ENERGY SAVER

EFFICIENT DESIGN

Passive Solar Homes

Energy Saver

Passive solar design takes advantage of a building's site, climate, and materials to minimize energy use. A well-designed passive solar home first reduces heating and cooling loads through **energy-efficiency strategies** and then meets those reduced loads in whole or part with solar energy. Because of the small heating loads of modern homes it is very important to avoid oversizing south-facing glass and ensure that south-facing glass is properly shaded to prevent overheating and increased cooling loads in the spring and fall.

Energy Efficiency First

Before you add solar features to your new home design or existing house, remember that energy efficiency is the most cost-effective strategy for reducing heating and cooling bills. Choose building professionals experienced in energy-efficient house design and construction and work with them to optimize your home's energy efficiency. If you're remodeling an existing home, the first step is to have a **home energy audit** to prioritize the most cost-effective energy efficiency improvements.

Site Selection

If you're planning a new passive solar home, a portion of the south side of your house must have an unobstructed "view" of the sun. Consider possible future uses of the land to the south of your site—small trees become tall trees, and a future multi-story building can block your home's access to the sun. In some areas, zoning or other land use regulations protect landowners' solar access. If solar access isn't protected in your region, look for a lot that is deep from north to south and place the house on the north end of the lot.

How Passive Solar Home Design Works

In simple terms, a passive solar home collects heat as the sun shines through south-facing windows and retains it in materials that store heat, known as thermal mass. The share of the home's heating load that the passive solar design can meet is called the passive solar fraction, and depends on the area of glazing and the amount of thermal mass. The ideal ratio of thermal mass to glazing varies by climate. Well-designed passive solar homes also provide daylight all year and comfort during the cooling season through the use of nighttime ventilation.

To be successful, a passive solar home design must include some basic elements that work together:

- **Properly oriented windows**. Typically, windows or other devices that collect solar energy should face within 30 degrees of true south and should not be shaded during the heating season by other buildings or trees from 9 a.m. to 3 p.m. each day. During the spring, fall, and cooling season, the windows should be shaded to avoid overheating. Be sure to keep window glass clean.
- **Thermal mass**. Thermal mass in a passive solar home -- commonly concrete, brick, stone, and tile -- absorbs heat from sunlight during the heating season and absorbs heat from warm air in the house during the cooling season. Other thermal mass materials such as water and phase change products are more efficient at storing heat, but masonry has the advantage of doing double duty

as a structural and/or finish material. In well-insulated homes in moderate climates, the thermal mass inherent in home furnishings and drywall may be sufficient, eliminating the need for additional thermal storage materials. Make sure that objects do not block sunlight on thermal mass materials.

- **Distribution mechanisms**. Solar heat is transferred from where it is collected and stored to different areas of the house by conduction, convection, and radiation. In some homes, small fans and blowers help distribute heat. *Conduction* occurs when heat moves between two objects that are in direct contact with each other, such as when a sun-heated floor warms your bare feet. *Convection* is heat transfer through a fluid such as air or water, and passive solar homes often use convection to move air from warmer areas -- a sunspace, for example -- into the rest of the house. *Radiation* is what you feel when you stand next to a wood stove or a sunny window and feel its warmth on your skin. Darker colors absorb more heat than lighter colors, and are a better choice for thermal mass in passive solar homes.
- **Control strategies**. Properly sized **roof overhangs** can provide shade to vertical south windows during summer months. Other control approaches include electronic sensing devices, such as a differential thermostat that signals a fan to turn on; operable vents and dampers that allow or restrict heat flow; **low-emissivity blinds**; operable insulating shutters; and **awnings**.

Refining the Design

Although conceptually simple, a successful passive solar home requires that a number of details and variables come into balance. An experienced designer can use a computer model to simulate the details of a passive solar home in different configurations until the design fits the site as well as the owner's budget, aesthetic preferences, and performance requirements.

Some of the elements the designer will consider include:

- **Insulation** and **air sealing**
- **Window** location, glazing type, and window shading
- Thermal mass location and type.
- Auxiliary **heating and cooling systems**.

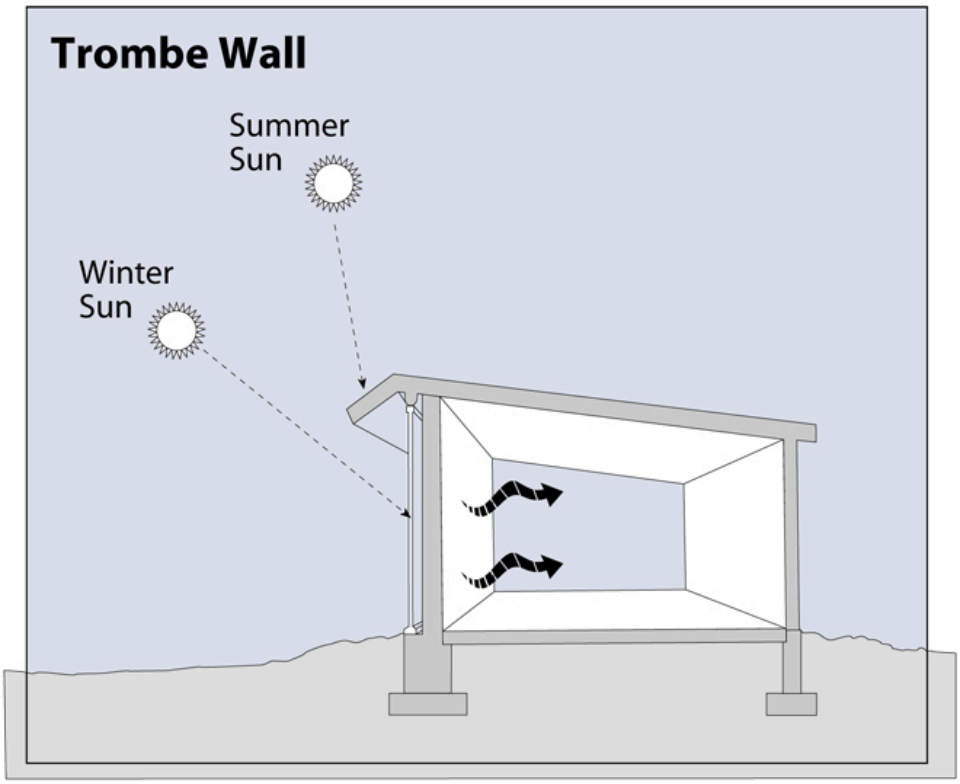
The designer will apply these elements using passive solar design techniques that include direct gain, indirect gain, and isolated gain.

