Chapter 1

Why Passive?

Passive solar designs are simple. This simplicity means greater reliability, lower costs, and longer system lifetimes.

Since passive systems have few if any) moving parts, they perform effortlessly and quietly without mechanical or electrical assistance. Simplicity lowers the cost of the job. Without motorized dampers, automatic valves, sophisticated control systems, or high-tech components, much of the work can be done using standard building materials and basic construction skills.

The most significant reason that passive makes sense economically is that most passive designs are inherently durable, lasting at least as long as the rest of the house with little or no maintenance or repair. Conventional building materials such as glass, concrete, and brick weather well and are generally longlasting. For the life of the house, a passive system should continually maintain, if not improve, its value at least as well as the rest of the house. It should require little more maintenance than a standard wall or roof.

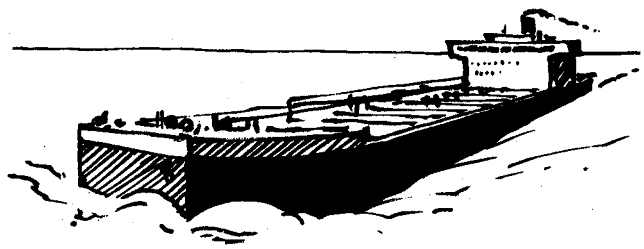
Because you can build passive designs in small sizes, the initial effort need not involve a large financial commitment. Instead, the first step can be relatively small with correspondingly little risk.

For optimum performance, some passive systems require daily or monthly adjustments of shades, shutters, or vents. Although some people may at first regard this as an imposition, it is really no more trouble than operating a dishwasher or closing draperies in the evening. Before long, passive-home residents will find these to be pleasant routines that bring them closer to the flux of the

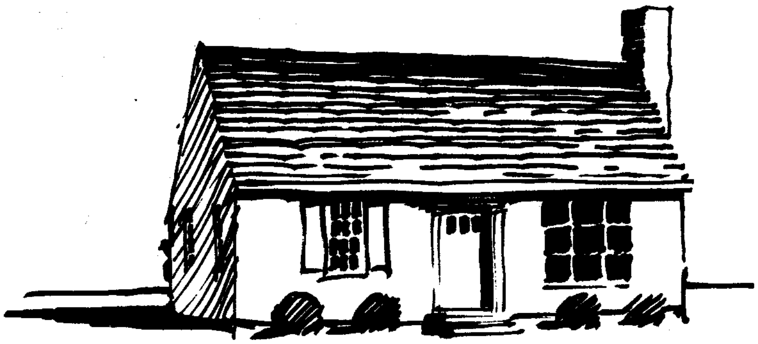
Is this really true or is it just a lot of passive sales talk?

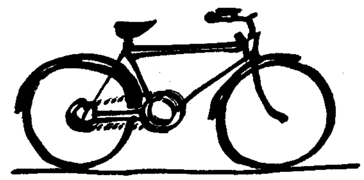
environment to which their homes are atuned. They are usually rewarded with a rich and exciting living . experience as a result of their efforts, while saving both energy and money.

Radiant heat from large passive collecting surfaces is usually more comfortable than the drafty heat of conventional hot air or hot water heating. In well-designed systems, temperature variations are small, generally within a range of 5° to 10º each day. But in less well designed houses, temperatures can vary more widely. Some solar enthusiasts feel such temperature fluctuations are natural, and not uncomfortable, particularly at the higher end. In fact, many passive home residents enjoy the warmer-than-usual temperatures on a sunny winter day.

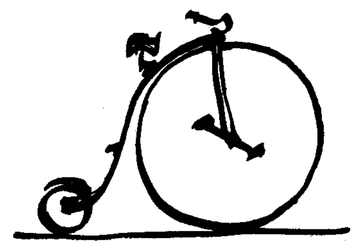


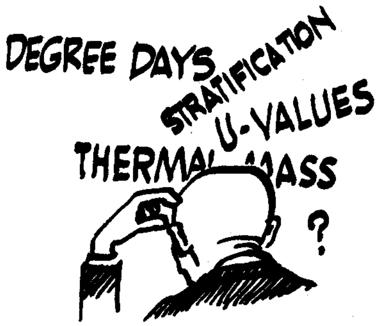
Passive solar systems save fossil fuels. The economy is benefitted because the nation imports less oil. And since passive energy systems do not require transmission lines, pipe lines, or strip mines, they produce neither dangerous radioactive wastes nor polluted air and water. Passive systems have few negative consequences. They can use renewable and recyclable materials, and they produce jobs.





