Potential of Energy Efficiency and Window Treatment for Energy Conservation

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Window treatment for energy conservation

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This Energy Note gives the non-technical reader a clear look at windows — how to get the most from them in cooling, heating, ventilating and illuminating the home. Although most of the points are applicable anywhere in the country, emphasis is on summer solar heat gain experienced in buildings in Florida.

Two common features of Southern building style are large window areas to let the light and breezes in, and shading devices or window films to keep the hot sunshine out. This energy note addresses design guidelines and strategies as well as shading devices and window films for existing windows.

In winter, windows should seal tightly and allow the sun to enter the building without glare but prevent heat loss to the outside. For the warmer seasons they should be operable to let breezes in; they should keep solar heat out while still allowing light to enter.

One window design for all seasons is not a practical expectation. Large windows for maximum view and solar illumination of the interior might be nice on a summer day, but so would small ones to minimize heat gain in a building. In winter, large well-insulated openings facing the sun can provide both illumination and direct solar heating with a minimum of glare. But at night these openings should be sealed and insulated tightly if they are to prevent heat escape.

The best window design will be a compromise combination of these competing features. It is possible to design a wonder window complete with continuously adjustable shutters or louvers, reflective films, exterior shading devices, and removable insulating plugs that would meet all the requirements. Such a window would save considerable energy and perform well. It would also cost a lot of money and demand maintenance.

Window design guidelines

Following are some Florida guidelines for optimum cooling, heating, ventilating and illumination:

1. To minimize infiltration energy losses in winter and summer, and to maximize ventilation control at other times, all windows should be openable, with easy-to-operate mechanisms for controlling airflow. When closed, they should seal tightly all the way around — a feature lacking in jalousie windows.
2. Double-pane windows with an insulating air space sealed tightly between the panes of glass or plastic resist conductive heat transfer. (In the relatively mild Florida climate, well-insulated and sealed single-pane windows are adequate if heating and air conditioning are seldom used.) Window frames should be made of poor heat conducting material such as wood or plastic. If made of metal (a good heat conductor) they should contain "thermal breaks," which are insulating sections built into the window frame to block heat conduction through it (Figure 1).

   When window shopping, always ask about frame design. Have the salesperson show you how the window minimizes conductive heat transfer. Make sure that the window seals tightly when closed.

   Sliding glass doors rival jalousies' inability to seal tightly, and they often lack thermal breaks. Furthermore, they are generally larger in area than windows, making double glazings more effective here.
3. Windows should be shaded from direct summer sun to minimize summer heat gain. Figure 2 shows that the sun is much higher overhead at noon in the summer than in the winter, also that it rises and sets north of east and north of west in summer, and south of east and south of west in winter. These sun paths are important in design and placement of windows and shading devices. More detailed charts showing solar positions at different times and how to use them are

