As seen in

GOOD DAY SUNSHINE

A Nobel Prize-winning environmental scientist and his eco-minded wife create a cutting-edge solar house

WRITTEN BY **TRESCA WEINSTEIN**
PHOTOGRAPHY BY **KIT LATHAM**

What if a home were a miniature ecosystem, a laboratory, a teaching tool, and a vision for the future—all without sacrificing a scintilla of comfort or aesthetics?

William and Margot Moomaw's solar-powered house in Williamstown, Massachusetts, completed in 2007, is all that—so state-of-the-art that it's among some two-dozen homes nationwide where environmental systems are being monitored by the National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy as part of a study to help develop net-zero-energy homes—houses that produce as much energy as they consume—by the year 2020.

In their 2,200-square-foot home, the Moomaws' goal was to create a building with minimal negative impact on its builders and residents, its fourteen-acre site, the energy grid, and the world at large. With myriad creative solutions, they developed a house that is beautiful, comfortable, and meets ambitious goals for energy efficiency. "We wanted to show it could be done and [that] people could do all or any part of this. Even if they only did a small part of what we did here, they would be more comfortable, be in a healthier house, and have a smaller environmental impact," Bill says.

Passionate, dedicated, and immensely knowledgeable, the Moomaws are ideally suited for a project of this scope. For the past fifteen years, Bill Moomaw has served as a member of the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize with Al Gore. His experience convinced him that there are hundreds of ways to achieve energy efficiency in a private home. As a professor of international environmental policy at Tufts University, a former Williams College chemistry professor and director of Williams' Center for Environmental Studies, and former head of the Climate Program at the World Resources Institute in Washington, D.C., Bill Moomaw knows as much as just about anyone on the planet about how to protect and preserve its riches.

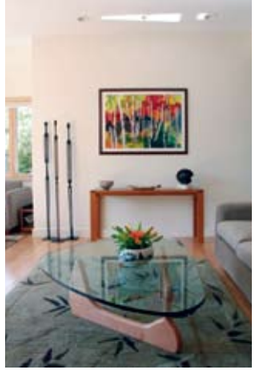
Margot Moomaw, a graduate of the Harvard School of Public Health, has worked in the healthcare field for more than twenty-five years. The former vice president of Berkshire Medical Center and director of the Berkshire Area Health Education Center (AHEC) program, she became an independent consultant in 1997. The author of the Kendall Foundation's report on "green" schools, Margot is now a consultant to homeowners and builders. In green design, she notes, it's important to evaluate tradeoffs and performance, to track evolving technologies and their cost-benefits, and to understand that green building requires more than just meeting the U.S. Building Council's LEED (Leadership in Energy & Environmental Design) checklist.

"What Bill and Margot brought to the table was an informed set of values about what kind of building they wanted to create and pass on to society," says environmental design consultant Marc Rosenbaum. "We need these kinds of people—people who care enough to put in the effort."

At first glance, you'd never guess that the future of green architecture is contained within this elegant, traditional building, which fits seamlessly into its rural New England surroundings. "The house itself looks relatively conventional," says architect Bruce Coldham. "They haven't chosen anything on the outside that looks different from what you're used to seeing. They wanted to design a house that people wouldn't dismiss as being quirky or irrelevant, but that would make a sufficient difference so that people could see it was a step in the right direction."

In the design phase, the Moomaws considered every detail of the house's location, construction, materials, and infrastructure. Before siting, they consulted a U.S. Geological Survey topographical map and used a computer program that tracks the amount and angle of the sun every hour of the day, every day of the year, in any given place on earth. "We wanted the building to have essentially eight hours of sun, four hours on either side of noon, even in the wintertime," Coldham explains. Energy consumption was carefully calculated, down to the placement, type, and wattage of every light bulb. The first structure built on the property was a stor-

Traditional New England style meets cutting-edge technology. Clockwise from top: South façade; north entry and courtyard; solar panels; solar-panel-fitted shed; guest quarters at left are linked to the main house by a screened connector; the formal entry on the home's north façade, with guest quarters at right.



