Passive Solar Energy for Homeowners
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PASSIVE SOLAR ENERGY FOR HOMEOWNERS

Passive solar space heating is a simple, efficient method for keeping properly built new homes comfortable and providing supplemental space heat for older homes. Of course, the thermal shell of the older home should be improved as much as possible (insulation, weatherstripping, and caulking, etc.) before solar additions are considered. Passive solar systems use no fossil fuel-driven devices to collect, store, and distribute solar energy. (Occasionally a small fan can be used to move solar heated air from one space to another.)

Collection of radiant energy takes place through a south-facing window. Orientation of the solar collector surface as much as 20 degrees either east or west of true south only reduces the solar gain by about five percent.

Storage of radiant energy is in some form of thermal mass (stone, concrete, brick, drum or tank of water) which should have a dark surface. The mass absorbs the radiant energy and holds it until the surrounding air temperature drops below the temperature in the thermal mass and then "releases" the heat into the surrounding air.

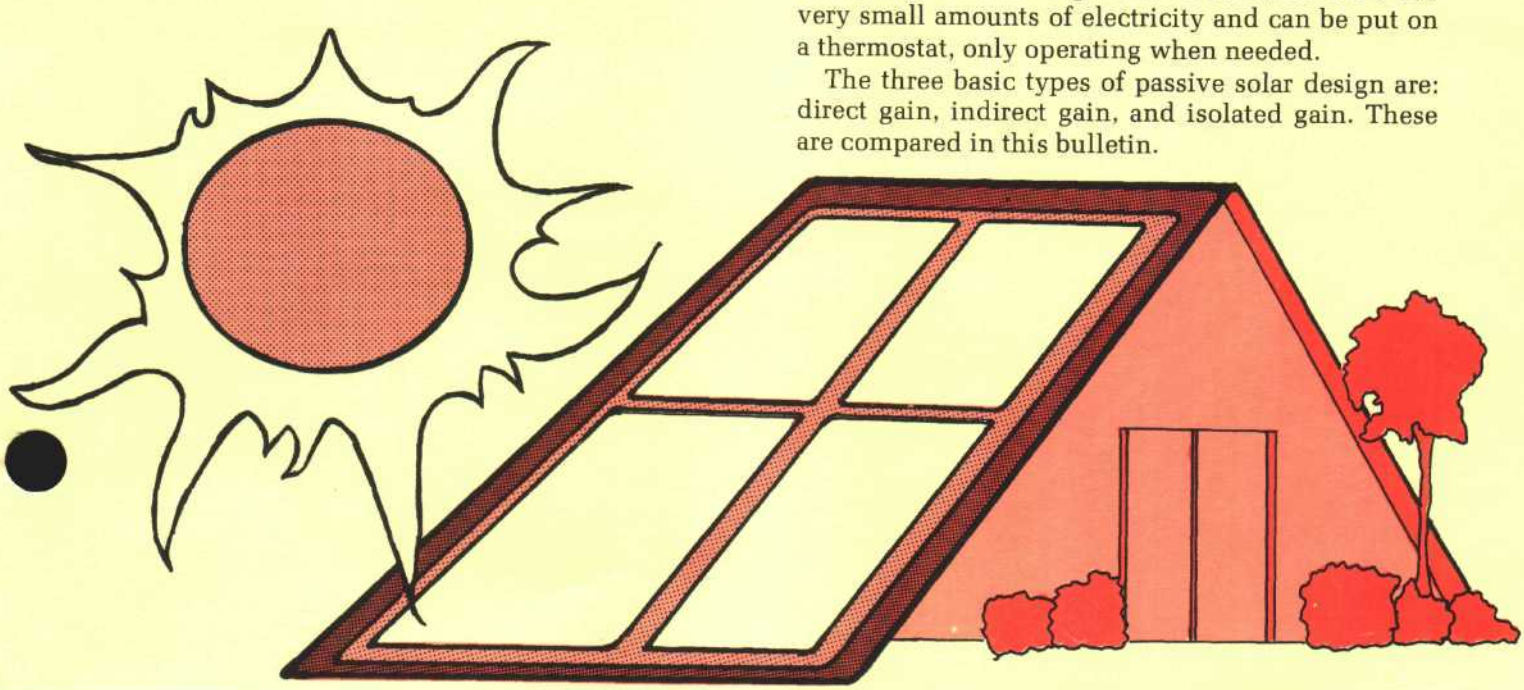
Distribution of radiant energy takes place naturally. Solar-heated air will rise into the upper reaches of a home. Therefore, heat distribution doesn't require the use of fans or ductwork. This phenomenon can also be of benefit in the summer when you are trying to exhaust summer heat build-up. Hot air, unfortunately, tends to remain in the upper portions of a room or a house unless it is forced back down.

In the summer you will want to open a window and exhaust rising hot air to the outdoors.

