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Performance Glazing & Building Envelope Optimization

GLAZING16

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"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements."

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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:

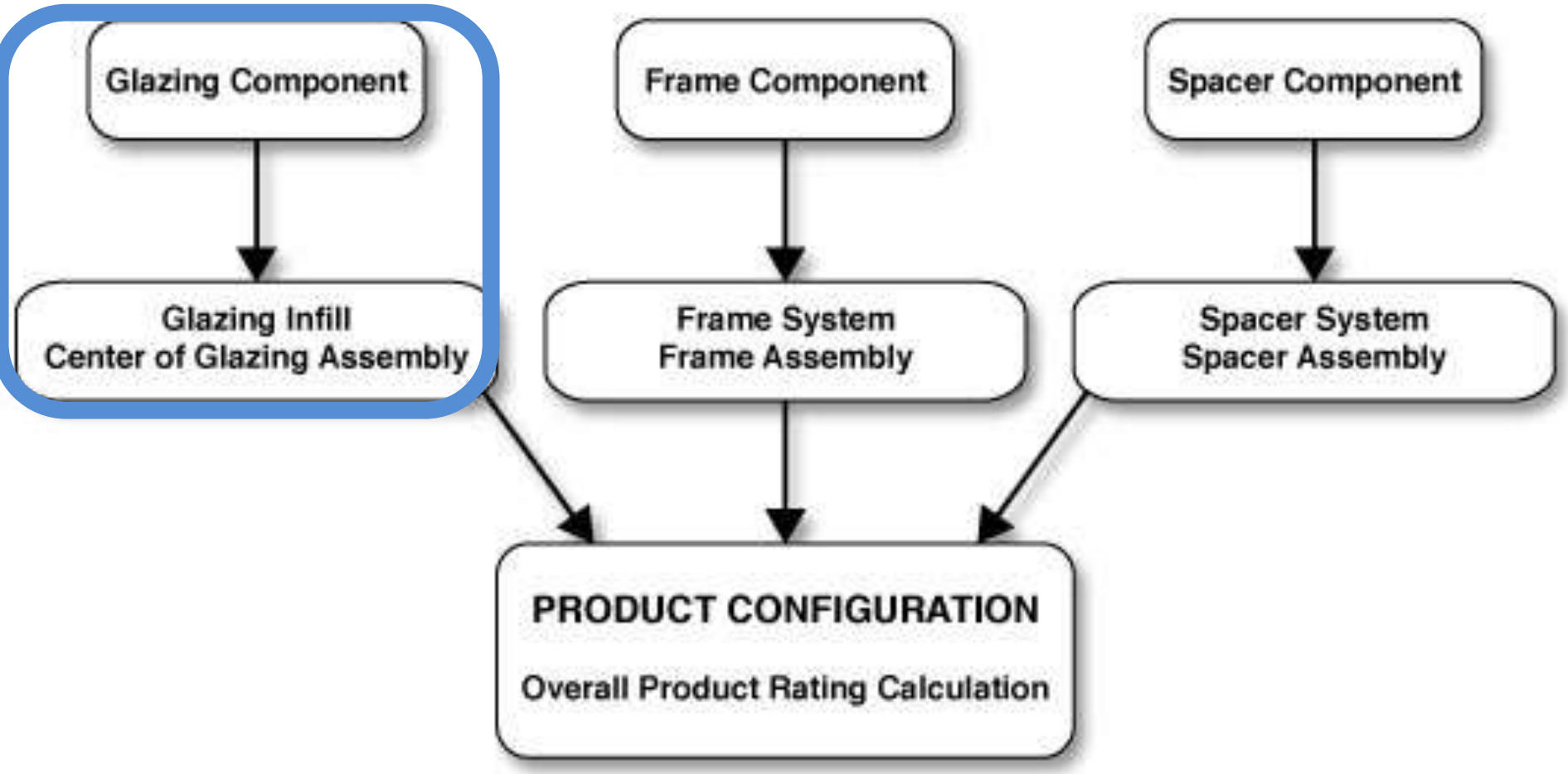
1. Explain NFRC (National Fenestration Rating Council) units and labeling
2. Understand the science of the Light Spectrum
3. Discuss Coating Performance
4. Describe Application Technology
5. Apply Knowledge for Optimization Engineering

NFRC Label

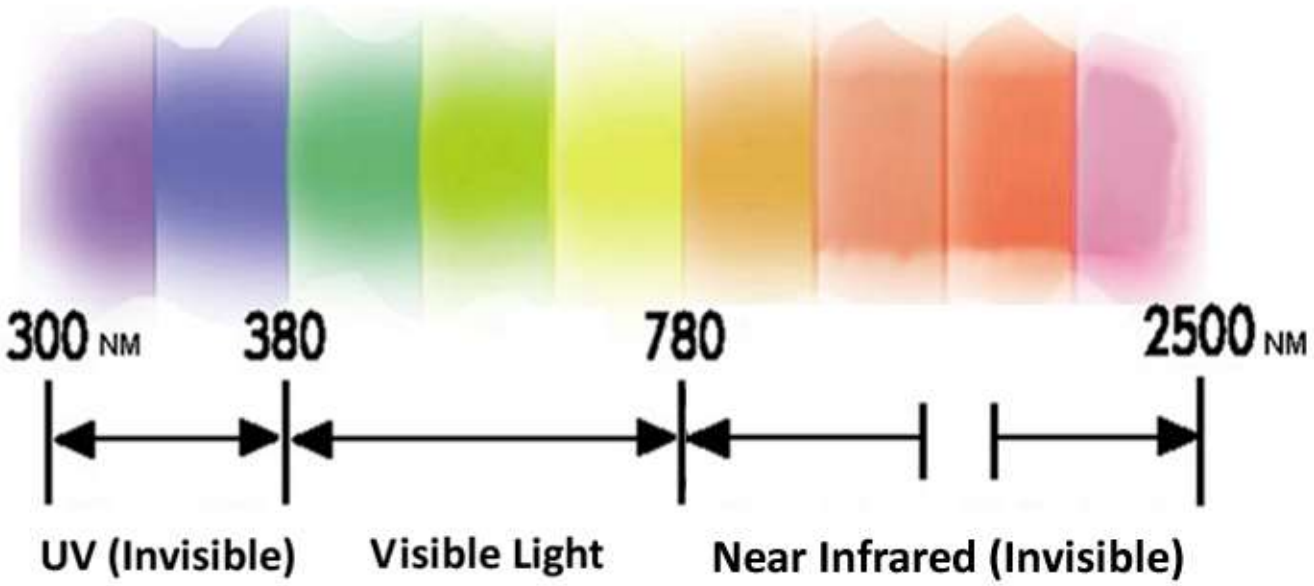

NFRC
National Fenestration Rating Council ®
CERTIFIED
World's Best Window Co.
Millennium 2000+
Vinyl-Clad Wood Frame
Double Glazing • Argon Fill • Low E
Product Type: Vertical Slider
ENERGY PERFORMANCE RATINGS
U-Factor (U.S./I-P)
0.35
Solar Heat Gain Coefficient
0.32
ADDITIONAL PERFORMANCE RATINGS
Visible Transmittance
0.51
Air Leakage (U.S./I-P)
0.2
Condensation Resistance
51
—
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.
www.nfrc.org

NFRC ratings are derived from the

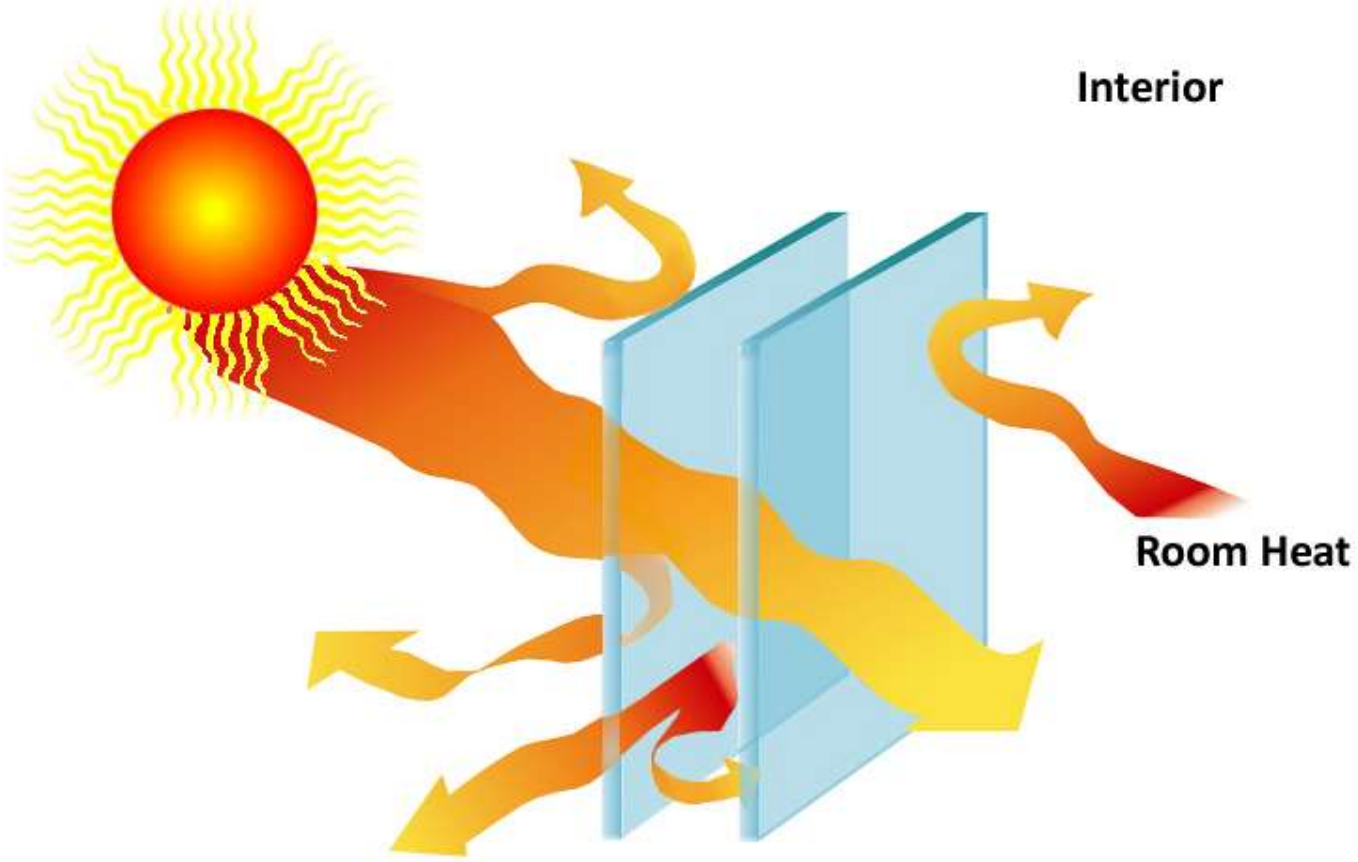
Component Modeling Approach



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 Institue US)

