Cardinal®
Glass Industries Inc.

20 Years of Energy Efficient Buildings & *Windows*

Presented by Jim Larsen

A Hole in the Wall?

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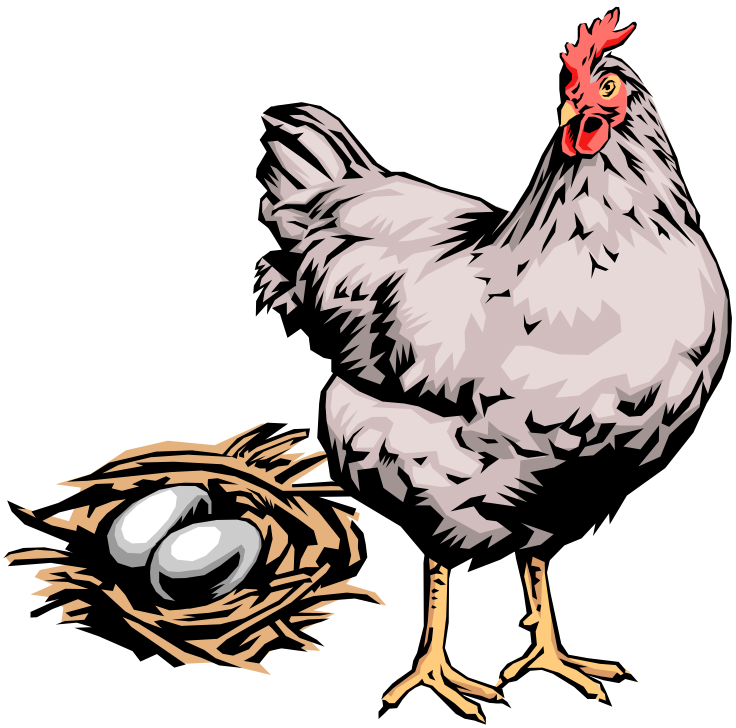
Which Came First?



Energy Codes

Or

Efficient Windows?

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3 Example Cities……..

- Minneapolis (mostly heating)
- Kansas City (heating and cooling)
- San Antonio (mostly cooling)

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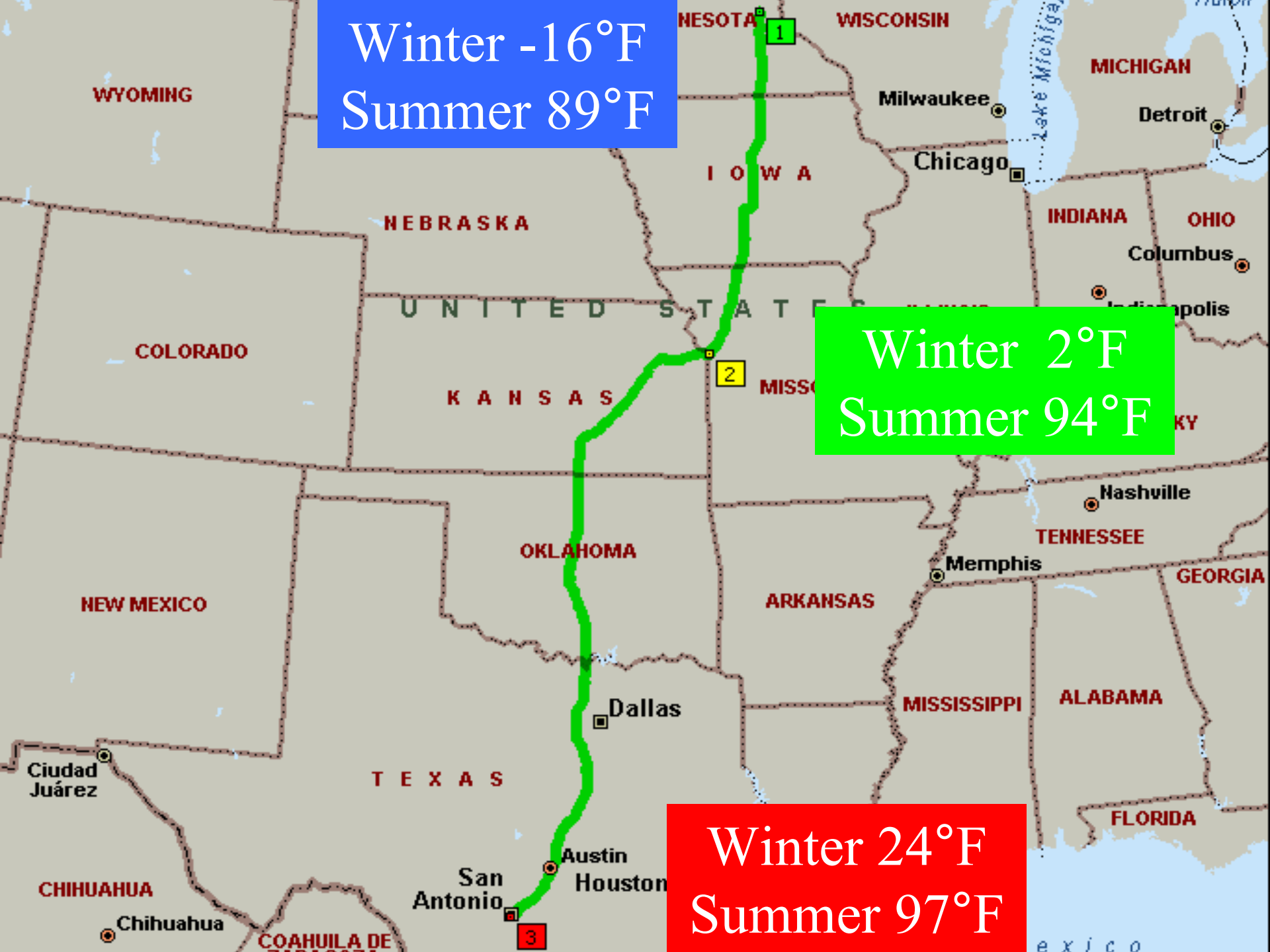
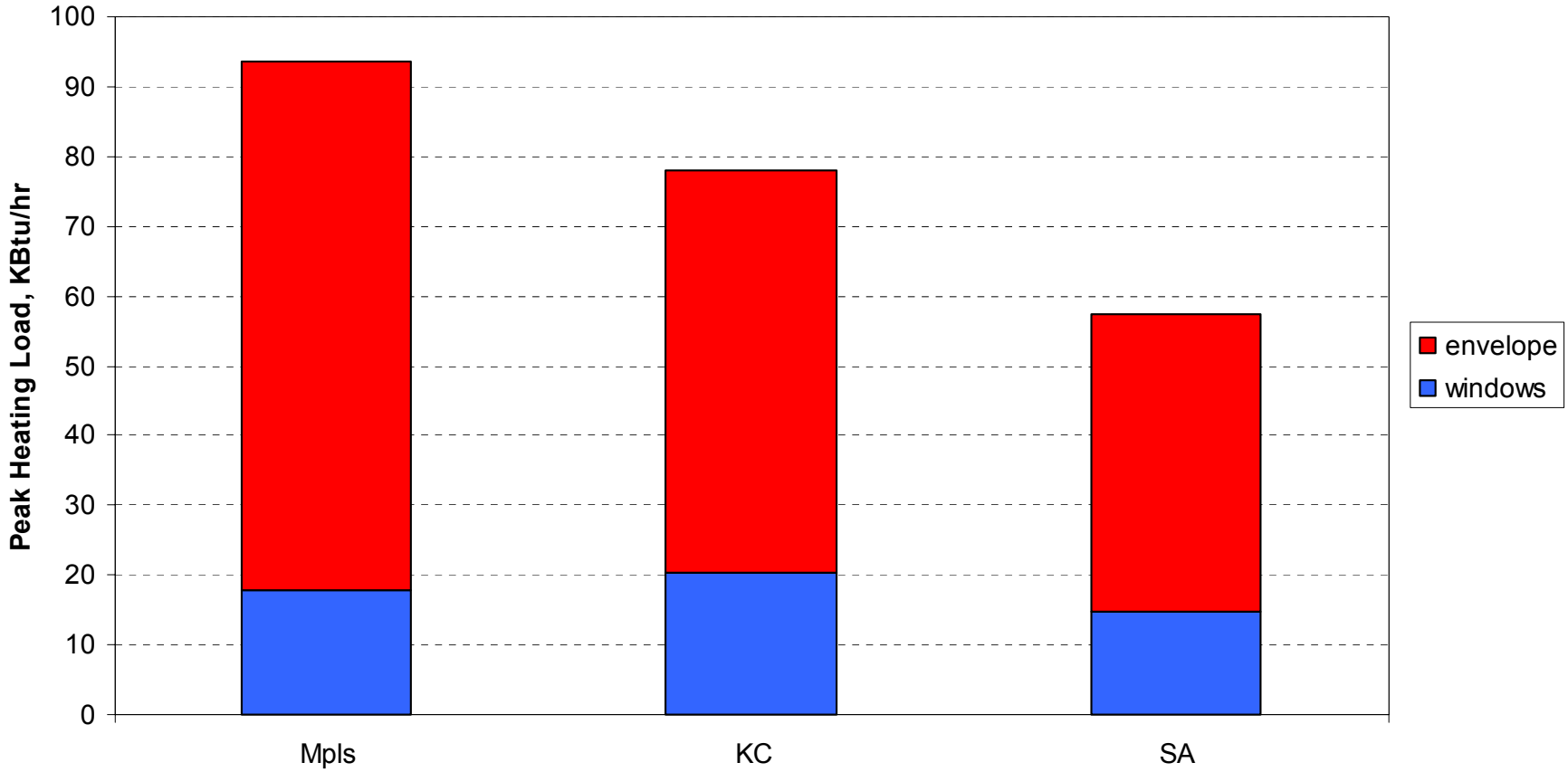

