



Window Energy Efficiency Solutions for Public and Affordable Housing

www.efficientwindows.org

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Energy-efficient windows lower energy bills, improve occupant comfort, and reduce condensation. Although initial cost is often a barrier in low-income housing, window energy efficiency measures may qualify for financing and incentive programs and may allow for smaller, less expensive HVAC equipment due to lower heating and cooling loads. Also note that in buildings with lead paint hazard, window replacement can be the single most effective way to eliminate lead dust. Where windows are in good condition and without lead paint, storm windows and shading devices are also feasible energy efficiency options.

This info sheet presents window energy efficiency considerations for both new and existing public and affordable housing.



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Visit www.efficientwindows.org for more information on the benefits of efficient windows, how windows work, how to select an efficient window, and what manufacturers provide efficient products.

Specify for maximum energy savings

Windows must meet local energy code requirements. For even higher energy performance, consider ENERGY STAR windows, which are recommended for low-rise dwellings and are often suitable for mid-rise dwellings as well.

For window and storm window options with superior performance in cold climates, check out the U.S. Department of Energy's highly insulating windows purchasing program (see next page).

Seize Opportunities to Reduce Cost

Government or utility incentives and financing may be available for energy efficiency in low-income housing. Check www.dsireusa.org for up-to-date information on incentive programs.

New construction often offers low- and no-cost opportunities for window energy efficiency. For instance, buildings can be orientated and shaded to invite the low winter sun while minimizing solar heat gain in the summer. Where higher window performance reduces heating and cooling loads, HVAC equipment downsizing helps reduce initial cost.

Alternatives to window replacement, such as storm windows and shading, can boost energy efficiency at a lower upfront cost. With all window retrofit options, lifetime energy savings and durability should be considered in addition to first cost.

Ensure Proper Implementation for Full Benefits

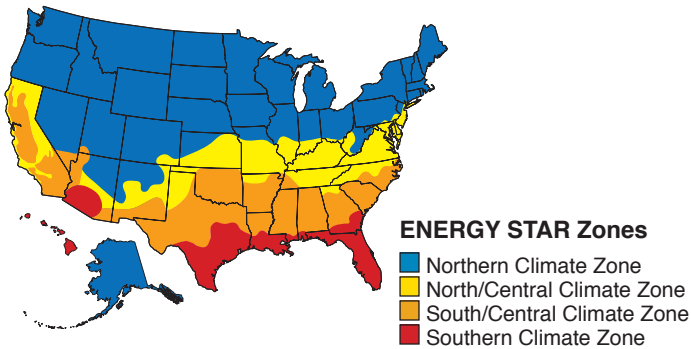
For optimal window performance, proper installation is necessary to ensure an airtight fit and avoid water leakage. Always follow manufacturers' installation guidelines and use trained professionals for window installation. The most prominent standard for window installation is ASTM Standard E 2112.

In older homes with lead paint, windows are often the largest source of lead hazard. For window replacement to be an effective remedy and for worker protection, ensure that contractors are lead-safe certified and perform their work in accordance with the EPA Renovation, Repair and Painting rule.



Look for the ENERGY STAR

ENERGY STAR windows are recommended for low-rise dwellings and, if they meet structural requirements, are often suitable for mid-rise buildings as well.



Recommendations: Northern Zone (mostly heating)

U-factor	SHGC
Windows: $U \leq 0.30$ If windows provide good access to winter solar heat gain (SHGC 0.40 or higher and southern orientation), a U-factor of 0.32 is also acceptable. For superior insulation, windows with a U-factor of 0.22 or less are available.	No requirement. If air conditioning is not a concern, look for a high SHGC (0.30-0.60) so that winter solar heat gains can offset a portion of the heating energy need. If cooling is a significant concern and no shading is available, select windows with a SHGC less than 0.40.

Recommendations: North/Central Zone (heating & cooling)

U-factor	SHGC
Windows: $U \leq 0.32$ The larger your heating bill, the more important a low U-factor becomes. For superior insulation, windows with a U-factor of 0.22 or less are available.	Windows: $SHGC \leq 0.40$ If you have significant air conditioning costs or summer overheating problems, look for SHGC values of 0.30 or less. While windows with lower SHGC values reduce summer cooling demand, they also reduce free winter solar heat gain.

