Chapter 7

Energy-Efficient Windows and Doors

Recommendations	First Cost	% Potential Savings	
		Cooling	Heating
1. Minimize glass area.	R	5-10	5-10
2. Shade glass areas using porches, trees awnings, sunscreens, shutters, sun control films, interior shades or blinds.	S/M/H	5-15	—
3. Choose reduced transmittance glass products with low shading coefficients.	M	5-15	—
4. Base glass and shading choices in large part on compass orientation.	N	0-10	—
5. Choose windows with low infiltration ratings and durable hardware. Choose well-weather-stripped doors.	N/S	5	5-10
6. Choose windows and doors with maximum *openable* area for improved ventilation (casements; awning type; pocket or swinging glass doors to porches).	S/M/H	5	—
7. Choose casement windows for rooms with only one outside wall to create a wingwall effect for improved ventilation.	M/H	0-5	—
8. Use screen doors for ventilation.	S	0-5	—
9. Consider using insulated glass.	M	0-5	15-20
Maximum Combined Total	H	30	30

Cost Codes:
R = reduced
N = negligible
S = small (<$0.25/ft² of floor area)
M = medium (>$0.25 and <$1.00/ft² of floor area)
H = high (>$1.00/ft² of floor area)

Marketing Energy-Efficient Windows and Doors

View, daylight, ventilation. These have been the functions of windows for centuries. But since the energy crisis, possibly no other house component has come under as much scrutiny. That is because the window is the weak link in the building envelope. It admits solar heat, tends to leak, and is a poor insulator relative to the rest of the building. More than one unhappy home owner call their windows "holes in the insulation."

But manufacturers are responding almost daily with new window products claiming greater energy efficiency. As a result, knowing what window features to look for can be confusing for the builder. This is particularly true in Florida because many of the energy-efficient features promoted by national window manufacturers save heating energy, but not necessarily cooling energy.

This chapter discusses windows and doors for Florida homes. After reading it you will know not only what to look for in currently available window products but also which features are desirable so that you can evaluate future products. Your knowledge of windows, as demonstrated in your homes, will be one of your best selling tools.

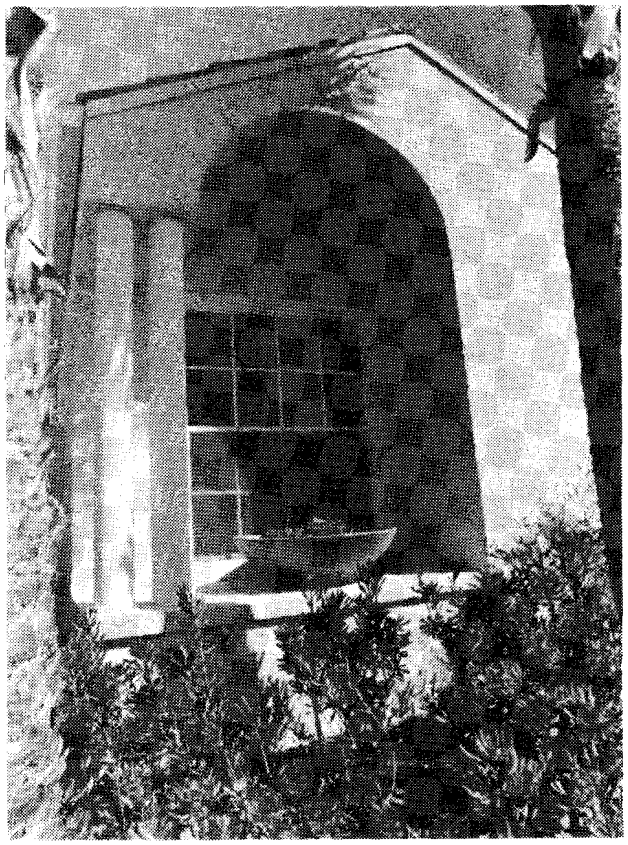
Keep in mind that there are four key items that can significantly affect the home owner's utility bills:

- solar heat passing through the glass
- air leakage through and around the window
- heat flow outward through the window in winter
- ventilation of the house.

Start by selling a potential buyer on your choice of home plans that have reduced glass area, emphasizing these advantages:

- less expensive to build and operate
- lower initial cost for air conditioner
- less of the sun's heat entering the house, therefore less air conditioning needed
- less heat escaping in winter
- greater thermal comfort for anyone sitting or standing near (smaller) windows, because of less radiant heat exchange between the glass and the person in winter or summer.

You can also point out other benefits of less window area. The home buyer will not have to spend as much on window coverings. The house will generally be quieter. It will be more secure with fewer or smaller points of entry.



Windows allow you to look out, and let in light and breezes. But windows are the weak link in the building envelope.

