A Home For the New Millennium

A Scottsdale Couple Demonstrates That it is Possible to Build a Home That is Environment, Energy AND Conservation Friendly

by Lydia Enderle Bell

A model of the home, which may become the prototype for future housing.

The HOME Center

It takes a professional engineer to have the courage to build a home that incorporates the green building concept with alternative energy in such an innovative and unique way that it may very well become the prototype for future generations. Bryan Baeulieu and his wife Yvette, together with a few dedicated scientists and an avant-garde architect, are about to embark on the construction of a home that combines the use of clean hydrogen energy with environment-friendly, non-toxic materials and techniques that will elevate desert living to a brand-new level.

The Beaulieus' goal is to create a house that provides a healthy living environment for their family by using both old and new methods to keep cool in summer and warm in winter, without inflicting a negative impact on the environment, or using up valuable, non-renewable resources.

The couple became interested in building a "green" house because Yvette was having breathing problems. "We thought about all the dust, mold, paint and the electromagnetic radiation [and wanted to get away from all that], so we attended seminars about building a home that was free of them."

Beaulieu, a mechanical engineer with 10 years experience in wastewater treatment systems and 20 patents in structural systems, has been working with architectural designer Bob Bacon, energy resource analyst Charles Terry, and Roy McAlister, president of the American Hydrogen Association, to design the most sustainable desert home possible.

The house falls under the guidelines of the green building program of the City of Scottsdale's Building Department. The program advocates a whole system approach for the standard green building that utilizes design and building techniques to minimize environmental impact and reduce energy consumption, while contributing to the health of the occupants, says

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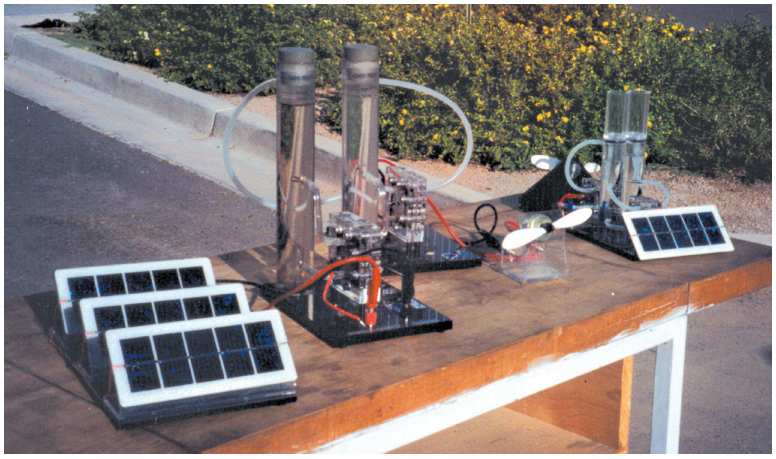
Anthony Floyd, the program's project coordinator.

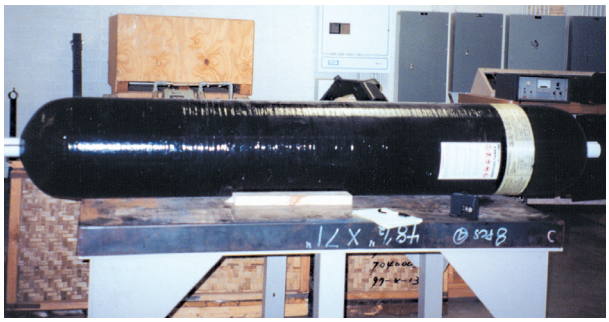
The Green Building Program offers 150 green building options to achieve design flexibility, and rates homes in six environmental impact areas: site use, energy conservation, low-impact building materials, water conservation, indoor air quality, and solid waste reduction.

