HOME ENERGY GUIDE

TECHNIQUES TACTICS & TIPS

Windows & Doors

Minnesota Department of Commerce Energy Information Center

If you are shopping for windows and doors, this guide helps you understand your options and how your choices can affect your home's comfort and energy costs. This guide also provides tips on installing windows and doors and it explains the terminology that will help you ask the right questions before you make a purchase. Becoming an educated shopper will allow you to choose the features your home needs, without paying for more than you need.

Efficiency recommendations

Improving the efficiency of your existing windows

Remedies for condensation

Understanding the standards

Installation tips

Related Guides:
Home Heating
Home Cooling
House Diagnostics
Home Moisture
New Homes
Caulking/Weatherstripping

Energy efficient windows: What to look for

Traditionally, windows, doors and skylights have been a weak energy link in home construction, often accounting for 35 to 40 percent of a home's heat loss in the winter and an even larger fraction of heat gain in the summer; but new technology has greatly improved the energy efficiency of today's products. Fortunately, "window shopping" has been simplified for consumers by the National Fenestration Rating Council (NFRC), which has labeled all the windows it has tested and rated. Learning what to look for on the NFRC label is the key to comparing windows and to making the right choice.

The three key elements of efficient windows are:

- **U-factor,** which measures insulating ability.
- **Solar Heat Gain Coefficient,** which measures solar heat-blocking ability.
- **proper installation.**

Both the U-factor and the solar heat gain coefficient are listed on the NFRC label. Look for a U-factor of 0.35 or less and a solar heat gain coefficient of 0.55 or less.

Understanding the standards

These are common terms used to describe the energy efficiency of windows and doors.

R-value and U-factor are the two common measures used to rate how well a specific material or system resists or conducts heat flow. R-value measures the resistance to heat flow. In windows and doors, however, R-value can be misleading, since it applies only to specific parts, such as the frame or center of glass.

U-factor measures the ability of a material or system to conduct the flow of heat. The lower the number, the better its insulating ability. U-factors for windows and doors most often refer to the insulating quality of the entire system (the glass, frame and spacer combined). Therefore, it is a more useful measure of energy efficiency. U-factor is based on a scale of zero to 1. For energy efficient windows, look for a U-factor of .35 or less. For doors, the recommended U-factor is 0.25 or less.

Solar Heat Gain Coefficient (SHGC) measures a window's ability to reduce heat gain by blocking the heat-producing rays. It is also based on a scale of zero to 1. A high coefficient will allow more sunlight, and warmth, into the house. A low coefficient will block more sunlight to reduce summer heat gain. In Minnesota, look for a coefficient of

Look for the NFRC label

National Fenestration Rating Council (NFRC) is a non-profit, public/private organization created by the window, door and skylight industry. It is comprised of manufacturers, suppliers, builders, architects and designers, specifiers, code officials, utilities and government agencies. The NFRC provides consistent ratings on window, door and skylight products. If there is no NFRC label on the window, it may have been tested and rated by an independent company or manufacturer using a different rating system, which may not be as reliable as the NFRC's rating.

The U-factor and the SHGC are the most important indicators of energy efficiency.

0.5 or less to achieve a good year-around balance. Windows with a low SHGC do the most good on the east and west sides of the house.

Emissivity describes how well the surface of the glass radiates heat. The lower the emissivity, the less heat is allowed to pass through and the better the energy savings. The term "low-e" refers to windows with low emissivity.

Air infiltration rate is measured in cubic-feet-per-minute (cfm) and refers to air leakage that occurs through cracks in the window assembly. The lower the number, the less air will pass through. Air tightness in windows and doors used to be more of a consideration than it is today. The small amount of air leakage through windows and doors provides an acceptable (and sometimes necessary) amount of ventilation for your home.

Window features

The following features all contribute to a window's energy efficiency.

Multiple glazings. Generally, the more panes (or glazings), the better the insulating quality of the window.

Gas filling. The air space between the glazings adds to the window's insulating quality. The efficiency increases even more if the space is filled with gas (such as argon or krypton) which is a better insulator than air.

Low-e coatings. Adding a metallic coating on one or more panes of glass (usually on inside layers) lowers the window's ability to transfer heat, thereby saving energy.

Insulating spacer. The traditional aluminum spacers are excellent heat conductors, but terrible insulators. The primary benefit of using an insulating material for spacing is reducing the potential for condensation.