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

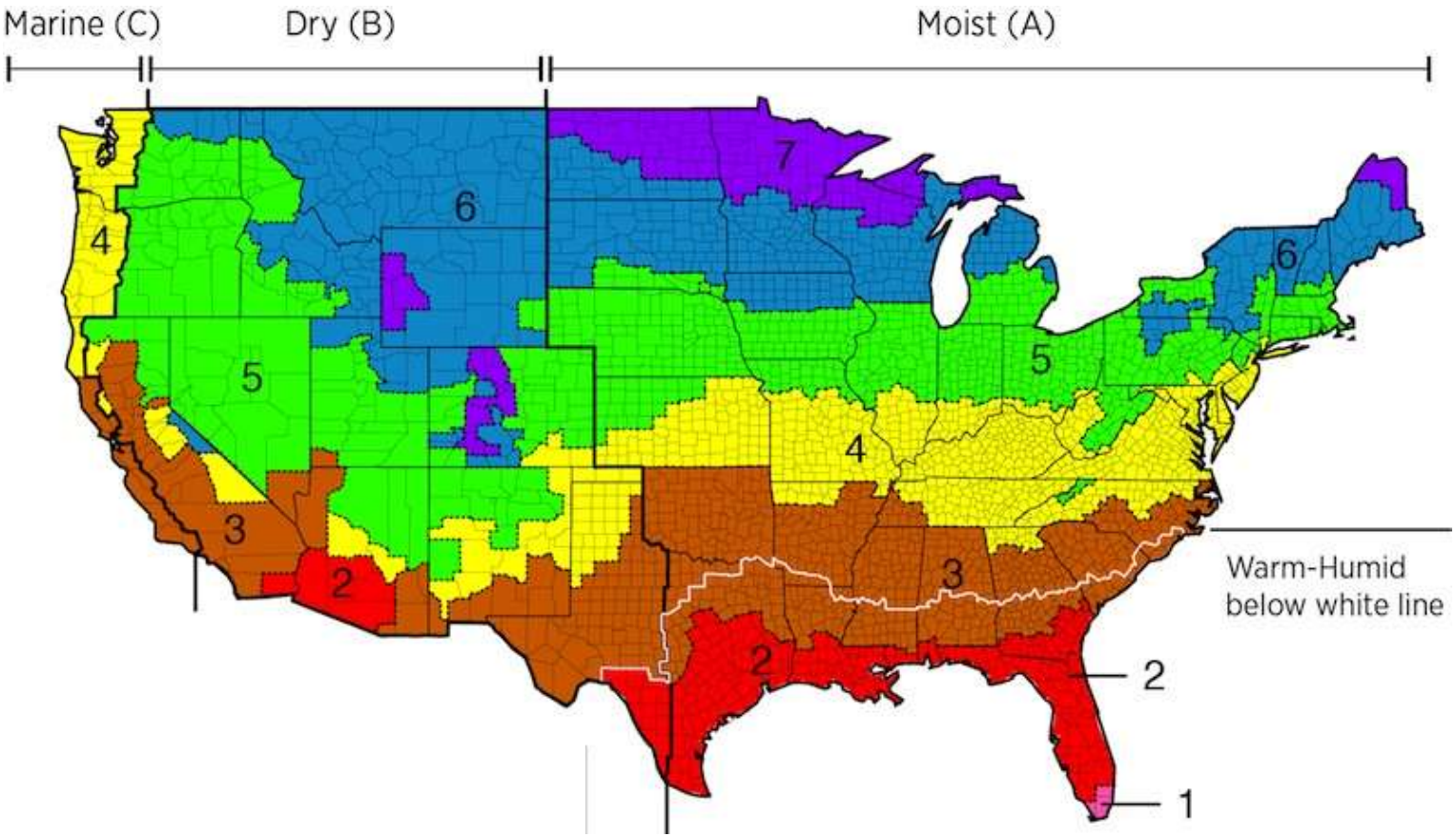
EnergyStar

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

IECC

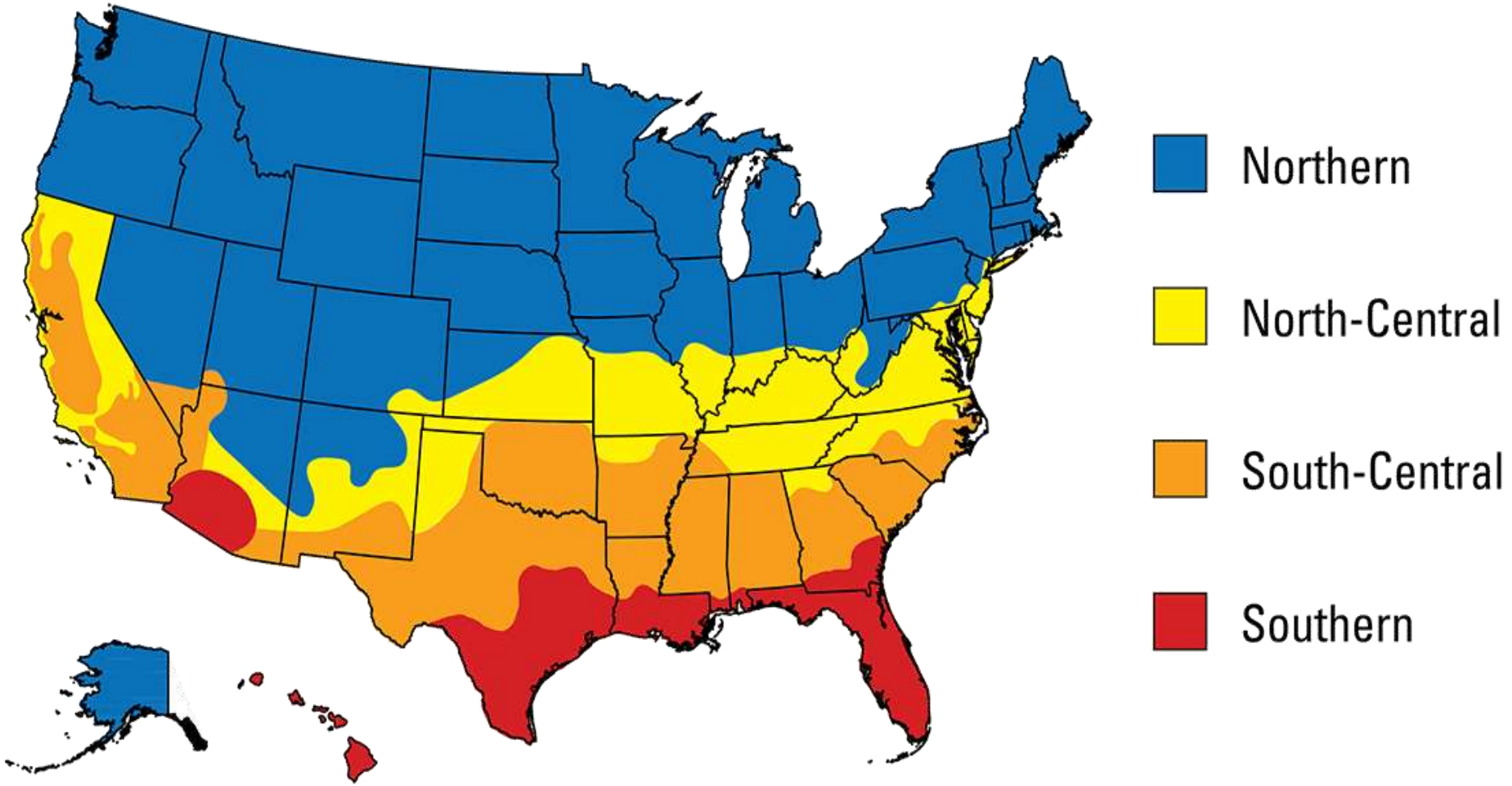
Climate Zone Map

(PHIUS, ASHRAE)