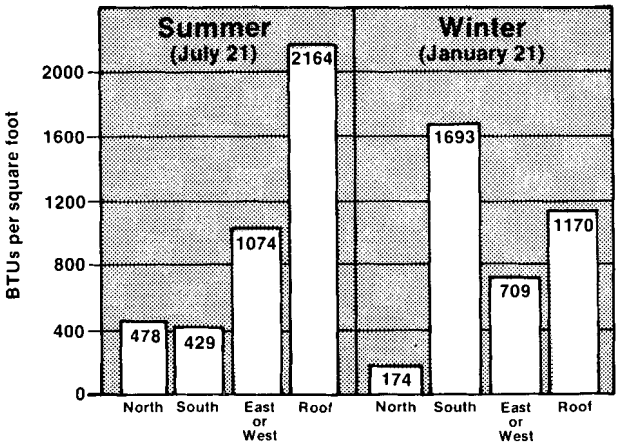
Regardless of all these benefits, many home buyers will want more glass for the sake of light and appearance. As an alternative to small windows and window areas, you can provide larger window areas that are well shaded. A big advantage to their use is that glare is much less of a potential problem than with small unshaded windows.

There are many methods of shading windows. When you select trees, awnings, sunscreens, reflective glass or interior blinds, you have something tangible and visible to sell. Show clients the shading device and explain that it will cut out unwanted heat from the sun. Mention that the sun's heat entering the house can account for about 20% to 30% of their air conditioning bill.

Explain that the south side receives less sun in summer and more in winter, so seasonal shading is ideal for south-facing windows. Indicate how you have taken special care to minimize eastwardly and

westwardly facing windows, which are difficult to shade, but have assured adequate shading for windows that do appear on those sides of the house. (Refer to Chapters 3 and 4 for more marketing suggestions.)

Daily Solar Heat Gain for 1/8" Single Glass



North- and south-facing glass is preferred to east, west, and roof (horizontal) facing glass.

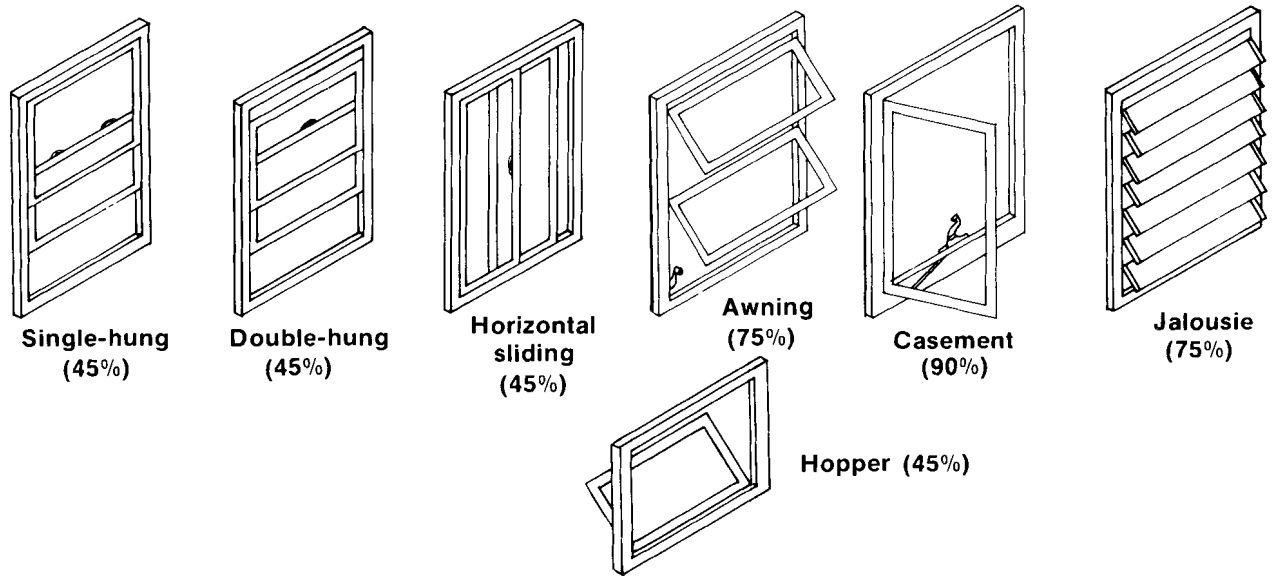
Explain to clients that cracks around windows and doors can cause a loss of up to 10% of their heated or cooled air. Show them the door weatherstripping and the caulking around the windows and glass doors. If you have chosen window products that are two, three or four times tighter than industry standards, with hardware guaranteed to be durable (10-year or lifetime guarantees), make sure to point that out. Potential home buyers who have lived in an apartment or house with poorly sealed windows will appreciate superior products.

