Passive Solar Design for the Home

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

SECO FACT SHEET **NO. 17**

HIGHLIGHTS

- **Direct or indirect gain, solar heating can save money**
- **House orientation and window sizing are keys to proper design**
- **Thermal storage helps control overheating of spaces**
- **Porches and trees are important elements in solar control**

SUMMARY

Solar orientation for heating and cooling is not a new idea. Builders in China and Greece were designing buildings that captured the heat of the sun well over 2,000 years ago. Buildings in any climate can take advantage of the sun. All that is required is a willingness to incorporate passive solar design into the home, which then becomes in effect a large solar collector.

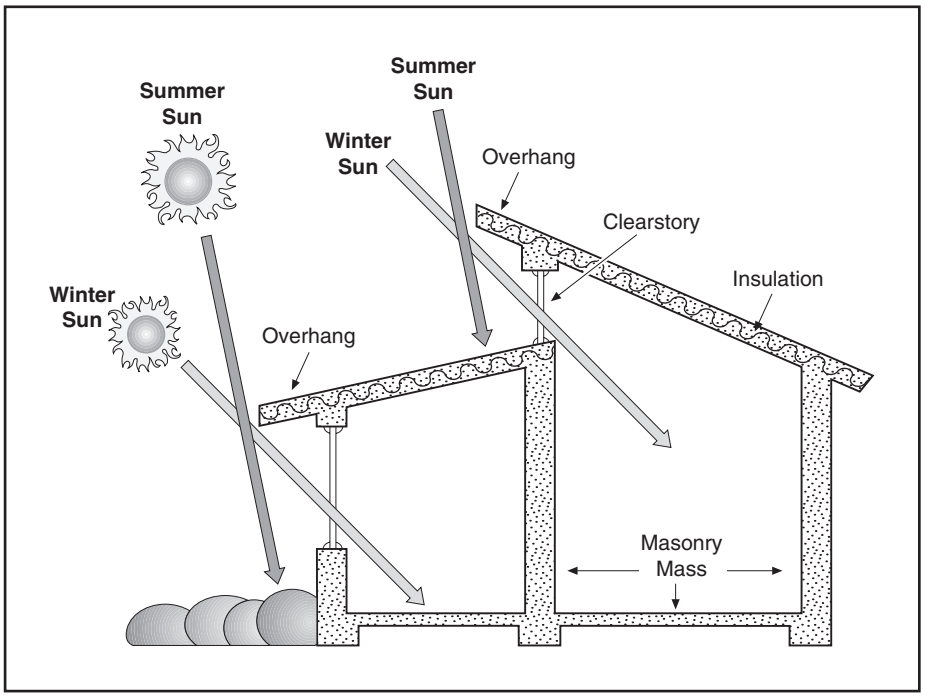

Fig. 1. Sun angles *This cross-section illustrates the direct gain concept.*

ANGLING FOR MAXIMUM EFFICIENCY

Except for locations near the equator, the sun is much lower in the sky during the winter than it is in the summer. Solar homes are designed to take advantage of the changing position of the sun to allow sunlight to shine into the house in the winter and to block it during the summer. To achieve that objective, homeowners and builders must know the actual sun angles at various times of the year. Using that information, they will know where to place windows and overhangs.

DIRECT-GAIN SYSTEM

The simplest way to incorporate passive solar heating is to just let the sun shine into the home. Known as a direct gain system, this design uses south facing windows to admit heat from the winter sun (See Fig. 1). That heat is then stored using thermal mass. During the summer, when the sun is higher in the sky, the sun is blocked by window overhangs. For Texans, the most impor-

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tant consideration is to make sure that the south facing windows are in proper proportion to the square footage of the house. Too many windows will result in too much heat, which could be worse than none at all. (See Table 1 for glass to floor area ratios).

When designed properly, a direct-gain solar home in a north Texas city like Amarillo could get 75 percent of its annual heating from the sun.

INDIRECT-GAIN SYSTEMS

The most common type of indirect system is a greenhouse or sun porch (See Fig. 2). These rooms trap heat from the sun that can be used in other parts of the house. These structures – which can provide additional living area or a place for growing plants – usually contain a substantial amount of thermal mass to help store heat from the sun. This heat can then be distributed to other parts of the house by natural convection or by a low-power fan.

During the hot Texas summer, when homeowners want to keep their homes as cool as possible, these structures can be covered with a curtain, shades or blinds. Or the space can simply be vented so that warm air escapes to the outside.

THERMAL STORAGE

Solar homes function best when they are constructed with dense material that gains and loses heat slowly. These dense materials, known as thermal mass, can be water, adobe, insulated concrete slabs, masonry or even a brick fireplace. The thermal mass absorbs heat during the day when the sun is shining and releases it at night and during cloudy periods. Thermal

RELATIONSHIP BETWEEN DIRECT-GAIN GLAZING AND HEAT CONTRIBUTED BY SUNLIGHT
(Single-Story House)

City	Percent South-facing Glazing Necessary (Compared to floor area)	Percent Annual Heating from Solar Contribution*
Abiline	8 to 15	44 to 69
Amarillo	12 to 19	54 to 75
Austin	6 to 12	36 to 63
Brownsville	3 to 7	33 to 60
Corpus Christi	4 to 9	35 to 62
Dallas	6 to 13	35 to 63
Del Rio	6 to 11	38 to 64
El Paso	10 to 16	58 to 77
Fort Worth	6 to 13	35 to 63
Houston	4 to 10	28 to 58
Laredo	4 to 8	33 to 60
Lubbock	11 to 18	56 to 76
Lufkin	6 to 12	34 to 62
Midland-Odessa	10 to 15	55 to 75
Port Arthur	5 to 11	32 to 61
San Angelo	8 to 14	44 to 69
San Antonio	6 to 11	36 to 64
Sherman	7 to 14	34 to 62
Waco	6 to 12	35 to 63
Wichita Falls	8 to 15	40 to 66

* Assuming heavy masonry mass 3 to 4 inches thick with a surface area at least three times as great as the area of south facing glass (with six times preferred).