Direct Gain

In a direct gain design, sunlight enters the house through south-facing windows and strikes masonry floors and/or walls, which absorb and store the solar heat. As the room cools during the night, the thermal mass releases heat into the house.

Some builders and homeowners use water-filled containers located inside the living space to absorb and store solar heat. Although water stores twice as much heat as masonry materials per cubic foot of volume, water thermal storage requires carefully designed structural support. An advantage of water thermal storage is that it can be installed in an existing home if the structure can support the weight.

Indirect Gain (Trombe Wall)

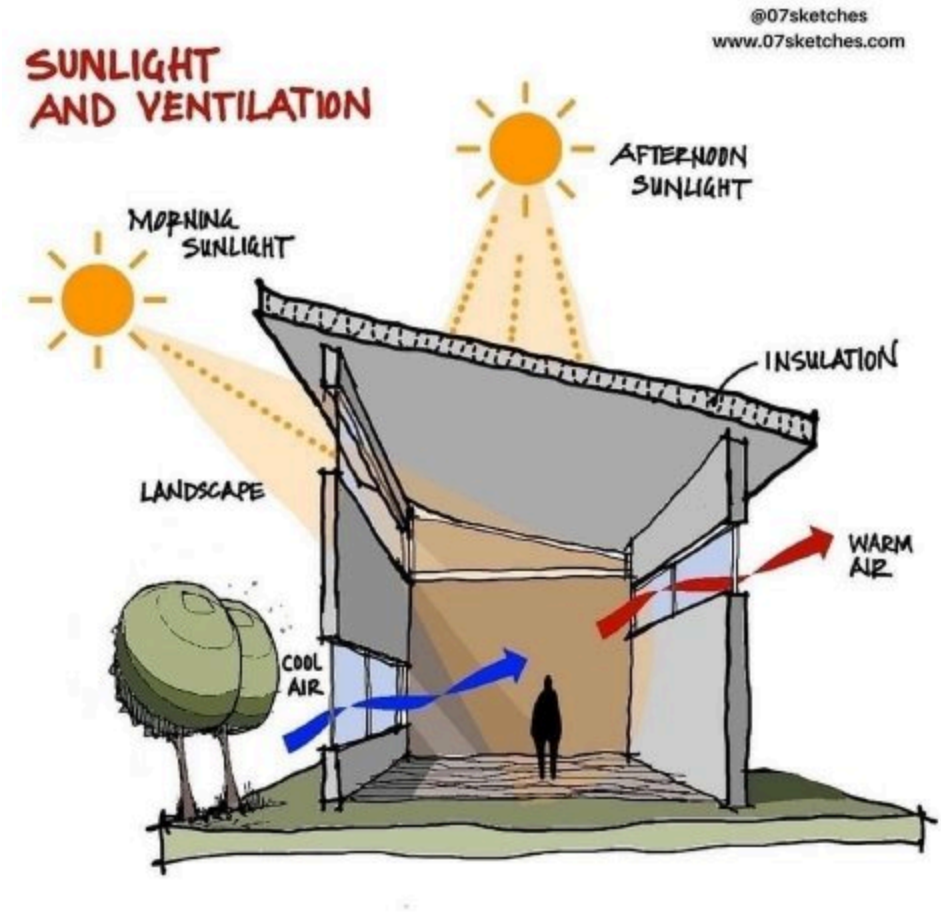


An indirect-gain passive solar home has its thermal storage between the south-facing windows and the living spaces. The most common indirect-gain approach is a Trombe wall.

The wall consists of an 8-inch to 16-inch thick masonry wall on the south side of a house. A single or double layer of glass mounted about one inch or less in front of the dark-colored wall absorbs solar heat, which is stored in the wall's mass. The heat migrates through the wall and radiates into the living space.

Heat travels through a masonry wall at an average rate of one inch per hour, so the heat absorbed on the outside of an 8-inch thick concrete wall at noon will enter the interior living space around 8 p.m.

Isolated Gain (Sunspaces)



The most common isolated-gain passive solar home design is a **sunspace** that can be closed off from the house with doors, windows, and other operable openings. Also known as a sunroom, solar room, or solarium, a sunspace can be included in a new home design or added to an existing home.

Sunspaces should not be confused with greenhouses, which are designed to grow plants. Sunspaces serve three main functions -- they provide auxiliary heat, a sunny space to grow plants, and a pleasant living area. The design considerations for these three functions are very different, and accommodating all three functions requires compromises.

Passive Solar Home Design for Summer Comfort

Experienced passive solar home designers plan for summer comfort as well as winter heating. A passive solar house requires careful design and siting, which vary by local climate conditions.

In most climates, an **overhang or other devices**, such as awnings, shutters, and trellises will be necessary to block summer solar heat gain. **Landscaping** can also help keep your passive solar home comfortable during the cooling season. If you are considering passive solar design for a new home or a major remodel, consult an architect familiar with passive solar techniques.

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