ENERGY

Attached solar greenhouses no. 10.612

By Lloyd Walker[1]

Quick Facts...

An attached solar greenhouse or sunspace can be used to extend the growing season, provide solar heated living space or provide supplemental heat to the house.

Consider the use, appearance, cost and applicable building codes when adding a sunspace.

A sunspace can be added to almost any house if a southern exposure is available with unobstructed sunlight most of the day during winter.

The building and covering materials for greenhouses must be able to withstand moisture and solar transmission, and be impact resistant.

Colorado State University Cooperative Extension

An attached solar greenhouse is a structure added to a house that can serve as:

- a greenhouse that extends Colorado's generally short growing season;
- a solarium or sunroom that provides additional solar heated living space for a house;
- a solar collector that provides supplemental solar heat to the house.

"Sunspace" may be a more appropriate term for this structure since it can make use of solar energy in a number of ways.

Initial Planning

Consider several important points before adding a sunspace to a house.

1. Decide on the appearance of the sunspace.
   - portable or temporary (plastic film over a lightweight frame) is an ideal solution for renters
   - functional (fiberglass over a construction grade lumber frame)
   - elegant (glass or acrylic over an aluminum or redwood frame)
2. Determine costs and financing. Sunspace cost is directly related to appearance, choice of materials, cost of labor and ingenuity of builder. The cost will range from $4 to $30 per square foot of floor area.
3. Contact a local building inspector to determine what building codes apply to sunspaces.

Once these decisions are made, begin by selecting a site.

Selecting a Site

A sunspace can be added to almost any house if certain principles are followed to insure efficient operation.

- A site should have a wall that faces south. However, the wall may be as much as 45 degrees to the east or west of south and still be acceptable.
- The site should receive unobstructed sunlight from nine a.m. to three p.m. during the winter. This ensures maximum solar heating of the structure and adequate light for plant growth.
- Use deciduous shade trees for summer shading. Shade trees that block the afternoon summer sun reduce overheating problems in the sunspace.
- Protect the site from winter winds by a fence, windbreak hedge or the house.
- Sunspace should enclose an existing window, door or both in order to easily vent solar heat into the house.

With the site selected, designing the sunspace can begin.

Design

Sunspace design is relatively simple if the following principles are followed.

Sunspace size and shape. A long, rectangular shape is preferred for several reasons: there is room for growing space and other activities; the sunspace can be constructed with lightweight, standard length building materials; the structural framework is simpler to build; the shared wall area between house and sunspace is increased, which reduces heat loss from the house and adds some thermal storage to the sunspace; the sunspace can more easily provide supplemental heat to the house through windows and doors covered by the sunspace; the increased area of south facing glazing produces more solar heat.

A design where the length is 1 1/2 to two times the width has proved to be convenient. A greenhouse that measures 10 feet by 16 feet is a reasonable size to consider.

Foundation. A foundation can be a poured concrete wall; piers of concrete or pressure treated wood (treated with a waterborne salt wood preservative); or timbers laid on the ground (for portable or temporary sunspaces only). A wood frame sunspace is a lightweight structure and a post foundation will be adequate support. However, if you are planning to build masonry walls, a poured concrete foundation is necessary. Insulate the foundation walls with rigid board insulation to reduce heat loss.

Floor. The floor of a sunspace can be brick, stone, gravel, sand or combinations of these materials. A porous floor is recommended in a sunspace to reduce algae problems, provide drainage and store moisture that helps humidify the sunspace. Lay 2 inches of rigid board insulation on the ground covered by 8 inches of flooring material. This will allow the floor to store solar heat efficiently.

East and west walls. These walls can be solid, glazed or a combination of both, depending on how the sunspace is used. If the space will be used primarily as a cold season garden, the end walls can be solid to reduce heat loss and still not adversely affect light levels. However, if the sunspace is to be used for growing plants throughout the year, some light must be admitted through the east or west wall. A recommended design is to have a glazed or partly glazed east wall to help warm the sunspace in the morning after a cold winter night. Additionally, a solid west wall will aid in reducing summer overheating and protect the west side from the prevailing winter winds.

