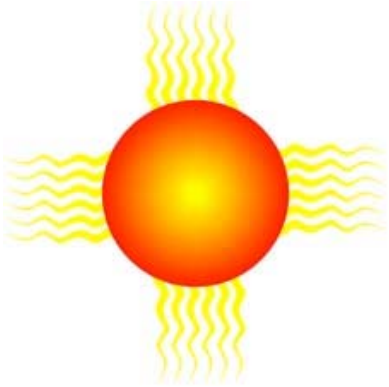


Everyday Environmental Stewardship

Passive Heating
Andrew Siliski

Key issue:
Environmentally-Harmful Heating

Stewardship Opportunities
Passive Solar Heating

Passive solar heating is environmentally friendly. There is no electricity consumed with electric fans and no emissions produced with burning fossil fuels. In fact, when set up, passive systems consume no energy at all. Though these systems are most easily applicable when building a new home, some elements can be installed in many existing homes, especially when doing some major renovations.

Passive solar systems do not replace mechanical heating systems, but instead act to reduce heating load requirements. Passive solar heating can reduce dependency on mechanical heating systems by 5%-25% at almost no extra cost. More comprehensive passive heating systems can reduce dependency by 25%-75%, but have large initial investment requirements.

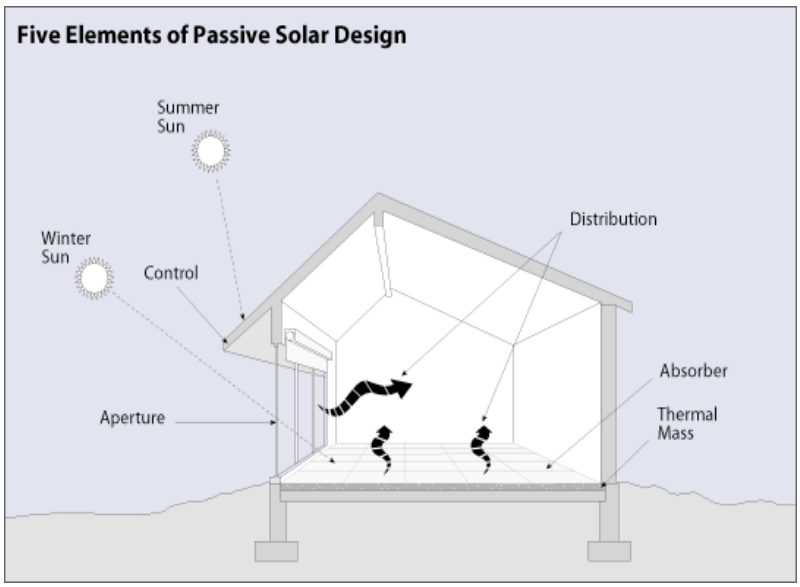
Passive Solar Heating Is…
A passive solar heating system is a way for the building materials to collect, store, and distribute solar energy by natural convection, conduction, and radiation. The building itself acts as thermal mass to store the heat it collects during the day which is then released during the night. Homes with high potential for solar electricity usually have good potential for passive solar heat.

How it Works
A passive heating system depends on the combination of architecture and building materials. Window design and glazing is extremely important for the effectiveness of the system. The more space dedicated for passive heat, the more effective it is. There are many ways to create a passive heating systems in many different architecture styles.

Five Parts of a Passive Solar Heating System
There are five parts of a passive solar heating system. Each does a separate, but necessary job for the system to function properly.

Aperture

Aperture is the collector through which solar energy enters the building. This is glass or plastic; it should face no more than 30 degrees from due south. It should also be in the sun from at least 9 AM to 3 PM daily during the heating system.



Courtesy of the Energy Information Administration

Absorber

The hard, dark, surface which absorbs the solar energy after it passes through the aperture. The absorber is usually a masonry wall, floor, or drums of water placed in the sunlight.

Thermal Mass

Materials which retain the heat until it is released during the night. The difference between the absorber and the thermal mass is that the thermal mass is not exposed to sunlight.

Distribution

How the heat is transferred from the thermal mass to the interior space. A purely passive system will only use convection, conduction, and radiation, but fans and ducts can help.

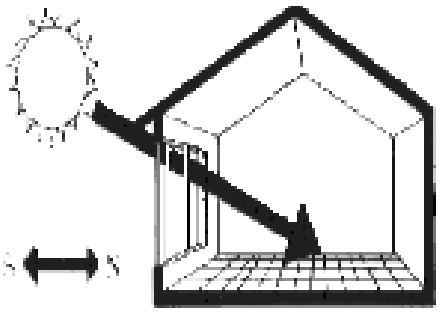
Control

Roof overhangs or eves shade the aperture from the sun. This prevents the home from unnecessary heating during the summer.

Three Passive Solar Designs

There are three different kinds of passive solar heating systems: direct gain, indirect gain, and isolated gain explained below.