The Beaulieu house qualifies in all areas. It will be adapted to the lay of the land so that it fits unobtrusively into the landscape, destroying as little natural vegetation as possible. It is to generate its own electricity by using hydrogen, with the help of 60 5-x-2-foot solar panels, water, a hydrogen generator and a fuel cell. Building materials will also contribute to maximum energy conservation, and water conservation is practiced in a variety of ways, without a drip or sprinkler system. An envelope of windows and vents in the skylights provide for fresh air circulation. In addition, only materials that don't emit toxic fumes will be used. As for solid waste reduction, simple procedures are designed to compost human waste and vegetable roughage.



A miniature of the solar/hydrogen energy model at the laboratory of the East Valley Institute of Technology.

The 6,000-square-foot house will be constructed in six separate, hexagonal structures equal in size, in a style similar to living quarters found in the South Sea Islands. The "Bali huts," as the Beaulieus have named their future abode, will be built at five or six different levels, to conform to the slope and terrain of the mountain they will be built on. The structures are to be connected by walkways leading around the natural boulders and cacti that already exist. The entire compound resembles an island resort in the South Pacific, but instead of palm trees swaying in the breeze, saguaro cacti are raising their prickly arms to the sky.



Sample of a hydrogen storage tank.

When the couple first consulted with Bacon, whom Beaulieu calls one of the premier architectural designers in the Valley, the couple had no idea what kind of house they wanted. "All we knew was that we wanted a house to live in that was healthy, without conventional air conditioning," says Beaulieu. Bacon, who had built earth shelter houses in northern climates back in the '70s, had been waiting for 30 years to build a home using the technology planned for the Beaulieu house.

The couple chose this unusual design because they wanted to take advantage of the desert environment. "In a conventional house," says Beaulieu, "you spend your entire summer inside in an air conditioned bubble. You don't go outside, you don't enjoy the desert. We intentionally decided to separate all our rooms, so we would have to go outdoors and be exposed to our environment when going from one living area to another."

Since Yvette had always liked the look of Bali huts, and the construction of six hut-like structures was exceptionally suitable for the use of prefabricated components, they decided to go with this very atypical design. One structure houses an indoor living room and kitchen, an adjacent structure, built in the same hexagonal design but as a gazebo, enhances the outdoor living concept with an open-air living room and kitchen. A walkway leading over a bridge, past the pool and a waterfall, and along a brook that flows between natural boulders, connects the kitchen/living room structure with the bedroom complex 100 feet uphill. Other structures accommodate a workshop, lab and office space, and a playroom. A carport, which stays cooler than a garage, is planned underneath the living quarters, to be built partially into the mountain.

"The goal is to use as little electricity as possible for cooling and heating," says Beaulieu. "This means higher start-up costs for equipment. We have a lot of equipment investments up front, in our solar cells, the hydrogen generator, storage tanks, fuel cells and the 60 photovoltaic panels. Storage tanks are expensive because right now they are only used for industry and government projects. We are using what is available off the shelves right now as far as storage tanks go. But we hope that with the experiments that Roy and Chuck are doing here, we will be able to use low-cost equipment for residential purposes. If I'm the only

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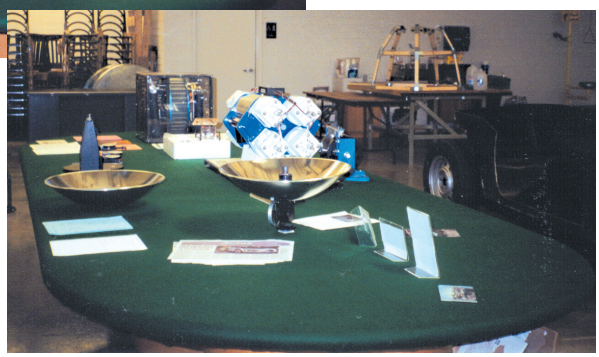
one who can afford this kind of energy, it's not going to do the world much good."

