www.solartoday.org The Voice of the Renewable Energy Community Jan/Feb 2006

SOLAR TODAY®

Fueling the **Biodiesel** Debate

Zero-Energy Home Shines in the Pacific Northwest

Cost Breakthrough Ahead for Solar Energy?

Focus on Energy-Efficient HVAC

Ask Ken: How Much Insulation Is Enough?

Zero-Energy House Defies Northwest Climate

GREG KOZAWA

OREGON DEPARTMENT OF ENERGY

Despite its location on the rainy Oregon coast, solar is the primary energy source for this award-winning home.

By Marnie McPhee

Imagine living at the Oregon coast and producing the equivalent of all the energy you need for a year from just the sun and stable soil temperature — and maybe even getting a net-zero energy bill from your electric utility for the year! It's not an easy challenge in any climate, but the prospect is particularly intriguing at the notoriously gray coast.

But is the coast really so gray, and so inhospitable to solar energy? The owners of a new home in Cannon Beach, on Oregon's northern coast, are proving it's not — especially when a hyper-efficient building is matched with the coast's mild climate, the site's superb solar exposure, a brilliant architect, savvy Oregon Department of Energy staff, experienced local builders and installers, and most of all, committed owners, willing to try new approaches to building an environmentally sustainable home.

The resulting home was named the 2005 Custom Green Home of the Year by the National Association of Home Builders. It also has earned a top-level Earth Advantage Platinum certification and a Home Energy Rating System rating of 94.0 (5-star-plus), and it is 58 percent more efficient than required by the Oregon Energy Code. More, it is a gorgeous, "green" retreat for the owners, and a wonderful legacy.

Designing a House to Inspire

This home could be called the Phoenix House, for it replaces two homes that were destroyed by fire: the owners' beloved old cabin near the beach and a previous home located on this site. After their cabin burned down, the owners decided to build a new home on this hill overlooking the beach.

“We wanted to use conventional building techniques, to inspire others to say, ‘I can do that!’”

The design evolved over one-and-one-half years. The team carefully analyzed the site, sun charts, 30-year climate data from the nearby Astoria and Seaside airports, and recent data from a weather station in Cannon Beach (www.oceansolar.com). The owners, neighbors and builders provided invaluable information about local conditions, particularly the intense winter storms.

As the owner said, “We wanted to build a special home. We enjoy the possibility of people being inspired by the house. Yet we wanted to use conventional building techniques, to inspire others to say, ‘I can do that!’ We wanted it to be spacious without feeling big, lodge-like yet cozy without being cramped, and use natural materials extensively. And I wanted to hear rain on the roof! I know that achieving all of that was a horrible challenge for our architect, Nathan Good.”

Originally the team planned for the home to be 100 percent passive-solar-heated. But then Good, who previously operated the Earth Smart and Green Building programs for Portland General Electric, the largest local electric utility, showed the early plans to Charlie Stephens, an Oregon Department of Energy (ODOE) policy analyst. Stephens asked if the owners instead might want to build one of Oregon’s first model net-zero-energy homes, with support from ODOE. *(See the May/June 2004* SOLAR TODAY *and Summer 2004* Solar Oregon *issues for articles about other net-zero-energy houses).* The owners and the rest of the design team enthusiastically agreed.

The Oregon Institute of Technology is monitoring the home’s energy usage to determine whether they have accomplished the “net-zero” part of the plan. So far, performance data is on track.

The team already knows that the 2,263-square-foot, two-bedroom, three-bath home meets the family’s functional, aesthetic and other environmental goals. The L-shaped home nestles into a south-facing hill overlooking Cannon Beach and the Haystack Rock marine and bird sanctuary and wraps around a centuries-old Sitka spruce the owners insisted on preserving. The home features two parallel curved roofs: the upper, eco-roof is vegetated; the lower roof is topped by photovoltaic panels. A rack of solar collector tubes hunkers into the hill below the south-facing patio. Natural and sustainably produced materials — particularly stone and wood — dominate.

An innovative conditioned “short” basement allows access to mechanical systems and controls, prevents mold and mildew buildup and reduces air leakage.

The eco-roof provides many benefits: storm water management, extended roof life, visual appeal for uphill neighbors, added insulative value and relatively low maintenance. The owner particularly values this last feature. “We’ve spent only a few hours weeding the roof since it was planted,” she said. “I’ve enjoyed it much more than I thought I would, and the neighbors get the biggest kick out of it!”

Drawing on the Sun

As always in good solar design, the team focused first on reducing energy consumption. The house is predicted to use about half as much energy as a typical house its size. The roof has R-50 insulation. The walls are constructed of Durisol blocks, which are made of concrete mixed with wood chips and filled with mineral wool. They provide R-25.6 insulation above grade and R-21 below. The blocks also are resistant to rot and termites, are fire-retardant, and boost the home’s thermal mass.

In this mild coastal environment, daylighting is more important than solar gain, according to Stephens. Because the house contains more than 600 square feet of glass — much more than a typical house — Good and Gary Curtis of the West Wall Group chose high-performance Cardinal glazing with a U-value of less than 0.32, visual transmittance greater than 80 percent, and a solar heat gain coefficient of 0.41. The window frames, from Bergerson Cedar Windows in nearby Warrenton, are made from sustainably harvested cedar.

The daylighting design provides natural light for all needs, including reading during daylight hours. Good called the result a “vessel of continuous visual delight.” The second-story light shelf, clerestories and expansive south-facing windows illuminate the great room “with indirect sunlight emerging into the room from multiple undisclosed sources,” he said.

