The Role of Energy Efficient Windows in Codes

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Energy Efficient Windows and Energy Codes Go Hand-in-Hand

- **Proliferation of energy efficient, low-e windows**
  - Has led to improved energy codes to properly recognize the benefits of, and even require such windows
- **Low upgrade cost**
  - Low-e windows can cost-effectively perform substantially better than clear, double pane windows for both heating and cooling energy use and comfort
- **NFRC in the Marketplace**
  - As low-e technology progressed, rating tools developed to accurately determine improved performance, allowing the builders and codes to specify a more efficient window

Energy Efficient Windows and Energy Codes Go Hand-in-Hand (cont.)

- **NFRC in Codes**
  - First step in improving window provisions in codes were new requirements to use the NFRC rating system
- **Low-e Is the Primary Standard for Energy Efficient Windows**
  - The obvious energy efficient window technology nationwide as codes have paved the way to substantial market share (40%), economies of scale and low upgrade cost
- **The IECC Requires Energy Efficient Windows for all but the central U.S.**
  - DOE's newest proposal should lead to low-e as the standard nationwide

Latest Model Building Energy Codes

2003 International Energy Conservation Code (IECC)
Chapter 11 of the 2003 International Residential Code (IRC)

- These are “model” codes because they have been developed through a public hearing process by national experts under the direction of the International Code Council (ICC).
- The ICC has developed the International “family” of codes, including other codes such as the International Building Code (IBC), International Mechanical Code (IMC), International Plumbing Code (IPC), and more.

What is the Difference Between the IECC and the IRC Energy Chapter?

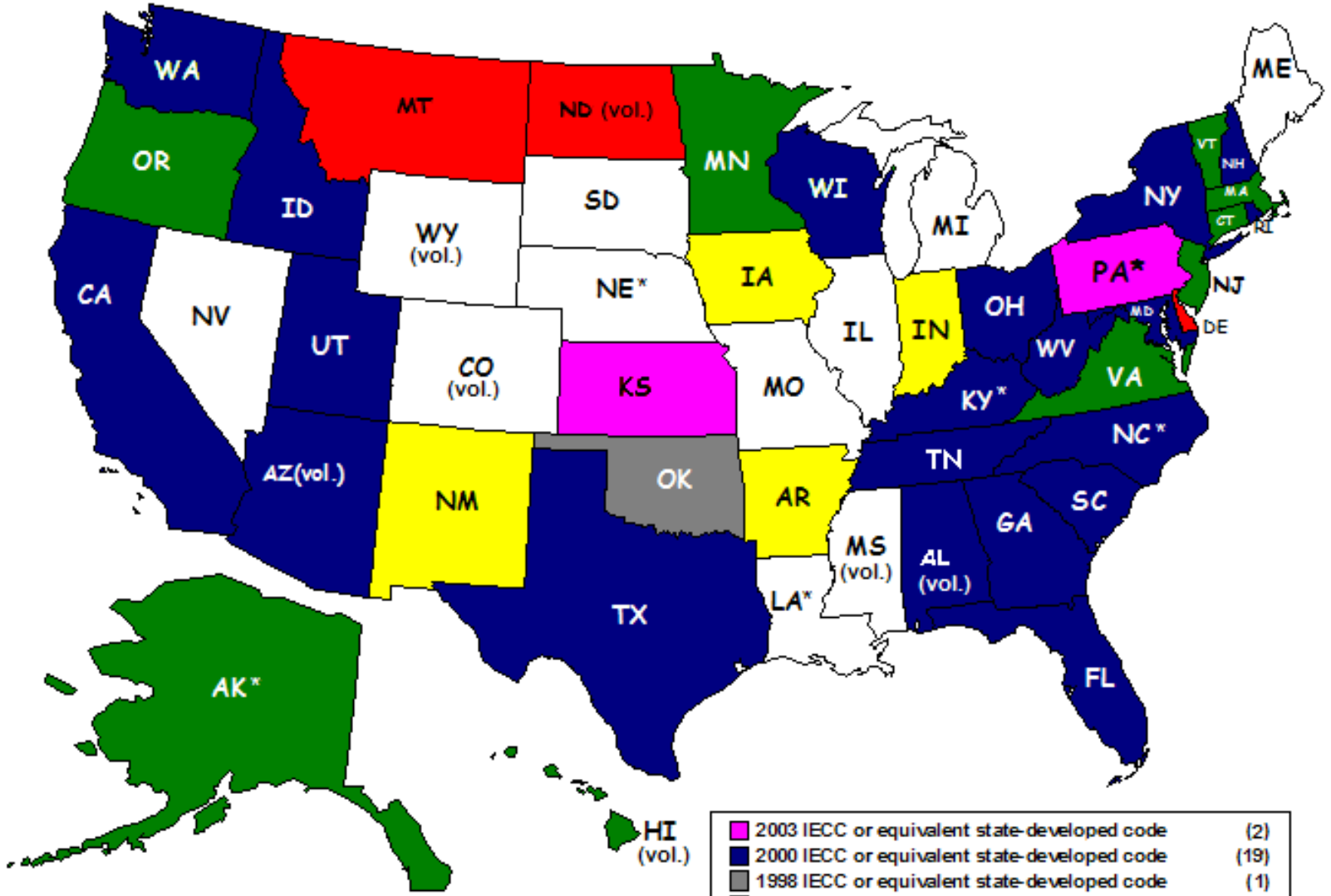
Short answer: Nothing!

- The IRC energy chapter is a simplified prescriptive compliance option written to be entirely consistent with the IECC.
- The IRC has two compliance options: (1) follow the simplified prescriptive option in its Chapter 11; or (2) follow the IECC.
  - The IRC option is capped at 15% window-to-wall area (same as 15% WWR table in IECC). For higher glazing areas, user has to follow the IECC.
- Chapter 6 of the IECC is (for all intents and purposes) the same as Chapter 11 of the IRC.

Why Are Building Energy Codes Important?

- Set meaningful thresholds for all new construction and existing buildings:
  - Windows: maximum U-factors and SHGCs for windows, doors and skylights.
  - Insulation: minimum levels of insulation for walls, ceilings, floors, foundations and ducts.
  - Infiltration: require proper sealing.
  - Equipment: require proper HVAC equipment sizing (in an ideal code).
- Ensure a baseline level of comfort and energy performance for all homes.

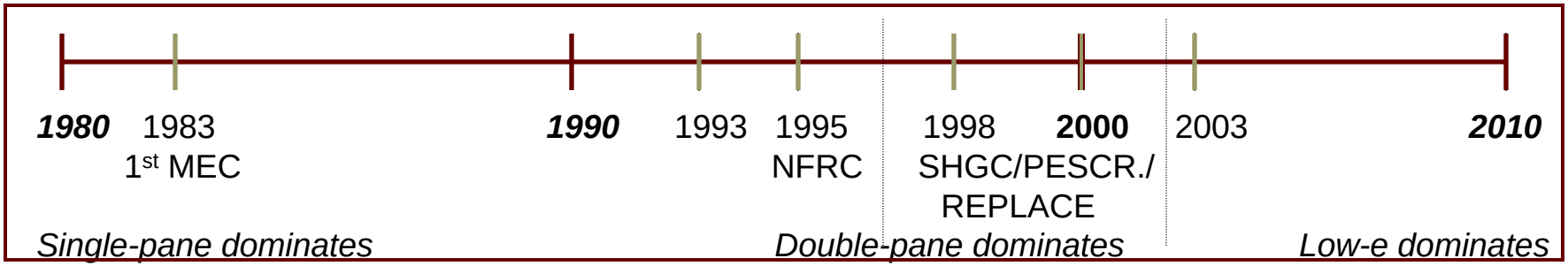
States Adopting the MEC/IECC



Revised June 2003

How Energy Efficient Windows Have Improved Codes

Energy Codes and Windows: Timeline



- **Ignored for 10 years: 1983 – 1993 MECs**
  - Windows buried in wall requirements
  - Window SHGC ignored for compliance purposes
- **U-factor Born in the Code: 1995 MEC**
  - NFRC 100 adopted
- **SHGC, Prescriptive Tables and Replacement Windows Born in the Code: 1998 – 2003 IECCs**
  - NFRC 200 adopted
  - Simplified prescriptive tables (based on WWR) and a replacement window and additions table