The system is designed so that they will not have to purchase any energy from the public utility grid. "To create hydrogen energy, we basically start out with photovoltaic panels that are attached to the roof overhangs. The solar panels create the electricity needed to split water into hydrogen and oxygen with a hydrogen generator that is no larger than a washing machine. The gases are stored in tanks, and when more electricity is needed, the hydrogen is fed into a fuel cell that generates electricity from the hydrogen gas. With solar energy, you'd put electricity from the sun into a battery, but we want to store the energy as hydrogen gas, because you can keep it forever, and you can store much more energy than you can in a battery. We can use it for powering our cars, or for running a fuel cell or engine to produce electricity, or a pump, or a water heater. We also plan to burn it in our indoor and outdoor fireplaces. It burns like natural gas, and when you burn hydrogen, the process creates distilled water and takes pollutants out of the air, and the air is actually cleaner than it was before. So the water we use to produce hydrogen will become water again. Kind of like magic, but it is a pollution-free way of making energy." Hydrogen that exceeds their storage tank capacity will be converted back into electricity and sold to the local utility company.



Left: *The lab at East Valley Institute of Technology (Bryan Beaulieu at right) where Roy McAlister, Charles Terry and Beaulieu introduce students to practical application of hydrogen energy.*

Below: *Prototypes of the equipment that will be used in the house.*

Green building calls for a heating/cooling system that requires the correct "envelope," which consists of a combination of building materials and techniques that pave the way for saving energy and limiting the enormous start-up expense and space requirements of the solar panels. The envelope, namely the ceilings and walls, will be a combination of solid concrete and glass. Each pyramid-shaped roof is to be of massive, poured concrete, topped with a two-foot layer of soil (100 tons) to keep the heat out of the interior space, providing as much constant temperature year round as possible. While the bottom half of the walls are of concrete in a pebble texture, eliminating the need for paint, the top half consists completely of windows containing a heat mirror film between two layers of glass to keep the heat outside in summer, and inside in winter.

In fact, says Beaulieu, there is so little wall space in the six structures that they can hang only one piece of art throughout. The windows compensate for the lack of solid wall space with a spectacular view of the mountain outside. More importantly, they provide plenty of fresh air circulation. For maximum air flow, the roofs have ventilation "holes" at the center of the pyramid-shaped top, as well as ventilated skylights that are computer controlled and can be opened and closed, based on the direction of the wind. Open vents facing the wind allow the air to come into the rooms, and vents facing away from the direction of the wind draw air out of the structure.

"In your conventional house, you have very little air change, if any," says Beaulieu. "We like a lot of fresh air, but instead of the air cooling and heating the house, as is done with air conditioners in a conventional home, we have the house cool the air, which is a more efficient way of doing it. It is better if the walls are cool and the body heat radiates to the walls. That is why we have a lot of glass. It is a material that absorbs body heat well when it is cool. The trick is to keep the glass cool."

They'll accomplish this with trellis roof overhangs projecting seven feet from the roofs. The trellises are to be covered with vines, which will aid in cooling in two ways: At night, as the water evaporates from the soil in which the vines are planted, it cools off the soil and adds to the cooling process of the structures. During the day, the vines shade the windows and the units. "It's basically a simple thing that has been done for hundreds of years. It is not a science we invented. You keep direct sunlight from the walls and windows. That makes a huge difference in the temperature," says Beaulieu.

To maximize this concept on the walls that are exposed to the morning and late afternoon sun, "heat shields" of corrugated steel placed four inches away from the walls are intended to create shade and allow air to circulate, keeping the heat off the wall.

The heating system itself consists of a series of hollow, connected steel tubes that hold up the trellises

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and act as the exterior framework of the individual structures. During the day, the sun heats up the air inside the tubes, and the hot air is then fed into a heat exchanger that transfers the heat to the water, which is circulated through plastic tubes embedded in the concrete floor for indoor heating in the winter.

For cooling, the plan calls for two systems. One system consists of a stainless steel screen, over which the water drips from the pool. As the air is forced through the screen, it is cooled and funneled into the living spaces and circulated by convection or electric fans. The second system circulates cool water through the tubes under the floor. "The idea," says Beaulieu, "is to cool the house, not the air."

Numerous other innovations used in the construction of the house and grounds are designed to have a positive impact on the environment and the homes' inhabitants. One problem area, as far as green building requirements are concerned, is the swimming pool. Since a swimming pool violates the program's water conservation principles, Beaulieu solved the pool's high water evaporation problem with an inflatable pool floor. Whenever the pool is not in use, a floor resting at the pool's bottom can be inflated and raised. "This stops evaporation of water during the day, and reduces heat loss at night," says Beaulieu. "We don't need as much energy to heat the pool. It also acts as a safety cover. "

To keep the interior of the home as healthy as possible, no materials that emit fumes, such as paint or plastic counter tops, will be used. Nor will drapes be used, since they have a tendency to collect dust mites. Instead, outside shutters, like those that have been popular in Europe for decades, will provide privacy. Instead of the wall-to-wall carpeting that collects both dust mites and mold, floors will be organic, made either of bamboo and/or cork. "These materials won't absorb water," says Beaulieu, "because anything that absorbs water has a potential for growing mold. It's why we stick with concrete, glass and steel, and don't have sheet rock on the interior walls. Sheet rock is susceptible to mold, which loves warm, wet paper."

The Beaulieu's health consciousness extends to other harmful spheres of the environment, such as the excess electromagnetic radiation that is common in households. There will be projectors in the bedroom instead televisions, and lamps and clocks will be limited to a 12-volt output whenever possible, and placed at a safe distance from the beds. The couple even bought a mattress without coil springs, because, says Beaulieu, coil springs act like little antennas intercepting radiation from television and radio signals.

To carry the green concept to conservation of precious water resources, no irrigation system is installed on the property. The desert environment and vegetation on the lot will be left intact as much as possible, with structures to be placed in spaces that allow for century-old saguaro cacti or boulders to remain in place. The pyramid rooftops of the Bali huts will be planted with desert vegetation that requires little water and blends into the environment. Rain collectors will funnel whatever sparse rainwater Arizona's climate furnishes into a cistern, and "gray" water from sinks and showers is to be utilized to water the vines on the trellises and a flower garden. The distilled water resulting from the burning of hydrogen is intended for a vegetable garden near the kitchen. The latter will be hydroponic, with plants growing in water instead of soil, which eliminates the need for pesticides, and allows for recycling of water.

Human waste, too, has a place in the green program, and will be recycled through aeration, the addition of aerobic bacteria which breaks down human waste into harmless compost that can be used as fertilizer for the flower garden instead of polluting rivers and streams. As if that was not enough, vegetable roughage that is normally flushed down the disposal is utilized in a beneficial way, as well. The disposal is connected to an insulated tank in the carport area, which contains anaerobic bacteria that break down the roughage and in the process, produce methane gas. Though the latter can be used like natural gas, McAlister is presently experimenting with conversion of methane gas into hydrogen gas.

"This house becomes a laboratory in the sense that we are testing equipment here," says McAlister, who is working with Terry and Beaulieu to implement the energy/related features on the home.

McAlister is among those scientists who take the position that clean, environment-friendly energy is available right now, whether it is for powering cars, homes, or anything else that presently uses non-renewable energy polluting the environment. He is working on all sorts of alternative energy projects.

"Whether we make it right here, or have another company make it, the goal is to get as many companies as possible interested in making hydrogen-based energy systems as soon as possible." The trio presently has a lab at the East Valley Technology Institute, where they plan to involve students in the Beaulieu house project.

When finished, the Beaulieus plan to share the secrets of their environment-friendly home with the world. "We hope to show it off to the public with tours and field trips for kids, so everyone can see first-hand how this technology can be used. Also, there is a video production company that is doing a series on green building that will follow the construction of this house from start to finish."

Construction will start as soon as they have all the building permits and formal approval from the homeowners association, whose main requirement was that it fit in with the rest of the homes in the subdivision.

Though his house will be more expensive to build than an equal size conventional house because of all the engineering technology, the goal, says Beaulieu, is to produce a structure that is no more expensive than a regular stick-built house. "We want to see hundreds and thousands of homes built along those concepts in the future." Ⓢ

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