The Energy-Efficient House

Case History

RICHARD CRUME

Screened porches and decks help make this 1,600-square-foot house feel larger.

How one family proved that a **low-maintenance** home doesn't have to cost more.

BY RICHARD V. CRUME

When Yoko and I were first married nearly 25 years ago, we bought a run-down, 175-year-old farmhouse on the Eno River in Hillsborough, N.C. Our historic house was hardly an energy-efficient structure. With five fireplaces, old-fashioned windows and no insulation in the attic and walls, it was a bit drafty, to say the least. Yet, taken by the simplicity and structural integrity of the old house, we resolved that if we ever built our own home, it would share these same qualities.

Now, 25 years later, we are finally living in our custom-designed home. Like our Hillsborough house, it is a simple and sturdy structure, built to last forever. But unlike our first house, our new home in nearby Durham is highly energy efficient, scoring the highest "five-star plus" rating during U.S. Environmental Protection Agency ENERGY STAR testing.

Why, when electricity and natural gas for home use are relatively affordable, was building an energy-efficient house important to us? One reason was our conviction that energy prices are certain to continue rising in the future, and energy conservation will become more and more important. We also felt a responsibility to minimize impacts on the environment, including air pollution from electricity-generating power plants.

Our final motivation for building an energy-efficient house was one of personal economics. As baby boomers approaching retirement age, Yoko and I are concerned about maintaining an independent lifestyle as the cost of living rises. By living in a moderately priced, energy-efficient home, we can better control our housing costs and apply the savings to other essential needs.

BALANCING DESIGN AND COST

Our approach to designing and building the house involved finding a balance of design, technology and cost. With modest incomes and a child in college, we needed to build the house at a cost comparable with other more conventional construction in the area. That meant forgoing high-tech materials and expensive construction techniques, and that any special design features or equipment had to be reasonably priced and cost-effective to install and operate. At the same time, we wanted to realize significant energy savings.

Following months of research, including consultation with the

Why BUILD SMALL?

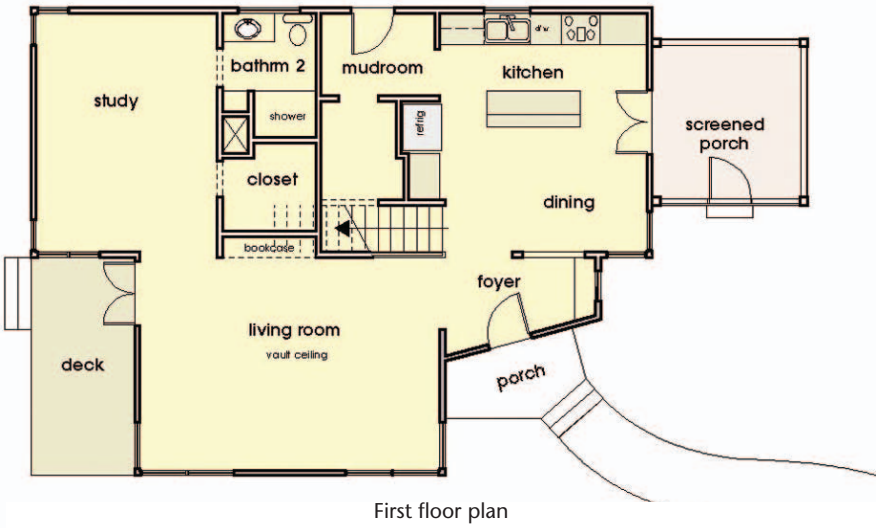
- Building a small house is one of the most obvious and efficient ways to conserve energy.
- It is also one of the most economical.

North Carolina Solar Center in Raleigh, we concluded that the first and foremost step to building an energy-efficient house was to *build small*. Like most people, we spend most of our time in just two or three rooms of the house. Our five-room, 1,600-square-foot home is more than sufficient for the two of us plus a big dog and our daughter, when she's home on college breaks.