Independent Rating System

- National Fenestration Rating System (NFRC)
  - Fenestration means windows, doors and skylights
  - Fair, accurate and credible
- Ratings for the entire product:
  - Frame
  - Glass
  - Gas fills, Dividers, Spacers, etc.
- Ratings:
  - U-factor, Solar Heat Gain Coefficient (SHGC), Visible Transmittance (VT), Condensation Resistance (CR) and Air Leakage

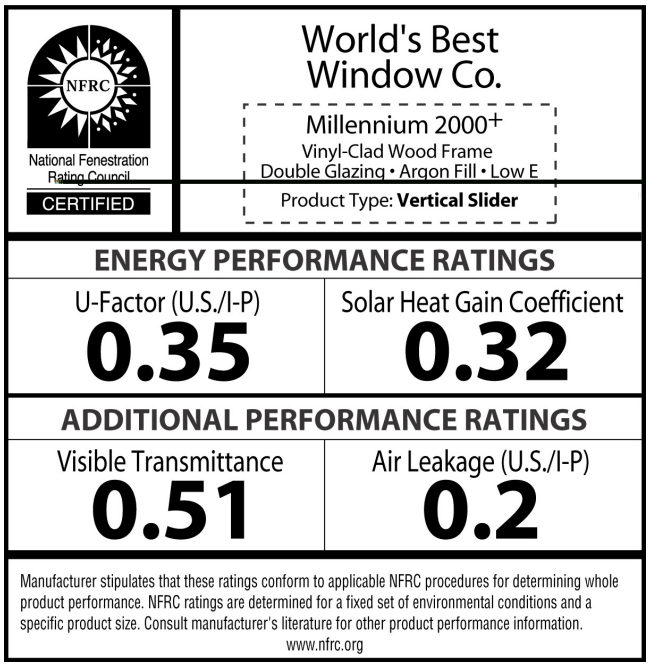


TABLE 502.2.4(3)
PRESCRIPTIVE BUILDING ENVELOPE REQUIREMENTS, DETACHED ONE- AND TWO-FAMILY DWELLINGS
WINDOW AREA 15 PERCENT OF GROSS EXTERIOR WALL AREA

ZONE	HEATING DEGREE DAYS	MAXIMUM	MINIMUM					
		Glazing *U*-factor	Ceiling *R*-value	Exterior wall *R*-value	Floor *R*-value	Basement wall *R*-value	Slab perimeter *R*-value and depth	Crawl space wall *R*-value
1	0 - 499	Any	R-13	R-11	R-11	R-0	R-0	R-0
2	500 - 999	0.90	R-19	R-11	R-11	R-0	R-0	R-4
3	1,000 - 1,499	0.75	R-19	R-11	R-11	R-0	R-0	R-5
4	1,500 - 1,999	0.75	R-26	R-13	R-11	R-5	R-0	R-5
5	2,000 - 2,499	0.65	R-30	R-13	R-11	R-5	R-0	R-6
6	2,500 - 2,999	0.60	R-30	R-13	R-19	R-6	R-4, 2 ft.	R-7
7	3,000 - 3,499	0.55	R-30	R-13	R-19	R-7	R-4, 2 ft.	R-8
8	3,500 - 3,999	0.50	R-30	R-13	R-19	R-8	R-5, 2 ft.	R-10
9	4,000 - 4,499	0.45	R-38	R-13	R-19	R-8	R-5, 2 ft.	R-11
10	4,500 - 4,999	0.45	R-38	R-16	R-19	R-9	R-6, 2 ft.	R-17
11	5,000 - 5,499	0.45	R-38	R-18	R-19	R-9	R-6, 2 ft.	R-17
12	5,500 - 5,999	0.40	R-38	R-18	R-21	R-10	R-9, 2 ft.	R-19
13	6,000 - 6,499	0.35	R-38	R-18	R-21	R-10	R-9, 4 ft.	R-20
14	6,500 - 6,999	0.35	R-49	R-21	R-21	R-11	R-11, 4 ft.	R-20
15	7,000 - 8,499	0.35	R-49	R-21	R-21	R-11	R-13, 4 ft.	R-20
16	8,500 - 8,999	0.35	R-49	R-21	R-21	R-18	R-14, 4 ft.	R-20
17	9,000 - 12,999	0.35	R-49	R-21	R-21	R-19	R-18, 4 ft.	R-20

For SI: 1 foot = 304.8 mm.

TABLE 502.2.5
PRESCRIPTIVE ENVELOPE COMPONENT CRITERIA
ADDITIONS TO AND REPLACEMENT WINDOWS FOR EXISTING DETACHED ONE- AND TWO-FAMILY DWELLINGS

	MAXIMUM	MINIMUM					
HEATING DEGREE DAYS	Fenestration *U*-factor[e]	Ceiling *R*-value[a,e]	Wall *R*-value[e]	Floor *R*-value	Basement wall *R*-value[b]	Slab perimeter *R*-value and depth[c]	Crawl space wall *R*-value[d]
0 - 1,999	0.75	R-26	R-13	R-11	R-5	R-0	R-5
2,000 - 3,999	0.50	R-30	R-13	R-19	R-8	R-5, 2 ft.	R-10
4,000 - 5,999	0.40	R-38	R-18	R-21	R-10	R-9, 2 ft.	R-19
6,000 - 8,499	0.35	R-49	R-21	R-21	R-11	R-13, 4 ft.	R-20
8,500 - 12,999	0.35	R-49	R-21	R-21	R-19	R-18, 4 ft.	R-20

For SI: 1 foot = 304.8 mm.

a. "Ceiling *R*-value" shall be required for flat or inclined (cathedral) ceilings. Floors over outside air shall meet "Ceiling *R*-value" requirements.

b. Basement wall insulation shall be installed in accordance with Section 502.2.1.6.

c. Slab perimeter insulation shall be installed in accordance with Section 502.2.1.4. An additional R-2 shall be added to "Slab perimeter *R*-value" in the table if the slab is heated.

d. "Crawl space wall *R*-value" shall apply to unventilated crawl spaces only. Crawl space insulation shall be installed in accordance with Section 502.2.1.5.

e. Sunroom additions shall be required to have a maximum fenestration *U*-factor of 0.50 in locations with 2,000 - 12,999 HDD. In locations with 0-5,999 HDD, the minimum ceiling *R*-value shall be R-19 and the minimum wall *R*-value shall be R-13. In locations with 6,000 - 12,999 HDD, the minimum ceiling *R*-value shall be R-24 and the minimum wall *R*-value shall be R-13.