South wall. The south wall of a sunspace is glazed and can be built vertically or angled as much as 60 degrees (from horizontal). An angled wall will admit a maximum amount of winter sun to the sunspace. However, an angled wall will reduce headroom at the south end of the sunspace and may be more difficult to construct. Either a vertical or angled wall will work satisfactorily in a sunspace.

Roof. The roof of the sunspace should be solid and insulated for a distance of 4 feet out from the house, and glazed for the remainder. In this way, the winter sun, which is low in the sky, will shine into the sunspace, but the high summer sun will be partly blocked and reduce overheating problems.

Doors and vents. Locate the sunspace door on the east wall, away from prevailing winter winds. Air vents on the east and west walls are necessary for summer cooling. Total cooling vent area, including the door, should be 15 percent to 20 percent of the floor area of the sunspace. Vents located low on the west wall, and high on the east wall will work most efficiently.

Roof vents are not recommended due to sealing problems. Vents between the sunspace and the house are necessary to circulate solar heated air into the house. Total home heating vent area should be 8 percent to 15 percent of the floor area of the sunspace. There should be high and low home heating vents for proper air circulation. A door and windows make the simplest home heating vents.

Thermal storage. Thermal storage is used in a sunspace to store solar heat and reduce the day-night temperature variation. The amount of thermal storage to use will depend upon the intended use of the sunspace. If the sunspace is to be used as a season extender for spring and fall and as a collector in winter, little or no storage is necessary. In this way, the daytime winter temperatures can get quite high (over 100 degrees) making the sunspace an effective solar collector.

If the use of the sunspace is more oriented to growing plants, thermal storage equal to two to three gallons of water or 80 to 120 pounds of masonry per square foot of south facing glazing is recommended. This should maintain temperatures about 30 degrees F above outside low temperatures and make the sunspace an effective plant growing area in all but the coldest months of the year. Water is a preferred storage material since a given volume of water will store twice the heat of the same volume of rocks. Of course in the mountains, supplementary heat and moveable insulation will be necessary.

An alternative to designing your own sunspace is to purchase a greenhouse kit from a manufacturer. They come in a variety of materials, shapes and costs. A kit provides a well-developed design, the necessary pre-cut materials and assembly instructions. The extra cost of a kit is worthwhile to homeowners who don't want to design, procure materials and fabricate the structure themselves.

With the sunspace design fully developed, the construction can begin.

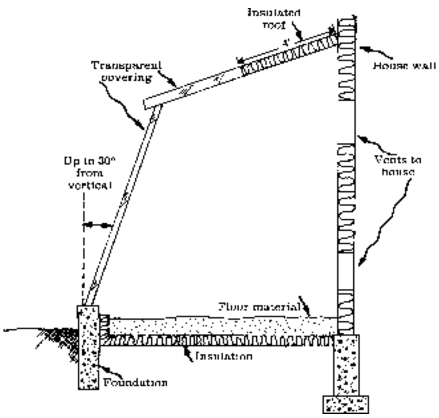

Figure 1: Sunspace/greenhouse construction cross-section.

Construction

Sunspace construction methods are similar to house construction methods. (See Figure 1.) However, there are some unique features.

Choice of materials. The high humidity levels in a greenhouse require materials that do not deteriorate with moisture. Aluminum channels are used in some kit greenhouses, however, they are difficult to work with in an owner-built greenhouse and might conduct heat out of the sunspace. Redwood or cedar are preferred woods to use due to their natural resistance to rot. If construction-grade lumber is used in the greenhouse, it must be treated with a waterborne-salt wood preservative (i.e., copper or zinc salt mixtures.)

