Solar Greenhouse Plans

Calling a greenhouse solar is somewhat redundant, since all greenhouses are solar heated to some extent. The greenhouse itself traps the heat each day, as anyone who has been inside a greenhouse for just a few minutes on a sunny day knows. But although a traditional greenhouse acts as a natural solar collector on sunny days, it does not retain the sun's heat at night. Consequently, 75 to 80 percent of the cost of heating a greenhouse by conventional energy sources is expended at night.

To retain the sun's heat, the greenhouse requires something into which the heat can sink and be stored. This heat sink can consist of barrels of water, rocks, concrete walls, or other thermal mass. At night the stored heat emanates back through the greenhouse.

There are two types of solar energy systems: active and passive. The system most commonly used in home greenhouses is passive. Here, a thermal mass, such as rocks or water-filled drums, captures heat during the day and radiates it back at night.

The active system requires electricity or another conventional source of energy to pump heated air into a storage area, such as a basement, filled with rocks or water drums. More efficient than passive solar heating, this type of system is also more expensive and more complex.

Both types of solar systems work better in areas with a high percentage of sunny days, even if they are cold, than they do in areas where overcast days are common.

Solar Heat Storage

Heat arrives from the sun in the form of short waves, which strike and heat objects in the greenhouse. A south-facing greenhouse with a sloping roof permits maximum penetration of sunlight. Inside the greenhouse the heated objects radiate warmth in the form of long waves, which do not readily penetrate the greenhouse covering. These long waves are the ones that can be trapped and stored.

Probably the most widely used heat sink is water in ordinary 55-gallon drums painted a dark, non-reflective color for better heat absorption. Piles of rocks in wire-mesh cages are also common. Place the storage units

where they will collect the most heat. Make sure they don't touch the exterior wall or glazing; the outside cold will quickly draw the heat away. To calculate the minimum heat storage required, allow 2 gallons of water or 80 pounds of rocks for each square foot of greenhouse that admits sunlight directly onto the storage units. Generally, just calculate the south-facing roof and wall.

Another efficient heat sink consists of either a brick wall or cinder blocks poured full of concrete. If you already have an attached greenhouse, cover the back wall--the house wall--with bricks. Buy black bricks or paint them dark for maximum heat absorption. Firmly affix this brick facing to the side of the house with steel braces set in mortar and screwed to the house studs at regular intervals. The disadvantage of most traditional heat sinks is that they are cumbersome and take up a great deal of space. Newer lightweight materials occupying less space are in the experimental stage. For example, researchers at the University of Delaware are studying solar heat storage in inexpensive chemical compounds known as eutectics. These salts store the heat from the sun's rays at a constant temperature for use on cloudy days and at nights. Whatever type of heat sink you use in a passive system, you can't count on it to eliminate conventional heating altogether unless your greenhouse operates under ideal conditions. You should have a conventional backup unit ready, although you may not need it very often. You will probably find that the solar heat storage principles put into practice in your greenhouse will help you conserve energy and reduce your heating costs.

Insulation

All the heat you hope to store in your greenhouse will be lost if you can't prevent it from escaping as soon as it is radiated from the heat sink. The greenhouse should be made as airtight as possible. Put weather stripping around the doors and vents, and use a flexible sealant to close all joints between the roof and walls. Make sure the glazing fits snugly.
Even in a tightly sealed greenhouse, heat is lost through the glazing material. The quickest Way to cut this loss is to install double or triple glazing, line the interior with inflated layers of polyethylene plastic, or use insulating greenhouse curtains that roll down the inside of the glazing at night.

The north wall of the greenhouse provides a quick escape route for heat. You can retain some of that heat by covering the wall with a material that insulates as well as reflects light back into the interior. For an aluminum

and glass structure, one effective method is to seal the north wall with panels of white, rigid insulation cut to fit each opening. In a frame greenhouse, you can fill the north wall with fiberglass insulation and cover it with exterior grade plywood. Apply a coat of water seal to the plywood and then paint it white.

When thinking about insulation, it is easy to forget the floor and foundation. During the winter months in some regions, the ground is frozen many inches deep. That cold surface is a severe drain on greenhouse heat. To block it, put sheets of rigid insulation 1 or 2 inches thick around the outside of the foundation from the footing to the top of the foundation wall. An alternative is to dig a 4-inch-wide trench down to the bottom of the footing and fill it with pumice stone.

The floor, particularly a brick or flagstone floor is a good heat sink, but its heat gain will be quickly lost if it is not insulated. An effective insulation consists of 4 inches of pumice rock laid beneath the flooring. Water will still drain through.

Solar Heat Sinks

Here are some materials used for capturing and storing solar heat in greenhouses:
Stacked water filled steel drums
Concrete-filled cinder or pumice concrete blocks
Brick, stone, or adobe wall
Concrete slab on top of a bed of rocks
Bin or loose pile of rocks
Water filled steel drums in metal racks
Concrete wall and slab floor
Rock wall held in place with wire-mesh fencing

Passive System
The sun's warmth is deposited and held in the thermal-mass heat sink during the day. At night, this heat radiates out and keeps the greenhouse warm.