Special Energy Code Requirements for Glazing in the South

Windows are the **BIGGEST** contributors to heat gain and heat loss in homes

0.40 Maximum Solar Heat Gain Coefficient (SHGC) Requirement in the IECC

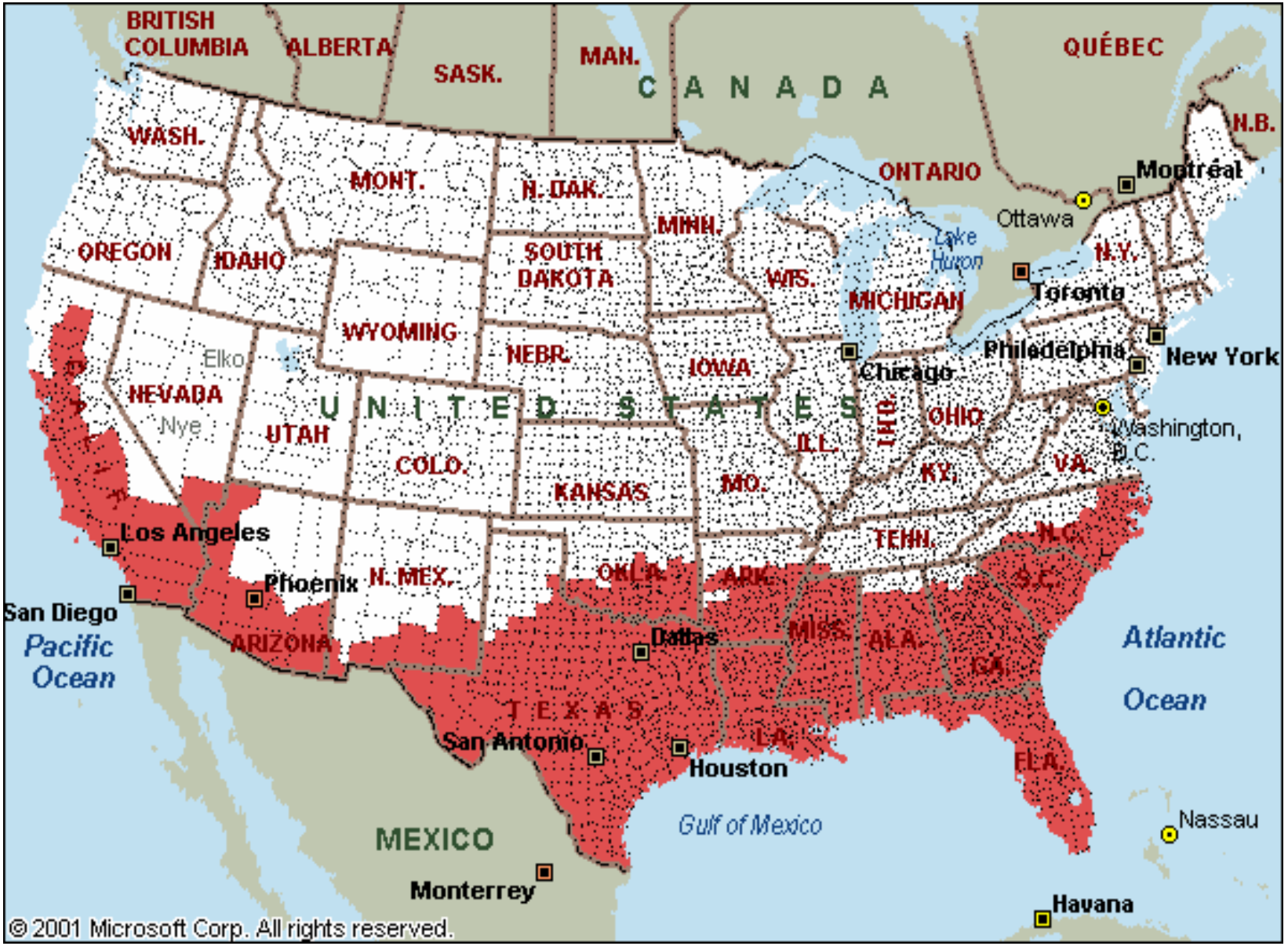
- In addition to prescriptive tables for U-factor, the 1998 – 2003 IECCs limit the amount of solar heat that can pass through windows (SHGC).

SHGC = Solar Heat Gain Coefficient

The area-weighted average SHGC of all fenestration installed in climates up to 3,500 HDD shall not exceed 0.40

- Applies to new AND replacement windows.
- Low-solar gain, low-e windows are the easiest, most cost-effective way to meet this requirement.

Maximum 0.40 SHGC for HDD Less than 3,500



Area-Weighted Average SHGC

What does area-weighted average mean?

- 300 sq.ft. of windows with 0.32 SHGC
- 25 sq.ft. of windows with 0.52 SHGC
- Area-weighted average SHGC = 0.34

Why an area-weighted average?

- Decorative windows
- Glass block for security

US DOE Official Determination on the IECC

- DOE cited the IECC's treatment of windows, and specifically the 0.40 SHGC requirement, as "major" improvements in energy efficiency.
- "Setting the maximum SHGC for glazing products to 0.40 in climates below 3,500 HDD recognizes that low SHGC glazing is an effective cooling load reduction strategy in those parts of the country needing significant air conditioning."

Impediments/Myths Affecting Low-E Acceptance in Codes and Implementation

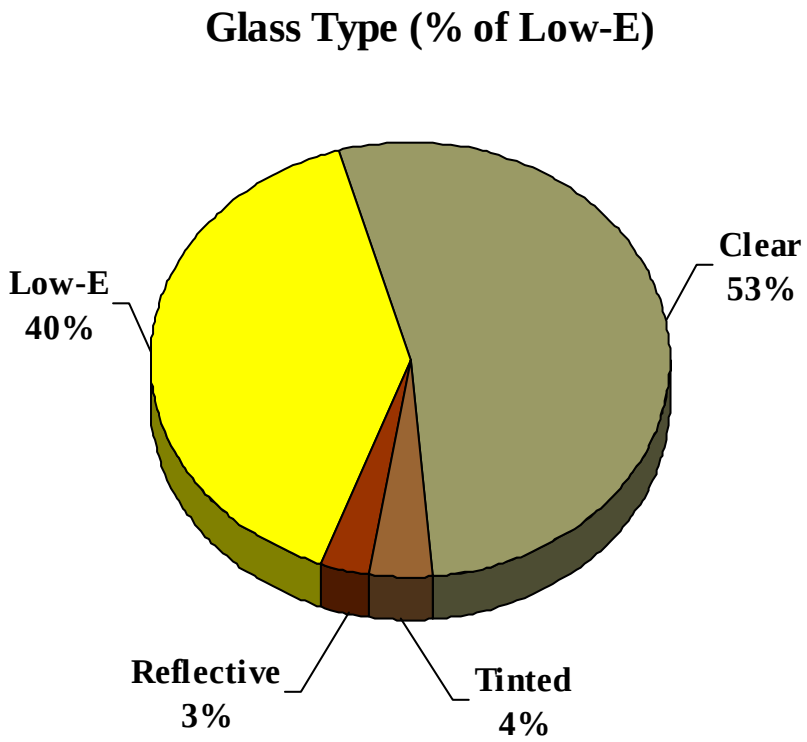
- Not available/Can't be done
- Costs too much
- Doesn't really work
- Need a trade-off

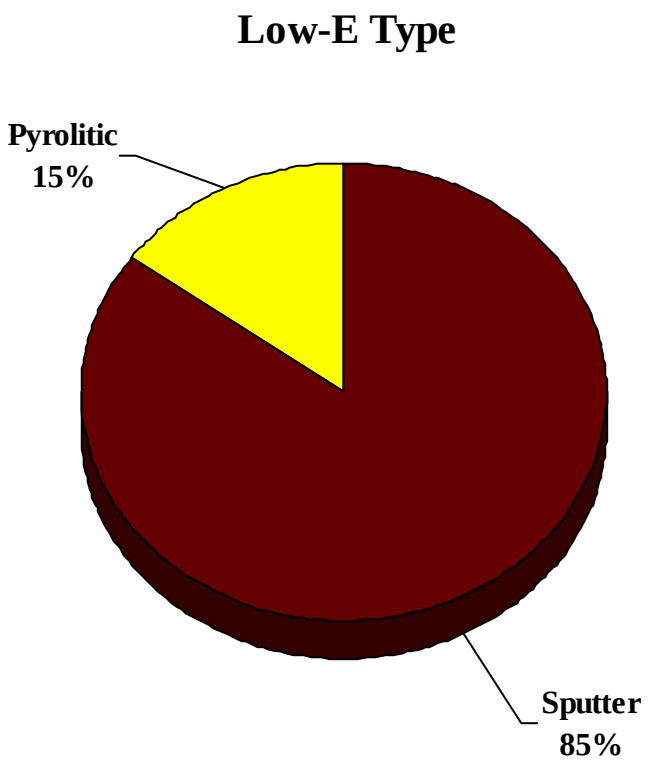
Low-E Windows = Base Case Energy Efficient Window Today

