SOLAR PASSIVE DESIGN – COMBINING ORIENTATION, THERMAL MASS AND WINDOWS

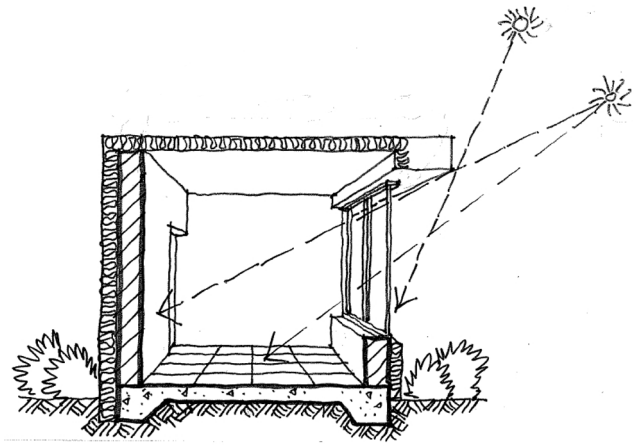
FACTSHEET 01

There is one form of energy that is easy to access with clever building design, and completely free – the Sun! Correct application of the principles of solar passive design allows any building to trap the heat contained in sunlight as free heating in winter, while minimising entry of sunlight to the building in summer to prevent overheating. This can lead to greater comfort, low or no heating and cooling costs, and a significantly smaller environmental footprint for passive solar buildings.

SUN ANGLES IN GOOGONG

Earth's vertical axis, the line around which the planet spins, is tilted 23.5° from vertical. As Earth orbits the Sun, this tilt means that the angle of incoming sunlight changes relative to the ground. This effect causes the seasons and also influences the way buildings are affected by the heat in sunlight.

In Googong, at latitude 35.4°, on the summer solstice (December 22) at midday the Sun is 78.1° from horizontal, almost directly overhead. On the winter solstice (June 22) at midday, the Sun is 31.1° from horizontal, low in the northern sky. The Sun moves between these extremes at roughly 8° per month.



Properly accounting for this change of Sun angle when orienting and designing a house can significantly reduce the need for heating and cooling.

This in turn improves comfort, reduces energy consumption, energy bills and greenhouse gas emissions. Here is a useful application for you to visualise where the Sun is at any time of year (set to Googong, although you can change it to anywhere on the planet):

http://www.suncalc.net/#/-35.3916,149.2348,12

SUN ANGLES AND BUILDING ORIENTATION

You do not need to know exactly where the Sun will be on every day of the year to understand how to orient your home – it is simply a matter of orienting to maximise incoming sunlight in winter and minimise incoming sunlight in summer.

Put simply, to take advantage of solar passive design, your home should be oriented with the long axis as close to true east-west as possible.

This maximises exposure of the building's surface area to the north, maximising the sunlight entering the building's windows in winter, helping to warm it during the day. This orientation also minimises exposure of the building to the east and west, which minimises sunlight striking the building in summer, keeping it cooler during the day in summer. The correct orientation helps in both seasons!

THERMAL MASS – STORING THE HEAT IN SUNLIGHT

Thermal mass is the ability of a material to absorb and retain heat. All materials have some degree of thermal mass, but many cannot store large quantities of heat (e.g. wood, plasterboard), while others re-radiate heat rapidly rather than retaining it (e.g. metals). Water has the highest thermal

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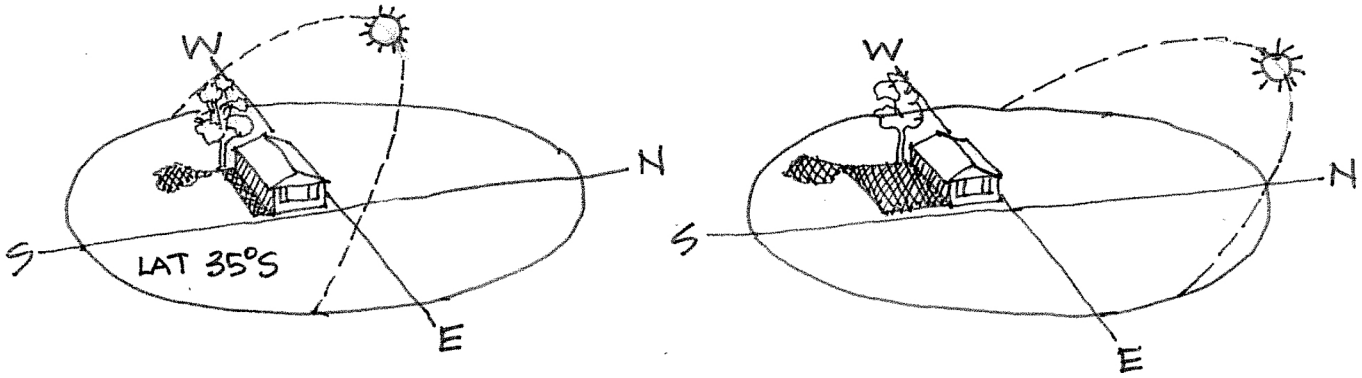

Figure 2 – correct orientation maximises exposure to sunlight in winter, minimises exposure to sunlight in summer

mass of any common material on Earth, but we cannot build with water, so the best thermal mass for building includes heavy materials such as concrete, brick and stone.

Thermal mass materials absorb heat from the air when they are cooler than the air around them, and release heat to the air when they are warmer than the air around them. They also absorb heat from radiant heat sources like sunlight or heaters.

The best way to use high thermal mass materials in building is to place them inside the building where they will be hit by sunlight during the day in winter – in front of north-facing windows is ideal – but are shaded from sunlight in summer.

Used in this way, the high thermal mass will absorb the heat from the sunlight which strikes it during the day, warming the thermal mass. Then, when the air cools below the temperature of the thermal mass at night, it will start to release the heat absorbed during the day. This heat absorbing and releasing property of high thermal mass materials acts to reduce temperature fluctuations within the house, making it more comfortable.

WINDOWS – LETTING THE SUNLIGHT IN!

Solar passive design requires sunlight to enter a building in order to be useful.

This is called solar access. Sunlight that hits external walls is of little benefit, even if it strikes a thermal mass material like brick, because that brick is outside the building envelope and has insulation between it and the living area you are trying to keep warm. So, careful positioning of appropriate windows to allow winter sunlight access to internal thermal mass is extremely important.

Most heating is used in common living areas, so if possible they should face north and feature large, north-facing windows (see Design). Double (or triple) glazing will not significantly reduce the amount of sunlight penetrating a window – after all, double glazing is simply two panes of glass with a gap in-between. However, double glazing will help to keep in the heat by reducing conductive heat loss, so it is preferable to single glazing. Regardless of glazing type, insulating internal window coverings, such as pelmeted multilayered curtains or honeycomb blinds sealed to the architraves, are necessary in a cold climate like Googong to help keep the warmth in at night.

In summer, it is preferable to eliminate solar access through windows because the heat in sunlight becomes trapped in the house, especially if it is well sealed and insulated.

Eaves and other kinds of structural overhang are designed to block out sunlight when the Sun is at a high angle in the sky in summer, but any east/west/north windows exposed in summer may require further shading using external coverings such as awnings or roller shutters (see Shading). Clever design to prevent sunlight from entering your home in summer will keep it much cooler.

For more detailed information: http://www.yourhome.gov.au/passive-design/.