Winter -16°F
Summer 89°F
Winter 2°F
Summer 94°F
Winter 24°F
Summer 97°F
1
2
3
WYOMING
NEBRASKA
COLORADO
KANSAS
OKLAHOMA
NEW MEXICO
TEXAS
IOWA
WISCONSIN
MICHIGAN
INDIANA
OHIO
ARKANSAS
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
CHIHUAHUA
COAHUILA DE
Milwaukee
Detroit
Chicago
Columbus
Nashville
Memphis
Dallas
Austin
Houston
San Antonio
Ciudad Juárez
Chihuahua
Lake Michigan

Design Heat Loss
20 Years Ago



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Priority 1
Improve the Envelope

- Increase insulation levels in ceilings, walls, and foundation
- Reduce air infiltration

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How to Improve the Windows

Every glass layer adds approximately
1 point to the R-value

- Single Pane U 1.04 (R1)
- Double Glazing U 0.48 (R2)
- Triple Glazing U 0.33 (R3)

- Eight Panes U 0.13 (R8)

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Double Glazing Options

- Single Pane + Storm Panel U 0.48
- Clear 2 Pane Insulating Glass U 0.48
- Clear 2 Pane IG + Argon U 0.46

- 2 Pane Low-E IG U 0.31

- 2 Pane Low-E IG + Argon U 0.25*

* optimum for 2-pane glazing

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Triple Glazing Options

- Double Pane IG + Storm U 0.32
- Triple Pane IG U 0.33
- Tri-Pane + 1 Low-E/Argon U 0.19
- Tri-Pane + 2 Low-E/Argon U 0.13 *

* (2) ¼” krypton cavities gives same performance as (2) ½” argon filled spaces

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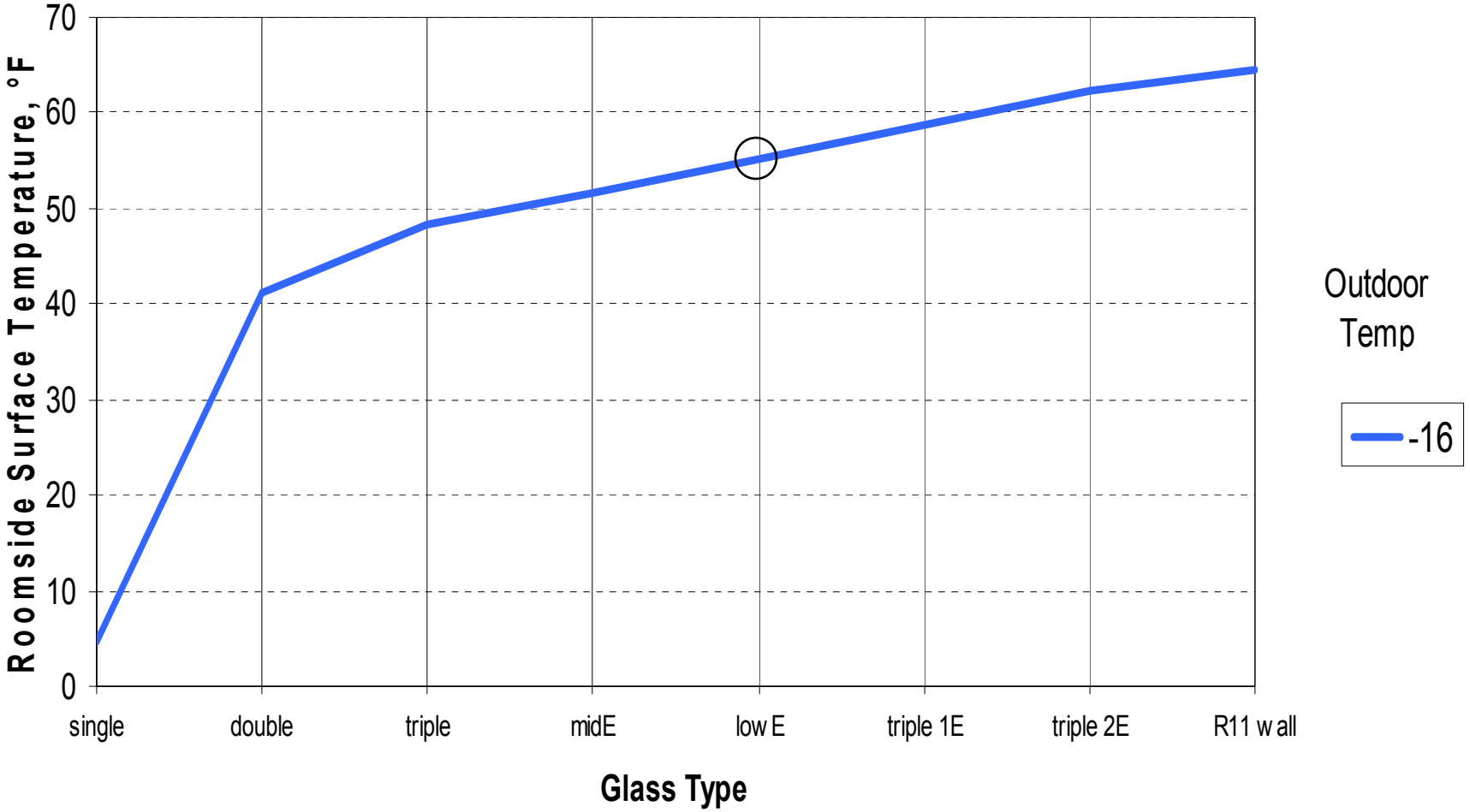
Winter Comfort in Minneapolis



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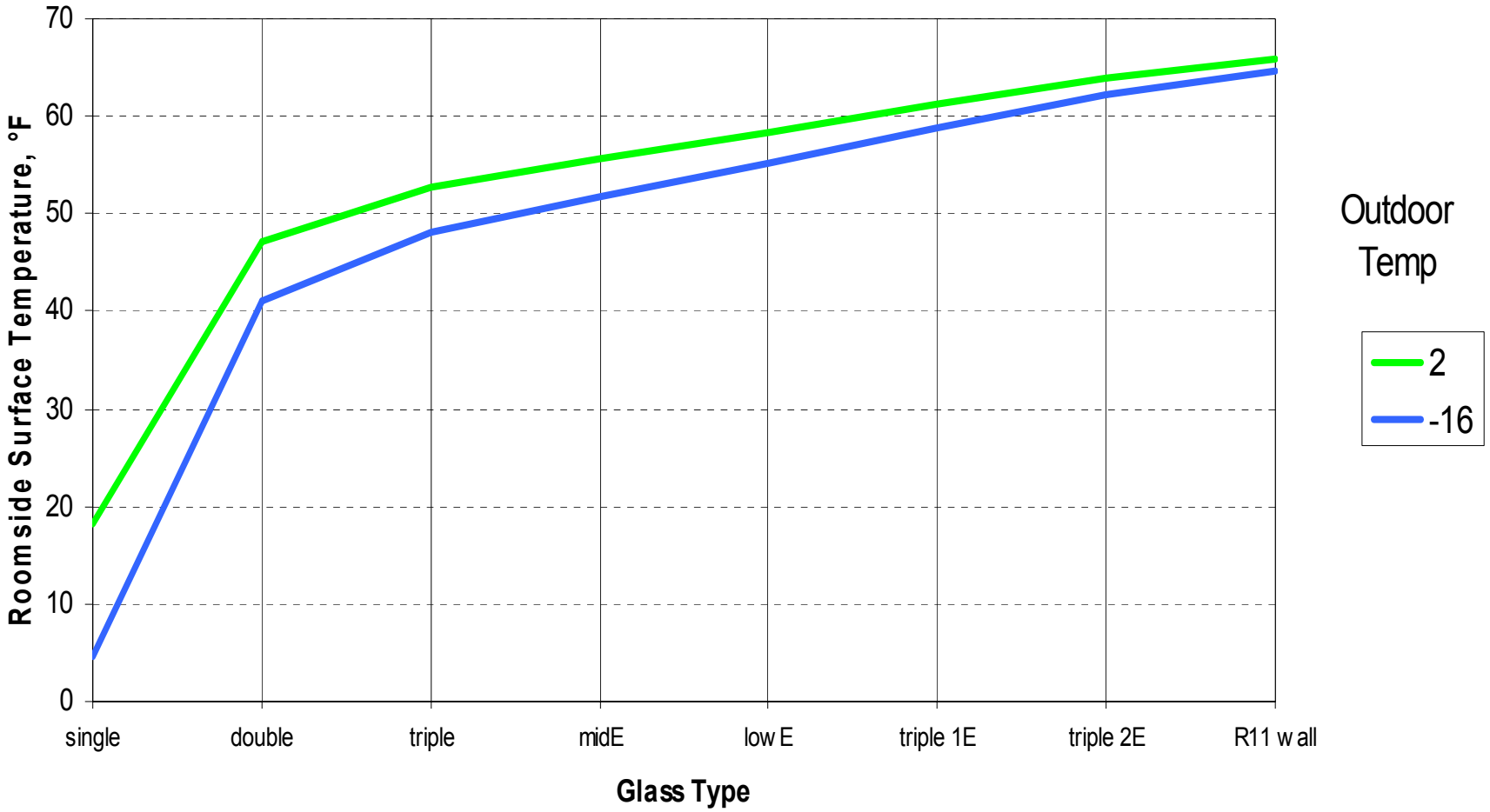
Winter Comfort

