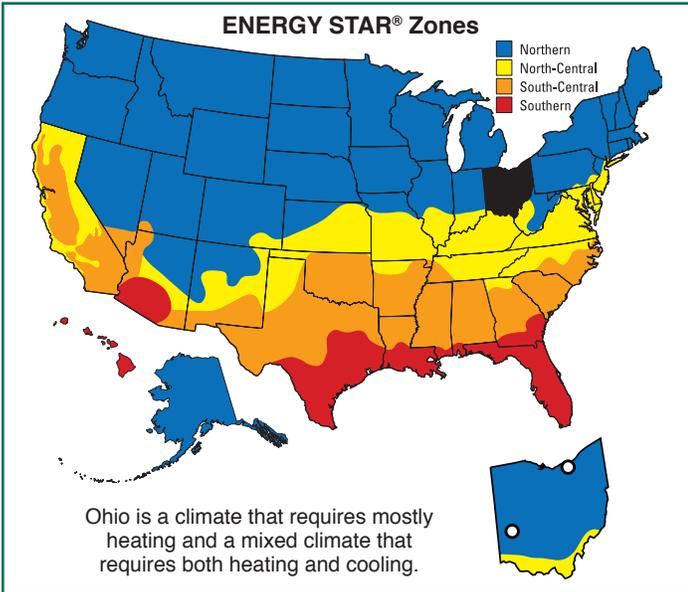


Selecting Energy Efficient New Windows in Ohio



| U-factor | SHGC | Air Leakage |
|---------------------|----------------------|----------------------|
| Windows: U ≤ 0.27 | Windows: Any | Windows: AL ≤ 0.30 |
| Windows: U = 0.28 | Windows: SHGC ≥ 0.32 | Skylights: AL ≤ 0.30 |
| Windows: U = 0.29 | Windows: SHGC ≥ 0.37 | |
| Windows: U = 0.30 | Windows: SHGC ≥ 0.42 | |
| Skylights: U ≤ 0.50 | Skylights: Any | |

For superior energy performance, select windows with a U-factor of 0.25 or less. If air conditioning is not a concern, look for a higher Solar Heat Gain Coefficient (SHGC) of 0.35–0.60 so winter solar heat can help offset the heating energy need. If cooling is a significant concern and no shading is available, select windows with a SHGC less than 0.32.

| U-factor | SHGC | Air Leakage |
|---------------------|------------------------|----------------------|
| Windows: U ≤ 0.30 | Windows: SHGC ≤ 0.40 | Windows: AL ≤ 0.30 |
| Skylights: U ≤ 0.53 | Skylights: SHGC ≤ 0.35 | Skylights: AL ≤ 0.30 |

The larger your heating bill, the more important a low U-factor becomes. For superior energy performance, select windows with a U-factor of 0.25 or less. A low SHGC value reduces summer cooling demand, but also reduces free winter solar heat gain. If you have significant air conditioning costs or summer overheating issues, look for SHGC values of 0.25 or less.

| U-factor | SHGC | Air Leakage |
|---------------------|------------------------|----------------------|
| Windows: U ≤ 0.30 | Windows: SHGC ≤ 0.25 | Windows: AL ≤ 0.30 |
| Skylights: U ≤ 0.53 | Skylights: SHGC ≤ 0.28 | Skylights: AL ≤ 0.30 |

A low U-factor is useful during cold days when heating is needed and is also helpful during hot days when it is important to keep the heat out. Windows with low SHGC values help reduce summer cooling demand. If you have significant air conditioning costs or summer overheating issues, look for SHGC values of 0.25 or less.

| U-factor | SHGC | Air Leakage |
|---------------------|------------------------|----------------------|
| Windows: U ≤ 0.40 | Windows: SHGC ≤ 0.25 | Windows: AL ≤ 0.30 |
| Skylights: U ≤ 0.60 | Skylights: SHGC ≤ 0.28 | Skylights: AL ≤ 0.30 |

A low SHGC is the important window property in warm to hot climates. For superior energy performance, select windows with a SHGC of 0.25 or less. A low U-factor is useful during cold days when heating is needed and is also helpful during hot days when it is important to keep the heat out.

