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INDUSTRY NEWS

A Wind-Powered House Aims For Net-Zero

Last year, builders completed a new custom home for architect David Pill on his semi-rural property in Charlotte, Vermont. Pill designed the 2,700-square-foot all-electric home to be a near-zero-energy house. The Pill house has no photovoltaic or solar-thermal panels; the family generates electricity with a 10-kilowatt wind turbine (see Figure 1).

Pill has successfully completed the paperwork for his house to receive LEED platinum certification. So far,



Figure 1. Protected by a porch, the Pill house's entry door faces west. The home's Bergey wind turbine is on the home's east side.

he's very pleased with his home's performance. "We were shooting to do a net-zero-energy house," Pill told *EDU*. "It's been performing very well."

Closing In On Net Zero

During their first eight months living in the house (from August 10, 2007 to April 9, 2008), the four-person Pill family used 5,479 kWh, or 685 kWh per month, for all uses (including space heat, domestic hot water, cooking, and a clothes dryer). Supplemental space heat was provided by a woodstove that consumed 1/3 cord of firewood. (Assuming that the woodstove's efficiency is 70%, firewood provided about 5,480,000 Btus, or 1,606 kWh of heat). The family did not burn any natural gas or propane.

During the same period, the Pill family's Bergey wind turbine produced 3,549 kWh of electricity. During the monitoring period, however, the wind

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Table I — David Pill House Specifications

Location	Charlotte, Vermont
Completion date	August 2007
Building size	2,700 square feet
Foundation	Poured concrete basement
Basement slab insulation	4" EPS under entire slab
Basement wall insulation	2" EPS on interior basement walls between concrete and 2x4 studs filled with cellulose; total R-20
Rim joist insulation	5" closed-cell SPF
Wall construction	2x6 studs, 24" o.c., with exterior plywood sheathing
Wall insulation	5" closed-cell SPF in stud cavities and 1"-thick foil-faced polyisocyanurate over exterior plywood sheathing (R-40 wall assembly)
Siding	Most walls have white-cedar clapboard over Cedar Breather rain screen; Galvalume metal siding on remainder of walls
Roof construction	Conditioned unvented attic with insulated 2x10 rafters; plywood roof sheathing
Roof insulation	2x10 rafter bays filled with 9" closed-cell SPF (R-54 to R-60)
Roofing	Standing-seam galvanized steel roof
Passive solar features	Long dimension oriented east-west; most windows face south; orientation-specific glazing
Windows / glazing	Fiberglass-framed Thermotech awning windows with double low-e triple glazing (U-0.17)
Blower door results	500 cfm @ 50 pascals
Design heating load	28,000 Btu/h
Annual energy for space heat	29,000,000 Btu
Space heating system	3-ton Econar ground-source heat pump (heat source is 430' standing-column well); 2 hot water storage tanks (one for space heat, one for DHW); woodstove backup
Heat distribution	Hydronic distribution with 100°F water circulating through in-floor PEX loop embedded in 4-inch-thick concrete slab over wood framing
Air conditioning	None
Ventilation system	Venmar HRV with dedicated ductwork
Domestic hot water	Ground-source heat pump with electric-resistance backup; waste pipes include 5' GFX drainwater heat-recovery device
Solar thermal system	None
Photovoltaic system	None
Wind electric system	10-kW Bergey wind turbine on a 120' NRG tower; Xantrex grid-tie inverter

system was out of commission for more than two months due to inverter problems. According to data from Pill's anemometer, his wind system would have produced 4,849 kWh — 88.5% of the family's electricity use — during the eight-month period if the inverter hadn't failed.

Advanced Framing Negotiations

As often happens on residential construction sites, some of the construction details for the Pill house resulted from negotiations between the designer (David Pill) and the builder (Jim Huntington of New England Housewrights). Their dialog over framing options will

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Figure 2. The rim joists at the Pill house are insulated with 5 inches of closed-cell spray polyurethane foam.

have a familiar ring to many energy-efficient residential designers: while Pill advocated advanced framing techniques, Huntington remained skeptical.

“David wanted to reduce the amount of framing because of the conductivity of the framing,” Huntington told *EDU*. “But from my perspective the structure comes first. He wanted to use foam sheathing with diagonal bracing, and I told him we needed plywood sheathing because it was a windy area. He wanted to use single top plates. My input as a carpenter was to say, ‘You need double top plates to tie the walls together.’” Pill eventually agreed with Huntington’s framing recommendations.

Lots of Insulation

Like most Vermont houses, the Pill house has a full basement. Four inches of expanded polystyrene (EPS) insulation was installed under the entire basement slab (see Table 1, page 2). To insulate the basement walls, a layer of 2-inch-thick EPS was installed against the interior of the concrete, followed by a 2x4 stud wall filled with cellulose insulation.

To minimize air leakage and maximize R-value, Pill specified closed-cell spray polyurethane foam (SPF) for the home’s above-grade walls, roof, and rim-joist areas (see Figure 2). In addition to filling the 2x6 walls with 5 inches of closed-cell spray foam, the builders installed a layer of one-inch-thick foil-faced polyisocyanurate foam on top of the exterior plywood wall sheathing (see Figure 3).

According to Huntington, the rigid foam was inconsistent. “The foam varied an eighth of an inch or more in



Figure 3. The exterior walls were covered with a layer of 1-inch-thick foil-faced polyisocyanurate foam insulation. Builder Jim Huntington taped the seams with Tyvek tape.

thickness, and we were worried that it would telegraph through the clapboard,” said Huntington. “We sent the foam back and got another batch, but the second batch had the same problem. The R-Max rep came out and looked at it, and in the end we decided that there wasn’t much we could do about it.”

Window Leaks

Like many energy-efficient Vermont homes that aren’t constrained by a tight budget, the Pill house has fiberglass-framed Thermotech windows with triple glazing. Pill specified a mixture of fixed and awning windows, most of which face south (see Figure 4).

Unfortunately, some of the windows have leaked; it remains unclear whether the leaks are due to a manufacturing problem or an installation error. “There were quite a few issues with the windows — issues with leakage,” said Huntington. “When it rained really hard, a few drops of moisture were showing up on the inside,



Figure 4. Most of the Pill house’s windows face south. The siding is a mixture of white-cedar clapboard and Galvalume metal siding.

at the bottom corners of the windows. The Thermotech people came back a few times, but we are not completely confident that the problem has been solved. It's been a frustrating thing to diagnose. We used Vycor all around the perimeters, and we still had the problem. We have never had leaking windows before this job."

Sealed Right: Bag Tight

Everybody involved with the Pill house is pleased with the blower-door results (500 cfm at 50 pascals). "We really went over everything with a fine-toothed comb to reduce all infiltration," said Huntington. "The walls were double-sealed. We taped all the foam seams with Tyvek tape, and the Typar housewrap under the foam was also taped."