Low-e is a simple, low-cost upgrade:

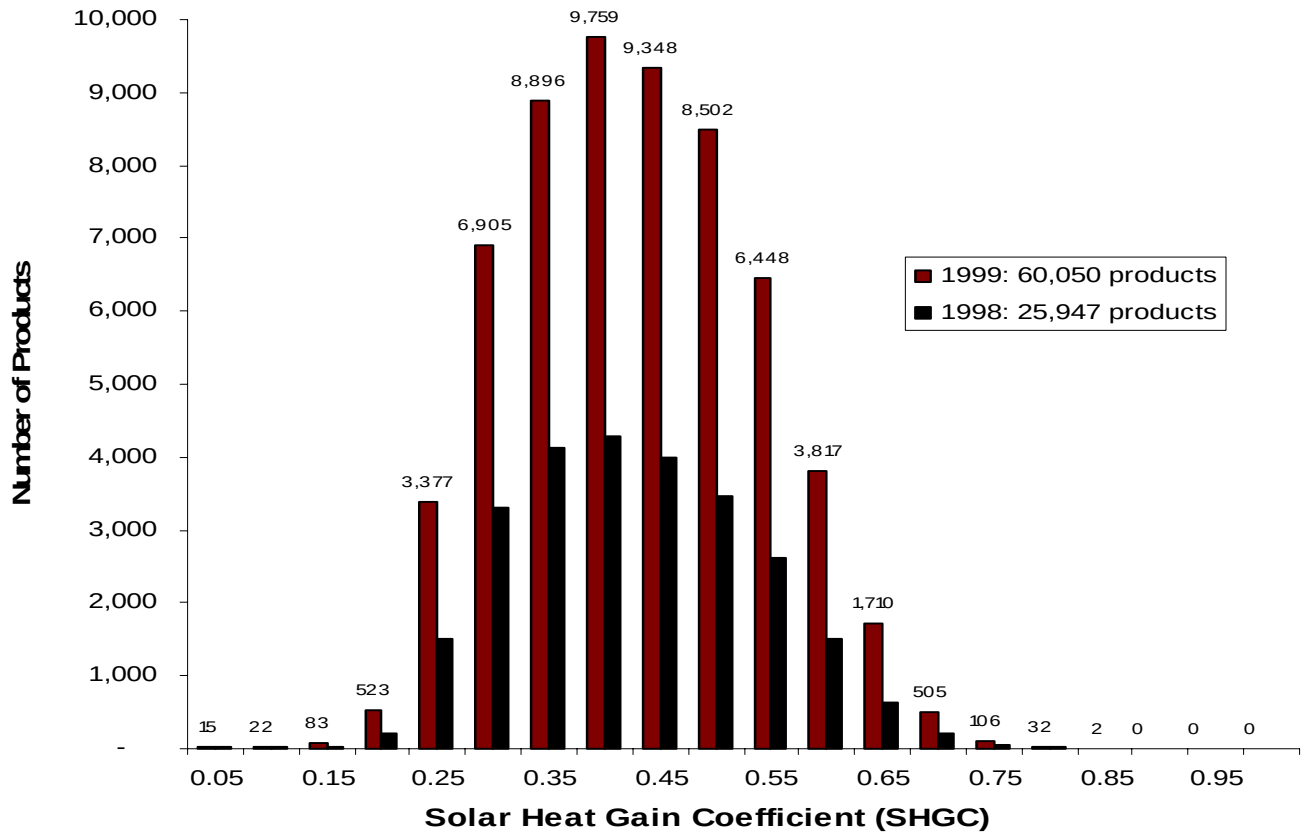
- The vast majority of fenestration products sold in the U.S. are double-pane units.
- Low-e coatings added to double-pane IG units in almost any wood/vinyl frame can achieve 0.40 – 0.35 U-factor (sometimes argon is also added) – meeting winter heating requirements
- Low solar low-e can achieve 0.40 SHGC in any frame – meeting summer cooling requirements
- The expected cost of the upgrade is less than $1.50 per square foot

Low-E is Available and Widely Used





Products with NFRC-Rated SHGCs Less than 0.40



Upgrade Cost of Low-e Glazing

- Less than $1.50/sq.ft.

  A cost range of $0.80/sq.ft. to $1.35/sq.ft. is consistent with surveys conducted of retailers across the country

  - Studies

    Washington SEO Study (1995): $1.24 to $1.65/sq.ft.

    Ohio Study (1996): $0.65/sq.ft.

    Xenergy Study (California 2001): $1.68/sq.ft.

    Quantec Study (Northwest 2002): $0.89/sq.ft.

Trade-offs for Low-E Not Good Public Policy

- HVAC Equipment
  - Shorter life: 15 years vs. 40 years
  - Federal Standards constantly improving: 8 SEER, 10 SEER, 12 SEER, ?? SEER (same for AFUE)
  - SEER ≠ Real-world efficiency
- Window Area: all windows should be energy efficient – regardless how many
- Insulation: trades off heating for cooling; ignores comfort, condensation and other issues

IECC Compliance Alternatives

- Chapter 4: Systems Analysis Approach
- Chapters 5 & 6: Envelope-only Compliance:
  - Individual envelope component performance (graphs)
  - Total building envelope performance (total envelope heat gain/loss of proposed vs. standard)
  - Acceptable practice for individual components
  - **Prescriptive requirements for individual components (prescriptive tables – most common)**
  - Simplified prescriptive requirements (Ch. 6)

RES*Check*

Combines Chs. 4 & 5 to create prescriptive trade-offs

- Broad U-factor trade-offs
  - HVAC (Ch. 4)
  - Heating savings for cooling savings
- Limited SHGC trade-offs (Georgia)
  - Shade screens
  - Overhangs

RES*Check* (cont.)

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2	500 - 999	0.90	R-19	R-11	R-11	R-0	R-0	R-4
3	1,000 - 1,499	0.75	R-19	R-11	R-11	R-0	R-0	R-5
4	1,500 - 1,999	0.75	R-26	R-13	R-11	R-5	R-0	R-5
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7	3,000 - 3,499	0.55	R-30	R-13	R-19	R-7	R-4, 2 ft.	R-8
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ZONE

Single-Family Prescr
1998/2000

Step by Step Instructions

Step 1: Determine the glazing area %.

Step 2: The glazing area percentage is a maximum, so as long as any building's listed glazing area percentage, the buildings will comply with the selected [illegible]. Each component requirement must be met within the selected package, otherwise select another package or use the RES*check*™ software, which can calculate trade-offs for compliance.

Step 3: Complete the Prescriptive Package Worksheet available online at www.energycodes.gov/rescheck/prescriptive.stm.

