ENERGY
FACTS

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Add-on Sunspaces for Solar Heating

The most important consideration when designing or purchasing an add-on sunspace is how you want to use it. One design will be best for home heating, another for added living space, and still another for growing plants. This bulletin focuses on the collection of solar energy for house heating in Michigan, though it will also consider multiple uses of sunspaces.

The greatest amount of solar heat gain is possible with south-facing glass or plastic glazing materials (see Table 1). Fifteen compass degrees east or west of south, however, has almost no effect on amount of energy collected.

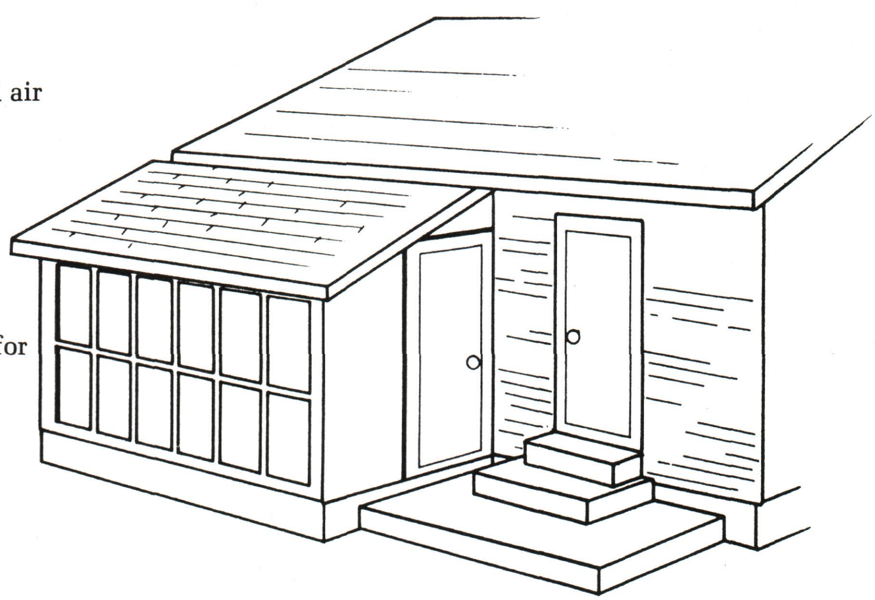
Attaching the sunspace to the south side of the house not only makes it less costly than a free-standing greenhouse but also eliminates heat loss through a north greenhouse wall. Heat produced in the attached sunspace is readily available for use in the house. A small, thermostat-controlled fan can move solar-heated air from high in the sunspace into the home. Cool return air from the house can be drawn into the sunspace low on the same wall.

Vertical Glass

There has been a great deal of discussion of, and experimentation with, the proper angle for sunspace glazing. Vertical glass, with no slope at all, has some advantages:

- Vertical glass is easy to install.
- It loses less heat to the sky at night.
- Overheating is less of a problem in the summer.
- Seals against wind and water are easier to construct and maintain.
- Vertical glass is often much less expensive than sloped glazing.
- When fresh snow is on the ground (often the case in Michigan), vertical glazing will collect about as much winter solar energy as sloped glazing due to sunlight reflected by the snow.

Whether glass, plastic or fiberglass glazing materials are used, double glazing — two layers — is recommended for sunspaces used as living areas. With single glazing, night-time heat loss is greater than daily solar gains. New glazing materials with three or even four layers have been shown to perform well in the coldest winter months. Remember, however, that each layer of glazing



ADD-ON SUNSPACE WITH VERTICAL GLAZING.

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reduces the level of light and therefore reduces heat gain. The inner layers of some window units are of a heat-reflecting film that allows sunlight to pass through but prevents radiant heat energy from escaping. Department of Energy tests for January and February have shown quad-glazed (four-layer), heat-reflecting vertical glazing performed better in moderate climates than 60-degree sloped double glass with night insulation. The quad glazing did only slightly worse in March and April. This heat-reflecting glazing system can be expensive — $6 to $8 per square foot — but may be less expensive than sloped double glazing with movable night insulation. Movable insulation requires someone, or an automatic system, to move it into and out of place, depending on time of day and cloud conditions.