Kansas City and Minneapolis



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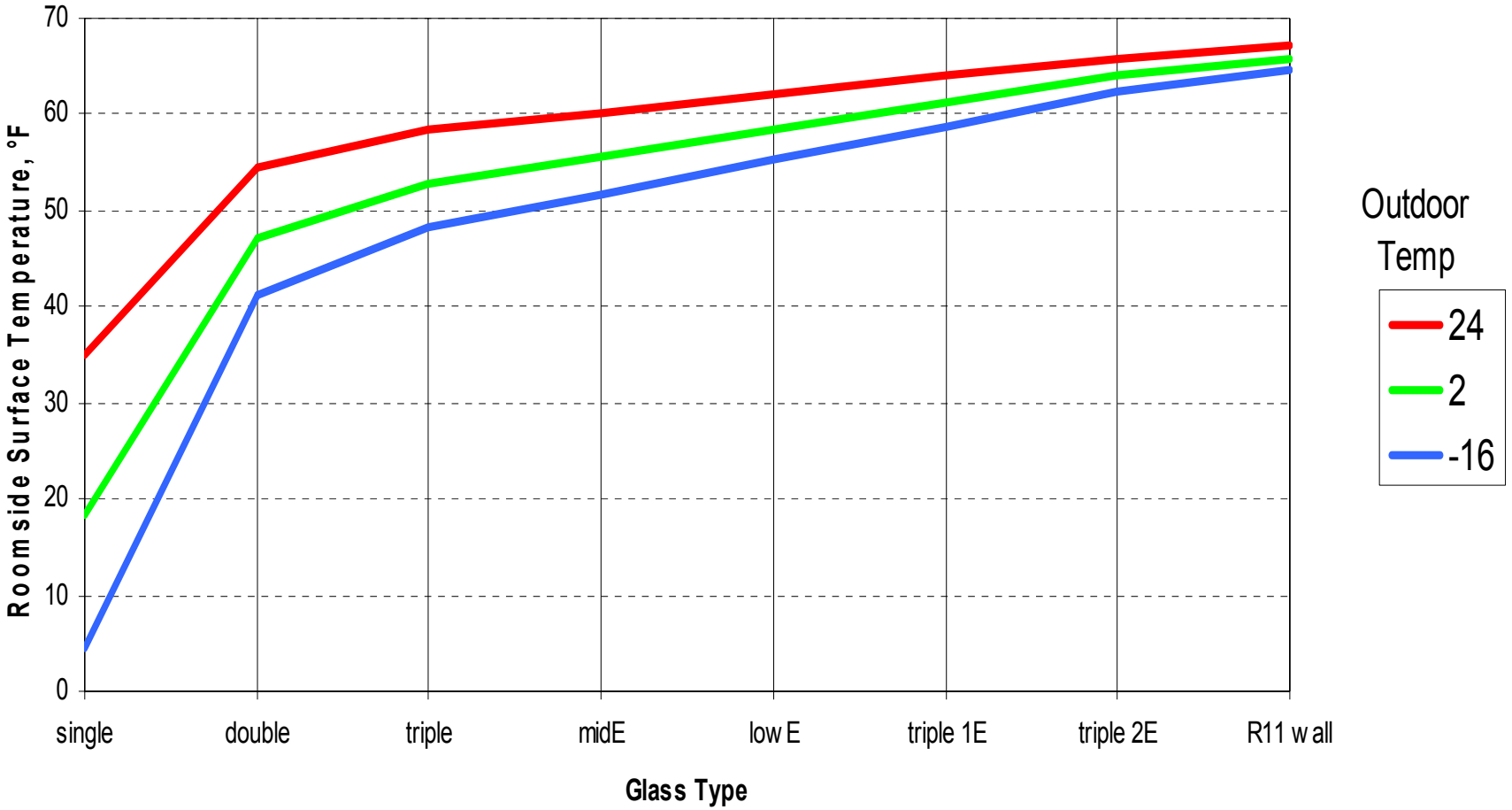
Winter Comfort

San Antonio, KC, and MPLS



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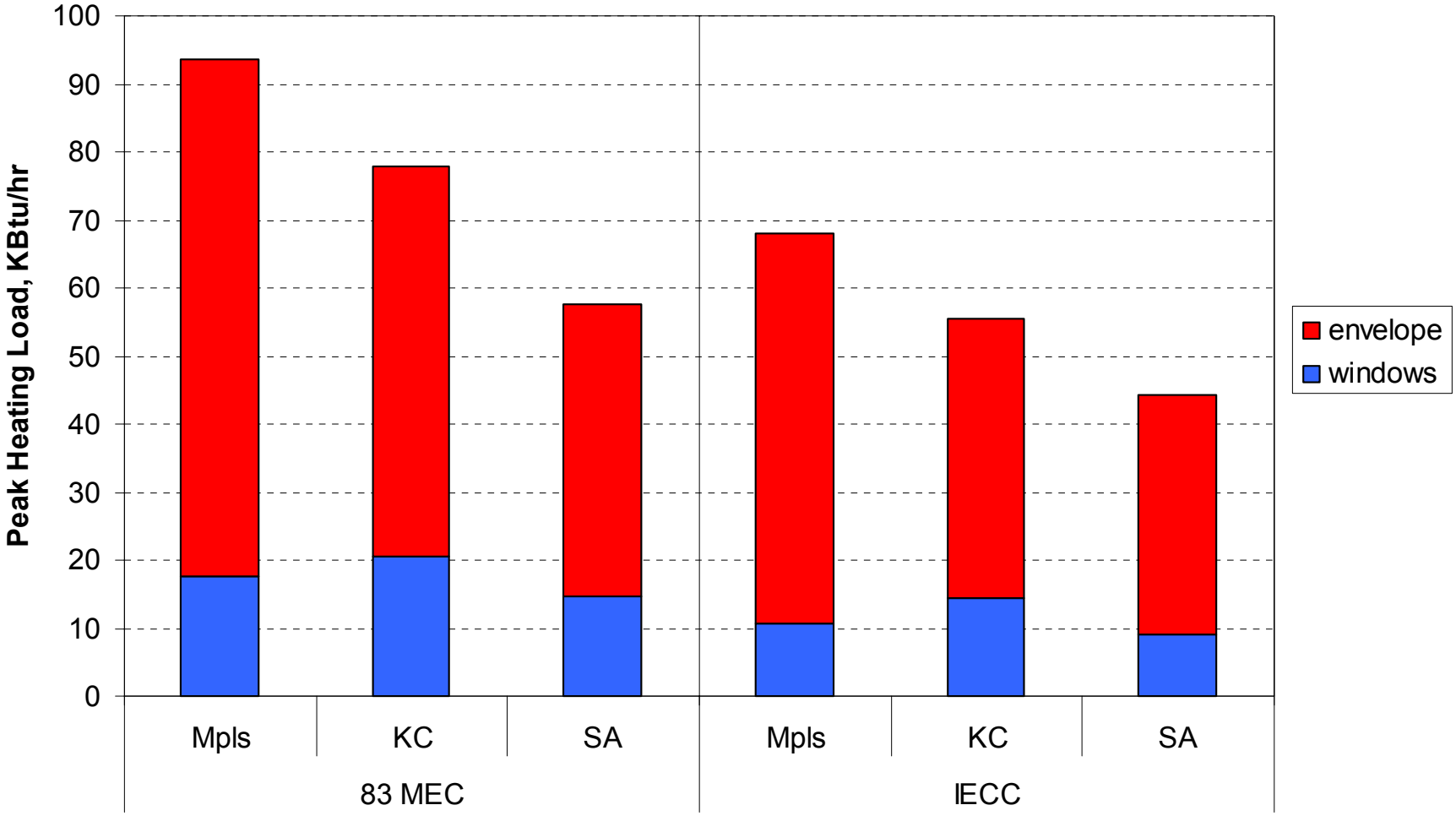
Design Heat Loss Then & Now



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Heating Summary

- Design heat loss has been reduced approximately 25% in the last 20 years
- Window portion of the peak heating loss has been reduced by about the same amount
- Windows constitute about 20% of the peak heating load

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Cooling
The Other Season for Windows

- Most new homes have air conditioning
- Window solar gain is the single largest contributor to cooling loads

