Passive Solar Greenhouse

What is a Passive Solar Greenhouse?

All greenhouses collect solar energy. Solar greenhouses are designed not only to collect solar energy during sunny days but also to store heat for use at night or during periods when it is cloudy. They can either stand alone or be attached to houses or barns.

Passive solar greenhouses are often good choices for small growers because they are a cost-efficient way for farmers to extend the growing season, potentially year-round.
Basic Principles of Solar Greenhouse Design

Solar greenhouses differ from conventional greenhouses in the following four ways; Solar greenhouses:

- have glazing oriented to receive maximum solar heat during the winter.
- use heat storing materials to retain solar heat.
- have large amounts of insulation where there is little or no direct sunlight.
- use glazing material and glazing installation methods that minimize heat loss.
- rely primarily on natural ventilation for summer cooling.

Solar Heat Absorption

The two most critical factors affecting the amount of solar heat a greenhouse is able to absorb are:

- The position or location of the greenhouse in relation to the sun
- The type of glazing material used

Solar Orientation

Since the sun's energy is strongest on the southern side of a building, glazing for solar greenhouses should ideally face true south. However, if trees, mountains, or other buildings block the path of the sun when the greenhouse is in a true south
orientation, an orientation within 15° to 20° of true south will provide about 90% of the solar capture of a true south orientation. The latitude of your location and the location of potential obstructions may also require that you adjust the orientation of your greenhouse slightly from true south to obtain optimal solar energy gain.

**Slope of Glazing Material**
In addition to north-south orientation, greenhouse glazing should be properly sloped to absorb the greatest amount of the sun's heat. A good rule of thumb is to add 10° or 15° to the site latitude to get the proper angle. For example, if you are in northern California or central Illinois at latitude 40° north, the glazing should be sloped at a 50° to 55° angle (40° + 10° or 15°).

**Glazing**
Glazing materials used in solar greenhouses should allow the greatest amount of solar energy to enter into the greenhouse while minimizing energy loss. Rough-surface glass, double-layer rigid plastic, and fiberglass diffuse light, while clear glass transmits direct light. Although plants grow well with both direct and diffuse light, direct light through glazing subdivided by structural supports causes more shadows and uneven plant growth. Diffuse light passing through glazing evens out the shadows caused by structural supports, resulting in more even plant growth.

As a general rule, a solar greenhouse should have approximately 0.75 to 1.5 square feet of glazing for each square foot of floor space.
Solar Heat Storage

For solar greenhouses to remain warm during cool nights or on cloudy days, solar heat that enters on sunny days must be stored within the greenhouse for later use. The most common method for storing solar energy is to place rocks, concrete, or water in direct line with the sunlight to absorb its heat.

Cob, Strawbale, Brick, or Cinder block walls at the back (north side) of the greenhouse can also provide heat storage. However, only the outer four inches of thickness of this storage material effectively absorbs heat. Medium to dark colored ceramic tile flooring can also provide some heat storage. Walls not used for heat absorption should be light colored or reflective to direct heat and light back into the greenhouse and to provide a more even distribution of light for the plants.

Heat Storage Material (Water is recommended)

The amount of heat storage material required depends on your location. If you live in southern or mid-latitude locations, you will need at least 2 gallons of water or 80 pounds of rocks to store the heat transmitted through each square foot of glazing. If you live in the northern states, you will need 5 gallons or more of water to absorb the heat that enters through each square foot of glazing.

The amount of heat-storage material required also depends on whether you intend to use your solar greenhouse for extending the growing season, or whether you want to grow plants in it year-round. For season extension in cold climates, you will need 2 ½ gallons of water per square foot of glazing, or about half of what you would need for year-round production.

If you use water as heat-storage material, ordinary 55-gallon drums painted a dark, non-reflective color work well. Smaller containers, such as milk jugs or glass bottles, are more effective than 55-gallon drums in providing heat storage in areas that are frequently cloudy. The smaller container has a higher ratio of surface area, resulting in more rapid absorption of heat when the sun does shine. Clear glass containers provide the advantages of capturing heat better than dark metal containers and not degrading, but they can be easily broken.
Features of a Typical Passive Solar Greenhouse

- Insulated foundation. Unlike most greenhouses where plants are grown in containers or hydroponically, the passive solar greenhouse allows the gardener to plant directly into the ground. With two feet of insulated foundation, depending upon the depth of your frost line, the soil stays warm enough to grow plants year round.
- Rear north facing straw bale, cob, or brick wall
- Glass or polycarbonate glazing, both more durable than plastic. Polycarbonate is a difficult to break, lightweight glass alternative that is user-friendly; doesn't burn the plants, and is guaranteed for ten years against yellowing.
- Super-insulated side walls (either straw bale or conventional insulation) and roof
- Passive solar water wall
- Active solar fan and vent: uses the sun to run the ventilation system (augmented by human operated vents). The size, placement, and number of vents can be customized to fit your heat and humidity profile