Recommendations: South/Central Zone (heating & cooling)

U-factor	SHGC
Windows: $U \leq 0.35$ The larger your heating bill, the more important a low U-factor becomes.	Windows: $SHGC \leq 0.30$ Windows with low SHGC values reduce summer cooling and overheating. However, they also reduce winter solar heat gain.

Recommendations: Southern Zone (mostly cooling)

U-factor	SHGC
Windows: $U \leq 0.60$ A low U-factor is useful during cold days when heating is needed. A low U-factor is also helpful during hot days when it is important to keep the heat out, but it is less important than SHGC in warm climates.	Windows: $SHGC \leq 0.27$ A low SHGC is the most important window property in warm climates.

NFRC Window Energy Ratings

National Fenestration Rating Council (NFRC) ratings are third party verified and recognized by energy codes as indicators of whole window energy performance.

U-factor: The rate of non-solar heat transfer through a whole window in $\text{Btu}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$. The lower the U-factor, the better a window's insulating value.

Solar heat gain coefficient (SHGC): The fraction of incident solar heat admitted through a window. Appropriate SHGC depends on the climate, orientation, and shading conditions.

Visible transmittance (VT): The fraction of visible light transmitted through a window. Most window VT values are between 0.3 and 0.7.

Air leakage (AL): Most energy codes require a tested air infiltration rate no higher than 0.3 cubic feet of air per square foot of window area (cfm/sf). AL is an optional rating on the NFRC label and can also be obtained in accordance with the North American Fenestration Standard (AAMA/WDMA/CSA 101/I.S.2/A440).

DOE High-Performance Windows Purchasing Program

Through its windows volume purchase program, the U.S. Department of Energy helps buyers find products for maximum heating energy savings: highly insulating windows and low-E storm windows from various vendors at competitive prices. Windows in this program have a U-factor of no higher than 0.22, while storm windows must include heat-reflective low-E glass. For information on this DOE program, go to www.windowsvolumepurchase.org.

Retrofit Option: Low-E Storm Windows

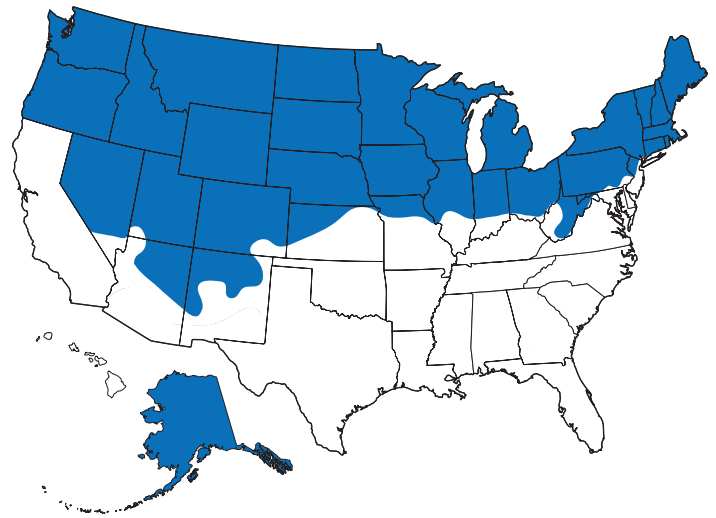
Low-emissivity coatings (low-E) have long been used in energy-efficient windows but are not yet as common among storm windows. Nevertheless, low-E glass can boost the insulating value of storm windows at a relatively minor additional cost.

A 2006 field study by HUD's Partnership for Advancing Technology in Housing (PATH) suggests that the payback for storm windows is faster with low-E glass.



Comparing Window Performance in a Northern Climate (Chicago, Illinois)

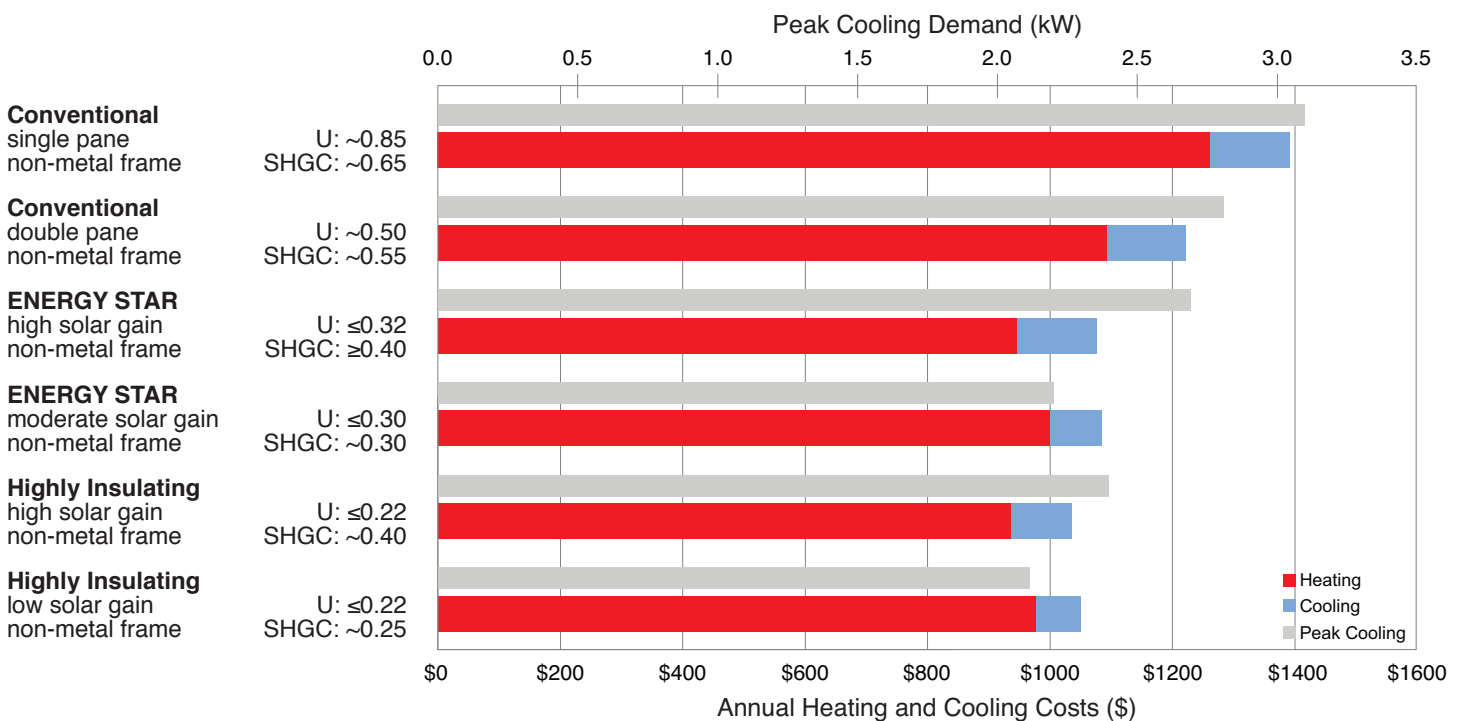
The window performance graphs shown here compare annual energy use and peak cooling demand assuming a typical 1700 sq. ft. house built before 1990 with 15% window-to-floor area. The windows are equally distributed on all four sides of the house and include typical shading (interior shades, overhangs, trees and neighboring buildings). The single pane window performance shown here may be representative of many existing windows in low-income housing but does not take into account that older windows often suffer from increased air leakage. The peak cooling demand shown here indicates the estimated impact of window SHGC on cooling equipment sizing.



Window Case

Properties

Annual Energy Use & Peak Cooling Demand

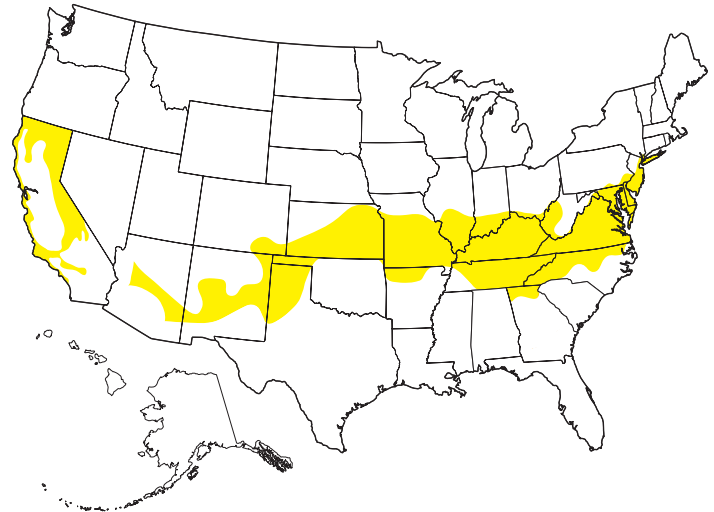


Note: The annual energy performance and peak cooling demand figures shown here are based on performance simulations of representative window types by Lawrence Berkeley National Laboratory (windows.lbl.gov/ESTar2008). Results assume a typical 1700 sq ft house built before 1990 with 15% window-to-floor area. The windows are equally distributed on all four sides and include typical shading (interior shades, overhangs, trees, and neighboring buildings). U-factor and SHGC of the simulated windows are roughly equivalent to the properties shown on this page (e.g. U-factor 0.84 and SHGC 0.64 for non-metal-framed single pane windows) and are for the total window including frame. The costs shown here are annual costs for space heating and space cooling only and thus will be less than total utility bills. Costs for lights, appliances, hot water, cooking, and other uses are not included in these figures. The mechanical system uses a gas furnace for heating and air conditioning for cooling. The natural gas price used is \$1.20/therm, which is close to the 2010 national average based on price data by the Energy Information Administration (EIA). The electricity price used is \$0.12/kWh, which is close to the 2010 national average based on EIA price data (www.eia.doe.gov).



Comparing Window Performance in a North Central Climate (Baltimore, Maryland)

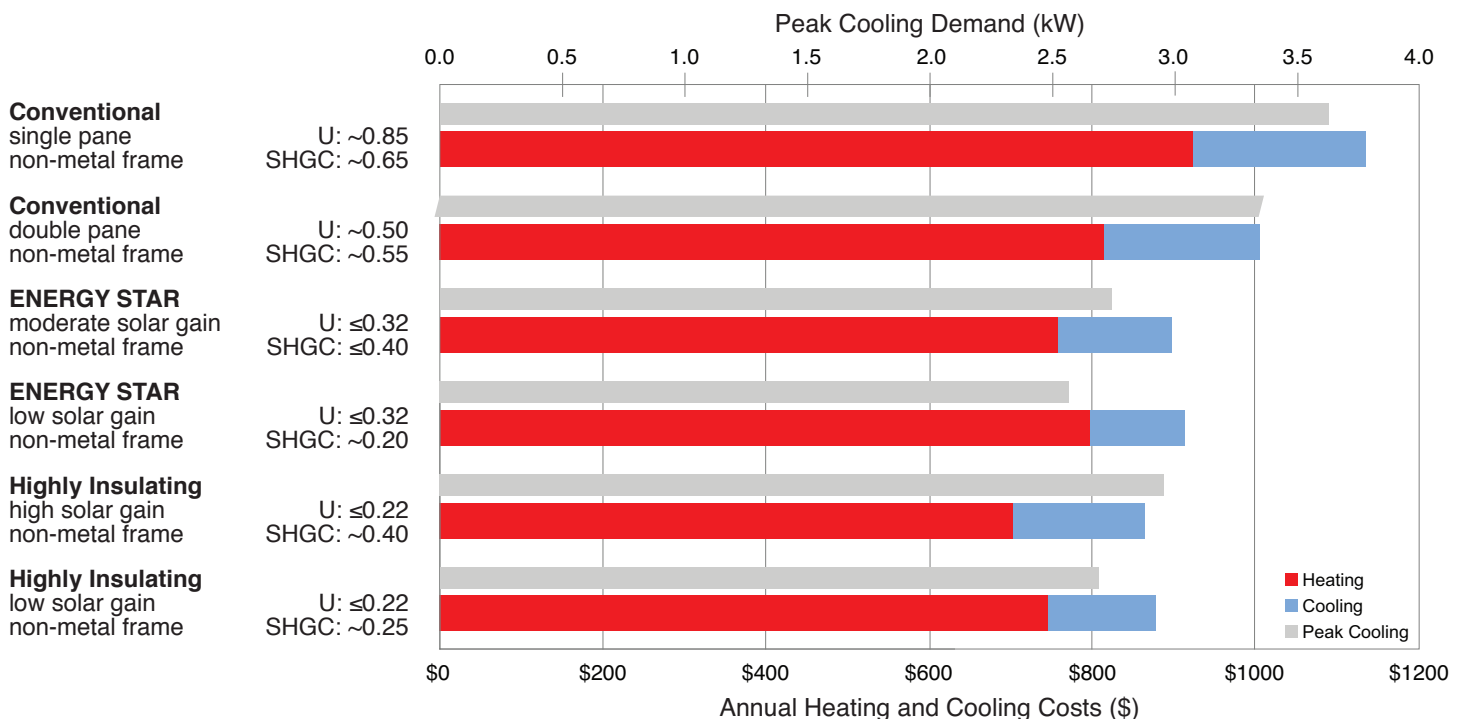
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Comparing Window Performance in a South Central Climate (Atlanta, Georgia)

