



Leading by example,
saving energy and
taxpayer dollars in
federal facilities

Legal Authorities

Federal agencies are required by the Energy Policy Act of 2005 (P.L. 109-58) and Federal Acquisition Regulations (FAR) Subpart 23.2 to specify and buy ENERGY STAR®-qualified products or, in categories with no ENERGY STAR label, FEMP-designated products which are among the highest 25 percent of equivalent products for energy efficiency.

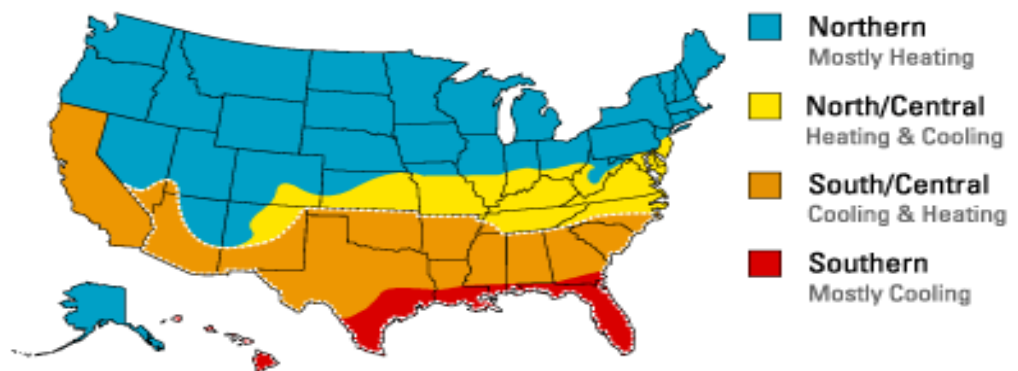


Purchasing Specifications for Energy-Efficient Products

Performance Requirement for Federal Purchases

Climate Zone	Windows and Doors		Skylights		
	U-Factor ^a	SHGC ^b	U-Factor 2001 NFRC ^c	U-Factor RES97 ^d	SHGC
Northern	0.35 or less	Any	0.60 or less	0.45 or less	Any
North/Central	0.40 or less	0.55 or less	0.60 or less	0.45 or less	0.40 or less
South/Central	0.40 or less	0.40 or less	0.60 or less	0.45 or less	0.40 or less
	0.41 or less	0.36 or less			
	0.42 or less	0.30 or less			
Southern	0.43 or less	0.24 or less	0.75 or less	0.75 or less	0.40 or less
	0.65 or less	0.40 or less			
	0.66 or less	0.39 or less			
	0.67 or less				
	0.68 or less	0.38 or less			
	0.69 or less	0.37 or less			
	0.70 or less				
	0.71 or less	0.36 or less			
	0.72 or less	0.35 or less			
0.73 or less					
0.74 or less	0.34 or less				
0.75 or less	0.33 or less				

- a) Thermal Transmittance in Btu/(h*ft²*°F).
- b) Solar Heat Gain Coefficient, dimensionless fraction of incident solar radiation.
- c) Based on 2001 NFRC certification procedures that rate skylights at a 20° angle. Although reported U-Factor is higher than RES97 rated products, performance at the ENERGY STAR minimum qualifying level is equivalent.
- d) Based on 1997 NFRC certification procedures that rated skylights at a 90° angle (installed vertically). Skylights rated under this procedure state "RES97 rated at 90°" and may be found in the marketplace until March 31, 2008.



U.S. Department of Energy

**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

FEMP Designated Product:

Residential Windows, Doors & Skylights

Buying Residential Windows, Doors & Skylights

Fenestration products, such as windows, doors and skylights, do not consume energy directly. They do, however, add to the heating and cooling loads of the buildings in which they are installed. Selecting and installing energy-efficient windows, doors and skylights can minimize these additional space conditioning loads and reduce the amount of energy used by the building's heating and cooling system.

Unlike many products, the energy-efficiency of fenestration products varies according to climate. Features that make windows energy efficient in one climate type may offer little benefit in another. The energy efficiency of fenestration products is primarily a function of the U-factor and Solar Heat Gain Coefficient (SHGC). To choose fenestration products that meet this *Specification*, first identify the climate zone where they will be installed (see map on page 1 or the ENERGY STAR Web site) and then find products with U-factors and SHGCs that are less than or equal to those specified in the *Performance Requirements* table on page 1. All qualifying units must be certified and labeled by the National Fenestration Rating Council (NFRC). When buying fenestration products through commercial sources, choose those that are ENERGY STAR®-qualified for the climate zone where they will be installed. When fenestration products are being provided as part of a construction or renovation contract, specify the U-factor and SHGC for the climate zone from the *Performance Requirements* table.

The federal supply source for windows is the General Services Administration (GSA), which offers them through its Federal Supply Catalog "FSC 56 - Building Materials (563 24)." Note that not all windows sold by GSA are ENERGY STAR-qualified and some products that do qualify may not be indicated as such. When buying windows from this source, check the models you are considering against the ENERGY STAR Web site or the NFRC Certified Products Directory (see *For More Information*) to assure they meet this *Specification*.