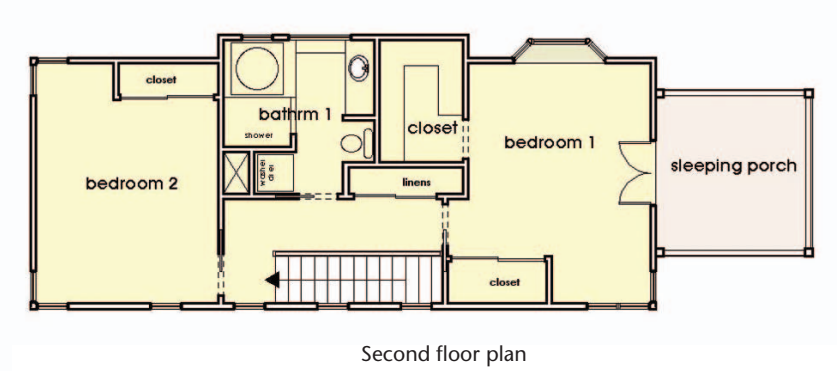
To help make our small house feel larger, we incorporated into the design visual open spaces, long lines of sight and 48 windows. Two decks and two screen porches also help by creating a transition space between the interior of the house and the natural surroundings. Pocket doors free up wall space, and three walk-in closets and a pantry provide valuable storage area.

The next step was to install a rooftop solar water heater. Custom-built by Solar Consultants Inc., Carrboro, N.C., the solar water heater includes two 4- by 8-foot, 27,500 Btu per day collectors manufactured by Alternate Energy Technologies, Jacksonville, Fla.

This unit reduces electricity bills for hot water about 75 percent, and at $4,500 installed (minus our state's $1,400 solar water heater tax credit), the cost is not unreasonable. Furthermore, by incorporating the solar water heater cost into our home mortgage, we pay just $13 per month extra. Additional electricity savings are achieved by powering the unit's pump with a roof-top-mounted photovoltaic cell.



First floor plan



Second floor plan

JAMES MORGAN, BELLADOMUS INC., WWW.BELLADOMUS.COM

To make the Crumes' house feel larger, the design incorporates open spaces, long lines of sight and 48 windows placed to achieve maximum solar gain during winter.

A third crucial step in designing our energy-efficient house was to size window openings to achieve maximum solar gain in the winter months while minimizing overheating during the summer. By installing 34- by 46-inch casement windows on the south side of the house, located 12 inches below a 30-inch roof overhang, the windows receive full sunlight in the winter when the sun is low in the sky. During the summer months when the sun is at a higher angle, the roof overhang completely shades the windows.

We used casement and awning windows throughout the house because they seal better than double-hung windows and have no muntins or center rails to obscure the sunlight. High-insulating *low-e* windows were installed on the north, east, and west sides, but not on the south side where maximum transmission of sunlight is desired. One advantage we found to building a small house is that every room can be designed to have at least one south-facing window.

To reduce cooling costs, we studied the prevailing winds in our area, which generally are from the southwest 10 months of the year. Taking advantage of the natural ventilation afforded by the prevailing winds, we designed our casement windows to open to the southwest. The resulting breeze circulates throughout the house, exiting through double-screen porch doors near the northeast corner. Air circulation is aided by a 24-inch-diameter whole house fan and ceiling fans located in individual rooms.

OPTIMIZING THE LOT AND HOUSE SITING

The location of the house on our lot was especially important to us. We live in Solterra, an environmentally friendly co-housing community, where house footprints are offset such that no house blocks the sunlight from a neighboring house. To take full advantage of the potential for solar heating, we situated our rectangular foundation with the long axis having an east-west orientation so that the longer sides face due north and south.

We worked with our builder to save the trees on our lot, especially the hardwoods along the south and west sides of the house that provide valuable summer shading without blocking the winter sunlight. By preserving as many trees as possible, we reduced the amount of lawn maintenance required. Two 80-gallon rain barrels help conserve water for garden use.

To make the exterior of the house as low maintenance as possible, we used fiber cement Hardiplank lap siding from James Hardie, Mission Viejo, Calif.; Caradco metal-clad windows from Jeld-Wen, Klamath Falls, Ore.; and a natural-finish galvanized metal roof.

