Passive Solar Heating, Cooling and Daylighting

Buildings designed for passive solar and daylighting incorporate design features such as large south-facing windows and building materials that absorb and slowly release the sun's heat. No mechanical means are employed in passive solar heating. Incorporating passive solar designs can reduce heating bills as much as 50 percent. Passive solar designs can also include natural ventilation for cooling. Windows are an important aspect of passive solar design—for information on window technologies, see the Building Envelope section of the EREN Buildings page.

Design Principles

Proper building orientation, so the longest walls run from east to west, allows solar heat to enter the home in winter, while allowing in as little sun as possible during summer. Shading and overhangs also reduce excessive summer heat, while still permitting winter sun. In passive solar designs, the optimal window-to-wall area ratio is 25-35 percent.

Passive Solar Heating

In cold climates, south-facing windows designed to let the sun's heat in while insulating against the cold are ideal. In hot and moderate climates, the strategy is to admit light while rejecting heat. Interior spaces requiring the most light, heat, and cooling are located along the south face of the building, with less used space to the north. Open floor plans allow more sun inside.

The simplest passive design is the direct gain system in which the sun shines directly into a building, heating it up. The sun's heat is stored by the building's inherent thermal mass in materials such as concrete, stone floor slabs, or masonry partitions that hold and slowly release heat. With indirect gain systems, thermal mass is located between the sun and the living space. An isolated gain system is one where the system is isolated from the primary living area, such as a sunroom or solar greenhouse with convective loops into the living space.

Passive Solar Cooling

Many passive solar designs include natural ventilation for cooling. By installing casement or other operable windows for passive solar gain and adding vertical panels, called wing walls, perpendicular to the wall on the windward side of the house, you can accelerate the natural breeze in the interior. Another passive solar cooling device is the thermal chimney, which can be designed like a smoke chimney to vent hot air from the house out through the roof.

Daylighting

Daylighting is using natural sunlight to light a building's interior. In addition to south-facing windows and skylights, clerestory windows—a row of windows near the peak of the roof—can let light into north-facing rooms and upper levels. An open floor plan allows the light to reach throughout the building. Daylighting in businesses and commercial buildings can result in substantial savings on electric bills, and not only provides a higher quality of light, but improves productivity and health. Daylighting in schools has improved student grades and attendance.

Technologies

Sunrooms

South-facing sunrooms are often added on as a way to retrofit a home to take advantage of the sun's heat and light. It is also possible to use a sunroom to help ventilate the rest of the house. Lower vents from the sunroom to the interior rooms draw air through the living space to be expelled out the upper vents to the outside along the top of the sunroom.

Trombe Walls

A Trombe wall consists an 8- to 16-inch thick masonry wall coated with a dark, heat-absorbing material and covered by a single or double layer of glass, placed from about 3/4" to 6" away from the masonry wall. Heat from the sun is stored in the air space between the glass and dark material, and conducted slowly to the interior of the building through the masonry. Adding a Trombe wall and south-facing windows is an easy way for a home to take advantage of solar heat.

Solar Cookers

Passive solar is not just a design technique for using the sun to heat and cool a home. Passive solar heating is also a common way to heat water (see the section on Solar Hot Water), and, particularly in developing nations where the electrical grid is undeveloped, passive solar heat is sometimes captured to cook food. Solar cookers can cook just about any food a conventional oven can. A basic cooker consists of an insulated box with a glass top. Heat from concentrated sunlight gets trapped in the box and can be used to heat food enclosed in the box.

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