Insulation Values

R-19* is the minimum insulation value for the east and west walls of the sunspace, and unglazed areas of the south wall. The roof should be insulated to about R-38. If the roof is of sloped glazing, movable insulation with insulating value of R-5 or better should be used. Insulation of at least R-10 should be installed on the outside of foundation walls, down the footings and under the sunspace floor. Movable night-time insulation with at least an R-5 rating is necessary for double glazing if the sunspace is used to keep plants or serve as

* *R refers to resistance of a material to the flow of heat. Higher R values indicate higher resistance and lower heat loss.*

TABLE 1. GLAZING MATERIALS.

(not a complete listing)

Material	*Available Sizes*	*per sq. ft.* Cost ($)	*per sq. ft.* Weight (lbs.)	*Life (yrs.)*	*Installation*	*Availability*	*Comments*
Glass (double strength) 1/8 in. minimum	Cut to size, usually at no extra cost.	1.00 to 1.75	1.6	50	Set on neoprene blocks; butyl tape all around.	Glazing and plate glass companies; some hardware and home repair outlets.	Very fragile; temperature to 400°F.
Glass (tempered) 1/8 in. minimum	Many standard sizes; cannot be cut.	1.25 to 2.00					Somewhat fragile; temperature to 400°F.
Glass 3/16 in. low iron or Water White Crystal	Same as above.	to 3.00+	2.0	50	Set on neoprene blocks; butyl tape all around.	Glazing and plate glass companies; some hardware and home repair outlets.	Usually available in textured surface, which is good for collecting diffuse energy.
Glass (double glazed) thermal patio door replacements	76 in. x 34 in. most common, other sizes available.	About 3.50	4.0	50	Same as glass above.	Glazing and plate glass companies.	Only use types with flexible (not welded) joints between the two layers of glass; temp. to 400°F, somewhat fragile.
Fiberglass Reinforced Plastic (FRP)	24-60 in. wide; 8 ft. sheets to 50 ft. rolls; various thicknesses.	.80 to 1.60	0.5 to 1.0	8-12	Nails or screws with rubber washers through oversized drilled holes.	Not as available as glass; becoming more popular; mail orders possible.	Max. temp. 200°F; moderate impact resistance; will yellow quickly if not coated with Uv protection; easily cut to size.
Acrylic Plastic	Great variety of sizes and thicknesses.	1.50 to 2.75	.75 to 1.6 in Normal Thicknesses	25	Similar to glass; can be drilled and mounted like FRP.	Widely available in lumber and hardware stores, glazing and glass companies.	Moderate impact resistance; temp. range 160°F to 200°F; scratches easily; easy to cut; may yellow with age.
Polycarbonate	Great variety of sizes and thicknesses.	1.20 to 7.00	Up to 1.0	10-15	Similar to glass; can be drilled and mounted like FRP.	Less widely available than others, solar specialty suppliers.	Highly impact resistant; temp. range 200°F to 260°F; scratches easily, easy to cut; may yellow with age.

living space. Expect some night-time winter temperatures in the low 40s even with R-5 insulation and double glass, so choose cold-hardy plants and be prepared to provide some supplementary heat to insure plant survival over long cloudy periods.