Heating With Electricity

The Pill family has two space-heating appliances: a wood stove and a ground-source heat pump (GSHP). The 3-ton Econar water-to-water heat pump extracts heat from water drawn from a 430-foot-deep standing-column well — the same well used for the home's domestic water supply (see Figure 5). Once cooled by the heat pump, the water is returned to the well.

To reduce energy consumption, the submersible well pump is controlled by a variable-speed drive. The GSHP supplies heat to two storage tanks; one tank is dedicated to the hydronic heating system, while the other stores domestic hot water. The domestic hot water tank has an electric-resistance element as a backup source of heat; Pill has chosen to disconnect power to the backup element.

Wastewater from both of the home's bathrooms is directed to a 5-foot-long GFX drainwater heat-recovery device (see Figure 6).

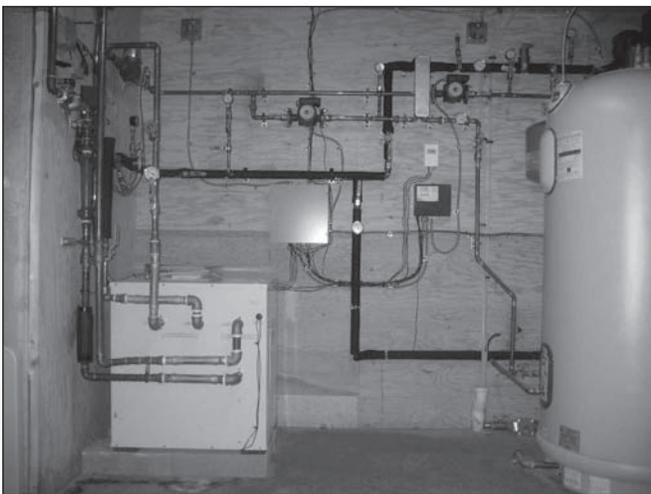


Figure 5. The ground-source heat pump is located in the basement utility room.

The in-floor radiant heat loop circulates water at 100°F — much cooler than the 180°F water typically circulated through hydronic baseboard units. Since most GSHPs struggle to produce water any warmer than 120°F or 130°F, distribution systems using low-temperature water are a good match for a heat pump.

Although the Pill house has two floors in addition to the basement, heat is distributed only to the first floor. Pill chose to embed the system's radiant PEX tubing in a 4-inch-thick concrete slab installed over a wood-framed floor (see Figure 7).

Few residential designers in Vermont specify heat pumps. "It is a complicated system," noted Huntington. "It's not a very common system at all in Vermont, so you really have to want it to make it happen — especially because the upfront costs are substantially higher than a high-efficiency boiler."

Dedicated Ventilation Ducts

The home's mechanical ventilation system consists of a Venmar heat-recovery ventilator with dedicated ventilation ductwork. Fresh air is supplied to the living room and bedrooms, while exhaust air is pulled from the bathrooms and kitchen.

Making Electricity At Home

Like most designers of near-zero-energy houses, Pill considered installing a photovoltaic system. "At first,



Figure 6. This drainwater heat-recovery unit serves both upstairs bathrooms.



Figure 7. The hydronic PEX tubing was embedded in a 4-inch concrete slab installed over a wood-framed floor.

we were looking at doing PV and solar thermal,” Pill told *EDU*. “But then we realized that the site was good for wind, since we are on the crest of a hill. It’s like a natural wind tunnel.”

Pill installed a 10-kilowatt Bergey turbine on a 120-foot NRG tower. The total cost of the wind system was \$40,500; after the \$12,500 renewable-energy incentive, the net cost to Pill was \$28,000.

The Bergey system came with a Xantrex inverter. “The inverter failed a few times,” said Pill. “We had to send it back to Xantrex, and the wind system was out for all of August and September. Then the inverter went out again in the beginning of January. We sent it back again and they sent us a brand new one.”

Less Than Ten Bucks a Month

When the wind is blowing and the ground-source heat pump isn’t required for space heat, the Pill family has

Rethinking LEED

A reorganized version of the Leadership in Energy and Environmental Design (LEED) system for certifying green buildings was recently released for public comment. According to LEED’s parent organization, the United States Green Building Council (USGBC), the new version of the certification sys-

Table 2 — Pill Family Electricity Use

August 10, 2007 to September 9, 2007	329 kWh
September 10, 2007 to October 9, 2007	371 kWh
October 10, 2007 to November 9, 2007	400 kWh
November 10, 2007 to December 9, 2007	1,048 kWh
December 10, 2007 to January 9, 2008	1,029 kWh
January 10, 2008 to February 9, 2008	1,099 kWh
February 10, 2008 to March 9, 2008	775 kWh
March 10, 2008 to April 9, 2008	428 kWh
Total -- August 10, 2007 to April 9, 2008	5,479 kWh

Table 2. Operation of the Pills’ ground-source heat pump accounts for much of the increase in energy use during the winter. In the months covered by this table, the Pills’ wind turbine produced about 600 kWh per month.

a monthly electric bill of \$9.83. That’s the minimum utility charge; a bill of \$9.83 means they’re generating more electricity than they’re using.

Pill realizes that a zero-energy home requires energy-conserving behavior by the occupants (see Table 2). Describing his family, Pill noted, “We are all very energy-conscious. Everyone is on board with the whole thing.”

Inevitably, however, family members have varying behavior. “I take a 6-gallon shower, but my son takes a 12-gallon shower,” said Pill. Pill’s current goal is to reduce the family’s use of their clothes dryer. “This past winter, we used the electric clothes dryer a lot,” said Pill. “That’s a big draw. Now we’re using the clothesline more.”

Achieving net-zero-energy use requires more than good architecture. “I think a huge piece of this is homeowner awareness,” said Pill. “You could build a hundred energy-efficient houses like this, and each house would have different usage data.”

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tem “resets the bar” by providing new regional flexibility and a new weighting system: “LEED 2009 is not a ‘tear down and rebuild’ of the LEED that exists in the market but rather a reorganization of the existing LEED Rating Systems along with several key advancements.”

“The Sum Is Less Than The Parts”

The development of LEED 2009 was spurred in part by widespread criticism of LEED's illogical elements. “As critics like to point out, a \$395 bike rack and a multimillion-dollar low-energy air-conditioning system both get one point,” wrote Clay Risen in the April 20, 2008 issue of the *New York Times Magazine*. “Detractors’ biggest complaint is that by relying on a cumulative point system, LEED encourages developers to nitpick over individual details rather than creatively approach a building’s overall sustainability — making the sum or a building’s LEED points less than its parts. ‘I’d much rather see BTU and CO₂ requirements and let the professional community solve the problem,’ the architect Thom Mayne told the journal *Architectural Record*. ‘If you give prescriptive requirements, it stagnates new development and research.’”