Active System
The sun's heat warms the transfer fluid (water or air) in a solar collector. The fluid is pumped to another location and stored for redistribution as heat later.

Attached Solar Greenhouse

Designed and built by New Mexico landscape architect John Mosely for his own Santa Fe home, the solar greenhouse shown below is attached by a sliding glass door to the house not only for convenience but also to take advantage of greenhouse heat during the winter. In the summer, cooler air in the house is vented through the greenhouse to the outside.

The roof of the 8- by 14-foot glass and redwood structure is angled for maximum exposure to the summer sun. The upper third of the roof is covered with insulation to provide relief from the overhead summer sun.

The 14-foot-wide north wall, made from pumice block poured with concrete, is the heat sink. The outside of the 8-foot-high wall is insulated with 4-inch-thick rigid insulation stuccoes to protect it from the weather.

The front wall and the roof were originally designed to hold only one pane of glass in each opening, but the local code required two. The code also required that the glass windows be separated at the corners, so the block wall was extended and a work area formed beside the outside entrance.

You can adapt this greenhouse to your area, eliminating the block wall extension if it is not required locally. Begin the construction by laying out the site and excavating the ground so that the floor of the greenhouse will be level with the house floor. Position slip forms of 1 by 4s for the footing around the inside perimeter and level them. Form the outside of the footing with rigid insulation braced against the excavated wall. Pour the concrete; when the footing has hardened, build the walls with standard sized pumice blocks.

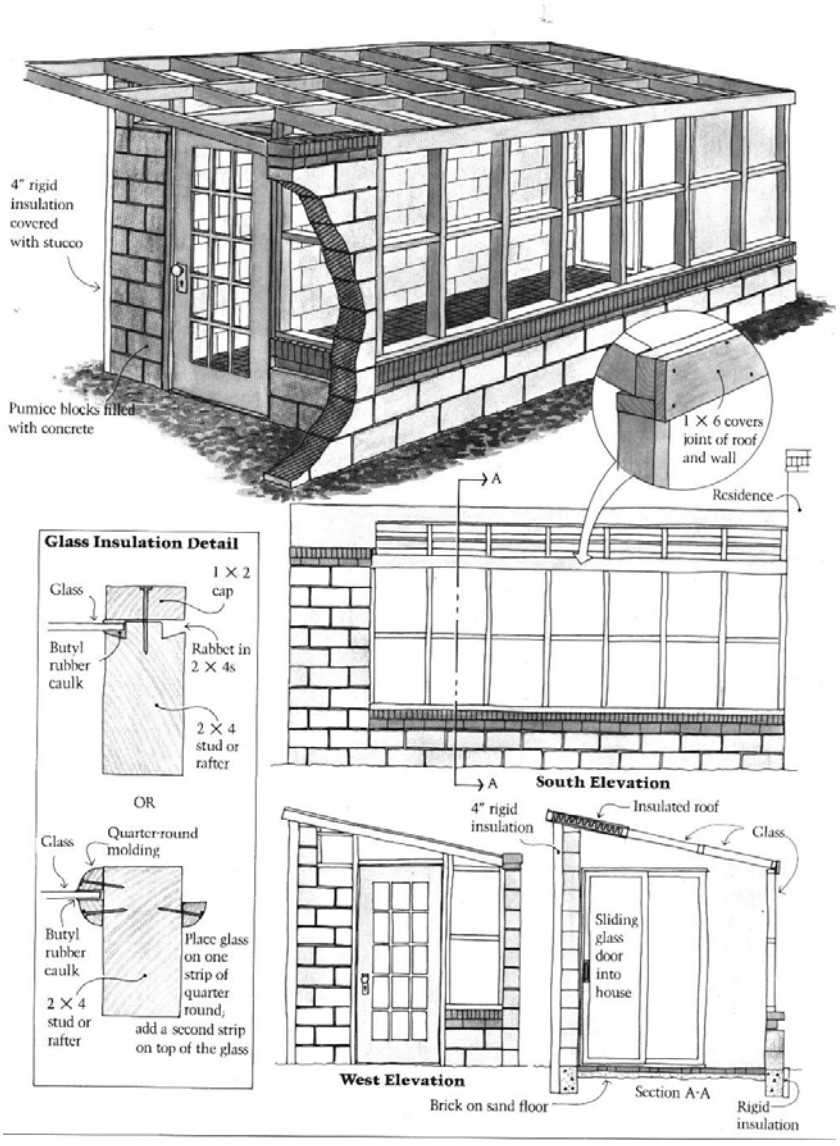
Rabbet each vertical stud, plus the top and bottom plates and the crosspieces, to receive the panes of glass. If you don't have access to a table saw for rabbeting, you can install the glass using quarter-round molding or 1 by 1 redwood strips as stops nailed to the studs and rafters.

