Going Green

A Wise Consumer's Guide to a Shrinking Planet

Sally Kneidel, PhD, and Sadie Kneidel

the two through a gap in the rubber divider.

The panel functions by allowing sunlight to shine through the glass and heat the black rubber. If you stand the panel on one short end facing the sun, with the other short end opening into your house through a window, the air warmed by the sun will rise through the open end of the panel and flow into your house. Meanwhile, chilly air from the house is drawn into the insulated lower layer of the panel. It flows through the gap at the lower end of the rubber layer and replaces the recently warmed air.

For construction details and more explanation of the unit's operation, see the *Mother Earth News* web page below.

Note

1. "Mother's Solar Heat Grabber," *Mother Earth News*, September/October 1977 www.motherearthnews.com/Green-Home-Building/1977-09-01/Mothers-Heat-Grabber.aspx .

A Solar Water Heater

A water-heating panel is more complicated because the materials are harder to come by, particularly if you scavenge them. But after you have the supplies, building takes about three hours and can be close to free.

This device works by pumping water through metal tubes inside a warm solar box. By the time the water has passed through all the tubing, it has absorbed much of the solar heat captured by the box around it. You can collect this water in buckets and pour it into your tub for a hot bath or into your sink for dishes or delicate laundry. By the time it empties into the bucket, it will be warm. If the water flows continuously on a reasonably sunny day, it will heat from 70 degrees to 110 degrees by the time it has passed through the system. If you stop the flow and allow the water to sit in the panel for a few minutes, it can get as hot as 170 degrees.[1]

For construction details, see the website below.

Note

1. The Sietch, "Build Your Own Solar Thermal Panel," www.thesietch.org/projects/solarthermalpanel2/index.htm.

Building Techniques

Passive-Solar Design

Altering your existing home is one thing, but building a new home opens a world of opportunity for going green. If you're considering building an energy-efficient home, the most important concept to understand is passive-solar construction.

The south side of Kathleen Jardine and Jim Cameron's passive-solar home features solar-thermal panels and a broad expanse of windows.

Passive-solar design doesn't involve technology, hence the word *passive*. Rather, it prescribes the layout of the home and how the building is situated on the lot. A passive-solar design captures the sun's heat and light in winter and deflects it in summer. We visited Kathleen Jardine and Jim Cameron's passive-solar home to see what this means in action.

Approaching Cameron and Jardine's cottage on foot, we walked through the lush flower and vegetable gardens that surround the south and southeast sides of the house. Although it was autumn, sprightly orange blossoms stood tall, profusions of pink and purple blooms nodded gently in the breeze, and a fat green bullfrog burped a greeting from the handsome stonework around a burbling fishpond.

Buck Naked Outdoors

As it turns out, the outdoor charms are a big piece of the puzzle in the passive-solar strategy for energy efficiency. By incorporating pleasant outdoor areas into their living space, homeowners can be comfortable with a smaller house without feeling crowded. A smaller home is cheaper and more efficient to build as well as maintain.

In addition to the verdant gardens and ponds, Jardine and Cameron have maximized their outdoor space with shady, covered porches. The east porch offers inviting benches, while the west porch features a gas stove—and a shower stall!

As if the pleasure of cooking and showering in the sweet, fresh summer air weren't enough, the heat and humidity associated with cooking and showering also disperse into the great outdoors. Of course, there is an indoor kitchen and bathroom as well for chilly times—and for modest visitors.

The outdoors is also made accessible by the home's low floor, with just one step down to the ground. In addition to making the outdoors feel more available, the easy transition also helps older people to stay in their home longer as their knees and hips grow weaker.

What Is *Passive-Solar*, Exactly?

Unlike photovoltaic homes, passive-solar design does not use panels to harness energy. Instead, the house itself captures and stores the sun's energy. The design and orientation of the house trap the sun's heat inside the house in winter and block the sun's rays in summer in order to reduce the amount of fuel or electricity required for heating and cooling.

A passive-solar house should be rectangular in shape, with its longest walls on the north and south sides. In the northern hemisphere, the south side of such a house will

Kathleen Jardine and Jim Cameron's south-facing windows overlook a beautiful garden and pond. The midday winter sun floods the home with heat.

get the most exposure to the sun, so it should have many large windows to admit the rays of the sun in winter. To get the maximum warming benefit of the sun in winter, the long southern wall should face within fifteen degrees of true south.

Interestingly, virtually all caves that once housed humans open to the south, as do all the pueblos and cliff dwellings in the southwestern United States. People who lived in these places learned long ago the principles of heating homes with the warmth of the sun.

A Wide Overhang Blocks Summer Sun

Every day, the sun rises in the east and sets in the west, regardless of the season. But during summer, the arc that the sun travels every day is higher in the sky than it is during winter. So during summer, the sun shines on the house from a relatively high point in the sky.

This is crucial to solar design. At a latitude of 35° north (around the middle of the United States), the roof on the southern side of a passive-solar house needs a two-foot overhang about seven-and-a-half feet from the floor. The overhang blocks the rays of the high midday summer sun and keeps them from hitting the windows directly. But during winter, the sun is low enough in the sky, even at midday, to peek under the overhang and send its warming rays inside the house. As you move farther north, the summer sun is less high in the sky, so you need a bigger overhang. (There are formulas for calculating just how wide this overhang must be. Sustainable By Design has a number of useful calculators online at http://susdesign.com/tools.php.)

The wide overhang on the south side of Kathleen Jardine and Jim Cameron's home blocks the higher rays of the midday summer sun.

Climbing Vines Galore

Jardine and Cameron's passive-solar house is adorned with lush climbing vines above the windows on all sides of the house. The east side, with its main entry, features jasmine, climbing aster, and old rose; on the south side are grapevines. During summer, when the vines are full and leafy, they help the overhang block sunlight from entering the windows. During the winter, when the vines lose their leaves, they allow solar heat in through the windows.

When leafed out during summertime, vines help shield these east-facing windows from the morning sun.

Deciduous trees, which lose their leaves in winter, perform the same function. But evergreen trees, which keep their leaves or needles all year, have to be dealt with differently. Cameron and Jardine explained that an object ten feet tall casts a shadow seventeen feet long; the shadow is 1.7 times as long as the object's height. So if you have a ten-foot-tall evergreen tree on the south side, as Jardine and Cameron do, then it must be seventeen feet from the south wall or else it will block your solar gain in winter. One way to get around this and to keep more trees is by positioning the house on the northern edge of a downward slope so that the trees on the south side are shorter in height relative to the south-facing windows.

An outbuilding or neighbor's house on the south side requires similar considerations. If the ridge of the building's roof is twenty feet tall, then it will need to be thirty-four feet from the south side of your passive-solar home.

Cameron and Jardine have resolved the sunlight issue by locating their gardens on the south side of their home. On the north side of the house, close shrubs and trees help block cold winter winds and don't interfere with light.

A Gorgeous Thermal Mass

If your bare feet have ever felt the warmth of a paved road after the sun has gone down, you've experienced a thermal mass. A substantial thermal mass—something that absorbs solar heat during the day and releases the heat slowly after the sun is gone—is an essential part of a passive-solar home—it helps heat the home in the evenings after the sun is gone. Early solar homes in the 1970s sometimes had barrels of water standing around to serve as thermal masses. Cameron and Jardine have a prettier solution.

One of the first things we noticed when entering their home for the first time was the lovely red stonelike floor throughout. Like the charming red roof and the golden stucco exterior, the red floor lends the inside rooms a warm and cozy feel. But we learned soon after our arrival that their floor is neither stone nor ceramic tile, as we had assumed. It's actually scored and tinted concrete. *Scored* means that the surface has narrow grooves that appear to be seams between large squares. Adding pigment to the concrete before it comes out of the mixer results in a varied tint with slightly different hues and irregular patterns, such as one might expect in natural stone or marbled tile. The effect is beautiful. As solar designers, Cameron and Jardine know that concrete is an excellent thermal mass, and the least expensive option for flooring that can serve that purpose. As an additional bonus, the floor is maintenance free forever.

Does the Passive-Solar Design Take Care of All Their Heating Needs?

Cameron and Jardine's home has other sources of heat in addition to the solar gain from their southern windows in winter. Their radiant-floor tubing that circulates solar-heated water just under the surface of their concrete floor also heats the indoor air in winter.