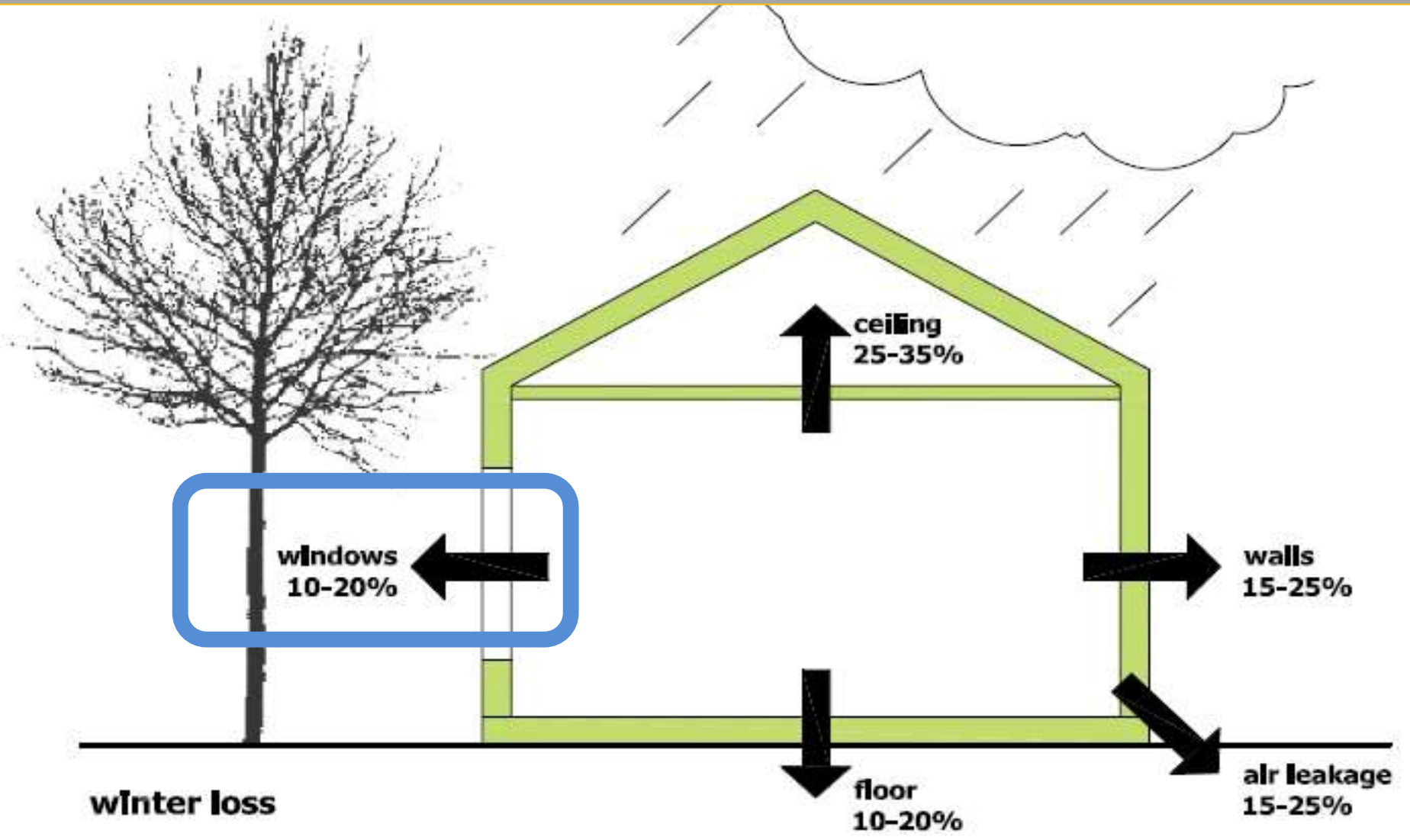


EnergyStar

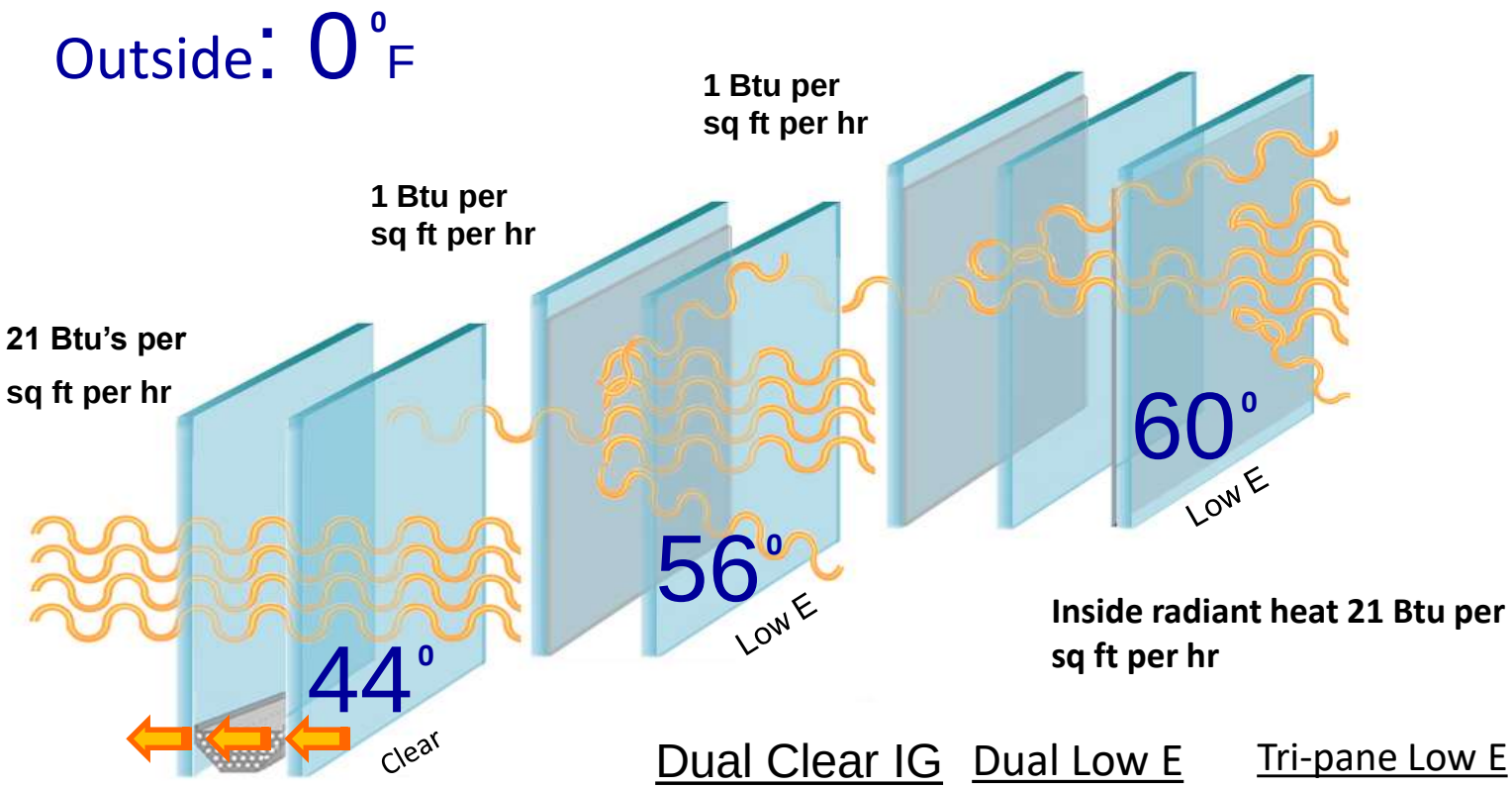
EPA Map



Average Percentages of Heat Loss in Winter

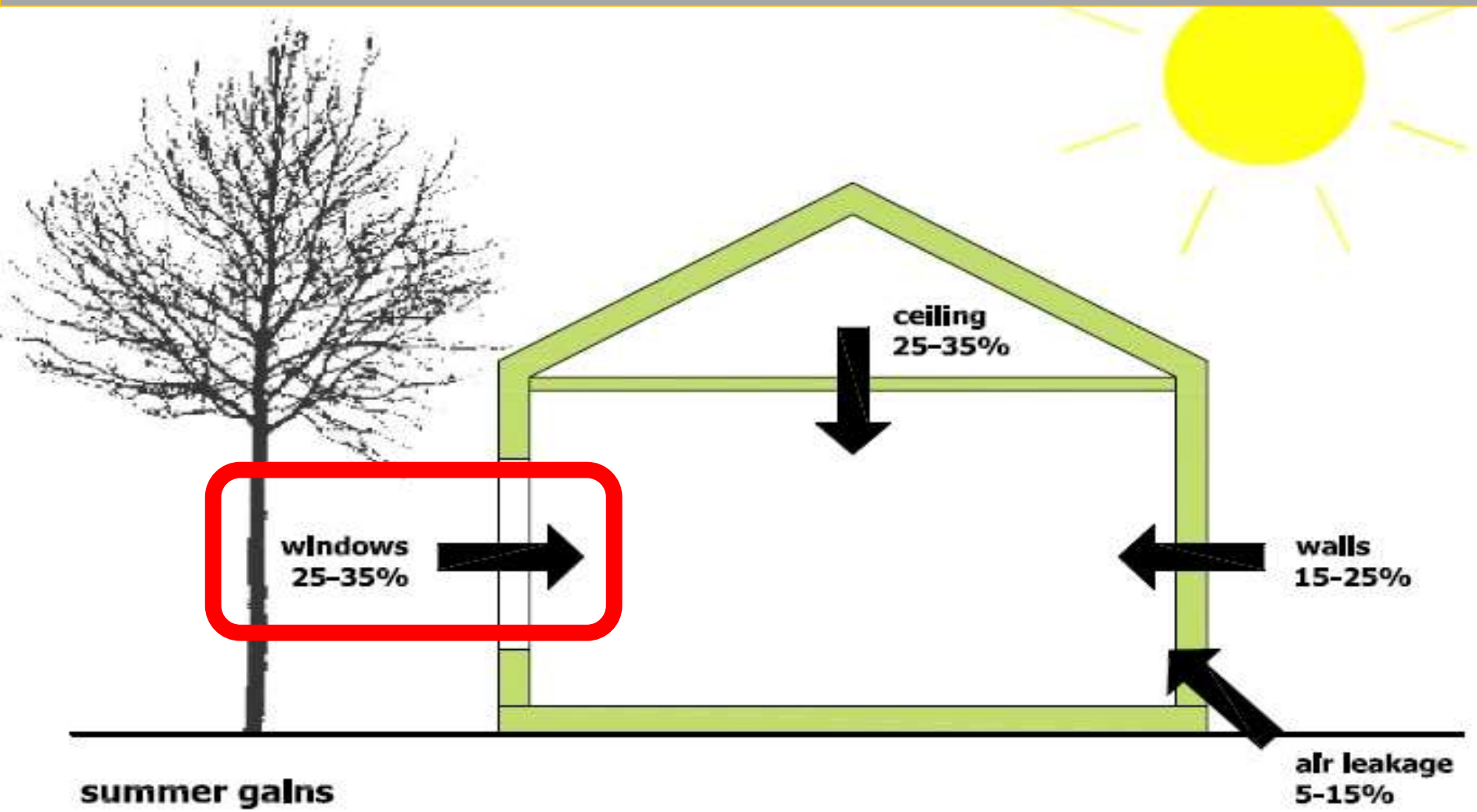


Low E Effect On Winter Nights

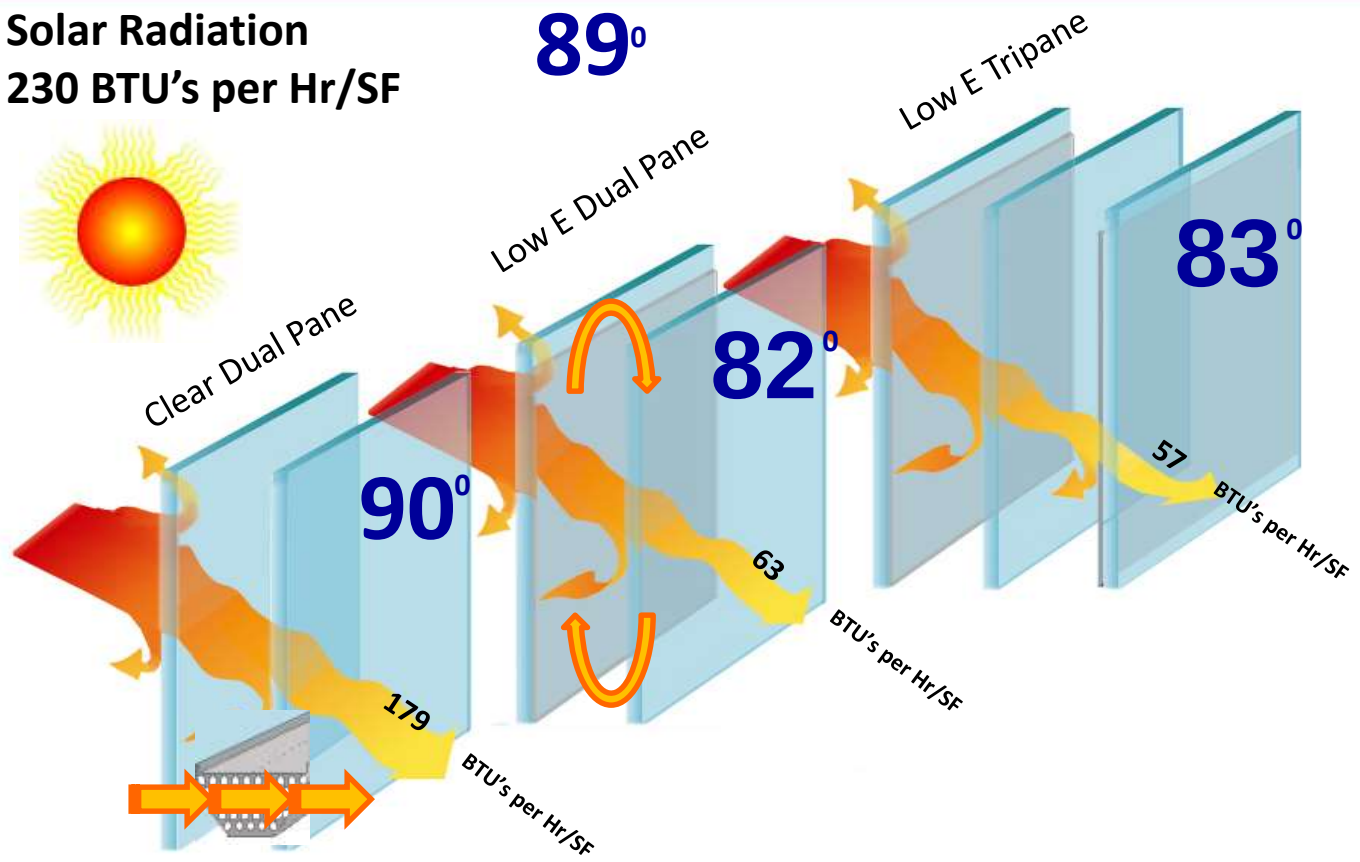


	Dual Clear IG	Dual Low E	Tri-pane Low E
Btu of radiant heat loss from the home :	21 Btu	1 Btu	1 Btu
Conduction heat loss through materials:	13 Btu	16 Btu	10 Btu
Inside glass temp at 0 degrees F outside :	44 deg	56 deg	60 degrees
Total Btu exiting through the glazing:	**34 Btu**	**17 Btu**	**11 Btu**

