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INDUSTRY NEWS

Factor 9 and Factor 10

Addressing global climate change may require North Americans and Europeans to reduce fossil fuel consumption by a factor of 9 or 10, according to some climate scientists. Several residential designers have accepted the Factor 9 or Factor 10 challenge: in Regina, Saskatchewan, for example, a recently completed home has been dubbed the Factor 9 House, while a low-energy building in Böheimkirchen, Austria, has been called a Factor 10 house.

The Carnoules Declaration

The Factor 10 concept has its roots in the Carnoules Declaration, a 1994 manifesto issued by a group called the Factor 10 Club. Meeting in Carnoules, France, the 16 members of the club proposed that industrialized countries decrease resource consumption by a factor of 10. (A more modest goal was proposed a few years later in *Factor Four*, a 1998 book by Amory Lovins, L. Hunter Lovins, and Ernst von Weizsäcker.)

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The driving force behind the Factor 9 House in Regina is Rob Dumont, the head of the building performance section of the Saskatchewan Research Council. Dumont's goal was a house using one-ninth of the energy consumed in a typical 1970s-era home.

Dumont recently recalled, "Back in 1998, at the Green Building Challenge conference, I heard William Rees from the University of British Columbia refer to Factor 10. The concept seemed pretty convincing to me: with increasing population and increasing consumption per person, the only technical solution to our problems is improved efficiency—around a tenfold improvement in efficiency. When I learned that there is already a Factor 10 House in Chicago, I decided to use 'Factor 9' to describe the house in Regina."

Sustainability Math

According to Dumont, the Factor 9 concept aims at sustainability: it incorporates anticipated future population growth (factor 1.5) multiplied by future consumption growth per person (factor 3) multiplied by the required reduction in greenhouse gas emissions (factor 2).

Several partners have contributed to the design, monitoring, and funding of the Dumont's Factor 9 House; these partners include the Saskatchewan Research Council, the University of Regina, the City of Regina, the Saskatchewan Homebuilder's Association, Natural Resources Canada, and the Canada Mortgage and Housing Corporation.

A Stingy Energy Budget

Completed in November 2006, the Factor 9 House is a detached bungalow with an active solar space heating system. Early on in the design process, an amenable family—the eventual homeowners—was selected to participate in the construction of the Factor 9 House. Most of the construction cost for the Factor 9 House is being borne by the homeowners, Rolf and Shannon Holzkaemper, who have agreed to cooperate with ongoing performance monitoring.

Dumont established an ambitious energy budget for the home: only 9,030 kWh per year, or 30 kWh per square meter. (To put the goal in perspective, the widely praised Saskatchewan Conservation House, built in 1977, consumed 76 kWh per square meter per year.)

An Unusual Foundation

In Regina, expansive clay soils complicate foundation design. Although the foundation of the Factor 9 House is typical for Regina, it would be considered unusual in most areas of North America. At the bottom of an extra-deep basement excavation, the foundation contractor drilled 22 holes, each 12 inches in diameter and 16 feet deep (see Table 1, page 4). These piling holes were filled with reinforced concrete. The tops of the concrete pilings were then connected by concrete perimeter beams measuring 10 inches wide by 24 inches high.

The perimeter beams enclose a sub-basement crawlspace; above this crawlspace is a wood-framed basement floor. Surprisingly, the basement walls are framed with structural insulated panels (SIPs). These below-grade 6 ½-inch-thick SIPs have an exterior facing of pressure-treated plywood. The foundation includes the same waterproofing and drainage details required for all-wood foundations, including peel-and-stick membrane over the exterior face of the basement walls and clear-draining crushed-rock backfill. When asked about the unusual basement walls, Dumont explained, "We used SIPs for the basement walls because they were supplied by Emercor, one of the project sponsors."

Figure 1. The Factor 9 House in Regina, Saskatchewan, has an attached garage on the north side.