The next step is to frame piece by piece the west wall, which holds the exterior door. The 2 by 6 door frame goes in first. The next elements to be installed are the top plate, the door header, and the window and vent frames.

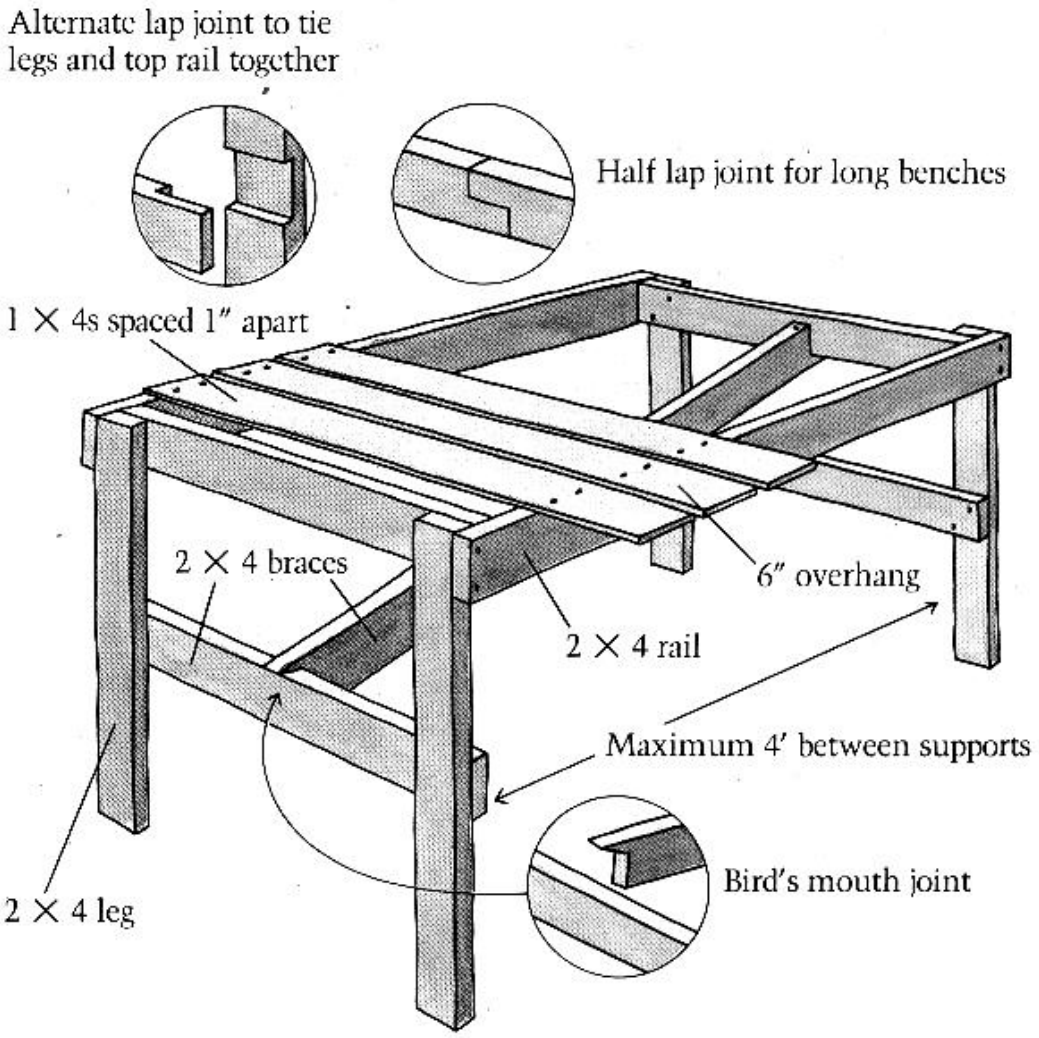
With the front and side walls in place, it is time to put up the roof. Instead of installing each rafter individually, measure and lay out the roof as if it were a wall. Cut the front end of the rafters so that they are in a vertical line with the front wall. Rabbet each piece as you did the front wall. Then nail together the entire roof section. Lift it into place and toenail it to the top plate of the front wall; nail on a 1 by 6 to cover the seam. With exterior-grade plywood, cover the back area where the roof extended above and slightly over the wall; insulate it inside and outside.

Install the glass, sealing each piece on both sides with butyl rubber. Use 1 by 2 strips to hold the glass in place. Complete the greenhouse by installing a brick-and-sand floor.

Attached Solar Greenhouse



Basic Bench


Alternate lap joint to tie legs and top rail together
Half lap joint for long benches
1 × 4s spaced 1" apart
2 × 4 braces
6" overhang
2 × 4 rail
Maximum 4' between supports
Bird's mouth joint
2 × 4 leg