Average Percentages of Heat Gains in Summer

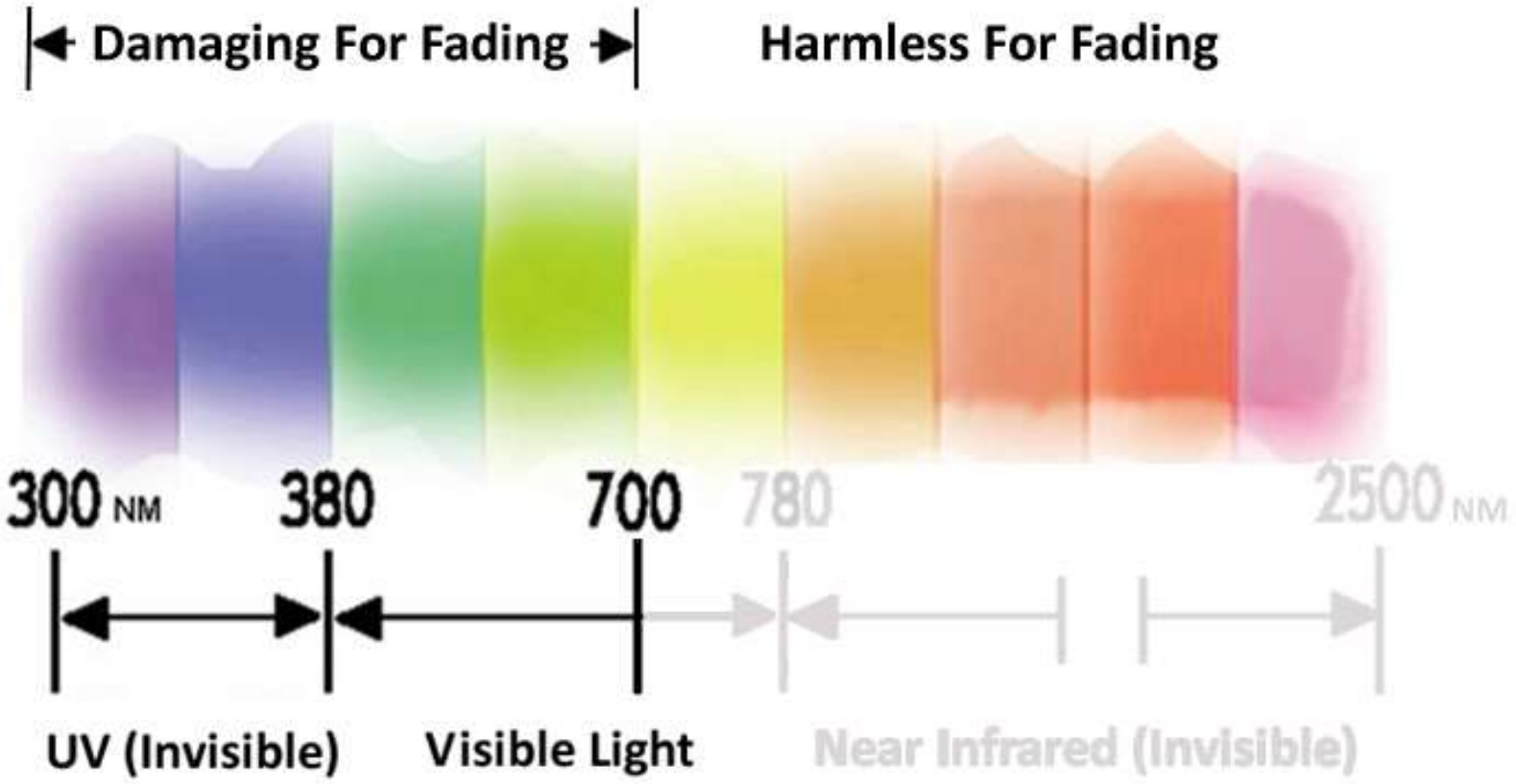


Low E Effect On Summertime Sun



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

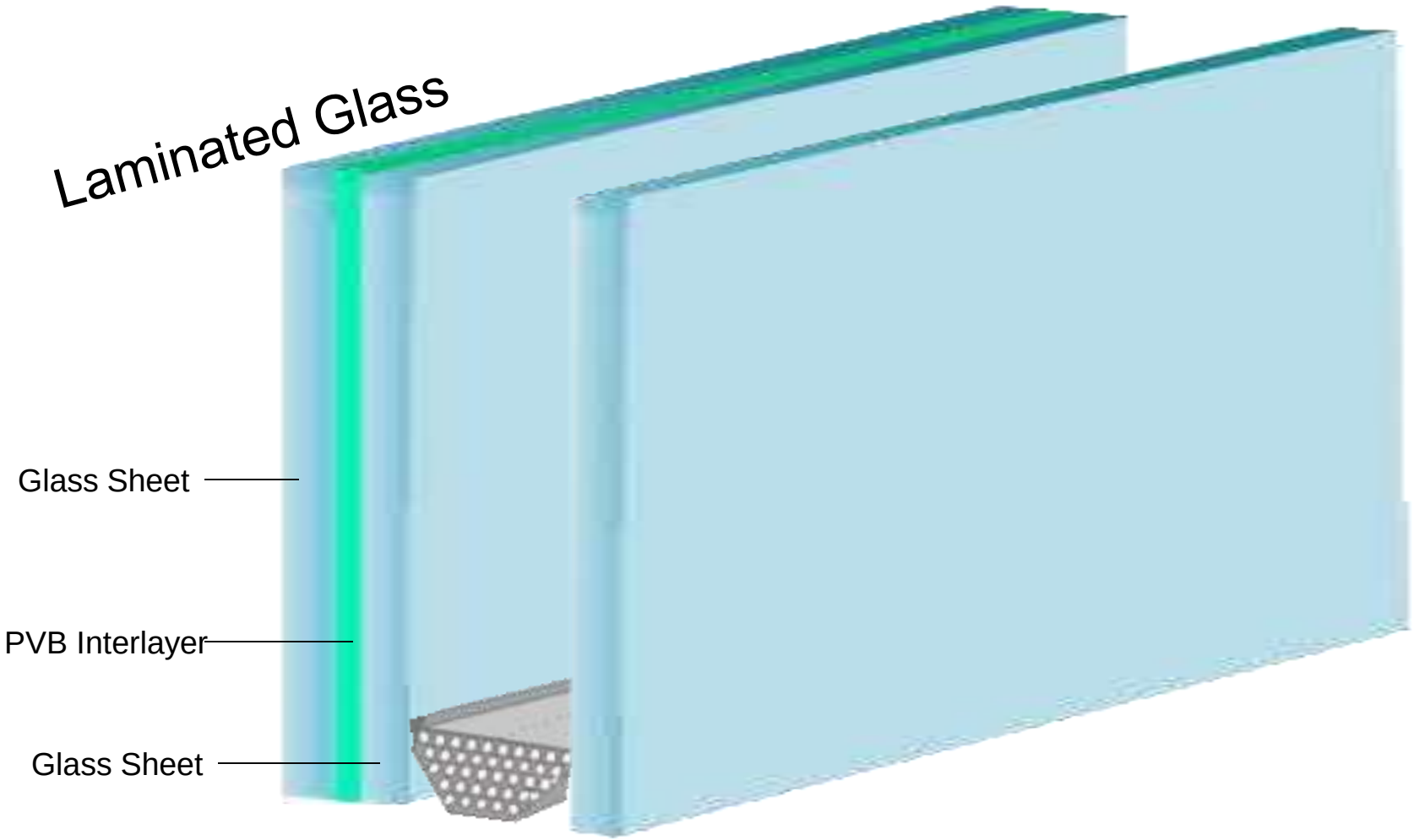


← 40% →← 25% →

+25% from heat (infrared+interior)

+10% from interior light & humidity

Laminated Glass Benefits



Energy-efficient glazing systems

1.) Defining Emissivity (E)

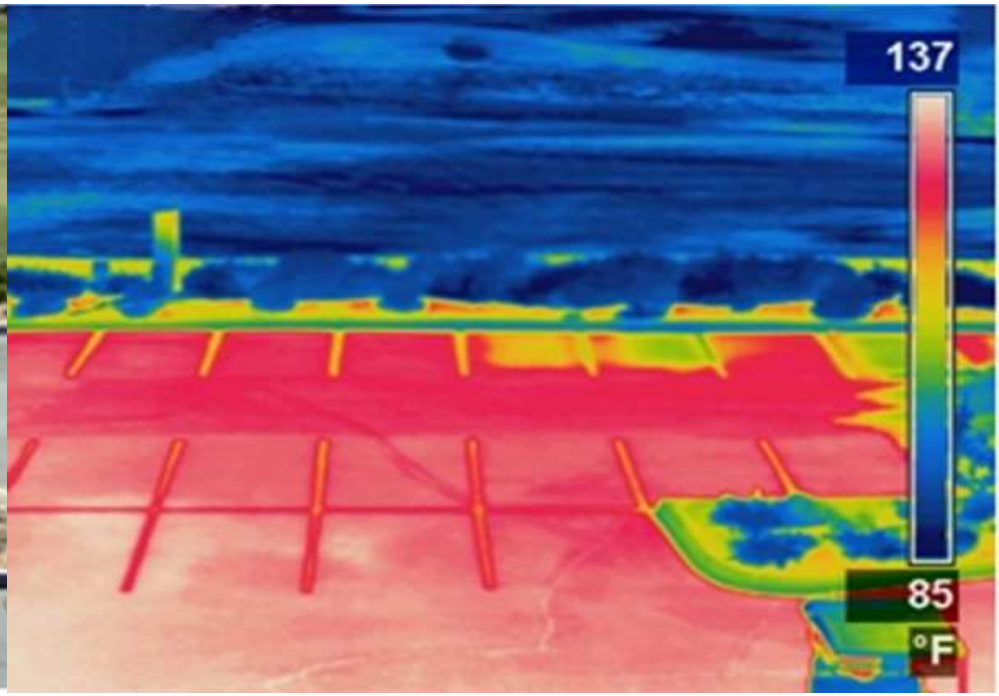
2.) Types of Low E

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

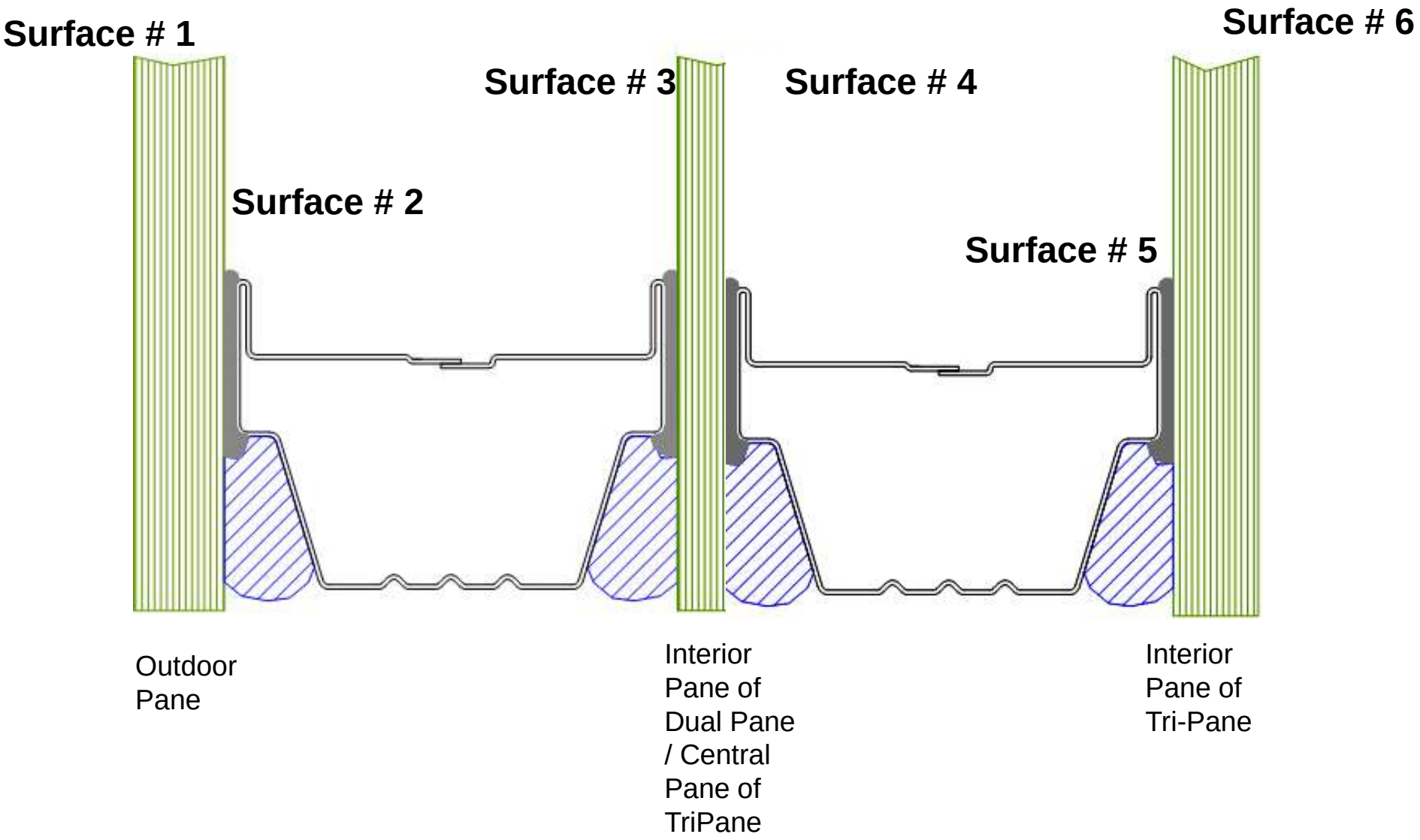
- Low emissivity
- Low-Med-High SHG
- Silver based
- Vacuum deposition
- Uniform
- Neutral color
- Low Haze
- Must be insulated

vs.