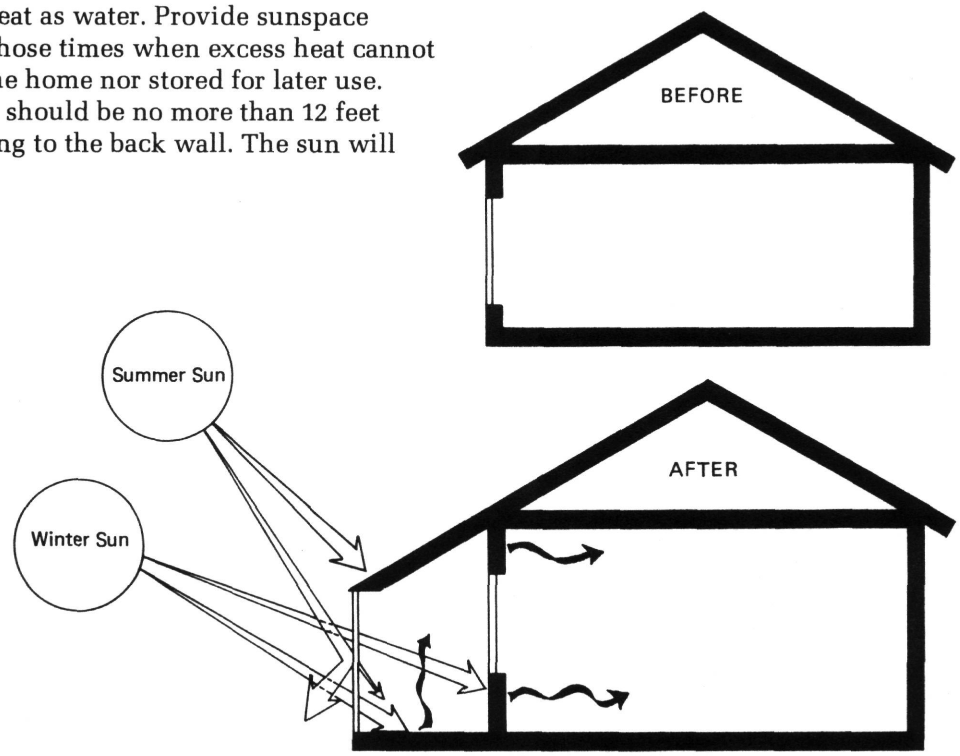
Heat Storage

In addition to glazing and insulation, heat storage is a necessary consideration in sunspace design. If home heating is the only use of the sunspace, heat storage isn't absolutely necessary. Bright sunlit days, however, even in winter, can heat sunspaces to 120F degrees. Night-time temperatures may drop below freezing. High temperatures are great for supplying heated air to your home, but neither plants nor people can live in sunspaces with those highs and lows. Thermal storage of solar energy will moderate the day-time highs and the night-time lows, increasing comfort level and plant survivability. Masonry, containers of water or phase-change materials (also called eutectic salts) all store heat. To minimize temperature swings, you need for every square foot of glazing the equivalent thermal storage of 3 to 5 gallons of water in the direct path of the incoming sun. The phase-change materials store from four to seven times as much heat as equal volumes of water. Masonry, on the other hand, requires about five times the volume to store as much heat as water. Provide sunspace ventilation for those times when excess heat cannot be utilized by the home nor stored for later use.

The sunspace should be no more than 12 feet deep from glazing to the back wall. The sun will penetrate no deeper than that on most winter days in Michigan. Placement of furniture or room for planting beds and garden tending requires that sunspace depth be no less than about 8 feet. If home heating is the only use, then the sunspace need only be deep enough to allow for occasional cleaning of the glazing.

Consider the following when deciding about building a sunspace:

- The primary purpose of the space — heat collector, living space or greenhouse.
- State and federal tax incentives. (The IRS rarely allows all of the cost of a sunspace in calculations of tax credits.)
- Expected future increases in heating fuel costs.
- The long heating season in Michigan (October through April).
- Opportunity cost — other ways to spend, invest or save your money — need to weigh this against heating fuel savings, increased home value.
- Increased insurance costs.
- Cost of interest on money borrowed to finance a sunspace.
- Add-on sunspace can add to your quality of life if it is carefully designed to serve your needs.



RETROFIT ATTACHED SUNSPACE.

Further Reading and Resources

Extension Bulletins
E1573 - *Caulking and Weatherstripping*
E1141 - *Window Treatments for Thermal Comfort*
E1163 - *Heating Your Home With Solar Energy*
E1164 - *Energy Conservation – The Tax Approach*
E1548 - Energy Tax Credits
E1640 - *Passive Solar Energy for Homeowners*

Solar Greenhouses and Sunspaces: Lessons Learned, National Center for Appropriate Technology (NCAT), U.S. Department of Energy publication.

Ron Alward and Andy Shapiro, *Low-Cost Passive Solar Greenhouses,* NCAT, Butte, Montana, 1980.

J.W. Bartok, Jr., et. al., *Solar Greenhouses for the Home,* Cooperative Extension, NRAES, Riley Robb Hall, Cornell University, Ithaca, NY.

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