Stop Housing's Biggest Energy Drain

Without doubt, windows and doors are the biggest source of energy loss in the typical house. Conversely, they offer the biggest opportunity to conserve energy. Double glazing, proper orientation, good screening, careful design—all can cut energy loss through these openings to a minimum and reduce operating costs substantially.

Windows and doors fall in the category of necessary evils in energy conservation. The holes in walls which they fill account for the loss of more energy than does any other section of a home. One recent report by the department of Housing and Urban Development (HUD) shows that almost 70 percent of a typical single-family unit's heating load is associated with windows and doors. The cooling load is increased 46 percent by windows and doors.

What causes this energy drain and, more important, how can it be reduced?

Hill

Rittelmann

There are three different ways energy is lost through and around windows and doors: (1) by infiltration, which consists of air leaking around the glass and frames; (2) by conduction, the passage of heat through glass; and (3) by radiation, the transmission of solar energy into a building. The amount of energy waste that can be attributed to each of these three sources depends upon a variety of factors, including window and door size, quality and placement.

For windows, every cubic foot per minute (cfm) of air infiltration robs about as much energy as one square foot of glass; and one cfm infiltrates for every three feet of edge of operable sash area. With a typical 3x5 foot, single-glazed, double-hung window, almost three times the energy would be lost *through* the glass as is lost *around* the sash area. This does not include the additional heat leaks that will take place if insulation is not properly installed in the cracks around the frame before the drywall is applied.

For doors, the heat loss *through* or *around* the door is approximately the same. In other words, the crack is costing the same amount of energy as is the whole surface of the door. Heat loss *around* a sliding glass door is almost three times as much per lineal foot as for a standard swinging door because of the mechanical construction of the frame. The loss *through* a sliding glass door is also substantially more than through a standard door due to the large expanse of glass.

Many steps that can cut window and door energy loss do not require large outlays of money. What is required is careful planning and attention to detail. Other energy conserving steps, such as the installation of insulating glass, screening devices, storm doors and windows cost more money, but are almost always justified by the amount of energy they save.

Cutting the loss by using glass wisely

The most obvious and, from an energy standpoint, the best way to cut losses associated with windows and doors is to reduce their area. Window area is especially critical for two reasons. First, windows usually take up more wall area than do doors. Second and more significant, they contain glass while standard doors have little, if any, glass.

But cutting window area by any substantial amount is not practical. As architect Alva Hill of Burt, Hill & Associates, puts it, "Aesthetics is a very powerful force. If you cut the glass area to a minimum you run the risk of losing the buyer."

Fortunately, energy conservation is not only dependent upon the amount of glass used, but on the way it is handled, according to P. Richard Rittelmann, a senior associate with Hill's Butler, Pa., based architectural firm. Rittelmann has been doing research on energy use in buildings for several years, and is considered a leading expert on solar energy. His advice: avoid single glazing.

A single pane of glass, Rittelmann told PB, is worse than no glass at all in a typical residential window, except for the fact that it blocks out the wind. Heat transfer or U value, of a single pane of glass is 1.13—more than "unity" (which has a U value of 1.00). A material having a U value of 1.00 conducts heat as though there were nothing there to block its path. The higher the U value the worse the insulating properties of a material. The 1.13 value of a single pane of glass is explained by the fact that glass not only conducts heat, but stores and reradiates some of the heat, adding to the original amount. By way of comparison, a reasonably well insulated wall has a U value of 0.10 to 0.15.

Interpreting these figures Rittelmann said, "One square foot of glass can lose as much heat as ten square feet of wall."

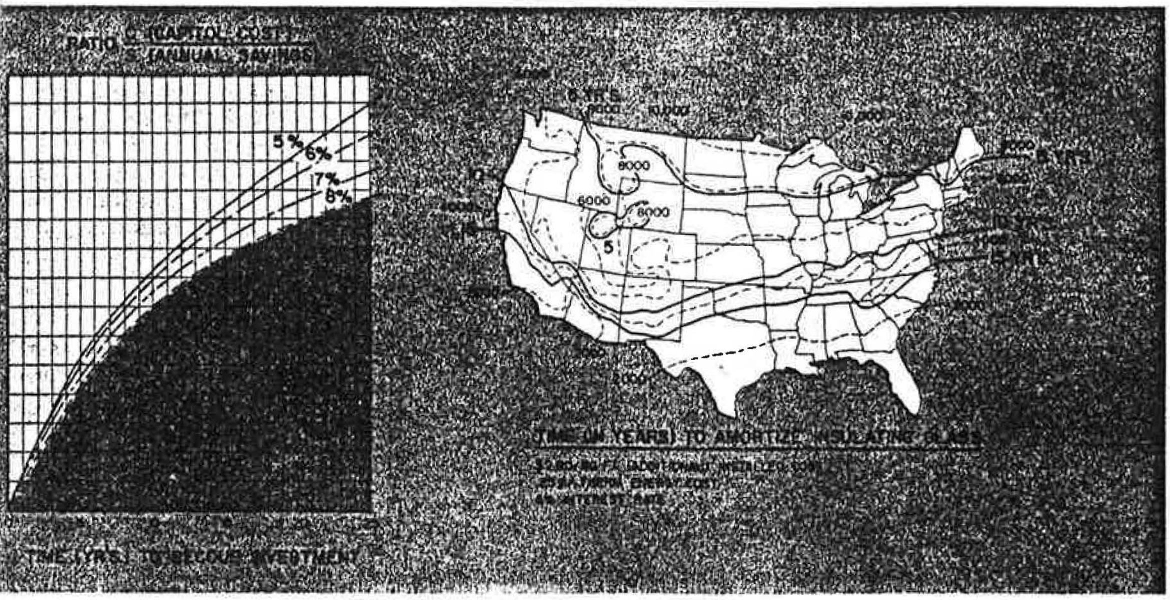
Insulating glass a bargain at $6 per square foot

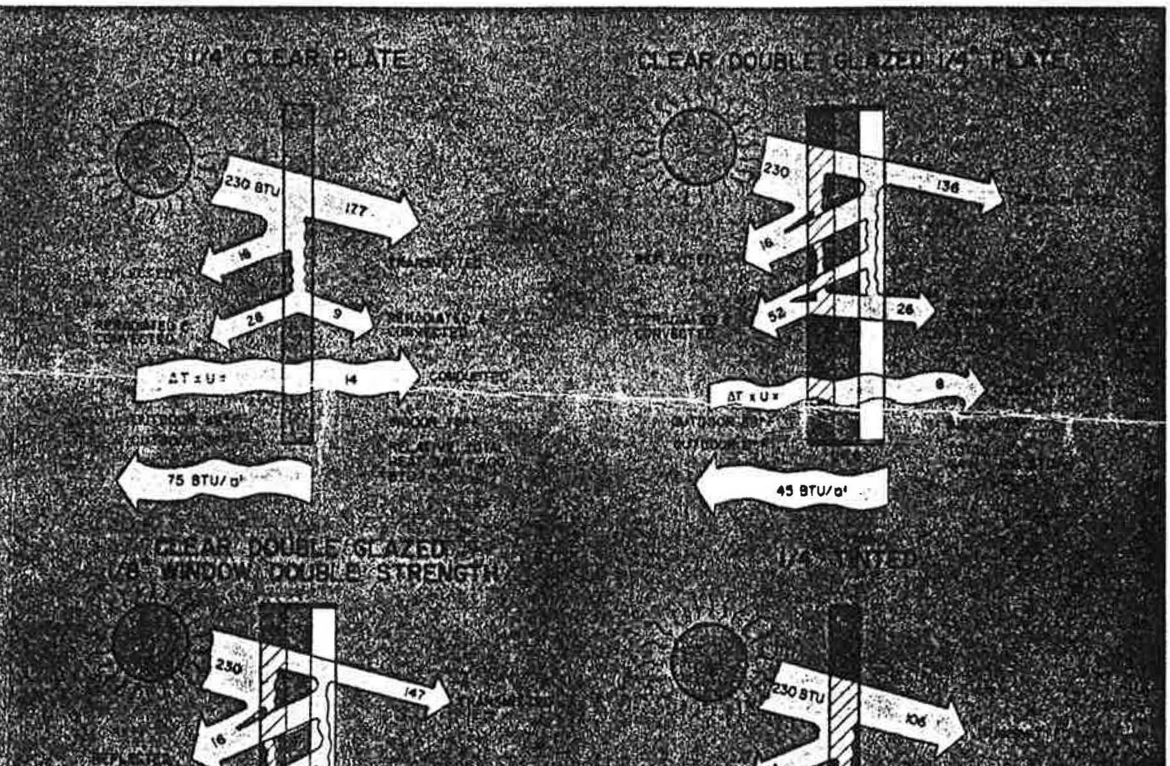
In most parts of the U.S. heat loss through windows in the winter presents more of an energy loss problem than does heat gain in the summer. This is because the amount of heat lost or gained through glass is highly dependent on the temperature difference between the inside and outside air. This difference is frequently greater during the winter in cold regions than it is during the summer in hot areas.

Insulating glass, being most effective in reducing temperature conduction, is therefore of greatest importance in colder or temperate climates where there is a large temperature differential between the outside and inside air. Tinted glass, on the other hand, is most effective in hot weather areas where more energy is expended to reduce heat gained through solar radiation or transmission.

Insulating glass, according to Rittelmann, also can save considerable amounts of energy in warmer climates. "I don't

s & Doors





Investment Return

The formula below, charts at left, were developed by Burt, Hill & Associates for PB. They offer a simple means to determine the value of energy saving investments—the time it will take, in short, to recover the initial expense of insulating glass, weatherstripping or storm windows through savings in operating costs.

First step in the system is to use the formula C/S, where:

C=cost per sq. ft. installed, and
S=annual energy savings.

Annual energy savings (S) is equal to a constant (see below) x the number of degree days x the fuel cost per therm. Constants are as follows:

For insulating glass—.00029
For weatherstripping— .00037
For storm windows—.00046

Next step is to plot the results of the formula on the interest rate graph at left.

For example, if storm windows cost $2.94/sq. ft. in an area of 5432 degree days (see dotted degree day lines on map), and energy in the area costs 25 cents/therm, then:

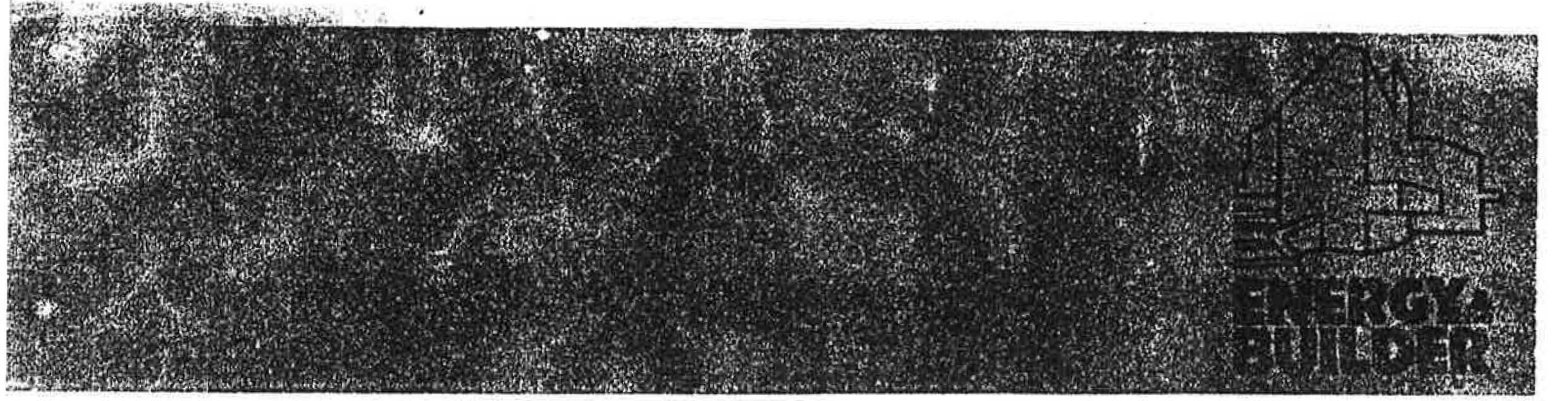
$$\frac{C}{S} = \frac{2.94}{.00046 \times 5432 \times .25} = 4.7$$

Next, find 4.7 on the side of the interest rate graph. Draw a line across to the curve representing the amount of interest paid for the storm windows. Finally, where these lines intersect, draw another line down to the bottom of the graph to read the number of years to recover first cost.

The return on investment time for insulating glass is indicated on a general area basis on the map at left by heavy black lines. Numbers alongside the lines give the number of years for investment recovery for the area below each line.

Thermal Qualities

Most of the heat loss through glass in the winter escapes via conduction. The use of double glazing is the best way to stem this leakage. First two drawings at bottom left show the amount of heat conducted outside during the winter (bottom arrow), as well as that which goes inside in hot weather. During the summer, the most substantial energy drain, as shown, is caused by heat transmitted indoors. Tinted glass is effective in reducing this gain.



think there is any question," he added, "that it would be worthwhile to install insulating glass in any part of the country. Normally it pays for itself in seven years, but now it will pay off even sooner due to the increased cost of energy."

Although costs vary from place to place and from window size to window size, $\frac{1}{4}$-inch clear plate glass, which would be used for large residential windows, costs about $2 per square foot. Insulated glass with a $\frac{1}{4}$-inch thick sheet of glass, a $\frac{1}{2}$-inch air space, and another $\frac{1}{4}$-inch glass sheet, can cost $6 per square foot. Insulated glass for smaller windows utilizing $\frac{1}{8}$-inch glass, $\frac{1}{4}$-inch air space, and $\frac{1}{8}$-inch glass, costs about $3 per square foot.

Standard sized storm windows, which have about the same insulating effect as insulating glass, can be purchased for $20 apiece. They have the added benefit of providing a second window frame, thus reducing infiltration and conduction. Storm windows or insulating glass also keeps the inside temperature of the glass surface warm in winter. This helps prevent ice formation on the inside of windows, which absorbs indoor body heat, reduces indoor humidity and causes maintenance problems.

Equally important as good glazing is the use of well fitted, high quality frames. Poor frames themselves can cause very substantial energy losses with accompanying ice formation.

To counter the poor thermal qualities of plain metal windows, manufacturers have developed frames and sashes with thermal breaks—i.e., vinyl or other low thermal conduction material separating the indoor and outdoor metal surfaces. A 3 ft. x 3 ft. horizontal sliding aluminum window, glazed with insulating glass has a list price of about $60. The same size window with a thermal break, or made of vinyl clad wood, lists for about $85.

A nickel every time you open the front door

Infiltration is the greatest energy loss factor associated with doors. The average infiltration loss around a closed, well-fitted and weatherstripped door is about 865 Btu's per hour. The loss doubles if there is no weatherstripping, and quadruples if the door is poorly fitted. Material used in the door, on the other hand, has little significance. A $1\frac{3}{4}$-inch solid wood door and an insulated metal-clad door have about the same thermal conduction qualities. Both conduct about 830 Btu's per hour.

The obvious conclusion: use quality, well-fitted doors with good weatherstripping. Storm doors also help greatly in cutting down both infiltration and conducted heat loss.

In addition, the manner in which doors (and windows) are incorporated into the design of a residential unit can make a great deal of difference in the amount of energy used.

With an outside temperature of zero and an inside temperature of 72, an average of 18,000 Btu's are lost for every minute an exterior door is open. At today's energy prices that comes to about five cents per minute—in effect, it costs a nickel every time you open the front door.

Such a loss can be reduced greatly by incorporating an air lock into the entrance door design. And, in fact, "The use of draft vestibules is starting to come back," Rittelmann said. "But to be effective from an energy conservation standpoint," he added, "a vestibule has to have two doors." A vestibule without two doors may increase the comfort of the residents by keeping cold drafts from entering the living area of a unit when the door is opened, but air still enters and has to be heated.

The orientation of doors is also a significant factor. Explained Rittelmann: "The southeast is the best exposure for doors. Winds swing seasonally and are strongest during the winter from the northwest. Facing a door toward the wind not only increases infiltration, but can cause maintenance problems as rain and snow are driven against it."

Orient the glass, and aim for the south

The orientation of glass areas, whether windows or sliding glass doors, is also important—at least as important as how much glass is used.

The prime rule: Do not orient too much glass east or west. "These are the most extreme conditions for solar gains," Rittelmann said. "Also, the prevailing winds are usually west to east and this aggravates the infiltration factor. South is the preferred exposure for glass in almost all parts of the country."

The reason for this is that during the summer when the air conditioner is being used the sun is at its highest elevation, so that with a reasonable amount of overhang you can shade the sun from the glass. In the winter, when it is desirable to have the sun shine into the house, the sun is low enough in the southern sky so that it can come in under the same overhang.

Keeping the majority of the glass to the south also makes it desirable to orient the living areas of a house in the same direction to take advantage of the feeling of openness given by the glass. The bedrooms, baths and storage areas then can be oriented to the north, since they can do with a minimum of fenestration and with a somewhat lower design temperature.

Of course, when building multi-family or single-family tract housing it can be extremely difficult if not impossible to properly orient every unit. But you can use extensive glass in east or west exposure, Rittelmann said, "if you do other things to protect the glass."

Creating the "green house" effect

Shading or screening is a very effective way to cut down on energy loss through glass, and external screening is far more beneficial than internal screening.

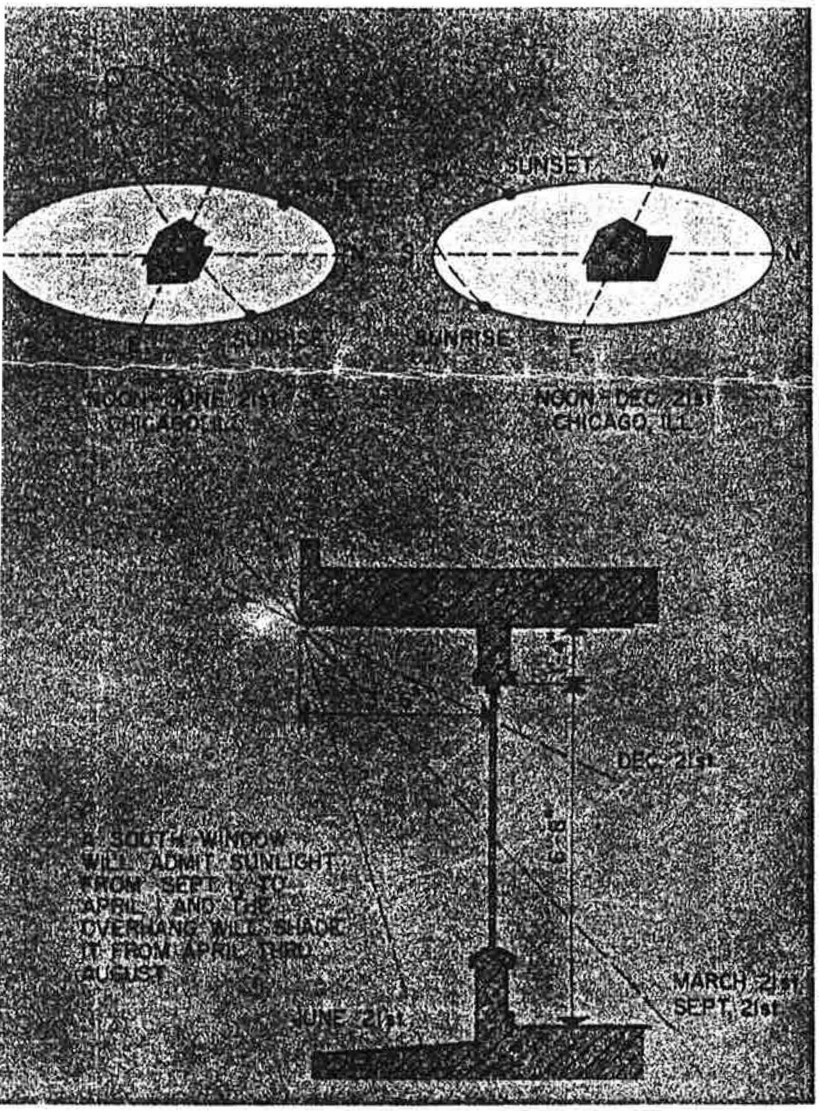
"Sunlight radiation comes indoors in very short wave lengths," Rittelmann explained. "When it passes through the glass and heats an object such as the back of a venetian blind, the blind reradiates long wave length radiation. Glass is transparent to short wave lengths, but is opaque to long wave lengths so once the heat enters the room it can't radiate out of the glass. Instead, it stays in the room. This is called the 'green house' effect. Solar collectors work on the same principle."