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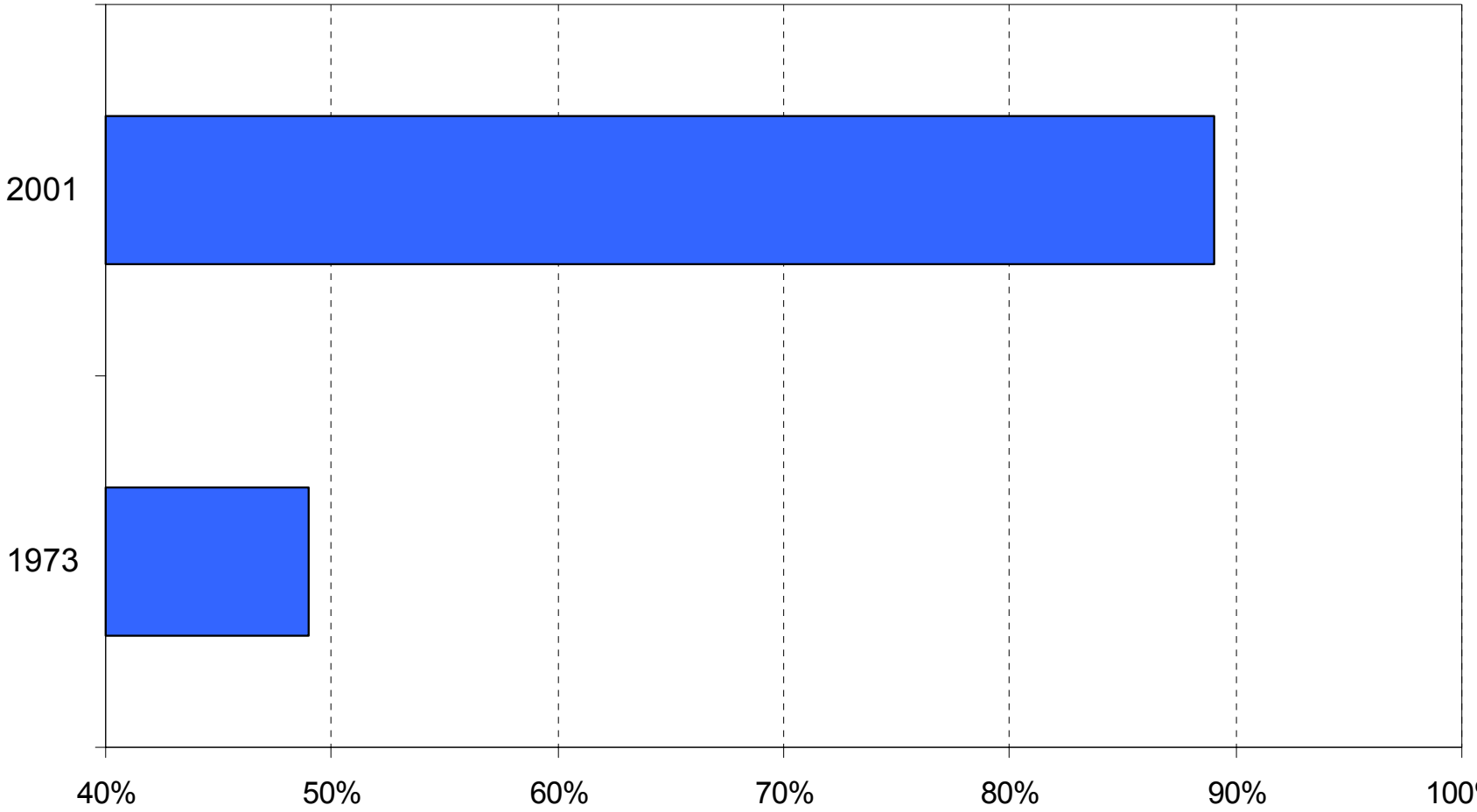
Single Family Homes Sold with Air-Conditioning



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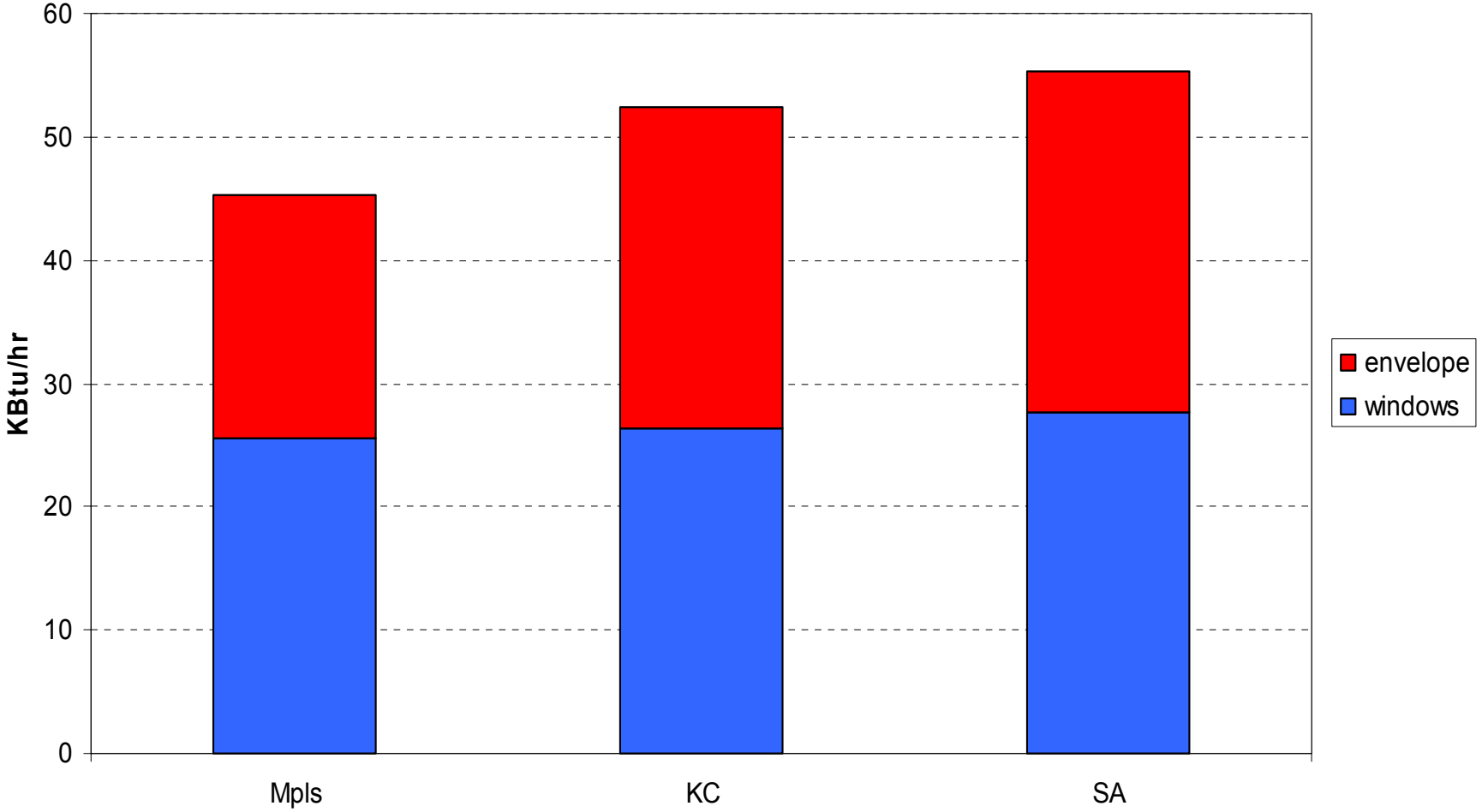
Design Heat Gain
20 Years Ago



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Priority 1
Reduce Solar Heat Gain

- External Shading
- Internal Shading
- Low Solar Gain Glass

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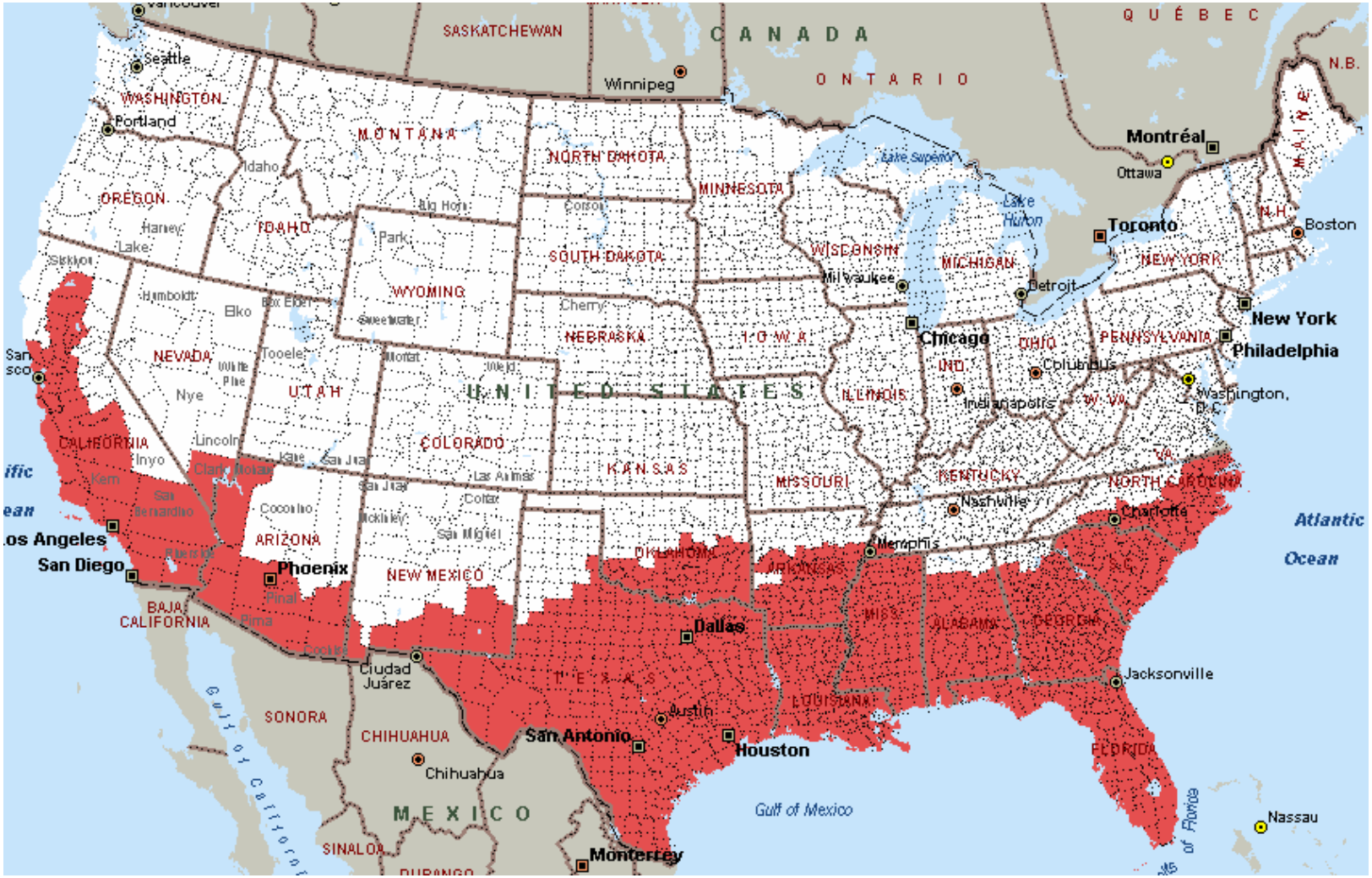
SHGC Requirements in the IECC



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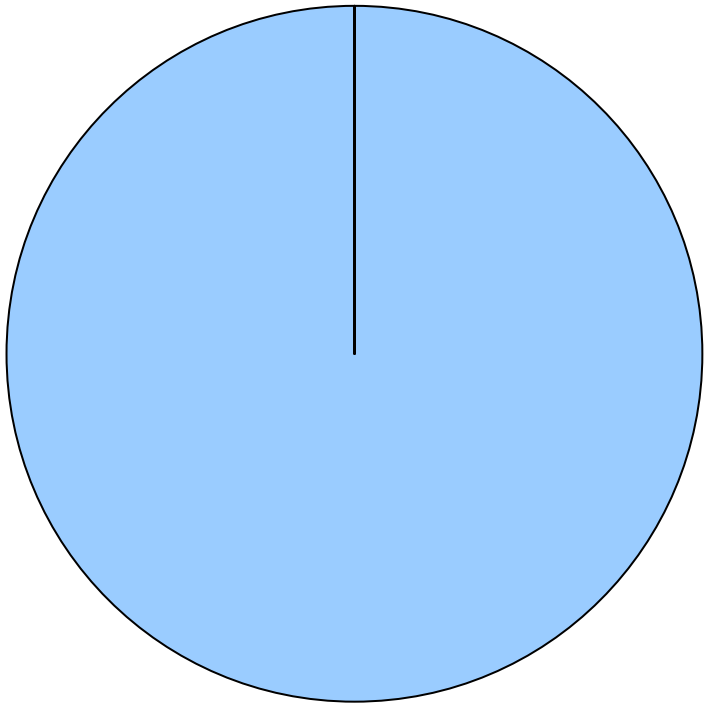
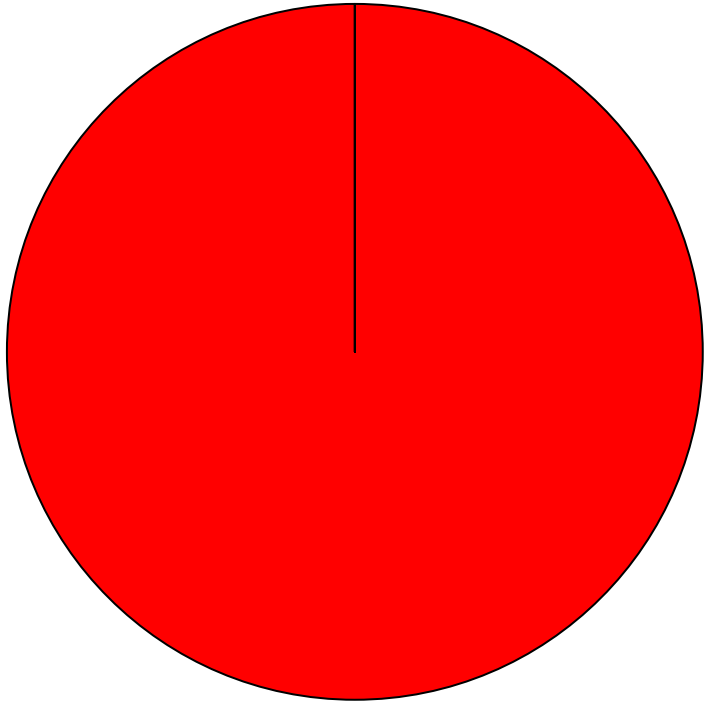
Sunlight Has 2 Equal Parts

Visible Light



Infrared



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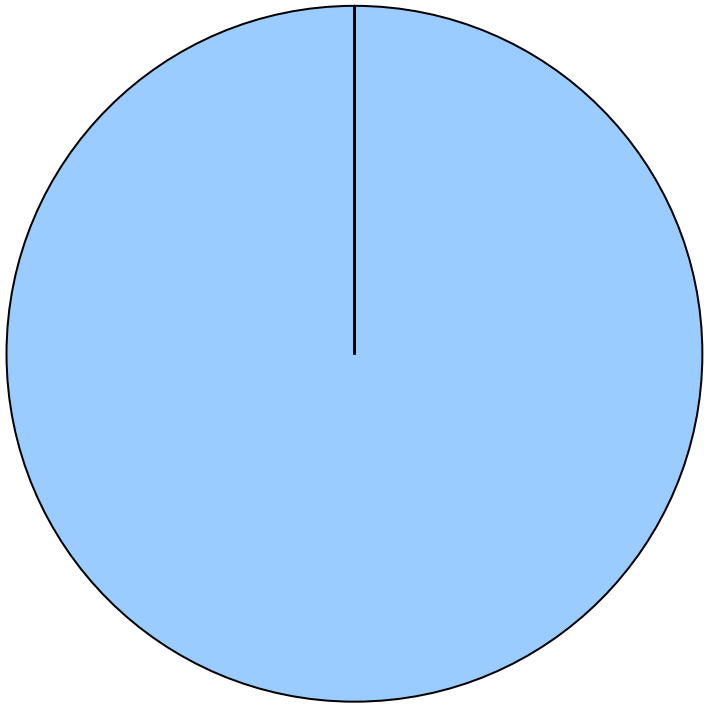
50% Solar Gain

