How To Guides: Process Navigation and Timeline Estimation

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Passive Solar Orientation

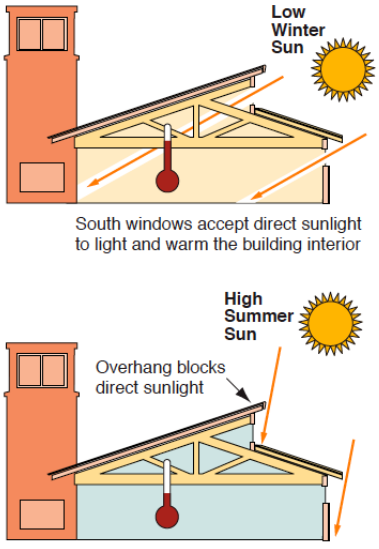
Orientation / South Facing Windows

Based on the movements of the sun, passive solar buildings typically have windows (glazing) on the southern facing side* of the building in order to absorb the sun's heat energy to warm a building during the winter. In order to stay cool in the summer, passive solar houses rely on a system of shading (or an overhang) to keep the building cool.

***** Simply by building in this way, a house can reduce its heating and cooling costs by 85%. *****

*In the northern hemisphere, windows face the south to obtain maximum solar gain; whereas in the southern hemisphere, it is the opposite with windows facing north.

Seasonal Window Considerations



The diagram shows how the low winter sun can enter the building, but not high summer sun.

Winter
The diagram to the left shows how the sun is lower in the winter, while it is much higher in the summer. (See the building at Zion National Park.) During the day, the low winter sun can shine through windows are to allow heat energy to be absorbed into the building's thermal mass.

While windows allow heat into a building to be absorbed, their thin and transparent nature also allows heat to escape a building.

In order to keep this from happening in cold climates, it is recommended that the glass panes are doubled (double glazing) or even tripled. An insulated window covering or thick shade can also be used to help insulate the windows and help keep the heat in the building after the sun goes down.

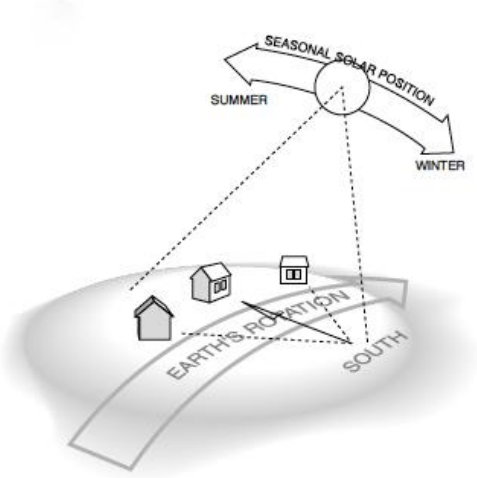
Summer
In the summer, as temperatures rise, a passive solar building uses its thermal mass to help keep the building cool. In order for this to happen, the summer sun is kept from reaching the thermal mass of the building.

The summer sun's path aides in this process by traveling high in the summer sky, thus a proper overhang or other type of system is needed to shade or cover the widow, in the summer so that the sun's heat energy is blocked or avoided when it is desired to have the building cooler than the outside temperature.

A properly designed overhang keeps the heat and energy from being absorbed into the house in the summer. (In the picture at the very top of this post, you may also notice that the overhang is keeping the high summer sun from entering the house.)

Building Orientation

Because the sun rises in the east and sets in the west, the side of the building that is utilized for solar gain needs to be facing the south to take maximum advantage of the sun's potential energy. If the building's axis is located on the east-west direction with its longest dimension facing the south, more of the building is situated to absorb the sun's heat energy.



If the building in the middle were longer, stretching toward the two houses located on either side of it, more of its mass would be ideally situated to absorb and radiate heat in the winter

Passive solar buildings are typically rectangular with the long side of the building facing south. The distance from the source of incoming heat (south) to where it is absorbed (typically a northern wall) should be minimized. The resulting shape is a rectangle. This is one of the lessons learned in the construction of this Off Grid Passive Solar Earthship-Style Home.