USGBC President Rick Fedrizzi believes LEED 2009 represents an improvement over the existing LEED rating system. “It was clear that incremental change to how LEED functions wasn’t enough,” said Fedrizzi. According to Scot Horst, chairman of the volunteer LEED Steering Committee, “The ‘big ideas’ we’ve proposed include transparent weightings of LEED credits so the highest-priority credits achieve the most points.” With LEED 2009, the USGBC has attempted to “redis-

tribute the available points in LEED so that a given credit’s point value more accurately reflects its potential to either mitigate the negative or promote positive environmental impacts of a building.”

More Weight To Energy Performance

According to Brendan Owens, USGBC’s vice president of LEED technical development, the importance of reducing a building’s energy use has increased under LEED 2009. “When it comes to the number of points associated with energy efficiency and energy improvements, we have given those credits more weight,” Owens told *EDU*. “That makes energy efficiency more important, because it is harder to ignore that section and still get a LEED-certified project. When it comes to the credit achievement threshold, we updated the basis of the energy optimization credit from ASHRAE 90.1-2004 to ASHRAE 90.1-2007. Since ASHRAE moved the bar higher, we have actually increased the stringency in the energy credit achievement slightly, even though you used to have to get 14 percent above ASHRAE 90.1, and now you only have to get 10 percent above ASHRAE 90.1.”

The public comment period for LEED 2009 ended on June 22. For more information, visit www.usgbc.org.

NEWS BRIEFS

DOE Announces Solid-State Lighting Prize

WASHINGTON, DC — The US Department of Energy (DOE) will offer a large cash prize, dubbed the “L Prize,” for the development of a solid-state (LED) lamp with an efficiency of 90 lumens per watt. The winning lamp must draw less than 10 watts while producing more than 900 lumens. Since the prize depends on future Congressional appropriations, the amount of the award has not yet been determined. The DOE calls the L Prize “the first government-sponsored technology competition designed to spur lighting manufacturers to develop high quality, high efficiency solid-state lighting products to replace the common light bulb.” The competition’s rules, developed by the DOE in consultation with a group of California utilities, can be reviewed online at www.lightingprize.org.

US House Passes Extension Of Energy Tax Credits

WASHINGTON, DC — The US House of Representatives has passed a bill (HR 6049) to extend energy-efficiency tax credits, including the homeowners’ tax credit covering 30% of the cost of installing solar equipment. For the bill to become

law, it must be passed by the Senate and signed by President Bush; according to *Renewable Energy World*, the Bush administration has threatened to veto the bill. While the US Senate has passed its own version of a bill to extend energy-efficiency tax credits, its provisions differ from those in HR 6049. A similar bill, HR 5984 (also known as the Clean Energy Tax Stimulus Act of 2008), has been introduced to the House, but has not been passed. HR 6049 proposes extending the homeowners’ tax credit for photovoltaic and solar thermal equipment through December 31, 2009, and eliminating the existing \$2,000 tax credit cap. It would also extend the builders’ tax credit for new energy-efficient homes through December 31, 2010. Solar equipment manufacturers and installers are monitoring developments closely; the *Renewable Energy World* article notes, “Congress has been trying unsuccessfully for a year to extend tax credits for individuals, businesses, and developers who invest in clean power. When the credits expire at the end of this year, it’s estimated that more than 100,000 jobs and close to US \$20 billion in investment will disappear.”

CertainTeed Enters the Spray-Foam Business

VALLEY FORGE, PA — CertainTeed, a leading US manufacturer of fiberglass insulation, has entered the spray-foam business. Forming a partnership with an unidentified chemical supplier, CertainTeed is selling spray-foam ingredients to “CertainTeed-qualified” insulation contractors. The new two-component spray foam product, CertaSpray, is available in two formulas: open-cell and closed-cell. Shawn Bears, a CertainTeed marketing manager, told *EDU*, “Officially, we’ve only been in the spray-foam business for less than a month and a half. Right now we’re working with a small number of contractors.”

Don’t Call It “Geo-Exchange”

OTTAWA, ONTARIO — After being sued by a US trade association for using the word “geo-exchange,” several Canadian renewable energy societies promoting the use of ground-source heat pumps — including the Earth Energy Society of Canada (EESC) and the Canadian Association for Renewable Energies — have reached an out-of-court settlement. According to the EESC Web site (www.earthenergy.ca), “In 2006, EESC was served with a major legal claim for promoting the technology through a Web site which uses the term ‘geo-exchange.’ The word ‘geoexchange’ is a trademark and people who use that term are being sued. ... Due to the legal action launched under the geo-exchange trademark, EESC does not have resources to provide a package of information as it has for the past ten years.” According to the Canadian Association for Renewable Energies, “The agreement stipulates that no details of the settlement be released.” The most prominent US Web site using the word “geoexchange” is www.geoexchange.org, a site maintained by the Geothermal Heat Pump Consortium.

New State Laws Protect Homeowners’ Solar Rights

WASHINGTON, DC — Responding to restrictions by homeowners’ associations on the installation of solar thermal collectors and photovoltaic modules, eight states are considering, or have recently passed, legislation protecting homeowners’ rights to install solar equipment. According to an article in *USA Today*, James Draheim, a homeowner in Burke, Virginia, was prevented from installing solar equipment on his roof by restrictions imposed by his homeowners’ association, the Burke Centre Conservancy. “His reaction: ‘You’ve got this energy just falling on your property and you’re not allowed to use it because of aesthetics?’” One sponsor of a solar rights bill, Illinois state representative Karen May, explained the need for new legislation: “If you’re going to have local governments

and condo associations saying, ‘Solar panels are ugly, that’s a real stumbling block.’” The article noted that attempts to protect homeowners’ solar rights at the federal level have not yet been successful: “Bills that would protect homeowners wanting to go solar were introduced in both houses of Congress last year, but few members have signed on as co-sponsors. The bills have not come up for a vote.”

More Homeowners Choosing To Lease PV Systems

SACRAMENTO, CA — Increasing numbers of California homeowners are choosing to lease, rather than own, their rooftop photovoltaic (PV) arrays, according to an article in *Renewable Energy World*. Most homeowners who lease PV equipment sign a contract called a power purchase agreement (PPA); among the companies offering PPAs to homeowners is Sun Run, a Silicon Valley start-up founded by Nat Kreamer. “Our standard agreement provides electricity at 13.5 cents per kilowatt-hour for 18 years,” Kreamer explained. “At the end of the term, customers can renew their contracts for a year at a time, or buy out the system at a fraction of the installed cost.” Sun Run subcontracts the PV installation work to experienced solar installers like REC Solar in San Luis Obispo and Borrego Solar in San Diego. David Arfin, the vice president for customer financing at Solar City, a PV leasing company in Foster City, California, predicted, “There is going to be a boom — massive adoption — in the residential market, which we can already see this year.”

Vermont Utility Proposes PV Feed-In Tariff

MONTPELIER, VT — A Vermont utility, Green Mountain Power, has proposed the adoption of a new photovoltaic (PV) feed-in tariff. If the proposal is approved by the Vermont Public Service board, Green Mountain Power customers will be paid 19 cents per kWh for PV-generated power — 6 cents more than the current net-metering benefit of 13 cents per kWh. “We are doing everything we can to encourage the adoption of solar energy,” said Mary Powell, the chief operating officer of Green Mountain Power. “It is good for Vermont economically and environmentally.”

New Hampshire Offers New PV and Wind Incentives

CONCORD, NH — New Hampshire legislators have passed a bill (HB 1628) establishing incentives for the installation of photovoltaic, wind, and micro-hydro systems. Governor John Lynch is expected to sign the bill, according to *Renewable Energy World*. The bill sets rebates of \$3 per watt, up to a maximum of \$6,000, for renewable energy systems rated at 5 kW or less.

Ontario Restricts Access to PV Feed-In Tariffs

OTTAWA, ONTARIO — The Ontario Power Authority has moved to limit the number of large renewable energy projects eligible for the province's ground-breaking photovoltaic (PV) feed-in tariff rate structure, called the Renewable Energy Standard Offer program. Surprised by the number of applications for the PV tariff, the Ontario Power Authority announced sweeping changes to the program, including a limit of 10 MW of renewable energy projects per transformer station, effective May 12, 2008. "The response to this program for small renewable energy projects has been incredible," says energy minister Gerry Phillips. The changes are unlikely to affect most Ontario homeowners; the power authority has pledged that "current and future applications from micro-scale generators (up to 10 kilowatts) and small, farm-based biomass projects up to 250 kilowatts will continue to be processed under the existing rules." The sudden changes to the Standard Offer program were strongly criticized by the Canadian Solar Industries Association (CanSIA), which announced that the association "is shocked following the Ontario government and the Ontario Power Authority's sudden move to suspend its Renewable Energy Standard Offer Program pending further review. ... 'The province was just starting to go places, attracting significant interest from both Canadian and international investors. Now the provincial government has decided to put everything on hold. You cannot build an industry in this sort of uncertain environment,' said Elizabeth McDonald, CanSIA Executive Director."

In Canada, Sears Will Install Drainwater Heat-Recovery Devices

OTTAWA, ONTARIO — Sears Home Services has announced a new national program to install Power-Pipe drainwater heat-recovery devices. Like the better-known GFX device, the Power-Pipe is a vertical copper drain pipe surrounded by a spiraling water-supply pipe. Sears will install three different models of the Power-Pipe at prices ranging from \$900 to \$1,200, including installation. The cost to homeowners is likely to be lower, however, since several Canadian provinces and utilities offer rebate programs to subsidize the cost of installing a drain-water heat-recovery device. Canadians interested in more information from Sears can call (800) 469-4663.

Juneau Residents Drastically Reduce Electricity Use

JUNEAU, AK — After an April 16 avalanche destroyed transmission towers and damaged a powerline connecting Juneau with the hydroelectric facility that

usually provides most of the city's electricity, the local utility switched to a backup generator. Burdened by the unexpected cost of expensive diesel fuel, the utility increased electricity rates 400%, from 11 cents to 53 cents per kWh. According to the *New York Times*, Juneau residents responded by cutting their electricity use by more than 38% in just a few weeks, from a pre-avalanche average of 1,006 megawatt-hours per day to 625 megawatt-hours per day. "People are suddenly interested in talking about their water heaters," said Maria Gladziszewski, who handles special projects for the city manager's office. "As they say, it's a teachable moment." The *Times* reported that Juneau residents rushed to convert to compact fluorescent bulbs. "Local stores ran out of clothespins because so many people started hanging their laundry outside. ... 'It takes about two days to get them dry,' Linda Augustine, 66, an elementary school teacher, said as she used plastic clothes hangers to dry blue jeans and T-shirts under the awning on the back porch of her mobile home. 'And I don't iron my clothes now. You massage them to get the wrinkles out while they're still on the hanger.'" On June 1, the Alaska Electric Light and Power Company announced that the damaged powerline had been repaired, several weeks ahead of schedule.

British Columbia Raises Energy Code Stringency

VICTORIA, BRITISH COLUMBIA — British Columbia's housing minister, Rich Coleman, has announced changes to the province's building code intended to reduce greenhouse gas emissions (see "News Briefs," *EDU*, January 2008). "Greening the BC Building code will reduce the environmental footprint of buildings and will lower energy bills for British Columbians," said Coleman. Effective September 5, 2008, the changes affect single-family, multi-family, and commercial buildings. Builders will be able to choose between new prescriptive insulation standards or a performance code requiring a minimum EnerGuide Rating of 77. For more information, visit www.housing.gov.bc.ca/building.

Retrofitting Houston Homes, One Neighborhood At A Time

HOUSTON, TX — The city of Houston is funding a program, the Residential Energy Efficiency Program (REEP), subsidizing energy retrofit work in low-income neighborhoods. According to the May 2008 issue of *RESNET Notes*, a newsletter published by the Residential Energy Services Network, "Those who reside in the communities automatically qualify for the upgrades free of charge, which cuts through bureaucracy and allows residents to save on their utility bill without complicated applications or lengthy upgrades

to the house. The City of Houston first implemented REEP in the community of Pleasantville, whose residents have a median income of \$28,000 and one of the highest kWh per foot ratios in the city. After over 600 homes were upgraded in Pleasantville, the program was expanded to include additional communities in Houston. As of March, 2008 over 2,000 homes had been improved. The improvements to the homes included adding insulation to water heaters and attics, caulking windows, and replacing lighting. Since all homes are from the same neighborhood, the limited variety of buildings significantly reduces the amount of time needed to upgrade the home. The City of Houston cites average savings of \$335 per household over a six-month period. ... Houston's REEP program shows what can be done when local leaders make energy efficiency a priority."

A Passivhaus Project in South Boston

BOSTON, MA — A planned development in South Boston is being touted as "the nation's first 'zero-energy' multi-unit residential complex." The project's boilers will be fueled by wood chips or vegetable oil. According to the *Boston Herald*, developer Fred Gordon's plans for a 65-unit project at 516 East Second Street are based on Passivhaus principles. "This is a huge thing in Europe and now we're bringing it to the United States," said Gordon, who estimates that the incremental cost of including the energy-efficiency features "is only 3 percent."

In Philadelphia, a \$100,000 Passivhaus

PHILADELPHIA, PA — A Philadelphia developer, Chad Ludeman, has announced his intention to build a Passivhaus residence on an urban infill site (2100 East Susquehanna Avenue, Philadelphia). Constrained by a tight \$100,000 budget, the Passivhaus building (dubbed the "100K House") will be designed to use only 53% of the energy of a code-minimum house. Solar thermal collectors will be installed on the home's flat roof, and walls will be built with structural insulated panels (SIPs). For more information, visit www.postgreen.com/projects/100khouse.