Quality sashes and frames

Although not the most important part of a window in terms of energy efficiency, the sash and frame material affects efficiency and plays a part in the total unit U-factor. Three important questions to ask are: Is the material a good insulator? How resistant is it to expanding and contracting with changes in temperature? And, will the frame help prevent condensation in our cold winter conditions?

Solid steel and aluminum are the least effective because, although durable, they are poor insulators and tend to expand and contract more than any other material. Avoid windows made of these materials.

Wood is the traditional frame material because it is a good insulator. Wood frames also expand and contract less than most other materials, but require more maintenance and are susceptible to moisture damage. Wood components treated with a preservative or clad with metal or vinyl offer the benefits of low maintenance and high insulating value.

Vinyl frames are nearly maintenance free and are similar to wood in insulating quality. However, if you select vinyl windows, ask for a guarantee against sun damage, peeling, warping, or discoloration. Also, like metal, vinyl expands and contracts with temperature changes.

Fiberglass frames, or vinyl with a core of fiberglass insulation, offer high insulating quality as well as low susceptibility to expansion.

Quality weatherstripping

Weatherstripping is also a major factor in determining a window's long term performance. Before purchasing a window, check two important points: Is the weatherstripping material durable and is it easily replaceable? For instance, polyurethane, mylar, neoprene, and EPDM rubber are ideal for Minnesota's climate because they remain flexible under temperature extremes and help provide a tight seal demanded by our northern climate. Second, since all weatherstripping will eventually show wear, it should be easily replaceable. Ask the sales representative to show you how it can be removed and replaced.

Proper window installation

Quality installation is essential if you are to get the full benefits of efficient windows. Even the highest quality window will be greatly diminished in energy efficiency if you allow heavy air infiltration between the rough framing and the window. And simply stuffing fiberglass insulation into this area is not adequate. We recommend the following measures for eliminating the gap between the rough opening and the window.

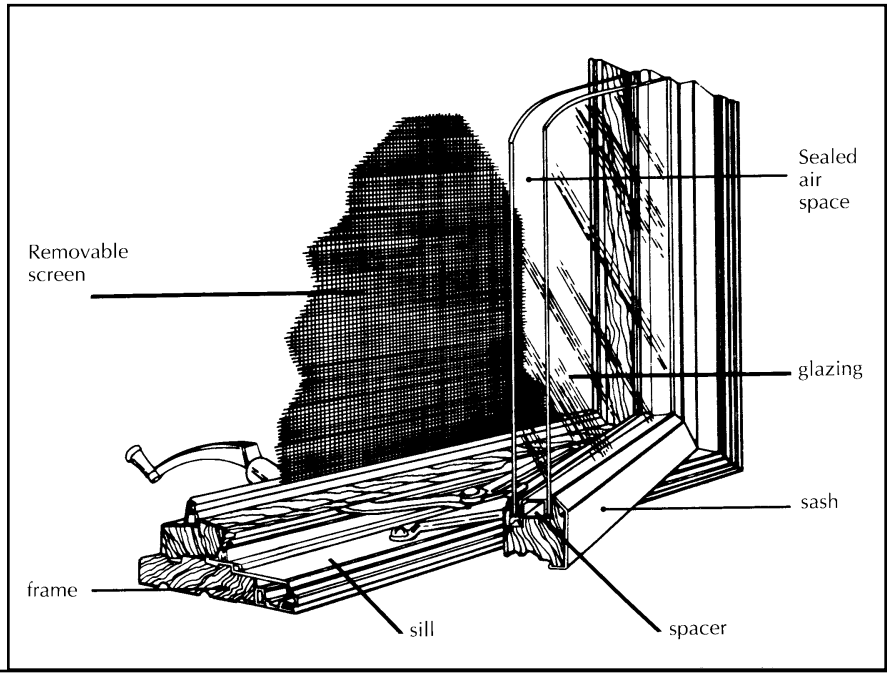
The Minnesota Building Code dictates that windows and doors be sealed when installed to make them weather proof. Failure to correctly seal windows and doors could cause problems later, such as moisture problems, which often require costly callbacks. For example in a housewrap application the practice of cutting an "X" in the housewrap at window and door openings is incorrect and can result in directing water into the rough opening. The housewrap or other flashing must be installed in such a way as to become a part of the weather seal for the window or door. A full explanation of proper installation techniques is beyond the scope of this publication. Your builder should consult the following two resources for recommended window & door installation practices:

- Window Installation Video available from the Builders Association of Minnesota 651-646-7959.
- "Moisture Intrusion" publication available on the Commerce website: http://www.commerce.state.mn.us/pages/Energy/Builders/ResBuilders.htm

Caution

Houses built before 1978 may contain lead-based paint. The older a house is, the more likely it is to have high concentrations of lead in paint. If you work on windows that have painted trim, you need to control any dust and chips and dispose of them safely. Intact paint should not be removed. Pregnant women and small children should stay away from the area until it is cleaned. Information on lead is available from the MN Department of Health, 651-215-0890.

