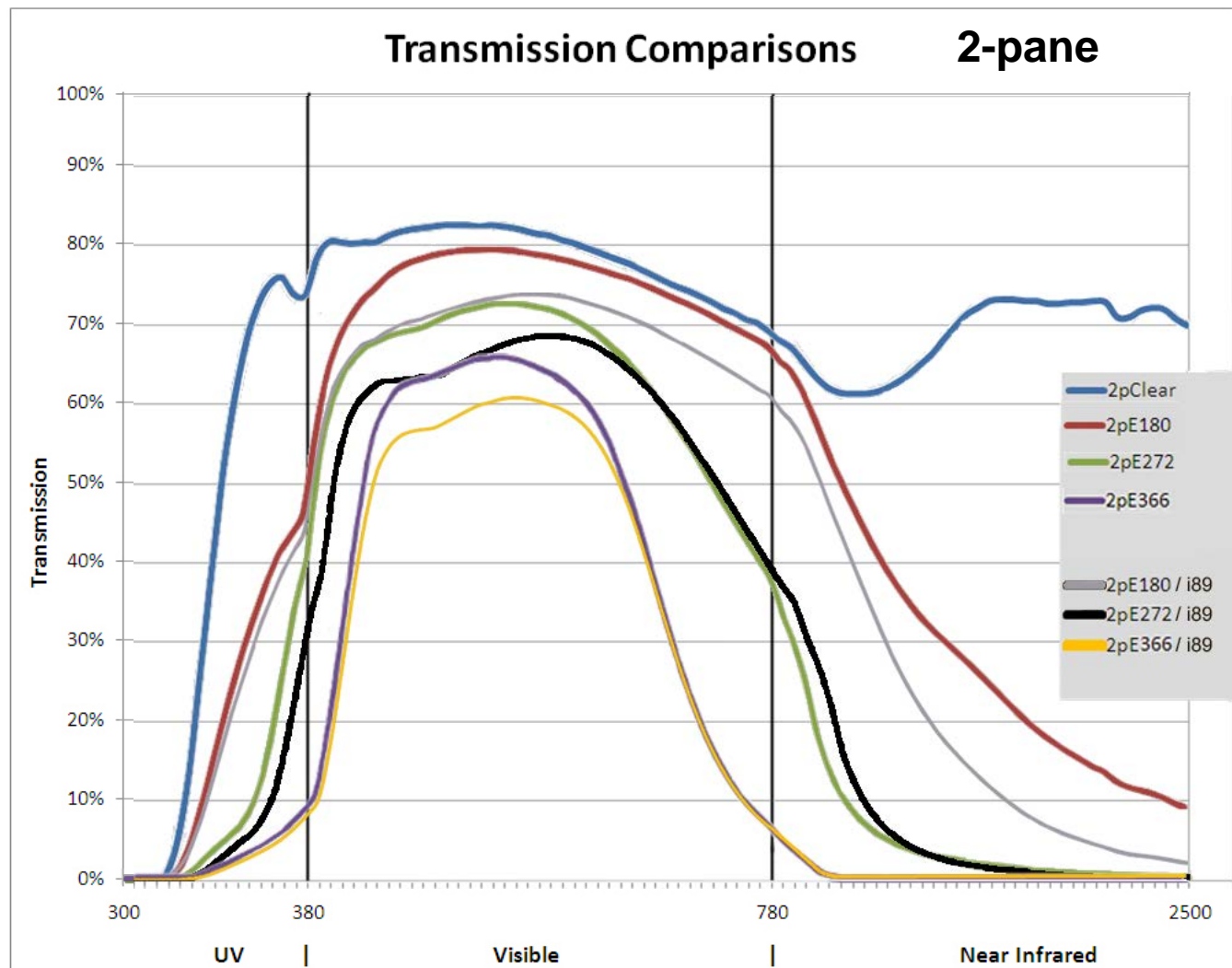
Double-Pane Clear	89 %
<hr/>	
Double-Pane LoE-180_{tm}	79 %
Double-Pane LoE-180_{tm} Gray Tint**	53 % **
Double-Pane LoE -272_{tm}	72 %
Double-Pane LoE -366_{tm}	65 %
Double-Pane LoE -340_{tm}	39 % **
<hr/>	
Triple-Pane LoE-180_{tm}	70 %
Triple-Pane LoE -366_{tm}	47 %

3mm, ½ "space, 3mm (90% ARGON filled, opposed to air, or KRYPTON)
Coatings on surface #2, except for: Graytint = #3 ; Tripane= #2 and #5

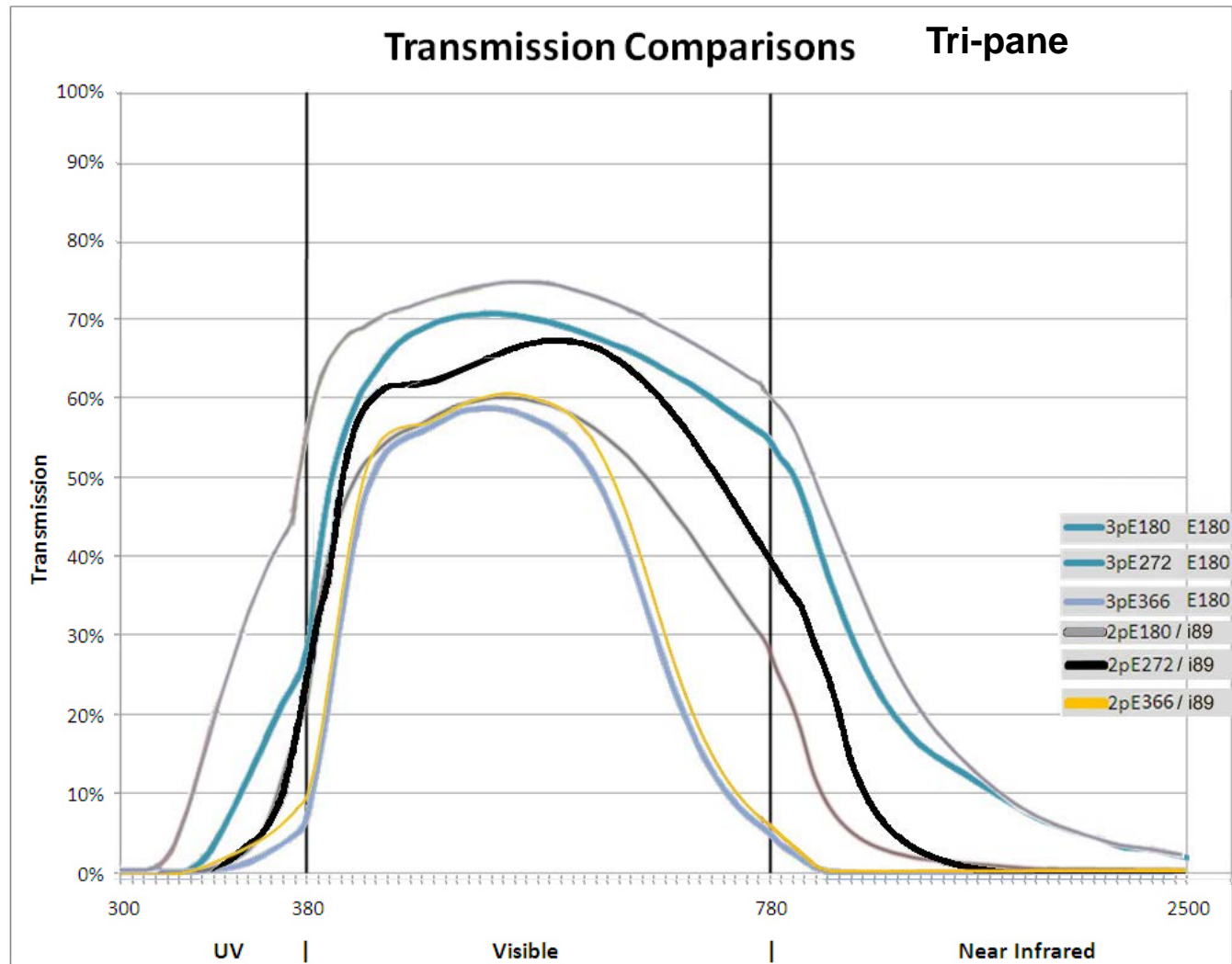
Solar Spectrum



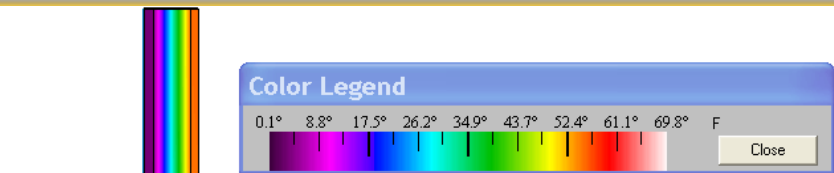
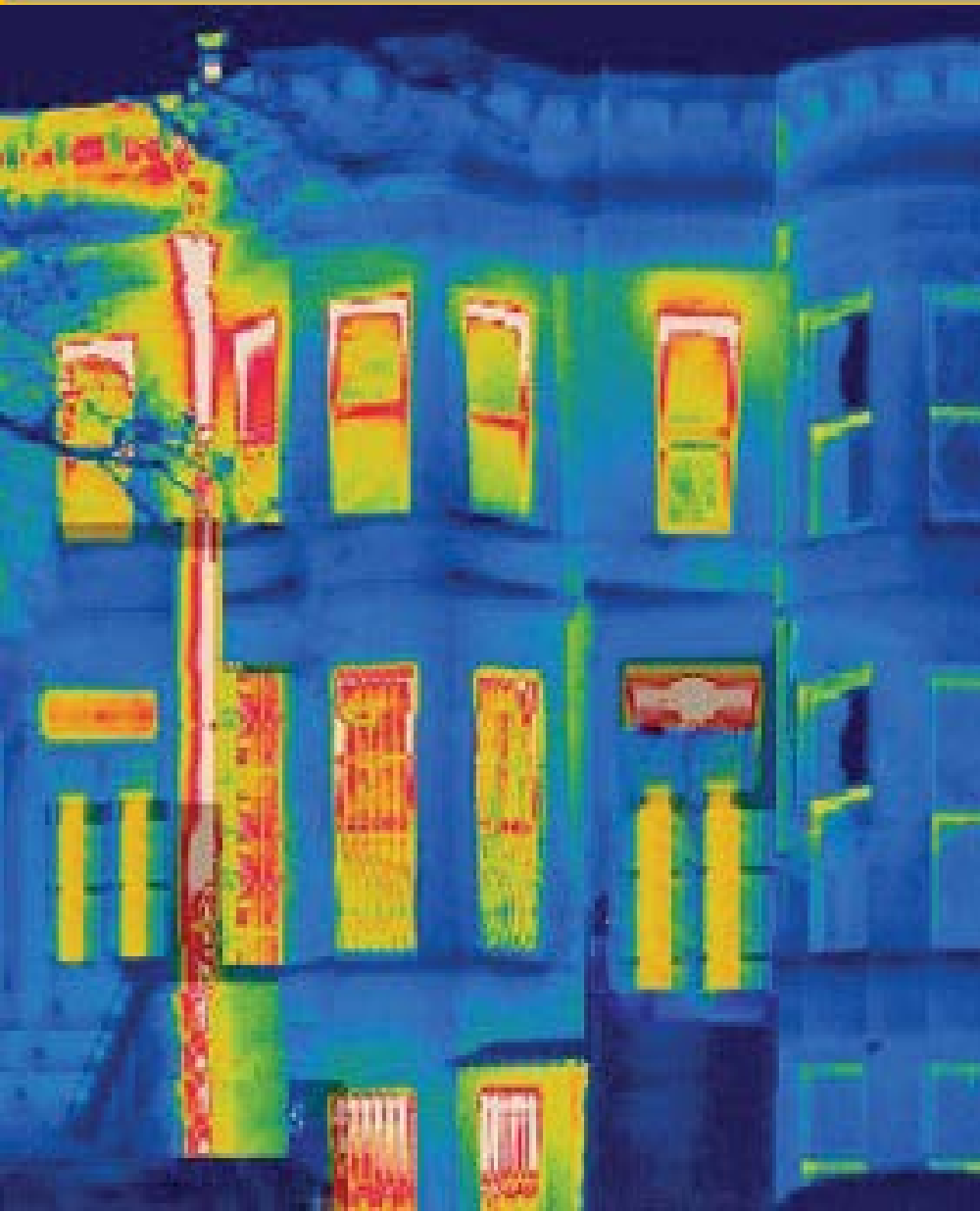
Solar Spectrum



