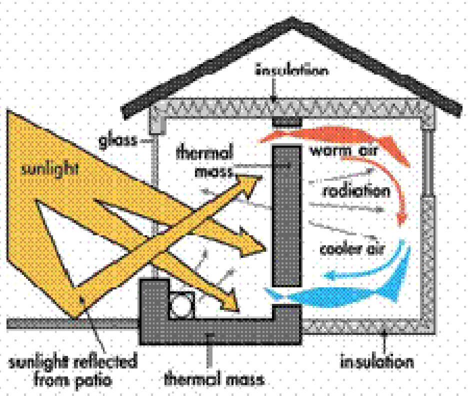
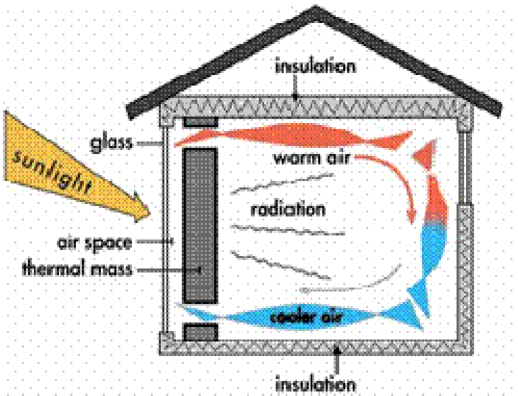
Passive Solar Design

Passive solar design tries to optimise the amount of energy that can be derived directly from the sun, by careful planning of buildings to collect the sun's heat, thus reducing the need for heating.



Direct gain system



Indirect gain (Trombe wall) system

What is it?

Passive solar houses are designed to let heat into the building during the winter months and block out the sun during hot summer days. This can be achieved using deciduous trees or bushes to the south of the buildings. During the summer, the leaves on these trees block out a lot of the sunshine and unneeded heat. These trees lose their leaves in the winter, allowing an increase in the solar gain during the colder days. Also the building can be designed to have louvres or shutters systems to block out sun when it is high in the sky while allowing it in during the winter when it is lower in the sky.

Simple features can be incorporated at the design stage such as large south-facing windows and building materials (thermal mass) that absorb and slowly release the sun's heat. Passive solar designs can also include natural ventilation for cooling with windows playing a large part in passive solar design.

How does it work?

Direct Gain systems are the simplest passive solar design, whereby the sun's heat directly heats up the building. Heat can be stored in the buildings thermal mass, such as concrete, stone floor slabs. A direct gain system usually includes south-facing windows and a large mass placed within the space to receive the most direct sunlight in cold weather and the least direct sunlight in hot weather. In this type of system, sunlight passes through the windows, and its heat is trapped by the thermal mass in the room.

For winter, the mass absorbs solar heat during its exposure to direct sunlight and radiates that heat back into the space during the cooler night. During the summer, the reverse occurs. The thermal mass is prevented from receiving direct sunlight and absorbs the

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heat in the room, helping to keep the room's temperature cooler.

The most effective thermal mass is made from dense and heavy materials that will retain the heat even in the absence of direct sunlight. Examples include an internal wall or floor made of concrete, stone or masonry, especially if painted a flat, dark colour.

Although it uses the same materials and design principles as a direct gain system, an indirect gain system positions the thermal mass between the sun and the space to be heated.

The sun's heat is collected and trapped in a narrow space between the window and the thick masonry wall after it passes through the windows. This heats the air, which rises and spills into the room through vents at the top of the wall. Cooled air then moves to take its place from vents at bottom of the wall. The heated air circulates throughout the room by convection. The thermal mass continues to absorb and store heat to radiate back into the room after the sun has gone. louvres can be placed in the vents to prevent warm air from escaping through them at night.

During the summer months, the process is reversed. The thermal mass is prevented from receiving direct sunlight while absorbing the heat in the room, helping to keep the temperature cooler.

Earth sheltering

In some constructions the north-facing side of the house can be built up with earth, giving extra thermal mass and protection from the worst winter weather.

Key Principles

There are six key principles to implementing passive solar design in new houses that can help reduce the overall energy demand of a house;

• keep the main orientation of the building within 30° of south - houses orientated east of south will benefit more from morning sun, while those orientated west of south will catch late afternoon sun delaying the evening heating period.

• use thermal mass within the masonry walls to allow the sun to be ‘soaked up’ during daylight hours and then released into the building at night – suitable thermal mass prevents overheating during the summer and avoids cold conditions during the winter.

• place the most frequently used rooms - requiring most heating – on the south side of the dwelling (i.e. living room)

• rooms used less often or those that do not benefit from sunlight should be placed to the north of the building (i.e. hallways, bathrooms, utility rooms, stores). Also they should have smaller windows to minimise heat loss.

• windows should be large enough to provide adequate day lighting - at least 15% of a room’s floor area.(Dept. of Env. – Best Practice Programme)

• also necessary is a responsive, zoned heating systems to automatically cut in when and where necessary – this can be more energy efficient than leaving

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heating on all day, or heating an unoccupied room.

Conservatories

Passive solar design is best applied in new buildings, where the orientation of the building, the size and position of the glazed areas, the density of buildings within an area, and materials used can be designed to maximise free solar gains. Designing a property to maximise free solar gain need not add to the price of construction.

Passive solar measures can be applied to existing buildings to good effect. However, energy efficiency measures may well yield better results with a shorter payback period. Where passive solar measures are incorporated, it is best to use complementary energy conservation measures as well.

Retrofitting conservatories, atria or greenhouses can be expensive and cannot be justified on the grounds of energy efficiency alone. However, a well-designed conservatory can provide an extra unheated living space, which also provides significant free solar gains. One should bear in mind, however, that the positive energy gains of a conservatory are lost if the space is heated like the rest of the building.

A conservatory could save up to 20% of annual heating bills although this is strongly dependent on the size of the house, siting, design and materials used. A well-designed conservatory acts as extra insulation for the house, preheats the ventilation air and provides direct solar heating to the intervening wall, which is drawn into the house.

More information:

http://www.greenbuildingforum.co.uk/

http://www.surrey.ac.uk/eng/InfoPoint/mddp/mddp03/group-2a/passive.HTM

http://www.solarcentury.com/knowledge_base/articles/passive_solar_design_in_architecture

www.cep.org.uk for energy advice

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