Energy Efficient Windows and Doors

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Section 1. Energy Performance Testing, Certification, and Labeling

You can use the energy performance ratings of windows, doors, and skylights to understand their potential for gaining and losing heat, as well as bringing sunlight into your home.

The National Fenestration Rating Council (NFRC) operates a voluntary program that tests, certifies, and labels windows, doors, and skylights based on their energy performance ratings. The NFRC label, shown in Section 1.1, provides a reliable way to determine a window's energy properties and to compare products.

In addition to the NFRC label, the federal government provides a label for energy efficiency called ENERGY STAR®, which appears like this:

The NFRC label can be found on all ENERGY STAR® qualified window, door, and skylight products, but ENERGY STAR bases its qualification only on U-factor and solar heat gain coefficient ratings, which are described in the next section.

1.1 Heat Gain and Loss

Windows, doors, skylights can gain and lose heat through:

- Direct conduction and convection heat transfer through the glass or multi-layer glazing and framing
- Thermal radiation into a house and out of a house from room-temperature objects, such as exterior walls and windows, people, equipment, furniture, and interior walls
- The solar radiation into a house, which is converted to heat when absorbed by building surfaces
- Air leakage through and around them.

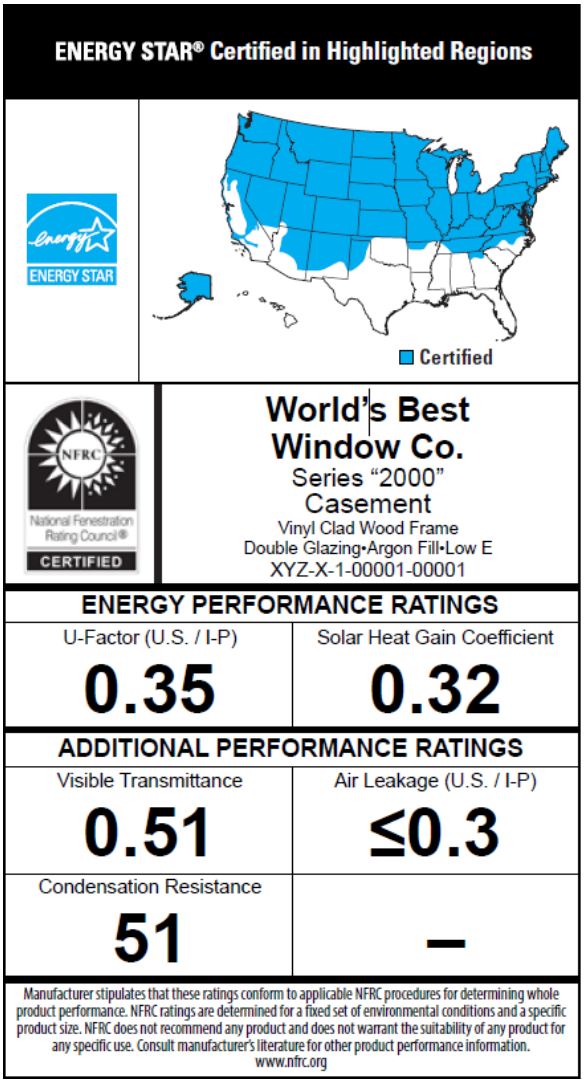
These properties can be measured and rated according to the following energy performance characteristics:

- U-factor is the rate at which a window, door, or skylight transmits non-solar heat flow. For windows, skylights, and glass doors, a U-factor may refer to just the glass or glazing alone. NFRC U-factor ratings, however, represent the entire window performance, including frame and spacer material. The lower the U-factor, the more energy-efficient the window, door, or skylight.
- Solar heat gain coefficient (SHGC) is the fraction of solar radiation admitted through a window, door, or skylight -- either transmitted directly and/or absorbed, and subsequently

released as heat inside a home. The lower the SHGC, the less solar heat it transmits and the greater its shading ability. A product with a high SHGC rating is more effective at collecting solar heat during the winter. A product with a low SHGC rating is more effective at reducing cooling loads during the summer by blocking heat gain from the sun. Your home's climate, orientation, and external shading will determine the optimal SHGC for a particular window, door, or skylight.

- Air leakage is the rate of air movement around a window, door, or skylight in the presence of a specific pressure difference across it. A product with a low air leakage rating is tighter than one with a high air leakage rating. Note that air leakage also depends on proper installation of a window, which is assumed in all ratings.

The U-Factor and Solar Heat Gain Coefficient for a particular window type are given in the NFRC label shown on the next page.



NFRC labels on window units give ratings for U-factor, SHGC, visible light transmittance (VT), and (optionally) air leakage (AL) and condensation resistance (CR) ratings. National Fenestration Rating Council

1.2 Sunlight Transmittance

The ability of glazing in a window, door, or skylight to transmit sunlight into a home can be measured and rated according to the following energy performance characteristics:

- Visible transmittance (VT) is a fraction of the visible spectrum of sunlight (380 to 720 nanometers), weighted by the sensitivity of the human eye, that is transmitted through the glazing of a window, door, or skylight. A product with a higher VT transmits more visible light. VT is expressed as a number between 0 and 1. The VT you need for a window, door, or skylight should be determined by your home's daylighting requirements and/or whether you need to reduce interior glare in a space.
- Light-to-solar gain (LSG)is the ratio between the VT and SHGC. It provides a gauge of the relative efficiency of different glass or glazing types in transmitting daylight while blocking heat gains. The higher the number, the more light transmitted without adding excessive amounts of heat. This energy performance rating isn't always provided.

Section 2. Window Types and Technologies

Many design features and technologies make windows more energy efficient and improve the durability, aesthetics, and functionality. When selecting new windows, consider the frame materials, the glazing or glass features, gas fills and spacers, and the type of operation. All of these factors will influence the overall energy-related properties of the window. To assess and compare the overall window properties, look for an NFRC label.

2.1 Frames and Sash

Improving the thermal resistance of the frame can contribute to a window's overall energy efficiency, particularly its heat loss rate U-factor. There are advantages and disadvantages to all types of frame materials, but vinyl, wood, fiberglass, and some composite frame materials provide greater thermal resistance than metal.

Aluminum or Metal Frames

Although very strong, light, and almost maintenance free, metal or aluminum window frames conduct heat very rapidly, which makes metal a very poor insulating material.

To reduce heat flow, metal frames should have a thermal break -- an insulating plastic strip placed between the inside and outside of the frame and sash.

Composite Frames

Composite window frames consist of composite wood products, such as particleboard and laminated strand lumber, and some are mixed with polymer plastics. These composites are very

stable, they have the same or better structural and thermal properties as conventional wood, and they have better moisture and decay resistance.

Fiberglass Frames

Fiberglass window frames are dimensionally stable and have air cavities that can be filled with insulation, giving them superior thermal performance compared to wood or uninsulated vinyl.

Vinyl Frames

Vinyl window frames are made of polyvinyl chloride (PVC) with ultraviolet light (UV) stabilizers to keep sunlight from breaking down the material. Vinyl window frames do not require painting and have good moisture resistance. The hollow cavities of vinyl frames can be filled with insulation, which makes them thermally superior to standard vinyl and wood frames.