Insulating Siding

The above-grade walls consist of Emercor SIPs covered with a siding product called Pan-Brick *(www.panbrick.com)*. Pan-Brick is a laminated siding with three layers: a backing of ⅜-inch-thick plywood sheathing, a core of 1⅝-inch-thick polyurethane foam insulation, and an outer layer of ½-inch-thick slices of clay brick veneer. The siding has an R-value 12.9; at the Factor 9 House, where the Pan-Brick is installed over R-28 SIPs, the resulting wall assembly has an R-value of about 41. The attic floor includes even more insulation—a deep R-80 layer of blown cellulose.

The glazing in the Loewen wood-framed windows varies by orientation. The north and east windows have low-e argon-filled triple glazing (see Figure 1). Since the house is designed to take advantage of solar heat gain, most of the windows face south; the south-facing windows have low-e argon-filled double glazing (see Figure 2).

To limit overheating, the Factor 9 House includes extra thermal mass; Dumont reports, "We stuffed the interior partition walls with scraps of gypsum board."

Vertical Solar Collectors

The 1,614-square-foot house has a design heating load of 30,500 Btuh at -29°F. The house includes an active

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Figure 2. Most of the Factor 9 House windows face south. The two horizontal bands of south windows—one for the upper floor, and one for the lower floor—are separated by a band of vertical solar thermal collectors. This photo was taken after two of the home's 12 solar collectors had been installed. The height of the floor framing is indicated by the location of the door sill on the west side of the house.

Figure 3. The designers of the S-House in Böheimkirchen, Austria, have described it as a Factor 10 house. Most of the building's glazing faces south.

solar thermal system sized to meet a significant portion of the home's space heating load. The system's 12 Thermodynamics solar collectors are installed vertically on the south wall between two horizontal bands of windows.

The amount of energy collected annually by vertical solar collectors is less than for sloped collectors. According to Dumont's calculations, vertical collectors in Regina collect 18% less energy annually than collectors installed at the same angle as the latitude (50°). However, vertical collectors are less likely to cause overheating problems during the summer than collectors installed at an angle.

"Installing them on the wall gave us more design freedom, and gave the house a more conventional appearance," Dumont told ***EDU***. "Since they are integrated with the façade, there is no extra cost for mounting hardware—they are simply attached to the wall. Any heat loss from the back of the solar panels helps heat the house. Also, vertical collectors don't require the use of tempered glass. Finally, you don't get much frost or snow accumulation on vertical collectors."

A photovoltaic-powered DC pump circulates an antifreeze solution between the solar collectors and a 700-gallon insulated stainless-steel tank. When the thermostat calls for heat, solar-heated water circulates through a finned coil in the air handler; the space heat is distributed through forced-air ductwork. (During cloudy weather, backup space heat is provided by baseboard electric resistance heaters.) The Enerzone air handler *(www.enerzoneinc.com)* is equipped with a very efficient ECM blower.

Similarly efficient blowers are found in the home's Venmar heat-recovery ventilator (HRV). Venmar's latest HRVs include brushless DC motors, assuring very low electricity consumption.

Embedding PEX Tubing In the Foundation

Instead of a conventional air conditioner, the Factor 9 House is equipped with a compressor-free cooling system. When the foundation piers were being prepared, vertical loops of PEX tubing were lowered into the 22 piling holes, attached to the necessary steel reinforcement rods. These PEX loops were eventually encased in concrete. According to Dumont, the concrete pilings should have an average temperature of 41°F.

When the house thermostat calls for cooling, water is circulated between the PEX loops in the concrete pilings and a finned coil in the home's air handler. The cooling system is experimental; Dumont notes, "We are installing a data logger to quantify the contribution of the cooling loops."

A PV-Ready Roof Slope

According to Dumont, the cost of installing enough photovoltaic (PV) modules to make the Factor 9 House a net-zero-energy house would be between $30,000 and $40,000—too steep for the project budget. However, the south-facing roof of the Factor 9 House is an ideal location for a PV array; if PV prices drop in the future, the homeowners may eventually install a PV system.

