U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Guide to Passive Solar Home Design

By using the basic physical characteristics and layout of your home, you can improve its natural lighting and regulate temperature for indoor comfort. Passive solar design can reduce your electricity consumption and reduce your energy bills – no matter your climate zone.

What is Passive Solar Design?

Passive solar design incorporates features in your home and its natural surroundings that harness the sun's low rays in winter and deflect the sun's high rays in summer to naturally warm and cool the interior.

A home's orientation, elevation, room layout, materials, and surrounding outdoor landscaping all contribute to its passive solar design.

Unlike active solar heating systems, passive solar design does not involve the use of mechanical and electrical devices, such as pumps, fans, or electrical controls, to move collected solar heat. Instead, it incorporates the use of windows, walls, and floors to collect, store, and distribute solar energy in the form of heat in the winter and block solar heat in the summer.

Passive solar homes range from those heated almost entirely by the sun to those with south-facing windows that provide some fraction of the heating load.

You can apply passive solar design techniques to a new home. However, you can adapt or update existing buildings to passively collect and store solar heat.

Elements of Passive Solar Design

To design a completely passive solar home, you need to incorporate what are considered the five elements of passive solar design:

1. **Aperture (Windows)** – Windows should face within 30 degrees of true south, and during winter months they should not be shaded from 9 a.m. to 3 p.m. The windows in living areas should face south, while the windows in bedrooms should face north. In colder climates, reduce the window area on north-, east-, and west-facing walls, while still allowing for adequate daylight. In warmer climates, use north-facing windows along with generously shaded south-facing windows. When purchasing windows, look for ENERGY STAR® qualified windows.

2. **Absorber** – The hard, darkened surface of the storage element is the absorber. This surface – such as a masonry wall, floor, or partition – sits in the direct path of sunlight. Sunlight hits the surface and is absorbed as heat.

3. **Thermal Mass** – Floors and walls that absorb heat are particularly useful for naturally heating homes in colder climates. Thermal mass refers to materials that retain or store the heat produced by sunlight. The difference between the absorber and thermal mass, although they often form the same wall or floor, is that the absorber is an exposed surface whereas thermal mass is the material below or behind that surface.

4. **Heat Distribution** – Passive solar design allows solar heat to circulate from collection and storage points to different areas of the house. A strictly passive design will rely on natural heat transfer, but some applications use fans, ducts, and blowers to help distribute heat.

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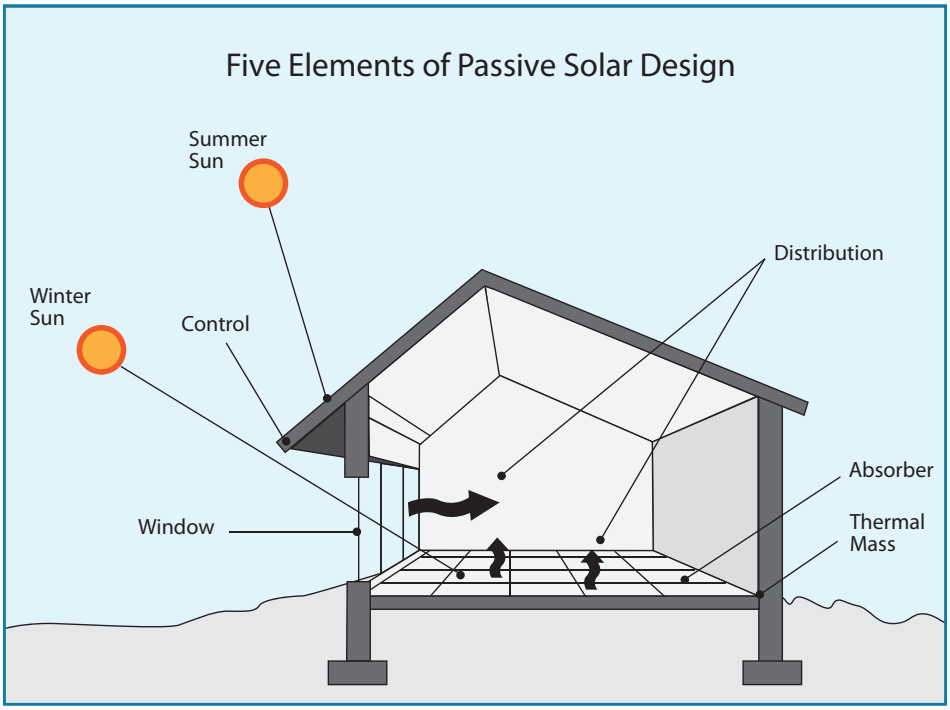

5. **Control** – Elements such as roof overhangs or trees can be used to shade the window during summer months. Other elements for controlling temperature include electronic sensing devices, such as differential thermostats that signal a fan to turn on, vents and dampers that allow or restrict heat flow, low-emissivity (low-e) blinds, and awnings.

How Passive Solar Heats and Cools

Understanding how passive solar home design works also means understanding how heat moves and how it can be stored.

Heat moves from warmer materials to cooler ones until there is no longer a temperature difference between the two. Thus, passive solar design lets heat flow through the house from warmer areas to cooler areas by using the following heat-movement and heat-storage mechanisms:

- **Convection.** Warmer gases and liquids will rise, while cooler liquids and gases will sink. In a house, warm air rises because it is lighter than cold air, which sinks. This explains why warmer air accumulates on the second floor of a house, while the basement stays cool. Some passive solar homes use air convection to carry solar heat from a south wall into interior spaces.
- **Radiation.** Heat can radiate and move through the air from warmer objects to cooler ones. To design for warmer weather, passive solar design can incorporate light-colored materials to reflect incoming solar heat and radiate heat off a building. To design for colder weather, homeowners can use darker materials to absorb the sun's heat and radiate it into the home. Clear glass, which transmits nearly 90% of the sun's heat, can also be incorporated to radiate the heat into a home's interior – like a greenhouse.
- **Heat capacity.** Passive solar design takes advantage of many different materials capable of storing heat. Masonry materials like concrete, stones, brick, and tile are commonly used as thermal mass in passive solar homes, especially in floors and walls.

Further Reading

DOE Energy Savers: Passive Solar Home Design
www.energysavers.gov/passive_solar

DOE Energy Savers: Windows, Doors, and Skylights
www.energysavers.gov/windows_doors

New Mexico Solar Energy Association (Search "Homeowners")
www.nmsea.org

Financial Incentives

Tax credits, incentives, and rebates may be available in your area. Please visit **www.energysavers.gov/taxcredits** for more information.

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