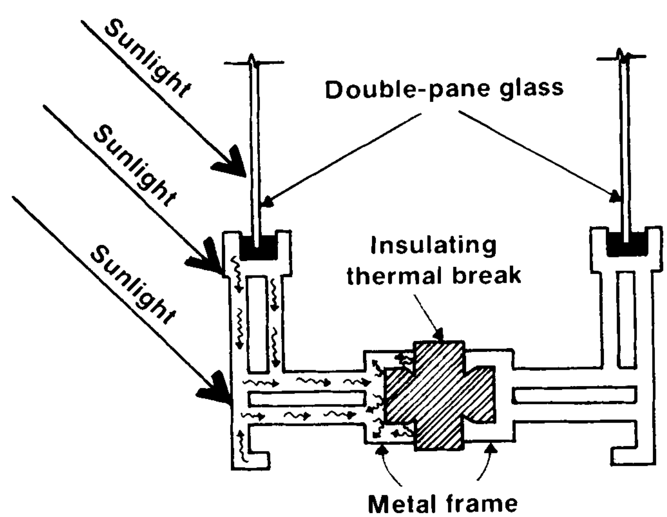

Figure 1. Window frame section showing thermal breaks

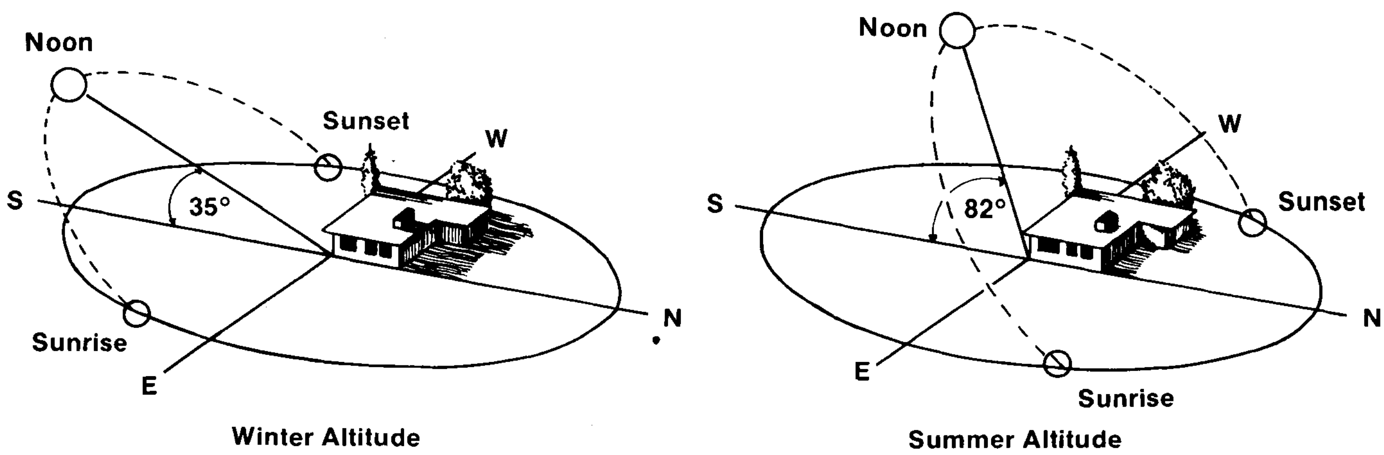

Figure 2. Sun path diagrams

available in FSEC's Design Note 4.

4. Use shades on east- and west-facing windows that will block early morning or late afternoon direct sunlight but that will let daylight in when the sun is on the other sid of the building or high overhead.

Window design strategies

1. A southern window exposure with proper roof overhang (Figure 3) provides shade from the hot midday summer sun but lets solar heat enter in winter. Information on roof overhangs is contained in FSEC Design Notes 1 and 2, by Philip W. Fairey. To minimize glare that can result when direct beam radiation enters a window, operable interior drapes and shutters can be effective.
2. A northern window exposure provides excellent and cool illumination. The small amounts of direct sunshine reaching these windows from early morning and late afternoon summer sun comes at such a low angle that very little heat enters the building. Northern window exposures are particularly suited to southern Florida's brief heating season and lengthy cooling season.
3. Windows facing east or west (or south without adequate roof overhangs) should be avoided or minimized. If this is not possible, they should have some exterior shading from trees, shrubs or trellis vines that tend to lose their leaves in winter, or from awnings or shutters. Place the shading device away from the window to let reflected daylight in but keep direct solar heat out.

Retrofit options

Much can be done to minimize energy costs when designing a building from scratch, but options for existing buildings are limited. The problem grows with windows and sliding glass doors that are poorly oriented or lack adequate overhangs.

Relace or repair poor energy-performing windows. Permanently closed windows should be replaced with operable ones. Jalousies should be replaced with better-sealing units. Think about double-pane windows if much glass area or space conditioning is used. Caulking can do wonders to stop air leaks through some window frame designs. Storm windows and doors also greatly increase efficient use of energy.

Although a shading device reflects a lot of sunshine, it also absorbs a lot of it and gets hot. A shading device's purpose is partially defeated if it is indoors.

Among the many types of exterior shading devices are louvered insect screens that allow a view of the outside yet block direct sunshine, and metal or canvas awnings (Figure 4). Some canvas awnings can be rolled up and down as required. Exterior shading vanes or permanently fixed louvers are common in the tropics.

Roll blinds of hollow or insulation-filled slat construction can have small slats to allow some filtered sunlight to enter the window. They are available in motorized or hand-operated models. (Figure 5.)

Window shutters abound — the Sarasota; the Bahama (or Bimini); the split, side-hinged type; and the side-sliding shutter (Figure 6) all can be effective in shading.

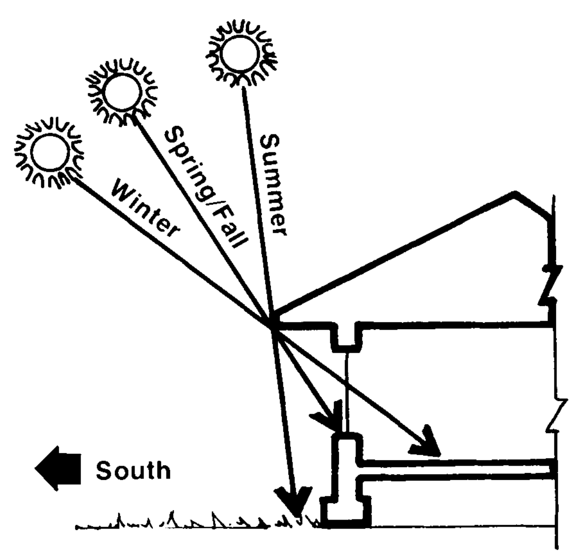

Figure 3. Seasonal shading performance of south-facing roof overhangs.