Thanks to funding provided by Natural Resources Canada and the Canada Mortgage and Housing

Table 1 — Factor 9 House and Factor 10 House Specifications

	Factor 9 House	Factor 10 House (S-House)
Location	Regina, Saskatchewan, Canada	Böheimkirchen, Austria
Completion date	November 2006	Spring 2005
Building size	1,614 square feet	4,300 square feet (400 square meters)
Foundation	Concrete pilings supporting below-grade concrete perimeter beams, supporting a below-grade wood-framed basement floor	Concrete piers supporting above-grade structural wood floor panels
Basement wall construction	Below-grade SIP walls; exterior face of SIP is pressure-treated plywood covered with peel-and-stick membrane	Not applicable
Basement wall insulation	On average, R-50 (below grade, R-44 SIPs; above-grade, R-44 SIPs covered with R-12.9 siding)	Not applicable
Floor insulation	R-12 fiberglass batts in floor framing below basement	19.7-inch straw bales (about R-28.5)
Above-grade wall construction	Structural insulated panels	Structural wood panels, supplemented with post-and-beam framing
Wall insulation	R-28 SIPs covered with R-12.9 siding	19.7-inch straw bales (about R-28.5)
Siding	Pan-Brick (R-12.9 urethane foam sandwiched between ⅜" plywood and ½"-thick slices of brick veneer)	Horizontal board siding attached to vertical furring strips
Roof construction	Wood trusses over an unconditioned attic	Structural wood panels; low-slope (flat) roof
Attic / roof insulation	R-80 blown fiberglass	19.7-inch straw bales (about R-28.5)
Roofing	Asphalt shingles	Vegetated (green) roof over rubber membrane roofing
Passive solar design features	Extensive south glazing; drywall scraps inserted in partition stud bays provide extra thermal mass	Extensive south glazing; stone floor provides extra thermal mass
Windows / glazing	Loewen windows with low-e argon-filled glazing; south windows are double-glazed, while north and east windows are triple-glazed	U-0.14 windows; further details unavailable
Solar thermal system	12 vertical solar collectors (Thermodynamics, Dartmouth, Nova Scotia) connected to a recycled 700-gallon stainless-steel water storage tank; PV-powered pump.	Solar collectors are connected to a 264-gallon water tank; further details unavailable
Space heating system	Hydro-air system using solar-heated water; backup provided by baseboard electric resistance heaters. Enerzone air handler equipped with ECM blower.	Wood stove; wooden ductwork is used to distribute heat from the south side of the house to the north side.
Domestic hot water	Solar thermal, with electric instantaneous water heater for backup	Solar thermal system
Space cooling	Water circulates between PEX tubing embedded in concrete pilings and finned coil in the air handler	Ventilation system pulls fresh air through buried ducts
Ventilation system	Venmar HRV with brushless DC motors	80% efficient heat-recovery ventilator
Photovoltaic system	None, except small modules to run solar thermal system pump	None
Construction budget	$250,000 including land	$1,924,000

Figure 4. The floor of the S-House is insulated with a layer of straw bales sandwiched between wood panels.

Figure 5. The roof load of the S-House's south wall is carried by timber posts.

Corporation, the Factor 9 House has been equipped with sensors and data-logging equipment. The Saskatchewan Research Council will monitor most of the energy flows through the house, including the performance of the solar thermal system and the Watercycles wastewater heat exchanger, for at least a year.

Across the Atlantic, a Factor 10 House

Like Rob Dumont in Saskatchewan, engineers at the Center of Appropriate Technology (Gruppe Angepasste Technologie), a department of the Vienna University of Technology in Austria, were inspired by Factor 10 thinking to design a model low-energy building. Completed in the spring of 2005 in the town of Böheimkirchen, about 50 kilometers from Vienna, the small educational building and test facility has been dubbed the S-House (see Figure 3). The S-House design team included Robert Wimmer, Hannes Hohensinner, and Manfred Drack.

According to a project brochure ("S-House Layman Report"), the designers of the S-House aimed at sustainability: "By using building materials derived from renewable raw materials and … passive house technology, the consumption of resources during the construction of a building could be minimized by Factor 10 as compared to conventional construction methods…."

Another project brochure, "Buildings of Tomorrow," notes that the S-House designers aimed for minimal environmental impact—not only during the building's construction, but also in terms of its ongoing energy use: "Passive solar house technology allows the reduction of energy use to 10 percent of today's average consumption."

Insulating Floors With Straw

While the Saskatchewan designers shared the Third Little Pig's design preference for brick façades, the Austrian designers followed the example of the First and Second Little Pigs, opting for wood and straw.

The S-House is a 4,300-square-foot passive solar structure insulated with straw bales. The designers favored materials that could be recycled or reused, and aimed to minimize the use of synthetic materials and metal. According to the "Buildings of Tomorrow" brochure, "An important aim was to spare … resources and minimize building leftover materials during construction of the building and to reuse all building components in order to avoid environmental pollution even after the usage period of the building."

Winters in Böheimkirchen are much less severe than those in Regina, Saskatchewan, and the S-House has a heating energy budget of only 6 kWh per square meter per year—considerably less than the Passivhaus maximum of 15 kWh per square meter per year (see ***EDU***, February 2004).

The S-House uses structural wood panels instead of floor framing; these floor panels were set by crane over a concrete pier foundation. The entire building envelope, including the floor and attic, is insulated with straw bales. The floor construction consists of a layer of structural floor panels, followed by a layer of 20-inch-thick straw bales. These bales are then topped with a second layer of floor panels, finished with stone flooring (see Figure 4).

Straw-Bale Wall Insulation

The S-House is a two-story building; the south elevation is almost entirely glazed. The structural loads of

Figure 6. The S-House does not include any conventional roof framing; the structural roof consists of engineered wood panels. After these ceiling panels were set, a layer of straw bales was installed as insulation. On top of the bales, a second layer of wood roof panels was then installed by crane.

the roof are carried by a combination of timber framing and structural wood wall panels (see Figure 5). In order to minimize thermal bridging, the straw bales are stacked outside of the wooden wall panels; the bales are attached to the wall panels with heavy string.

After the straw-bale walls were stacked, the bales were coated on the exterior with plaster made from clay gathered on site. Once the plaster was dry, vertical wood furring strips were attached to the straw-bale walls with plastic "straw screws" invented by the project developers. Finally, horizontal board siding was nailed to the furring strips. No housewrap or building paper was used in the walls.

Like the floor, the roof is a sandwich consisting of a layer of straw bales between two layers of wood-framed panels installed by crane (see Figure 6). The green (vegetated) roof is installed over rubber membrane roofing.

Measuring R-Value

The engineers at the Center of Appropriate Technology calculated that the S-House's floor, walls, and ceiling have an R-value of 70. Since most of this R-value derives from the building's 20-inch thick layer of straw bales, the figure may be optimistic. According to tests performed by engineers at the Oak Ridge National Laboratory, a realistic R-value for straw-bale walls is about R-1.45 per inch (see *Home Energy* magazine, April 1999). Using this conservative value, the straw bales installed in the Austrian house would have an R-value of about 28.5.

The north wall of the Factor 10 house includes test panels where several experimental insulation materials are being evaluated. Engineers are now monitoring the thermal performance of panels insulated with cork, flax, wool, and hemp. (For more information on hemp insulation, see ***EDU***, November 2002.)

Wood Heat

Like most European low-energy buildings, the S-House includes a heat-recovery ventilator (HRV). The HRV pulls fresh air into the building through buried ventilation ducts.

The S-House is equipped with a small solar thermal system to provide domestic hot water. Space heat is provided by a wood stove with ducted exterior combustion air.

For more information on the Factor 9 House, contact Rob Dumont, Saskatchewan Research Council, 125-15 Innovation Boulevard, Saskatoon, SK S7N 2X8, Canada. E-mail: dumont@src.sk.ca; Web site: *www.factor9.ca*.

For more information on the S-House, contact Hannes Hohensinner, Gruppe Angepasste Technologie, Technische Universität Wien, Wiedner Hauptstrasse 8-10, A-1040 Wien, Austria. Tel: 43-1-58801-49523; E-mail: hh@grat.at; Web site: *www.s-house.at*.

NEWS BRIEFS

Insurance Rebates For Owners of Energy-Efficient Buildings

MUNICH, GERMANY—A position paper issued by a major insurance company has proposed offering reduced insurance rates to owners of buildings that are energy-efficient or equipped with renewable energy systems. The report, "Climate Change & Insurance: An Agenda for Action in the United States," is a collaboration between Allianz Group Insurance and the World Wildlife Fund. Alarmed by predictions that global climate change will result in huge losses to insurance companies, executives at Allianz Group are considering policies that offer lower insurance premiums to customers who invest in technologies tending to slow climate change. A subsidiary of Alliance Group, Fireman's Fund Insurance, is already offering lower premiums on commercial insurance policies for LEED-certified buildings. The complete report is posted online at *www.allianz.com/Az_Cnt/az/_any/cma/contents/1260000/saObj_1260144_allianz_Climate_US_2006_e.pdf*.

Researchers Monitor Wall Assemblies In British Columbia

COQUITLAM, BRITISH COLUMBIA—A new 900-square-foot test hut in coastal British Columbia will help Canadian researchers identify which wall assemblies best resist wind-driven rain and promote drying. The hut, dubbed the Coquitlam Field Exposure Test Facility, is a collaboration between Balanced Solutions of Waterloo, Ontario; the Building Science Corporation of Westford, Massachusetts; and Gauvin 2000 Construction of Coquitlam, British Columbia. The wall research project in Coquitlam is, in part, a response to British Columbia's disastrous $2 billion leaky-condo crisis (see ***EDU***, December 1997). Professor John Straube, from the University of Waterloo in Ontario, has been monitoring the performance of the hut's 28 wall assembly panels since November 2005; results will not be reported until two years of data have been gathered. A variety of wall assembly types are being monitored, including face-sealed stucco assemblies and rainscreen assemblies. Some of the wall panels include a polyethylene vapor retarder, while others are equipped with a kraft-paper retarder. "That's one question we're hoping to zero in on, whether polyethylene is suitable for the West Coast," Straube recently told a reporter from the *Vancouver Province*. "We haven't seen much difference between poly and no-poly walls over one winter." For more information on the Coquitlam research project, visit *www.deborahmesher.ca/coquitlam.*

Iowa Inventor Develops Manure Furnace

WAUKEE, IA—John Kimberlin, an Iowa farmer and inventor, has developed a forced-air furnace that burns manure. The outdoor furnace has a large hopper that needs to be loaded with manure once or twice a day. An electric auger transfers the manure to a forced-draft firebox. "It's simple, really simple," Kimberlin told a reporter from the *Des Moines Register*. "Most people tend to overthink it." According to a calculation made by the Iowa Department of Natural Resources, Iowa farms produce enough manure to heat 325,000 homes. Kimberlin's company, Nature's Furnace, manufactures manure furnaces in several sizes, ranging from 175,000 Btuh to 400,000 Btuh. For more information, visit *www.naturesfurnace.com*.

A Settlement Is Reached In the Lawsuit Against DOE

WASHINGTON, DC—A settlement has been reached in the lawsuit filed by 15 state attorneys general and several consumer protection groups against the US Department of Energy (DOE) for failure to comply with federal laws mandating improvements in appliance efficiency standards (see "News Briefs," ***EDU***, November 2005). Under the terms of the agreement approved by US District Court Judge John Sprizzo, the DOE has agreed to finalize new energy-efficiency standards for 22 appliances, including air conditioners, hot water heaters, dishwashers, and clothes dryers, by 2011.

A Net-Zero-Energy-Ready Development In Colorado

ARVADA, CO—The architects of Generation, a planned residential development on 20 acres in Arvada, describe the project's 260 units of housing as "net-zero-energy-ready." Michael Tavel Architects has oriented the 2-story and 3-story buildings in the proposed mixed-use urban neighborhood to optimize solar access. The designers promise that all of the homes will have "greatly reduced heating and cooling loads." The Denver chapter of the American Institute of Architects has honored the Generation project with a Sustainability Award. One of the jurors evaluating candidates for the prize noted, "I think most of us have written off the 'burbs as hopeless, but this project shows hope."

Library Patrons Borrow Portable Watt Meters

CHATHAM, MA—The Cape Light Compact, a service organization that operates energy-efficiency programs on Cape Cod, has distributed "Home Energy Detective Kits" to area public libraries so that the kits can be lent to the public at no charge. To help homeowners evaluate residential plug loads, each kit includes a portable watt meter (the Kill-A-Watt meter). One patron taking advantage of the offer was journalist Tim Wood, who described the program in a local newspaper, the *Cape Cod Chronicle:* "Armed with a small device about the size of a TV remote control, I crawled around on the floor, beneath tables and under desks, unplugging lamps, computers, and heaters, and then plugging them in again, in an attempt to find out just how much electricity the household was using. I never got the full answer, but I picked up enough clues to realize that we've been letting a lot of juice go to waste." According to Cape Light Compact administrator Margaret Downey, the watt-meter lending program has been very popular. "Especially with children," said Downey. "The science clubs love it."

Developing Energy Monitors For Homeowners

NORWALK, CT—Consultants from Steven Winter Associates are working with engineers from Home Automation, Inc. to develop a new whole-house monitoring system allowing homeowners to quantify a home's electrical use, hot water consumption, and natural gas use—a proposed Holy Grail device that does not yet exist. In the meantime, the consultants are evaluating a whole-house electrical monitoring system from Whirlpool. Installed in a house built by Veridian Homes, a Building America builder in Madison, Wisconsin, the Whirlpool monitor tracks total electrical use, as well as electrical use broken down by individual rooms and even individual appliances. For more information, see the November 2006 issue of CARB News at *http://carb-swa.com/PDF%20files/CNNovember06.pdf.*

Roof-Integrated PV and Solar Thermal

RALEIGH, NC—The roof of a model green home in Raleigh will feature double-layer solar collectors, with a 9.7-kilowatt photovoltaic (PV) array on top of solar thermal tubing. The hybrid system resembles the one installed in a model green home built last year in Paterson, New Jersey (see "News Briefs," ***EDU***, February 2006). Like the Paterson house, the Raleigh house will use PEX tubing clips (purlins) developed by Dawn Solar (see ***EDU***, February 2005). The PV array consists of Sunslates (roof-integrated PV shingles) from Atlantis Energy; the back of the Sunslates touch the Dawn Solar purlins into which the PEX is snapped. The developer of the Raleigh home, Cherokee Investment Partners, claims that the spray-foam-insulated house will require 50% less fossil fuel than a typical new home. For more information, visit *www.mainstreamgreenhome.com*.

A Solar Residential Development in Oregon

MOSIER, OR—A 34-unit residential development called Mosier Creek Homes is being marketed as "the largest solar community in the nation following LEED-for-Homes guidelines." Each townhouse is equipped with a 3-kW photovoltaic (PV) array and a 56-square-foot solar thermal collector. Since available PV incentives are more generous for commercial enterprises than for homeowners, the developer, Peter Erickson, is retaining ownership of most of the Mosier Creek PV arrays. The developer plans to charge the homeowners for the electricity generated by the PV arrays installed on homeowners' rooftops, at the favorable price of 15% below the retail price of grid-supplied power. Homeowners who prefer to own their PV array outright can buy the equipment at closing, as long as they are willing to cough up an extra $29,000. After six years, homeowners will be given a second opportunity to buy their PV arrays, at a price that has yet to be determined. For more information, visit *www.mosiercreek.com*.

BuildingGreen Chooses Top Ten Products For 2006

BRATTLEBORO, VT—BuildingGreen, the publisher of *Environmental Building News*, has included three energy-related items on its annual list of the best green building products of the year: the Coolerado indirect evaporative cooler (see ***EDU***, May 2005); SageGlass electrically tintable glazing from Sage Electrochomics; and renewable energy credits from Community Energy, Inc. SageGlass (*www.sage-ec.com*) is an electrified glazing with a variable solar-heat gain coefficient (SHGC); when SageGlass is energized with 0.28 watts of electricity per square foot, its SHGC decreases from 0.48 to 0.09. Electricity customers who purchase renewable energy credits from Community Energy (*www.communityenergy.biz*) agree to buy electricity at a price above the going rate, with the understanding that Community Energy will invest the premium in renewable energy production. For more information on BuildingGreen's top ten list, visit *www.buildinggreen.com/press/topten2006/index.cfm*.