Cameron and Jardine also have a woodstove in their living room, which they use

on some cold evenings, often for atmosphere more than for heat. Their Jack Russell terrier, Sleety, spends evenings on her back near the stove, sprawled on their handmade rug, her feet twitching as she dreams of squirrels.

We probably learned more from Jardine and Cameron than from any other single source we interviewed or visited. Over the course of several visits to their home, we found that passive-solar is only one part of their approach to sustainable and energy-efficient building. They are equally passionate about using nontoxic and durable materials. Their ardor on the subject really raised our consciousness about the environmental merits of durability.

Durable Green Building Materials

In addition to passive-solar design, durable green building materials are key to designing an energy-efficient and nonpolluting home. Two main problems with conventional building materials are toxicity and disposability.

Many conventional building materials are made with chemicals that can be hazardous to health or to the environment, though contractors tend to ignore toxicity. For example, popular oriented strand board (OSB), a type of chipboard used for indoor walls, is made of formaldehyde, polystyrene, and wood chips. Not only does OSB give off toxic fumes in the home, but it's also toxic to factory workers, and the production of the wood chips is decimating southeastern forests.[1]

Another potentially toxic building material to look out for is insulation. According to Cornell University, "the manufacture and installation of foam insulations commonly involves the use of CFCs [chlorofluorocarbon] or HCFCs [hydrochlorofluorocarbon], both of which should be avoided. Some other types of foam insulation offgas formaldehyde or contain harmful chemicals. Fiberglass contains small particles that can cause respiratory irritation when released into the air."[2]

That said, *Builder News* magazine reports that some brands of fiberglass are better than others. A few manufacturers are incorporating recycled materials, and some products have lower emissions of formaldehyde and other pollutants than others. The magazine mentions CertainTeed's and Owens Corning's insulations as those that have lower emissions.[3]

In addition to OSB and some insulations, other potentially harmful materials include treated wood, carpets, vinyl siding, and some paints. Offgassing is only part of the problem. These products also harm the factory workers who produce them and the environments in which they are manufactured and where they are eventually thrown away. According to Jardine, carpets and shingles are the two largest single fillers of landfills. If you've ever lived with wall-to-wall carpeting, you know how quickly it becomes trodden and stained. And shingles, which need to be replaced every fifteen to twenty years, are essentially disposable roofs.

For nontoxic and sustainable walls and roofs, Jardine and Cameron use autoclaved aerated concrete (AAC) blocks and steel roofing.

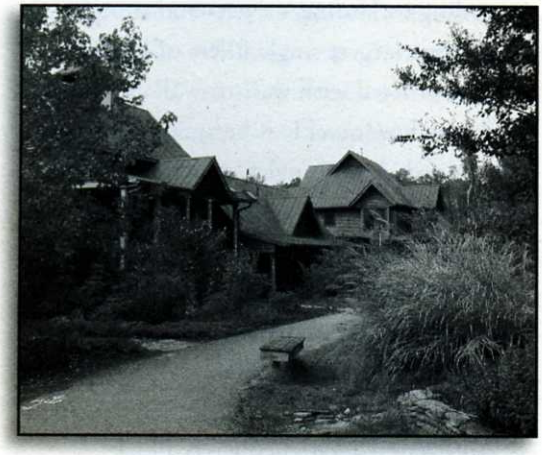
Autoclaved aerated concrete blocks, erroneously called Hebel blocks (the Hebel company is defunct), are white and smooth,

similar in size to cinder blocks. They lack the recessed surfaces and holes of a standard concrete block. They are made by adding foaming aluminum powder to concrete, which makes it fluffier and lighter than plain concrete. Said Jardine, "It's mostly sand. There are no pollutants in the manufacturing of it, no offgassing in the home. And it's hypoallergenic to live in—it doesn't mold."

When Jardine and Cameron found out about AAC blocks from a friend in Israel, no one had heard of them in the United States. Now, more customers are demanding them than manufacturers can keep up with.

Green builders often prefer AAC blocks because they are are energy-efficient, durable, and work well with passive-solar design. They also function as a thermal mass to some degree and are inherently airtight, conserving indoor heat in winter and cool air in summer.[4]

A house made of AAC blocks can last for hundreds of years, keeping truckloads of waste from our landfills. The concrete is also termite proof and very sturdy in hurricanes, earthquakes, and fires. It also requires no maintenance. Blocks are covered with mineral plaster on the inside and stucco on the outside. Once applied, the stucco needs no repainting or retouching—unless you feel like changing the color.



