A Step Ahead in SOLAR LIVING

BY CHERYL SCOTT

This home has no furnace, no air conditioner, not even a fan. Yet the house maintains comfortable indoor temperatures year-round. How? Air flows in a gravity convection loop through an air space that acts as a buffer between you and the weather. Read on and we'll explain how this ingenious design works.

Lots of people think that Tom Smith's home in Lake Tahoe, California, is just another passive solar house—that is, one that doesn't use mechanical means to generate and distribute heat. The house does have a lot in common with passive solar homes. The similarities include a south-facing greenhouse in front, no windows on the north side, few windows on the east and west, plenty of insulation, no mechanical comfort equipment, and (best of all) incredibly low heating and cooling bills. But Tom Smith's house has something that other passive homes lack: a second skin.

Any house transfers heat through its roof, walls, floor, windows, and doors—all components of the buil...

exterior

Construction of Smith's three-bedroom, 2,000-square-foot home called for no unconventional building materials or methods, so the home cost *no more* to build than any house of similar square footage in the Tahoe area. The simple box shape of the house and the lack of ductwork resulted in savings that offset the additional framing costs for the extra 2x4 stud wall on the north side.

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The greenhouse, *right*, is more than an inviting place to relax; it's part of the air envelope, too. Double glazing helps the greenhouse act as a solar collector. Air warmed in the greenhouse rises to ceiling level and begins its flow through the roof/north wall plenum, then down to the crawl space, and back to the greenhouse through the slatted wood floor.

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Photographs: Fred Lyon. Architect: Lee Porter Butler. Source: Barbara Cathcart. Art Director: Sheila Barger

SOLAR LIVING

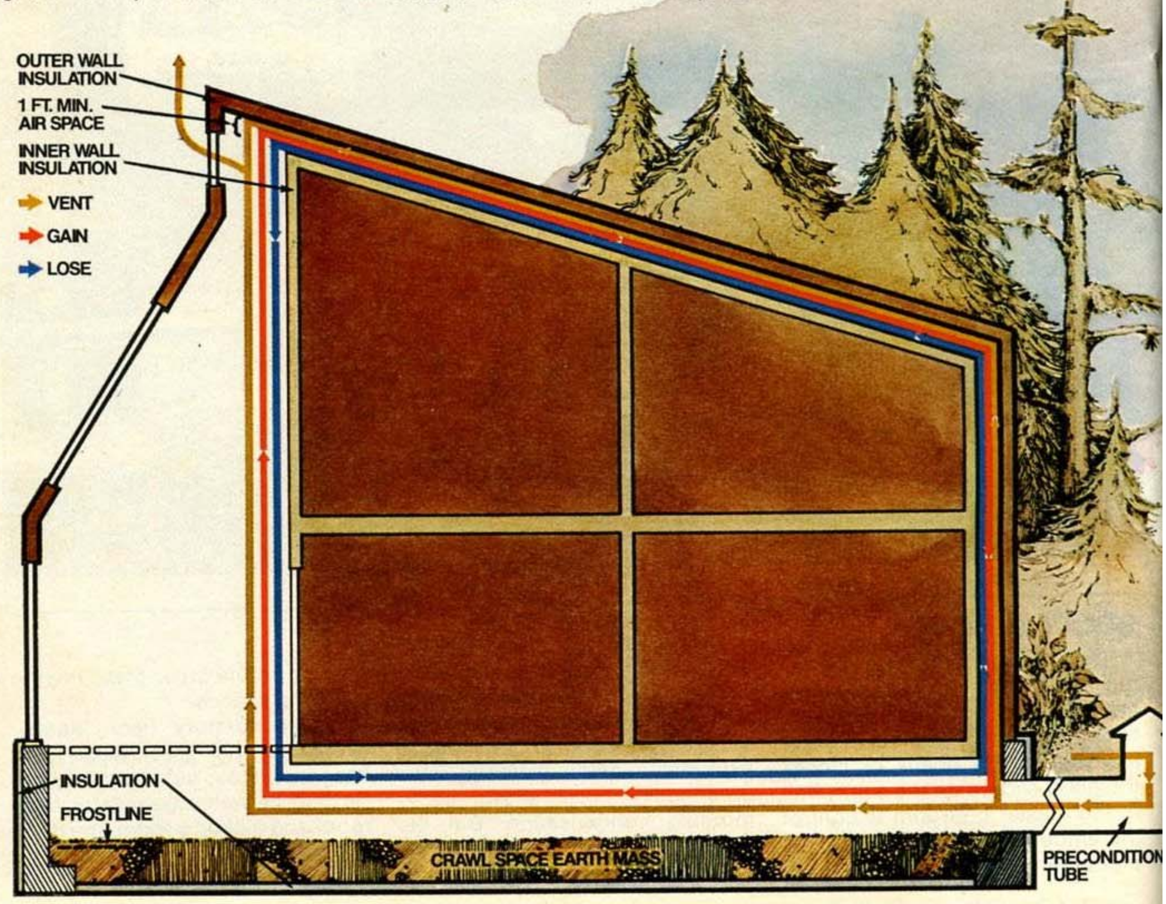
A STEP AHEAD

How the system works

The Smith house is surrounded on four of its six sides (think of the house as a cube) by an envelope of solar-tempered air. This heat transfer envelope is a continuous space consisting of the earth-floored crawl space, the south-facing greenhouse, and a 12-inch-deep plenum that runs between the rafters along the roof and between the studs along the north wall of the house. Air flowing within this heat-transfer envelope space can accomplish three things: gain heat, lose heat, and ventilate and cool. Follow the colored arrows in the diagram below and see how each mode works.