Package	MAXIMUM Glazing Area %[1]	MAXIMUM Glazing U-Factor[2]	MINIMUM Ceiling R-Value[3]	MINIMUM Wall R-Value[4]	MINIMUM Floor R-Value[5]	MINIMUM Basement Wall R-Value[6]	MINIMUM Slab Perimeter R-Value[7]	MINIMUM Crawl Space Wall R-Value[8]	Heating/Cooling Equipment Efficiency[9]
1	8%	0.43	R-38	R-16	R-19	R-10	R-7	R-16	Normal
2	12%	0.45	R-49	R-19	R-26	R-13	—	—	Normal
3	12%	0.40	R-49	R-21	R-19	R-10	R-7	R-17	Normal
4	12%	0.35	R-38	R-19	R-19	R-10	R-7	R-17	Normal
5	15%	0.35	R-49	R-21	R-21	R-11	R-11	R-20	Normal
6	18%	0.33	R-49	R-22	R-25	R-11	R-14	R-19	Normal
7	20%	0.30	R-49	R-26	R-21	R-11	R-10	R-17	Normal
8	22%	0.30	R-49	R-22	R-30	R-14	—	—	Normal
9	25%	0.25	R-49	R-19	R-30	R-14	—	—	Normal
10	12%	0.65	R-38	R-18	R-19	R-9	R-4	R-22	High Heating
11	12%	0.50	R-38	R-13	R-19	R-9	R-4	R-22	High Heating
12	15%	0.55	R-38	R-18	R-21	R-10	R-5	R-28	High Heating
13	15%	0.45	R-49	R-13	R-21	R-10	R-5	R-24	High Heating
14	18%	0.45	R-38	R-18	R-19	R-9	R-4	R-22	High Heating
15	18%	0.40	R-38	R-13	R-26	R-11	R-9	—	High Heating
16	22%	0.40	R-49	R-19	R-19	R-9	R-4	R-22	High Heating
17	22%	0.35	R-49	R-15	R-21	R-10	R-5	R-26	High Heating
18	12%	0.60	R-38	R-18	R-15	R-8	R-2	R-14	High Heat/Cool

Some Lead IECC Adopters (Standard Window Provisions)

- Maryland
- New York (replacement and electric heat nuances)
- Texas

Some States that Have Adopted IECC with Unique Window Provisions

- Georgia
- Kansas (mandatory disclosure)
- North Carolina (removed SHGC requirement)

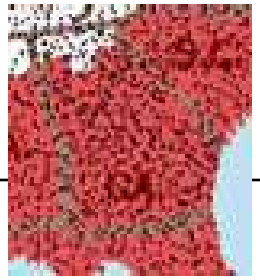
Georgia

Impediments/Myths Affecting Low-E Acceptance in Codes and Implementation

- **Not available/Can't be done**
- **Costs too much**
- **Doesn't really work**
- **Need a trade-off**

- **<u>Thoroughly</u>** studied (and restudied) 0.40 SHGC requirement – over 1 ½ years.
- 0.40 SHGC adopted across the entire state (zones 4-8) – even in the northern counties
  - Suppliers wanted it; promotes streamlined inventories, economies of scale for consumers.
- Maximum 0.65 U-factor – under any compliance approach.
- **<u>All</u>** windows MUST BE labeled (NFRC or Default Label)
- 18% WWR "base case" for simplified option and "Single-Step Compliance Sheets

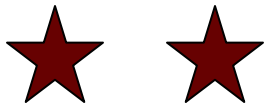
Georgia (Cont.)



- Maximum “18% Fenestration Area”

Table 602.1
SIMPLIFIED PRESCRIPTIVE BUILDING ENVELOPE THERMAL COMPONENT CRITERIA
MINIMUM REQUIRED THERMAL PERFORMANCE (*U*-FACTOR AND *R*-VALUE)[1]

Maximum				Minimum				
CLIMATE ZONE FROM FIGURE 302.1(11)	Glazing U-factor	SHGC[2]	Ceiling R-value[3,4]	Exterior Wall R-value[5]	Floor R-value	Basement Wall R-value	Slab Perimeter R-value[6]	Crawl Space Wall R-value
4B	0.65	0.40	R-30	R-13	R-11	R-5	R-0	R-5
5A	0.55	0.40	R-30	R-13	R-13	R-5	R-0	R-6
6B	0.55	0.40	R-30	R-13	R-19	R-6	R-0	R-7
7A	0.55	0.40	R-38	R-16	R-19	R-7	R-0	R-8
8	0.50	0.40	R-38	R-16	R-19	R-8	R-0	R-10



Georgia (Cont.)

- "Single-Step" Code Compliance Sheets (Climate Zones 4-8; multiple options in some zones)

"Single-Step" Residential Energy Code Compliance

Climate Zone 7A -Greater Atlanta Area– Option 7A-1

(R-30 ceiling, R-13 batt + R-3 sheathing, 0.55=Uwindow)

You are "deemed to comply" with the *Georgia State Energy Code for Buildings* if your residential structure meets the following conditions:

1. Your building shall be a one or two family detached dwelling built using wood framing.
2. Your building is three stories or less in height and not larger than 5,000 square feet of conditioned area.
3. Your building site must be located in Climate Zone 7A, as shown in the IECC 2000 Figure 302.1(11), an area of the state where the climatic conditions of approximately 3,500 Heating Degree Days or less apply.
4. You shall not make any substitutions of any kind for R-values/U-factors listed below.
5. Your window and door openings shall not exceed 18 percent of the gross wall area.
6. You shall comply with code requirements for envelope air sealing including all air tight, I. C. rated light fixtures in ceilings with attics and seal all ductwork with mastic.
7. Equipment minimum efficiencies shall be observed:
   Gas furnace: AFUE min 78%; A/C or Heat pump: SEER 10.0; Heat pump: HSPF 6.8; other (explain) _____

-% Openings in gross area of exterior wall[1]	**18% Max.**
-Doors U-factor	**0.35 Max.**
-Windows, Double Pane, U-factor[2]	**0.55 Max.**
-Solar Heat Gain Coefficient (SHGC)[2]	**0.40 Max.**
-Ceiling insulation[3]	**R-30**
-Wall cavity insulation	**R-13**
-Knee Wall insulation	**R-19**
-Insulating Sheathing[4]	**R-3**
-Floor Insulation	**R-19**
-Basement Masonry wall insulation	**R-7**
-Slab Perimeter Insulation[5]	**R-0**

All R-values shall be printed on the actual insulation and be stabilized R-values
All Windows shall have labels listing U-factor, SHGC, and Key Features

Foam Plastics shall not be installed below grade on foundation walls or below grade on slab foundations. These R-values may result in some degree of "over-design". However, this method will apply to a majority of one and two family residences built in the Greater Atlanta area. If you must change one or more of the R-values/U-factors listed to a lower R-value or higher U-factor, then do not use this method. **No substitutions are allowed here.**

Instead, you may use one of the other methods to show compliance, such as The Tradeoff Worksheet or the free MECcheck software (available at www.energycodes.gov). You may also use one of the Chapter 4, 5, or 6 approaches of the 2000 IECC with Georgia modifications.

At the time a permit is requested, you shall show how you plan to meet the Georgia Energy Code. When using the ***"Single-Step" Residential Energy Code Compliance*** method, you may not be required to turn in additional paperwork to obtain a building permit.

Note 1: "% Openings" is defined by the total area of the openings of windows and doors divided by the total gross area of the exterior wall. % Openings = 100 x (windows + doors) / (opaque walls + windows + doors).

Note 2: Up to 5% of the window area may be exempt from meeting the window U-factor and SHGC requirements to allow for decorative glazing.