In Illinois, A Near-Zero-Energy Spec House

GLENVIEW, IL — An Illinois developer, Bernie Schmidt of Schmidt Luxury Homes, has built an energy-efficient spec house at 724 Laramie Lane in Glenview, according to a story in an Illinois newspaper, *Pioneer Local*. Equipped with roof-integrated photovoltaic modules, the house is being touted as a "zero-energy home" by Carol Coulas, a real-estate agent for Coldwell Banker. The price, says Coulas, is "only a million dollars."

In Missouri, Another Near-Zero-Energy Spec House

CREVE COEUR, MO — A Missouri builder, Sage Homebuilders, has completed a 5,000-square-foot spec house described as "a near-zero-energy home." According to the *St. Louis Post-Dispatch*, the house on Beacon Hill Lane in Creve Coeur is equipped with a roof-mounted photovoltaic array designed to supply about 65% of the home's energy. The home will be heated by a ground-source heat pump; according to Rick Hunter, a managing principal for Sage Homebuilders, the owners of the home can expect an average monthly electric bill of \$140. "Every crack, every seam, the floor, any spot where there is any possibility of air coming in, is sealed to minimize energy loss," said Sage's senior construction manager, Jim Thomas. Sage Homebuilders has put the home on the market for \$1.2 million.

First LEED Home in Lake Tahoe Is Offered At \$1.25 Million

LAKE TAHOE, CA — A Tahoe developer, Brett Hackett, has built a spec house described by the *San Francisco Chronicle* as "the only LEED-certified residential building in Tahoe." The 2,600-square-foot house has walls built with structural insulated panels (SIPs), an instantaneous water heater, a heat-recovery ventilator, a driveway equipped with a snowmelt system, an oversized (760-square-foot) garage, and a "tropical wood deck." The four-bedroom house is on the market for \$1.25 million.

Solar Thermal Pioneer George Szego Dies

DOVER, DE — George Szego, the engineer who designed the solar hot water system installed on the Carter White House, died on April 23 at the age of 88. According to the *Washington Post*, Szego was born in Budapest, Hungary; his family emigrated to the US when Szego was 2. During World War Two, Szego served in the US Army, and fought in the Battle of the Bulge. In 1970, Szego founded a company, InterTechnology Solar, to manufacture solar-thermal collectors. Szego's obituary in the *Washington Post* included a quote from *EDU's* January 2006 issue, which featured Szego's last media interview.

New York Utility Launches New Efficiency Initiatives

UNIONDALE, NY — The Long Island Power Authority (LIPA) has announced a plan to invest \$924 million in energy-efficiency programs over the next ten years. The program, called Efficiency Long Island, will be funded by a surcharge on custom-

ers' utility bills averaging about \$3.30 per month. Residential customers will be offered rebates for a variety of energy retrofit measures (including duct sealing), as well as for the purchase of efficient air conditioners and heat pumps. LIPA will also offer incentives to builders of new Energy Star homes.

Massachusetts Program Offers No-Interest Loans for Energy Upgrades

NORTH ADAMS, MA — As part of a program called MassSAVE, two Massachusetts banks (Hoosac Bank and Williamstown Savings Bank) are offering \$10,000 no-interest loans to homeowners investing in energy retrofit work. MassSAVE is a partnership between the Massachusetts Division of Energy Resources and utility-sponsored efficiency programs. The no-interest loans, called HEAT Loans, can be used to pay for a variety of measures, including insulation, new heating systems, water heaters, or Energy Star windows. Those interested in applying for a HEAT Loan must first obtain a home energy audit. For more information, contact Cindy Sault, Hoosac Bank, at (413) 662-2132, or Myra Wilk, Williamstown Savings Bank, at (413) 458-8720.

Colorado Bill Helps Counties Launch Energy Retrofit Programs

DENVER, CO — Colorado Governor Bill Ritter has signed a bill, HB 1350, granting county governments the authority to sell tax-exempt bonds to fund energy-retrofit loans to homeowners. According to the *Longmont* [Colorado] *Times Call*, the bonds will be backed not by the taxpayers, but by homeowners' repayment obligations. Boulder County commissioner Will Toor told the *Times Call* that Boulder officials "hope to move forward quickly" to develop a program offering below-market loans to homeowners interested in insulation and air-sealing projects. "This sets the groundwork so every Colorado home, farm, ranch, and business can save on their utility bills while investing in a new energy future," said Alice Madden, Colorado House majority leader.

German Engineers Set New PV Cell Efficiency Record

FREIBURG, GERMANY — A team of researchers from the Fraunhofer Institute and Eindhoven University of Technology claim to have developed photovoltaic cells with an efficiency of 23.2%, a world record. According to *Renewable Energy Focus*, the international renewable energy magazine, credit for the cells' performance is due to an ultra-thin layer of aluminum oxide at the front of the cells.

Electric Utility Will Use Giant Flywheels For Energy Storage

STEPHENTOWN, NY — A Massachusetts company, Beacon Power Corporation, is planning to build the nation's first flywheel plant for energy storage. The company is seeking permits to build a 20-megawatt plant housing 200 massive flywheels, each 7 feet tall and 3 feet wide. Designed to spin at 16,000 rpm, the flywheels will be sealed in a vacuum and floating on magnetic bearings. As the statewide demand for electricity ebbs and flows, the flywheels will be used, as required, to generate electricity. According to an Albany-area newspaper, the *Times Union*, the \$50 million plant will be built at the intersection of Routes 22 and 43 in Rensselaer County, New York. If approved, construction will begin this year.

Thieves Steal Used Fryer Oil For Biodiesel Market

MORGAN HILL, CA — According to the *New York Times*, thieves supplying the biodiesel market are victimizing restaurants by stealing used fryer oil. In Morgan Hill, California, a thief stole 300 gallons of used fryer oil from the back of a Burger King restaurant; when police followed the thief and forced him to stop, they discovered that his truck contained 2,500 gallons of used oil. Commenting on the theft, Mark Rosenzweig, the owner of a grease collection business in Morgan Hill, noted, "Ten years ago we couldn't give this stuff away. Now everybody's fighting over it." Since 2000, the price of used fryer oil has more than quadrupled; it now sells for about \$2.50 per gallon. According to Nick Damianidis, the owner of Olympia Pizza and Pasta in Arlington, Washington, thieves have emptied the tank of used fryer oil behind his restaurant "seven or eight times." Damianidis said, "Fryer grease has become gold. And just over a year ago, I had to pay someone to take it away."