Pyrolytic

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

Surface Designation



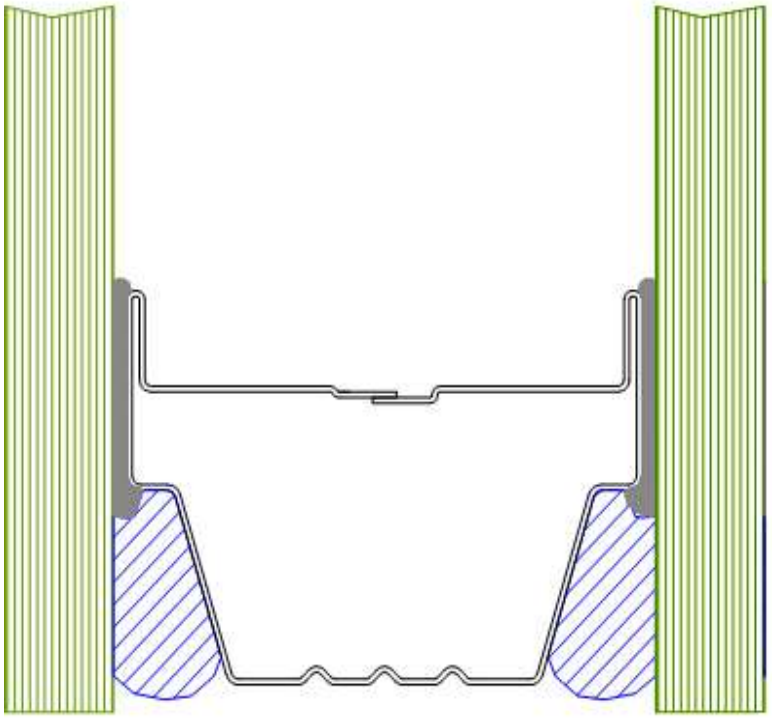
Coating Locations & Their Effects

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

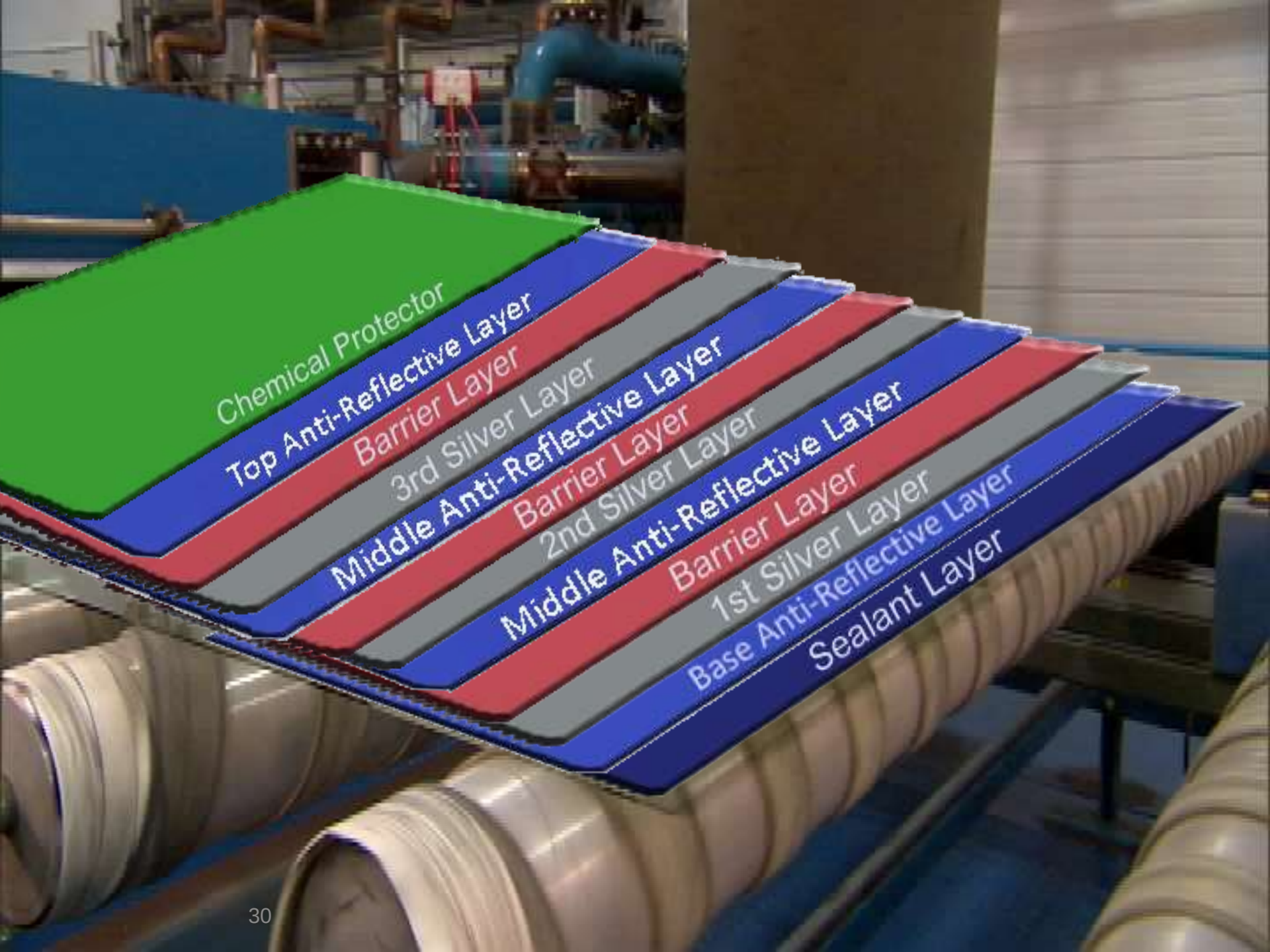
Surface #4 (Dual Pane)

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

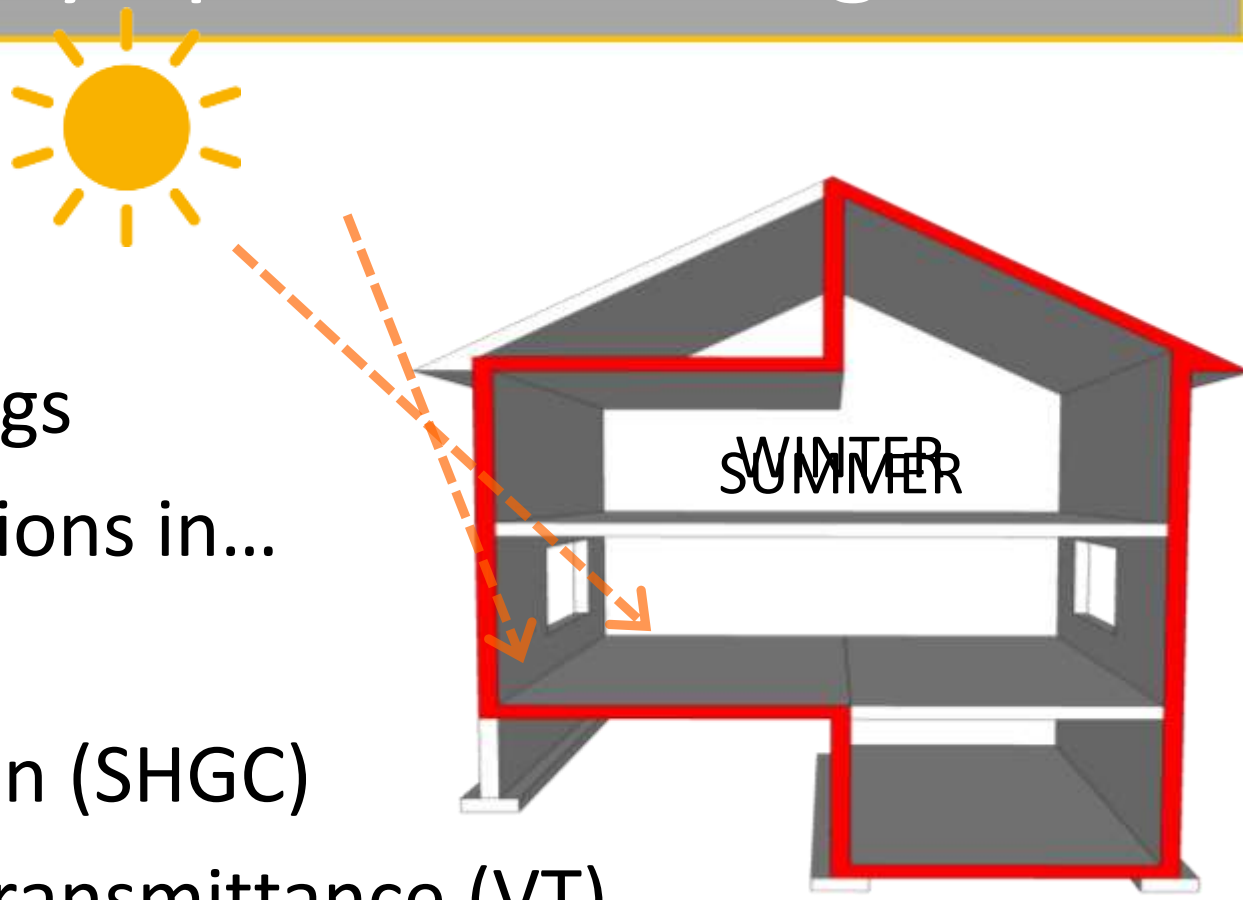
Tri-pane is typically assembled with the coatings on surfaces 2 and 5.