South Facing Windows and Orientation

It is ideal to have the windows (solar glazing) within 5 degrees of true south. However, windows that are within 15 degrees of true south are said to function *almost* as well.

As the degree difference from true south expands, the overall potential solar efficiency of the structure decreases. Put another way, the greater the degree variation from true south, will decrease the amount of the the building's solar gain. As a result, larger amounts of supplementary energy may be needed to heat the building in the winter. As the building's glass (glazing) faces more to the southwest, more energy may be needed for summer cooling.

Passive solar buildings typically have many windows facing the south exposure.

Southern facing windows (southern solar glazing) are a vital component for a passive solar design and building. Because the southern side of the building is the side that will potentially receive sunlight throughout the day, most passive solar buildings will feature glass dominating the southern side. Southern facing glass allows the sun's energy to be absorbed and distributed through the building's thermal mass.

You may hear people referring to glass as glazing. Glazing is the fancy architectural word typically used for southern facing glass that has the capacity to transfer the sun's energy.

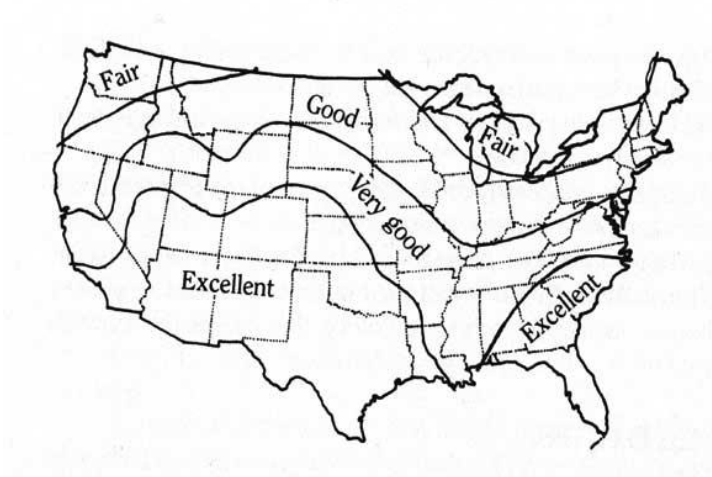
Another benefit of having windows on the south side, is that it allows natural light to bathe the house throughout the day. This aspect can also lower energy use throughout the house since it minimizes the use of artificial light.

All of these factors can be used to one's advantage, depending upon the site location and depending on the specific characteristics that you want within the house.

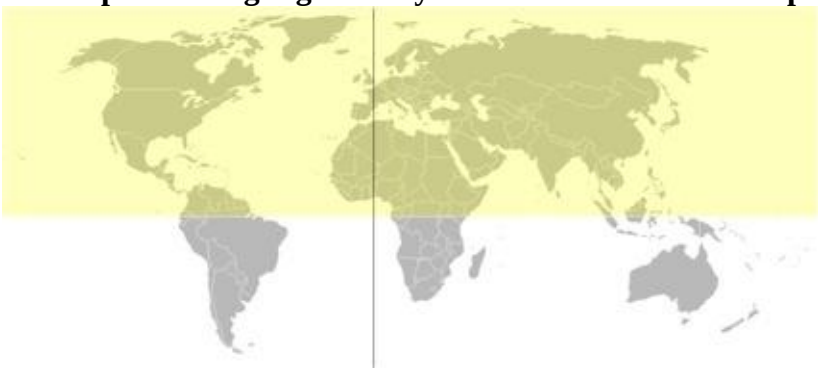
While southern facing windows (glazing) are a necessary component of passive solar design, care must be taken to insulate them in the winter after the sun goes down, as well as shade them in the summer.

In many parts of the U.S., passive solar houses do not require any auxiliary energy for heating and cooling. Given current and future projected fuel costs, the additional construction cost is recovered quickly.

Potential for passive solar heating in the United States.



The northern hemisphere is highlighted in yellow. The southern hemisphere is white.



Note that because the Earth is a sphere, depending on where you are located, the sun will interact slightly differently than in other places. For example, the angle of the summer and winter sun will be different. If, however, you are located in the Southern Hemisphere, in order to build a passive or active solar home, the building will need to be oriented to the north.