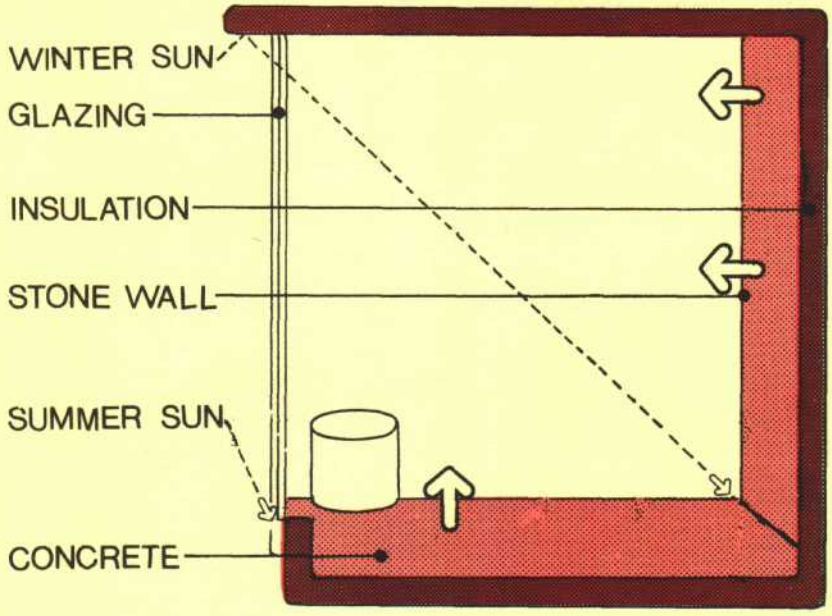
In the winter you will want to recirculate heated air to ground level to be used again. This can be accomplished in several ways. One of the most attractive solutions is a "Casablanca fan". If you have adequate clearance, (about 18 inches from the ceiling and 48 inches across would be maximum) these fans do an excellent job of forcing heated air down. You will want one that has both variable speed and reverse action.

Another solution is a return air duct which can gather heated air from the ceiling or second floor and pump it down to ground level. These units use very small amounts of electricity and can be put on a thermostat, only operating when needed.

The three basic types of passive solar design are: direct gain, indirect gain, and isolated gain. These are compared in this bulletin.



DIRECT GAIN LIVING AREA



In this drawing, the water tank, stone wall and concrete floor are all forms of thermal mass. All three could be used in new construction designed for passive solar energy.

The direct gain concept is the easiest and least costly to incorporate into a new structure. Direct gain means that the solar radiation is collected, stored and distributed within the living area itself.

The storage mass absorbs solar radiation during a winter day (because the sun is low in the sky) and then gives it off at night as space heat. The high summer sun can be blocked by an adequate overhang structure in which case the thermal storage acts as a cooling mass. **Moveable** shade devices are particularly effective for sun control in Michigan.

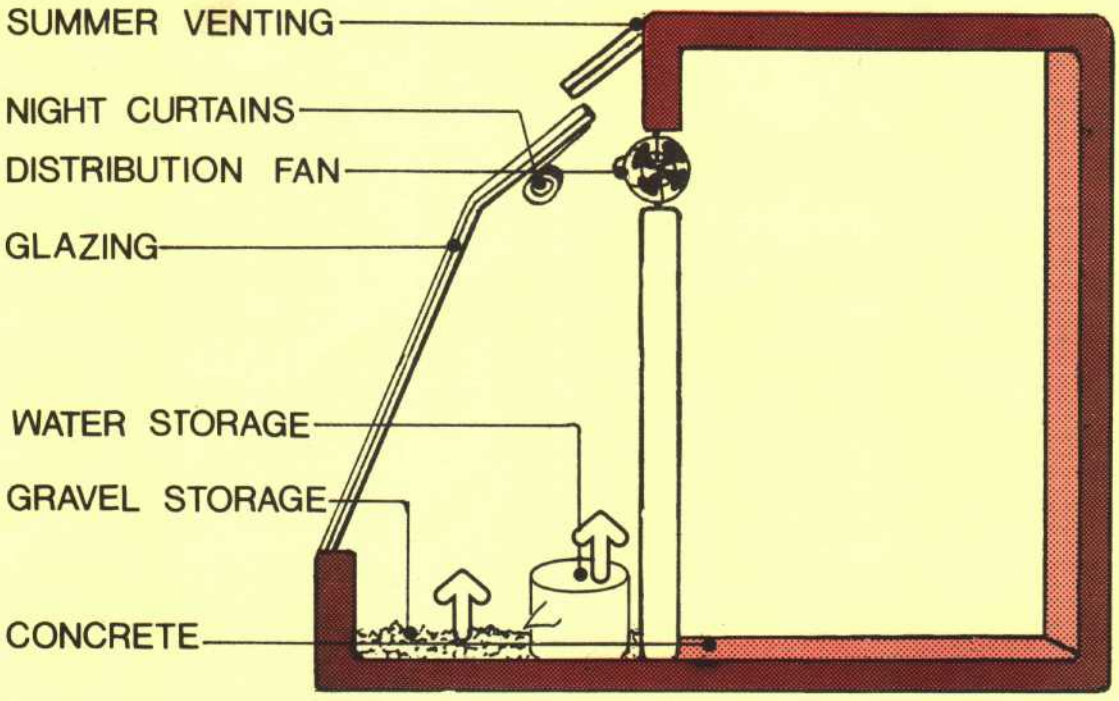
Pros

1. This is the least expensive system, since the parts can also function as structural components of the house.
2. Direct gain design does not obstruct views to the south or light transmission from the outside.