100% Visible Light

Infrared

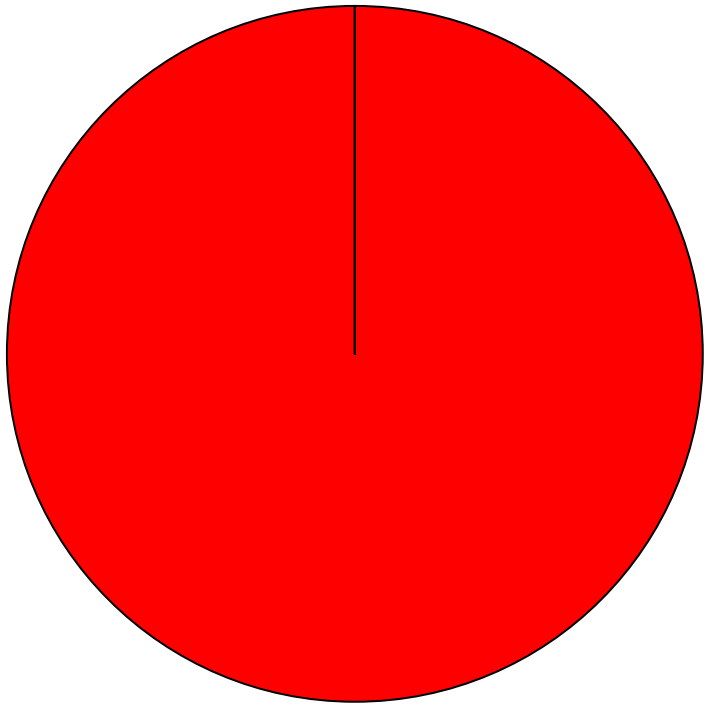


Cardinal®

50% Solar Gain

Visible Light

100% Infrared



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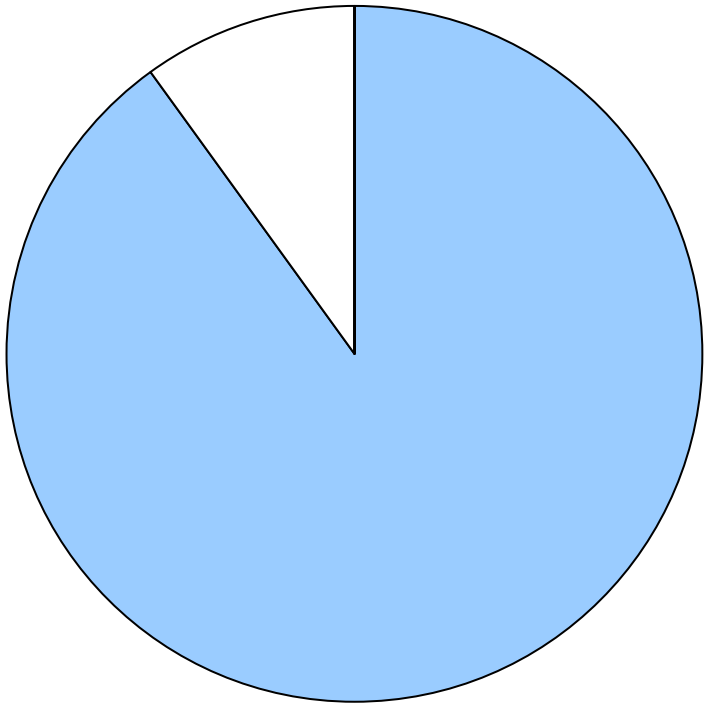
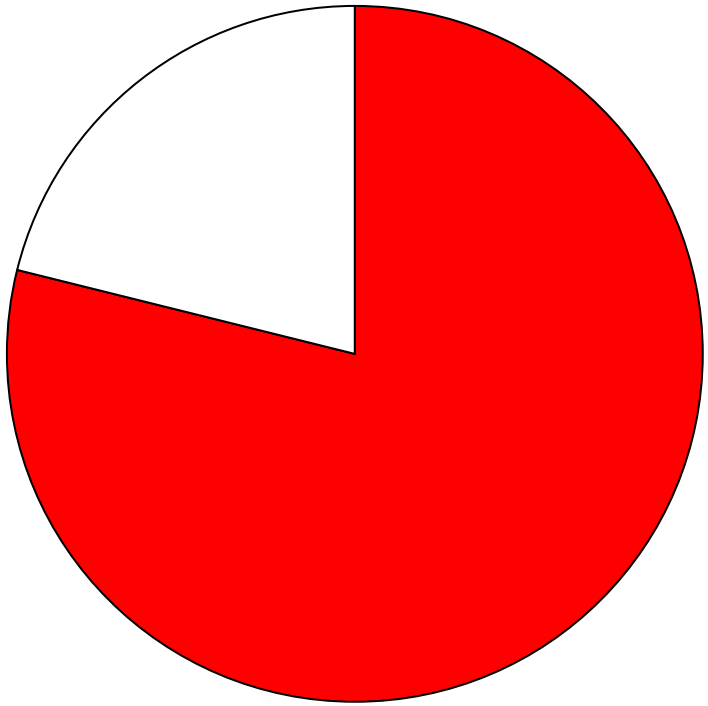
They look different but have the same solar gain

Clear Glass
85% Solar

90% Visible Light



80% Infrared



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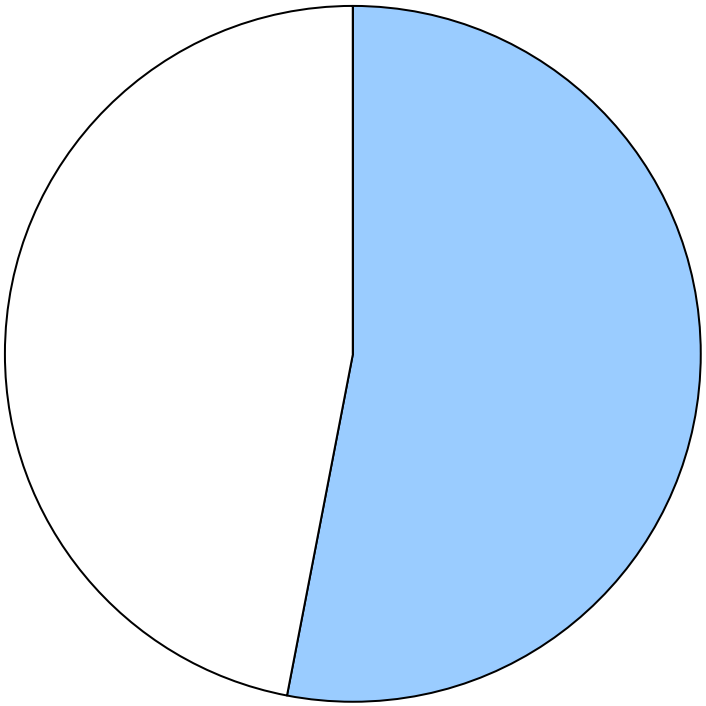
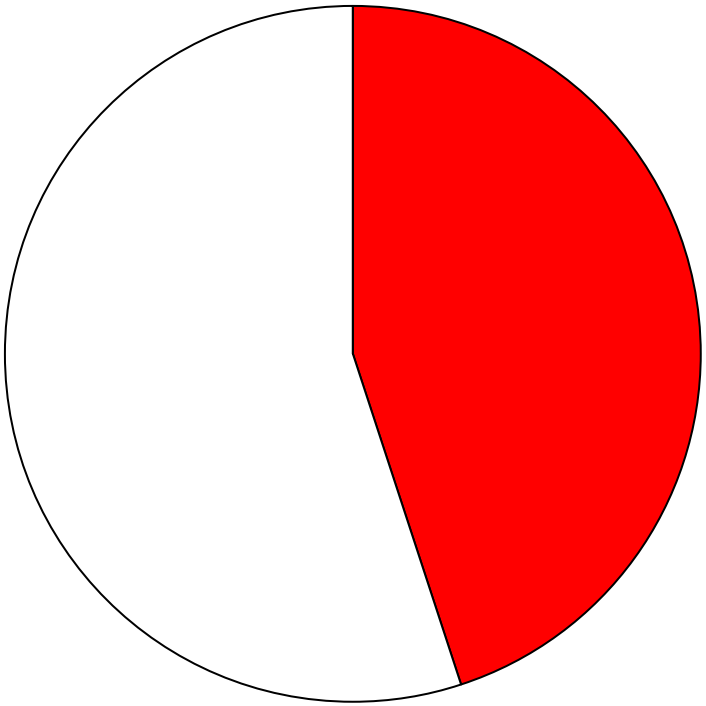
Tinted Glass
49% Solar

53% Visible Light



45% Infrared



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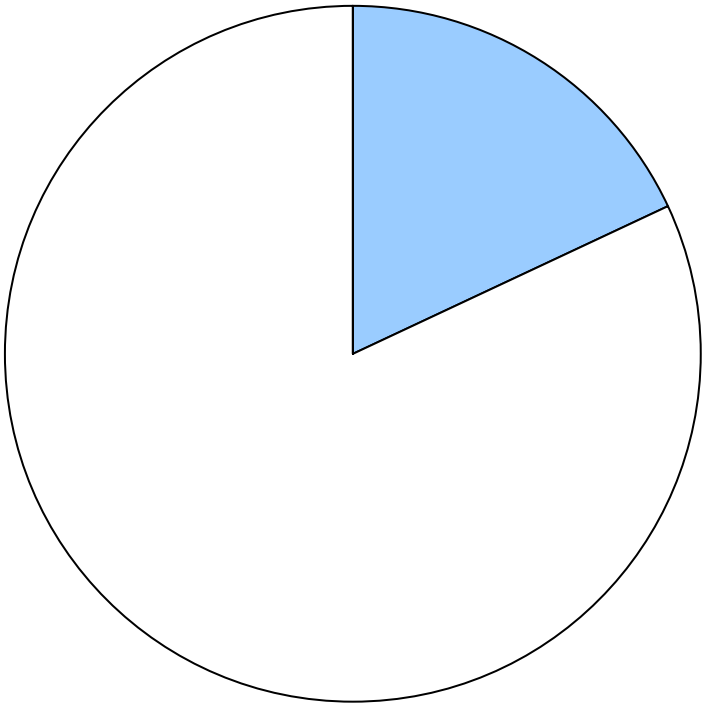
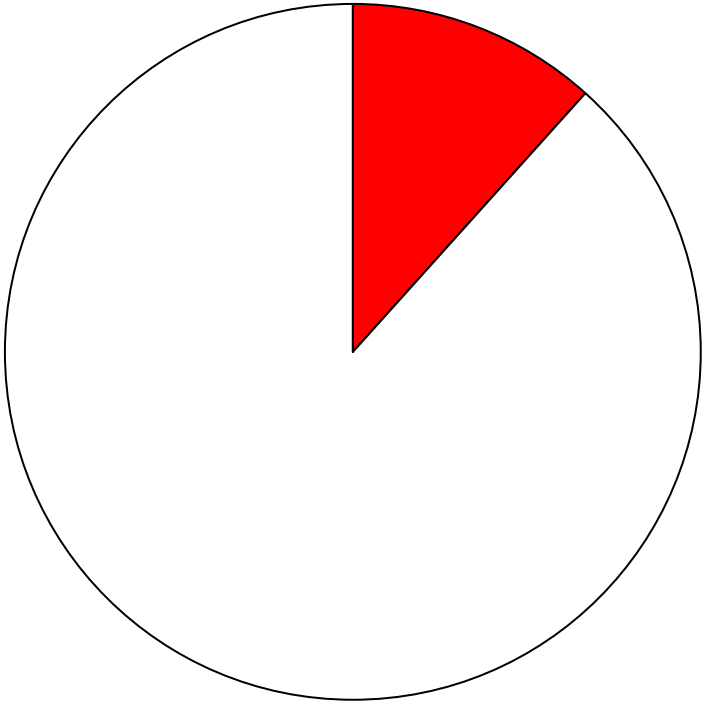
Reflective Glass
16% Solar

20% Visible Light



12% Infrared



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“Conventional” Glass Technology

Clear, tinted, and reflective glasses do not improve the U-factor

The level of illumination varies but the proportion solar heat gain to light remains similar

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What about Low-E Glass?