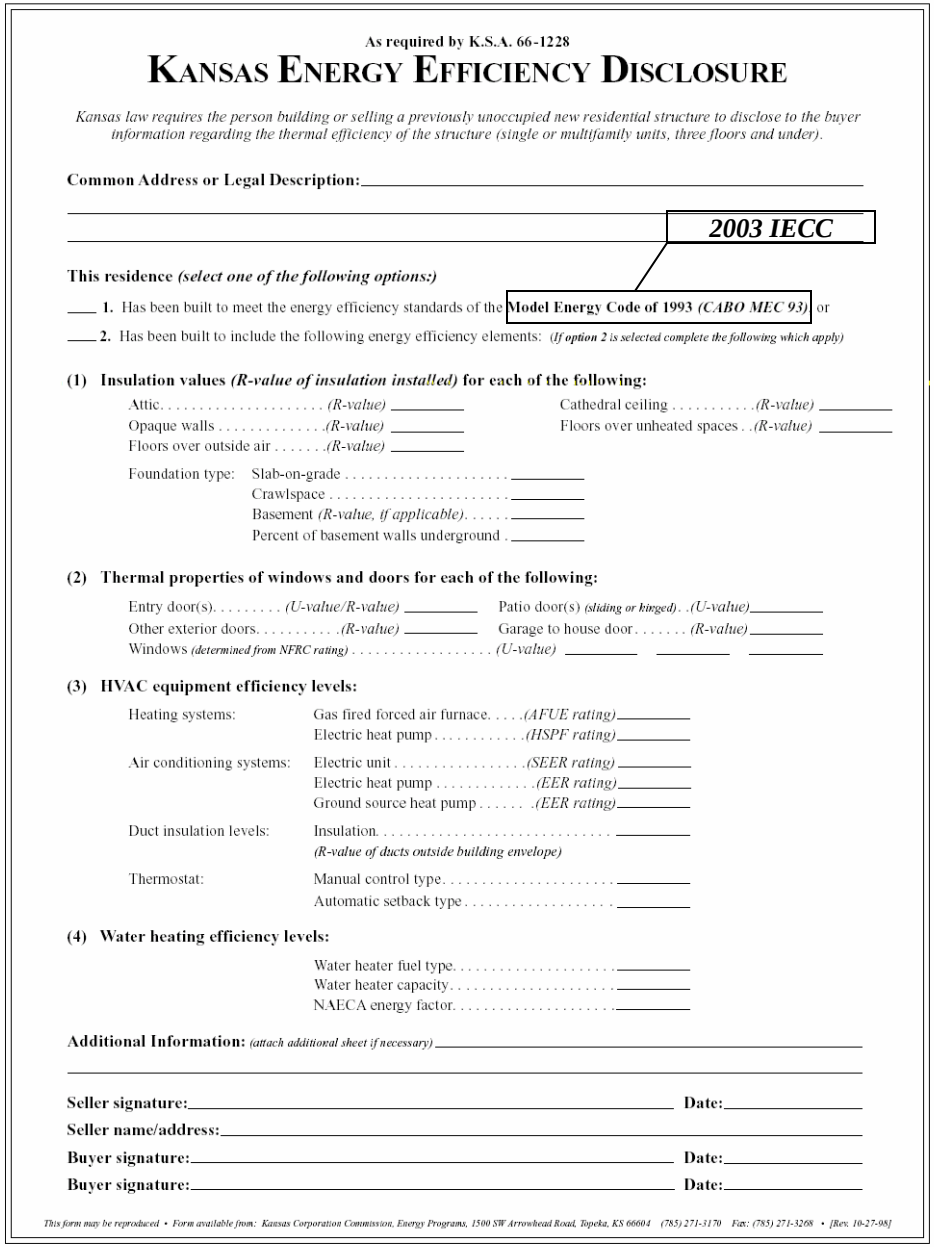
Note 3: Sloped ceilings, such as cathedral & tray ceilings, which require batt insulation, may be insulated with R-19 batts, provided the R-19 portion does not exceed 25% of the total ceiling area and provided the flat portions of the ceiling are insulated to obtain full height R-30.

Note 4: When the Exterior Wall R-value is cavity insulation and continuous insulated sheathing, 25% of the gross wall area may be Plywood/OSB (for corner bracing/structural requirements) or gypsum fastened direct to the garage wall studs.

Note 5: Unheated slabs.

Kansas

- Mandatory Disclosure
  - Meet the 2003 IECC (eff. July 1, 2003); or
  - HERS Score of 80; or
  - If neither, tell the homeowner about the energy performance of the components in their home.



As required by K.S.A. 66-1228

KANSAS ENERGY EFFICIENCY DISCLOSURE

Kansas law requires the person building or selling a previously unoccupied new residential structure to disclose to the buyer information regarding the thermal efficiency of the structure (single or multifamily units, three floors and under).

Common Address or Legal Description: _____

_____

2003 IECC

This residence ***(select one of the following options:)***

___ **1.** Has been built to meet the energy efficiency standards of the **Model Energy Code of 1993** ***(CABO MEC 93)*** or

___ **2.** Has been built to include the following energy efficiency elements: ***(If option 2 is selected complete the following which apply)***

(1) Insulation values *(R-value of insulation installed)* for each of the following:

Attic. . . . . *(R-value)* _____ Cathedral ceiling . . . . . *(R-value)* _____

Opaque walls . . . . . *(R-value)* _____ Floors over unheated spaces . . *(R-value)* _____

Floors over outside air . . . . . *(R-value)* _____

Foundation type: Slab-on-grade . . . . . _____

Crawlspace . . . . . _____

Basement *(R-value, if applicable)*. . . . . _____

Percent of basement walls underground . _____

(2) Thermal properties of windows and doors for each of the following:

Entry door(s). . . . . *(U-value/R-value)* _____ Patio door(s) *(sliding or hinged)* . . *(U-value)*_____

Other exterior doors. . . . . *(R-value)* _____ Garage to house door. . . . . *(R-value)* _____

Windows *(determined from NFRC rating)* . . . . . *(U-value)* _____ _____ _____

(3) HVAC equipment efficiency levels:

Heating systems: Gas fired forced air furnace. . . . . *(AFUE rating)* _____

Electric heat pump . . . . . *(HSPF rating)* _____

Air conditioning systems: Electric unit . . . . . *(SEER rating)* _____

Electric heat pump . . . . . *(EER rating)* _____

Ground source heat pump . . . . . *(EER rating)* _____

Duct insulation levels: Insulation. . . . . _____

(R-value of ducts outside building envelope)

Thermostat: Manual control type. . . . . _____

Automatic setback type . . . . . _____

(4) Water heating efficiency levels:

Water heater fuel type. . . . . _____

Water heater capacity. . . . . _____

NAECA energy factor. . . . . _____

Additional Information: *(attach additional sheet if necessary)* _____

_____

Seller signature: _____ **Date:** _____

Seller name/address: _____

Buyer signature: _____ **Date:** _____

Buyer signature: _____ **Date:** _____

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North Carolina

- NC: Climate Zones 6 – 9, 11; IECC requires max. 0.40 SHGC in Zones 6 & 7.
- ~~*The area-weighted average SHGC of all fenestration installed in climates up to 3,500 HDD shall not exceed 0.40*~~ *(Deleted)*

ZONE	HEATING DEGREE DAYS	MAXIMUM Glazing *U*-factor
6	2,500 - 2,999	0.60
7	3,000 - 3,499	0.55
8	3,500 - 3,999	0.50
9	4,000 - 4,499	0.45
11	5,000 - 5,499	0.45

- Result: Double-pane clear dominates (0.60 or 0.55 U-factor required in Zones 6 and 7); double pane ≠ energy efficient.
- *Pick a problem and focus on it for the state or region*: reduce heating use (winter comfort) = maximum U-factor (0.40 – 0.35); reduce cooling use (summer comfort) = maximum SHGC (0.40); reduce both = use both standards …

