Capturing Solar Heat
by
Retrofitting Existing Homes

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This guide is written for people who’d like to use the sun as an auxiliary source of energy for winter heating by taking advantage of the existing structural features of their dwellings and by simple modifications.

Just as the fuel companies are exploring now for new sources of oil and gas, so is the foresighted homeowner looking for new, reliable ways of keeping his home warm during the uncertainties of shortages and rising fuel costs.

Basics of Solar Heating

There are at least four fundamentals involved in the application of solar energy to heating:

- **Solar Radiation.** This energy, which we call sunshine—and which we can see and feel—travels through space from the sun and then, as solar radiation, passes through glass and other transparent materials with relatively small heat losses. (About 15 to 20 per cent is reflected and absorbed by a typical glass.)

- **Absorption and Conversion.** When solar radiation strikes a solid opaque material, some of the radiation may be reflected back and away from the surface, and some may be absorbed by the surface. This absorbed energy is immediately converted into heat; thus, a surface that is a good absorber will also be an efficient solar energy converter. An example of this is a surface painted flat black.

- **Trapping Solar Energy.** After solar radiation passes through a transparent material and is converted to heat energy by an absorbing surface, it is difficult for this heat energy to escape back through the transparent material. As a result, the solar radiation (energy) can enter a transparent enclosure much faster than it can escape as heat energy. The result is a gradual accumulation of heat energy and a rise in temperature of the enclosed space. This trapping of the sun’s energy is called the “Greenhouse Effect.”

- **Winter Sun Angles.** Figure 1 shows how the noontime sun angles change during the seasons in Central Missouri. It is important to observe that during the coldest months, November through January, the highest rays of the sun arrive at an angle of only about 30° above the south horizon. This means that these rays shine almost directly on south-facing vertical surfaces, a fortunate coincidence for solar heating during these colder months. South windows can therefore admit...
Fig. 2. South porch converted into a solar air heater

more solar energy during the coldest month when the heating effect is needed most.

Since the sun is so low in the southern sky during the cold months, most of the useful sun rays arrive between 9 a.m. and 3 p.m. During this period of the most intense solar rays, most of the solar radiation reaches the south surfaces of the home, with very little reaching the east and west walls.

Applying the Basics

* South-Facing Windows. Since the south walls receive most of the solar radiation, those who have large areas of south windows already know how effective these windows can be for winter heating by solar energy. If the south windows make up a large proportion of the south wall, it is not unusual for these windows to admit enough energy to comfortably heat the adjoining rooms throughout the sunlit hours of a cold winter day. All drapes and curtains should be pulled aside on the south windows during the sunny hours.

* Screened-In Porches. A south-facing porch or other screened area can be readily converted to a solarium and, if properly sealed against air leakage, will provide substantial amounts of warm air for the adjoining space in the house. If the original screen panels are removable, they can be replaced with glass panels during the winter months. A less expensive way is to make up wooden frames to replace the screened-in sections. These can be covered with transparent plastic film. An advantage of this method is that the frames can be removed and stored during the summer. Careful consideration should be given to protection against wind load and careful fitting of the frames to minimize cold air leakage.

Add-On (Retrofit) Solar Heating

The above methods of enclosing south areas with glass or plastic illustrate a basic principle of solar heating. These simple, affordable approaches essentially convert a part of the house into a solar air heater. To make the most effective use of these "air heaters," ports or vents should be built into the house wall so that solar heated air can move freely into the house and be replaced by cooler air from the house. Figure 2 illustrates the simple flow principles. The ports should be fitted with doors or covers which can be closed at night.

Corrugated fiberglass panels offer an easy method of enclosing spaces and provide an added feature of privacy. These panels are usually easier to install than glass and are less likely to be broken. Their disadvantage is that they are less transparent than glass and admit less solar energy; therefore, a translucent type should be chosen. Again, special attention should be given to sealing all the joints against air leakage.

* Areaways, Entryways, Etc. In many houses, there are open sections along the south walls with the open area toward the south. These openings are especially easy to enclose for solar heating if they are already covered by the roof or roof overhang. To adapt these, it is usually only a matter of providing panels of glass or plastic to cover the exposed, south-facing part of the area. For brick or stone houses, this may involve fitting and caulking-in a wooden frame to hold the glass or plastic panels. In general, the larger the area covered, the larger will be the amount of solar energy trapped in the space enclosed.

Fig. 3. The add-on greenhouse is an efficient air heater
The Greenhouse Is An Efficient Solar Collector

Many houses do not have areaways, alcoves, or porches on the south, but do have south walls. A lean-to greenhouse on the south, southeast, or southwest can furnish a major percentage of the winter heating requirements of a home. As described above, ports should connect through the house wall. With a thermostat controlled circulating fan, the warm air heating can be an automatic operation. Figure 3 shows a method of greenhouse solar heating which has proven successful.

Do-It-Yourself Solar Air Heaters

The most efficient way of solar heating is to use south-facing windows. In cases where it may not be convenient to add more south windows, the next best method is to add south-wall air heaters. These can be attractively arranged and installed along a south wall between existing windows. When carefully done all along the south wall, enough heat can be picked up to heat all the adjacent rooms of the house. Figures 4 and 5 show how this can be done.

These are a few types of solar air heaters available commercially. However, homeowners and builders with average skills will find that the air heater is no more than a glass-covered box with insulation in the back. There are several ways of absorbing the sun’s radiation inside the box. Figure 6 shows three different ways of arranging the interior section. All these can be built on-site.

It is especially important to note that the best location for solar air heaters is on a south wall, protected by overhang from the summer sun. They should not be designed to be added on to roofs. There are several good reasons for this:

- The south-wall air heater will last longer, since it is protected from summer overheating.
• It can be built of less expensive materials, since the overhang will protect it from the rain and hail.
• With the proper overhang, the air heater will be automatically controlled by the sun's angles. In winter, maximum heating will occur and in the summer it will be shaded.
• It is accessible for minor repairs and changes.

Conserving Heat Energy

Some homeowners may be surprised to find how many exterior walls and surfaces lack adequate insulation. The concerned owner should assume the responsibility of checking this for himself. He should start in the attic and see if the ceilings have insulation at least 9" to 10" thick. This can be either a poured-in or a bat-type of insulation. Check to see if all heating ducts are well insulated.

Identifying the type and thickness of wall insulation is more difficult. One method is to remove a switch plate or electrical outlet plate and look carefully around the metal box for the insulation.

Basement rooms used as living areas are sometimes poorly insulated. It is especially important that basement walls be insulated when the outside of the wall is above ground.

Windows are excellent for admitting solar energy, but are not good insulators against nighttime heat losses. Single-thickness glass windows without storm sash allow about 10 times as much heat loss as a well-insulated wall. So-called insulating glass (2 panes with air spaces) loses about one half as much heat as a single pane, but this is still about 5 times as much as the insulated wall loses. Homes with large floor-to-ceiling glass areas probably lose most of their heat through the window glass.

In the days of adequate fuel supplies, excessive heat losses through poorly insulated walls and large glass areas were “taken care of” by installing larger heating units and allowing homeowners to pay the higher heating bills.

Most of us are stuck with such places, and will have to make-do with our present house. Before any consideration is given to solar heating, the homeowner should see to it that the walls, ceilings, floors, basement, and all exposed surfaces are well-insulated. Assuming all this has been done, there will still be a major loss of heat through windows and doors for most homes.

Striking At The Root of the Problem

Conventional insulation procedures are prescriptive in form and attack the problem in bits and pieces. When the most careful homeowner or builder has conscientiously followed all the recommended steps, his home will still leak 30 to 40 percent of its expensive heat out the windows and doors, even though he has double-pane windows or storm windows and doors.

The prescriptive nature of conventional insulation procedures neglects the overall insulation effect. Ideally, the entire envelope (exposed surface area) of the structure should have the same insulation value on the per square foot basis. Very few homes have this feature. To achieve this, the windows and doors will need to have an insulation value as high as that of the walls and ceiling. Insulated doors are beginning to be manufactured. Insulation for windows is available in rigid panel form, but must be custom fitted in insulated shutter or door form.

Insulating Drapes

There are many ways of insulating windows. The most ineffective ways are with storm windows or conventional drapes. To effectively seal off glass areas from heat loss, it is necessary to stop both conduction and convection; that is, heat flow through the materials and heat carried away by air movement.

Drapes can be designed to insulate windows effectively. To do so, the material will have to be light and fluffy, at least 2 inches thick, and impervious to air flow through the material. In addition, both the edges and the bottom of the drape will have to fit tightly against the window frame, sealing off all air flow when the drapes are closed. This can be accomplished with "velcro" fastening strips or other mechanical means. Reference I illustrates how this can be done. Obviously, the bulk of such insulating drapes will require more space beside the window when the drapes are opened. On larger window areas, multi-layered, custom designed Roman drapes have proven effective both aesthetically and

Fig. 7. Insulated shutter cut to fit individual window opening
Insulated Shutters

A more direct remedy for the window heat loss is to fit rigid panel insulation over the window opening. This can be done on either the inside or the outside of the window, but is more convenient on the inside where the homeowner can open and close them. Figure 7 shows a very direct, simple way of insulating windows on a temporary basis. The 1-inch styrofoam insulation is available in 4 x 8 ft panels. Using a sharp kitchen knife and a straight edge, slices are cut to fit snugly against the window frame on all four sides. These panels are light in weight and can be set in place at night and removed at will. For windows (and doors) in unused rooms, this insulation can be left in place all winter.

Solar home builders are now using 2" x 6" and 2" x 8" walls for better insulation thickness. This allows space within the wall for insulated shutters to slide on either side of the window opening, as shown in Figure 8. There are other clever ways of mechanizing the shutter operation so that their closure on winter nights is convenient and can become a pleasant habit.

Putting It All Together

One of our greatest problems in educating the homeowner in the realities of solar heating is to rid him of the preconceived notions picked up from the popular media. Most of those notions are wrong. More energy can be saved in the average home by overall insulation techniques than can ever be saved by the most expensive addition of solar hardware. The two sections above which describe the thorough insulation of windows are the most important in this guide. INSULATE BEFORE YOU INSULATE.

The basic principle to be followed in solar heating homes, new or existing, is rather simple but not very well known. All buildings and homes are already partially solar heated at least 10 to 15 percent. The extent of this "free" solar heating depends on the season, the shape and orientation of the building, and the outside air temperature. Typically, on a sunlit day the inside temperature of a home will be 5 to 10 degrees above the outside air temperature without any furnace heat. This is a matter of scientific record.

Effective, affordable solar heating can be best accomplished by following this principle: Accent the desirable winter solar heating effects by considering the entire structure as a solar collector, modifying the surfaces intercepting the most winter sun. Conversely, achieve a cooler home in the summer by shading out and venting off the undesirable solar inputs and effects.

Recommended for further reading:
2. The Owner-built Home, Ken Kern, Charles Scribner & Sons N.Y., 1972