Promote the ventilation aspects of awning and casement windows and pocketing or swinging glass doors by demonstrating how the entire windowed area opens to provide the greatest ventilation with the least amount of glass (see illustration below).

Consider selling screen doors as a ventilation-enhancing option, both for front doors and doors opening to the garage or other outside area. Many home owners add screen doors later, so why not show an appropriate one on your model?

Most home buyers recognize that insulated (double pane) glass is an energy saver, so merely pointing out that you have used it may be sufficient. Explain that in winter when it is 40°F outside and 70°F inside, a single layer of non-insulated glass isn't effective enough in deterring the escape of heat. Furthermore, anyone sitting or standing near glass will be far more comfortable if it is insulated. Also, insulated glass reduces moisture condensation and usually will reduce sound transmission as well.

If you have chosen insulated steel doors, promote them in a similar fashion.



Effective open area of various types of windows (percentages).

Selecting and Installing Energy-Efficient Windows and Doors

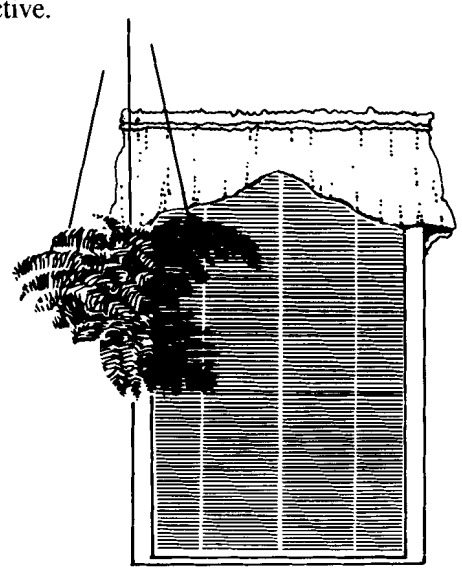
1. Reduced glass area

Your approach to reducing the amount of glass in the home is best begun at the time you select the house plan. Check the plans. Will smaller windows significantly affect the marketability of the house? Can an 8-foot-wide section of windows be replaced by a 6-foot section? Consult the architect or designer to explore the possibilities. In some situations, front doors with glass may be less desirable than solid doors. In other cases, larger glass areas can be tolerated for marketing and aesthetic reasons, without significant energy penalties, if they are oriented properly and shaded well.

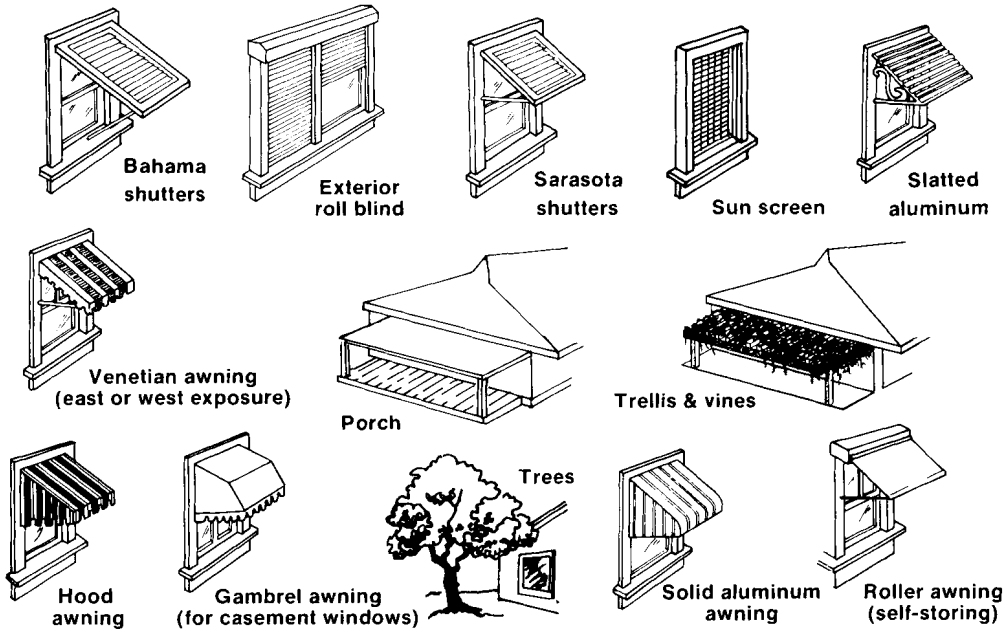
2. Shaded glass

Sun entering through windows in a home can account for 30% of the air conditioning load. Typically, residents use interior drapes or blinds to help reject the sun's heat, reducing the solar load to about 20% of the air conditioning load. You can take steps to reduce that even more. Choose Bahama shutters, awnings, trees, trellises, window films or sunscreens for exterior shading. Each of these is effective. Exterior shading is generally more effective than interior shading because the heat absorbed by the shade is dissipated outdoors rather than inside the house.