Agencies must use ENERGY STAR-qualified and FEMP-designated performance requirements for all procurements of energy-consuming products and systems including guide specifications, project specifications, and construction, renovation and service contracts. They should also be used in evaluating responses to solicitations.

Agencies can claim an exception to these requirements only through a written finding that no ENERGY STAR-qualified or FEMP-designated product is available to meet the functional requirements, or no such product is life-cycle cost-effective for the particular application.

Buyer Tips

To select or specify energy-efficient windows properly, federal buyers must be familiar with the following terms and strategies.

U-Factor – The heat lost or gained through fenestration can have a substantial impact on the energy required to condition a building. Heat transfer through fenestration is a function of the difference between indoor and outdoor temperatures and the U-Factor (thermal transmittance) of the glazing system. The U-Factor is a measure of the rate of heat flow through glazing products; the lower a U-Factor, the less heat will flow through the window. In the United States, U-Factors are reported in Btu/(h•ft²•°F), and typically range between 0.2 to 1.2 Btu/(h•ft²•°F).

Features that reduce the thermal transmittance and lower the U-Factor include increasing the number of panes to two or more, adding low emittance (low-e) coatings to glazing layers, filling the space between panes with either argon or krypton gas, and constructing the frames and sashes with non-thermally conductive materials such as wood, vinyl or fiberglass. If the frame or sash component is mostly metal, it needs to have carefully integrated thermal breaks to minimize conductive heat flow.

Solar Heat Gain Coefficient (SHGC) – Fenestrations can allow significant amount of solar irradiation, or heat, into buildings. SHGC is a measure of heat transmitted through glass and theoretically varies between 0 and 1, where the lower the number, the less heat is transmitted. The SHGC of actual fenestration products is typically between 0.20 and 0.80. Features impacting SHGC are low-e coatings and tints. Fenestration products with low-e coatings are available in low, moderate, and high solar gain. Low gain (less than 0.4) products are designed for hot climate zones while high gain products (greater than 0.55) are designed for cold climate zones. While tinting can reduce solar heat gain, it also reduces the ability to see clearly through a glazing unit. Because of this, tinting is not recommended for residential buildings. Exterior overhangs or sunscreens, and interior blinds or shades can also be used to effectively reduce undesirable solar heat gain.

Visible Transmittance (VT) – Visible Transmittance is a measure of the amount of energy within the visible spectrum (light) that passes through a glazing unit. While similar to SHGC, VT indicates how much daylight is transmitted whereas SHGC is a measurement of the amount of heat transmitted. The NFRC Certified Products Directory and NFRC labels typically report VT, which is expressed as a value from 0 to 1. The VT of actual fenestration products, which includes opaque areas such as the frame and sash, varies between 0.10 and 0.80. A higher value indicates that a greater percentage of light is transmitted through the window. Typically, high values are preferred in residential applications. VT values below 0.5 noticeably reduce the amount of light transmitted. When purchasing windows with a low SHGC, verify that the VT is not too low.

FEMP Designated Product: Residential Windows, Doors & Skylights

Air Leakage – Although it is not required by ENERGY STAR or FEMP, air leakage through fenestration can be a significant source of heat loss or gain in a building. The air infiltration of many fenestration products are reported in the NFRC Certified Products Directory and on NFRC labels. The air leakage rate is a measure of how much air leaks through cracks in a window under pre-established test temperatures and pressure differences. Although the air leakage is reported in cubic feet per minute per window area in the NFRC Certified Products Directory (cfm/ft²), some manufacturers report air infiltration in cubic feet per minute per linear foot of window edge (cfm/ft). A lower value means less air leakage. Minimizing the air infiltration through windows increases occupant comfort by reducing drafts and condensation.

Condensation Resistance – Condensation Resistance ratings may also be provided by NFRC and are listed for some products in the Certified Products Directory. The Condensation Resistance value indicates how well a window, door or skylight prevents moisture or frost from forming on its interior surface. The higher the value, the less condensation will occur when it is cold outside. Over time, excess condensation can damage window components and the surrounding wall surfaces, and promote the growth of unhealthy mold and mildew.

Cold Climate Strategy – In cold climates, where space-heating costs are a concern, buy or specify products with a low U-Factor to keep heat loss to a minimum. High SHGC are preferred in these climates, to utilize the sun's free heat. Reduce drafts and increase comfort by choosing products with a low Air Leakage rate. Specify fenestration with high Condensation Resistance ratings in extremely cold regions.

Hot Climate Strategy – In warm climates, where air conditioning costs are the concern, buy or specify products with low SHGCs to reduce unwanted heat gain. Windows with low-e coatings, especially spectrally selective coatings, are effective at reducing summer heat gain and air conditioning costs without significantly impacting visible light or color. Tinted windows also reduce solar heat gain but transmit less visible light and, therefore, often have an undesirable aesthetic impact. Although windows and skylights are often designed to be operable (i.e., open to allow air to pass), it is desirable to choose windows with low Air Leakage rates, especially if the building is air-conditioned.