Vertical and Angled Glass (Glazing)

Most glass that is used in building is vertical. Angled glass, however, is frequently used in passive solar design because it increases the amount of solar energy that can be absorbed. **Caution!** This can cause overheating in the summertime.

*This information pertaining to facing windows to the south works for those in the northern hemisphere. Down under, in order to use solar gain, they need to face the windows to the north.

Net Zero PV Log Home

Standing proudly on a hill surrounded by gorgeous mountain views, situated in one of the coldest areas of Colorado, the Fraser-Granby mountain valley, is a surprisingly efficient house.

This log home incorporates passive and active solar features. It's well insulated and efficient.

The contemporary active-passive solar house is situated and built to be cool in the summer and warm in the winter. It is a grid-tied (connected to the local electricity utility) house that is both efficient and comfortable.

The home achieves net-zero energy use in the summer by using two different forms of active solar electricity: solar photovoltaics to create electricity, as well as evacuated solar tubes, to heat the house with radiant heat and supply hot water for domestic use. (To be technically accurate, it is actually ***net-less-than-one***, rather than net-zero. Although it *could* achieve net-zero and it's really darn efficient!)

This two- part article will explore different aspects of active PV, solar evacuated tubes and the passive solar features of the grid-tied home. Oh yes, we'll get into the guts and inner-working parts of the house in part 2.

Passive Solar Aspects of the House

I visited the house both during the summer and in the winter to learn about its solar gain.

The log home's south facing side, with lots of windows to allow the winter sun's heat into the house.

The southern side of the house contains most of the windows, while the north side of the house (picture below) has a minimal amount of windows.

If southern facing windows have a properly planned overhang, it can be situated in a way that blocks the summer sun, yet allows the winter sun to reach deep into the house.

The porch on the southern side of the house is covered by an overhang that blocks the summer sun's rays from entering the house, yet in the winter when the sun rotates a lower arc across the sky the sun's heat can enter and heat the house.

The north facing side of the house has a minimal amount of windows, cutting down on potential heat loss in the winter.

This house has been built in a location has often been referred to as the "Ice Box" of the nation.

Because windows are a liability in colder climates, they are typically the biggest source of heat loss in a building (besides an open door).

The lack of windows on the north side of the house help minimize heat loss out the coldest part of the house. Most of the windows in this home are fixed (with no openings) and triple paned.

Even with an expansive porch on the south side of the home, sunlight reaches deep into the house in the winter within a passive solar designed home.

This picture was taken five days after the winter solstice and shows the winter sun's rays penetrating deep into the house.

In addition to passive solar winter heat from the sun, there is radiant in floor heat within the two floors that comprise the main living areas.

The kitchen flooring is travertine, a rock-based material that has density and thus, thermal mass to absorb the sun's heat, also helping to keep the house warm in the winter.

This combination of design and its materials complement the home's overall efficiency.

The home gleams of luxury, with its marble counter tops, its slate stone tiled custom shower in the guest room, yet this house also includes scavenged materials.

The owner builder used scavenged, high quality materials that were headed for the scrap-yard unless they were used. The guest shower has been made from 'dumpster' slate. The owner-builder said that the tiling the shower took a lot of planning, with a week of time spent arranging and grouting. Yet the shower, which I used, was luxurious. Had the owner not told me that it was dumpster slate, I would have thought every piece was cut exactly for the place and purpose it is in.

It's also worthy to note that almost all the lights in the house are compact fluorescent, using approximately 70% less energy than conventional light bulbs. The newer, more efficient kitchen appliances also use less electricity.

Using Locally Sourced Materials

The house is built almost entirely from beetle kill pine, and its blue tinged wood line the inner sanctum.

The wood for the railings, posts, stairs & cabinets come from nearby because the house is located in one of the areas in Colorado that has been drastically impacted from the 'beetle-killed' pine trees. While having drastic ecological impacts, this situation has also created a surplus of timber. The most of the lumber for this house was milled locally, and the trees did not travel far, likely coming from within a 75 mile radius where the house was built.

Owner built house with two principle builders
House Square Feet – 3,700
Time on Build – Two years while working different full time jobs