Left: South-facing dining area is tucked between the living room and kitchen. Below: open-plan kitchen. Middle: The living room's antique, openwork Chinese screen allows the flow of air and light. Opposite, clockwise from top left: Living room vignette; kitchen compost bin set into the countertop; kitchen with its sun-loving south window.

age shed fitted with solar panels to generate energy for the builders' power tools. Whenever possible, materials were sourced from suppliers within five hundred miles of Williamstown, to reduce energy consumed in shipping.

Looking ahead to their later years, the Moomaws incorporated wide doors, baths with hand-held showers and grab bars, stair railings, and a table-height counter/eating area in the kitchen. And, with health in mind, they chose nontoxic, sustainable, and durable building materials, rather than products such as synthetic carpet or particleboard and fiberglass containing formaldehyde.

Like the home's twelve-inch walls—twice the conventional thickness—the Moomaws' approach to designing an energy-efficient, eco-conscious residence was multilayered. The house, with a one-room guesthouse on its west end, follows an east-west axis and faces south-southwest. Large, south-facing windows offer maximum passive solar benefit. A nearby rise in the landscape blocks northwest winds. The house's north side contains its "front door" and a corridor; the area leading from a side entry to the master suite is lined with small windows and borrows south light through an antique Chinese screen in the living room and the staircase's open balustrade. "We took lessons from the vernacular architecture of New England," says Margot. "These are things people knew and which, when central heat and artificial light came along, they started to ignore." Bill estimates that the house's siting alone produces a twenty to thirty percent energy savings annually.

This commonsense approach combines with leading-edge systems. Sixty-six solar panels on south roof slopes of the house and shed (a 7.3-kilowatt array) soak up the sun. In the basement—where wires from the house's ground-source heat pump, water pump, light fixtures, and wall sockets lead to gauges transmitting data to NREL—current produced by the solar cells is converted into electricity. A graph on a wall tracks sunshine and energy produced by the panels; the charted lines follow each other precisely, showing parallel dips when a cloud passes over the sun. On a sunny day, the house generates about five thousand watts of power; on a rainy day, nearly zero. Aiming to produce more energy than they need, the Moomaws buy power from the grid on gray days and sell energy the house generates on sunny days. They also pay for renewably generated electricity from wind and landfill gas so "what we're buying is almost as clean as what we're generating," Bill says.

Water and heating systems are equally forward-looking. An Econar ground-source heat pump taps into the stored energy of the earth, which remains at a relatively constant temperature (fifty to fifty-five degrees) year-round. The pump carries water into the house through six 265-foot closed loops, heats it another twenty to twenty-five degrees, and circulates it through radiant heating pipes. It also heats water from the well, located uphill from the house, to 120 degrees for use in the kitchen and baths (which have low-flow toilets and showerheads). Pipes are made of bendable plastic PEX instead of copper, so water has fewer right angles to navigate, allowing the use of a water pump about half the conventional size. When the bathroom showers are running, heat from draining water warms cold water in the incoming pipe so less water needs to be heated in the first place.

Throughout the house, energy-efficient appliances and electronics minimize electricity use. These include a Bosch cooktop and convection oven, a KitchenAid Energy Star refrigerator, an ASKO dishwasher and washing machine, and a 32-inch Sony LCD high-definition TV that draws less than one-tenth of a watt when turned off. (Even when turned off, many electronics still plugged in continue to consume power.) "When you have to live within the energy you produce, you pay a lot of attention to the wattage you're using," Margot says. The key, she says, is to beware of "feature creep"—usually the