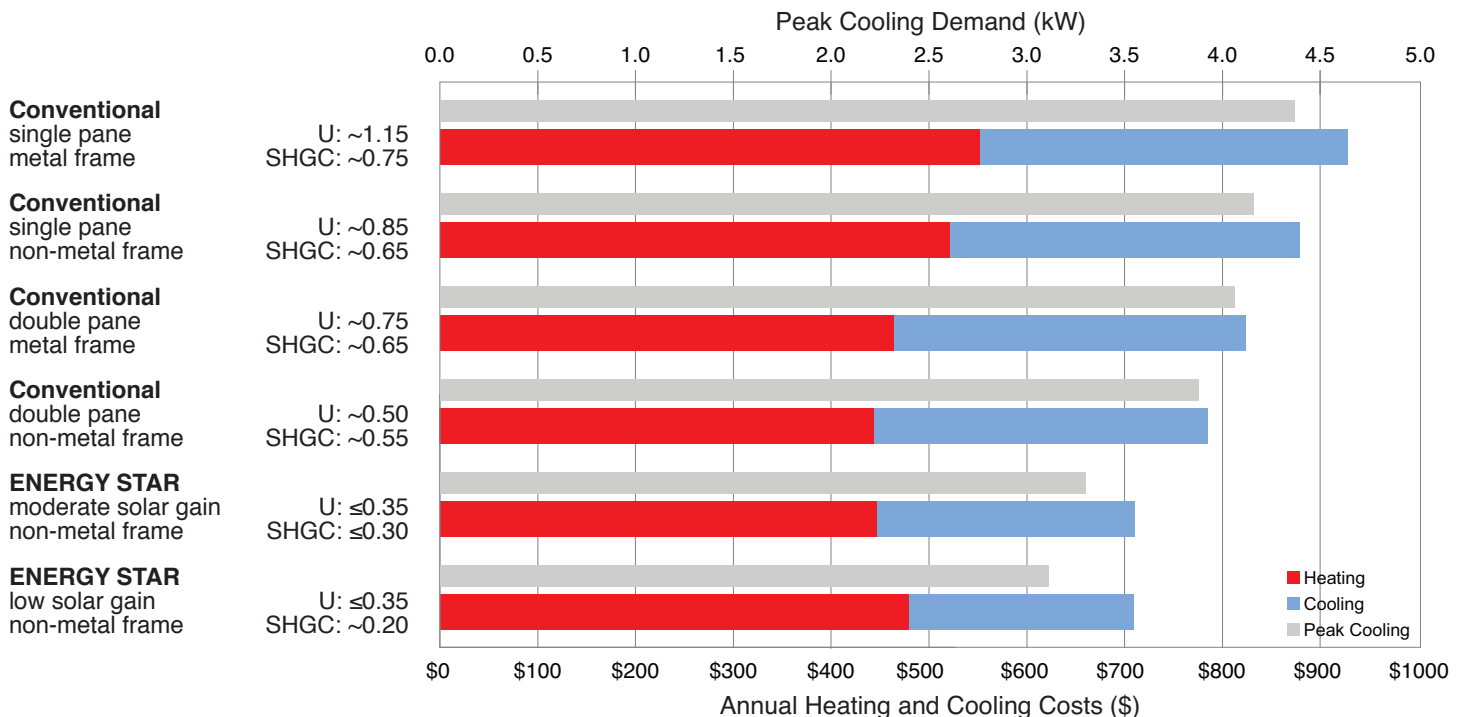
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Comparing Window Performance in a Southern Climate (Houston, Texas)

