



FACT SHEET

ASSEMBLIES: WINDOW

Description

Smaller houses are more directly and dramatically affected by changes to the envelope than large ones. Due to this fact, the choice of windows can dramatically improve the energy efficiency of the home, help to minimize operating costs, and increase comfort. The following comparative analysis identifies the relative economic, energy, and environmental implications of three high performance windows: Double-glazed Low-E (high solar gain), Double-glazed Low-E (low solar gain), and Triple-glazed Low-E (moderate solar gain). All windows discussed in this section meet or exceed the minimum energy code requirements for Minnesota. For additional information on windows see House: Window Orientation 1 Story, House: Window Orientation 2 Story, House: Window Area 1 Story, and House: Window Area 2 Story.

Recommendations

Balancing cost and performance select a double low-E argon window with a performance rating of u-value of .35 or less, solar heat gain coefficient (SHGC) between .30 and .60, and a visible light transmittance VT of .50 or more. Passive solar homes should look for windows with a high solar heat gain coefficient to maximize solar gain. Always select windows with NFRC ratings that meet Energy Star criteria.

Citations

Residential Windows, A Guide to New Technologies and Energy Performance, 2nd Edition. John Carmody, Stephen Selkowitz, Dariush Arasteh, and Lisa Hescong. W.W.Norton & Company 2000

Efficient Windows. The Efficient Windows Web Site is sponsored by the U.S. Department of Energy's Windows and Glazings Program in collaboration with members of the Efficient Window Collaborative (EWC). EWC members have made a commitment towards manufacturing and promoting energy efficient windows. www.efficientwindows.org

Window Alternatives

alternatives	average unit cost		energy cost/sf-habitable
	frame	cost	
double low E high solar gain	vinyl	\$184.00	\$1.39
	wood	\$245.00	
	wood clad vinyl	\$256.00	
	wood clad metal	\$235.00	
double low E low solar gain	vinyl	\$184.00	\$1.35
	wood	\$245.00	
	wood clad vinyl	\$256.00	
	wood clad metal	\$235.00	
triple glazing	wood clad metal	not available	\$1.34

The cost and energy model is a Minnesota code base zone 2, 1-story 864 sf house, with wood siding, 130 sf of double low-E argon glazing, equally distributed on all for orientations, 80 AFUE furnace, and 10 EER air conditioning. Cost information is based on Means Cost Works 2004 (for a 2 x 5 double-hung window). Energy modeling was conducted on Visual DOE 3.1.

Criteria Summaries

Cost: Both types of double-glazed low-E windows cost less than the triple-glazed option. Windows with vinyl frames cost less than windows with wood or wood clad frames.

Energy: Comparing low solar gain and high solar gain low-E windows, there is a tradeoff between heating and cooling. The low solar gain version has lower cooling costs while the high solar gain window has lower heating costs by taking better advantage of passive solar gains. The difference is small in a conventional house, but if passive solar was optimized with greater mass and proper orientation, the advantage of high solar gain glazing would be greater. Triple-glazed windows perform slightly better in this analysis but not enough to justify the initial cost increase. Vinyl and wood frames have similar energy performance.

alternatives	cooling cost/sf-habitable	heating cost/sf-habitable	energy cost/sf-habitable	yearly energy cost
double low E high solar gain	\$0.12	\$0.34	\$1.39	\$1,197.00
double low E low solar gain	\$0.09	\$0.35	\$1.35	\$1,167.51
triple glazing	\$0.10	\$0.34	\$1.34	\$1,159.31

The cost and energy model is a Minnesota code base zone 2, 1-story 864 sf house, with wood siding, window area as noted, double low-E argon glazing, equally distributed on all for orientations, 80 AFUE furnace, and 10 EER air conditioning. Cost information is based on Means Cost Works 2004. Energy modeling was conducted on Visual DOE 3.1.

Material: Comparing the three window options in terms of material use, triple-glazing requires 50% more glass (unless the third layer is a plastic film). Vinyl frames present certain environmental concerns while wood frames should be from sustainable harvested forests to lower impacts.

Life Cycle Thinking—Glazing

- Energy consumption (especially non-renewable, fossil fuel energy): Use of materials salvaged from waste products are perceived as more environmentally sound choices. The glass industry has developed its post-industrial and post-consumer waste management to a high level, minimizing virgin material use. The glass manufacturing and coating process uses high levels of energy to heat and process raw materials, including metals, heavy metals, and silica. Glass is relatively heavy to ship and requires significant amounts of packaging, increasing energy required for transportation.
- Pollutants generated in production: Toxins are produced from the distillation of heavy metals and chemicals used in the bonding process for some glass coatings. Mono- and diorganotins, deposited by chemical vapor deposition (CVD), are used in the manufacture of Low E glass and have been linked to some of the toxic issues related to pesticide and biocides. Films are petroleum-based and generate air and water pollution in their production, and contain many of the same metals and chemicals as hard or sputter glass coatings.
- Potential for out-gassing in the building: Glass and coated glass products do not off-gas in the building.
- Durability of the product: There are no significant differences in durability of coatings. Argon gas can escape over time but this does not significantly degrade window performance. Some insulating glass units remain sealed longer than others. Rely on warrantee information to ensure long term performance.
- Potential for future recycling: Glass coatings make recycling more difficult, as coatings reduce the ability of glass to ‘fuse’ again into another usable product.

Life Cycle Thinking—Frame

- Energy consumption (especially non-renewable, fossil fuel energy): Wood frame materials use the least energy of the four major types of framing materials (wood, aluminum, PVC, and vinyl-clad wood) throughout their entire life cycle, with aluminum and vinyl-clad wood using the most.
- Pollutants generated in production: The extraction of aluminum-bearing ores and petroleum for PVC products, along with the processing for production, create air and water pollutants, some of which we are only now beginning to understand (i.e. dioxins during the PVC production process, as well as after disposal.)
- Potential for out-gassing in the building: The exterior components of the framing system do not affect indoor air quality. Some products have different interior finishes (i.e. wood frames with vinyl cladding on the exterior and exposed wood interiors) available, but, in general, wood products need to be finished with low- or no-VOC finishes to prevent offgassing of formaldehyde. Vinyl-clad and PVC frames on the interior will offgas over time, including small amounts of vinyl chloride, a known carcinogen in humans.
- Durability of the product: Vinyl, especially when colored, tends to turn brittle and discolor over time (5-10 years in some cases). Aluminum, if coated with high-grade finishes, will not discolor
- Potential for future recycling: Wood can be downcycled into composite or engineered wood products; this is a technology and service generally provided through waste management services. Aluminum can be continually recycled, even if coated. PVC, on the other hand, does not have a consistent recycling system in place anywhere in the country and, therefore, ends up in landfills 98% of the time. Because PVC products contain so many additives to enhance performance, they are generally difficult to recycle.