

Solar

Passive Heating and Cooling — The Basics

By D.A. "Cap't. Solar" Bainbridge

The first step in passive design is improving the thermal performance of a house. Improving the energy efficiency of a house beyond the standard level is remarkably easy. In most areas it is reasonable to expect at least a doubling in the energy efficiency of the house — with only minor increases in cost. The following steps should be included: A) orientation, B) insulation, C) weatherizing, D) shading, E) modifying the environment.

A. Orientation

Good orientation is essential for an energy efficient house. The effects of bad orientation can be remedied to some extent — but doing so can be expensive. The best orientation is for the house to be longer east-west than it is north-south, with a major yard to the south, and most of the windows facing south and a few facing north, east or west. This orientation will maximize solar heating in winter and minimize summer overheating by making best use of the difference in sun path. Even a house with less than ideal shape will work well if the glazing is predominantly on the south side.

B. Insulation

The second step in building or remodeling for energy efficiency is reducing unwanted conductive heat loss (or gain). Insulation is the key — not only for the walls and ceiling, but also for the foundation or slab perimeter, the windows, and the people inside.

C. Weatherizing

Infiltration losses are as important as conductive losses and careful weatherizing is necessary. This includes both the obvious problems of weather-stripping doors and windows and also the more general problems of caulking and sealing of building joints, access holes, and any other areas where unwanted infiltration occurs. Infiltration may account for almost 1/2 of the heat loss in a well insulated but poorly weatherized house.

The infiltration rate on a typical house is around 1.5 air changes/hour. It can go up significantly if a high wind is blowing. However, with very careful attention to detail this can be reduced to about 0.5 air changes/hour. The Swedish have reduced infiltration in some of their houses to 0.2 air changes/hour.

D. Shading

The importance of effective shading is best illustrated with an example. In the Central Valley near Sacramento 55 square feet of west facing glass will add 55,000 BTU to a house during the afternoon. A ton of air conditioning is required to offset this gain. And to run the air conditioner at the peak period of electrical use almost 2 kw of generating capacity are required.

Shading or solar control is relatively easy if the house is oriented properly. Overhangs and wing walls can shade most south windows. Those windows that cannot be shaded in this manner may be shaded with any of the exterior shade screens.

E. Modifying the Environment

Very substantial savings in energy use for heating or cooling may be realized by altering the environment the house sits on. Three possibilities are particularly attractive: landscaping, berming or undergrounding, and building a house within a house.

Most of these should be fairly obvious and familiar, however, the house within a house looks particularly attractive in more severe climates and deserves greater attention. The concept was recently developed (or rediscovered by Malcolm Lillywhite in Colorado, but has been popularized by Lee Butler and Tom Smith. Tom Smith's house is shown in cross section to show why we call it a house within a house.

This design greatly reduces the interior house heat loss from both conduction and convection and enables south windows to provide much of the winter heating.

After improving the house, then we can apply the following principles of passive solar design to make it a naturally heated and cooled house.

Passive solar systems are very effective for heating. They differ widely in configuration, performance and cost, but do have several features in common. These include: glazing to admit the sun's energy, glazing control (insulated drapes or shutters) to reduce unwanted heat loss or heat gain through glazing, and thermal mass to store the sun's energy. The following rules apply to all passive solar heating systems.

SIX RULES FOR LOW COST PASSIVE HEATING:

1. Make sure the house is weather tight and well insulated.
2. Make sure the house is oriented properly, with most windows on the south.
3. Use the minimum amount of glazing necessary for heating.
4. Make glazing control simple, reliable, effective and convenient to use.
5. Use the simplest, smallest, and most economical method of providing needed thermal mass.
6. Consider cooling demand as well and integrate design to achieve lowest cost heating and cooling.

AND FOR COOLING:

SEVEN RULES FOR PASSIVE COOLING

1. Make sure the house is oriented properly with most windows in south and north, few on east and west.
 2. Provide shading for all windows in summer (awning, overhang, etc.)
 3. Use light roof color.
 4. Provide windows, vents, and fans (if necessary) for good ventilation and convective cooling.
 5. Use thermal mass (water tanks, rock or concrete) to store nighttime cooling for use during the day.
 6. Consider heating demand as well and integrate design to achieve lowest possible cost.
- That's all it really involves.