Cons

1. Carpet and furnishings can fade in direct sunlight.
2. Glare can be a problem.
3. Placement of cabinets and furniture is restricted by the need for exposed thermal mass (floors or walls).

ISOLATED GAIN AREA & LIVING SPACE



The **isolated gain** system provides for a thermally separated space to collect and store solar radiation which can then be distributed to the living area on demand. An example of an isolated gain design is a greenhouse or sunspace built as a lean-to on the south side of an existing house.

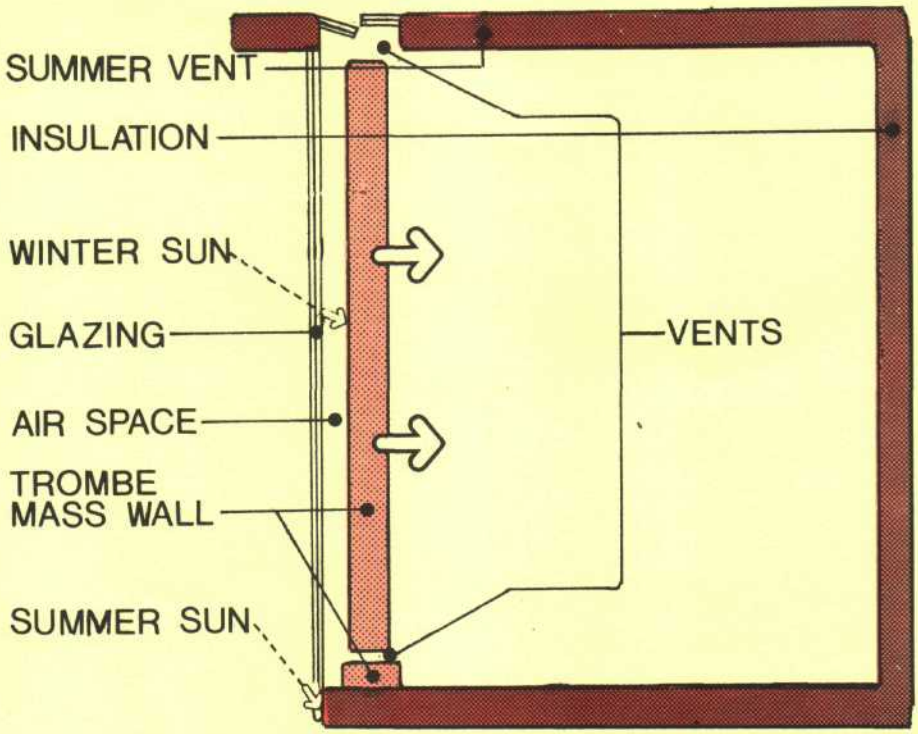
Pros

1. This **isolated gain** design is particularly appropriate for existing housing.
2. The sunspace can also act as extended living space or a place to grow food.
3. A sunspace can often enhance the outward appearance of an older home.

Cons

1. Since this system requires the addition of a complete structure (foundation, walls, roof, etc.) it can amount to quite an investment.
2. Sealing of all glass and wood joints can be difficult.

INDIRECT GAIN LIVING AREA



The **indirect gain** concept usually requires a double wall system. A mass wall of stone, concrete or water intercepts solar radiation entering through the south glazing.

Heat is collected in the space between the glazing and the mass "trombe" wall, absorbed by the dark surface of the wall and vented into the living space.

Pros

1. There is better control over higher temperatures.
2. Furnishings do not fade.
3. Furniture placement is easy.

Cons

1. View to the south is blocked.
2. Light source is restricted in winter.
3. Mass wall adds expense.

Special considerations for solar retrofits

1. In snow climates, the use of vertical south glazing is beneficial because of the added benefit of solar reflection off the snow surfaces.

2. Fixed overhangs can be a problem since they will provide the same amount of shading in September, when it's needed, as they do in March when it's not. Moveable awnings are a better choice.

3. Thermal control of south glazing **in all of the systems mentioned** is essential. This could be exterior insulated shutters or interior window quilts or shutters.

4. To avoid heat stratification in a passive solar design, a fan of some type will be needed to redistribute rising air to lower areas. On the other hand, heated air which accumulates at the top of a structure in the summer would be vented from that point.

Some numbers to remember

1. Ideally, the area of south glazing should be 40 percent of the building's heated floor area. This is rarely possible but can act as a goal.

2. The volume of storage mass per square foot of south glazing is: 5.4 gallons of water or 2 cubic feet of concrete.

3. The thickness range of mass walls as in a trombe wall scheme is 8 to 12 inches. This thickness allows the transfer of heat through the wall in one collection day. For floors, the optimal thickness is 4 to 8 inches.

These basic concepts and rules will help you design your passive solar system for many years of trouble-free solar heat.

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