

SOLAR

Stewardship

by John Patterson
& Suzanne Olsen

Driven by her desire to set an example for others and create a healthy environment for her son, Candace Gossen tackled a rehab of her 1924 two-bedroom bungalow in a historic neighborhood in southeast Portland.

“When I bought the house, it had bars on the windows and a chain-link fence around it. It was a very closed-off place,” says the 45-year-old mother of one. “I wanted to bring life back to it and make it a healthy home.”

Green and blue glass bottles get a second life in a whimsical garden wall.



Shawn Schreiner (2)



Homeowner Candace Gossen
at her eco-renovated Portland home.

Suzanne Olsen



Shawn Schreiner

Above: A large picture window on the south side of the house lets in lots of natural light.

Right: The garage apartment features straw-bale insulated walls for improved thermal performance.



Candace updated the home over the course of 12 years—one project at a time as her budget allowed. She had an edge when it came to the DIY improvements—a bachelor’s degree in architecture, a master’s degree in building science, and a decade of hands-on practice with sustainable principles. Shortly after purchasing the home, she set up a studio devoted to teaching ecological design. Even with her resources and

know-how, she chose to keep the projects simple, doable, and affordable. Her approach followed the life mantra of Buckminster Fuller: *You see what needs to be done and you just do it. Do more with less.*

Candace initially improved the home’s energy efficiency through simple upgrades and common-sense measures. She removed the bars and grates from the large south-facing

Recycled and salvaged materials, as well as renewable energy technologies, come together to create an efficient and comfortable urban oasis.

A model of a living roof serves as a neighborhood education tool.



Shawn Schreiner



Suzanne Olsen



Left: A 4- by 10-foot solar hot water collector and a 1,540-watt PV array provide heat and power to the home.

The drain-down solar hot water system has been working well for years.

window in the living room to capitalize on some passive solar gain. In lieu of curtains or blinds, deciduous trees outside the south-facing window provide shading during the warmer months and allow some passive solar gain through in the winter. Energy-efficient lighting and new Energy Star appliances—including a super-efficient 10-cubic-foot refrigerator—rounded out her energy strategy. Lastly, the much-anticipated demise of the home's 40-year-old oil furnace gave Candace the chance to reduce the home's dependency on fossil fuel (see below).

"I wanted the home to show options to homeowners and put the technology in the open—outside—so people passing by could see what we did," she says. "Most people—me included—cannot afford to spend thousands upon thousands of dollars on home improvements for the sake of sustainability and efficiency."

Instead, Candace focused on low-cost, do-it-yourself solutions that "make sense for the average homeowner." To support her sustainable lifestyle and make the community available to others, she eventually converted the finished basement and the garage into two rental apartments.

The house proved to be the perfect demonstration piece for her design studio as well as an ideal classroom for the workshops she teaches through the local community college and university. "It's really important that I give back more than I take," she says. "Using this house to show what can be done and teaching through the various projects seemed like a natural way to be a steward for change."

She used many of the projects to provide her students with hands-on instruction and often invited people in the community to participate. Her home is a favorite on several home tours in the area—including last year's Build it Green! Tour of Homes, where a record number of people turned out to admire their work. Here are a few of the applications that had the crowds stretching on their tiptoes for a second look.



Shawn Schreiner (2)

Solar Hot Water

Cost: \$1,000 after \$1,500 state tax credit

In 1997, Candace received approval from her neighborhood advisory board to add a 4-by-10-foot solar hot water collector on the south-facing roof of the garage. In the open-loop drain-down system, potable water is directly heated in the solar thermal collector. During cold weather, when temperatures drop below 40°F, an automatic valve drains the water out of the system and into a rainwater collection system. This drain-down system protects the collector and pipes from freezing. Once the temperature on the collector rises above 40°F, the valve allows water into the collector. Although thousands of these systems were installed in the 1990s, most were abandoned due to their complexity and common failures during freezing—in favor of closed-loop glycol systems. But Candace's system has worked perfectly through the years.

Straw Bale At Work

In the back corner of the yard stands a testament to Candace's dedication to both teaching and learning about sustainability. In 1997, she designed a load-bearing straw bale building. She and her students built the 10-by-12-foot structure from renewable and recycled materials as a research project. The goal was to test straw bale construction and other eco-building techniques against the climate conditions in the Pacific Northwest.

Reclaimed concrete from a dump site and old tires helped form the foundation. A layer of decking made from a recycled wood/plastic product, paired with a rubber sealant and 30-pound felt paper, provided a moisture break between the foundation and the 42 straw bales that form the walls.

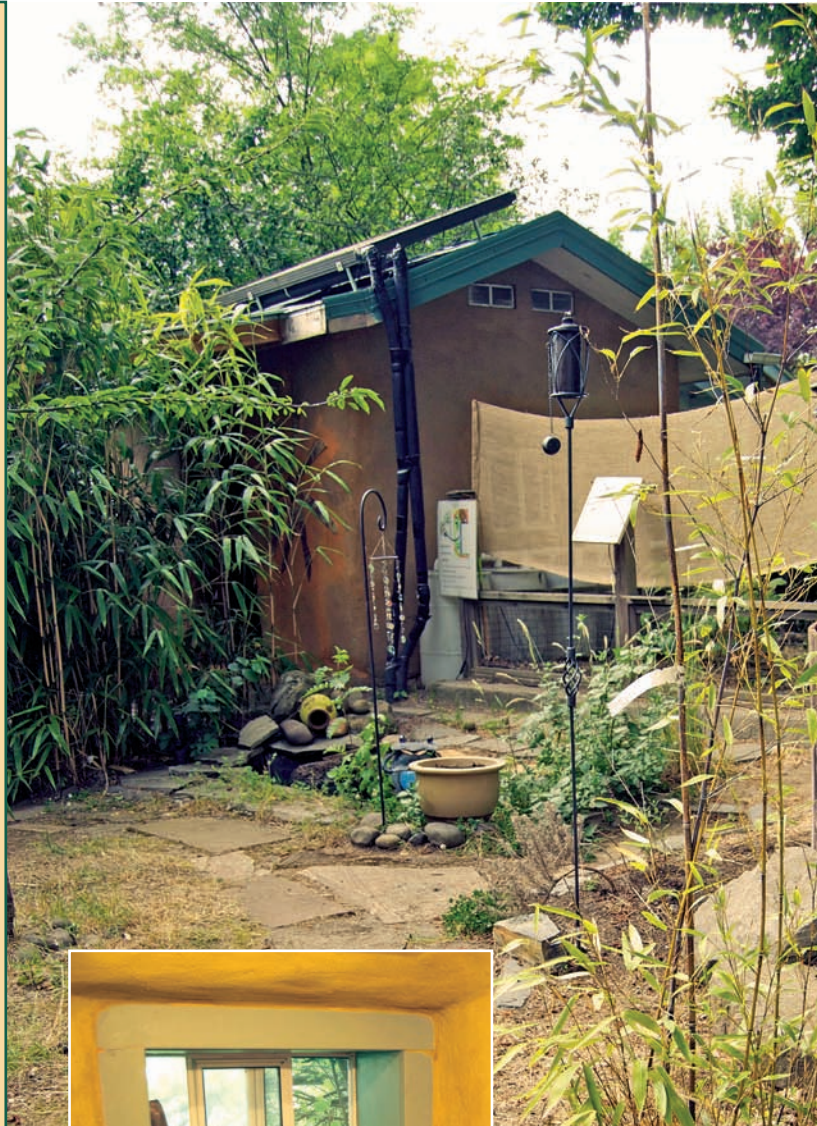
The bales were stacked five high and covered with a box beam of 2- by 6-inch boards and CDX plywood filled with straw flakes for insulation. Seven trusses, formed from 2 by 6s, made up the roof—complete with a built-in trough to catch water in a 180-gallon collection system.

The windows and door openings were wrapped with 30-pound felt paper. The straw bales were covered in coconut fiber, which gave a surface to apply the stucco—a mix of clay, clean soil, cement, fine sand, linseed oil, skim milk (for casein), water, and chopped straw. A thin cement stucco mixed with ochre pigment finished off the exterior. Before plastering, Candace placed 12 manual-read moisture sensors within the bales so she could monitor moisture at various points within the wall structure.

Reclaimed bricks laid over tamped sand make up the interior floor. Beneath that, a layer of recycled nylon sand bags on top of a 3-inch layer of river rock creates 18 inches of thermal mass for the floor.

The success of the project prompted Candace to convert her garage into an eco-friendlier studio by infilling the north and west interior walls with straw bales. Overhead rafters were used as a box beam to attach bamboo pins, and the straw bales were covered with burlap—instead of wire mesh—as an experiment to see how well fibers and plasters would adhere together. Candace brushed three layers of plaster made of earth and lime onto the burlap, and covered the burlap with reed matting. Six moisture sensors monitor moisture in the straw-bale walls. Renewable and recyclable materials complete the décor—bamboo flooring, a ship-bath with dual-flow toilet, interlocking floor mats made from old tires.

The finished garage served as a studio until Candace moved her work space into the straw bale building in the backyard. She renovated the 300-square-foot garage space into a one-bedroom apartment, designing with the principles of efficiency.



Suzanne Olsen (2)

Tucked into the corner of the yard, the straw bale studio make a cozy office/living space.

The 120 VAC controller sends energy to the drainback valve and pump independently, based on three temperature sensors. The system has demonstrated a 50% savings over the former electric-only water heater, depending upon weather.

Two fan-assisted hydronic heaters are connected in line with the solar water heating system—one in the garage apartment and another in her son's attic bedroom. Hot water from the solar preheat system and gas backup heater is pumped through a water-to-air heat exchanger, and a fan blows room air across it, providing ample warmth to those well-insulated areas.

Historic district zoning made roof-mounted PV taboo, but ironically, this highly visible, 12-foot pole mount was legit.

Six months of the year, the home's PV system produces more energy than its inhabitants use. During the winter months, the system offsets about 30% of the five residents' usage.



Shawn Schmeier (3)

The energy-aware household—five people living in the three apartments—uses about 5.5 kWh per day during the summer and about 20 kWh in the winter. At 3.95 average daily peak sun-hours, the system averages 4.3 kWh per day.

Biodiesel-Fired Furnace

Cost: One 1976 Morris Mini Minor

A walk around the house reveals a shed that houses a water heater and biodiesel burner system for the home's latest addition. In 2007, after the home's diesel furnace gave out, Candace was faced with the decision of how best to provide heating for the house. She wanted to use a renewable energy source for heating, but she wasn't exactly sure how to go about it and whether she could afford to do it. Short on funds, she got creative. She ended up contacting Juaning Higgins from Portland Green Heat to help create a heating system that would use biodiesel as the heat source, but keep the combustion unit separate from the living space. Candace bartered an even exchange—her 1976 Morris Mini Minor (a precursor to BMW's Mini Cooper) for a new furnace.

Biodiesel storage tanks share the laundry room.



1.5 kW Photovoltaic System

Cost: \$5,800 after \$6,200 Energy Trust credit and \$1,500 state tax credit

In 2004, Candace installed a grid-tied PV system to offset the household's utility electricity use. The roof-mounted design was originally approved by the city, but rejected by the neighborhood advisory board. Their concern? That the array would be too visible from the street-side view of the house and set an unacceptable precedent for future design considerations in the historic neighborhood. The alternative pole-mounted design was, however, given the green light—even though the array in the corner lot's side yard is equally, if not more, visible. The change in plans turned out to be a good thing, as the new site gets better and longer solar exposure.

Candace teamed up with Mr. Sun Solar, the company that also helped install her solar hot water system, to install the solar-electric system—(14) 110-watt BP modules wired in two strings of seven, feeding into a PV Powered 1,800 W inverter. To cut costs, Candace and her student crew did a lot of the grunt work, hand-digging the trenches and the 3-foot-diameter, 9-foot-deep hole for the pole, and pouring the concrete.

The array was mounted on a UniRac rack with an 8-inch-diameter, schedule 40 galvanized steel pole. The pole—with 9 feet underground and 12 feet above ground—was anchored in 2 1/3 cubic yards of concrete, and designed to withstand 100 mph winds.

Solar Hot Tub

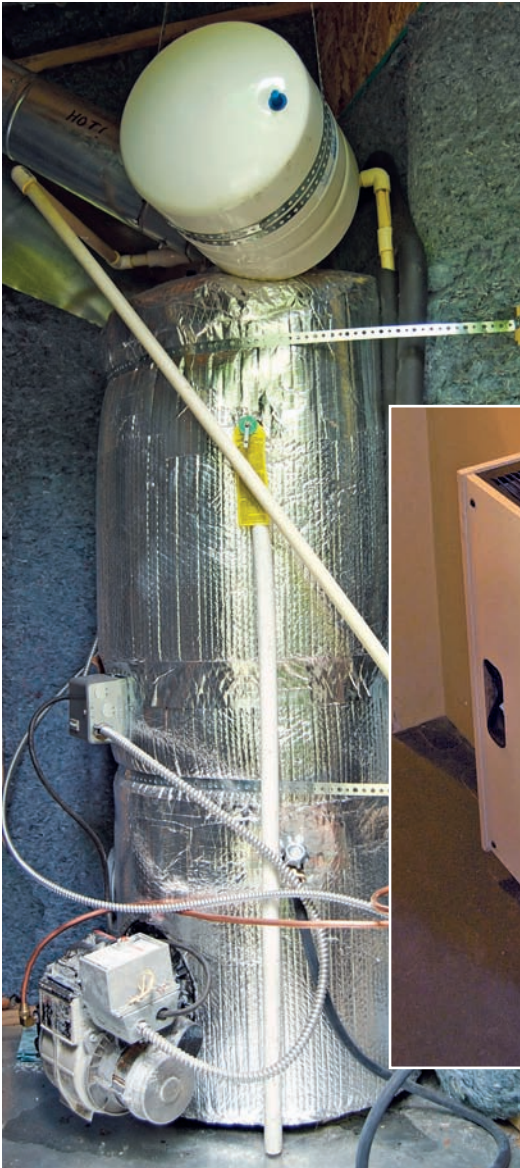
Cost: \$1,149

Using a 240-gallon cedar hot tub that she found on Craigslist, Candace and several of her students installed a solar hot tub in the backyard. Mr. Sun Solar handled the technical aspects of the installation.

The finished system relies on a used, 32-square-foot solar thermal collector. The hot glycol from the collector runs through cross-linked polyethylene (PEX) tubing underground into a coil of copper at the bottom of the tub.

The controller from Independent Energies allows the hot tub to reach temperatures up to 109°F before the pump shuts off. Polystyrene spray-foam insulation (R-7 per inch) in the tub's lid, walls, and bottom help keep the tub hot for days in sunny weather. The cost to run the system's pump and supplemental electric heater is about \$176 per year.

The solar-heated hot tub is heated by a 4- by 8-foot solar collector (not shown) through a copper coil, which can be seen at the bottom of the tub.



Shawn Schreiner



Suzanne Olsen

The blower remained in the utility room, and a hydronic radiator coil with 130,000 Btu capacity was installed in the old furnace cavity above the blower. The biodiesel burner was located outside in the shed, along with an expansion tank, biodiesel pump, and pump control box that was modified for B99—99% biodiesel fuel.

The furnace's relay and transformer are managed by a New Vision Pro 8000 touch-screen programmable thermostat, with a remote for upstairs. Two 110-gallon storage tanks in the laundry room hold the B99 fuel. Initially the furnace was burning 3 to 5 gallons of biodiesel fuel per day, but once Candace insulated the shed and wrapped the tank and pipes with insulation, usage dropped to 0.5 to 1 gallon per day. With new insulation added between the floor joists, and blown-in cellulose in the walls, the furnace and hydronic baseboard heaters (which are connected to the solar hot water system) keep the house comfortable.



Shawn Schreiner



Shawn Schreiner

Rainwater collection offsets water use and cost, for summertime irrigation.

Art and functionality combine in the bottle-wall, and throughout the property.



Suzanne Olsen

Rain Collection System

Cost: \$150

Candace also designed a simple rain collection system—nine 60-gallon barrels along the north side of the house and six 30-gallon barrels along the straw bale structure—to collect rainwater from the roofs. When the first barrel fills, overflow goes into the second barrel. The barrels can store 740 gallons of water for most of the summer garden’s needs.

Wall o’ Waste

Cost: Just her time.

Nothing goes to waste at Candace’s place. Discarded hubcaps, curvy sticks, and broken glass become *objets d’art*. Colored-glass wine bottles—donated by a local recycler and collected from the trash—create a mosaic wall along the front of the house. The project, as Candace says, serves to demonstrate that so-called waste materials don’t have to end up in landfills if someone is creative enough to find a use for them.

FYI: Buying “green” is not always a good thing. Green glass, especially that used for green wine bottles, is not highly marketable as a recycled material and often goes to waste.

Suzanne Olsen

Looking Ahead

Even with all of these improvements, says Candace, the house is an “ongoing, ever-evolving” project that may never be truly finished. She keeps busy these days working on her doctoral degree in ecological science, coring lakes on Rapa Nui, and raising a teenage son, but that has not slowed her down any. Her immediate plan is to finish off the biodiesel furnace shed with cob, a wine-bottle mosaic, and a living roof.

“If you’re industrious in learning what you need to, willing to put in the sweat effort, and resourceful when finding materials, it all can be affordable—even for a single mom,” Candace says. “I’m proof of that.”

Access

John Patterson (john@mrsunsolar.com) is president of Mr. Sun Solar and inventor of the Sol-Reliant solar water heating system. Over the past 28 years, his company has installed more than 2,000 solar energy systems, including PV, solar water heating, and solar pool heating systems.

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