Proven performance for winter heating savings and occupant comfort

Available today with a variety of solar properties

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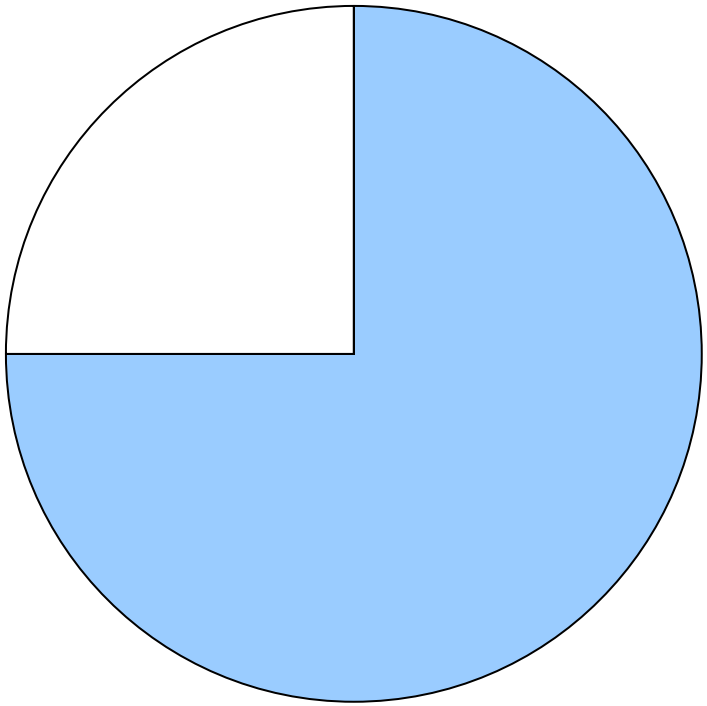
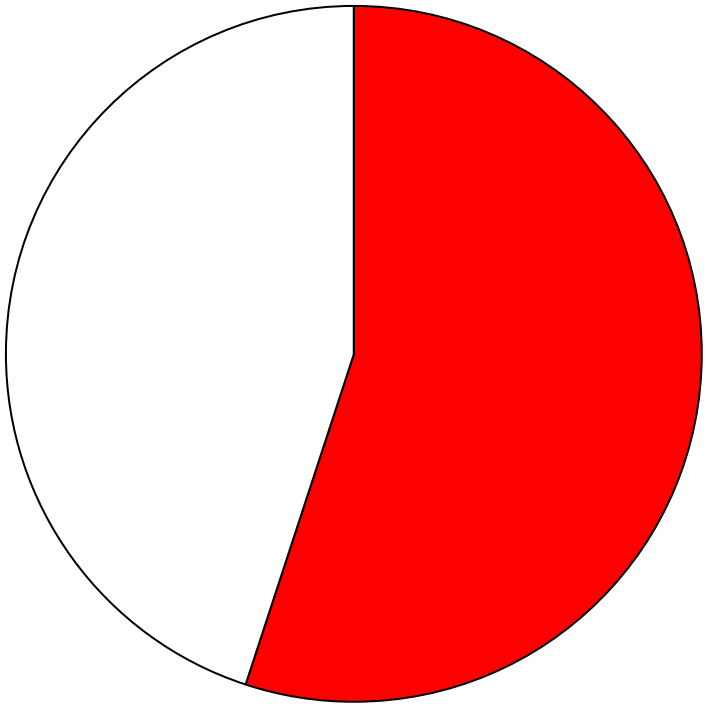
High Solar Gain Low-E
60% Solar

75% Visible Light



45% Infrared



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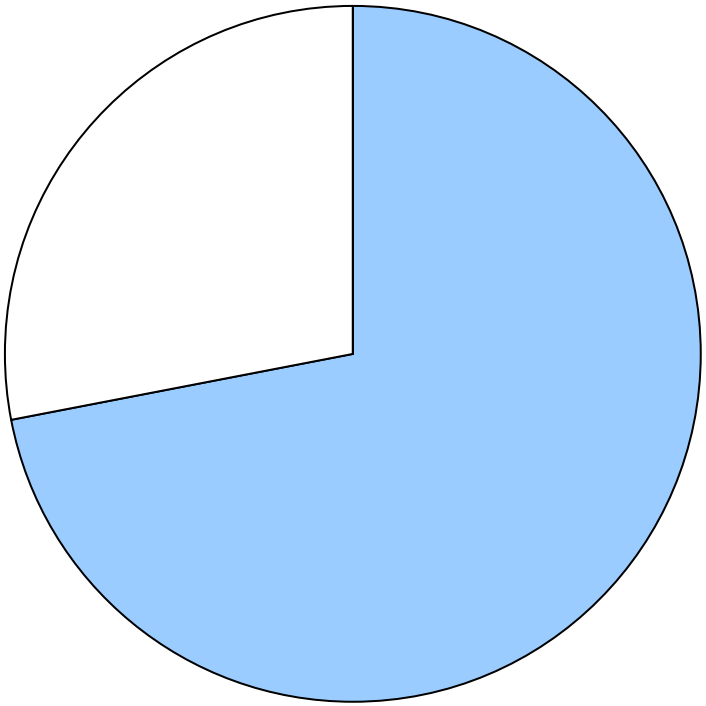
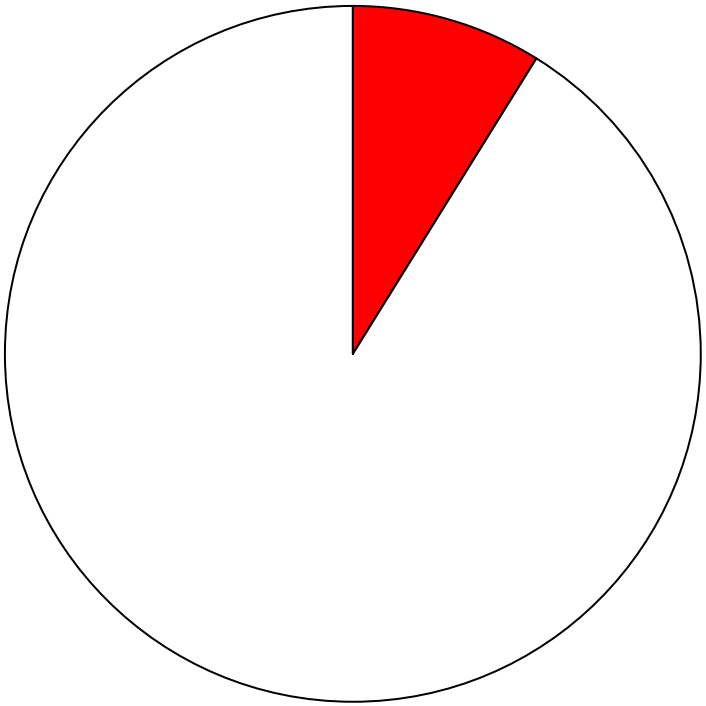
Solar Control Low-E
40% Solar

72% Visible Light



8% Infrared



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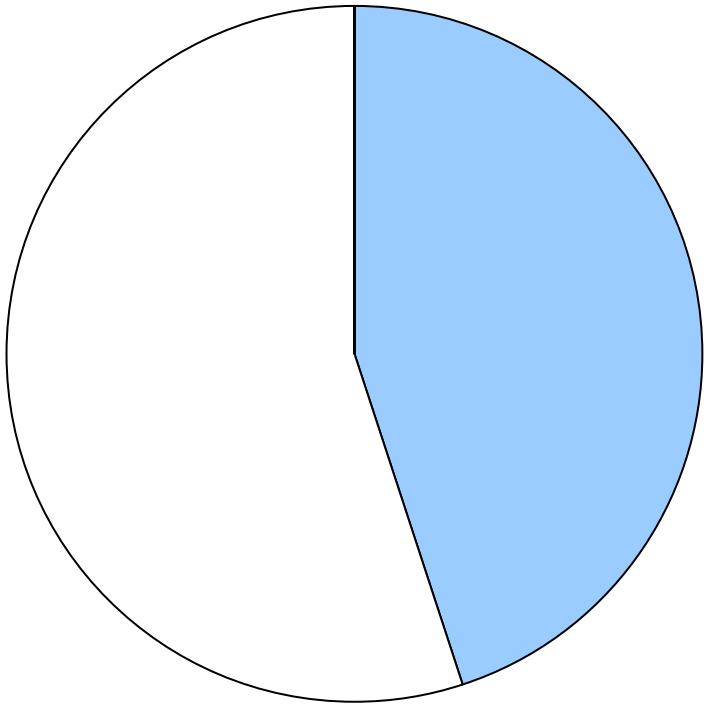
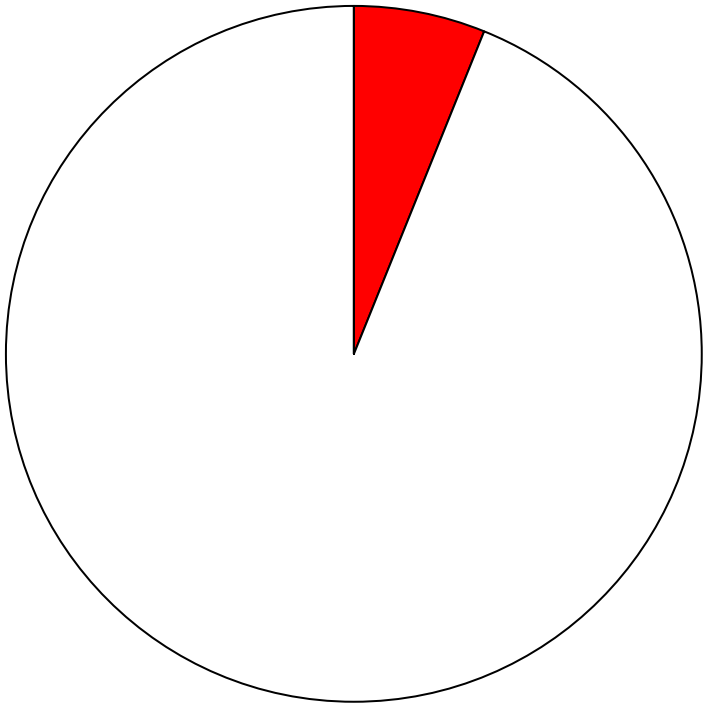
Tinted Solar Control Low-E
23% Solar