Why Build an ENERGY STAR House?

- The U.S. Environmental Protection Agency certifies energy-efficient homes under its ENERGY STAR program (www.energystar.gov).
- An ENERGY STAR home is at least 30 percent more energy efficient than a comparable reference house.
- Energy-efficient houses often have higher resale value than comparable houses.

RICHARD CRUME

The Crumes' home incorporates many of the features found in larger houses, including three bedrooms and two baths, hardwood floors and a roomy kitchen. Built-in shelving and long lines of sight add to the spaciousness.

CHANGING DIRECTION

As construction proceeded, Yoko and I made several late changes to our architectural plans, largely due to comfort considerations. One change was to switch from concrete to hardwood flooring in our living room, which receives the most solar heating. Concrete floors are popular in solar houses because of their solar mass (i.e., they absorb solar heat during the day and slowly release it at night). Because we had other sources of solar mass in the house, such as slate flooring in several areas, we felt we could sacrifice the concrete in favor of more comfortable hardwood.

Another last-minute change was to add more windows to the north side of the house. As a general rule, north-side windows should be minimized because they receive no solar heating and have less insulating value than solid walls against the cold winter winds. Nevertheless, we decided to add more windows because we wanted to extend lines of sight within the small house. To reduce the adverse effects of additional north-side windows, we selected small windows, mostly 14 by 20 inches.

ASSESSING THE ENVIRONMENTAL BENEFITS

Home designers and builders often overlook the environmental advantages of building a small, energy-efficient house. For example, every kilowatt-hour of electricity consumed by an American home increases the demand on electric-utility power plants. That, in turn, increases the amount of air pollution emitted from the plants.

ENERGY STAR testing helped us estimate the amount of electricity savings over a more conventional house, and this savings translates directly into reduced air pollution. For our house, the annual air pollution reductions are estimated to be about 115 pounds of sulfur dioxide, 72 pounds of nitrogen oxides and 14,150

Crume House HIGHLIGHTS

Durham, N.C.

- 1,600-square-foot passive solar house designed for economy, energy efficiency
- South-facing windows have 30-inch roof overhangs for summer shading
- Solar water heater saves 75 percent of water-heating costs
- Utility bill savings are estimated at more than 50 percent
- Household energy savings reduce emissions of carbon dioxide by about 14,150 pounds annually
- $192,000 construction cost
- Construction completed January 2004

How Do Energy-Efficient Houses Improve Environmental Quality?

- The utility power plants that provide electricity to our homes produce large amounts of air pollution. Often, this air pollution will drift hundreds of miles, affecting broad regions.
- Because less electricity is consumed in an energy-efficient house, power plant pollution is reduced.

pounds of carbon dioxide. While these pollution reductions are relatively small, the combined reductions achieved by the thousands of energy-efficient houses nationwide are significant.

ADOPTING AN ENERGY-EFFICIENT LIFESTYLE

How we live in our house also has an important impact on energy consumption. In our new house, we are more conscientious than ever before about turning lights off when leaving a room, setting the thermostat a few degrees cooler in the winter and warmer in the summer, and washing clothes in cold water. The process of downsizing from larger houses has forced us to reexamine our priorities and simplify our lifestyle.

Our small house incorporates many of the features found in larger homes, including three bedrooms and two baths, a Jacuzzi tub, hardwood and slate floors, a roomy kitchen, screen porches and decks, an outside workshop, and yard fencing and landscaping. At a construction cost of $192,000, our home is less expensive than most new construction in our area, and the estimated utility bill savings of at least 50 percent is hard to beat. ●

Richard Crume works as an environmental engineer and teaches a college graduate-level course on air pollution. His house was included in the 2004 ASES National Solar Tour. Crume lives with his wife, Yoko, in Durham, N.C. Contact him at crume_richard@yahoo.com.

RICHARD CRUME

A pergola shades west-facing windows from the hot afternoon sun. Trees and shrubbery were preserved to shade the house and reduce lawn maintenance.