How Coatings are Applied

How Coatings are Applied


Chemical Protector
Top Anti-Reflective Layer
Barrier Layer
3rd Silver Layer
Middle Anti-Reflective Layer
Barrier Layer
2nd Silver Layer
Middle Anti-Reflective Layer
Barrier Layer
1st Silver Layer
Base Anti-Reflective Layer
Sealant Layer

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/Rvalue = BTU / hr.ft$_2$.°F

Measurement of heat transfer through a material or an assembly

Center of Glass **U-factor**

	(Btu/hr/ft2F)
Double-Pane Clear	0.48
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

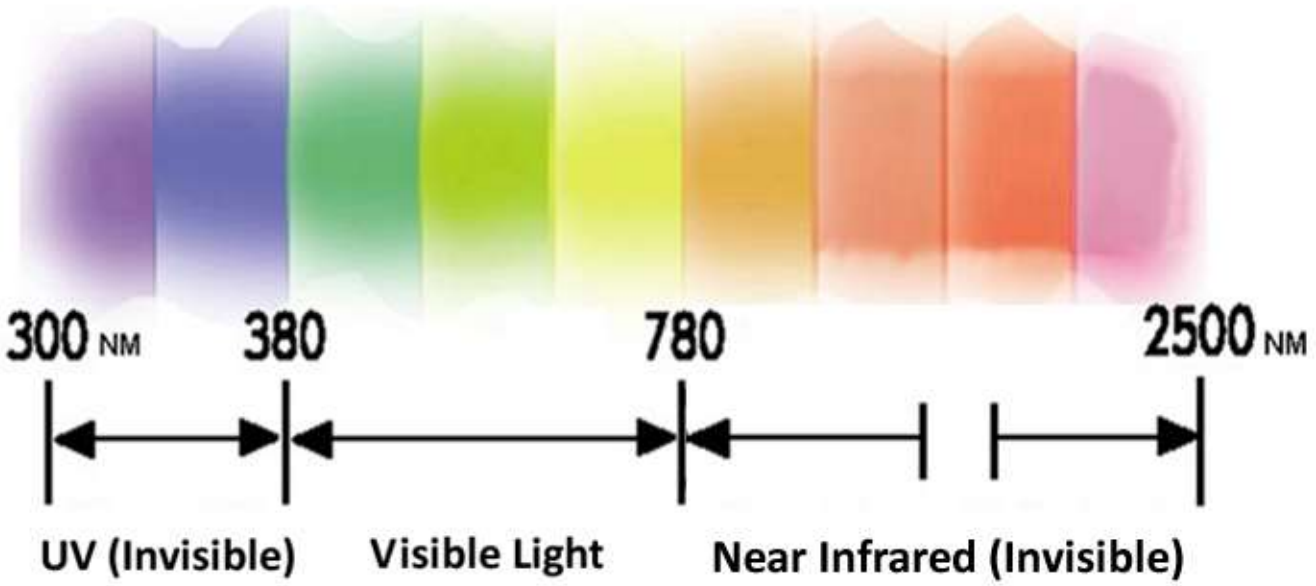
3mm, ½ ”space, 3mm (90% ARGON filled, opposed to air, or KRYPTON)
Coatings on surface #2, except for: Graytint = #3 ; Tripane= #2 *and* #5

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 Temp ^{0}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):

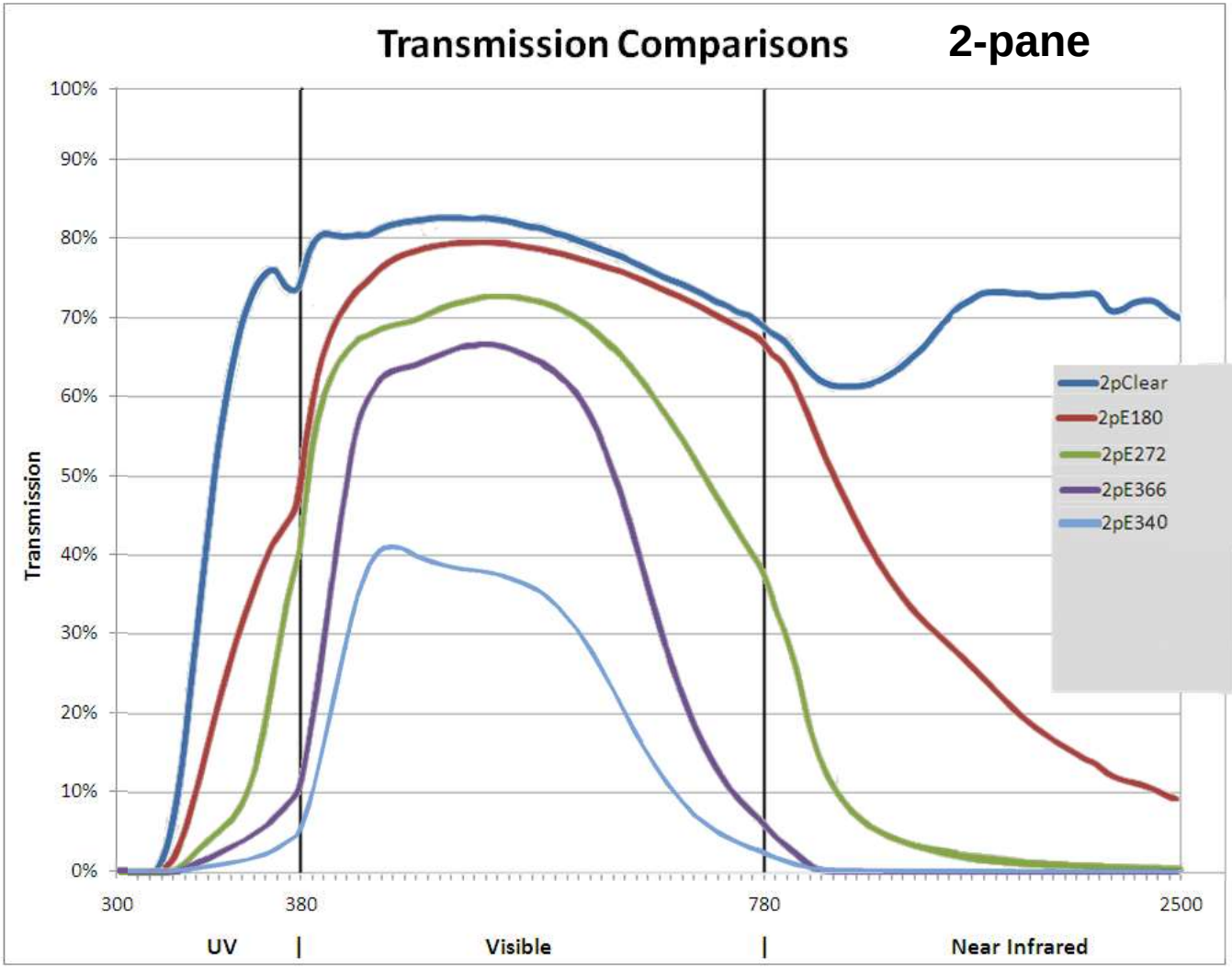
- An optical property for the amount of visible light transmitted.
- A number between 0 and 1, typically between 0.3 and 0.8