40% Visible Light



6% Infrared



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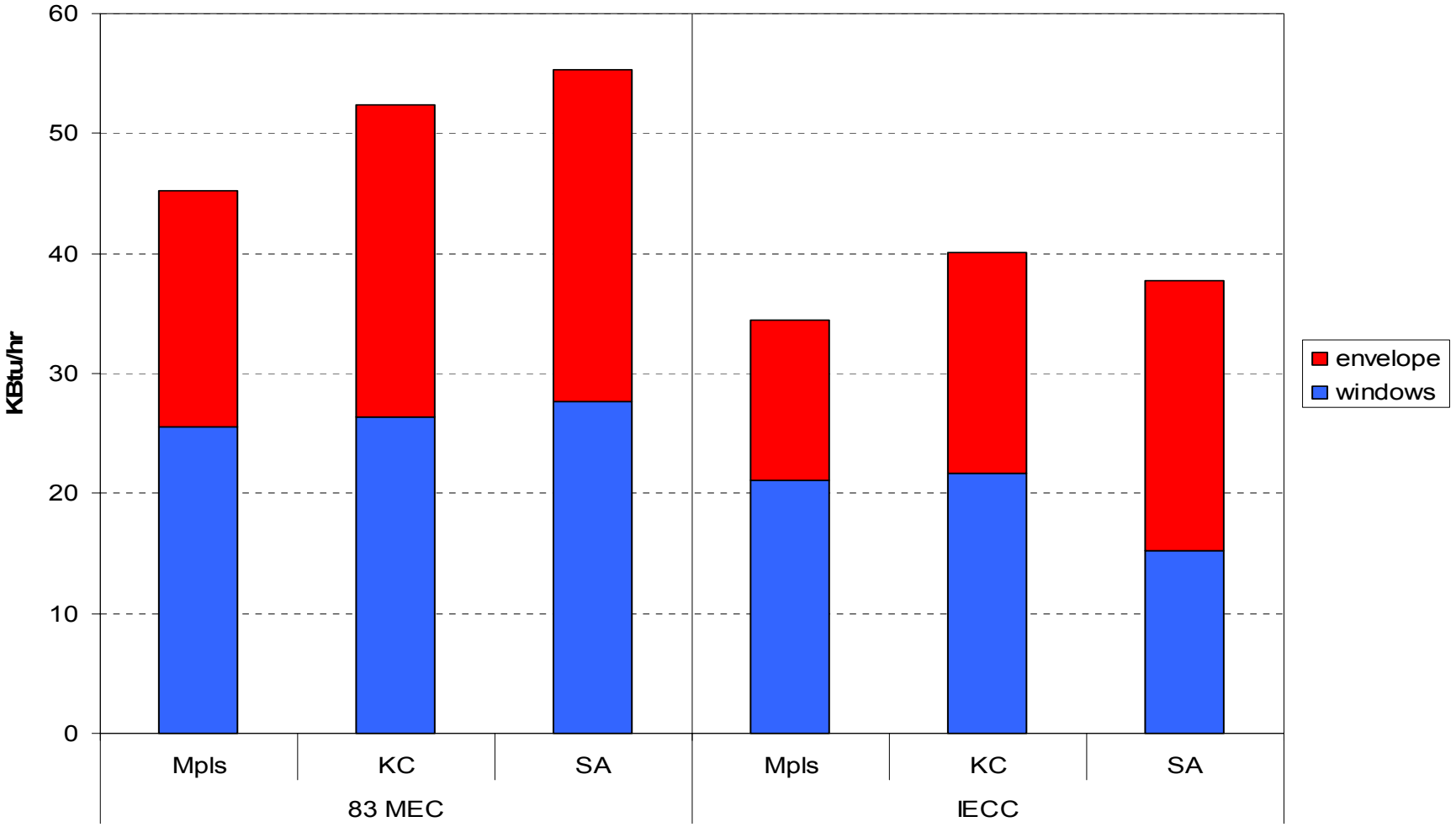
Design Heat Gain Then and Now



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Cooling Summary

- In the southern climates, low solar gain windows and envelope improvements have reduced cooling peaks by 30% or more
- In the northern climates, envelope improvements have reduced cooling peaks by nearly 20%
- High solar gain windows can be nearly 2/3 of the cooling peak in a well insulated house

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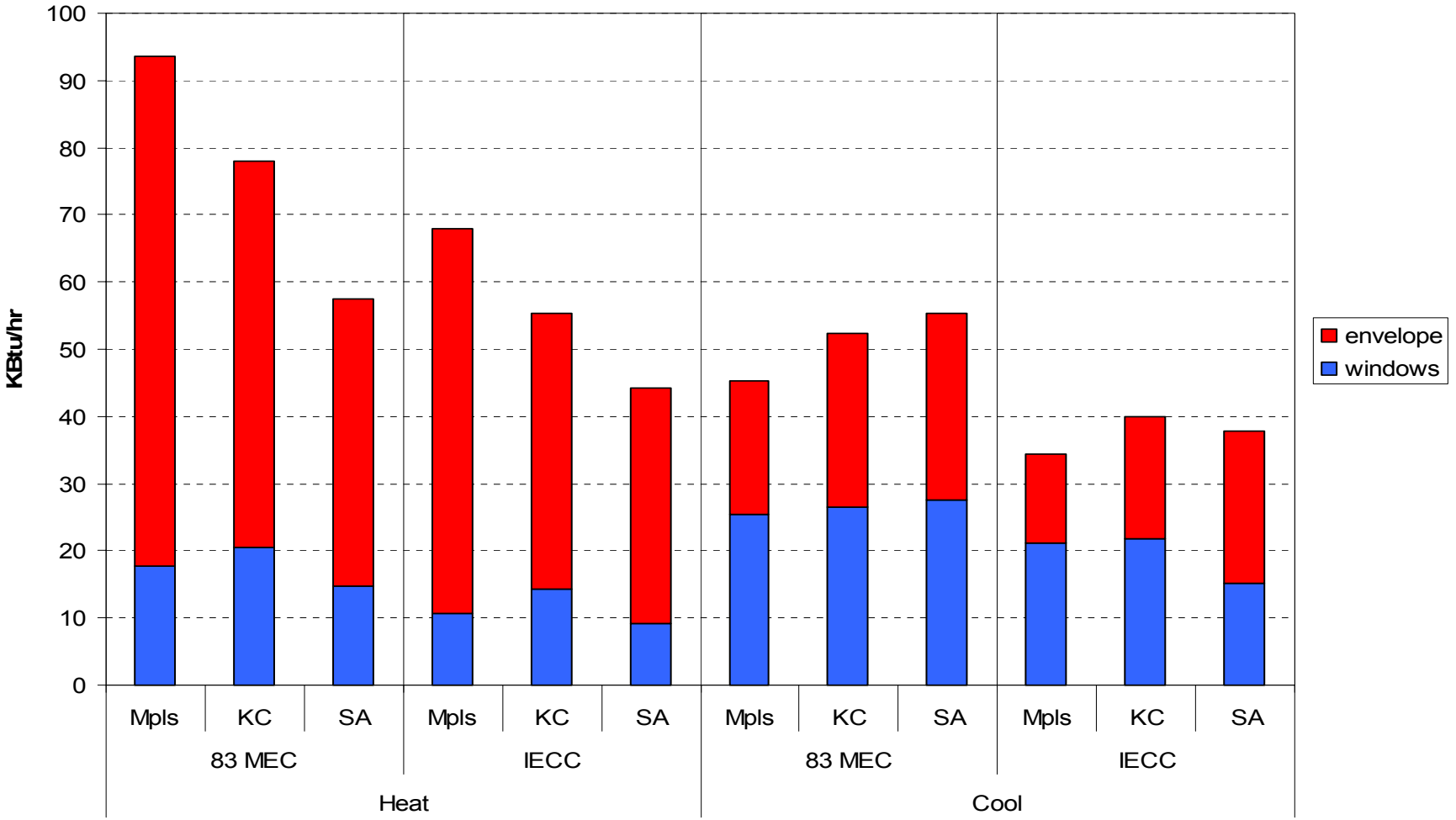
Design Heat Flows Then and Now



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The Next Generation of Efficient Windows

- Better insulating (triple panes?)
- Less solar gain (reduce daylight?)
- Switchable glass
  (winter gains, summer blockage)
- ??

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Efficient
Windows
Energy
Codes