US CO₂ Emissions Still Rising

WASHINGTON, DC — US carbon-dioxide emissions from burning fossil fuels were 1.6% higher in 2007 than the previous year. According to the DOE's Energy Information Administration, "Factors that drove the emissions increase included weather conditions that increased the demand for heating and cooling services and a higher carbon intensity of electricity supply. Total US energy-related carbon dioxide emissions have grown by 19.4 percent since 1990." For more information, visit www.eia.doe.gov/oiaf/1605/flash/flash.html.

South African Utility Offers Solar Water Heater Incentives

JOHANNESBURG, SOUTH AFRICA — A South African utility, Eskom, is offering a rebate to home-

owners who install solar hot water systems. The rebate will cover between 15% and 20% of the installed cost of a solar thermal system. For more information, visit www.eskom.co.za/dsm.

Queen Elizabeth Invests In Off-Shore Wind Turbines

ABERDEEN, SCOTLAND, U.K. — Queen Elizabeth has decided to invest in an offshore wind development that will include the largest wind turbine in the world, according to Reuters News Service. The Queen will make the investment through her property company, the Crown Estate.

Challenging Fine, Canadian Man Argues That Skateboards Are A Form Of Transportation

FREDERICTON, NEW BRUNSWICK — After Lee Breen, 25, was arrested and fined for riding his skateboard on Fredericton streets, he announced his

refusal to pay the fine. According to *The Calgary Sun*, Breen maintains that the law against skateboarding “is at odds with the city’s bid to be environmentally friendly.” Breen explained, “It’s a form of transportation. It’s a lot cheaper than buying a bicycle.” Unmoved by Breen’s logic, a judge ordered Breen to be jailed.

Quote Without Comment

“‘Advertising and marketing is what’s confusing to the consumer,’ said Robert Wisniewski, senior technical consultant at MaGrann Associates, a green-building consulting firm in Moorestown, N.J., who worked with Mr. Montalvo. ‘In reality, green is not really about what you can see; it’s about good building science. If you want something to show off, you can show off your energy bills.’” [“The House That Green Built” by Susan Farley, *New York Times*, April 20, 2008]

RESEARCH AND IDEAS

ICFs Provide No Thermal-Mass Benefit In Canada

Does the concrete in a wall built with insulated concrete forms (ICFs) provide a thermal mass benefit? According to a recent Canadian study, the answer is no — at least not during the winter in Canada.

The thermal-mass benefit of the concrete in an ICF wall, if any, is climate-dependent. Thermal mass is more likely to provide a benefit in a climate with wide daily swings in temperature, during seasons when the minimum outdoor temperature drops below 65°F and the maximum outdoor temperature rises above 80°F.

According to most experts, the benefits of thermal mass are greatest when the thermal mass is not separated from the interior by a layer of insulation; ideally, the thermal mass should be exposed to a home’s conditioned air. Such is not the case with an ICF wall.

“Effective R-Value” Claims

Although issues like climate variations and the location of ICF insulation should give pause to those tempted to tout the thermal-mass features of ICF walls, ICF marketers have not been deterred by these issues.

For example, Fox Block, an ICF manufacturer located in Omaha, Nebraska, includes this information in its technical data sheet: “EPS steady-state R-value: R-24. ... ICF Effective R-Value Performance: Up to R-32 or greater (the thermal

resistance performance of an entire assembled ICF wall, calculating the effects of thermal mass, thermal wicking, and low air infiltration).”

Monitoring A Seven-Story Building

In a research project funded by the Canada Mortgage and Housing Corporation (CMHC), researchers studied the performance of ICF walls in a seven-story multi-unit residential building in Waterloo, Ontario. At the time of construction, temperature sensors were placed at nine locations in the building; at each location, four sensors were inserted in the ICF wall (see Figure 8). Sensors were located:

- On the exterior surface of the outer layer of insulation;
- At the interface between the outer layer of insulation and the concrete;

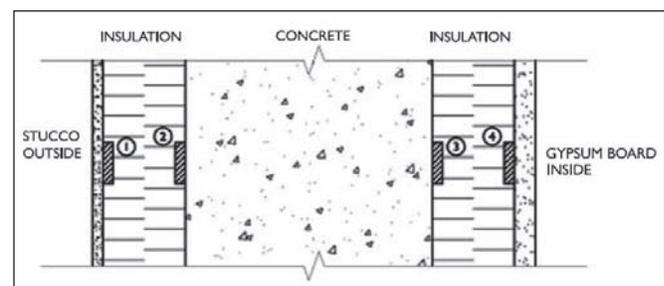


Figure 8. This illustration shows the locations of temperature sensors placed in the ICF walls of a seven-story building in Waterloo, Ontario.

- At the interface between the inner layer of insulation and the concrete; and
- On the interior surface of the inner layer of insulation.

The researchers also installed data loggers to record indoor air temperatures.

Data were collected from these sensors every 15 minutes for three winter months (December 1, 2005 to February 28, 2006). To identify the effects of thermal mass and air leakage on energy consumption, researchers also performed blower-door tests, thermographic scanning, and computer modeling.

ICFs Reduce Air Leakage

The researchers' data suggest that ICF construction contributed to a significant reduction in a building's air leakage rates. They concluded, "The results show that the overall building is relatively airtight, due in large part to the continuity of the ICF wall assembly, as no extraordinary air leakage control measures were undertaken at the roof and foundation levels and the building construction was not yet completely finished and all penetrations of the wall system were not sealed. The results from this test suggest that the design heating and cooling loads and subsequent sizing of the building's heating and cooling system may be based upon an air infiltration rate that is up to 60 per cent lower than standard construction."

CMHC researcher Duncan Hill was impressed by the air-sealing benefits of ICF construction. "The system proved to be relatively airtight," Hill told *EDU*. "Even though the builder didn't try to do anything special for air sealing beyond standard practice, the

blower-door test showed that he landed among the best of the best for air-leakage control."

It's The Insulation, Not the Thermal Mass

While ICF construction creates a wall with very low levels of air leakage — "the concrete is a poured-in-place air barrier," says Hill — the concrete had no thermal-mass benefit in Canada. The researchers wrote, "The ICF wall assembly studied in this research project had an insulating value that was fairly close to the nominal insulation value of the polystyrene layers of insulation. ... No thermal-mass impact or higher effective insulation value was observed. However, the air leakage testing found the building to be relatively airtight and this can, for the most part, be attributed to the ICF wall system."

The lack of any benefit from the thermal mass in ICF walls was confirmed by computer modeling: "Comparing the simulation results of Models 1 and 3 shows that the increased thermal mass offered by the ICF wall construction in this building showed an insignificant improvement when compared to a low-mass wall assembly having the same thermal resistance and infiltration."

The researchers examined the data carefully for signs of a thermal-mass effect. "We couldn't detect one in the work that we did," Hill told *EDU*. "We weren't able to tease anything from the monitoring data to show anything left over that might be seen as a benefit from thermal mass."