Figure 1
Sealed air space, double glazing, and insulating spacer are among the features of an energy efficient window.



Skylights

Skylights are popular because of the extra light and aesthetic appeal they bring to the home. Unfortunately, their roof location makes them a potential source of serious moisture problems, and winter heat loss or summertime heat gain. Skylights can also contribute to ice dam formation.

Extra care must be taken to install the skylight so that it is sealed tightly to the air-vapor retarder. Also, in cases where the skylight tunnels through the attic, make sure the tunnel and attic area is insulated correctly. Paying attention to detail is especially important when installing and insulating skylights.

Look for skylights with a U-factor of 0.45 or less, and a SHGC of 0.40 or less. Or, consider a clerestory window as an option to skylight.

Sealing the inside of the frame is important too. In new construction, make sure the builder sizes the rough opening large enough to allow for installing a good, airtight seal between the window frame and the rough opening. An installation clearance of at least 3/4-inch is usually recommended, but this can vary among different manufacturers. *It is critical that you follow the manufacturer's installation instructions.* If your home has a plastic air-vapor retarder, it can be sealed to the window frame. If your home does not have a plastic air-vapor retarder but has coats of oil based paint, or if it cannot be reached without removing part of the wall, the gap between the window and rough opening can be sealed with non-expanding foam, or with pre-formed foam rods and sheathing tape.

Storm windows and other options

Before multiple glazed windows became common, storm windows were necessary to protect the typical single-pane prime window, to cut down on drafts, condensation and to add another layer of insulation during the winter months. In newer homes, storms are not as critical, but for any home with single-glazed prime windows, storms are absolutely essential.

Exterior storm windows can be either a "fixed sash" unit, which is taken down in the summer and replaced with fixed-sash screens, or metal, wood, or vinyl combination storm and screen, which does not need to be taken down and stored each season. When installing combination storms, it is important to set the window in a bead of long-life caulk (silicone, butyl rubber, or polyurethane), but be sure to leave weep holes in the caulk to allow moisture to escape.

Interior storms may be suitable as a solution for one or two problem windows (excessively leaky or prone to condensation), but are not generally recommended for use throughout the house. They can be effective if they are designed well and installed very carefully, but poor design or installation can do more harm than good. Interior storms can permit moisture to accumulate between the interior storm and the prime window, creating moisture damage and reduced visibility.

Plastic film can be used to augment or replace traditional storm windows. It can be applied inside or out, depending on the desired effect. On the inside, shrink-wrap plastic can help stop heat loss through windows, and help with condensation problems. It can also help reduce air leaks, especially if used on the upper levels of a house. Shrink wrap is not very durable, however, and it prevents opening the window for quick ventilation.

It is also important to remember that plastic film can be too effective! Although it will reduce condensation on windows, it will also reduce or practically eliminate leakage at windows and patio doors. As a consequence, less fresh air will come into the living space, indoor air quality may be compromised, and the safe operation of furnaces, water heaters, and other fuel-burning appliances may be affected. Overall relative humidity of the indoor air also will increase, leading to possible moisture damage elsewhere in the home. Keep in mind that if condensation occurs throughout the house, or in certain large areas, you should treat the source of the moisture problem rather than treating the windows.

Window condensation: causes and cures

Condensation is not necessarily an indication that your windows are bad and need to be replaced. Condensation on windows depends upon a number of factors: type of glazing, frame and sash materials, glazing spacer material, depth of glazing into sash, and other construction details. Condensation will occur whenever the window surface is cool enough to allow moisture in the air to condense on it, which is why some condensation can be expected in the winter. The chart and accompanying text on page 5 describes the relationship between outdoor temperature, indoor relative humidity and the conductivity of window materials. Condensation should be controlled as much as possible by stopping air leakage. For instance, moisture on the inside of the storm window indicates that the prime window is allowing air (carrying moisture) to leak out to the storm window where it condenses. Caulking and weatherstripping to stop the air leaks will help stop the condensation and ultimately save your windows. Before you replace your windows, call the Energy Information Center for advice.