1. Meet the Energy Code & Look for the ENERGY STAR®

Windows must comply with your local energy code. Windows that are ENERGY STAR certified often meet or exceed energy code requirements. To verify if specific window energy properties comply with the local code requirements, look for the NFRC label.



2. Look for Efficient Properties on the NFRC Label

The National Fenestration Rating Council (NFRC) label is needed for verification of energy code compliance. The NFRC label displays whole-window energy properties and appears on all fenestration products which are part of the ENERGY STAR program (www.nfrc.org).

| ENERGY PERFORMANCE RATINGS | |
|--------------------------------|-----------------------------|
| U-Factor (U.S. I-P) | Solar Heat Gain Coefficient |
| 0.27 | 0.25 |
| ADDITIONAL PERFORMANCE RATINGS | |
| Visible Transmittance | Air Leakage (U.S. I-P) |
| 0.51 | ≤ 0.30 |
| Condensation Resistance | |
| 51 | — |

Manufacturer data files that have not yet been updated to include NFRC procedures for determining U-factor and SHGC values are shown in red text. All other values are shown in black text. For more information on NFRC labels, visit www.nfrc.org.

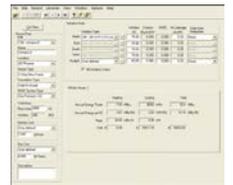
3. Compare Annual Energy Costs for a Typical House

Use computer simulations for a typical house to compare the annual energy performance of different window types. A comparison of the performance of a set of windows for this climate begins on Page 3 or use the Window Selection Tool on the EWC web site or the Window Selection Tool Mobile App (www.efficientwindows.org).



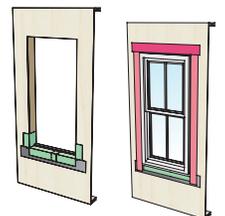
4. Customize Energy Use for a Specific House

A simulation program, such as RESFEN, lets you compare window options by calculating performance based on utility rates for your climate, house design, and window design options (windows.lbl.gov/software).



5. Ensure Proper Installation

Proper window and skylight installation is necessary for optimal performance, to avoid air and water leakage. Always follow manufacturers' installation guidelines and use trained professionals for window and skylight installation.





Benefits of High Performance Windows

Heating & Cooling Season Savings

In climates with a significant heating season, standard windows can represent a major source of unwanted heat loss. Low-E coatings, gas fills, and insulating spacers and frames result in a lower U-factor, meaning less winter heat loss. In climates that mainly require cooling, non-energy efficient windows can be a major source of unwanted heat gain. Low-solar-gain low-E coatings can reduce solar heat gain while still providing comfort, daylight and views.

Improved Daylight and View

Daylight and view are two fundamental attributes of a window. Low-E coatings can significantly reduce solar heat gain with a minimal loss of light and view.

Improved Comfort

High performance windows can make a home more comfortable. Cold glass can create uncomfortable drafts as air next to the window is cooled and drops to the floor. Windows with low U-factors will result in higher interior window temperatures in the heating seasons and thus greater comfort. Also, during cooling seasons, strong direct sunlight can create overheating and discomfort. Windows with a low SHGC will reduce the solar radiation (heat) coming through the glass.

Less Condensation

High performance windows with warm edge technology and insulating frames have a warm interior surface so that condensation on interior surfaces is significantly reduced or eliminated.

Reduced Fading

Coatings on glass or plastic films within the window or skylight assembly can significantly reduce the ultraviolet (UV) and other solar radiation which causes fading of fabrics and furnishings.

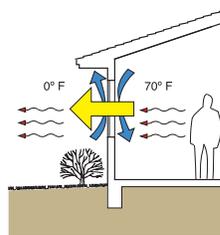
Lower Mechanical Equipment Costs

Efficient windows reduce annual heating and cooling bills as well as peak heating and cooling loads. Peak loads determine the size of the home's furnace, heat pump, air conditioner, and fans. Reducing peak load may allow homeowners to install a smaller heating or cooling system.

A Quieter Home

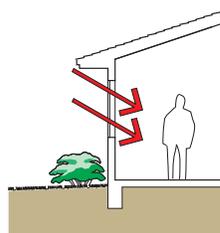
High performance windows provide reduced sound transmission, resulting in an Indoor-Outdoor Transmission Class (IOTC) rating that is often 5–10 points below a standard window.