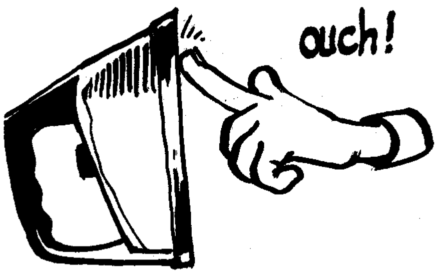
If a house has low heating or cooling requirements, and if a passive solar system is designed to provide only a small fraction of the energy, the system can be small and have only a slight effect on the overall appearance of a house. It need not make the house unattractive. In fact, properly designed passive houses can be more beautiful than conventional ones. Picture it-large expanses of south-facing glass overlooking your yard; a beautiful sunspace filled with plants year 'round. You can save energy, save money, and provide a better living environment, all at the same time! Comparing a good passive house to a conventional one is like comparing a modern, dependable lightweight bike to the high-wheeled terrors of the 1890s.





I Thought You Said It Was Simple

It is. Every material and principle incorporated into passive solar design is common and in everyday use. The melting of an ice cube or the ability of a stone to stay warm long after sunset-these are the kind of considerations on which all passive design is based. The only trick is to learn the labels so that it is easier to understand and discuss. Then you can say "thermal mass" instead of having to say (each time you discuss the phenomenon) "the ability of a stone to stay warm long after sunset."



Conduction

The transfer of heat between objects by direct contact.

Natural Convection

The movement of heat through the movement of air or water.

Thermal Radiation

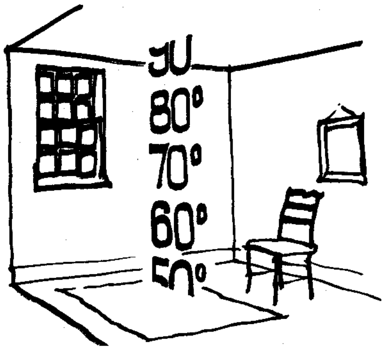
The transfer of heat between objects by electromagnetic radiation.

Mean Radiant Temperature

The average temperature you experience from the combination of all of the various surface temperatures in a room-walls, floors, ceilings, furniture and people.

Air Stratification

The tendency of heated air to rise and to arrange itself in layers with the warmest air at the top.

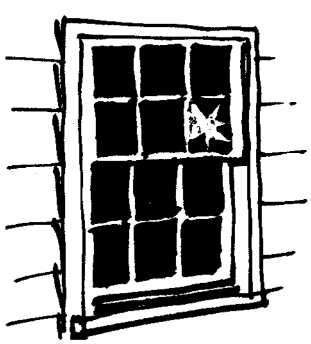


Degree day

A unit used to measure the intensity of winter. The more degree days there are in total for the season, the cooler the climate.

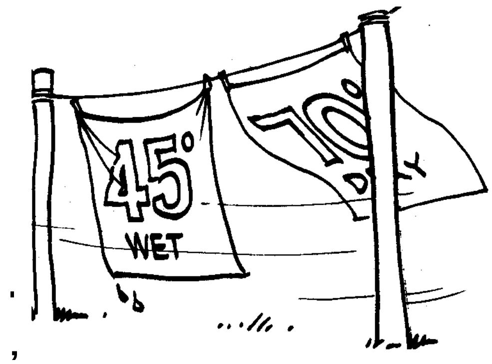
Windows

Windows let light (and heat) in and out).



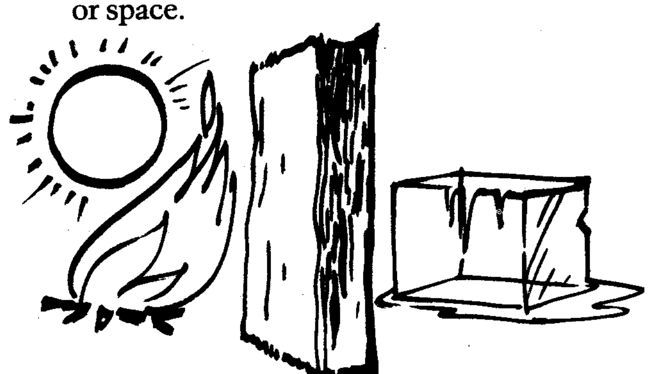
Evaporative Cooling

Natural cooling caused by water's ability to absorb heat as it vaporizes.



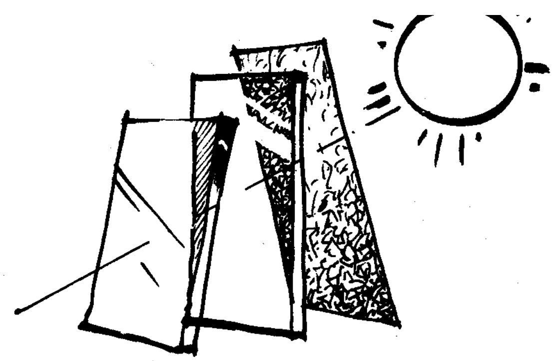
Insulation

Materials that conduct heat poorly and thereby reduce heat loss from an object or space.



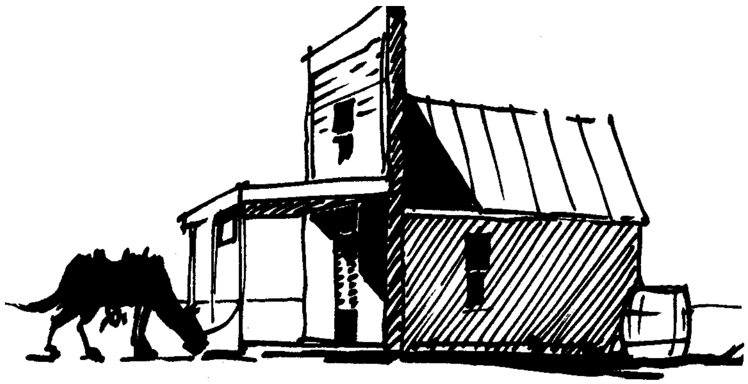
Glazing

Layers of glass or plastic, used in windows and other solar devices for admitting light and trapping heat.



Shading

Measures for blocking out unwanted sunlight that can overheat the house.

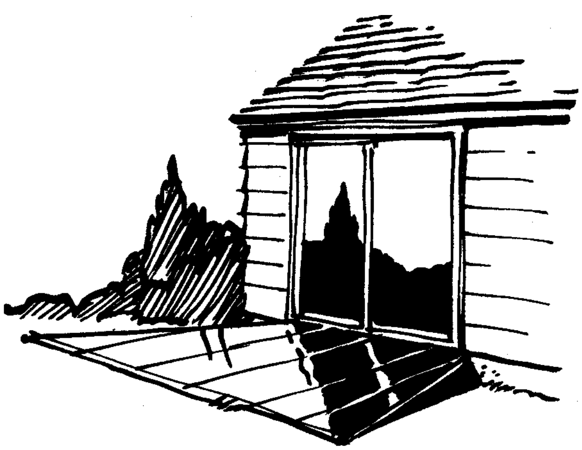


Movable Insulation

Insulating curtains, shutters, and shades that cover windows and other glazing at night to reduce heat loss.

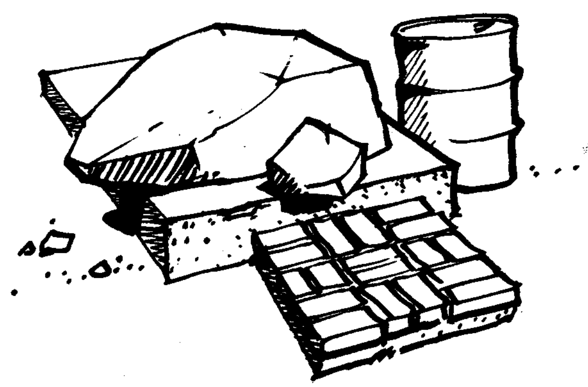
Reflectors

Shiny surfaces for bouncing sunlight or heat to where it's needed.

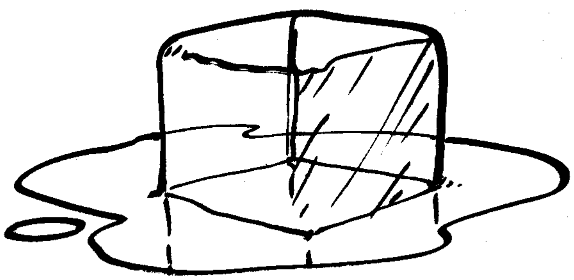


Thermal Mass

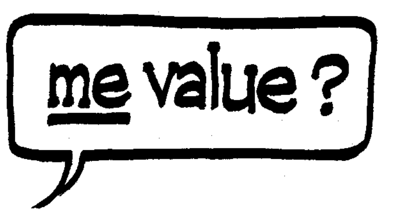
Materials that store heat. Heavy materials (concrete, stone, and even water) store a lot of heat in a small volume, compared with most lightweight materials, and release it when needed.



Heat-of-Fusion Storage Materials Meltable materials store heat when they "phase change" from solid to liquid form and release heat when they re-solidify. They require less mass (and vo1ume) to store the same amount of thermal energy as more conventional heat storage materials, and only small changes in temperature are necessary to induce the phase change.



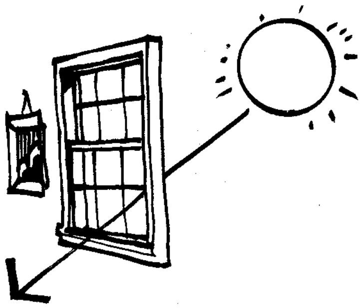
U-Value
A measure of the rate of heat loss through a wall or other part of a building. It is the reciprocal of the total R-va1ues present. The lower the U-value, the lower the heat loss.

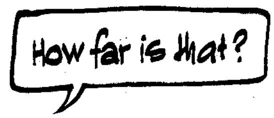


R-Value
A measure of the insulating ability of a material, a wall, a ceiling, etc. The higher the R-va1ue, the better the insulation and the less the heat loss.

What, More Definitions?

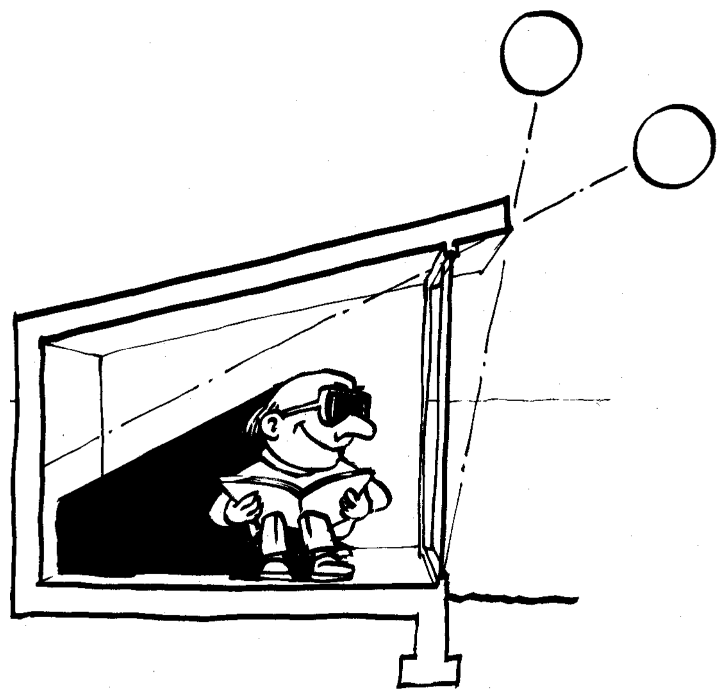
No, just a preview. The following are the passive systems covered by this book. As with everything else, there are both advantages and disadvantages. For most of us, though, the advantages far outweigh the disadvantages.





1. Solar Windows

When you make a conscious effort to place lots of glass on the south side of your house, feel free to call the extra glass "solarwindows." The sunlight that enters your house directly through windows turns into heat. Some of the heat is used immediately. Floors, walls, ceilings and



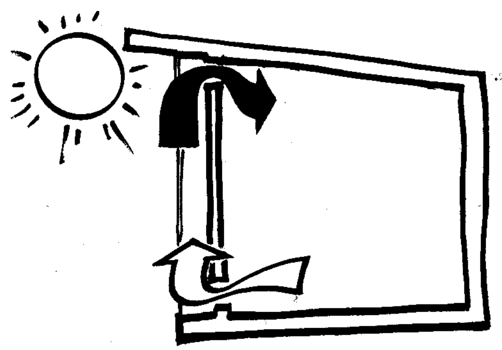
furniture store the excess heat. Movable insulation can cover the windows at night to reduce heat loss. South glass takes advantage of the winter sun's low position in the sky. In the summer, when the sun is high, the glass is easily shaded by roof overhangs or trees. Solar windows are often referred to as "direct gain" systems.

Advantages

Everyone can use this simplest of all solar designs. In fact, most of us already do, but not nearly as much as we should. Solar windows are inexpensive-often free-and they provide a light and airy feeling.

Disadvantages

Not everyone appreciates sunshine pouring in all day. Many people enjoy the extra heat and the higher temperatures, but sunlight can fade fabrics, and too much glass may cause too much glare.



2. Solar Chimneys

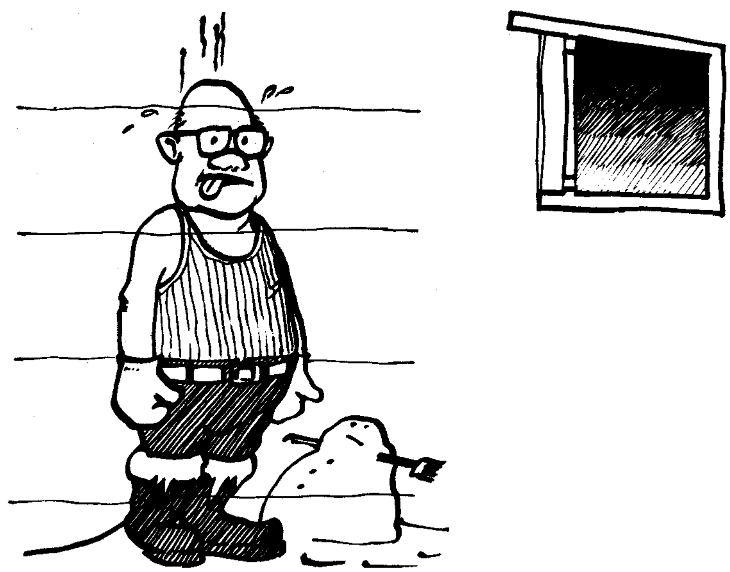
Air is warmed as it touches a solar-heated surface. The warmed air rises, and cooler air is drawn in to replace it. This is what happens in an ordinary chimney. The process of natural convection can occur in a continuous loop between your house and a solar collector attached to its south wall. As the air in the solar collector is heated, it expands, rises, and enters the house. Cooler house air is drawn into the collector to take its place. This is why these "solar chimneys" are usually referred to as "convective loops." Before too long, you should be able to buy solar chimney collectors from your local solar retail outlet or solar installer.

Advantages

Solar chimneys are very simple and avoid many of the problems of direct gain systems, such as glare and heat loss. Also, they're easy to attach to present homes.

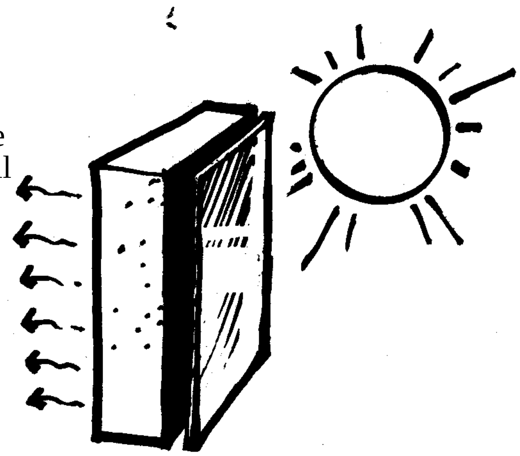
Disadvantages

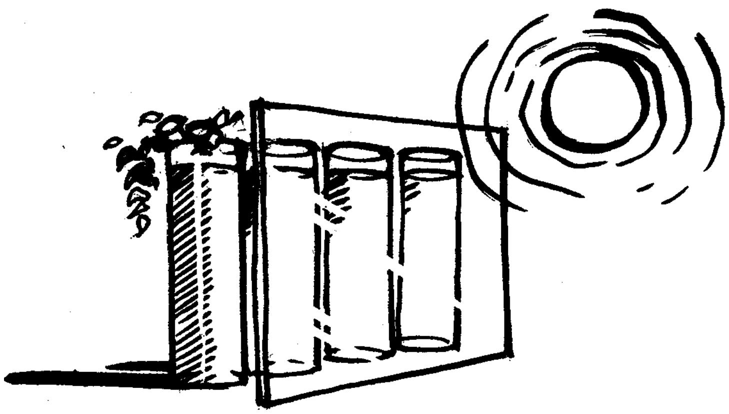
Like direct gain, too large a system may result in higher than normal temperatures in your house. Careful construction is required to ensure proper efficiency and durability.