Improving your existing windows

If you are looking for ways to improve the performance of your existing windows, significant energy savings can be achieved simply by applying the following measures:

Install weatherstripping. Loose fitting windows are a major source of air leaks. Installing weatherstripping closes the gaps between the window sash and frame on vertically and horizontally sliding windows and casement windows. The area where the two sashes meet in the center of a double hung (vertically sliding) window also should be weatherstripped. A basic rule is to use weatherstripping in junctures of surfaces that move or slide together and to use caulk on the non-moving parts.

Apply caulk on the inside, where the window frame meets the wall, to seal another potential source of air leaks. Caulk can also be applied between the frame and sash on permanent non-sliding sections. Although exterior caulking is important for weatherproofing, it does little to save energy. Interior caulking at window and door penetrations, on the other hand, can have a major effect on energy use and household comfort. (Call the Energy Information Center for more details on caulking and weatherstripping.)

Replacing sashes or reglazing a window are alternatives to replacing an entire window. Window manufacturers have combined the benefits of new glazing technologies with compact replacement tracks. These new systems make window upgrades a cost effective alternative. The value of this investment depends on the condition of your existing window frame. If your frame is in good condition and you are willing to maintain it, a replacement window package may be a great investment. Again, use the U-factor and Solar Heat Gain Coefficient as tools in choosing your new window; or, look for an Energy Star label, which also identifies efficient systems.

Make sure to choose a sash material with a high insulating value and gas-filled glazings with a low

Door & Window Recommendations

For windows:
U-factor = 0.35 or less
SHGC = 0.55 or less

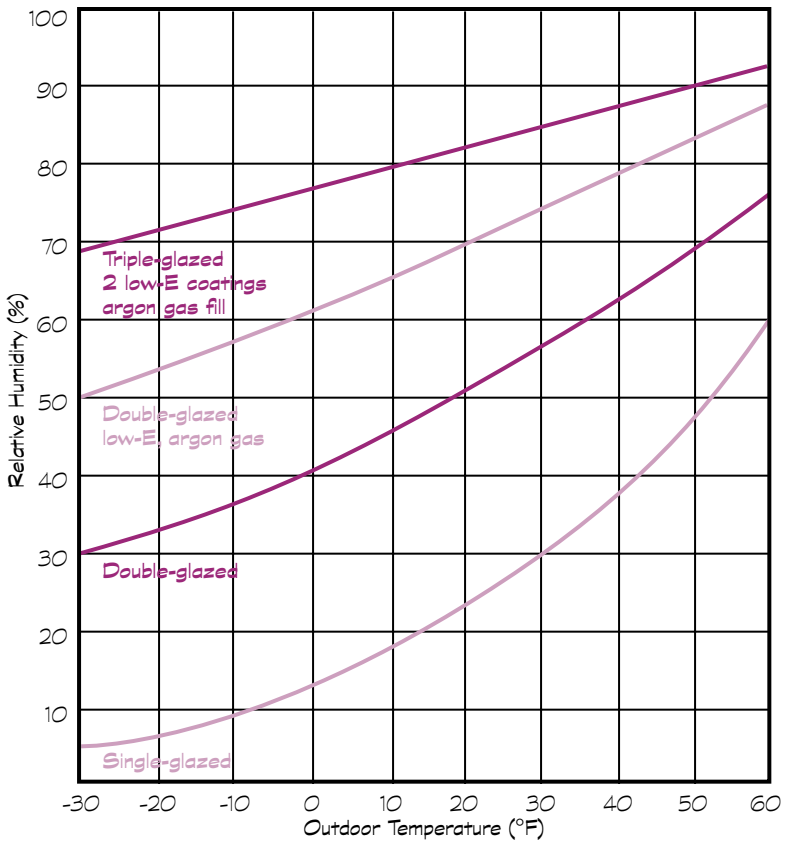
For skylights:
U-factor = 0.45 or less
SHGC = 0.40

For doors:
U-factor = 0.25 or less

Impact of Temperature, Humidity and Glass Choice on Center-of-Glass Condensation

This graph shows condensation potential on the center of glass area (the area at least 2.5" from the frame/glass edge) at various outdoor temperature and indoor relative humidity conditions. Condensation can occur at any points that fall on or above the curves. Note that the thermal conductivity at the edge of a window is general higher than at the center of the glass. For example, insulated glass with a low-e coating and argon gas may tolerate 61 percent humidity at 0 degrees, but the edge may show signs of condensation at only 26 percent humidity. When buying new windows, look for a low "U" value, and buy an ENERGY STAR window.