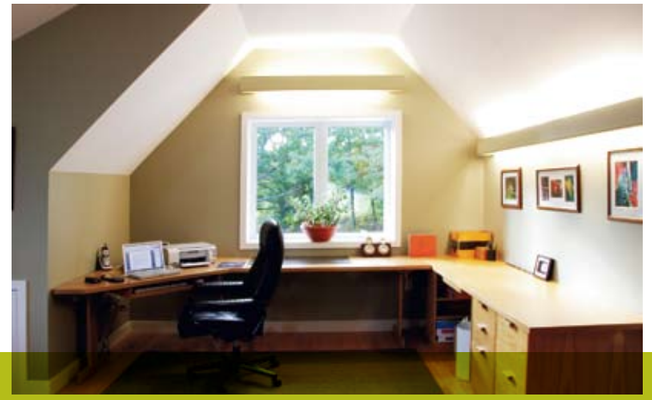
more features, the more energy an appliance consumes. As a whole, the house consumes one-third the electricity required for a conventional home of the same size.

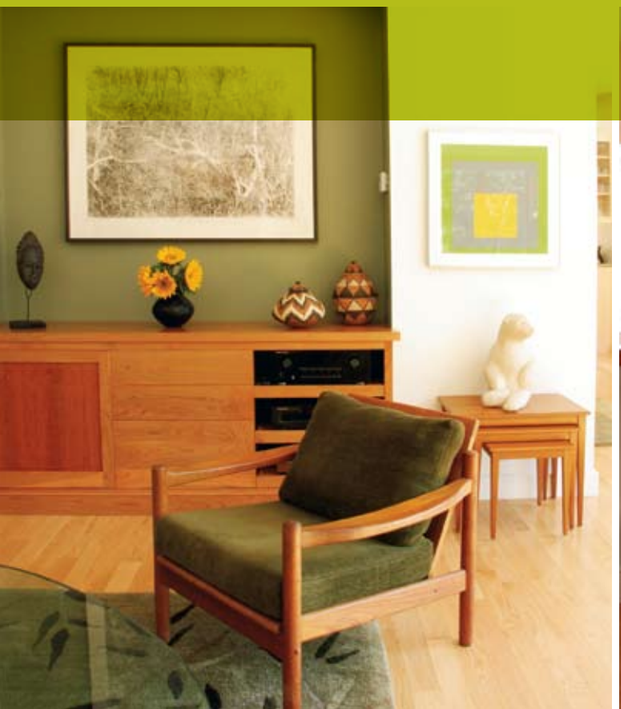
"In many ways, solar panels and super efficiency are an aesthetic and values decision," Margot says. Nonetheless, the Moomaws estimate that design and building costs ended up about $250 per square foot and that energy efficiency measures increased their costs a mere ten percent above a conventional home of the same size—a modest price to pay for an architect-designed project. While the solar panels and excavation for the ground source loops required a significant monetary outlay, energy-efficiency measures, such as insulation, windows, and doors, will pay for themselves within the decade—probably even more quickly, considering that the prices of oil and of natural gas are at record levels, Margot notes. The solar panels—which cost about the same as a masonry fireplace, Bill says—will pay back in perhaps twenty to twenty-five years at current energy prices, "but it is likely that current energy prices will look cheap over the coming decades and that the payback will be much faster," Margot says.

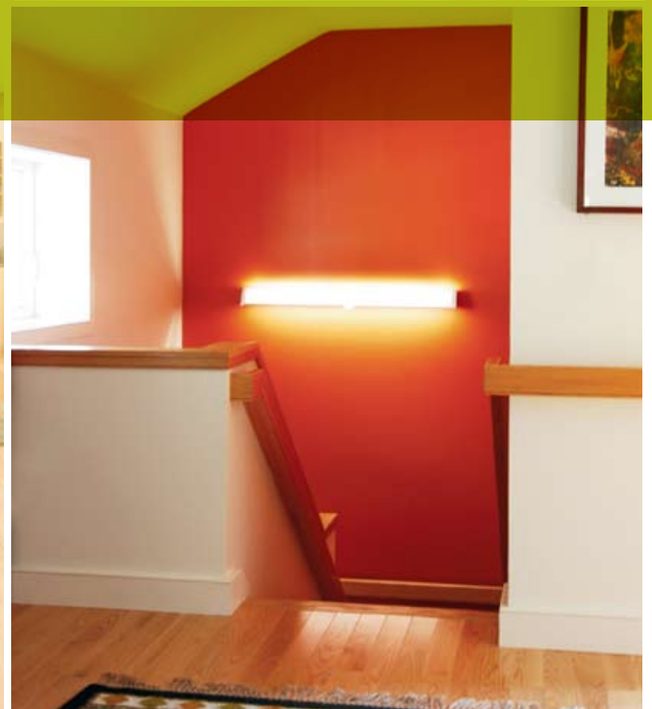
The house relates to the larger ecology not only in its energy efficiency, but also through its aesthetic sensibility, with natural materials, landscape-inspired color palette, and views of meadow, pond, and mountain. The living room's built-in cabinet was crafted of cherry wood harvested on the property, kitchen cupboards are of maple and glass, and Margot's color choices mirror the hues of a Berkshire autumn. Recycling bins are located in the pantry, and the kitchen, with its efficient sink-refrigerator-stove work triangle, features a stainless-steel bucket set into the granite-topped island near the sink for non-protein organic waste, coffee grounds, eggshells, and the like, which is eventually transferred to an outdoor bin and reused as nutrient-rich compost. In landscaping, native rock from the property served as raw material for a winding patchwork of grey, ochre, and rust stonewalls and pavers, and the south lawn was seeded with hardy grasses requiring minimal upkeep.

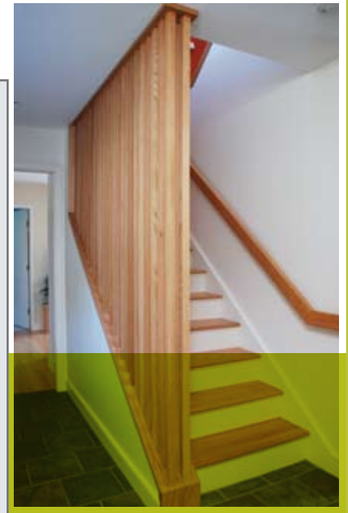
To protect flora and fauna during construction, builders erected a silt fence around the pond to block runoff and loose dirt and kept heavy equipment away from a grove of old oak trees. Disturbed growth was replaced with native plants. As for the fauna, "Most of the original inhabitants seem to accept us as neighbors," Bill says. "The otter is still in the pond, the great blue heron visits the pond every day in the summer, the fox comes across the meadow." On this small, sustainable piece of the planet, all inhabitants live in harmony. h+g

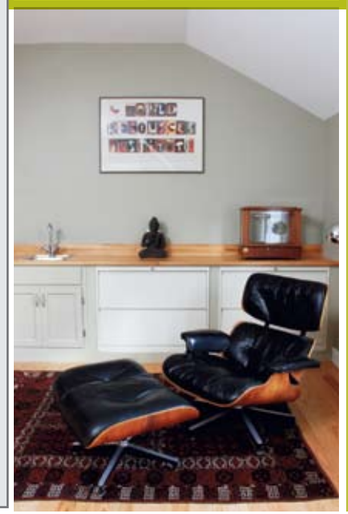
Tresca Weinstein *is a frequent contributor to* Berkshire Living.











Right: Bill Moomaw's desk tucks into a west-facing gable. Below, left: The living room's built-ins are made from cherrywood harvested on the property. Below, right: The stair's terra cotta hue worked well in low-energy fluorescent lighting. Opposite, top to bottom: Hot and cold water pipes snake along the basement ceiling; a columned wall admits light into the staircase; behind an Eames lounge chair and ottoman, Ikea cabinets house secondhand file cabinets.

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Berkshire Photovoltaic Services
46 Howland Ave.
Adams, Mass.
413.743.0152
www.bpvs.com

Coldham & Hartman Architects
155 Pine St.
Amherst, Mass.
413.549.3616
www.coldhamandhartman.com

Haskins Construction
694 Henderson Rd.
Williamstown, Mass.
413.458.5718

John Lapedota Woodworking
121 Union St.
North Adams, Mass.
413.663.5667

Marc Rosenbaum, environmental design consultant
Meriden, N.H.
603.469.3355
www.energysmiths.com

Margot Moomaw, "green" consultant
781.643.0328

Mount Greylock Greenhouses and Landscaping
281 West Mountain Rd.
Adams, Mass.
413.743.2064

Petersen Engineering
6 Market Square
Portsmouth, N.H.
603.436.4233
www.petersenengineering.com

Walter Cudnohufsky, landscape architect
455 Bug Hill Rd.
Ashfield, Mass.
413.628.4600
www.wcala.com

GREEN IS IN THE DETAILS

WALLS: Exterior walls are twelve inches thick, twice the typical thickness, and are filled with a cellulose insulation made from recycled newspaper. Interior walls are painted primarily in a soft white to maximize reflected light from the sun and from low-watt lamps mounted on ceilings and floors.

HEATING: Radiant heat, generated by warm water passing in loops beneath the main floor, keeps feet toasty. Powered by electricity, the system requires no fossil fuels. Because the house contains no furnace or radiators, homeowner's insurance costs less.

VENTILATION: To keep air quality healthy, a Lifebreath heat recovery ventilation (HRV) system exhausts air from the bathrooms and brings in air from outside, extracting heat from outgoing air to heat incoming air. The house has no air conditioning; it stays cool because it's so well insulated.

WINDOWS AND DOORS: Thermotech doors and windows lock in three places to create a tighter seal. Windows are triple-paned, coated with a sealant that prevents heat loss, and framed in fiberglass, which expands and contracts at the same rate as glass, providing a tight edge. In the living room, rather than access the deck through sliding doors, which facilitate heat loss, the Moomaws chose a triptych of tall windows; they access the deck via a conventional door nearby.

DECK: The deck along the home's south side is built of Trex, a durable wood and recycled plastic composite, which offers great traction and never needs painting.

SIDING: Clapboards are made from James Hardie fiber cement siding that resists warping, cracking, and rotting. Wood siding on the shed and guesthouse was sourced from a managed forest cooperative in Charlemont, Massachusetts.

ROOF: The leak- and rot-proof standing-seam metal roof easily accommodates clip-on solar panels.

FLOORS: Refinished red oak flooring, from a managed forest in Quebec, finished without harmful solvents that outgas into the air, is laid atop wood-composite "warmboard" flooring over the radiant heating pipes.

LIGHTING: Task lighting is used throughout the home; dimmer switches help curtail energy use; and, in the master bath, three compact five-watt fluorescent lights are mounted on the mirror, reflecting and amplifying the light. Energy-efficient bulbs in standard lighting fixtures cut electricity use between 40 and 75 percent per fixture. Low-watt, long-life, low-mercury Phillips 'green' fluorescent bulbs—recessed into the ceiling over kitchen cabinets, where they provide indirect light reflected off the ceiling, and mounted behind valances that direct light onto the wall—use one-fourth the electricity required by incandescent bulbs. Xenon pendant lights hang over the dining table and kitchen eating area, and wall sconces with translucent diffusers reduce glare.

PAINT: Colors echo the landscape: blues and whites, moss-green, beige, and curry-yellow coat the kitchen's accent walls, resembling the color of the property's beech trees in the fall. Each shade was tested in the type of light used in that space, since colors read differently under fluorescent lights than under halogen or Xenon lights. For instance, because of the staircase's fluorescent fixture, a rich terra cotta worked better than a vibrant red.—*TW*