To download a "Research Highlight" paper on the ICF research conducted by CMHC, visit www.cmhc-schl.gc.ca/odpub/pdf/65863.pdf.

NEW PRODUCTS

Two New Water Heaters From GE

General Electric has announced the development of two new residential water heaters: an instantaneous gas water heater and an electric heat-pump water heater. Both water heaters will meet the new Energy Star specifications for water heaters.

GE's heat-pump water heater is still in development, but the company's instantaneous gas water heater is already on the market. Two sizes are available: a 4 gallons-per-minute model and a 4.5 gallons-per-minute model (see Figure 9).

Unrealistic Flow Rates

GE's advertised flow rates are higher than those listed here. Since GE calculates the units' maximum flow rates at an unrealistic temperature rise (or delta-T) of only 35°F, *EDU* contacted the GE engineering department to obtain more realistic flow rates. Cold-climate homeowners with 40°F incoming water are more likely to be interested in maximum flow rates at a delta-T of 75°F than 35°F (see Table 3).

Both sizes of water heater can be ordered as an indoor model or an outdoor model. The smaller



Figure 9. GE's instantaneous gas water heaters are available as an outdoor model and an indoor model.

model is sold only as a natural gas version, while the larger model can be ordered for either natural gas or propane.

GE's instantaneous gas water heaters retail for \$1,300 to \$1,700.

Heat-Pump Water Heater

Still under development, GE's residential heat-pump water heater will be marketed as a "hybrid electric water heater." Originally scheduled for release in May 2009, the availability of the heat-pump water heater has been pushed back to "the end of 2009."

Engineers at the US Department of Energy's Oak Ridge National Laboratory (ORNL) are collaborating with GE



Figure 10. GE's heat-pump water heater is still under development.

engineers to develop the GE heat-pump water heater. After an initial round of testing at ORNL's Building Technologies Research and Integration Center, prototypes will undergo further field testing. According to Allison Eckelkamp, a public relations manager at GE, the heat-pump development team is aiming for a minimum Energy Factor (EF) of 2.0 (see Figure 10).

GE's Cloudy Future

GE has announced plans to sell its appliance division to the highest bidder, raising the possibility that GE appliances may soon sport a label like Daewoo or Hitachi. "Right now, GE is seeking strategic options," Eckelkamp told *EDU*.

For more information, contact General Electric Appliances, Appliance Park, Louisville, KY 40225. Tel: (800)-626-2000; Web site: www.geappliances.com.

Table 3 — Maximum Flow Rates For GE Instantaneous Water Heaters

GE Model number	Maximum flow rate at 35°F temperature rise	Maximum flow rate at 75°F temperature rise
GN75D	7.5 gallons per minute	4 gallons per minute
GN94D	9.4 gallons per minute	4.5 gallons per minute

Table 3. The high maximum flow rates included in GE's marketing materials for its instantaneous gas water heaters are based on a 35°F temperature rise. Flow rates at a more realistic temperature rise of 75°F are much lower.

INFORMATION RESOURCES

The Sun-Inspired House

The Sun-Inspired House, a 247-page book by architect Debra Rucker Coleman, may be the best available introduction to passive solar design (see Figure 11). Coleman's book is much more useful than three better-known books on the topic: James Kachadorian's *Passive Solar House Book* (see *EDU*, December 1997), Dan Chiras's *The Solar House* (see *EDU*, May 2003), and Steven Winters' *Passive Solar Design and Construction Handbook* (see *EDU*, July 2003).

Builders who glance at Coleman's book may hastily identify three strikes against it: it is written by an architect; it is written for homeowners; and it promotes the sale of the author's house plans.

As it turns out, however, none of these apparent defects detract from the book's usefulness. Coleman is a rare architect: at once eminently practical and willing to share trade secrets. Although she writes with homeowners in mind, Coleman assumes her readership to be curious, knowledgeable, and technically inclined. Finally, the self-promotional aspects of the book — Coleman's touting of her house plans — do not detract from the value of the advice she provides on passive house design.

Consider Hiring a Home Energy Rater

Coleman's common-sense advice is based on years of design experience. For example, she writes, "Few builders will say 'no' when asked if they build energy-efficient houses, so talk to previous clients about comfort, quality, and energy consumption. Consider employing a third party such as a home energy rater that has been certified under the Energy Star program."

Coleman advises readers looking for more information on building performance issues to consult the Web site and books produced by the Building Science Corporation in Westford, Massachusetts.

EDU salutes Coleman for the first two items she chose for her list of green building principles: "building small" and "renovating instead of building new." Appropriately, she returns to the theme of "building small" throughout the book.

Readers of *The Sun-Inspired House* will occasionally be distracted by Coleman's disjointed writing style

and erratic sense of organization. However, these minor flaws do not significantly undermine the value of her book.

Unimplemented Principles

The Sun-Inspired House ably covers the basics of passive solar design. Solar veterans may assume these principles to be well-known; but since the principles are almost never implemented in the US, they bear repeating:

- "South-facing windows allow sun to enter in cold months, while the correct placement of south window overhangs and awnings keeps the sun out during hot months."
- "Orient the longest wall of the house [to face] close to true south. ... A design that requires two walls to be oriented at 45 degree angles to true south is not optimum from an energy standpoint."
- "By choosing a fairly rectangular plan over one with many wings, additions, and roof forms, homeowners can save from 10 to 50 percent on heating and cooling energy consumption."
- "South windows should have a high solar heat gain coefficient (SHGC) to maximize the amount of the sun's heat that passes through the glass. ... It can be hard to locate glass other than clear with a high SHGC in southern climates."
- "A two-story rectangle is the easiest shape to maximize south glass in relation to the floor area. It is also easiest to maximize the south glass to floor area ratio in smaller houses."
- "Limit the use of skylights because it can be difficult to control summer heat."
- "Shading with porches works well for east and west windows."
- "Prefabricated sunrooms seem to have so much glass that it would be nearly impossible to add enough thermal mass to balance out the temperature swings. The room would most likely be too hot in summer and too cold in winter."

Rules of Thumb

To design a high-performance passive solar house, a builder needs more than general principles; what's needed are formulas and rules of thumb. Fortunately, Coleman fulfills this need:

- "The low winter sun angle ... varies with latitude: 67 degrees minus a given latitude = noon sun angle on 21 December."

- "Place a minimum of 5% and a maximum of 12% (of the conditioned area of the house) of glass on the south wall of the house. ... If south glass exceeds 7% of the floor area, install heat-absorbing materials (thermal mass) inside the house."
- "Keep east-facing glass to less than 4% of the conditioned floor area."
- "Limit west-facing glass to less than 2% of the conditioned floor area."
- "North-facing glass should not exceed 4% of the conditioned floor area unless the site is in a warm climate."
- "For 8 and 9 foot wall heights, a 2-foot [roof] overhang or awning can be sufficient to many roof and wall construction details with 5' to 6' windows. The overhang criteria should be refined according to the latitude, exact orientation of the south wall, and climate."
- "Strive for a minimum of 2 inches of thermal mass, but limit mass to 4 inches thick."
- "13 degrees F is the maximum recommended temperature swing for most people's comfort range. For instance, a room could reach a peak temperature of 80 degrees during the late afternoon, but be back down to 67 degrees in the early morning hours without assistance from backup heating systems."

Maybe Not 30 Percent

The Sun-Inspired House contains only one glaring technical error — namely, Coleman's assertion that "Radiant barriers have been shown by the Florida Solar Energy Center [FSEC] to reduce cooling costs in hot climates by approximately 30 percent."

In fact, FSEC research has shown that an attic radiant barrier can reduce *heat gain through an R-19 insulated ceiling by 30% to 40%*. A report from Oak Ridge National Laboratory concluded, "Since the ceiling heat gains represent about 15 to 25 percent of the total cooling load on the house, a radiant barrier would be expected to reduce the space cooling portion of summer utility bills by less than 15 to 25 percent. Multiplying this percentage (15 to 25 percent) by the percentage reduction in ceiling heat flow (16 to 42 percent) would result in a 2 to 10 percent reduction in the cooling portion of summer utility bills."

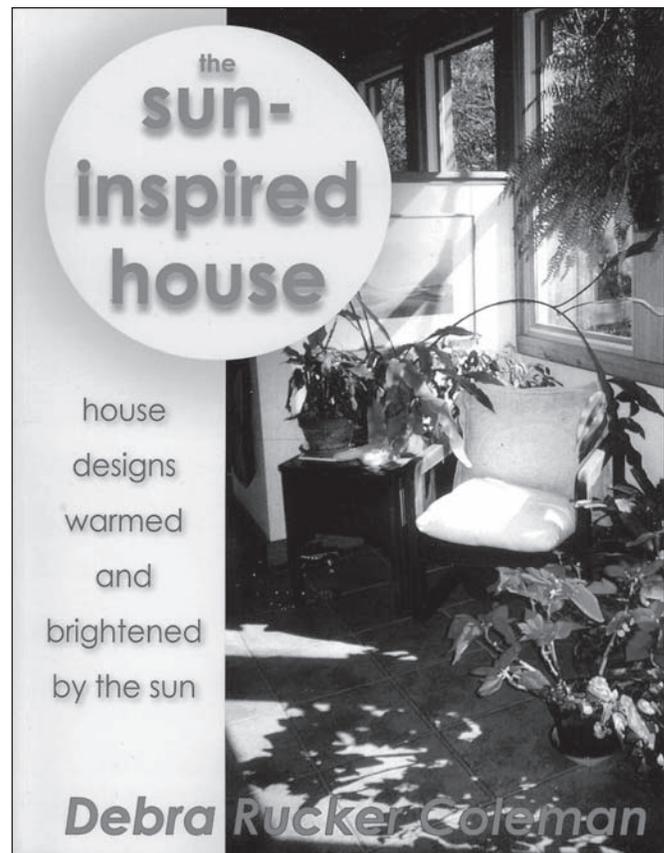


Figure 11. *The Sun-Inspired House* is an excellent introduction to the principles of passive solar design.

According to a fact sheet produced by the DOE's Office of Energy Efficiency and Renewable Energy, cold-climate builders who install an attic radiant barrier can expect even smaller reductions in energy bills: "Two field tests, one in Minnesota and one in Canada, both found that a radiant barrier placed over R-19 attic floor insulation (which is less than half the DOE minimum recommendation for those climates) found that the radiant barrier contributed to less than a 1% reduction in energy consumption for heating and cooling."

The Sun-Inspired House: House Designs Warmed and Brightened By the Sun (ISBN 978-0-9767318-0-1) by Debra Rucker Coleman is available for \$29.95 from Sun Plans, 18250 Tanner Road, Citronelle, AL 36522. Tel: (251) 866-2574; Fax: (251) 866-2576; E-mail: info@sunplans.com; Web site: www.sunplans.com.

BACK PAGE

The Six Sins of Greenwashing

A public relations company with offices in Philadelphia and Ottawa, TerraChoice Environmental Marketing, recently issued a well-researched report called “The Six Sins of Greenwashing.” The report (posted online at www.terrachoice.com/files/6_sins.pdf) summarizes the results of an investigation into claims made by marketers of “environmentally friendly” products.

According to the report, such marketers have a dismal performance record: “We identified 1,018 consumer products bearing 1,753 environmental claims. Of the 1,018 products examined, all but one made claims that are demonstrably false or that risk misleading intended audiences.”

The TerraChoice Report divided the misleading claims they waded through into six useful categories:

- The sin of the hidden trade-off.
- The sin of no proof.
- The sin of vagueness.
- The sin of irrelevance.
- The sin of the lesser of two evils.
- The sin of fibbing.

To clarify TerraChoice’s categories, *EDU* provides examples of the Six Sins of Greenwashing in the table below.

The TerraChoice report was based on claims for a variety of products — mostly consumer items like air fresheners, bathroom cleaners, envelopes, facial tissues, hairspray, ink cartridges, laundry detergent, oven cleaner, scrub pads, toilet paper, and toothpaste. However, the investigators did look at a few building materials, including appliances, caulk, flooring, insulation, light bulbs, and paint.

EDU salutes TerraChoice for its bold challenge to those marketing products touted as “green,” “environmentally friendly,” or “sustainable.” TerraChoice’s six categories are eminently useful; indeed, over the last several years, *EDU* has cited flagrant examples of all six sins.

TerraChoice’s finding that 99.9% of all “green” products are marketed with claims that are false or misleading will not surprise regular readers of *EDU*. Responsible marketers of energy-efficient homes should rise to the TerraChoice challenge by promoting better metrics — for example, the HERS Index — than those used by the ethically challenged crowd now touting “green” toothpaste and toilet paper.

The Six Sins of Greenwashing	TerraChoice’s Explanations	<i>EDU</i> ’s Examples
The Hidden Trade-Off	A claim that a product is green based on a single attribute, without attention to other important environmental issues	“Electric baseboard heat is 100% efficient.”
No Proof Available	A claim that cannot be substantiated by easily accessible supporting information	“Save 40% on your energy bill.”
Vagueness	A claim that is so poorly defined or broad that it is meaningless	“This building is green.”
Irrelevance	A claim that is true but unimportant (often because the statement is true for all similar products)	“Our exterior doors are fully weatherstripped.”
Lesser of Two Evils	A claim that is true within the product category but that distracts the consumer from the greater environmental impacts of the category as a whole	“Each 6,000-square-foot home at Willow Meadows meets Energy Star specifications.”
Fibbing	A claim that is simply false	“Two coats of our paint are equivalent to R-19 insulation.”