Source: Lawrence Berkeley National Laboratory.



U- Factors
(Approximates from National Fenestration Rating Council)

Description	Approx. U-factor
Triple-glazed, 2 low-E coatings, argon gas fill	0.32
Double-glazed, low-E, argon gas	0.37
Double-glazed	0.52
Single-glazed	1.10

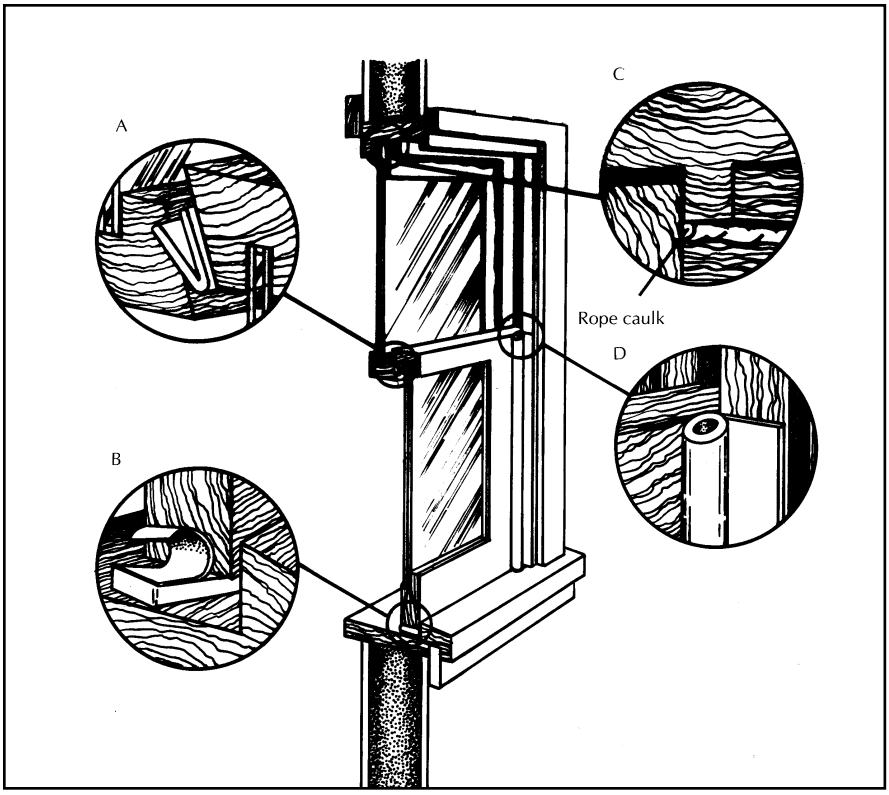


Figure 3
Different types of weatherstrip material are available for specific parts of a window. (A) Use V-strip at the "meeting rail" of a double-hung window; (B) Use self-stick adhesive backed foam at the bottom of the sash; (C) Removable rope caulk makes a good weatherstrip at the top sash; (D) Attach tubular weatherstrip to the side frame to help stop air leakage through the sash.

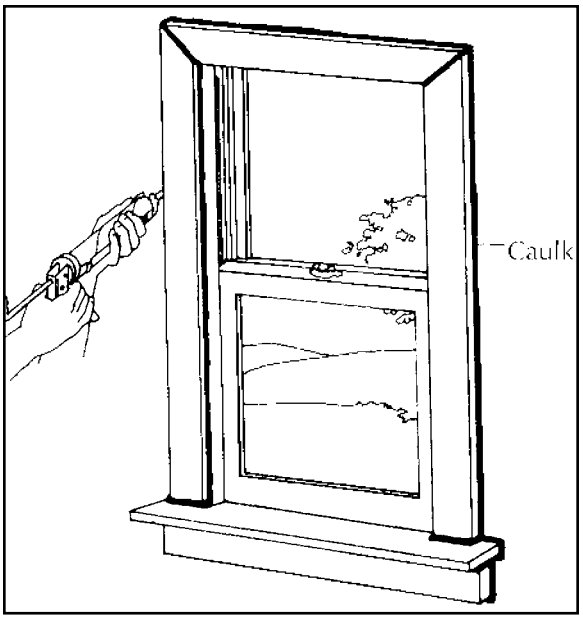


Figure 4
Apply caulk to stop air leaks at seams around the window frame.

emissive coating. (See "Energy efficient windows: What to look for" on page 1.) For window repair, check with lumberyards that provide millwork services.

Other energy saving window treatments

Outdoor awnings. A great technique to enhance summertime cooling is to install outdoor awnings, which can reduce heat gain through the window by as much as 90 percent while still letting in light. It is important, however, to size them correctly so they will not interfere with winter solar heat gain.

Follow this rule of thumb to determine how far the overhang should extend out from the window:

At 44° latitude (southern Minnesota) divide the height of the window (in inches) by 2.7. For instance, if your window is 3 feet high, the awning should extend 13 inches out (36 inches ÷ 2.7 = 13.3). In northern Minnesota, at 48° latitude, divide the window height by 2.2.

Indoor window coverings are important to reduce solar glare in the summer. However, specially designed energy efficient window coverings are not considered as important for saving energy in the winter as they were a few years ago, so this is no longer a suggested technique. Also, any window or frame damage that occurs because of applied window coverings (including interior storms) can void any warranty on insulated glass window systems.

Energy efficient doors: what to look for

Today's market offers a wide range of handsome doors that are significantly more energy efficient than old style doors. As with windows, it is the insulating quality (expressed as a U-factor) and installation that are the principal factors affecting energy efficiency. Look for the following features when shopping for doors.

Insulation-filled steel doors are much more energy efficient than doors without an insulated core. The most common door of this type has a steel face and is filled with polyurethane insulating foam. To understand its efficiency, consider that a typical wood panel door has a U-factor of

about 0.5, while an insulated steel door can have a value as low as 0.17. (Remember, lower is better when it comes to U-factors.)

Insulated fiberglass doors offer the advantages of insulated steel doors and have an appearance similar to wood. They are paintable and stainable and do not readily expand or contract in response to temperature and moisture changes. Some of these doors also have U-factors as low as 0.17.

Glass patio doors have developed a bad reputation as energy wasters based on the old style aluminum frame, double-panel sliding door. A number of improvements have been made, however, to significantly increase their energy efficiency. These include low-emissive coated, double glazed doors with gas filling. Another attractive energy efficient option is the terrace or atrium style door with one fixed panel and the other panel on hinges. (See Figure 2.) Many are available with a U-factor of less than 0.35. Again look for the NFRC label.

Weatherstripping is extremely important in preventing air infiltration around doors. Magnetic weatherstripping is commonly used on steel doors to provide a tight seal. The threshold or door bottom, a critical spot, should be made of material that is flexible enough to conform to different clearances and to tolerate extreme temperature changes and wear. Since door weatherstripping is vulnerable to damage, it should also be easy to replace, so ask your sales representative to demonstrate how to remove and re-apply weather-stripping. (For more information, call the Energy Information Center.)

Proper installation is as important for doors as it is for windows. Follow the same recommendations listed under window installation to ensure that the door fits snugly into the rough opening. Seal any existing gaps between the door frame and the wall with caulk. Also make sure that the doorway is high enough so that rain water drains away from the door.

Storm doors are often not necessary in newer homes because they usually have insulated doors. In older homes, storm doors add insulation value, reduce air infiltration, and protect your prime door from the weather. Some storm doors come with screens to allow for summer-time ventilation.

For more information on windows and doors...

Visit the following web sites:

Efficient Windows Collaborative–
http://www.efficientwindows.org

This web site provides unbiased information on the benefits of energy-efficient windows, descriptions of how they work, and recommendations for their selection and use.

Energy Star Windows–
http://www.energystar.gov/products/windows/

The Department of Energy (DOE) and the Environmental Protection Agency (EPA) have developed an "Energy Star" designation for products meeting certain energy performance criteria. Windows with the ENERGY STAR® label can keep your house comfortable and help save money on utility bills through superior designs that require less money and less energy.

National Fenestration Rating Council (NFRC)–
http://www.nfrc.org

NFRC provides consistent ratings on window, door and skylight products. The NFRC label appears on all products certified to the NFRC standards and on all window, door, and skylight products which are part of the Energy Star program.

Combustion Air Caution

Whenever you replace windows, caulk around windows or take other steps to reduce air leakage, it is important to make sure your furnace, water heater, and other fuel-burning appliances have sufficient combustion air. If they don't, backdrafting of carbon monoxide and other gases into the home could occur. Better yet, replace with power vent, direct vent or sealed combustion appliances for both energy efficiency and safety.

For information on combustion air, how to test for problems, and how to install a combustion airsupply, call the Energy Information Center and ask for a copy of the Combustion Air guide.