Wood Frames

Wood window frames insulate relatively well, but they require regular maintenance, although aluminum or vinyl cladding reduces maintenance requirements. Metal clad wood frames may have slightly lower thermal performance.

2.2 Glazing or Glass

In most windows the most important decision regarding energy efficiency is the selection of the glazing. Based on various window design factors such as window orientation, climate, building design, etc., you may even want to choose different types of glazing for different windows throughout your home.

While single glazing is common in older buildings, virtually all new efficient buildings use double or triple glazing units. The "insulating glazing units", or IGUS, are available in a wide range of properties based on the type of glass selected, the coatings on the glass, the gas used to fill the space between the panes, and the spacers that keep the glazing separated. Below are some of the most common coatings and technologies you may find when shopping for windows:

Insulated

Insulated window glazing refers to windows with two or more panes of glass. To insulate the window, the glass panes are spaced apart and hermetically sealed, leaving an insulating air space. Insulated window glazing primarily lowers the U-factor, but it also lowers the SHGC.

Low-Emissivity Coatings

Low-emissivity (low-e) coatings on glass control heat transfer within the insulated glazing. Windows manufactured with low-e coatings typically cost about 10% to 15% more than regular windows, but they reduce energy loss by as much as 30% to 50%.

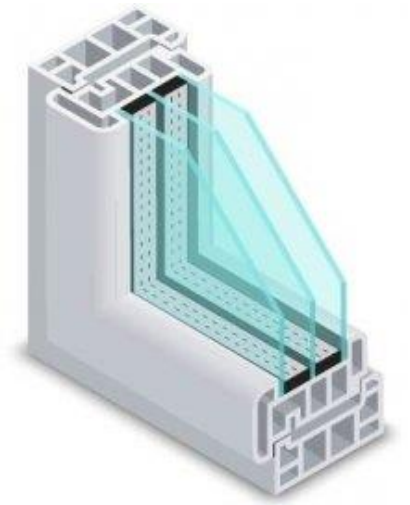
A low-e coating is a microscopically thin, virtually invisible, metal or metallic oxide layer deposited directly on the surface of one or more of the panes of glass. The low-e coating lowers the U-factor of the window, and can manage the daylight transmittance as well as the solar heat gain through the glazing system. Different types of low-e coatings have been designed to allow for high solar gain, moderate solar gain, or low solar gain, and they can also be tuned to control the amount of visible daylight transmitted.

Although low-e coatings are usually applied during manufacturing, some are available for do-it-yourselfers. These films are inexpensive compared to total window replacements, last 10 to 15 years without peeling, save energy, reduce fabric fading, and increase comfort.

Spectrally Selective Coatings

In those climates where cooling loads dominate, you will want a glazing that provides daylight and view but transmits as little of the sun's non-visible infrared radiation as possible, Some low-E coatings are designed to be spectrally selective, filtering out 40% to 70% of the heat normally transmitted through insulated window glass or glazing while allowing the full amount of daylight.

2.3 Gas Fills and Spacers



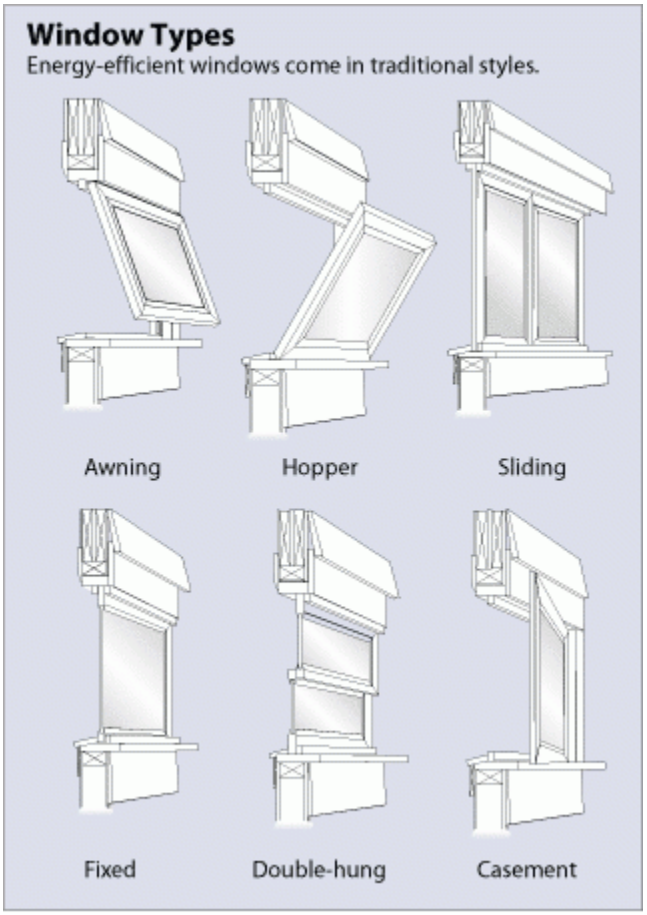
In order to minimize heat transfer between the interior and exterior of the window, the space between glazing layers, usually about 1/2", is filled with argon or krypton gas; both are inert, non-toxic, clear, and odorless.

Argon is most commonly used because it is inexpensive and performs well in the typical 1/2" space. Krypton can be used when the space in thinner than usual—usually about ¼ inch. It has better thermal performance than argon but is also more costly.

Spacers with associated sealants are used to keep the layers of glazing the correct distance apart. In addition, they provide accommodation for thermal expansion and pressure differences, while also preventing moisture and gas leaks.

A variety of spacers are available with different impacts on the window U-factor. Look for "warm edge" spacers which are designed to lower the window U-factor and reduce condensation at the edge of the window.

2.4 Operating Types



Another important consideration is how the windows operate. Since all operable windows may have undesired air leakage which will decrease your home's energy efficiency, the choice of operator type can impact overall energy use. Air leakage rates will vary with the type and quality of the weatherstripping and seals, and will generally increase over time due to operational use. Traditional operating types include:

- Awning. Hinged at the top and open outward. Because the sash closes by pressing against the frame, they generally have lower air leakage rates than sliding windows.

- Hopper. Hinged at the bottom and open inward. Like both awning and casement, they generally have lower air leakage rates because the sash closes by pressing against the frame.
- Single- and double-sliding. Both sashes slide horizontally in a double-sliding window. Only one sash slides in a single-sliding window. Like single- and double-hung windows, they generally have higher air leakage rates than projecting or hinged windows.
- Fixed. Fixed panes that don't open. When installed properly they're airtight but are not suitable in places where window ventilation and egress is desired.
- Single- and double-hung. Both sashes slide vertically in a double-hung window. Only the bottom sash slides upward in a single-hung window. These sliding windows generally have higher air leakage rates than projecting or hinged windows.
- Casement. Hinged at the sides. Like awning windows, they generally have lower air leakage rates than sliding windows because the sash closes by pressing against the frame.

Section 3. Storm Windows

Storm windows can help reduce air movement into and out of existing windows, helping to improve comfort and reduce heating and cooling costs. Replacing single-pane windows with double-pane windows that have high-performance glass may be cost effective, but you could also consider installing low emissivity (low-e) storm windows. Installing interior or exterior energy-efficient storm windows that are rated by the Attachment Energy Rating Council (AERC) can produce similar savings but at about 1/3 of the cost. The AERC defines “window attachments as products, including blinds, cellular shades, roller shades, storm windows, solar screens and pleated shades, that can be attached internally or externally to a window, in order to improve energy performance, create a more comfortable environment, reduce glare, provide privacy, or enhance appearances”.

Interior Storm Window

Courtesy Larsen Windows

Exterior Storm Window

Courtesy Larsen Windows

3.1 Low-E Storm Windows

While older storm windows were typically just clear glass, newer models are available with a low-e coating that reduces heat transmission through the storm window. Low-e storm windows are more insulating, reflecting heat back into the house into the winter, and can also help the home stay cooler during the summer, keeping the home more comfortable. Information on the energy efficiency of storm windows is available for all rated products through the AERC. You can find storm windows that have the ENERGY STAR label at energystar.gov .

Modern storm windows are not the same as the old seasonal storm windows that were removed for cleaning or to allow for entering or exiting. New low-e storm are designed to blend in with the existing architecture, are permanently mounted, and are available as fixed or operable models, such that you can maintain the operation of your existing window (e.g., single-hung storm window attaches over single-hung existing window).

Benefits of Low-e Storm Windows:

- Similar energy savings as full window replacement, but at about one-third the cost
- Aesthetically pleasing
- Operable
- Reduces drafts and increases comfort
- Reduces noise
- Reflect radiant heat 35% better than clear glass storm windows
- Act as an air sealing measure and can reduce overall home air leakage by 10% or more

Low-e exterior or interior storm windows can save you 10%-30% on heating and cooling costs, depending on the type of window already installed in the home.

For more information on the benefits, performance, cost, installation guidance, and energy rating and labels, search for these resources on the Internet:

- Building America Solution Center; Exterior-mounted storm doors
- Building America Solution Center: Interior-mounted storm doors
- Efficient Window Coverings
- Attachment Energy Rating Council (AERC)
- ENERGY STAR label

3.2 Installation

When installing storm windows, ensure they have weatherstripping at all movable joints; are made of strong, durable materials; and have interlocking or overlapping joints.

Section 4. Energy Efficient Windows Coverings

Window coverings are items added to existing windows to improve energy efficiency, reduce glare or natural lighting, provide privacy, or enhance the appearance or comfort of a home. Window coverings include:

- Interior shades and drapes
- Plastic films applied directly to glass
- Exterior shades
- Shutters
- Awnings
- Storm Windows

About 30% of a home's heating energy is lost through windows. In cooling seasons, about 76% of sunlight that falls on standard double-pane windows enters to become heat. Window coverings can help with this energy loss and lowering energy bills. The exact savings will depend on the type of attachment, the season, the climate, and how the attachment is used. In addition to the window coverings, storm windows with low-e coatings and/or multi-layer glazing are effective at improving thermal performance of windows and reducing solar heat gain.

4.1 Operable Window Coverings

Operable window coverings give you the flexibility to choose whether to keep your window coverings open or closed for privacy, and to maximize natural light, take advantage of heat from

the sun in the winter, and reduce heat gain in the summer. Options include shades, blinds, screens, awnings, draperies or curtains, and shutters.

Operable window shades help control daylighting. Chris Gunn / NREL

Operation of Window Coverings

Not all window coverings are operable, but of those that are, one study found that 75% of residential window coverings remain in the same position every day. If this describes your habits, be strategic about which coverings you open in the morning.

If it's winter and likely to be sunny, open the window coverings in the morning to allow the sun to heat your home through the day—especially those that receive direct sunlight.

In the summer, you may want to keep window coverings closed to reduce heat gain. For natural light, open those window coverings that don't get direct sunlight.

You may also want to try switching the ones that are opened and closed through the day to maximize light and heat from the sun when you want it.

Some window coverings offer automated options.

4.2 Interior Window Coverings

Insulated Cellular Shades

Insulated cellular shades are made of pleated materials that are designed to fold up, accordion-like, usually at the top of the window, but sometimes at either the top or the bottom. Insulated shades contain one or more air layers in a honeycomb cross-section. Some can be adjusted from the top, from the bottom, or both.

Insulated cellular shades are typically considered to have the highest R-values of all window coverings. The air pockets in the honeycomb cross-sections act as insulators, increasing the R-value and reducing the conduction of heat through the window.

Insulated cellular shades can be a good choice if you are looking for significant energy savings from their window coverings, as well as comfort, privacy, and increased home resale value.

In heating seasons, tightly installed cellular shades can reduce heat loss through windows by 40% or more, which equates to about 10% heating energy savings. In cooling seasons, cellular shades can reduce unwanted solar heat through windows by up to 60%, reducing the total solar gain to 20% when installed with a tight fit.

Cellular shades that operate on side tracks are most effective at increasing the R-value of windows, and those that open from both the top and bottom allow users to most effectively control daylight entering the home.

Some cellular shades include the option of automation, allowing the blinds to open and close on a set schedule. The schedule can be seasonally optimized to reduce heating and cooling loads while maximizing natural light and home comfort.

Window Quilts

Window quilts have a sheet of quilted material that can be opened by rolling and closed by unrolling. They typically fit snug against the trim, either on tracks or with an attachment such as Velcro or snaps.

Because of their snug fit, window quilts offer R-value decreases similar to cellular shades, and they typically cost less, however they are often more complicated to operate and provide less visible light when closed.

Roller and Roman Shades

Roller shades are usually inexpensive shades that are raised or lowered from a roller bar fitted at the top of the window. Roman shades are fabric window shades that are drawn up into a series of evenly stacked folds when raised or lowered.

These shades typically fit inside of the window casing, or just outside, and they come in a variety of fabrics, colors, and weaves. Heavier fabrics will typically offer slightly better thermal performance, but roller and roman shades offer only a small amount of insulation and are most effective for privacy, room darkening, and blocking sunlight.

Louvered Blinds

Window blinds—vertical (Venetian blinds) or horizontal slat-type (louvered-type)—are effective at reducing summer heat gain and reducing glare, while providing good daylight indoors.

Because of the numerous openings between the slats of blinds, it's difficult to control heat loss through interior window blinds, but the slats offer flexibility in the summer. Unlike shades, you can adjust the slats to control glare, light, and solar heat gain.

When completely closed and lowered on a sunny window, highly reflective blinds can reduce heat gain. Horizontal slat-type blinds can also be adjusted to block and reflect direct sunlight onto a light-colored ceiling. A light-colored ceiling will diffuse the light without much glare, while allowing you to take additional advantage of natural daylighting.

Curtains and Drapes

Curtains are fabric interior coverings that are sized to fit the window, while drapes reach all the way to the floor.

A drapery's ability to reduce heat loss and gain depends on several factors, including fabric type (closed or open weave) and color. With such a wide variety of draperies available, it's difficult to generalize about their energy performance.

During summer days, you should close draperies on windows receiving direct sunlight to prevent heat gain. Studies demonstrate that medium-colored draperies with white-plastic backings can reduce heat gains by 33%.

When drawn during cold weather, most conventional draperies can reduce heat loss from a warm room up to 10% and increase the thermal comfort of the home. Therefore, in winter, you should close all draperies at night, as well as draperies that don't receive sunlight during the day.

To reduce heat loss, draperies should be hung as close to windows as possible and fall onto a windowsill or floor. For maximum effectiveness, install a cornice at the top of a drapery or place the drapery against the ceiling. Then seal the drapery at both sides and overlap it in the center. You can use Velcro or magnetic tape to attach drapes to the wall at the sides and bottom. Taking these steps will further reduce heat loss.

Two draperies hung together will create a tighter air space than just one drapery. One advantage is that the room-side drapery will maintain around the same temperature as the interior space, adding to a room's comfort.

Window Films

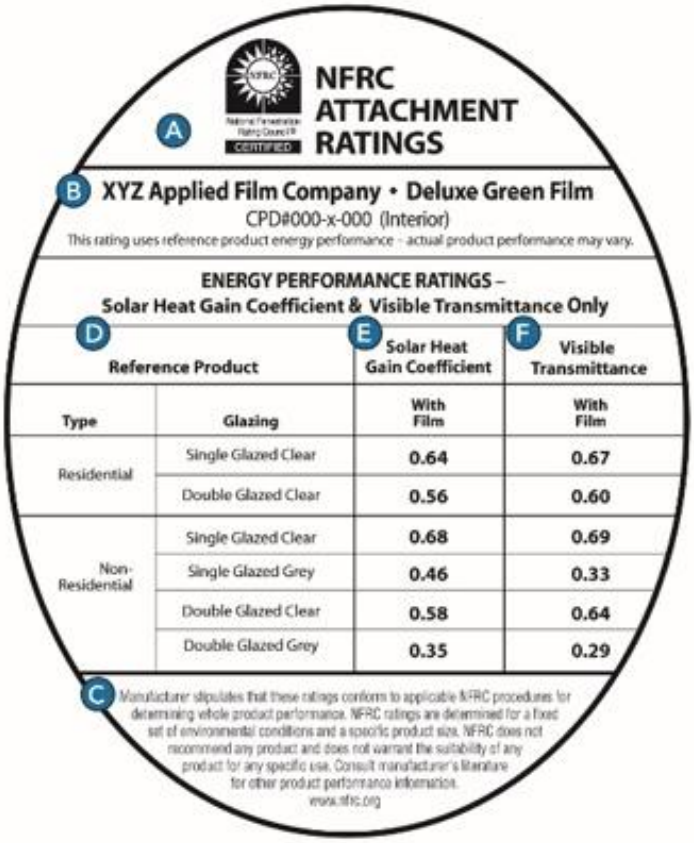
Window films (applied to the glazing surface) help block against solar heat gain and protect against glare and ultraviolet exposure. They are best used in climates with long cooling seasons, because they also block the sun's heat in the winter.

They can be useful for homeowners who don’t want to block views with other window treatments, but who have issues with glare and solar heat gain. They can also be a good choice on windows that are difficult to fit with other window treatments, or in places where artwork, furniture, or carpeting could be faded by UV exposure.

Films typically have three layers: an adhesive layer that sits against the glass, a polyester film layer, and a scratch-resistant coating. You may also choose options such as tints, UV blockers, or thicker films that offer security. Low-e films are also emerging as an energy-saving option.

Window films are rated by the National Fenestration Rating Council (NFRC), which also created window labeling and ratings for consumers. The NFRC's Window Film Energy Performance Label looks like this:

NFRC's Window Film Energy Performance Label



A NFRC ATTACHMENT RATINGS

B XYZ Applied Film Company • Deluxe Green Film
CPD#000-x-000 (Interior)
This rating uses reference product energy performance - actual product performance may vary.

ENERGY PERFORMANCE RATINGS –
Solar Heat Gain Coefficient & Visible Transmittance Only

D Reference Product		**E** Solar Heat Gain Coefficient	**F** Visible Transmittance
Type	Glazing	With Film	With Film
Residential	Single Glazed Clear	0.64	0.67
	Double Glazed Clear	0.56	0.60
Non-Residential	Single Glazed Clear	0.68	0.69
	Single Glazed Grey	0.46	0.33
	Double Glazed Clear	0.58	0.64
	Double Glazed Grey	0.35	0.29

C Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.
www.nfrc.org

A This mark indicates that the product's energy performance has been rated and certified in accordance with NFRC's certification process.

B This area is reserved for the name of the manufacturer and the product.

C This space provides details about NFRC's rating procedures.

D Consumers, building officials and others should use the information in the **Reference Product** columns to choose the glazing system that most closely matches the product on which the film is applied.

E **Solar Heat Gain Coefficient** (SHGC) measures how well a product blocks heat from the sun. SHGC is expressed as a number between 0 and 1. The lower the SGHC, the better a product is at blocking heat gain. Blocking solar heat gain is particularly important during the summer cooling season and in southern climates.

F **Visible Transmittance** (VT) measures how much light comes through a product. VT is expressed as a number between 0 and 1. The higher the VT, the higher the potential for daylighting.

The label includes the solar heat gain coefficient (SHGC) and visible transmittance (VT) of the window film, both numbers between 0 and 1. The lower the SHGC, the better the film is at blocking heat gain. The higher the VT, the more potential for daylighting.

Energy performance ratings have also been discussed in Section 1 above.

The effectiveness of these reflective films depends on:

- Size of window glazing area
- Window orientation
- Climate
- Building orientation
- Whether the window has interior insulation.

Silver, mirror-like films typically are more effective than the colored, more transparent ones. More recently, there are solar control films that have a more neutral appearance and are effective at blocking near IR (infrared radiation) solar radiation in the summer. East- and west-facing windows, because of their greater potential for heat gain, can benefit more from these films. North-facing windows won't benefit from them, and south-facing windows may benefit somewhat, but the benefit could be offset by the reduction of heat from the winter sun.

There are also window films that have low-e coatings, which can also be effective in reducing winter heat loss and increasing thermal comfort of occupants. They also typically are effective at reducing near IR solar radiation.

Window films can be professionally applied by a skilled installer or are available for do-it-yourself projects at home improvement stores.

Window films require extra care for cleaning. If they are primarily absorbing solar radiation (tinted films), they can damage insulated glazing unit (IGU) seals. Most window manufacturers will void their warranties if the film is installed on an IGU.

4.2 Exterior Window Treatments

Exterior Shutters and Shades

Exterior shutters and shades are usually made of a variety of materials, including fabric, wood, steel, aluminum, or vinyl. They are most effective at reducing solar heat gain.

Shades are typically fabric or vinyl and the material may have openings that allow some visibility through the window. The larger the openings, the less protection from solar gain. They are usually manually operated, though some can be opened or closed with a crank inside the home.

Roller shutters are usually mounted above the window and side channels guide them as they're lowered and raised. When you lower these blinds completely, their slats meet and provide shade, rivacy, security, and protection from storms. If partially raised, the blinds allow some air and daylight to enter through windows.

Most exterior shutter systems include a mechanical crank, rod, or motor to allow operation from indoors. This can help encourage daily use of the shutters, and may be required by local fire codes.

Awnings

An awning is a roof-like shelter installed on a home's exterior that shades windows from the sun's heat and glare. Awnings can also shade outdoor living spaces. Awnings can be fixed or retractable.

Window awnings can reduce solar heat gain in the summer by up to 65% on south-facing windows and 77% on west-facing windows. You can use an awning to shade one window or have an awning custom-made to shade the entire side of your house.

In the past, most awnings were made of metal or canvas, which need to be re-covered every five to seven years. Today, awnings are made from synthetic fabrics such as acrylic and polyvinyl laminates that are water-repellent and treated to resist mildew and fading. Whatever the fabric, you should choose one that is opaque and tightly woven. A light-colored awning will reflect more sunlight.

Awnings require ventilation to keep hot air from becoming trapped around the window. Grommets (eyelets) or other openings along the tops and sides of an awning can provide ventilation. The awning may also open to the sides or top to vent hot air.

While awnings can save energy during the cooling seasons, they can increase energy used for heating, so keep this in mind when deciding whether awnings are right for you. You can also adjust your use depending on the season: keep awnings installed or closed in the summer and remove or open awnings in the winter. Fixed awnings can sometimes be installed to allow the lower-angle winter sunlight to reach windows.

You can roll up adjustable or retractable awnings in the winter to let the sun warm the house. New hardware, such as lateral arms, makes the rolling up process quite easy. Some awnings can also be motorized for easy operation.

Exterior Solar Window Screens

Solar screens can reduce solar heat gain, UV damage, and glare. They can be installed on the interior or exterior as roller shades or fixed panels, and they typically allow for a view out the window and light transmission. They look similar to regular insect screens but provide more efficiency benefits.

The openness factor on solar screens varies and affects the efficiency benefits; greater openness reduces the protection against glare and solar heat gain but increases visibility and light transmission.

Section 5. Caulking

Caulk is a flexible material used to seal air leaks through cracks, gaps, or joints less than 1-quarter-inch wide between stationary building components and materials. For components that move—doors and operable windows, for example—weatherstripping is the appropriate material.

Before caulking air leaks in an existing home, you will need to detect the leaks and assess your ventilation needs to ensure adequate indoor air quality. In addition to sealing air leaks, caulking can also prevent water damage inside and outside of the home when applied around faucets, ceiling fixtures, water pipes, drains, bathtubs, and other plumbing fixtures.

Applying caulk to a window frame to prevent air leakage. This caulk is white when applied, and dries clear. | Photo courtesy of ©iStockphoto.com/BanksPhotos.

5.1 Selecting Caulking

Most caulking compounds come in disposable cartridges that fit in half-barrel caulking guns (if possible, purchase one with an automatic release). Some pressurized cartridges do not require caulking guns.

When deciding how much caulking to purchase, consider that you'll probably need a half-cartridge per window or door and four cartridges for the foundation sill of an average home. Caulking compounds can also be found in aerosol cans, squeeze tubes, and ropes for small jobs or special applications.

Caulking compounds vary in strength, properties, and prices. Water-based caulk can be cleaned with water, while solvent-based compounds require a solvent for cleanup. See the table below for information about common caulking compounds.

Common Caulking Compounds

CAULKING COMPOUND	RECOMMENDED USES	CLEANUP	SHRINKAGE	ADHESION	COST	COMMENTS
Silicone: Household	Seals joints between bath and kitchen fixtures and tile. Forms adhesive for tiles and metal fixtures. Seals metal joints, such as those in plumbing and gutters.	Dry cloth if immediate; mineral spirits or naphtha.	Little or none.	Good to excellent.	High	Flexible: cured silicone allows stretch of joints up to three times normal width or compression to one-half the width.
Silicone: Construction	Seals most dissimilar building materials such as wood and stone, metal flashing, and brick.	Dry cloth if immediate; mineral spirits or naphtha.	Little or none.	Good to excellent.	High	Permits joints to stretch or compress. Silicones will stick to painted surfaces, but paint will not adhere to most cured silicones.
Polyurethane, expandable spray foam	Expands when curing; good for larger cracks indoors or outdoors. Use in nonfriction areas, as material can become dry and powdery over time.	Solvent such as lacquer thinner, if immediate.	None; expands quite a bit.	Good to excellent.	Moderate to high.	Spray foam quickly expands to fit larger, irregular gaps. Flexible. Can be applied at variable temperatures. Must be painted for exterior use to protect from ultraviolet radiation. Manufacturing process produces greenhouse gases.
Water-based foam sealant	Around window and door frames in new construction; smaller cracks.	Water.	None; expands only 25%.	Good to excellent.	High	Takes 24 hours to cure. Cures to soft consistency. Water-based

CAULKING COMPOUND	RECOMMENDED USES	CLEANUP	SHRINKAGE	ADHESION	COST	COMMENTS
						foam production does not produce greenhouse gases. Will not over-expand to bend windows (new construction). Must be exposed to air to dry. Not useful for larger gaps, as curing becomes difficult.
Butyl rubber	Seals most dissimilar materials (glass, metal, plastic, wood, and concrete.) Seals around windows and flashing, bonds loose shingles.	Mineral spirits or naphtha.	From 5% to 30%.	Good.	Moderate to high.	Durable 10 or more years; resilient, not brittle. Can be painted after one week curing. Variable shrinkage; may require two applications. Does not adhere well to painted surfaces. Toxic; follow label precautions.
Latex	Seals joints around tub and shower. Fills cracks in tile, plaster, glass, and plastic; fills nail holes.	Water	From 5% to 10%.	From good to excellent.	Moderate.	Easy to use. Seams can be trimmed or smoothed with moist finger or tool. Water resistant when

CAULKING COMPOUND	RECOMMENDED USES	CLEANUP	SHRINKAGE	ADHESION	COST	COMMENTS
						dry. Can be sanded and painted. Less elastic than above materials. Varied durability, 2–10 years. Will not adhere to metal. Little flexibility once cured. Needs to be painted when used on exteriors.
Oil or resin-based	Seals exterior seams and joints on building materials.	Mineral spirits or naphtha.	From 10% to 20%.	Good.	Low.	Readily available. Least expensive of the four types. Rope and tube form available. Oils dry out and cause material to harden and fall out. Low durability, 1–4 years. Poor adhesion to porous surfaces like masonry. Should be painted. Can be toxic (check label). Limited temperature range.

5.2 Applying Caulk

Although not a high-tech operation, caulking can be tricky. Read and follow the instructions on the compound cartridge, and remember these tips:

- For good adhesion, clean all areas to be caulked. Remove any old caulk and paint, using a putty knife, large screwdriver, stiff brush, or special solvent. Make sure the area is dry so you don't seal in moisture.
- Apply caulk to all joints in a window frame and the joint between the frame and the wall.
- Hold the gun at a consistent angle. Forty-five degrees is best for getting deep into the crack. You know you've got the right angle when the caulk is immediately forced into the crack as it comes out of the tube.
- Caulk in one straight continuous stream, if possible. Avoid stops and starts.
- Send caulk to the bottom of an opening to avoid bubbles.
- Make sure the caulk sticks to both sides of a crack or seam.
- Release the trigger before pulling the gun away to avoid applying too much caulking compound. A caulking gun with an automatic release makes this much easier.
- If caulk oozes out of a crack, use a putty knife to push it back in.
- Don't skimp. If the caulk shrinks, reapply it to form a smooth bead that will seal the crack completely.

The best time to apply caulk is during dry weather when the outdoor temperature is above 45°F (7.2°C). Low humidity is important during application to prevent cracks from swelling with moisture. Warm temperatures are also necessary so the caulk will set properly and adhere to the surfaces.

Section 6. Weatherstripping

You can use weatherstripping in your home to seal air leaks around movable building components, such as doors or operable windows. For stationary components, caulk is the appropriate material for filling cracks and gaps.

Before applying weatherstripping in an existing home, you will need to detect the air leaks and assess your ventilation needs to ensure adequate indoor air quality.

6.1 Choosing Weatherstripping

Choose a type of weatherstripping that will withstand the friction, weather, temperature changes, and wear and tear associated with its location. For example, when applied to a door bottom or threshold, weatherstripping could drag on carpet or erode as a result of foot traffic. Weatherstripping in a window sash must accommodate the sliding of panes -- up and down, sideways, or out. The weatherstripping you choose should seal well when the door or window is closed but allow it to open freely.

Choose a product for each specific location. Felt and open-cell foams tend to be inexpensive, susceptible to weather, visible, and inefficient at blocking airflow. However, the ease of applying these materials may make them valuable in low-traffic areas. Vinyl, which is slightly more

expensive, holds up well and resists moisture. Metals (bronze, copper, stainless steel, and aluminum) last for years and are affordable. Metal weatherstripping can also provide a nice touch to older homes where vinyl might seem out of place.

You can use more than one type of weatherstripping to seal an irregularly shaped space. Also take durability into account when comparing costs. See the table below for information about the common types of weatherstripping.

WEATHERSTRIPPING	BEST USES	COST	ADVANTAGES	DISADVANTAGES
Tension seal: Self-stick plastic (vinyl) folded along length in a V-shape or a springy bronze strip (also copper, aluminum, and stainless steel) shaped to bridge a gap. The shape of the material creates a seal by pressing against the sides of a crack to block drafts.	Inside the track of a double-hung or sliding window, top and sides of door.	Moderate; varies with material used.	Durable, invisible when in place, very effective. Vinyl is fairly easy to install. Look of bronze works well for older homes.	Surfaces must be flat and smooth for vinyl. Can be difficult to install, as corners must be snug. Bronze must be nailed in place (every three inches or so) so as not to bend or wrinkle. Can increase resistance in opening/closing doors or windows. Self-adhesive vinyl available. Some manufacturers include extra strip for door striker plate.
Felt: Plain or reinforced with a flexible metal strip; sold in rolls. Must be stapled, glued, or tacked into place. Seals best if staples are parallel to length of the strip.	Around a door or window (reinforced felt); fitted into a door jamb so the door presses against it.	Low	Easy to install, inexpensive.	Low durability; least effective preventing airflow. Do not use where exposed to moisture or where there is friction or abrasion. All-wool felt is more durable and more expensive. Very visible.
Reinforced foam: Closed-cell foam attached to wood or metal strips.	Door or window stops; bottom or top of window sash; bottom of door.	Moderately low	Effective sealer, scored well in wind tests, rigid.	Can be difficult to install; must be sawed, nailed, and painted. Very visible. Manufacturing process produces greenhouse gas emissions.
Tape: Nonporous, closed-cell foam, open-cell foam, or EDPM (ethylene propylene diene monomer) rubber.	Top and bottom of window sash; door frames; attic hatches and inoperable windows. Good for blocking	Low	Extremely easy to install, works well when compressed, inexpensive. Can be reinforced with staples.	Durability varies with material used, but not especially high for all; use where little wear is expected; visible.

WEATHERSTRIPPING	BEST USES	COST	ADVANTAGES	DISADVANTAGES
	corners and irregular cracks.			
Rolled or reinforced vinyl: Pliable or rigid strip gasket (attached to wood or metal strips.)	Door or window stops; top or bottom of window sash; bottom of a door (rigid strip only).	Low to moderate	Easy installation, low to moderate cost. Self-adhesive on pliable vinyl may not adhere to metal; some types of rigid strip gaskets provide slot holes to adjust height, increasing durability. Comes in varying colors to help with visibility.	Visible
Door sweep: Aluminum or stainless steel with brush of plastic, vinyl, sponge, or felt.	Bottom of interior side of in-swinging door; bottom of exterior side of exterior-swinging door.	Moderate to high	Relatively easy to install; many types are adjustable for uneven threshold. Automatically retracting sweeps also available, which reduce drag on carpet and increase durability.	Visible. Can drag on carpet. Automatic sweeps are more expensive and can require a small pause once door is unlatched before retracting.
Magnetic: Works similarly to refrigerator gaskets.	Top and sides of doors, double-hung and sliding window channels.	High	Very effective air sealer.	
Tubular rubber and vinyl: Vinyl or sponge rubber tubes with a flange along length to staple or	Around a door.	Moderate to high	Effective air barrier.	Self-stick versions challenging to install.

WEATHERSTRIPPING	BEST USES	COST	ADVANTAGES	DISADVANTAGES
tack into place. Door or window presses against them to form a seal.				
Reinforced silicone: Tubular gasket attached to a metal strip that resembles reinforced tubular vinyl	On a doorjamb or a window stop.	Moderate to high	Seals well.	Installation can be tricky. Hacksaw required to cut metal; butting corners pose a challenge.
Door shoe: Aluminum face attachment with vinyl C-shaped insert to protect under the door.	To seal space beneath door.	Moderate to high.	Sheds rain on the exterior, durable. Can be used with uneven opening. Some door shoes have replaceable vinyl inserts.	Fairly expensive; installation moderately difficult. May require door bottom planing.
Bulb threshold: Vinyl and aluminum	Door thresholds.	Moderate to high	Combination threshold and weatherstrip; available in different heights.	Wears from foot traffic; relatively expensive.
"Frost-brake" threshold: Aluminum or other metal on exterior, wood on interior, with door-bottom seam and vinyl threshold replacement.	To seal beneath a door.	Moderate to high	The use of different materials means less cold transfer. Effective.	Moderately difficult to install, involves threshold replacement.
Fin seal: Pile weatherstrip with plastic Mylar fin centered in pile.	For aluminum sliding windows and sliding glass doors.	Moderate to high	Very durable.	Can be difficult to install.
Interlocking metal channels: Enables sash to engage one another when closed	Around door perimeters.	High	Exceptional weather seal.	Very difficult to install as alignment is critical. To be installed by a professional only.

Section 7. Reducing Energy Lost Through Your Windows

Energy efficient windows are an important consideration for both new and existing homes. Heat gain and heat loss through windows are responsible for 25%–30% of residential heating and cooling energy use.

If you are selecting windows for new construction or to replace existing windows, it's important to choose the most efficient windows you can afford that work best in your climate.

If your existing windows are in good condition, taking steps to reduce the energy loss through windows can make your home more comfortable and save you money on energy bills.

You have two broad options if you hope to reduce the amount of energy lost through your windows and improve the comfort of your home:

1. Update your existing windows to improve efficiency
2. Replace your windows.

7.1 Update Existing Windows to Improve Efficiency.

If your windows are in good condition, taking steps to improve their efficiency may be the most cost-effective option to increase the comfort of your home and save money on energy costs. There are several things you can do to improve the efficiency of your existing windows:

- Check existing windows for air leaks
- Caulk and weatherstrip.
- Add energy efficient window coverings. See Section 4, Energy Efficient Windows Covering, above.
- Add storm windows or panels
- Add solar control film
- Add exterior shading, such as awnings, exterior blinds, or overhangs.

With any efficiency improvements, take steps to ensure proper installation and check for air leaks again after making the improvement.

7.2 Replace Your Windows

If you decide to replace your windows, you will have to make several decisions about the type of windows you purchase and the type of replacement you will make.

You may have the option of replacing the windows in their existing frame; discuss this option with your window retailer and installer to find out if it will work for you.

You will also need to decide what features you want in your windows. You will need to decide on the following:

- Frame types
- Glazing type
- Gas fills and spacers
- Operation types

See Section 2 Window Types and Technologies above for more information on all of these options.

Selection Process

In addition to choosing the window type, you also need to consider design, energy use and labeling, warranties, and proper installation.

First look for the ENERGY STAR label when buying new windows. Then review ratings on the energy performance label from the National Fenestration Rating Council (NFRC) to find the most efficient windows for your needs.

NFRC ratings are included on all ENERGY STAR certified windows and provide a reliable way to determine a window's energy properties and compare products. See Section 1 above to learn about energy performance ratings for windows to understand how to read the labels and energy-use information.

The Efficient Windows Collaborative offers a selection process for both replacement windows and windows for new construction**.**

Window Selection Tips

- Look for the ENERGY STAR and NFRC labels.
- In colder climates, consider selecting gas-filled windows with low-e coatings to reduce heat loss. In warmer climates, select windows with coatings to reduce heat gain.
- Choose a low U-factor for better thermal resistance in colder climates; the U-factor is the rate at which a window conducts non-solar heat flow.
- Look for a low solar heat gain coefficient (SHGC). SHGC is a measure of solar radiation admitted through a window. Low SHGCs reduce heat gain in warm climates.
- Select windows with both low U-factors and low SHGCs to maximize energy savings in temperate climates with both cold and hot seasons.
- Look for whole-unit U-factors and SHGCs, rather than center-of-glass U-factors and SHGCs. Whole-unit numbers more accurately reflect the energy performance of the entire product.

Installation

Even the most energy-efficient window must be properly installed to ensure energy efficiency and comfort.

Have your windows installed by trained professionals according to manufacturer's instructions; otherwise, your warranty may be void.

Window installation varies depending on the type of window , the construction of the house (wood, masonry, etc.), the exterior cladding (wood siding, stucco, brick, etc.), and the type (if any) of weather-restrictive barrier.

Windows, flashing, and air sealing should all be installed according to the manufacturer's recommendations to perform correctly.

Section 8. Energy Efficient Doors

Your home's exterior doors can contribute significantly to air leakage, and can also waste energy through conduction, especially if it's old, uninsulated, improperly installed, and/or improperly air sealed. Weatherstripping can reduce the energy losses due to air leakage.

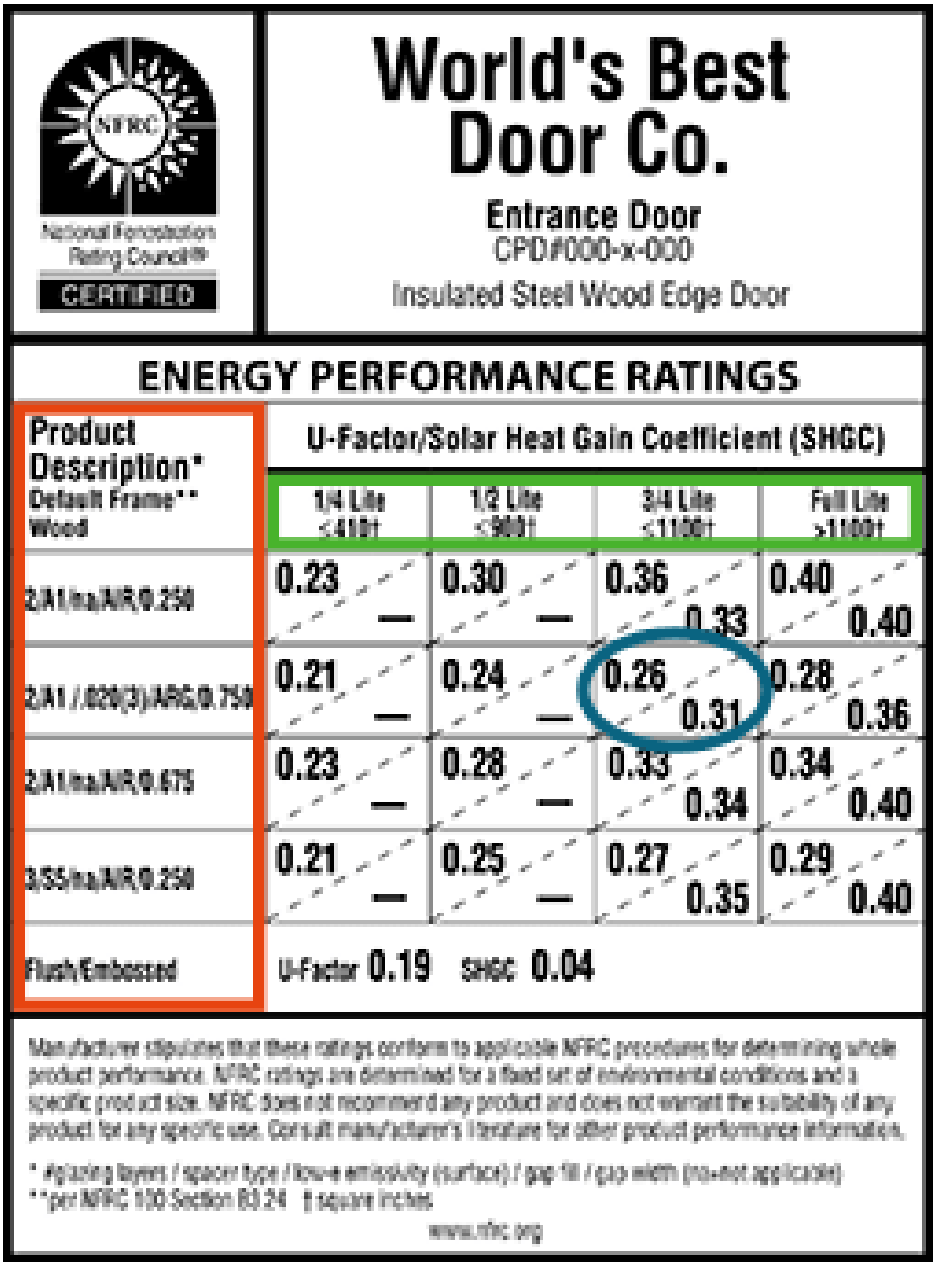
Although many people choose wood doors for their beauty, insulated steel and fiberglass doors are more energy-efficient. | Photo courtesy of ©iStockphoto/cstewart

New exterior doors often fit and insulate better than older types. If you have older doors in your home, replacing them might be a good investment, resulting in lower heating and cooling costs.