Efficient Window Properties



U-Factor

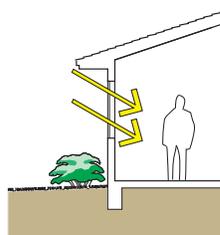
The rate of heat loss is indicated in terms of the U-factor (U-value). This rate of non-solar heat loss or gain through a whole window assembly is measured in Btu/hr-sf-°F. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value.



Solar Heat Gain Coefficient (SHGC)

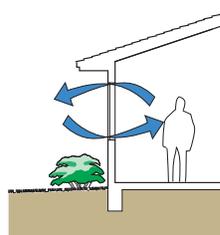
The SHGC is the fraction of incident solar radiation admitted through a window. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits.

Whether a higher or lower SHGC is desirable depends on the climate, orientation, shading conditions, and other factors.



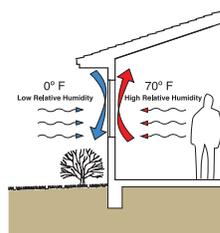
Visible Transmittance (VT)

The VT is an optical property that indicates the amount of visible light transmitted. VT is a whole window rating and includes the impact of the frame which does not transmit any visible light. While VT theoretically varies between 0 and 1, most values are between 0.3 and 0.7. The higher the VT, the more light is transmitted.



Air Leakage (AL)

AL is expressed in cubic feet of air passing through a square foot of window area (cfm/sf). The lower the AL, the less air will pass through cracks in the assembly. AL is very important, but not as important as U-factor and SHGC.



Condensation Resistance (CR)

CR measures how well a window resists the formation of condensation on the inside surface. CR is expressed as a number between 1 and 100. The higher the number, the better a product is able to resist condensation. CR is meant to compare products and their potential for condensation formation. CR is an optional rating on the NFRC label.



Comparing Window Performance in Cleveland, Ohio

The annual energy performance figures shown here assume a typical new 1700 sq. ft. single-story house with 15% window-to-floor area. The windows are equally distributed on all four sides of the house and include typical shading (partially deployed interior shades, overhangs, trees and neighboring buildings).



| ID | WINDOW SYSTEM | | | | | | STANDARDS | | PERFORMANCE | ENERGY | | COMFORT | | | |
|----|---------------|-----------|---------------------|-----------|-----------|-----------|-------------|-----------|-------------|--------|------|---------|--------|--------|-------|
| | Panes | Glass | Frame | U-factor | SHGC | VT | ENERGY STAR | 2012 IECC | | Heat | Cool | Total | Winter | Summer | Cond. |
| 18 | 3 | HSG Low-E | Non-metal, Improved | ≤0.22 | 0.41-0.60 | 0.41-0.50 | Yes | Yes | | | | | | | |
| 19 | 3 | MSG Low-E | Non-metal, Improved | ≤0.22 | 0.21-0.40 | 0.41-0.50 | Yes | Yes | | | | | | | |
| 20 | 3 | LSG Low-E | Non-metal, Improved | ≤0.22 | ≤0.20 | ≤0.40 | Yes | Yes | | | | | | | |
| 16 | 2 | MSG Low-E | Non-metal, Improved | 0.23-0.30 | 0.26-0.40 | 0.51-0.60 | Maybe | Yes | | | | | | | |
| 15 | 2 | HSG Low-E | Non-metal, Improved | 0.23-0.30 | 0.41-0.60 | 0.51-0.60 | Maybe | Yes | | | | | | | |
| 17 | 2 | LSG Low-E | Non-metal, Improved | 0.23-0.30 | ≤0.25 | 0.41-0.50 | Maybe | Yes | | | | | | | |
| 10 | 2 | MSG Low-E | Metal, Improved | 0.41-0.55 | 0.26-0.40 | 0.51-0.60 | No | No | | | | | | | |
| 9 | 2 | HSG Low-E | Metal, Improved | 0.41-0.55 | 0.41-0.60 | 0.51-0.60 | No | No | | | | | | | |
| 11 | 2 | LSG Low-E | Metal, Improved | 0.41-0.55 | ≤0.25 | 0.51-0.60 | No | No | | | | | | | |
| 4 | 2 | HSG Low-E | Metal | 0.56-0.70 | >0.60 | >0.60 | No | No | | | | | | | |
| 5 | 2 | MSG Low-E | Metal | 0.56-0.70 | 0.26-0.40 | 0.51-0.60 | No | No | | | | | | | |
| 6 | 2 | LSG Low-E | Metal | 0.56-0.70 | ≤0.25 | 0.51-0.60 | No | No | | | | | | | |
| 13 | 2 | Clear | Non-metal | 0.41-0.55 | 0.41-0.60 | 0.51-0.60 | No | No | | | | | | | |
| 14 | 2 | Tint | Non-metal | 0.41-0.55 | 0.41-0.60 | ≤0.40 | No | No | | | | | | | |
| 7 | 2 | Clear | Metal, Improved | 0.56-0.70 | >0.60 | >0.60 | No | No | | | | | | | |
| 8 | 2 | Tint | Metal, Improved | 0.56-0.70 | 0.41-0.60 | 0.41-0.50 | No | No | | | | | | | |
| 2 | 2 | Clear | Metal | 0.71-0.99 | >0.60 | >0.60 | No | No | | | | | | | |
| 3 | 2 | Tint | Metal | 0.71-0.99 | 0.41-0.60 | 0.51-0.60 | No | No | | | | | | | |
| 12 | 1 | Clear | Non-metal | 0.71-0.99 | >0.60 | >0.60 | No | No | | | | | | | |
| 1 | 1 | Clear | Metal | ≥1.00 | >0.60 | >0.60 | No | No | | | | | | | |