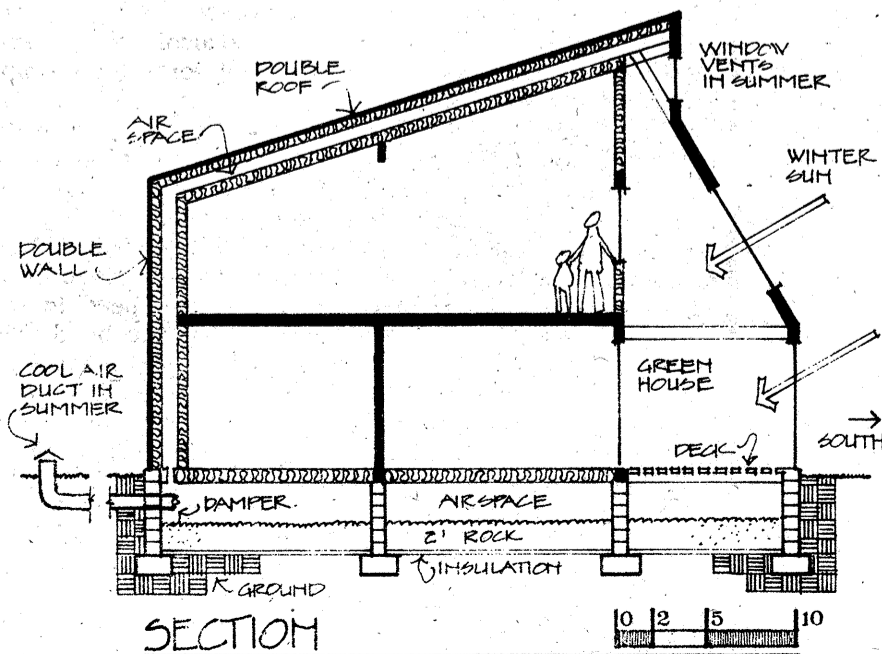
Present Value - Gigi Coe and others. (1979) Office of Appropriate Technology, 1530 Tenth, Sacramento, CA 95814.

This book is without a doubt one of the best government publications I have seen. It is timely, well illustrated, and well written, and free — who could ask for more.

It is more of a teaser than a how-to book, but its hard to expect more in a 46 page book that includes Active and Passive Solar design and examples, both residential and commercial, using water waste, recycling, gardening, biomass, wind, and more.

The whole thrust of the book is to demonstrate that renewable energy and energy conservation are feasible, attractive, and cost effective. It succeeds and points the way toward a sustainable future.

The Smith House



For more information:
The First Passive Solar Catalog (1978) D.A. Bainbridge, PSI, Box 722, Davis, CA 95616. \$6.00

The Passive Solar Book (1979). Ed Mazria, Rodale Press (at your bookstore). \$10.95

Homegrown Sundwellings. (1977) Peter Van Dresser, Lighting Tree Press, \$5.95

The Solar Greenhouse Book (1978) Jim McCaullagh, ed., Rodale Press. \$8.95

Natural Solar Architecture (1979) Dave Wright, Van Norstrand Reinhold.

Solar Heating (1978) Holly Antolini, ed. Sunset, Menlo Park (at bookstore). \$2.95

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The First Passive Solar Catalog, 1978, David A. Bainbridge \$6 ppd. (Ca add 30c tax)

Says William Shurcliff of The First Passive Solar Catalog:

A great book, a kind of mini-encyclopedia, containing a wealth of material, very up-to-date, excellently and profusely illustrated, and written with great clarity. As for accuracy: I just wasn't able to find any mistakes at all! The book is different from, and much more comprehensive than, a catalog. It is an across-the-board source-book. A broad-scope survey of the whole subject of passive solar heating.

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