3. Solar Walls

When the mass for absorbing the sun's heat is located right inside the glass, you have a "solar wall." The wall, painted a dark color, heats up as the sun passes through the glass and strikes it. Heat is then conducted through the wall and into the house.





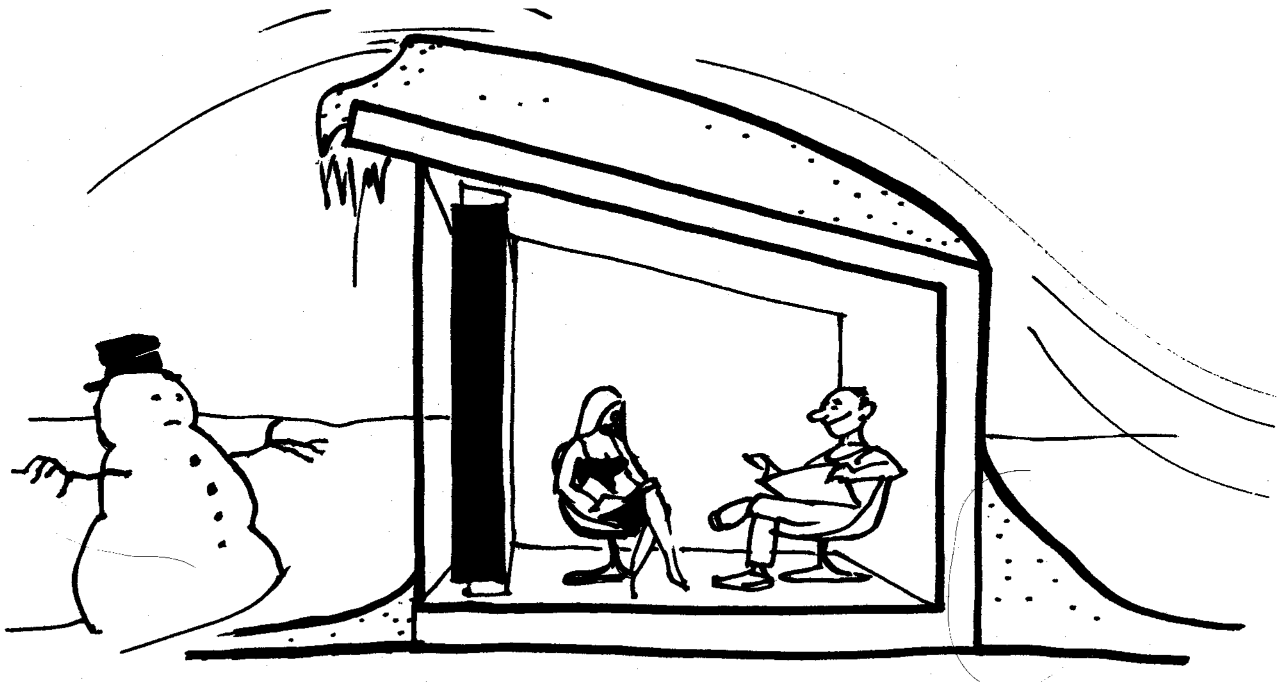
Another type of solar wall substitutes water for masonry. Tall cylinders of water, 55-gallon barrels, and specially-fabricated water walls are common. The water containers radiate their solar heat directly to the room. These walls are often referred to as "thermal storage walls."