Note: "HSG," "MSG," and "LSG" stand for high-solar-gain, moderate-solar-gain, and low-solar-gain respectively. "Improved" includes warm-edge spacer technology and thermally improved frame. The annual energy performance figures shown here were generated using RESFEN6 provided by Lawrence Berkeley National Laboratory. U-factor and SHGC 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. Natural gas prices used are projections of the average natural gas price for the heating seasons of 2012-2014. Electricity prices used are the average electricity price for the cooling seasons of 2012-2014. All pricing information provided by the Energy Information Administration (www.eia.doe.gov). A simple comfort analysis was performed using EPW weather files for each location to determine how often the winter night and summer day temperatures exceed beyond an acceptable number of hours. The room condition contains a large, west-facing window with a single person facing the window. A large window was used because a large view factor will have a greater impact on comfort. The two extremes of summer day and winter night conditions were only considered. A simple condensation analysis was performed using heating season design temperatures for each location, performance properties of the glazing system, edge performance properties of the framing system, and interior glass temperatures of a glazing system simulated in WINDOW6 to determine if the interior glass temperature falls to a level in which condensation may occur. See the www.efficientwindows.org for more information on all the energy, comfort, and condensations metrics.



Comparing Window Performance in Dayton, Ohio

The annual energy performance figures shown here assume a typical new 1700 sq. ft. single-story house with 15% window-to-floor area. The windows are equally distributed on all four sides of the house and include typical shading (partially deployed interior shades, overhangs, trees and neighboring buildings).



