Choosing Energy-Efficient Windows

By Sydney G. Roberts, Ph.D.

Windows and doors allow architects and designers to add character and personality to a home and provide home owners with important natural light, fresh air, entry and egress. They typically comprise 10 to 25 percent of a home's wall area. In the metro Atlanta climate, they can account for up to 50 percent of the cooling load during the peak summer afternoons.

Recent improvements in window technologies have significantly enhanced the thermal performance of windows. Technologies such as double panes, low-emissivity coatings, low-conductance gas fills, thermal breaks and improved framing materials can be used individually or in combination to produce windows that provide a better barrier between the indoor, conditioned space and the outdoor elements. They are also quieter, more durable and reduce condensation problems in the home.

Advanced technologies such as electrochromatic glass, which can be darkened when a current is passed through the glass, and ultra-insulating aerogel, which can be incorporated into translucent assemblies with R-values as high as R-20, are leading the next generation of windows.

For the designer and builder, there are three major decisions to make: where to put the windows, how many windows to use and which windows to choose. This article will explore some things to consider when making each of these decisions.

The south side of the Southface office building uses passive solar design. In the winter, the sun shines on the windows and warms the living space, reducing the heating load on the building. In the summer, overhangs shade the windows, reducing the cooling load on the building.

The residential energy code in Georgia requires windows to have a maximum U-factor of 0.65 and a maximum solar heat gain coefficient (SHGC) of 0.40. Choosing an ENERGY STAR window is one way to ensure that you are meeting the energy code because those windows will have a U ≤ 0.4 and SHGC ≤0.4 in our climate zone. Both U-factor and SHGC will appear on the National Fenestration Rating Council (NFRC) sticker on rated windows.

The NFRC label provides energy efficiency and performance data for the entire window or door unit. Look for a low U-factor and low SHGC.

U-factor is the inverse of R-value (1/R) that we are all familiar with when discussing insulation levels. Some of the very best windows available have U-factors = 0.25, which is equivalent to R = 4.0. This window will perform 167 percent better than a code window at stopping conduc-

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tive heat transfer.

Solar heat gain coefficient is a measure of how much radiant heat from the sun the window transmits into the home. The lower the number, the less radiant heat is transmitted through. In our climate it is generally best to choose windows with a low SHGC. Not only will this keep the heat out, especially on those hot summer afternoons when cooling loads are at the highest, but it will also help protect the floors, furniture, artwork and other valuables in the home by stopping ultraviolet rays from entering the home and damaging property.

Windows achieve a low SHGC by applying a very thin coating of metal on the inside surface of the glass for a double-paned window. This metallic surface reflects the sunlight away from the window and does not emit the heat into the home. This is the low-emissivity (low-e) coating.

WINDOW LOCATION

As the sun moves from east to west throughout the day, it gradually warms the home. In the morning and afternoon, the sun is so low in the sky that overhangs can not stop the sun from coming in the windows. At mid-day when the sun is coming from the south, the sun is highest in the sky, and overhangs can cast a shadow over windows. At no time does sun shine directly on north-facing windows.

Understanding this, it is best to locate windows on the north and south sides of a home to provide natural light and cross ventilation. The windows on the south side should not exceed 20 percent of floor area and should include overhangs that are designed to provide full shade in the summer. A typical overhang of 1.5 to 2 feet in our climate should shade windows that are located within a foot of the bottom of the overhang and are less than 6 feet tall.

East and west-facing windows should be minimized except as required for egress. Rooms with west-facing glazing will be especially difficult to cool on summer afternoons and evenings and will likely lead to uneven temperatures throughout the house.

HOW MANY WINDOWS

Recall that windows meeting energy code in Georgia must have R-values of at least 1.5. It's important to remember that every place where there is a window, an R-13 or R-15 wall is being replaced with approximately an R-1.5 window. This has very serious consequences for the overall energy efficiency and comfort of the home.

Heat will take the path of least resistance through a wall. For instance, if instead of a wall of R-13 insulation, 20 percent of that wall is

replaced with ENERGY STAR windows having U=0.4, the overall R-value of the wall is decreased to 7.1. That is a 45 percent decrease in resistance to heat transfer via conduction. If more energy-efficient windows are installed instead, the average R-value of the wall would increase, and resistance will further decrease. Because window R-values are so much lower than wall R-values, it's important to make sure that each window is chosen wisely to make the most of the natural light, ventilation and views.

WHICH WINDOWS?

After choosing the proper orientation and number of windows, the next step is to actually specify the window. There are many choices in terms of styles, materials and installation. When choosing a window, consider not only energy efficiency, but also durability of both the window and the entire wall structure.

First, make sure that your window is NFRC-rated. Windows that are NFRC-rated have been tested by a certified testing lab using national standards. It's not just the glazing, but the entire window unit that is tested, so this is a way to compare the energy performance of windows made of different materials.

The lower the U-factor, the higher the R-value, and the higher the resistance to conductive heat transfer. Similarly, the lower the SHGC, the lower the emissivity of solar radiation through the window. Look for windows with low U-factors and low SHGC.

A third measure of energy efficiency on the NFRC label is air tightness, which is reported in cubic feet per minute of air leakage per linear foot of window edge. A rating of 0.2 cfm/ft is good; the best windows have ratings of 0.1 cfm/ft or lower. Builders familiar with the performance blower door test used in EarthCraft House understand the importance of reducing air infiltration to overall energy efficiency and indoor air quality.

Visual transmittance, also on the NFRC label, is a measure of the amount of visible light that passes through the window. The higher the value, the more light will pass through the window providing more natural light and reducing the need to turn on the lights inside the house. Typical values range between 0.3 and 0.8. All other things being equal in terms of U-factor, SHGC and air tightness, it's better to choose a window with a higher visual transmittance.

The next time you shop for a window, remember to find one with the lowest U-factor, lowest SHGC, lowest air tightness and highest visual transmittance.