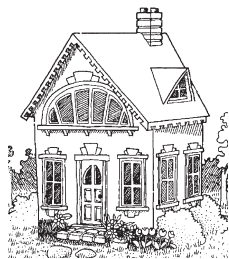


Home Energy Brief



#2 WINDOWS

Windows are typically the weakest link in a building's thermal barrier. In cold climates, they're responsible for 10–25% of a home's winter heat loss, or \$50–125 on an average annual heating bill. In warmer climates, excess solar radiation entering through windows can boost air-conditioning bills by a similar amount.

Replacing windows is a costly proposition, but there are many other low- and high-tech ways to improve the performance of existing windows. The first section of this brief highlights the most cost-effective measures for minimizing energy loss through windows. For those doing a major remodel or building a new home, the second section gives an introduction to high-performance window technologies.

With windows, as with all household energy-saving measures, a good rule of thumb is to start with the jobs that cost the least and yield the greatest savings. A common-sense combination of three or four techniques should result not only in substantial savings on your heating/cooling bill, but also in enhanced comfort: cold drafts will be minimized, the temperature of

your house will remain more constant, and areas near windows will become more habitable.

RETROFITTING EXISTING WINDOWS

Nearly half of all residential windows in place are single-pane, which do little more than prevent the wind from blowing through homes. Even double-pane windows (which many local building departments now require in all new construction) can be made more effective using the following techniques.

Cold-Weather Solutions

- The cheapest way to reduce heat loss is to stop the wind from blowing in your windows. **Caulk** around the edges of drafty frames and reputty loose panes; install weatherstripping around windows that are opened often, and use rope caulk (putty-like material that comes pre-formed in strips or coils) to seal windows that will remain shut for the winter.
- The next best option after caulking is to install temporary **plastic barriers** to create an extra insu-

WINDOW PERFORMANCE

Heat is lost through windows by direct conduction through the glass and frame, by air leakage through and around the window assembly, and by the radiation of heat by room-temperature objects such as people and furniture. (In hot weather, the same processes work in reverse, resulting in heat gain.) Conduction can be reduced by various means, including double-glazing and storm windows (which create dead-air space between the panes), curtains, and high-tech frame materials; caulk and putty help minimize leakage; and curtains, shades, and special light-filtering films cut down on radiation.

Windows are rated by either R-value (resistance to the flow of heat) or U-value (ability to transfer heat). The higher the R-value, the more energy-efficient the window. U-values are the reverse: the lower the number, the better. R-2 is the same as U-0.5, R-4 is the same as U-0.25, and so on.

Until recently, most windows were rated on their “center-of-glass” R- or U-value; such ratings ignore significant heat loss through the edge of the glass and the frame. A more useful measure is the “whole-unit” value. When comparing brands or window types, make sure they're rated in the same way.

lating dead-air space inside the window. Most hardware stores carry inexpensive kits consisting of heat-shrink clear plastic (you provide the heat with a hair dryer). Expect to pay about 20–40¢ per square foot—well worth it even for just one winter season, since such plastic barriers can cut the heat loss through single-pane windows by 25–40%.

- If you own **storm windows**, repair and weatherize them as you would regular windows. Storm windows are more expensive (\$7.50–\$12.50 per square foot of window area) than temporary barriers, but they have the advantages of permanence and better performance (up to 50% reduction in heat loss).
- Install tight-fitting **insulating shades**. These shades incorporate layers of insulating material, a radiant barrier, and a moisture-resistant layer to help prevent condensation. The whole unit rolls up during the day, and to reduce air flow should be sealed against the window frame at night.
- While conventional **curtains** are never as tight as shutters or insulating shades, you can use tightly fitting valances (wood or metal frames that go over the top of existing curtains) to keep air from circulating behind the curtains and creating a chill. During the day, be sure to open curtains on south-facing windows to let in heat and light.
- **Clean** solar-gain windows. Note also that remov-

ing outside screens for the winter on south windows can increase solar gain by up to 40%.