Table 1. Free Heat from the Sun *This table estimates the appropriate area of window glazing on a south-facing wall. For example, for a 2,000 sf home in El Paso, the table recommends 200 to 320 sf of glazing (2,000 x 10% or 2,000 x 16%). This should contribute 58% to 77% of the home's annual heating needs provided the design incorporates thermal mass to store the solar heat gain.*

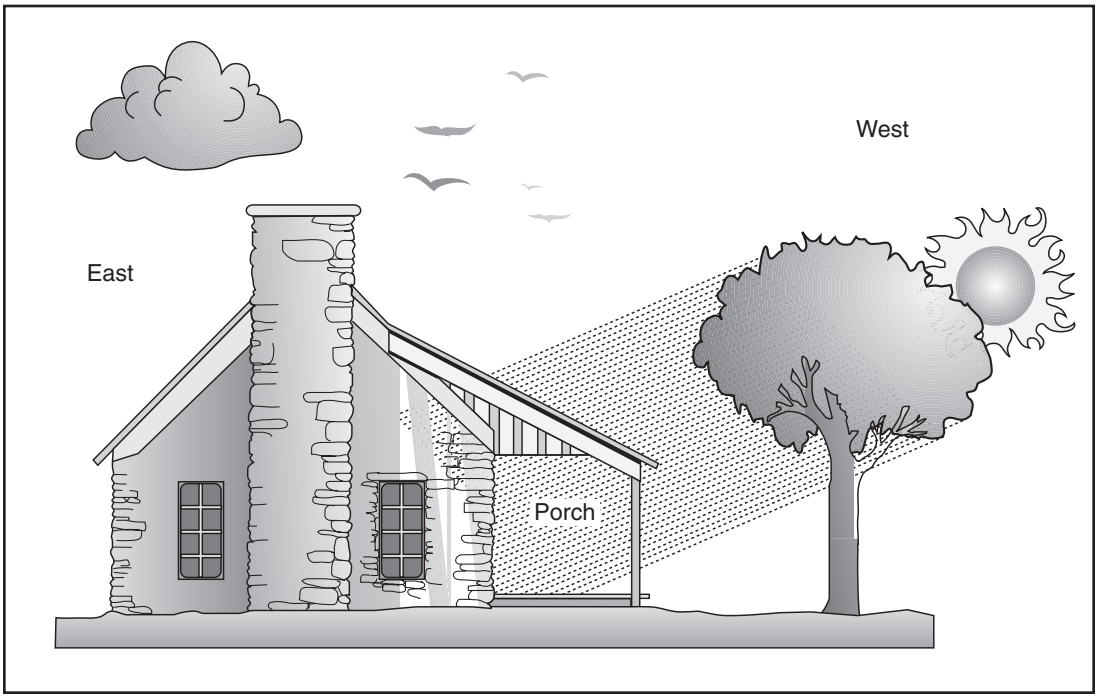

Fig. 2. Proper landscaping reduces energy cost *Using natural shading from trees and placing buffer spaces, such as porches and garages, on the west facade results in significant cost savings for heating and cooling.*

mass also helps prevent daytime overheating by absorbing excess heat.

Builders often use glass-covered thermal mass walls on the south side of homes. In use for centuries, these walls are sometimes called Trombe walls after French architect Felix Trombe. If the walls are constructed of masonry, they can be optimized by incorporating small vents in the top and bottom so that warm air from the air cavity in the wall will flow into the home. If the home becomes too warm, the vents can simply be closed.

In Texas, where cooling is usually more problematic than heating, thermal walls can be constructed so that vents will move heated air to the outside during the summer. In addition, a properly sized roof overhang will prevent sunlight from striking the wall during the hot summer months.

NATURAL SHADING AND LANDSCAPING

Deciduous trees may be low-tech, but they are one of the most effective tools that can be used in the design and operation of a solar home. During the summer, the trees provide shade, preventing the sun from warming the home. In the winter, stripped of leaves, they allow the sun's rays to provide heat. Studies have shown that home cooling and heating loads can be reduced as much as 30 percent through the proper use of landscaping elements like shade trees, windbreaks, shrubs and grass.

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ORGANIZATIONS

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ON THE WORLD WIDE WEB:

Renewables, products, sustainable living. A good place to start your search.
solstice.crest.org

Operated by the **North Carolina Solar Center**, this site offers a wealth of information, including ideas on how to decorate a passive solar home. **www.ncsc.ncsu.edu/**

Site operated by the **Texas Solar Energy Society,** a good place to start. **www.txses.org/**

City of Austin Green Builder Program's comprehensive guide covering energy, water, building materials, solid waste and other topics. A mammoth resource.
www.greenbuilder.com/sourcebook

Offers tips on solar orientation and other information. Also visit Oikos.com for a comprehensive guide to green building. **www.oikos.com/esb/42/solar.html**

BOOKS:

Interior Design for Passive Solar Homes. Jill C. Breen, National Renewable Energy Laboratory, 1981.

The Passive Solar House: Using Solar Design to Heat and Cool Your Home. James Kachadorian, Chelsea Green Publishing Co., 1997.

The Passive Solar Energy Book. Edward Mazria, Rodale Press, 1979. (Often available at libraries)

Sunspace Basics. U.S. Department of Energy, to order call (800) 523-2929.

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