Window films

Exterior shading devices are preferable to window films (or coatings) for reducing heat gain because they prevent direct sunshine from reaching the window pane in the first place. A properly designed shade should be able to block all direct rays from the sun but still admit enough indirect and diffuse light for illumination. Film typically reduces more light than heat gain. Smaller windows might be preferable to film from a heat standpoint, but the cost of replacing windows in a building could be prohibitive.

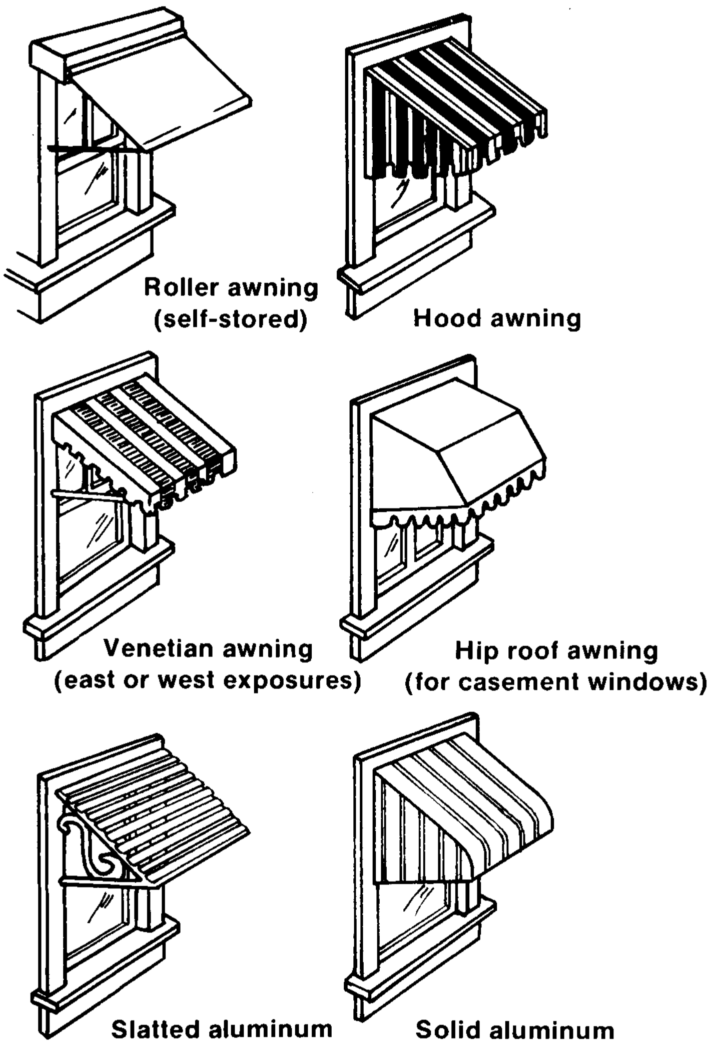

Figure 4. Types of awnings.

There may be times when window film is desirable for aesthetic, architectural or economic reasons. Slightly tinted window films can effectively reduce the glare resulting from excessive window brightness. (Properly designed exterior shades can accomplish the same purpose with better overall energy performance.) Most films are less expensive than many of the recommended exterior shading devices. A new type of spectrally-selective film is now available. It selects more of the sun's light and less of its heat for transmission. This new film transmits about as much light as it does heat, a substantial improvement over tinted films that transmit more heat than light.

It is difficult to find a direct-contact window film that can withstand being repeatedly taken off and put back on to suit the season, but a solution to the seasonal problem is now available from several manufacturers (Ref. 8). This product is a sort of interior storm window for use in warm climates. It seals tightly against the inside of the regular window, trapping an insulating "dead air" space in between. The summer version could be coated with a spectrally selective reflective material. The winter version should be highly transparent to admit maximum light and heat into the building but still provide the insulating advantage of a double-pane window. In the ventilating season, the interior storm window would be removed. These devices offer a very cost-effective alternative to replacing jalousies.