Although interior shading devices are subject to the control of the home owner and can be ineffective if not operated properly, most of them can be effective if designed and controlled correctly. Window coverings which have white (highly reflective) backs and are opaque (no light passing through) are most effective.



Vertical or horizontal blinds, white-backed draperies and shades are effective interior shading options.



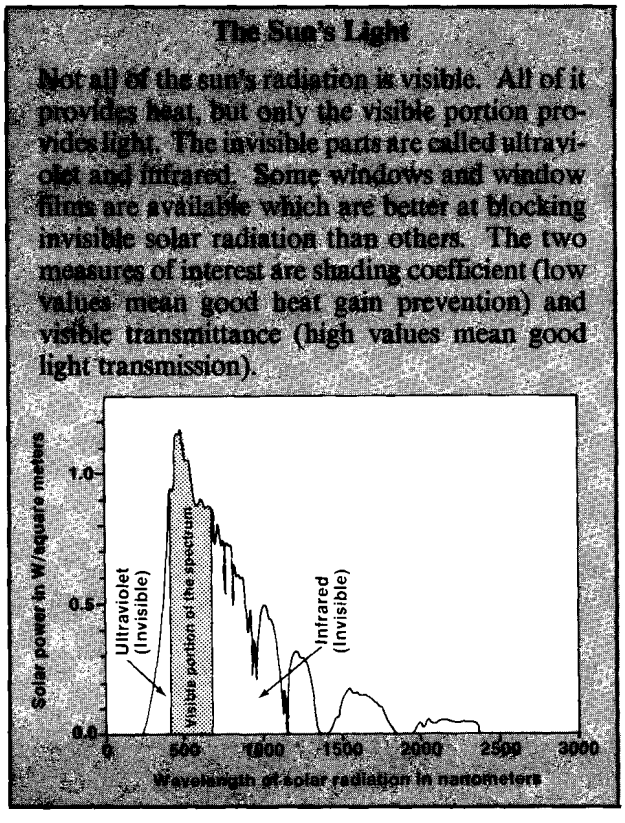
Exterior shading options.

3. Reduced-transmittance glass

Not all alternatives to clear glass are created equal. Some glass absorbs a lot of sun, and part of that absorbed heat reradiates into the house. Other kinds of glass are highly reflective and reject most radiant heat to the outside; others are only slightly reflective. Some appear almost clear; others look tinted.

There is a way to compare the available choices. Ask the dealer or manufacturer about two key measurable qualities: the "shading coefficient" and the "visible transmittance." A low shading coefficient is desired to block solar heat. A high visible transmittance is desirable for a clear appearance and letting light in (see box). However, if the exterior scene is composed of unshaded expanses of brightly reflecting surfaces (buildings, parking lots, or paved areas, etc.), the visible transmittance should be lowered somewhat to minimize glare. Values for certain glasses appear in the adjacent table.

If you cannot find a commercially available window with the combination of visible transmittance and shading coefficient you desire, a relatively low-cost alternative is to use clear glass with an applied plastic sun-control film having the desired characteristics. Inform the window supplier of your intentions. Some films have not worked well on certain windows, especially on insulated glass units.

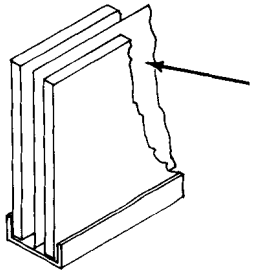


Shading Coefficient (SC)	=	**Total solar heat gain through window and shading device** / **Total solar heat gain through a single sheet of 1/8" glass**
% Visible Light Transmittance	=	**Amount of light that comes through window** / **Amount of light incident on window surface** **X 100**

Specifications of Various Window Glasses

Glass Type	% Visible (Daylight) Transmittance	Shading Coefficient	Winter R-Value
Single clear	90	1.00	.86
Single green	84-86	.85-.87	.86
Insulated clear	81	.89	1.72
Low-e clear insulated	76	.72	2-3
Insulated green	76-78	.71-.76	.76
Single bronze	69	.85	.86
Insulated bronze	62-67	.71-.78	1.72
Single plus control film	(10-90)	(.2-.9)	.86
Anderson Sun Glass, bronze	44	.38	3.13
Reflective bronze single	27	.51	.86
Reflective bronze insulated	25	.42	1.72
Heat Mirror*			
66/clear	55	.50	4.00
66/bronze	42	.41	4.00
44/clear	38	.35	4.20
44/bronze	22	.25	4.20

* See illustration below.