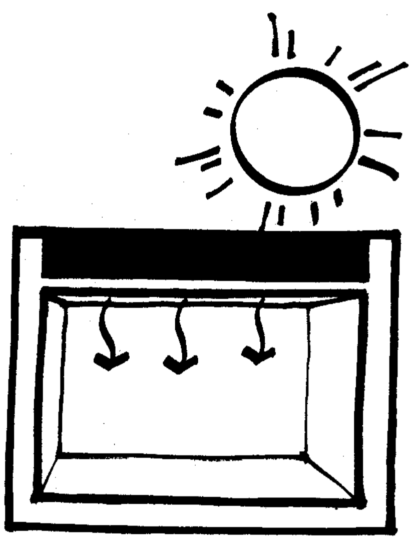
Advantages

Thermal storage walls have many of the same advantages as convective loops and simultaneously solve the heat storage problem. The mass is right where it belongs-in the sun. The thermal mass keeps the house at pretty even temperatures nearly 24 hours per day.

Disadvantages

The wall also loses heat back to the out-of-doors through the glass. Triple glazing or movable insulation solves this problem in cold climates but can be costly. Keep in mind that construction of the wall can be expensive and may in some cases reduce available floor area.





4. Solar Roofs

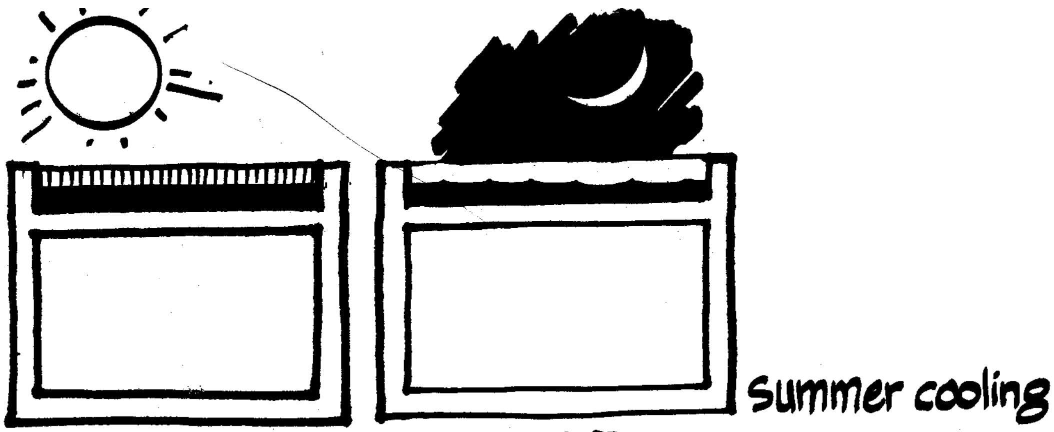
"Solar roofs" are like solar walls, only guess where the heat storage is instead! They are often called "thermal storage roofs." Most solar roofs use water in large black plastic bags (like waterbeds) to absorb heat during the day. The water ponds store the heat, which is in turn conducted through the ceiling and radiated to the house below. Insulating panels cover the ponds at night to reduce heat loss.

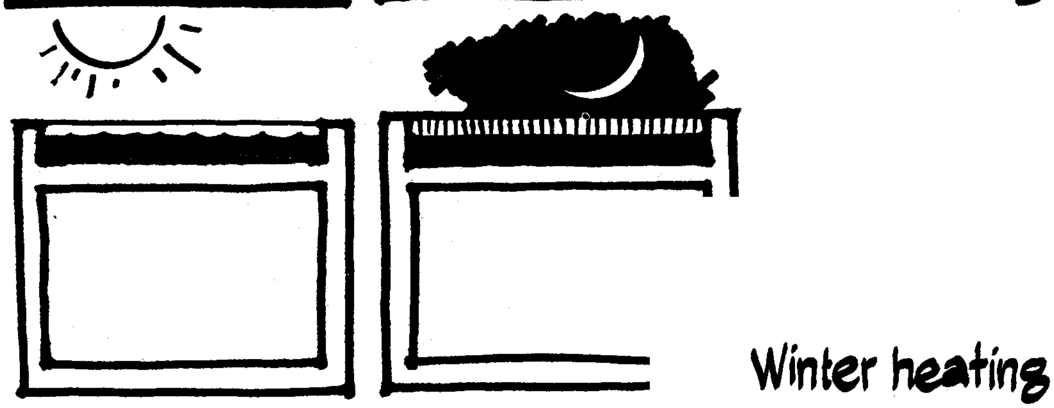
Solar roofs can, in certain climates, cool your house during the summer; the water absorbs heat from the house below and radiates it to the cool night sky. Insulating panels shade the ponds by day.