All the homes in this progressive community have durable, colorful steel roofs.

Steel roofs last 100 years, about six times longer than a shingled roof. They come in cheerful shades of red, blue, green, purple, and traditional silver. A steel roof gives a house old-fashioned charm, but some cities have covenants against them, claiming they look like barns. "Rules like that account for what our environment looks like," said Cameron. "People don't think about the long-term effects. ... They just don't think about the consequences."

Double-Hung Windows Save Birds

Some green builders choose casement windows, which open by cranking outward, over traditional double-hung windows, which open by sliding up and down. While casement windows are more airtight, they have a hidden flaw: their indoor screens make them invisible to birds. According to the Wild Bird Center[1] and David Sibley,[2] collisions with windows kill 100 million to 1 billion birds every year in the United States. The external window screens on double-hung windows not only reduce the number of collisions, but also cushion the blow for birds that still strike the window. If you choose casement windows, try to protect birds by relocating bird feeders to within three feet of a window, or decorating a window with decals or stained glass. However, these efforts are much less effective than exterior screens.

Notes

1. Wild Bird Center, "Project Prevent Collision," www.wildbirdcenter.com/content/project_prevent_collision.
2. Sibley Guides, Bird Conservation—Mortality, www.sibleyguides.com/mortality.htm.

Cost and Maintenence

A passive-solar home like Jardine and Cameron's, built with AAC blocks, a concrete floor, and a steel roof, requires about $25 of electricity a month. Hot water is free, thanks to the solar-thermal panels on the roof. Gas is needed only for cooking. No furnace is needed, and an air conditioner is optional. Cameron and Jardine cut a cord of wood per year for the woodstove. With stucco on the home's exterior, there are no repainting needs. The steel roof means no shingles to replace. Inside, the concrete floor means no waxing or replacing of flooring materials. In short, maintenance and operating costs are almost nil.

Notes

1. Denny Haldeman, "The Environmental and Health Impacts of Chipboard," *New Life Journal: Bringing Roots to Modern Culture*, www.newlifejournal.com/junjul02/haldeman.shtml (accessed February 14, 2006).
2. Cornell University, Department of Design and Environmental Analysis, Ecotecture, "Insulation/Energy Efficiency," http://ergo.human.cornell.edu/ecotecture/insulation.htm.
3. "Green Insulation: Some Insulations Out-Green Others," www.buildernewsmag.com/viewnews.pl?id=157.
4. "Concrete Building Systems, Aerated Concrete Blocks," www.scrapbookscrapbook.com/DAC-ART/concrete-building-systems.html (accessed February 16, 2006).

Additional Resources

Kathleen Jardine, "5 Ways to Build a Better House," *Smart HomeOwner* magazine, September/October 2005, www.smart-homeowner.com/ME2/dirmod.asp?sid=&nm=&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=0B62169DEC424961B42C05FD5865CFBD (accessed July 1, 2006).

Kathleen Jardine and Jim Cameron, "Building for Affordability and Energy Efficiency: Walls of Aerated Concrete Block, a Passive-Solar Design, and a Truss Roof All Make it Possible," *Fine Homebuilding* magazine, www.taunton.com/finehomebuilding/pages/h00002.asp (accessed February 14, 2006).

Sun Garden Homes, www.sungardenhouses.com.

Straw-Bale Homes

Thinking Outside the Box

Straw and mud as building materials are also compatible with passive-solar design. Both are currently gaining popularity in sustainable building.

Straw-bale houses have a number of environmental merits, great aesthetic appeal, and can be very economical to build. By itself, straw-bale construction does not have the potential to drastically cut our nation's energy consumption in the same way that passive-solar design can. But when paired with passive-solar design, straw-bale construction is a very environmentally friendly choice.

There is no standard way to build a straw-bale house, but in general, straw-bale homes have walls made of bales of straw or hay that are stacked like giant building

Trip Overholt's passive-solar straw-bale house. The solar-thermal panels above the roof and PV panels in the yard contribute to the home's energy efficiency.