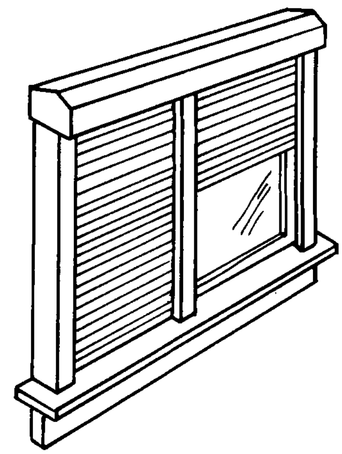

Figure 5. Exterior roll blind. Horizontal slats are encased in an edge frame. Blind rolls up into enclosure at top of window by motor or interior hand operation.

Research results

A study performed for Florida Power & Light Co. to assess the relative energy-saving capabilities of various shading strategies produced the results shown in Table 1. The table shows that exterior shades generally out perform window films, which also outperform lightly tinted glass in energy savings. The apparent good performance of shades on north-facing windows is due to the substantial quality of radiant heating which these windows can receive from clouds and sky. Shades on south-facing windows are less effective in north Florida because it has a longer winter season and the shades block winter heat gain. All of the listed shades can block nearly all solar radiation. In doing so they will block both view and illumination. If this forces use of interior electric lights for major portions of the day, the result can be an ***increase*** in energy use. Take care not to over shade.

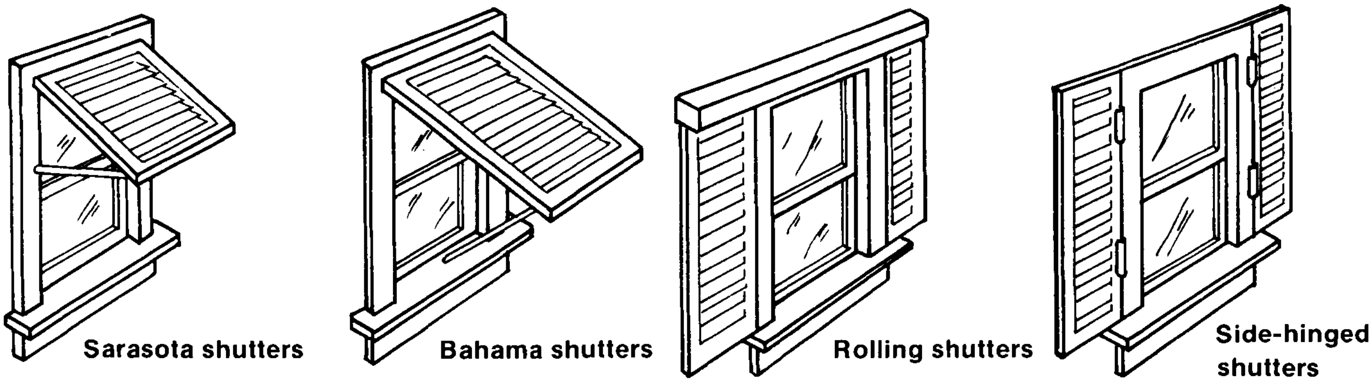

Figure 6. Types of shutters.

Summary

In general, exterior shading devices do the best job of protecting windows from direct sunshine. As an alternative, window films can reduce the summer air conditioning load. Reflective film is superior to absorptive, and the new spectrally-selective films are somewhat better than both of those. For the best energy control, film should be used only in the summer.

Film is somewhat more effective when applied to the outside of the window; however, exposure to the elements causes rapid deterioration. Interior installation, usually recommended by manufacturers, does not significantly affect the relative performance of reflective film.

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This document was promulgated at a cost of $204, or 13½¢ per copy, to inform the public about window treatment for energy conservation.

Table 1. Cooling season savings less heating season penalties in kWh/m²

Direction	Location	Plain glass	Tinted glass	Window film	Window shutters	Bahama shutters	Translucent canvas awnings with side walls	Metal awnings with side walls
N	NF	0	16.6	36.0	40.7	30.7	39.5	45.6
	CF	0	23.8	51.6	58.2	43.8	56.6	65.2
	SF	0	33.9	73.6	83.0	62.6	80.7	92.9
E	NF	0	15.7	34.2	38.5	44.3	42.0	48.2
	CF	0	27.5	59.9	67.6	68.3	71.9	82.6
	SF	0	48.3	104.9	118.3	109.5	122.8	141.1
S	NF	0	4.3	9.5	10.7	4.3	6.9	9.4
	CF	0	15.9	34.5	39.0	28.2	36.4	41.5
	SF	0	43.0	93.4	105.2	88.3	106.2	122.1
W	NF	0	24.6	53.5	60.3	60.0	63.8	73.3
	CF	0	35.5	71.3	87.0	82.9	90.9	104.5
	SF	0	50.2	109.1	122.9	110.7	126.5	145.5

Awning angle: 40° NF, CF, SF = North, Central, and South Florida.

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