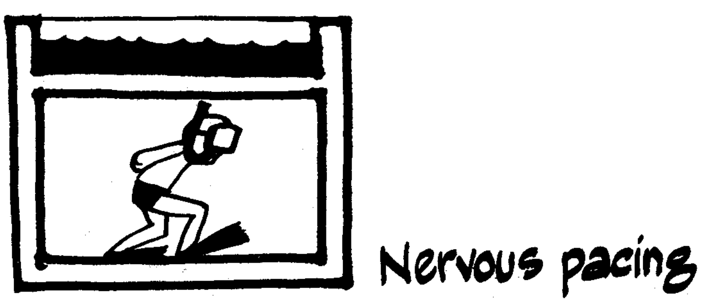
The most widely known solar roof, developed by Harold Hay, is called "Skytherm."

Advantages

These systems can, in some climates, provide for all your heating and cooling needs. And they can do so while keeping you as comfortable, or even more comfortable, than almost any other type of heating system, whether solar or conventional.

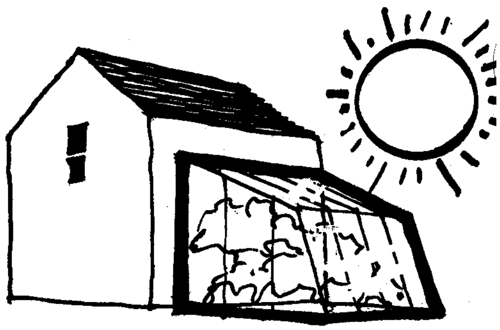






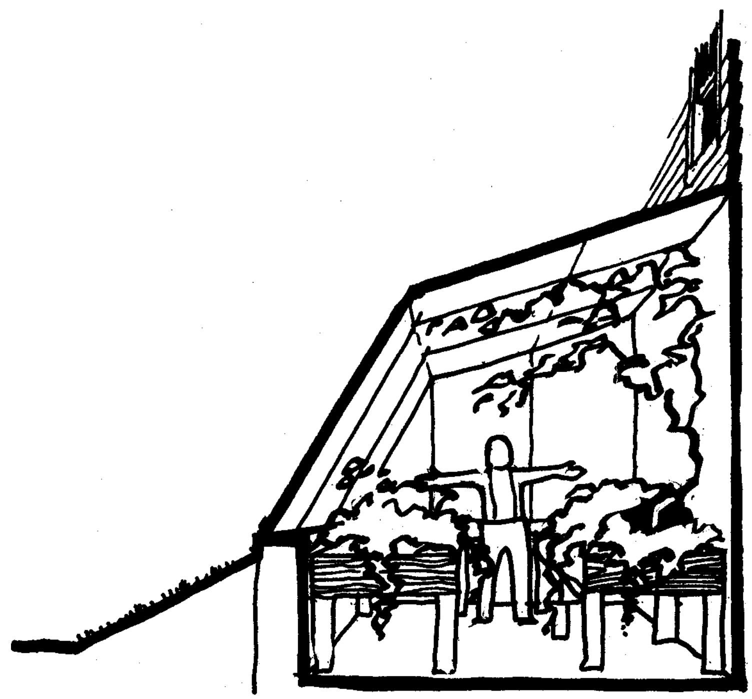
Disadvantages

Solar ponds require careful design, engineering and construction. Although little information is presently available, further research and development is currently under way. Their efficiency and cost effectiveness are not nearly as good in cold climates as they are in dry, sunny, southern ones.



5. Solar Rooms

Solar-heated rooms such as greenhouses, sun porches, and solariums are possibly the hands-down favorite passive solar system. They give the house extra solar heated living space; they provide a feeling of spaciousness-a sense of the outdoors; they act as buffer zones between the house and outdoor weather extremes. Solar rooms are often referred to as "attached sunspace."



Advantages

Solar rooms can greatly improve the interior "climate" of a house. Although solar room temperature swings may be large, since plants can tolerate much wider swings than people can, house temperature swings can still remain small (3°-8°). Solar rooms can add humidity to the house air if desired. A solar room can become additional living space for a relatively low cost. Besides, people love them! And they are readily adaptable to present homes.

Disadvantages

Improperly designed or built solar rooms will not work well. Although construction costs can be kept down, good quality construction is expensive. Factory-built kits can also be expensive.