Despite the coast’s rainy reputation, solar is the primary energy source, supplemented by a ground-source heat pump, with geothermal wells providing extra heat storage. To minimize energy requirements for ventilation, heat-recovery ventilators provide all fresh air. The site’s excellent solar exposure will be protected

Cannon Beach Cottage Design/Contractor Team

Architect: Nathan Good, Nathan Good Architect, P.C., www.nathangoodarchitect.com

Associate Architect: Leonard Lodder, Studio 3 Architecture, www.studio3architecture.com

Energy Consultant: Charlie Stephens, Oregon Department of Energy, www.oregon.gov/energy

Solar Energy Consultant: Doug Boleyn, Cascade Solar Consulting, www.cascadesolar.com

Solar Heating System Installer: Ron Summers, Summers Solar Systems, Salem, Ore.

Solar Photovoltaic System Installers: Rich Elstrom, Elstrom Construction, Gearhart, Ore.; and Mike Phillips, Phillips Electric

Structural Engineer: Andy Stricker, Stricker Engineering, www.oregoncoast.com/strickerengineering

Mechanical Engineer: Gene Johnson, SOLARC Architecture and Engineering, www.solarc-ae.net

Interior Designer: Georgia Erdenberger, Czopek and Erdenberger, www.czopek.com

Landscape Architect: George Erdenberger

Contractor: Rich Elstrom, Elstrom Construction, Gearhart, Ore.

Project Superintendent: Mark Ward, Elstrom Construction, Gearhart, Ore.

Monitoring: Bob Rogers, Oregon Institute of Technology, www.oit.edu

Click for More Information

Architect Nathan Good's website: www.nathangoodarchitect.com
SOLARC Architecture and Engineering:
www.solarc-ae.net/popup_project_cannon.html

OREGON DEPARTMENT OF ENERGY

Ventilation and heating are delivered by a hydronic loop and pump; three energy recovery ventilators, or ERVs (left); and a direct digital control system. Right photo, the open controls cabinet with the Zone 1 ERV to the left. In between them are four relays used to operate three of the pumps and the heat pump.

even if the adjacent vacant property is developed. Yet because solar exposure is low when it is needed most for heating, the house doesn't rely exclusively on passive solar heat. Instead, an innovative integration of the solar collectors with a ground-source heat pump system allows thermal energy to be alternately stored and used to provide both solar-assisted space- and water-heating.

The array of 90 Thermomax evacuated tubes gathers solar energy to heat a water/propylene glycol solution. The tubes, selected for their high efficiency in overcast and cloudy climates, regularly reach 200F (93.3C) — 20 degrees more than the team predicted. A heat exchanger transfers the heat from this closed-loop system to thermal storage tanks in the basement. Stephens said the system will supply about half of the annual hot-water demand at the house, which is regularly occupied by four or more family members. The system also will contribute to space heating from direct solar radiation on clear days during the winter.

If the storage tanks are fully heated and it's still sunny, excess solar energy is stored in the basalt rock under the house via a closed-loop ground-source heat exchanger — two vertical bores drilled into the basalt. When solar heating is not available, a high-efficiency ground-source heat pump connected to this water loop extracts heat from the basalt surrounding the bores and charges the two hot-water storage tanks for both space- and domestic water-heating.

Ventilation air and heating are delivered by the hydronic loop and pump, three high-efficiency energy recovery ventilators, or ERVs, (one for each heating/ventilating zone) from Stirling Technology Inc., Athens, Ohio, and a direct digital control system. The ERVs minimize ventilation-heating requirements while using 100 percent fresh air, "an important consideration in the moist coastal climate zone," according to Good. The manufacturer claims that the ERV has an overall efficiency of approximately 88 percent in transferring heat from the exhaust air to incoming fresh air. Stephens, of the ODOE, which is monitoring the home's performance, confirmed that estimate. "The ERVs achieve that 88 percent efficiency when they are running at 75 cfm [cubic feet per minute], which is most of the time," he said.

The heat exchanger uses a "heat wheel rotating between the two air streams," explained Gene Johnson, principal, SOLARC Architecture and Engineering in Eugene. Johnson designed the mechanical and control systems and assisted Bob Rogers of the Oregon Institute of Technology (OIT) with the installation and commissioning of the controls. When the ERVs require additional heat, a pump circulates hot water from the storage tanks. In case of equipment failure, the electric resistance heating elements in the final storage tank also can provide heat.

Obviously, this heating system is unusual for a house, particularly one at the coast. Johnson said the sophisticated direct digital controls are "worthy of an eight-story office building" and will provide valuable information about net-zero energy designs. OIT's Oregon Renewable Energy Center will monitor the home's performance for a year and post findings on its website, www.oit.edu. Ongoing monitoring plans have not been finalized.

As should be expected at the coast, the home will rely on passive cooling. The ERVs and operable windows will bring in fresh air and contribute to a natural stack effect to help cool the home during the rare hot days.

Backing Up the Electric Utility

A grid-connected 5.9-kilowatt photovoltaic system will supply the family's full electricity needs on an annual basis. It consists of 36 Sharp Solar 165-Watt modules (5,940-watt DC under standard test conditions) and two SMA Sunny Boy 2500U inverters, with an estimated annual output of 5,400 kilowatt-hours. According to first-year data, the system has achieved that target. On sunny days, the system produces more energy than the occupants use, while on cloudy or overcast days, it produces about as much power as they need.

The system feeds any excess power back into the grid. When demand for electricity exceeds the solar supply, the system will draw power from the grid. According to the owner, "It's so neat to be a powerhouse for the utility!" ●

Marnie McPhee is a freelance writer based in Portland, Ore., specializing in energy issues. This article is based on an article published in Solar Oregon, *which McPhee edited.* Solar Oregon *is the newsletter of the Solar Energy Association of Oregon, the American Solar Energy Society's Oregon chapter.*