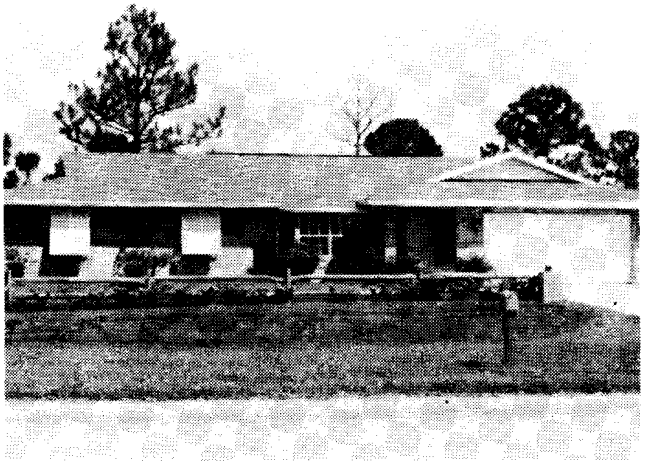


Heat mirror film is placed between two panes of glass.

4. Orientation

House design and site planning should place most or all glass areas on the north and south sides. Avoid easterly and westerly facing windows, or provide porches or other shading. If left unshaded, make certain to choose a glass or film with a low shading coefficient.

In North and Central Florida, select clear glass for south windows and shade them using seasonal methods such as deciduous trees (Chapter 3), overhangs (Chapter 4), retractable awnings, and interior white-backed blinds or shades. These permit winter sun to enter the room. White mini-blinds can reduce solar heat and still permit ventilation while maintaining privacy, making them a good choice for an energy-conserving window treatment. See Chapters 3 and 4 for more information on orientation.



Bahama shutters can be an effective shading strategy for east- or west-facing windows.

5. Tight-fitting windows, doors

You know that windows and doors should fit tightly to save energy. But how do you know if the products you are considering purchasing will be tight-fitting?

Windows are tested for air infiltration in accordance with the American Society for Testing and Manufacturing (ASTM) Test E-283. Product literature will sometimes list the results of the test. Request the results from your dealer or the manufacturer if you don't see them. The results will be expressed in cubic feet per minute per foot (cfm/ft) of sash for windows, and in cubic feet per minute per square foot (cfm/ft^2) of overall area for glass door units. The industry standard is a maximum of 0.375 cfm/ft for windows tested at 25 miles-per-hour wind speed. The standard for glass doors is 0.50 cfm/ft^2 of total glass area. Most windows and doors easily pass this test. Some windows have ratings as low as 0.02 cfm/ft. Use test data for comparisons. Make sure the tests were done at 25 mph or 1.56 pounds per square foot (psf), not 15 mph.

Be aware, however, that the window you obtain may or may not perform exactly like the tested unit, since the manufacturer usually selects the unit to be tested. Also, infiltration tests do not measure how well the window seal will hold up over the lifetime of the product.

Window seals vary not only between manufacturers, but certain types of windows have inherently better sealing capabilities. Casement and awning windows typically have low infiltration ratings (about 0.05 cfm/ft), while single-hung, double-hung and sliding windows typically have higher infiltration ratings

Example

Suppose you are building a 1500-square-foot house with about 224 square feet (15%) of window area: two glass doors make up 80 square feet and the remaining 144 square feet is in windows. Assume there are 12 windows, each 12 square feet. You're deciding whether to buy aluminum-clad wood casement windows approximately 2.4 feet wide by 5 feet high with an infiltration rating at 25 mph of 0.03 cfm/ft; or whether to buy aluminum-clad wood double-hung units 3 feet wide by 4 feet high with an infiltration rating at 25 mph of 0.24 cfm/ft. What is the total leakage of each window type at 25 mph?

Multiply the crack length by the infiltration rating by the number of windows to get total leakage:

Casements:

2.4 + 5.0 + 2.4 + 5.0 = 14.8 ft sash
14.8 ft/window x 0.03 cfm/ft x 12 windows
= 5.3 cfm

Double hung:

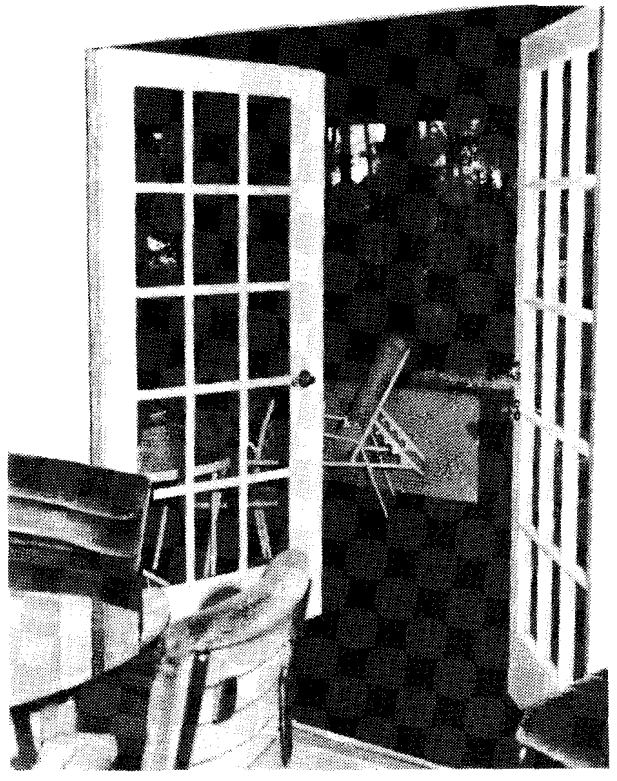
(3 + 2 + 3 + 2) x 2 (halves) = 20 ft sash
20 ft/window x 0.24 cfm/ft x 12 windows
= 56.7 cfm

The air leakage with the double-hung windows is, in this example, 10 times greater than with the casements. Use this formula to show clients how tight your windows are.

(0.15 to 0.30 cfm/ft). However, most of the crank operators on aluminum awning windows are not very durable — eventually leading to leaks. Most wood-frame casement and awning windows have compression seals and a separate hook-type lock in addition to the operating crank. They seal tightly when closed. Jalousie windows have severe problems with operator reliability and air leakage. They are not recommended for heated or air-conditioned buildings.

Installation. Proper installation of windows is important in preventing air leakage. Use spray insulation (foam caulk) around frame edges and caulk inside and out with a long-lasting material. Poor installation can defeat the quality built into a window unit. Window movement after installation can open up cracks. Air gaps around windows can short-circuit the tight seals provided in good windows.

Make sure you select doors that are well weatherstripped, and install them with a snug fit. When choosing glass doors, consider tight-fitting swinging doors instead of sliding doors, which frequently leak.



French doors are an efficient way to increase ventilation in a room.

6. Maximum ventilation openings

Swinging glass doors that open onto porches can provide greater ventilation than sliding glass doors. Consider a single 3-foot-wide swinging door (with or without French-style lights) instead of 5- or 6-foot sliding glass doors. Or consider a double-opening swinging door. Alternatively, select a sliding glass door that will pocket inside or just outside of a wall. Telescoping doors are also available and do not inhibit the placement of wall insulation.

Single-hung, double-hung and sliding windows provide an openable area that is less than half of the window area as shown in the adjacent illustration. Awning and casement windows provide 60% to 90% openable area.

A summary of the relative performance of window types (with single-hung the basis of comparison) is given below.

Outstanding, Good, Average, Below average, Poor

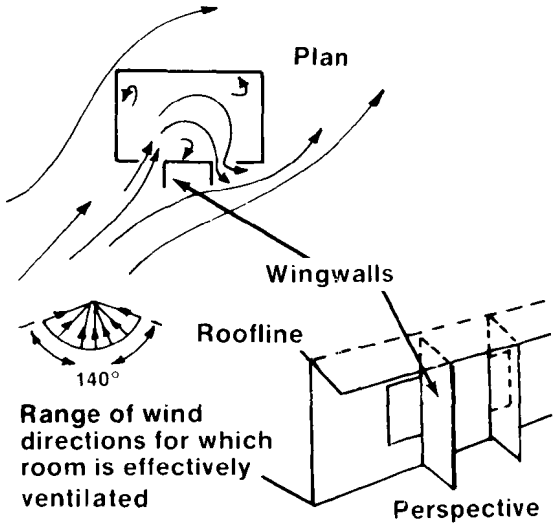
Window type	Ventilation	Infiltration	Egress [1]	Rain protection when open	View	Security
Casement	○	○[2]	○[3]	●	◐	◐
Awning	⊙	○[2]	●	○	◐	◐[2]
Aluminum awning	⊙	●[4]	●	○	◐	●[4]
Single hung	◐	◐	◐	◐	◐	◐
Double hung	◐	●	◐	⊙	◐	◐
Sliding /rolling	◐	●	◐	◐	◐	◐
Jalousie	⊙	●	●	○	●	●
Sliding door	◐	●	○	●	⊙	●
French door	◐	◐	○	●	⊙	●
Fixed glass	●	○	●	N.A.	○	○

[1] Window (not door) rating, based on minimizing glass area while providing egress in common sizes.
[2] Based on weatherstripped, locking models.
[3] Optional egress hardware may be required on smaller units.
[4] Typical aluminum awning window hardware.