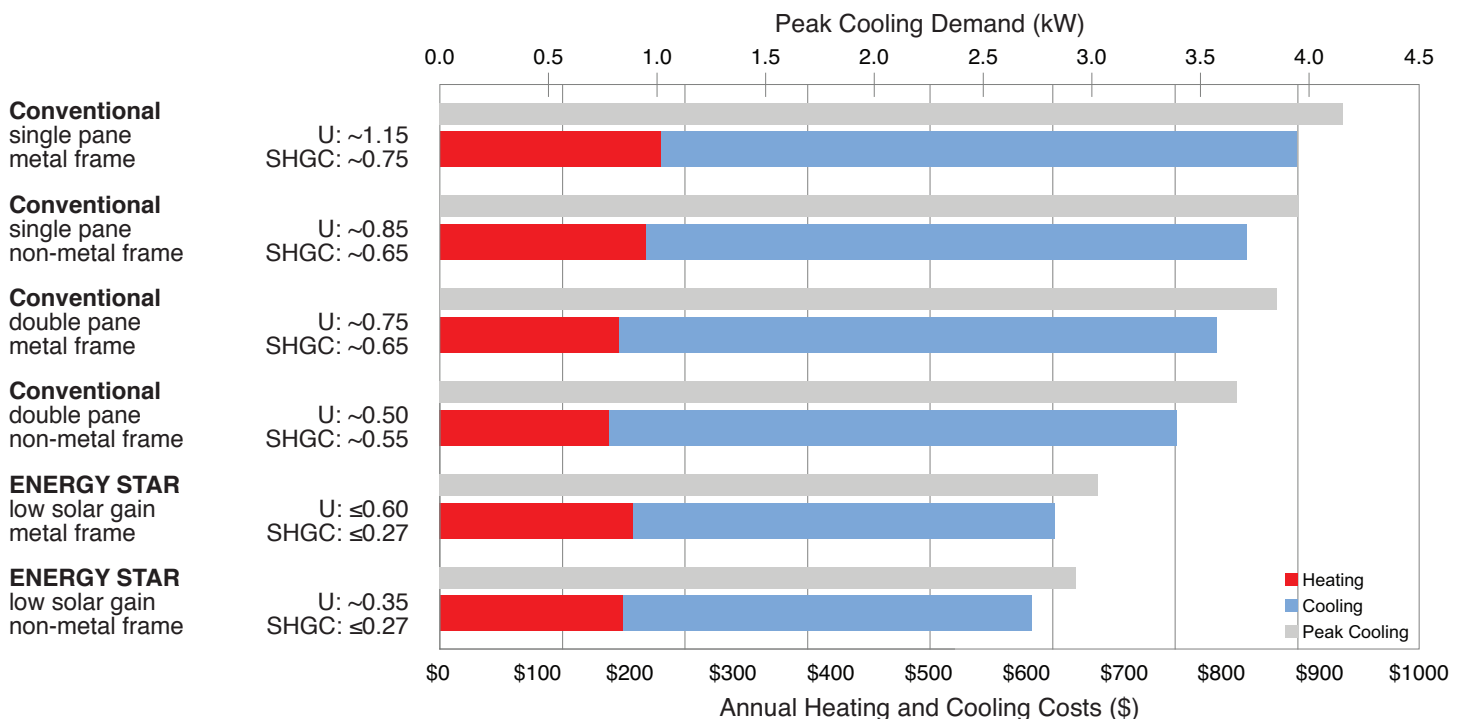
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