Some States with Their Own Unique Approach

- California
- Florida

But, both specify energy efficient windows

The Next Frontier

- Arizona
- Michigan
- Illinois

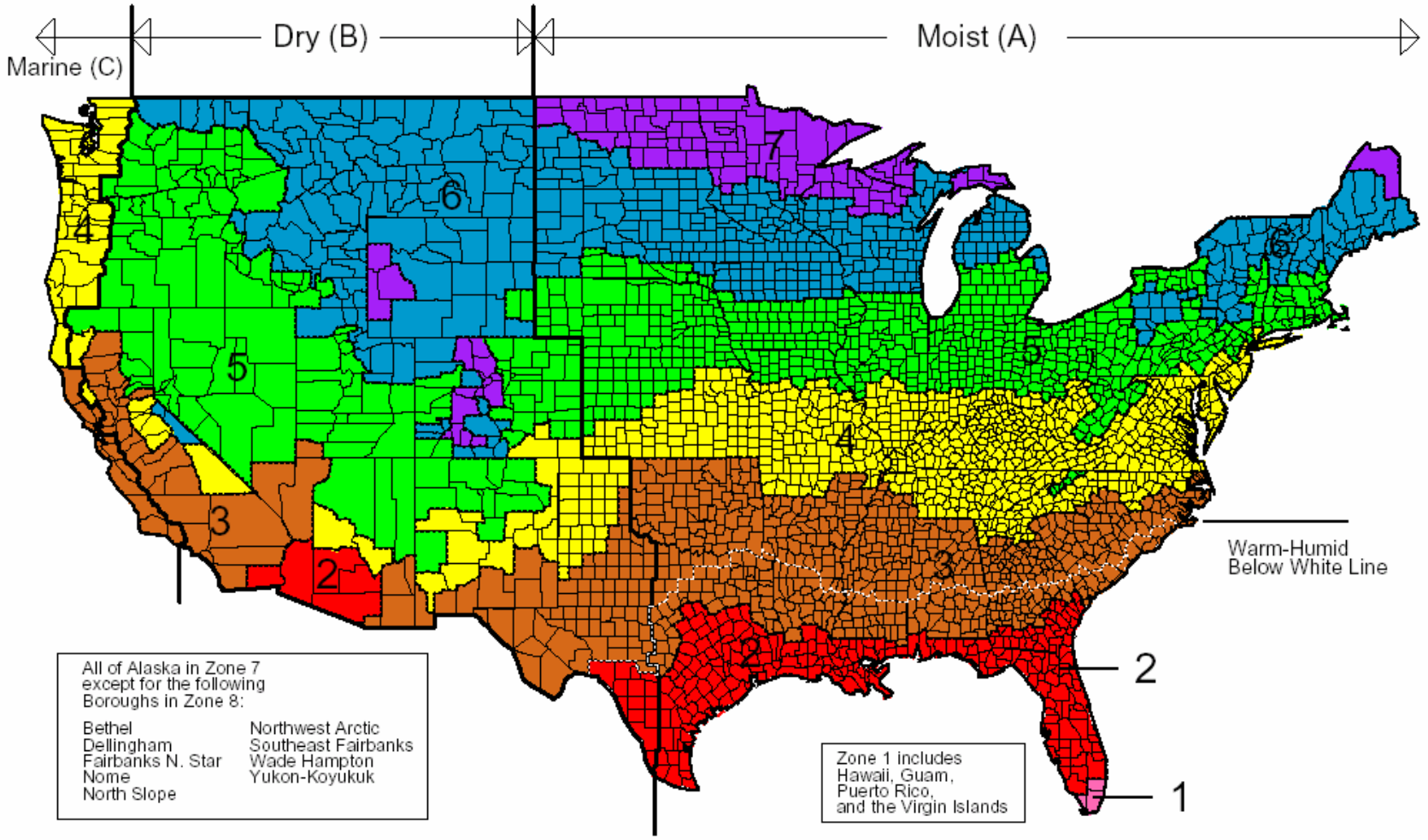
DOE Proposal – New IECC

Energy Efficient Windows Everywhere!

Table 402.1. Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration U-Factor	Skylight[b] U-Factor	Glazed Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value	Floor R-Value	Basement[c] Wall R-Value	Slab[d] R-Value & Depth	Crawl Space[c] Wall R-Value
1	1.20	1.60	0.40	30	13	6	13	0	0	0
2	0.80	1.05	0.40	30	13	6	13	0	0	0
3	0.60	0.90	0.40[e]	30	13	6	19	0	0	5/13
4 except Marine	0.40	0.60	NR	38	13	8	19	10 / 13	10, 2 ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5[g]	13	25[f]	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	19 or 13+5[g]	15	30[f]	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	21	30[f]	15 / 21	15, 4 ft	10 / 13

Map of DOE's Proposed Climate Zones



March 24, 2003

Making Sense of the IECC Window Requirements

- Become familiar with the prescriptive tables. They often make code compliance easier than with prior codes.
- Keep abreast of new building product technologies. Products that are a novel selling point now may one day be useful or even required for code compliance.
- Take advantage of available resources, like training and compliance tools, offered by the states or industry groups.

Texas Residential Building Guide to Energy Code Compliance

International Residential Code (IRC 2000) and International Energy Conservation Code (IECC 2000) as of May 1, 2001

Texas Edition 2001, Revision 1.04

Using This Guide

This guide contains eight color-coded climate zones (numbers 2 through 9) designed to simplify determination of the envelope requirements of the International Residential Code (IRC 2000, Chapter 11) or the International Energy Conservation Code (IECC 2000) for Texas. Refer to the IRC 2000 or IECC 2000, as amended by the 2001 Supplement, for a complete description of all the requirements and compliance alternatives. Local requirements may also vary. Each county is assigned to one of the eight zones, which vary according to the different climate zones in Texas.

Step-by-Step Instructions

A. Use the color-coded map to locate the county in which the construction or remodeling is taking place and find the climate zone (2 through 9) associated with that county.

B. Use the "Table of Building Envelope Requirements" (on the back of this sheet) to find the set of construction options or "paths" associated with the climate zone selected above. Each path describes an acceptable combination of envelope components based on percent glazed area.

C. Review the paths and select the one most suited to your project.

D. Construct or remodel the building according to the selected path and comply with basic code requirements, which include:

- Installing components to Mfr specifications
- Documenting load calculations to insure properly sized HVAC equipment
- Meeting minimum equipment efficiency requirements for HVAC, water heating and other fixtures (Tables 503.2 and 504.2 of IECC)
- Providing preventative maintenance manuals
- Installing temperature controls
- Limiting window and door leakage
- Caulking or sealing joints, gaps and penetrations
- Installing vapor retarders where required
- Sealing and insulating ducts (No duct tape allowed)
- Insulating pipes properly

Texas Counties by Climate Zones

Use the color-coded map of Texas to locate a county. The reverse side of this form shows three prescriptive paths for the selected Climate Zone.

9 — 4,000 - 4,499 HDD

Armstrong	Hansford	Oldham
Bailey	Hartley	Parmer
Carson	Hemphill	Potter
Castro	Hutchinson	Randall
Dallam	Lipscomb	Roberts
Deaf Smith	Moore	Sherman
Gray	Ochiltree	Wheeler

8 — 3,500 - 3,999 HDD

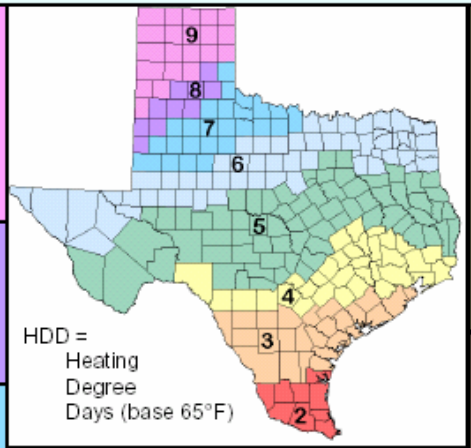
Briscoe	Hall
Cochran	Hockley
Donley	Lamb
Floyd	Swisher
Hale	Yoakum

7 — 3,000 - 3,499 HDD

Archer	Dickens	Lynn
Baylor	Foard	Motley
Borden	Gaines	Scurry
Childress	Garza	Stonewall
Clay	Hardeman	Terry
Collingsworth	Kent	Wichita
Cottle	King	Wibarger
Crosby	Knox	
Dawson	Lubbock	

6 — 2,500 - 2,999 HDD

Andrews	Gregg	Palo Pinto
Bowie	Harrison	Parker
Callahan	Haskell	Rains
Camp	Hopkins	Red River
Cass	Howard	Reeves
Coke	Hudspeth	Rockwall
Collin	Hunt	Shackelford
Cooke	Jack	Stephens
Culberson	Jeff Davis	Sterling
Delta	Jones	Taylor
Denton	Kaufman	Throckmorton
Eastland	Lamar	Titus
Ector	Loving	Upshur
El Paso	Marion	Van Zandt
Erath	Martin	Ward
Fannin	Midland	Winkler
Fisher	Mitchell	Wise
Franklin	Montague	Wood
Glasscock	Morris	Young
Grayson	Nolan	



5 — 2,000 - 2,499 HDD

Anderson	Henderson	Pecos
Angelina	Hill	Polk
Bandera	Hood	Presidio
Bell	Houston	Reagan
Blanco	Irion	Real
Bosque	Jasper	Runnels
Brewster	Johnson	Rusk
Brown	Kendall	Sabine
Burnet	Kerr	San Augustine
Cherokee	Kimble	San Saba
Coleman	Lampasas	Schleicher
Comanche	Leon	Shelby
Concho	Limestone	Smith
Coryell	Llano	Somervell
Crane	Mason	Sutton
Crockett	McCulloch	Tarrant
Dallas	McLennan	Terrell
Edwards	Menard	Tom Green
Ellis	Mills	Travis
Falls	Nacogdoches	Trinity
Freestone	Navarro	Tyler
Gillespie	Newton	Upton
Hamilton	Panola	Williamson
Hays		

4 — 1,500 - 1,999 HDD

Austin	Grimes	Milam
Bastrop	Guadalupe	Montgomery
Bexar	Hardin	Orange
Brazos	Harris	Robertson
Burleson	Jefferson	San Jacinto
Caldwell	Kinney	Uvalde
Chambers	Lavaca	Val Verde
Colorado	Lee	Walker
Comal	Liberty	Waller
Fayette	Madison	Washington
Fort Bend	Medina	Wilson
Gonzales		

3 — 1,000 - 1,499 HDD

Aransas	Galveston	McMullen
Atascosa	Goliad	Nueces
Bee	Jackson	Refugio
Brazoria	Jim Wells	San Patricio
Calhoun	Karnes	Victoria
DeWitt	La Salle	Webb
Dimmit	Live Oak	Wharton
Duval	Matagorda	Zavala
Frio	Maverick	

2 — 500 - 999 HDD

Brooks	Jim Hogg	Starr
Cameron	Kenedy	Willacy
Hidalgo	Kleberg	Zapata

Limitations

Texas recently enacted a statewide energy code. This guide provides a simplified prescriptive specification for individual envelope components to aid with code compliance. This guide does not provide a guarantee for meeting the IRC. For additional details on the IRC or IECC, refer to the code documents, consult local code officials or contact the International Code Council.

Energy Systems Laboratory - Texas A&M University
http://eslsb5.tamu.edu Toll Free: 1-877-AnM-CODE (1-877-266-2633)

Texas Residential Building Envelope Requirements

Simplified Prescriptive Paths for Envelope Compliance with the International Residential Code (IRC 2000)

Table of Building Envelope Requirements

Climate Zone	Path	Glazing and Insulation: Glazing Area%	Glazing U-Factor	Glazing SHGC	Ceiling	Wall	Foundation Type: Basement Wall Floor	Basement Wall	Slab Perimeter	Crawl Space Wall
9	1	15	.45	[1]NR	R-38	R-13	R-19	R-8	R-5, 2ft	R-11
	2	20	.37	[1]NR	R-38	R-13	R-19	R-9	R-6, 2ft	R-13
	3	25	.37	[1]NR	R-38	R-19	R-19	R-9	R-6, 2ft	R-13
8	1	15	.50	[1]NR	R-30	R-13	R-19	R-8	R-5, 2ft	R-10
	2	20	.42	[1]NR	R-38	R-13	R-19	R-8	R-6, 2ft	R-10
	3	25	.41	[1]NR	R-38	R-19	R-19	R-8	R-6, 2ft	R-10
7	1	15	.55	.40	R-30	R-13	R-19	R-7	[2]R-4, 2ft	R-8
	2	20	.46	.40	R-38	R-13	R-19	R-7	R-0	R-8
	3	25	.45	.40	R-38	R-19	R-19	R-7	R-0	R-8
6	1	15	.60	.40	R-30	R-13	R-19	R-6	[2]R-4, 2ft	R-7
	2	20	.50	.40	R-38	R-13	R-19	R-6	R-0	R-7
	3	25	.46	.40	R-38	R-16	R-19	R-6	R-0	R-7
5	1	15	.65	.40	R-30	R-13	R-11	R-5	R-0	R-6
	2	20	.52	.40	R-38	R-13	R-11	R-5	R-0	R-6
	3	25	.50	.40	R-38	R-13	R-19	R-8	R-0	R-10
4	1	15	.75	.40	R-26	R-13	R-11	R-5	R-0	R-5
	2	20	.60	.40	R-30	R-13	R-11	R-5	R-0	R-5
	3	25	.52	.40	R-30	R-13	R-13	R-6	R-0	R-6
3	1	15	.75	.40	R-19	R-11	R-11	R-0	R-0	R-5
	2	20	.70	.40	R-30	R-13	R-11	R-0	R-0	R-5
	3	25	.55	.40	R-30	R-13	R-11	R-0	R-0	R-5

Notes:

1. The Table of Building Envelope Requirements is based upon the 2000 International Residential Code (IRC), published by the International Code Council, as amended by the 2001 Supplement.
2. The IRC prescriptive requirements are applicable to single family homes with glazing areas of 15% and below. For homes designed with glazing areas greater than 15%, the IRC incorporates the International Energy Conservation Code (IECC) by reference, which contains additional prescriptive and performance-related compliance alternatives. The glazing areas for each path are maximum levels. For example, a glazing area of 22% must use Path 3, which is the path level for 25% glazing area.
3. Source of requirements: 2000 IRC, Ch. 11 (up to 15% only) and 2000 IECC, Ch. 5, Prescriptive Packages for Climate Zones 2-9, and the 2001 Supplement to IECC. IECC Chapter 4 must be used for glazing areas greater than 25%.
4. U-factor, and SHGC are **maximum** acceptable values.
5. Insulation R-values are **minimum** acceptable levels.
6. Applies to single-family, wood-frame residential construction, only. For mass wall construction, see IRC Section N1102.1.1.1; for steel-framed walls, see IRC Section N1102.1.1.2.
7. "Glazing" refers to any translucent or transparent material in exterior openings of buildings, including windows, skylights, sliding glass doors, the glass areas of opaque doors, and glass block.
8. Fenestration product (window, door, glazing) U-factor and SHGC must be determined from a National Fenestration Rating Council (NFRC) label on the product, or obtained from default tables (IECC Table 102.5.2(3) in Chapter 1).
9. Glazing area % is the ratio of the area of the rough opening of windows to the gross wall area, expressed as a percentage. Up to one percent of the total window area may be exempt from the U-factor requirement.
10. Opaque doors are not considered glazing (or "windows") and must have a U-factor less than 0.35. One exempt door allowed.
11. Infiltration requirements: Windows ≤ 0.30 cfm per sq.ft. of window area; sliding doors ≤ 0.30 cfm per sq.ft. of door area (swinging doors below 0.50 cfm); determined in accordance with AAMA/WDMA 101/I.S.2 (must be tested in accordance with ASTM E 283).
12. R-2 shall be added to the requirements for slab insulation where uninsulated hot water pipes, air distribution ducts or electric heating cables are installed in or under the slab.
13. Floors over outside air must meet ceiling insulation requirements (Table 502.2 in the IECC).
14. R-values for walls represent the sum of cavity insulation plus insulated sheathing, if any.
15. Prescriptive packages are based upon meeting or exceeding

The Role of Energy Efficient Windows in Codes: Conclusion

- Windows brought to the forefront
  - No longer buried in wall
  - NFRC ratings
  - Easy-to-use prescriptive tables
  - Simple SHGC requirement in cooling-dominated climates
  - 0.40 or Lower U-factors for the rest of the country
- Simple, low cost upgrade
  - Market transformation: double-pane dominates; easy low-e upgrade
  - Low-e can address both summer and winter
- Effective, easy opportunities for states to improve housing
  - Efficient windows for new construction and replacement windows

Resources

- Carmody, et. al., *Residential Windows: A Guide to New Technologies & Energy Performance* (2nd Ed.)
  - Efficient Windows Collaborative (www.efficientwindows.org)
  - Energy Star Windows (www.energystar.gov)
- The Responsible Energy Codes Alliance (www.ase.org/reca)
- Texas Window Initiative (www.texwin.com)