| ID | WINDOW SYSTEM | | | | | | STANDARDS | | PERFORMANCE | | | | ENERGY | | COMFORT | | | |
|----|---------------|-----------|---------------------|-----------|-----------|-----------|-------------|-----------|---------------------------------|--|--|--|--------|------|---------|--------|--------|-------|
| | Panes | Glass | Frame | U-factor | SHGC | VT | ENERGY STAR | 2012 IECC | Annual Energy Cost | | | | Heat | Cool | Total | Winter | Summer | Cond. |
| 18 | 3 | HSG Low-E | Non-metal, Improved | ≤0.22 | 0.41-0.60 | 0.41-0.50 | Yes | Yes | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 19 | 3 | MSG Low-E | Non-metal, Improved | ≤0.22 | 0.21-0.40 | 0.41-0.50 | Yes | Yes | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 20 | 3 | LSG Low-E | Non-metal, Improved | ≤0.22 | ≤0.20 | ≤0.40 | Yes | Yes | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 15 | 2 | HSG Low-E | Non-metal, Improved | 0.23-0.30 | 0.41-0.60 | 0.51-0.60 | Maybe | Yes | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 16 | 2 | MSG Low-E | Non-metal, Improved | 0.23-0.30 | 0.26-0.40 | 0.51-0.60 | Maybe | Yes | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 17 | 2 | LSG Low-E | Non-metal, Improved | 0.23-0.30 | ≤0.25 | 0.41-0.50 | Maybe | Yes | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 9 | 2 | HSG Low-E | Metal, Improved | 0.41-0.55 | 0.41-0.60 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 10 | 2 | MSG Low-E | Metal, Improved | 0.41-0.55 | 0.26-0.40 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 11 | 2 | LSG Low-E | Metal, Improved | 0.41-0.55 | ≤0.25 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 4 | 2 | HSG Low-E | Metal | 0.56-0.70 | >0.60 | >0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 5 | 2 | MSG Low-E | Metal | 0.56-0.70 | 0.26-0.40 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 6 | 2 | LSG Low-E | Metal | 0.56-0.70 | ≤0.25 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 13 | 2 | Clear | Non-metal | 0.41-0.55 | 0.41-0.60 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 14 | 2 | Tint | Non-metal | 0.41-0.55 | 0.41-0.60 | ≤0.40 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 7 | 2 | Clear | Metal, Improved | 0.56-0.70 | >0.60 | >0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 8 | 2 | Tint | Metal, Improved | 0.56-0.70 | 0.41-0.60 | 0.41-0.50 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 2 | 2 | Clear | Metal | 0.71-0.99 | >0.60 | >0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 3 | 2 | Tint | Metal | 0.71-0.99 | 0.41-0.60 | 0.51-0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 12 | 1 | Clear | Non-metal | 0.71-0.99 | >0.60 | >0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |
| 1 | 1 | Clear | Metal | ≥1.00 | >0.60 | >0.60 | No | No | [Bar chart showing energy cost] | | | | ● | ● | ● | ● | ● | ● |

Note: "HSG," "MSG," and "LSG" stand for high-solar-gain, moderate-solar-gain, and low-solar-gain respectively. "Improved" includes warm-edge spacer technology and thermally improved frame. The annual energy performance figures shown here were generated using RESFEN6 provided by Lawrence Berkeley National Laboratory. U-factor and SHGC 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. Natural gas prices used are projections of the average natural gas price for the heating seasons of 2012-2014. Electricity prices used are the average electricity price for the cooling seasons of 2012-2014. All pricing information provided by the Energy Information Administration (www.eia.doe.gov). A simple comfort analysis was performed using EPW weather files for each location to determine how often the winter night and summer day temperatures exceed beyond an acceptable number of hours. The room condition contains a large, west-facing window with a single person facing the window. A large window was used because a large view factor will have a greater impact on comfort. The two extremes of summer day and winter night conditions were only considered. A simple condensation analysis was performed using heating season design temperatures for each location, performance properties of the glazing system, edge performance properties of the framing system, and interior glass temperatures of a glazing system simulated in WINDOW6 to determine if the interior glass temperature falls to a level in which condensation may occur. See the www.efficientwindows.org for more information on all the energy, comfort, and condensations metrics.



In 1989 the glazing and fenestration industry self-organized to create the National Fenestration Rating Council (NFRC). Nine years later the Efficient Windows Collaborative (EWC) was formed and since that time, market share for high performance windows has grown from roughly 30% to over 80% in the residential sector. During that growth, the EWC has been at the forefront of educating manufacturers about how to communicate the value of energy efficiency to consumers and providing performance comparisons across generic products. First incorporating NFRC labels and then ENERGY STAR for fenestration labels, the EWC has maintained a clear and consistent message regarding product performance. The purpose of the EWC is to provide unbiased information, outreach, education, and research dissemination to the general public on the energy efficiency, technical, and human considerations that influence window and façade design, selection, and use.

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The mission of the Efficient Windows Collaborative is to lead and support — through the use of advanced window, façade and skylight technologies — the transformation of the built environment toward greater energy efficiency.

The Efficient Windows Collaborative is a nonprofit, 501(c)3 organization that partners with window, door, skylight, and component manufacturers, research organizations, federal, state & local government agencies, and others interested in expanding the market for high-efficiency fenestration products.