Choice of greenhouse covering material. Greenhouse covering materials can be broadly categorized into four areas: glass, clear rigid plastics, fiber-reinforced plastic (FRP) and plastic films. All of these materials transmit adequate levels of solar radiation for use in a greenhouse. The main considerations in choosing a covering material include:

Is it clear or translucent? The advantage of a clear material is aesthetics, a person can see through it. A translucent material will diffuse incoming light that is beneficial to plant growth.

Impact resistance. The ability to withstand hail damage is a major consideration in choosing a covering material for Colorado's climate.

Service life. For a covering material to have long service life, it must resist weathering due to wind, scratching from blowing sand and dust, and degradation due to ultraviolet rays.

Cost. Cost is directly related to durability and appearance.

Glass is a proven material that has an unlimited life, except for breakage. Tempered glass is recommended for improved impact strength. Glass is more difficult to work with and heavier than any other covering material.

Clear rigid plastics (i.e., Plexiglas, Lucite, Acrylite, Lexan) look much like glass but are structurally stronger. However, they tend to scratch easily and are more expensive than glass. The material can be easily drilled or cut.

Fiber-reinforced plastics (FRP) or fiberglass (i.e., Kalwall, Filon, Lascolite) are translucent but admit as much solar radiation as glass. The diffused light admitted by FRP provides for better plant growth than glass. These materials are commonly used on commercial greenhouses. Corrugated FRP has greater structural strength than flat, favoring it as a roof covering. FRP must be of greenhouse quality to ensure a long service life. An acrylic modified FRP with ultraviolet inhibitors and a Tedlar film laminated to the outside for longevity is a good choice. Low quality, lumber yard grade FRP will yellow due to ultraviolet degradation within a couple of years. FRP is easy to work with and less expensive than tempered glass.

Plastic films (i.e., Mylar, polyethylene) are inexpensive to use but not very durable. These materials may last two to five years. Some plastic films have additives to improve durability, but at additional cost. With plastic films, the thicker the material, the longer the service life, and the less light transmitted. Plastic films offer a low cost alternative glazing for temporary structures or in situations where low cost is a main consideration. However, the low cost is offset by the increased maintenance due to replacement of the film.

Wall construction. Sunspace construction uses standard house framing techniques. The structure must be strong enough to handle snow loads. Adequately insulate all solid walls to reduce heat loss. All glazed walls must be double glazed to insure good thermal performance. The sunspace must be properly sealed and caulked to make the structure as airtight as possible.

Interior finish. The interior surfaces of the sunspace should be light or dark, depending on their function. Any surfaces that absorb and store heat should be dark; all other surfaces should be light or white to reflect more light to the plants.

Operation Tips

In order for a sunspace to work in an energy-efficient manner, follow the following operating recommendations.

• Do not operate the structure as a sunspace year round unless some type of insulation is used to cover the glazed walls at night. During the winter months, plant growth is slowed by cooler temperatures and reduced daylight. Adding supplemental heat to a sunspace to maintain adequate temperature levels is not an energy wise practice, and maintaining a frost-free environment all year also promotes insect problems. By using the sunspace as a growing-season extender in spring and fall, and a sunroom and home solar heating device in the winter will avoid these problems.

• Plant according to the season. During the cool part of the year, grow cool weather crops that tolerate lower temperatures.

• Maintain the capacity to close off the sunspace from the rest of the house. Sunspace temperature can be maintained at somewhat lower levels than household temperatures, depending on the crops and production desired. By having a door, or dampers on vents between the sunspace and the house, the temperature difference can be maintained easily.

References

The Food and Heat Producing Solar Greenhouse, Bill Yanda and Rick Fisher, John Muir Publications, P.O. Box 613R, Santa Fe, New Mexico 87501, ($9.50).

The Complete Greenhouse Book, Peter Clegg and Derry Watkins, Garden Way Publishing, Charlotte, Vermont 05445 ($9.95).

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