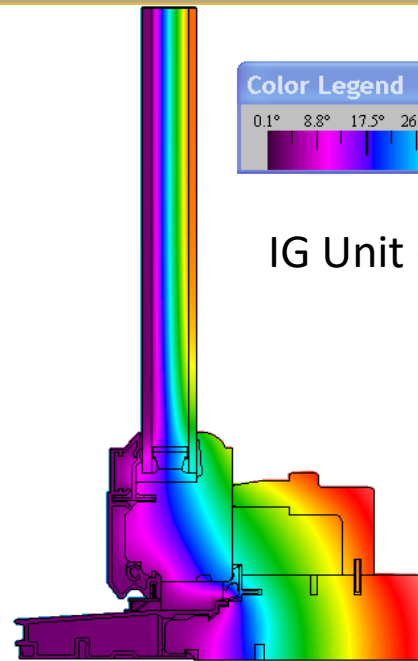
Solar Spectrum



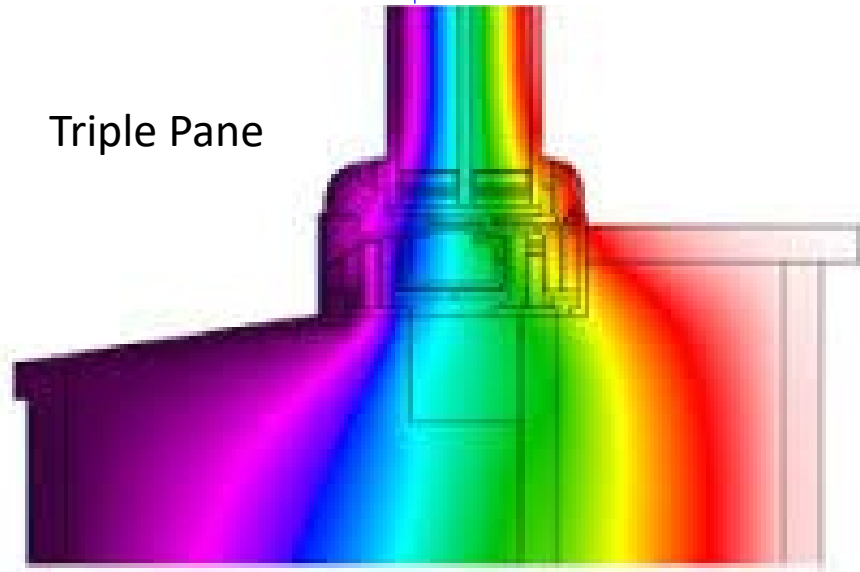
Thermal Performance



IG Unit (Dual Pane)



Triple Pane



Resources:

Marvin.com -- Cardinal Glass,

www.CardinalCorp.com

IECC, ieccsafe.org -- Passive House Institute US,

PHIUS.org

EPA.gov -- GreenBuildingAdvisor.com

USGBC.org -- NFRC.org



Thank you!

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