User Tips

Good installation practices will minimize air infiltration around fenestration products. ASTM E 2112 provides guidance on the proper installation of fenestration products (see *For More Information*). To minimize air infiltration when outside temperatures are extreme, keep windows tightly closed with all latches locked because this saves energy as well as minimizes uncomfortable drafts. Proper use of interior shades and blinds can reduce unwanted solar heat gain and maximize daylight to offset the need for interior electric lighting.

Additional Considerations

The selection of a window, door or skylight should also include considerations of other important factors that are not directly related to energy efficiency. Cost, aesthetics, structural capability, water resistance, durability, maintenance, sound control, ventilation, thermal comfort, fading and glare control are all important criteria when selecting fenestrations. The publications and Web sites shown in *For More Information* provide additional guidance on these issues.

Cost-Effectiveness Examples Washington, DC (North/Central Zone)

	Windows			Skylights	
	Base Model	Required ^a	Best Available ^b	Base Model	Required ^a
U-Factor ^c	0.76	0.37	0.18	0.94	0.53
Solar Heat Gain Coefficient	0.68	0.53	0.40	0.68	0.40
Annual Heating Energy Cost	\$1,075	\$880	\$790	\$1,012	\$970
Annual Cooling Energy Cost	\$130	\$110	\$90	\$113	\$110
Annual Energy Cost	\$1,205	\$990	\$880	\$1,125	\$1,080
Lifetime Energy Cost ^d	\$19,890	\$16,390	\$14,450	\$18,470	\$17,725
Lifetime Energy Cost Savings	-	\$3,500	\$5,440	-	\$745

a) This example most closely complies with ENERGY STAR performance criteria as obtained from the Efficient Window Collaborative (see *For More Information*).

b) Information on the *Best Available* model was obtained from the Efficient Window Collaborative.

c) Thermal transmittance, Btu/(h•ft²•°F)

d) Lifetime Energy Cost is the sum of the discounted value of annual energy costs based on average usage and an assumed window life of 25 years. Future energy price trends and a discount rate of 3.0% are based on federal guidelines (effective from April, 2006 to March, 2007).



Cost-Effectiveness Assumptions

The cost-effectiveness calculations shown on the previous page are the result of a simulation using a residential windows modeling program called RESFEN. Calculations are based on a new, two story, 2,000 square foot home in the Washington, DC area. The home is equipped with a standard efficiency gas furnace and central air conditioner. The house is not shaded and has 300 square feet of window area (approximately 15% of the exterior wall surface) equally distributed on all sides. There are five skylights with a combined area of 45 square feet. The *Base Model* windows and skylights are assumed to be double-paned with clear glass in aluminum frames (non-thermally broken). The *Required* windows and skylights are assumed to be double-paned glass with a low-e coating in wood or vinyl frames. The *Best Available* windows are assumed to be triple-paned glass with a spectrally selective low-e coating in wood or vinyl frames.

Using the Cost-Effectiveness Table

In the example on the previous page, the *Required* windows are cost-effective if their purchase price does not exceed the price of the *Base Model* windows by more than \$3,500. Similarly, the *Best Available* windows are cost-effective if their price is no more than \$5,440 above the price of *Base Model* windows. The *Required* skylights are cost effective if their purchase price is no more than \$745 above the price of the *Base Model* products.

How do I assess the energy savings potential for my situation?

RESFEN, which is available on the Lawrence Berkeley National Laboratory Web site (see *For More Information*), can estimate the heating and cooling costs for many house types, given an approximate knowledge of a few key parameters such as floor area, window area, heating and cooling system types, and utility rates.

For More Information:

EERE Information Center
1-877-EERE-INF or 1-877-337-3463
www.eere.energy.gov/femp/procurement/
DOE lists vendors of ENERGY STAR® windows and offers other information to help select energy-efficient residential windows.
(800) 363-3732
www.energystar.gov

Efficient Windows Collaborative provides information on selecting energy-efficient windows in various climates.
(202) 530-2245
www.efficientwindows.org

National Fenestration Rating Council (NFRC) lists energy performance of windows in their online *Certified Products Directory*.
(301) 589-1776
www.nfrc.org

Residential window technology and selection criteria are covered extensively in *Residential Windows: A Guide to New Technologies and Energy Performance*, published by W.W. Norton & Company.
(800) 287-8655

American Council for an Energy-Efficient Economy (ACEEE) publishes the *Consumer's Guide to Home Energy Savings* which contains a chapter on new windows. A condensed version is available online at www.aceee.org/consumerguide/mostenef.htm

ASTM E 2112-01 Standard Practice for Installation of Exterior Windows, Doors and Skylights. ASTM International Volume 04.12 www.astm.org

Lawrence Berkeley National Laboratory provided supporting analysis for this recommendation. LBNL offers an energy performance simulation software for residential windows, RESFEN, at: www.windows.lbl.gov

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



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Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable