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# Understanding Energy Standards and Codes for Windows

**Different levels of performance are called for by different requirements.**

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Windows are an integral part of all residential and light commercial buildings, and they directly impact both the energy performance and human comfort in those buildings. Of course, there are many different makes, models, types, sizes, and styles of windows and they can each provide different levels of energy performance. So how does anyone determine which windows to use in a building?

The answer lies in deciding first what energy performance level is being sought. Building codes, including the widely used International Energy Conservation Code (IECC), establish the baseline energy performance levels for buildings overall and for many different building components and

systems, including windows. The levels vary depending on which IECC Climate Zone the building is located in. Other programs and standards recognize buildings and window products for achieving energy performance levels better than code requirements. If a building is being designed, constructed, renovated, or being required to achieve a higher level of performance or comfort, then it is very likely that the selected windows will need to be higher performing as well.

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## THE BASIC PHYSICS

In order to help sort out the distinctions, it is important to remember that the physics of how windows perform are the same in all cases - the windows simply differ in the degree to which the scientific principles are supported or hindered.

### Heat Flow

Heat transfer through a window (e.g., either heat loss when the building is heated or heat gain when it is being cooled) is expressed in the amount of heat that passes through in a given amount of time. Note that this is for the entire window product, not just the glass and does not directly account for heat from the sun. The common measure for comparison in windows is the “U-factor” usually expressed as a decimal (i.e., 0.25) with lower numbers indicating less heat transfer and a higher number indicating more. Keep in mind that, in terms of the impact on a building, the size of windows matters. The glass area on windows commonly allows less heat transfer than the frame. Hence, large, stationary windows sometimes have a lower U-factor (less heat transfer) than smaller ones since the frame and edges are a smaller percentage of the overall larger window product. Nonetheless, any window will allow more heat transfer than an insulated, opaque wall. Therefore, balancing the total area of the windows with the total area of the opaque walls becomes an important consideration in energy conserving building design.

### Solar Heat Gain

Relatedly, the glass in a window will allow a certain amount of infrared sunlight to pass through it, adding heat to the building - a welcome benefit in cold weather, but not so welcome in hot weather. The way this is measured is quantified by the “Solar Heat Gain Coefficient” (SHGC) of the entire window. This is a number between zero and one expressed as a decimal with a higher number indicating more solar heat transmission and a lower one indicating less. Often, window glass can be treated or tinted to reach the desired lower numbers, but that can impact how the glass looks as well as the amount of light passing through it. Glass is therefore also tested on the basis of “Visible Transmittance” with results also on a scale of zero to one - higher numbers allow more daylight into the building; lower numbers restrict it.

### Air Leakage

Another consideration for both the energy performance of a window and the comfort of the people inside the building, is “air leakage” rate (i.e., air drafts). This is particularly relevant on windows that operate to open and close - the better the windows are constructed and the tighter they close, then the lower the air leakage rate. The Energy Code requires windows to test at or below 0.3 cubic feet per minute per square foot of window - lower is even better.



## NFRC WINDOW PERFORMANCE TESTING

The National Fenestration Rating Council (NFRC) is an independent non-profit organization that establishes objective window energy performance ratings to help consumers compare products. Manufacturers that follow NFRC’s product certification program (PCP) are allowed to label their independently tested products for: 1.) U-factor; 2.) Solar Heat Gain Coefficient; 3.) Visible Transmittance Rate. They also have developed standards for other voluntary ratings such as Air Leakage or Condensation. Note that NFRC doesn’t mandate any particular level of energy performance, the standards are simply used to determine the levels achieved by different products.

### European Windows

Note that in Europe, the NFRC is not the norm since different testing is done by different organizations. While the physics are the same, the math is different, and the results are reported in different ways. Therefore, it is very difficult to do an “apples to apples” comparison between European and US made windows purely on the basis of their respective testing reports. The best way to compare performance for projects in North America is to seek NFRC information to ensure the same testing procedures have been used.

 National Fenestration Rating Council® CERTIFIED	<b>World's Best Window Co.</b> Series "2000" Casement Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E XYZ-X-1-00001-00001
<b>ENERGY PERFORMANCE RATINGS</b>	
U-Factor (U.S./I-P) <b>0.22</b>	Solar Heat Gain Coefficient <b>0.23</b>
<b>ADDITIONAL PERFORMANCE RATINGS</b>	
Visible Transmittance <b>0.51</b>	Air Leakage (U.S./I-P) <b>≤ 0.3</b>
<small>Manufacturer stipulates that these ratings conform to the applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for 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</small>	

EXAMPLE OF  
NFRC LABEL

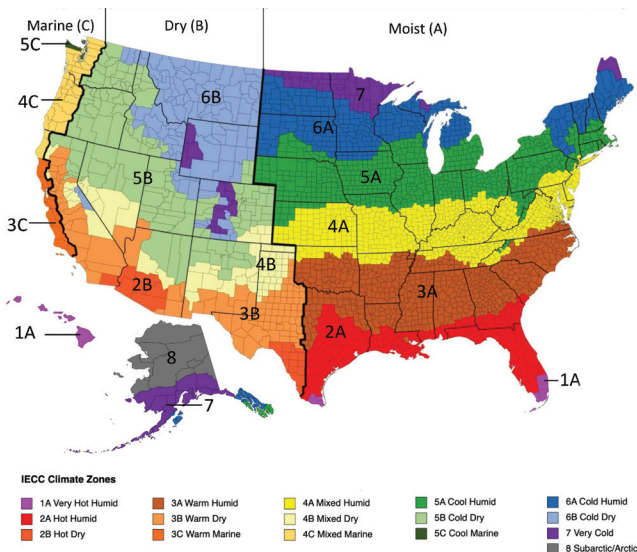
In the U.S., model building codes have been developed by the International Code Council (ICC) which are referred to as the International Codes or I-Codes. They include a coordinated family of building safety codes such as the International Building Code (IBC), the International Residential Code (IRC), the International Energy Conservation Code (IECC) and other specialty codes. These codes are typically adopted by states or local “authorities having jurisdiction” (AHJ). Note that the codes are reviewed and updated nationally on a 3-year cycle, but a State or local AHJ may or may not have adopted the latest version. The trend over the last decade or more has been for energy code requirements to become more stringent.

**Local Modifications**

Any AHJ is free to add other requirements to the model code or supplement it with their own code language. For example, some localities have adopted the voluntary International Green Construction Code (IgCC) which may impose other energy related requirements on buildings within their jurisdiction. Hence, it is always good to check in advance with the local Building Department to verify which version of the code is in effect or if local nuances exist.

**Climate Zones**

A fundamental energy code requirement is to identify the climate zone where the building is located. The IECC identifies 8 zones with the warmest (southern states) identified as Climate Zone 1, progressing upward to the very northern part of the country and Alaska at Climate Zone 8. The codes specify different levels of energy performance (including windows) based on the different climate zones. Therefore, it is important to identify the building’s proper climate zone.



**CODE COMPLIANCE**

Code compliance of buildings and windows can be shown in any of one of the following ways:

**Prescriptive Compliance Option**

The code prescribes the climate zone specific levels of performance which need to be documented on NFRC labels. This includes maximum U-factors along with maximum SHGC. The maximum air infiltration rate for windows is constant across all climate zones and also requires testing documentation. When using the prescriptive path to show energy code compliance, this method doesn’t require conducting calculations, rather, it simply requires documentation following the prescriptive tables and code sections.

**Total UA Alternative**

The use of available computer software such as ResCheck or ComCheck from the U.S. Department of Energy considers trade-offs between different parts of the building envelope, such as less insulation in walls, for example, if that reduction is adequately made up for with more insulation in roof and floor assemblies. The same could be true for windows that perform differently than prescribed when offset by other measures that can be traded off. Keep in mind that the air leakage rate still needs to be met - only the thermal properties can be traded off.

**Net Zero**

The code allows for another compliance alternative involving both software-based calculations and on-site inspection / verification of energy related features of a single-family dwelling unit. This usually means that a certified Home Energy Rating System (HERS) professional is employed to carry out the calculations and document the on-site conditions of the building, including all windows. The ERI process compares the calculated total energy performance of a home to a standard reference home of the same design to achieve a total score (ranging 0-100+ with lower scores using less energy). The energy code then lists maximum scores that must be obtained based on Climate Zone.

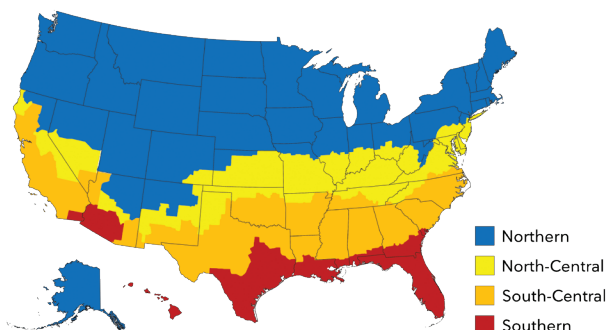


## ENHANCED PERFORMANCE STANDARDS

Architects and building owners are very often interested in creating buildings that exceed the minimum code requirements for energy usage, particularly architectural firms that have signed onto the AIA 2030 Commitment. In that regard there are several standards that identify different degrees of performance summarized as follows:

### Energy Star

This program is administered by the U.S. Environmental Protection Agency (EPA). ENERGY STAR is a voluntary labeling program whereby EPA sets energy efficiency specifications and those products that meet them can choose to display the ENERGY STAR logo. ENERGY STAR certified windows meet three criteria: 1.) they are manufactured by an ENERGY STAR partner; 2.) they are independently tested, certified and verified following NFRC standards, and 3.) Achieve NFRC ratings that meet the strict energy requirements set by the U.S. EPA. Note that the EPA requirements use four climate zones, different than the energy code, and have generally higher performance requirements than the code for U-factors and SHGC. Specific window products, therefore, need to show the ENERGY STAR climate zone map where they meet the criteria.



### LEED®

This well-known green building rating program is used for voluntarily improving the energy performance and general sustainability of residential and commercial buildings. Windows and glazed fenestration products are not specifically identified with prescriptive performance requirements under LEED, but they play a key role in addressing overall energy use, daylight, and views - all of which are areas that have the potential to earn points toward LEED certification.

### Passive House

Another popular program is Passive House (with different versions for the U.S., Canada, and Europe) which is a voluntary standard resulting in ultra-low energy use for space heating or cooling. In order for a home or multifamily building to be certified, all aspects of the thermal envelope are addressed including all windows/fenestration. Typically, that means additional requirements on the windows or other glazed products for reduced heat transfer and air infiltration. Some examples of how to achieve this level of performance include added panes of glass, added glass treatment, reduced window sizes, fixed (non-operable) windows, and enhanced air leakage resistance.

### Net Zero Homes

A growing number of homes are being designed based on the principle of generating as much energy as is consumed on an annual basis. Most commonly, that on-site generated energy comes from solar photovoltaic electricity and is designed to power the entire home - without the use of any fossil fuels. The first step to achieve this cost-effectively is to address all of the energy conservation measures of walls, roof, and windows to reduce the demand for energy in the first place. Then the solar electric system can be sized accordingly. High performance windows are usually an important part of the design of such homes, sometimes also being used to allow warming sunlight to help passively heat the home.

## CONCLUSION

When selecting windows for a home or light commercial building, determine first what level of performance is needed or desired by the owner. Then, carefully review the tested data from manufacturers to determine which window products meet the project requirements and rule out those that don't. In the end, well-designed, energy conserving windows help a home to be more comfortable, appealing, and affordable to operate.

For more information visit [marvin.com/energy-data](https://marvin.com/energy-data).

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