Relative performance of window types.

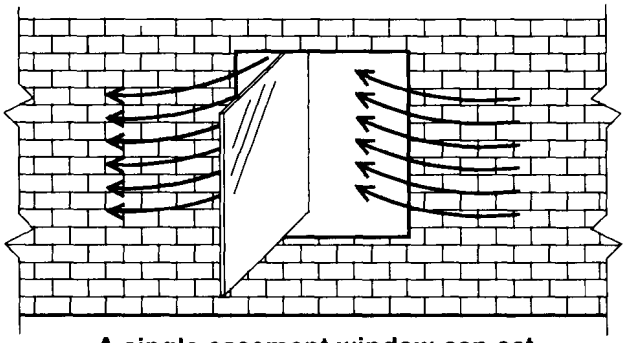
7. Casements as wingwalls

Rooms with windows on only one wall do not typically have cross-ventilation. One way to provide it is with two widely spaced windows, with short walls extending like wings from the wall adjacent to the windows. This creates positive and negative pressure zones, and breezes will be more likely to enter and leave the room. Look at the figure below and refer to Chapter 4 for more information on wingwalls.



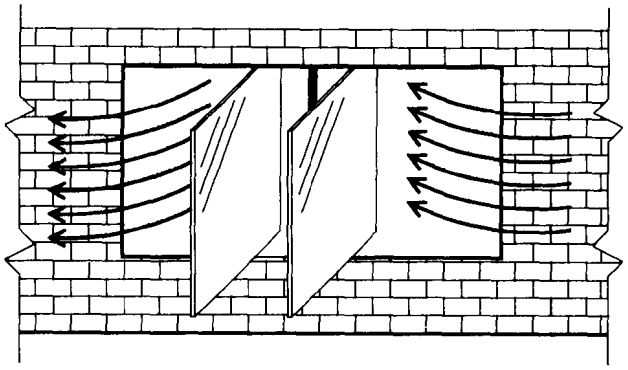
Wingwalls create inlets and outlets for ventilation of rooms with one outside wall.

A single casement window that is hinged so air can enter from each side can perform the same function as a wingwall. Note that most casement windows



A single casement window can act as a wingwall.

are hinged in this manner to permit cleaning of both sides of glass from inside the house. If two windows are used, whether together or apart, they should be hinged so they act as a wingwall. This hinging is different from most standard arrangements.



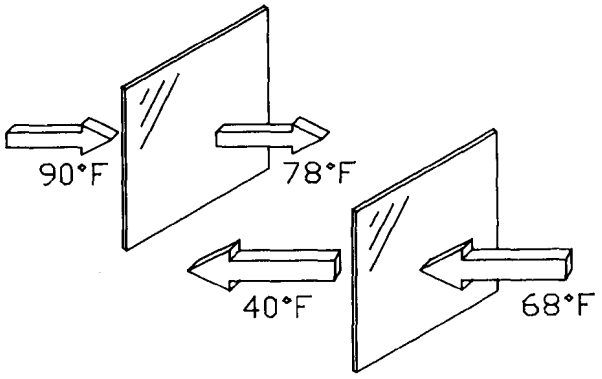
A double casement window hinged as shown can act as a wingwall.

8. Screen doors

A great method for increasing ventilation is through doorways. A solid opaque door blocks the daytime sun, but augmented with a screen door it can be opened to provide ventilation at night. For appearance's sake, wall pockets can be designed to conceal screen doors when they are not in use. If a double front door is used, use a double screen door. Use a screen door on the garage service door, too.

9. Insulated glass

Except for radiant heat from the sun, heat flows through a given type of glass at a rate directly related to the indoor-outdoor temperature difference. In hot climates like Florida, indoor and outdoor summer temperatures differ by 20°F at most. The average summer temperature difference over 24 hours is typically less than 10°F. Conduction through window glass is thus not a meaningful part of the cooling load. However, it is a concern in the heating season. The question is, how much extra can one justify paying for insulated glass? The answer is in the table on the next page.



Insulated glass is most important when temperature differences between outside and inside are high.