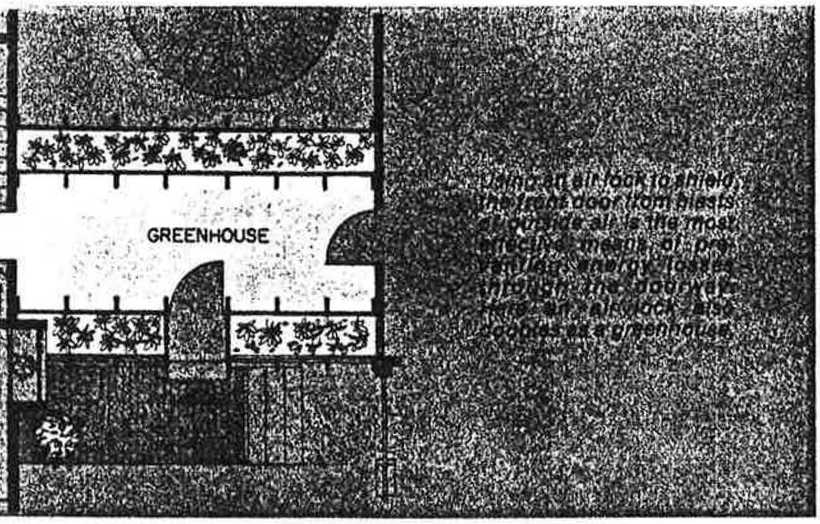
External shading devices also have the added potential of acting as wind screens, whereas internal shading devices cannot. One of the best methods of external shading is the use of trees. Architectural shading devices, such as awnings, louvered shutters or overhangs also can be employed.

As the drawings on the opposite page show, there are also some inexpensive things the builder can do on the *interior* side of windows to help prevent energy loss. An insulating door or partition, for example, can be used to cover large expanses of glass such as sliding glass doors. Glass enclosed window boxes could serve both as shelf space and insulators.

Screening, orientation, double glazing—all add up to energy savings for the home buyer or renter. For the builder with imagination and merchandising ability, they can add up to strong marketing pluses.

Windows & Doors



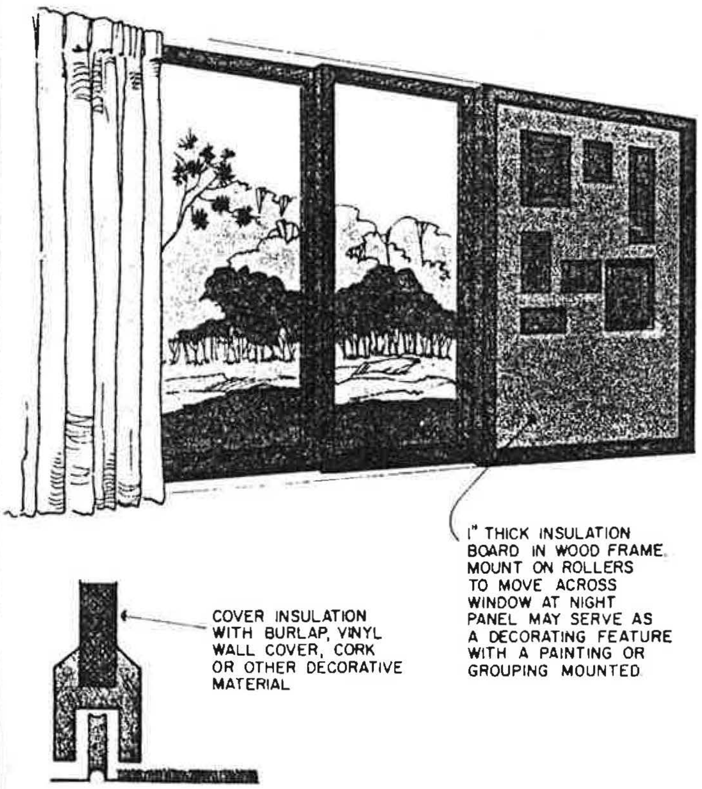


Follow The Sun

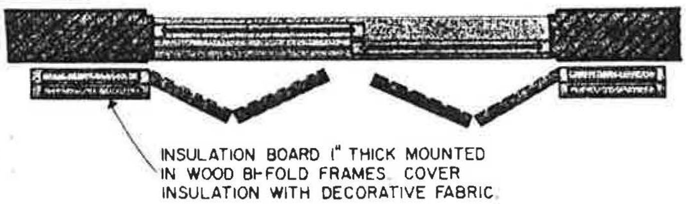
South is the preferred exposure for the glass areas of a house. Reason: This allows overhangs to keep the sun out during the summer when it is high in the sky, while admitting the sun's warmth during the winter when it is low in the southern sky.

Shading The Indoors

Either sliding or folding insulating panels can be added by the builder at little expense. They provide excellent screening for large glass areas such as sliding glass doors and effectively demonstrate a builder's concern for his buyer.



ROLLING INSULATION PANEL FOR SLIDING DOORS



INSULATED BI-FOLD SLIDING DOOR COVERS