If you're building a new home, you should consider buying the most energy-efficient doors possible.

When selecting doors for energy efficiency, it's important to first consider their energy performance ratings in relation to the local climate and your home's design. This will help narrow your selection. Look for the ENERGY STAR label to help identify energy efficient products for your climate.

The National Fenestration Rating Council (NFRC) label helps you compare energy performance ratings of doors. The label shows the solar heat gain coefficient (SHGC) and U-factor for the door.



National Fenestration Rating Council℠
CERTIFIED

World's Best Door Co.

Entrance Door
CPD#000-x-000
Insulated Steel Wood Edge Door

ENERGY PERFORMANCE RATINGS

Product Description* Default Frame** Wood	U-Factor/Solar Heat Gain Coefficient (SHGC)			
	1/4 Lite ≤4ft²	1/2 Lite ≤9ft²	3/4 Lite ≤11ft²	Full Lite >11ft²
2/A1/na/AIR/0.250	0.23 —	0.30 —	0.36 0.33	0.40 0.40
2/A1 /.020(3)/ARG/0.750	0.21 —	0.24 —	0.26 0.31	0.28 0.36
2/A1/na/AIR/0.875	0.23 —	0.28 —	0.33 0.34	0.34 0.40
3/SS/na/AIR/0.250	0.21 —	0.25 —	0.27 0.35	0.29 0.40
Flush/Embossed	U-Factor 0.19 SHGC 0.04			

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.

* #glazing layers / spacer type / low-e emissivity (surface) / gap fill / gap width (na=not applicable)
** per NFRC 100 Section 83.24 ft² square inches

www.nfrc.org

Product Description

Description of the door frame or glass.

Glass Area

Amount of glass in door by area.

Door-specific Rating

The circled value shows you the rating a door has received. Each rating is split into two values: Solar Heat Gain, and U-Factor.

Solar Heat Gain Coefficient measures how well a product can resist unwanted direct or indirect solar radiation. This radiation can cause your home to heat regardless of outside temperature, which may be favorable or unfavorable depending on whether you're heating or cooling your home. In summer months, a low solar heat gain coefficient helps to keep your home cool. In winter months, a higher solar heat gain coefficient can help to keep your home warm.

Range: 0-1

Look for: Low numbers in cooling conditions; high numbers in heating conditions.

U-Factor measures how well a product can keep heat from escaping from the inside of a room. The lower the number, the better a product is at keeping heat in.

Range: 0.00-2.00

Look for: Low numbers

Look for a low SHGC in a climate that mainly requires cooling and a high SHGC in a climate that requires heating. The range is from 0 to 1. SHGC measures how well a product keeps out solar heat.

Look for a low U-factor. The lower the U-factor, the better the door keeps in heat.

Types of Doors

One common type of exterior door has a steel skin with a polyurethane foam insulation core. It usually includes a magnetic strip (similar to a refrigerator door magnetic seal) as weather stripping. If installed correctly and not bent, this type of door needs no further weatherstripping.

The R-values of most steel and fiberglass-clad entry doors range from R-5 to R-6, excluding a window. For example, a 1-1/2 inch (3.81 cm) thick door without a window offers more than five times the insulating value of a solid wood door of the same size.

Single-pane glass or "patio" doors, especially sliding glass doors, lose much more heat than other types of doors because glass is a very poor insulator. Models with several layers of glass, low-emissivity coatings, and/or low-conductivity gases between the glass panes are a good investment. Most modern glass doors with metal frames have a thermal break, which is a plastic insulator between inner and outer parts of the frame. When buying or replacing patio doors, swinging doors generally offer a tighter seal than sliding types. Look at NFRC labels to find air leakage ratings. A door with one fixed panel will have less air leakage than a door with two operating panels.

It's impossible to stop all the air leakage around the weatherstripping on a sliding glass door and still be able to use the door. In addition, after years of use the weatherstripping wears down, so air leakage increases as the door ages. If the manufacturer has made it possible to do so, you can replace worn weatherstripping on sliding glass doors.

Installation

When you buy a door, it will probably be pre-hung. Pre-hung doors usually come with wood or steel frames. You will need to remove an existing doorframe from the rough opening before you install a pre-hung door. The doorframe must be as square as possible, so that the door seals tightly to the jamb and swings properly.

Before adding the interior trim, apply expanding foam caulking to seal the new doorframe to the rough opening and threshold. This will help prevent air from getting around the door seals and into the house. Apply carefully, especially if the frame is wood, to avoid having the foam force the frame out of square.

New, pre-hung exterior doors should have weatherstripping already installed. Check the weatherstripping on your exterior doors annually to see if it needs replacement.

Storm Doors

Adding a storm door can be a good investment if your existing door is old but still in good condition. However, adding a storm door to a newer, insulated door is not generally worth the expense, because you won't save much more energy.

If you plan to purchase a storm door, consider features that improve the energy efficiency.

Storm door frames are usually made of aluminum, steel, fiberglass, or wood (painted or not). Wooden storm doors require more maintenance than the other types. Metal-framed storm doors might have foam insulation inside their frames for added strength.

High-quality storm doors use low-emissivity (low-e) glass or glazing to increase energy efficiency. Other features may include screens with self-storing pockets, full-length screens with removable

glass panels, and screens and glass that slide past each other. All of these features add convenience and cost.

A glass storm door could trap heat against an entry door and cause damage if the exterior door gets more than a few hours of direct sun each day. Low-e glass will reduce the heat gained. Check the door manufacturer's recommendations if this is a concern.

Storm doors for patio doors are hard to find, but they are available. Adding one to a new, multi-glazed low-e door is seldom economic. Insulating attachments such as cellular shades, when closed for the night in winter or on sunny days in summer, are also a good idea.

Section 9. Product Information and Professional Services for Windows, Doors, and Skylights

Use the following names and titles to search on the Internet for product information and professional services for windows, doors, and skylights.

9.1 Product Information

- Independently Tested and Certified Energy Performance
- ENERGY STAR®
- Information on ENERGY STAR performance ratings for windows, doors, and skylights.

- Product Ratings
- National Fenestration Rating Council
- Find energy performance ratings and manufacturers of windows, doors, and skylights.

- Residential Windows, Doors, and Skylights
- ENERGY STAR®
- Learn how to save energy by sealing your home and choosing ENERGY STAR windows, doors, and skylights.

- Window Selection Tool
- Efficient Windows Collaborative
- Find the best windows to use in your area based on their energy efficiency and associated heating and cooling costs.

- Window Attachment Product Ratings
- Attachment Energy Rating Council
- Find energy performance ratings and the manufacturers of interior and exterior window attachments.

- Window Covering Selection Tool

- Efficient Window Coverings Collaborative
- Find guidance on the best window coverings for your climate, your needs, and your windows.

9.2 Professional Services

- Certified Window and Door Installers
- InstallationMasters Institute
- Find certified installers of windows and doors in your area.

- Locate an Awning Pro
- Professional Awning Manufacturers Association