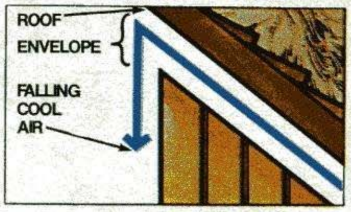
gaining heat

The large areas of insulated glass in the greenhouse help to collect solar heat during the day. As the greenhouse heats up, the envelope air acts as a gravity convection loop and goes into action. *(Follow the red arrows in the diagram below.)* Warmed air rises in the greenhouse and flows through the roof plenum. When the air reaches the cooler north wall, heat loss along the north face of the envelope allows gravity to draw the convection loop downward toward the crawl space. The mass of earth in the crawl space acts as a heat bank, absorbing the remaining warmth from the air as it flows over the earth. The airflow loop is complete when the air reaches the greenhouse. There the air again warms and rises, continuing the clockwise heat gain flow.



losing heat

At night, when the greenhouse glass is losing heat to the outdoors, the air convection loop runs in reverse *(blue arrows)*. The cooler greenhouse air falls toward the earth mass in the crawl space. As the air flows over the crawl-space earth, it gradually picks up warmth from the earth mass. As new, cool air falls to the crawl space from the greenhouse, the first batch of now warmer air begins to rise up the north wall plenum and flow through the roof plenum, warming the interior spaces below. Thus, air flows counterclockwise during a heat loss cycle.



ventilating and cooling

When it's uncomfortably warm in the house, you can use the gravity convection system to cool the living spaces *(orange arrows)*. By opening the glass sliders between the living areas and the greenhouse, and opening the clerestory windows at the top of the greenhouse, you can exhaust excess heat from the house. (By the way, homeowner Tom Smith reaches those topside windows with a pole like the ones you probably remember from your elementary school days.)

An underground tube, which preconditions outdoor air to ground temperature, can be used to provide a steady supply of cool air to the system. (In cold climates or at high elevations, such as the Lake Tahoe site, a preconditioning tube is not necessary.) In very humid climates, double masonry walls on the east and west walls can provide additional cooling and dehumidification.

Why the envelope system works

In effect, this house is triple-insulated on four of its six sides. The inner and outer walls that sandwich the airflow space, plus the floors, are insulated with fiber glass batts; the foundation and crawl space are insulated with urethane foam; and the interior and exterior sliders in the greenhouse are double-glazed. Between these layers of insulation, the air space acts as yet another buffer zone, slowing heat gain and heat loss between the inner house and the outer shell.

The envelope works the way that insulation does to slow the transfer of heat. By extending the distance that heat must travel as it is gained or lost by the house, the envelope modifies the difference in temperature between the outdoor and the indoor environments. Because the envelope also functions as an air distribution system, wrapping the house in a blanket of evenly warmed or cooled air, there are no hot or cold spots in rooms, no drafty corners. The house is amazingly quiet, too, because there is no on-off cycling of the furnace or air conditioner. Tom Smith said, "I never realized till now my refrigerator made so much noise."

The greenhouse and the crawl-space earth mass play important roles, too. The greenhouse collects the most heat when the home is sited with the greenhouse facing due south, but the greenhouse may be oriented slightly east or west and still be a viable collector.

The earth mass acts as a natural thermal battery, charging during heat gain cycles, discharging during heat loss cycles, as air circulates over the crawl-space soil.

Would it work for you?

In a word, yes, provided your envelope house is planned for its site. The design of Tom Smith's house was determined by such factors as latitude, longitude, the amount of shading from nearby trees, other topographical features of the site, the range of Lake Tahoe temperatures, and the amount of humidity, sun, and wind.

However, many engineering and materials specifications can be adjusted in order to develop a house that will work efficiently in *your* climate and on *your* piece of land. Here are just some of the factors that can be balanced:

- Insulation values
- Types, sizes, and location of windows, doors, and skylights
- Slope, orientation, and height of the roof above the living areas
- Depth and position of overhangs and other sun-shading devices
- Surface area of roof vents and dampers
- Size of the air preconditioning tube (if necessary in your climate)
- Waterproofing and subgrade foundation drainage system

You'll find more information on the envelope system in *The Energy Producing House: A Handbook/Case Study* ($18.95 per copy). The 60-page booklet tells the story of how the Smith house shown on these pages was planned and built.

An 80-page companion booklet, *Ekose'a Homes* ($24.95 per copy), includes a catalog of ten envelope homes designed for six major climate areas.

To order either booklet, make a check or money order payable to the publication you prefer and mail to *Handbook/Case Study* or *Ekose'a Homes*, 573 Mission St., San Francisco, Calif. 94105.