Warm-Weather Solutions

- Hang white **window shades** or **blinds**, which can reduce solar heat gain by 40–50%.
- Close south- and west-facing **curtains** during the day, and keep the windows closed.
- Install **awnings** on south-facing windows where there's no roof overhang to provide shade. Canvas awnings are more expensive than window shades, but they're more pleasing to the eye, they work better, and they don't obstruct your view.
- Alternatively, hang tightly-woven **insect screens** or **bamboo shades** outside windows during the summer. They'll reduce your view, but they'll stop 60–80% of the sun's heat from getting to the window.
- Plant **trees** or build a **trellis** to block out solar radiation. Deciduous (leaf-bearing) trees planted to the south, east, and west of your building provide valuable shade in the summer, then drop their leaves in the winter to allow half or more of the sun's heat to warm you on clear winter days.
- Apply **retrofit window films** (see below) to the inside of east-, south-, and west-facing windows and glass doors.

COST VS. R-VALUE FOR DIFFERENT WINDOW TYPES

(All are retail prices for 3x5-foot casement window)

	Whole unit R-value	Retail price	Cost per square foot
Single-pane, wood frame	1.1	\$190	\$13
Double-pane, wood frame	2.0	\$205	\$14
Double-pane low-e, wood frame	2.3	\$240	\$16
Double-pane low-e, gas fill, wood frame	2.6	\$240	\$16
Double-glass, plus suspended Heat Mirror	3.1	\$270	\$18
Triple-glass, two low-e coats, gas fill, vinyl frame*	4.5	\$225	\$15
Double-glass, plus two films, gas fill, wood frame	4.8	\$360	\$24

Adapted from Space Heating Technology Atlas (1993), E SOURCE, Boulder, CO.

Window prices vary greatly by manufacturer, frame type, and window type.

* New Viking Industries triple pane; only available in 13 western states as of November 1994.

HIGH-PERFORMANCE WINDOWS

An ordinary, well-sealed double-pane window has a whole-unit R-value of 2.0. Compare that with the high-performance windows that have become available in the past decade, which provide insulation of up to R-5 or more.

Unfortunately, while most high-performance windows cost only 20–50% more than standard double-pane units (see table), the payback period for such an upgrade in an existing house is typically 15–20 years. For most people, that's too long to be cost-effective. However, if you're planning to replace windows anyway, you'll recoup the extra cost of high-performance models in just a few years. In new construction, these windows can help pay for themselves further by reducing the size (and hence the cost) of heating and cooling systems required.

Low-Emissivity (Low-e) Coatings

Windows equipped with **low-emissivity (low-e)** coatings allow visible light through but selectively block infrared radiation (heat). That means heat has a much harder time escaping on cold days and entering on hot ones, boosting insulating efficiency.

Some manufacturers make windows “tuned” to hot or cold climates. The basic difference is that hot-climate windows block more solar radiation to reduce cooling costs, whereas cold-climate windows admit more solar radiation to lower heating costs.

Gas Fills

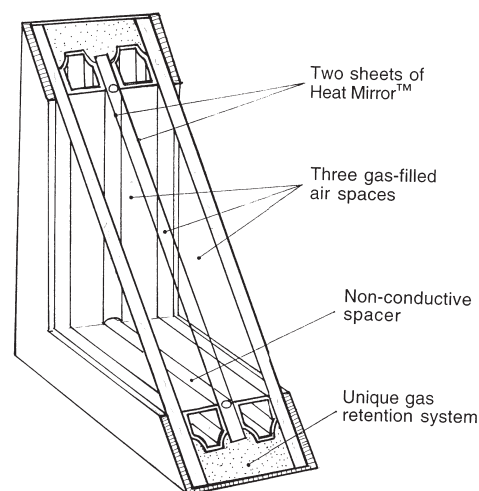
The insulating value of a low-e window can be improved by 15–20% with low-conductivity argon or krypton **gas** sealed inside the window instead of air. A number of manufacturers are now gas-filling many of their models. Though more expensive, krypton insulates better than argon, allowing the window assembly to be thinner.

Don't worry: these are inert gases that occur naturally in the atmosphere, and are harmless even if the window breaks.

Frames and Edge Seals

Now that glazings have advanced so much, reducing heat flow through **frames** has become more important. Good **edge seals** are also necessary to keep moisture out and gas fills in. All things being equal, a wood or vinyl frame will outperform a metal

one—however, the higher conductivity of the metal frame can be offset by a “thermal break” made of highly insulating material built into the seal and/or the glazing spacer to reduce heat loss. Also check a window's air tightness rating. Look for units with a rating no higher than 0.2 cfm/ft (cubic feet of air leakage per minute per foot of window edge). The best windows are lower than 0.1 cfm/ft.



Cross-section of a superwindow. Adapted from an illustration by Hurd Millwork.