Annual Savings of Using Insulated Glass Instead of Single-pane Glass($/sq.ft)[1]

	South Florida	Central Florida	North Florida
Heat Pump (COP=2.0)[2]	0.15	0.15	0.20
Electric Resistance	0.15	0.20	0.25

To obtain a reasonable return on investment, how much more can a home owner justify paying for insulated glass than single pane glass ($/sq.ft)[3]

	South Florida	Central Florida	North Florida
Heat Pump(COP=2.0)	1.65	2.00	2.25
Electric Resistance	1.75	2.60	3.30

Annual Savings of Using Clear Low-e Windows Instead of Clear Insulated Windows ($/sq.ft)[4]

	South Florida	Central Florida	North Florida
Low-e surface 3	0	0.05	0.05
Low-e surface 2	0.15	0.15	0.15
Heat Mirror 88	0.20	0.20	0.20

To obtain a reasonable return on investment, how much more can a home owner justify paying for low-e window than clear insulated windows ($/sq.ft)[3]

	South Florida	Central Florida	North Florida
Low-e surface 3	0	0.55	0.75
Low-e surface 2	1.75	1.75	1.75
Heat Mirror 88	2.25	2.50	2.75

[1] Assume an air conditioner with SEER=8.0, electricity costs at 8.5 cents/kWh. All values based on 10% duct loss. All values rounded to nearest $0.05. Heating set point = 68°F, Cooling set point = 78°F.

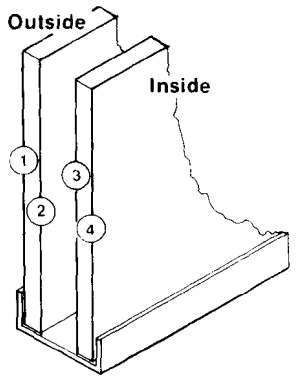
[2] Seasonally adjusted value. Equivalent of 2.5 to 3.0 COP units.

[3] Based on 10% internal rate of return on investment. Also assumes fuel prices increasing at 5% per year and a 20 year life for window products. All values rounded to nearest $0.05.

[4] Assume an air conditioner with SEER=8.0, electricity costs at 8.5 cents/kWh. Choice of heat type insignificant. All values rounded to nearest $0.05. Heating set point = 68°F, Cooling set point = 78°F.

Low-emissivity (low-e) insulated glass units have entered the market. These units have one surface with a special coating. The main effect of the coating is an increased resistance to heat flow. This product is ideal for the northern U.S., since it makes an insulated window unit that is the equivalent of a triple-pane unit. But again, how much more should you pay for such a unit in Florida?

If you are convinced that insulated glass is cost-effective, then examine the table above to see how much more you can justifiably pay for a clear, low-emissivity coating. The table lists values that depend on which surface has the low-e coating. Surface 2 is preferred for hot climates. Unfortunately, most manufacturers sell the unit with surface 3 as the low-e surface. Due to heating of the glass itself, this is less desirable than surface 2. Ask your supplier if you can order your windows with the low-e coating on surface 2.



The low-e coating in insulated units faces the airspace and absorbs heat. Having the coating on surface 2 rather than surface 3 more effectively block the sun's heat from the house.

The values given do not refer to low-transmittance glass choices, some of which use reflective glass or films in conjunction with a low-e surface. (See the section on low-transmittance glass in this chapter.)

Newcomers on the market are single-layer low-e glass and low-e window films. In general, they will perform nearly as well as insulated glass. Compare the additional cost with the justifiable costs in the insulated glass table.

Aside from energy savings, most insulated glass products offer greater noise control and improved thermal comfort to home occupants. They also reduce the number of times condensation will appear on the room side of the glass. That alone may make the difference worthwhile for some applications.

Summary

Minimizing unshaded glass is a principal requirement for an energy-efficient Florida house. The site planning and house plan selection should aim at providing windows oriented for summer shading. Shading can also be provided by awnings, shutters, sunscreens, window films and interior window coverings.

In selecting windows, you should generally choose glass with a low shading coefficient and high visible transmittance. Use insulated glass when its cost is justifiable. Use tight-fitting windows and doors with durable hardware.

Select floor plans that permit cross-ventilation, and then provide maximum open area with minimum glass. Consider swinging glass doors or pocketed sliding glass doors to porches, and casement windows for rooms with one outside wall. Use screened doors to provide excellent ventilation inlets and outlets.

For further information

"Window Treatment for Energy Conservation," W.R. McCluney, FSEC-EN-4-80, January 1985.

"Light Without Heat Gain - Glazing with a Difference," Bradley J. Davids, *Architectural Lighting,* June 1987.

"Windows for Hot Climates," R. Vieira, *Progressive Builder,* November 1986.

"A Buyer's Guide - High Performance Windows," *Practical Homeowner*, October 1987.

Solar Control and Shading Devices, Aladar Olgyay and Victor Olgyay, Princeton University Press, Princeton, NJ, 1957.

Architectural Aluminum Manufacturer's Association, 2700 River Road, Des Plaines, IL 60018, (312)699-7310.

National Wood Window & Door Association, 1400 East Touhy Ave., Suite G54, Des Plaines, IL 60018, (312)299-5200.

Vinyl Window & Door Institute, 355 Lexington Ave., New York, NY 10017, (212)370-9341.