VT: Visible Light Transmittance

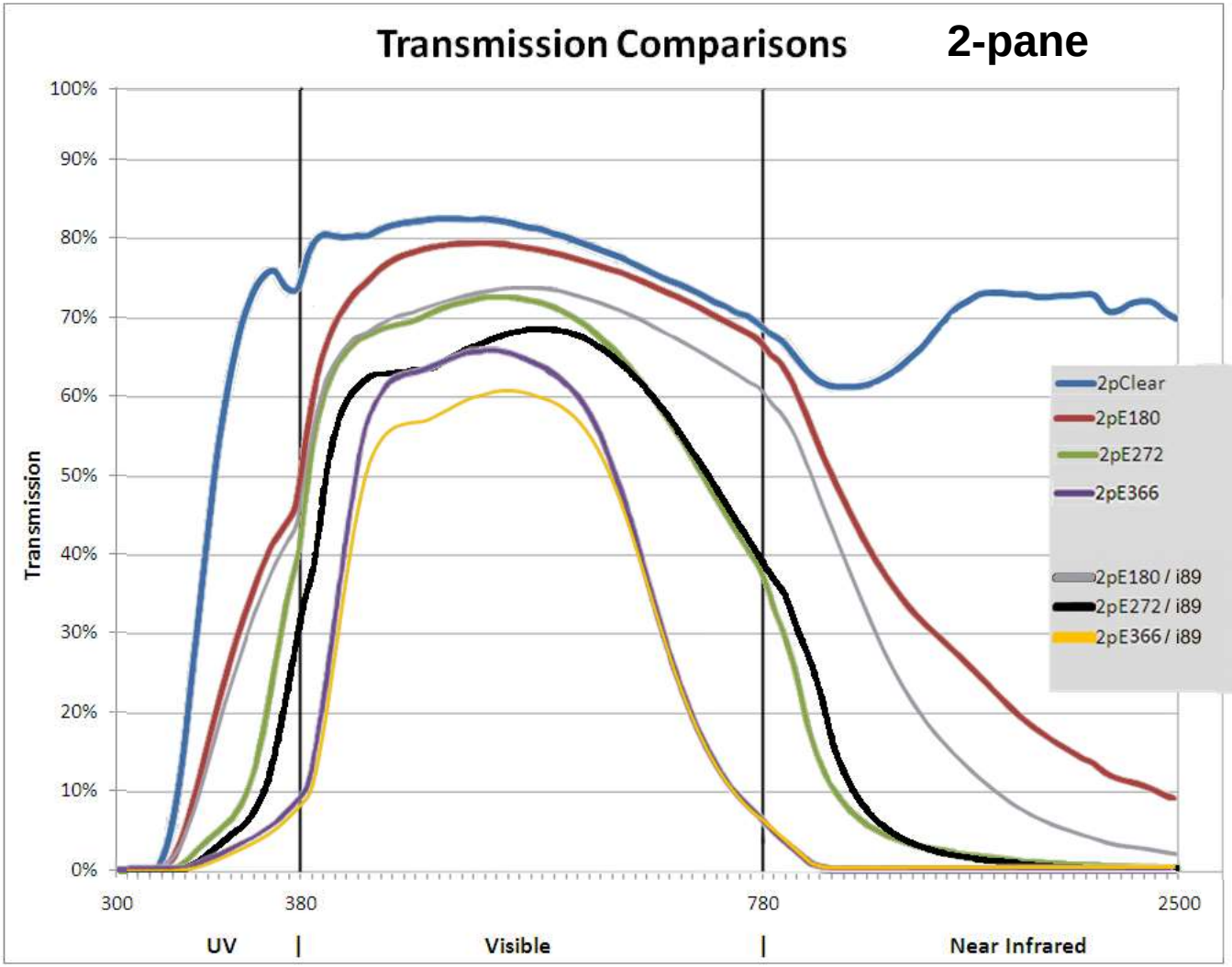
Double-Pane Clear	89 %
Double-Pane LoE-180 tm	79 %
Double-Pane LoE-180 tm Gray Tint**	53 % **
Double-Pane LoE -272 tm	72 %
Double-Pane LoE -366 tm	65 %
Double-Pane LoE -340 tm	39 % **
Triple-Pane LoE-180 tm	70 %
Triple-Pane LoE -366 tm	47 %

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

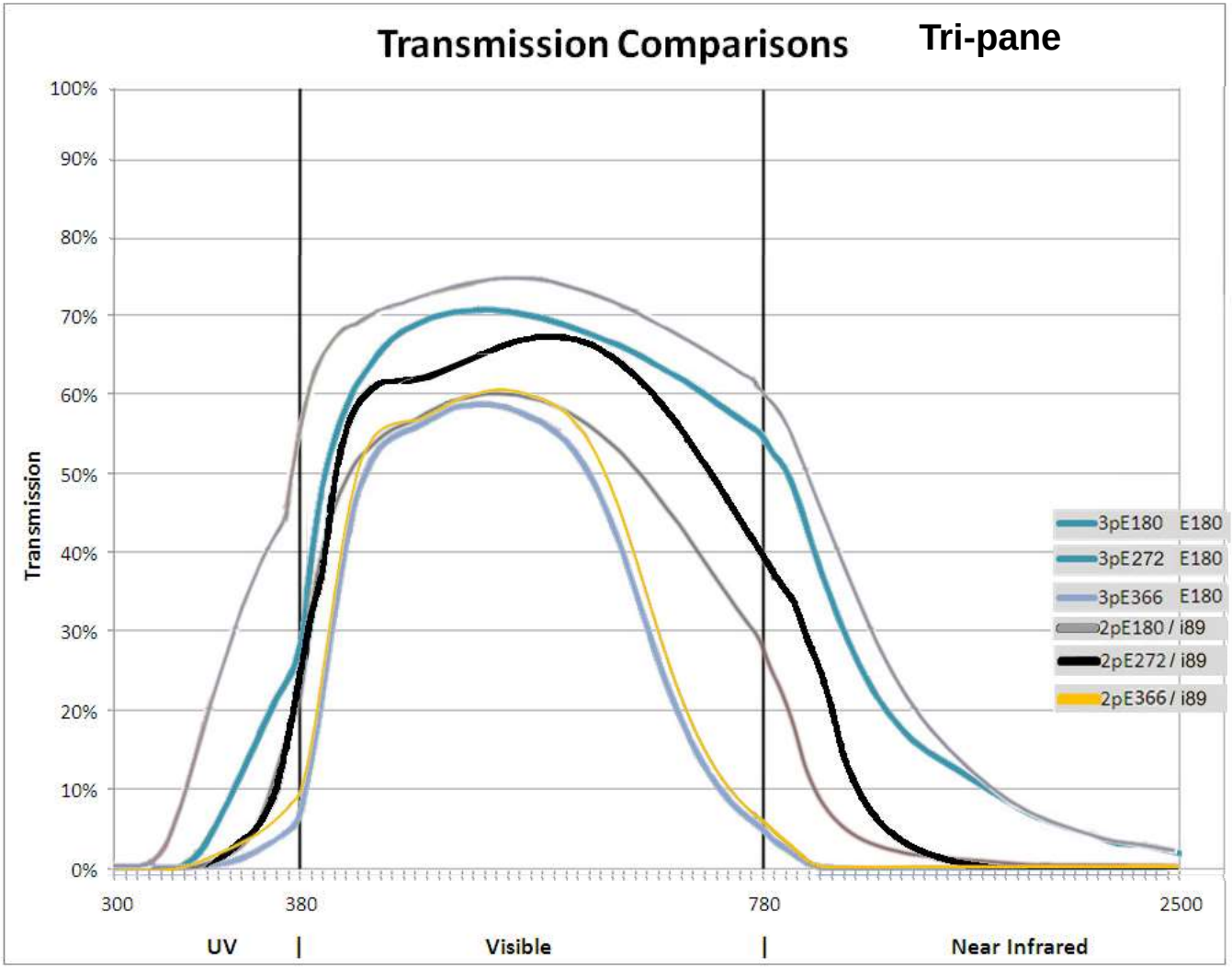
Solar Spectrum



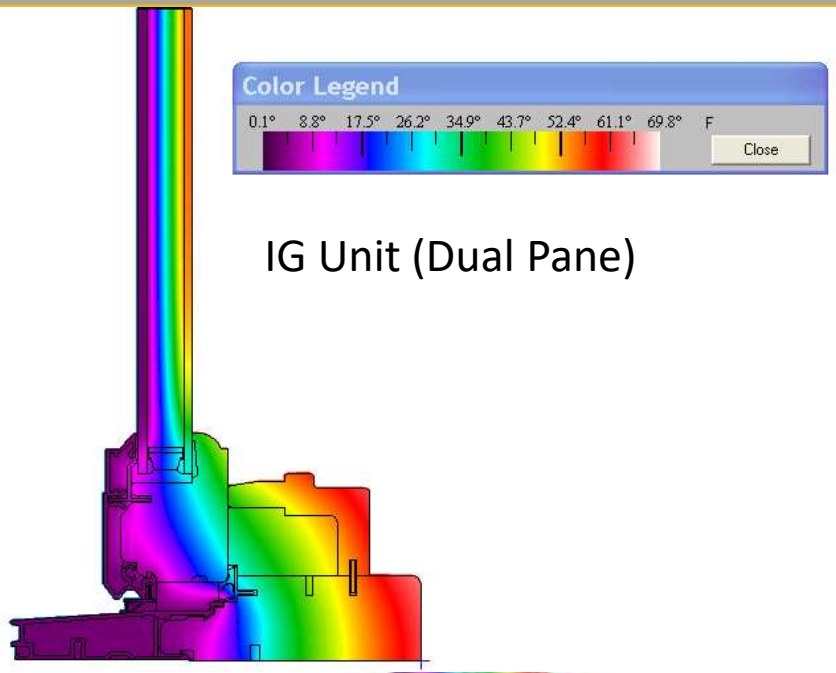
Solar Spectrum



Solar Spectrum

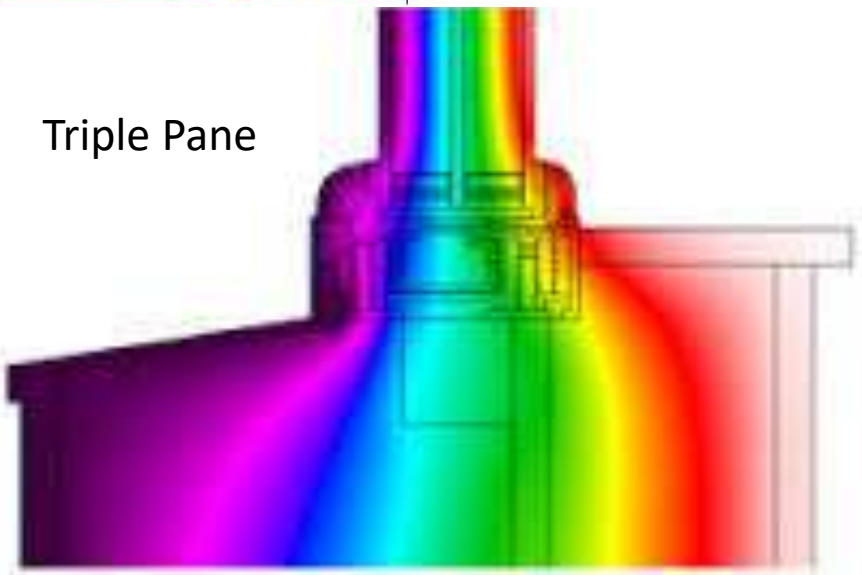


Thermal Performance



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

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