Superwindows

State-of-the-art superinsulating windows, or **superwindows**, combine all the above advanced features (low-e coatings, gas fill, good edge seals, insulated frames, and airtight construction) and then go one better: The low-e coating is applied not to the glass but to one or two sheets of Southwall Corp.'s Heat Mirror™, a transparent polyester film suspended between the glass panes. The result is windows with whole-unit ratings of up to R-6 (whole unit)—about twice as efficient as the same thickness of fiber-glass.

Heat Mirror comes in different “flavors” to block out varying amounts of solar radiation. For example, Heat Mirror 66 is used for hot climates and blocks more infrared, while Heat Mirror 88 is designed to

allow more solar gain. Several manufacturers (such as Hurd, Pella, and Visionwall) use Heat Mirror to make their superwindows. Viking's new triple-pane window doesn't, but it has a whole-unit rating comparable to the best superwindows, and is priced competitively with regular low-e units.

Because of their extra cost, superwindows are most likely to be cost-effective in very cold climates. Superwindows generally don't earn their keep in hot climates, where you're better off buying less expensive low-e windows and using shading techniques.

Retrofit Window Films

Retrofit window films can be installed directly to an existing window to cut glare and block heat in hot, sunny situations (they are not typically used in cold climates). Most retrofit films need to be installed by a professional and are fairly expensive—ranging from \$1 to \$5 per square foot of window area—but they still cost far less than new windows. Most of these films are tinted, although Southwall's Heat Mirror XIR is essentially transparent.

RESOURCES

Information

American Architectural Manufacturers Association, 1540 E. Dundee Rd., Palatine, IL 60067 (708/202-1350). Publishes *Window Selection Guide* and *Windows: A Consumer Guide*.

Energy Efficiency & Renewable Energy Clearinghouse, PO Box 3048, Merrifield, VA, 22116 (800/523-2929). Free pamphlets on high-performance windows and retrofit options.

Iris Communications, Inc., 258 E. 10th Ave., Suite E, Eugene, OR 97401-3284 (800/346-0104). Has a 20-minute video, *Window Design Decisions*, for owner-builders, architects, and home-buyers (\$20).

National Fenestration Rating Council, 1300 Spring Street, Suite 126, Silver Spring, MD 20910 (301/589-6372).

For more on window technologies, insulating solutions, and related home-energy measures, see Rocky Mountain Institute's forthcoming *Homemade Money: How to Save Energy and Dollars in Your Home*. Other titles in this series of Home Energy Briefs include *Lighting*; *Water Heating*; *Refrigerators and Freezers*; *Cooking Appliances and Dishwashers*; *Washers, Dryers, and Miscellaneous Appliances*; and *Computers and Peripherals*. Written by Richard Heede, Maureen Cureton, and Dave Reed. © Rocky Mountain Institute 1995.

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Publishes a *Certified Product Directory* (available for \$10) and has a video for architects and builders.

National Wood Window and Door Association, 1400 East Touhy Avenue, Des Plaines, IL 60018 (708/299-5200). Publishes *A Guide to Energy-Saving Windows*.

Window Manufacturers

Look in the Yellow Pages under "Windows." It's best to order windows locally because they're heavy and fragile and don't ship well, and because local window representatives will know what type of window works best in your climate. Some names to look out for: Alenco, Anderson, Better-Bilt, Blomberg, Craftline, H Window, Hurd, Kolbe & Kolbe, Marvin, Milgard, Northwest, Peachtree, Pella, Pozzi, Viking, Visionwall, Weather Shield, and Winter Seal.

Glazing Manufacturers

The following companies, which together account for about 80% of the high-performance glass market, can provide consumer information packets.

Cardinal Insulated Glass, 12301 Whitewater Dr., Minnetonka, MN 55343 (612/935-1722).

Libby Owens Ford, 811 Madison Ave., Toledo, OH 43695 (419/247-4884).

PPG Industries, 1 PPG Place, Pittsburgh, PA 15272 (412/434-2858).

Other Manufacturers

Appropriate Technology Corporation, Box 975, Brattleboro, VT 05302 (800/257-4501). Manufactures insulated track-mounted window shades.

Courtaulds Performance Films, PO Box 5068, Martinsville, VA 24115 (800/345-6088). Makes retrofit window films.

3M, Woodbury, MN (800/364-3577). Makes tinted and air-gap window films.

Southwall, 1029 Corporation Way, Palo Alto, CA 94303 (800/365-8794). Manufacturer of Heat Mirror.