Courtesy of the North Carolina Solar Center



Direct Gain

Direct gain is the simplest and most common passive heating system. Radiant heat shines directly into the living space through south facing windows and is absorbed by the thermal

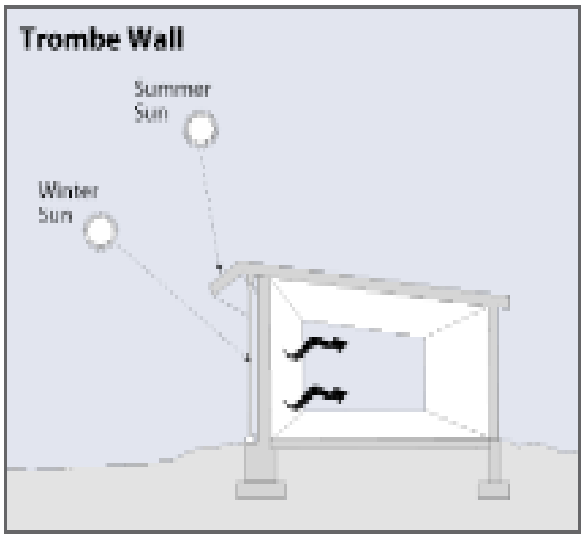
mass. The building itself acts as a storage device for the heat. Remember that heat always travels from warmer materials to cooler materials.

This process is reversed during the night to heat the building. The heat is re-radiated out from the building's core (inner walls/floors) and heats the interior space (outer walls and air) during the night. This continues as long as the core building is warmer than the interior space. Consider dedicating 1/2 to 2/3 of the home's total inside surface area (floors, wall, water) for direct gain.

Indirect Gain - Heat Collector

A dark colored heat collector is placed in front of a window directly in the sunlight. It must be dark (preferably black) because dark colored objects absorb and radiate more energy than light objects. Sunlight goes through the south facing glass windows and hits the heat collector. The heat collector in turn heats the air flowing inside it which creates the natural warm air convection loop. Drums of water can also be placed in the sunlight to absorb heat during the day and release it during the night.

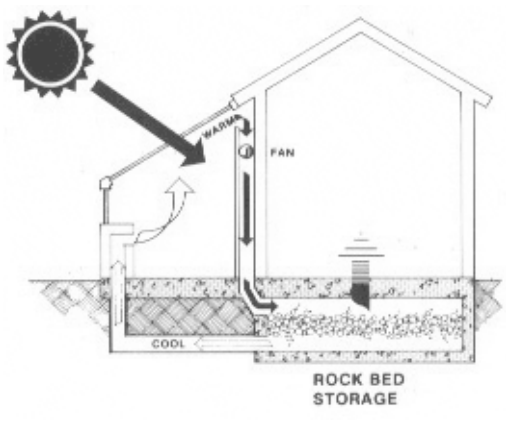
Indirect Gain - Trombe Wall



A trombe wall is the most common indirect gain approach. A trombe wall is a 8-16" thick south facing masonry wall. A single or double layer of glass is placed approximately one inch in front of the wall. The glass is sealed to the wall so no air can leak outside. Solar energy goes through the glass, hits the masonry wall, is absorbed, stored and radiated on the other side into the living space. A trombe wall can radiate heat for several hours after dark. According to the Department of Energy, heat transfers through masonry at a rate of one inch an hour, so heat hitting an 8" wall at noon will heat the inside of the building at 8 PM. The air circulates naturally to heat a room. Fans can be used to heat multiple rooms.

Isolated Gain - Sunspace

Isolated gain systems collect solar energy in a location separate from the space desired to be heated. Though there are multiple types of isolated gain systems, sunspaces are the most common. A sunspace (also called a solarium) can be built in the original design of a building or as part of a renovation.



A sunspace is a room designed to capture heat. Vertical windows capture the heat just like the direct and indirect gain system. The same

masonry walls or water drums are used as thermal mass. Distribution is achieved through ceiling and floor vents, windows/doors, and/or fans. The sunspace is often separated by the rest of the home using windows or doors. This protects the home against the sun's fluctuating temperatures.

Many times heat is stored in a rock bin as shown in the illustration. The heated air goes through pipes and into a rock bin. As it transfers its heat to the rocks, the air cools and falls to the bottom of the bed and back through the pipes to the solarium. At night, the heat stored in the rock bin radiates out and heats the home. An isolated gain system with a rock bin can also be used as a passive cooling system in the cooling months.

Cloudy Day Storage

Though their effectiveness is greatly reduced, passive heating systems work in cloudy days when there is no direct sunlight. Well designed passive heating systems are made to store heat for a few days. Climates with chronic cloudy weather need slightly larger systems.

Definitions

Thermal Mass

Thermal Mass is any material in the home that absorbs and stores heat. Masonry (concrete, brick, tile) is the most often used material for thermal mass. They are most effective when dark colored and located in direct sunlight. Drums filled with water are an excellent material for thermal mass because of water's high specific heat. They can heat spaces more quickly and more evenly than masonry or wood. Water also can store many times more heat than most other materials due to its high specific heat.

Links and References

The Energy Efficiency and Renewable Energy website has a wealth of information and is a good place to look up (among other things) passive heating and cooling systems.
http://www.eere.energy.gov/consumer/your_home/designing_remodeling/index.cfm/mytopic=10250

The North East Sustainable Energy Association has information as well as lists of recommended books, links, and more.
http://www.nesea.org/buildings/info/passivesolar.html