PV-Equipped Houses In Arizona

SCOTTSDALE, AZ—An Arizona developer, VIP Homes, is offering photovoltaic (PV) systems as an option to buyers of new homes in four housing projects in Arizona. VIP Homes claims that, after incentives and tax credits are taken into account, home buyers who choose a 2-kilowatt PV array will see "virtually no" additional cost, while buyers who choose a 4-kilowatt array will end up paying only $7,000 for the option.

European Union Announces Energy Efficiency Plan

BRUSSELS, BELGIUM—In its long-awaited Energy Efficiency Action Plan, the European Commission has called for European countries to reduce energy use by 20% by 2020. Noting, "Europe wastes at least 20% of the energy it uses," the plan proposes 75 new regulations, including measures to encourage the use of Passivhaus construction methods (see ***EDU***, February 2004); the establishment of new appliance efficiency standards for refrigerators, air conditioners, water heaters, boilers, and light fixtures; the establishment of minimum performance requirements for renovated buildings; and the expansion of existing energy-efficiency standards that now cover large buildings to include buildings under 1,000 square meters. For more information, visit *http://europa.eu/press_room/presspacks/energy/index_en.htm*.

California Launches New Solar Web Site

SACRAMENTO, CA—The state of California has launched a new Web site, Go Solar California, to provide information on photovoltaic (PV) technology and available PV incentives and tax credits. The Web site's address is *www.gosolarcalifornia.ca.gov.*

Britain Considers Banning Incandescent Bulbs

LONDON, UNITED KINGDOM—The British government has announced a plan to ban the sale of incandescent light bulbs by 2009, according to a BBC report. The report quotes a spokesperson for the Department for Environment, Food, and Rural Affairs, Penny Fox, who said, "In the UK, we are working with retailers and manufacturers on how we could remove inefficient lighting products from UK shelves in advance of European regulations."

PV-Equipped Homes in California

PALM DESERT, CA—A California developer, Ponderosa Homes, is offering photovoltaic (PV) systems as an available option to home buyers at its new development in Palm Desert. Buyers will be able to choose among several PV arrays, ranging from 1 to 3 kilowatts. The PV systems will use roof-integrated SolarSave modules from Open Energy (see ***EDU***, November 2005). "We are proud to offer this feature as part of our option package," said Cindy Douglas, Ponderosa's vice president of sales.

Turning Table Scraps Into Electricity

DAVIS, CA—A new waste-to-energy plant, the Biogas Energy Project, is generating electricity on the campus of the University of California in Davis. The plant's anaerobic digester coverts eight tons of garbage per week to methane; the methane is burned on site to generate electricity. The table scraps used to fuel the digester are gathered from Bay Area restaurants.

Quote Without Comment

"First of all, [oil] prices are not very high. Sixty dollars a barrel is not very high. If they were high, the American consumer in particular would behave differently. As long as each American consumer burns 26 barrels of oil per year against 12 for each European, this means that prices are not high. High means that people start to say that I can use my energy better. … Economies expand, inflation is low, consumers continue to drive SUVs, and air conditioners are so high in American restaurants that you have to put on a coat, otherwise you get sick." [Paoli Scaroni, chief executive of the Italian oil company Eni, quoted in the *New York Times*, October 7, 2006]

RESEARCH AND IDEAS

Some Solar Hot Water Systems Have Long Payback

According to an analysis of monitoring data from two cold-climate solar hot water systems, "these systems are not—in the purest economic sense—cost effective." The conclusion was reached by two researchers from Steven Winter Associates in Norwalk, Connecticut, Robb Aldrich and Gayathri Vijayakumar, who analyzed data from two residential solar thermal systems: one in Hadley, Massachusetts, and one in Madison, Wisconsin.

Aldrich and Vijayakumar reported their findings in a paper, "Cost, Design and Performance of Solar Hot Water In Cold-Climate Homes," presented on July 12, 2006 at Solar 2006, the American Solar Energy Society conference in Denver, Colorado.

The monitored hot water systems are both indirect, closed-loop glycol systems. Each system includes two roof-mounted 4′ by 8′ flat-plate collectors and an 80-gallon storage tank; each family uses between 60 and 80 gallons of hot water per day.

AC Pumps Carry An Energy Penalty

The main difference between the two systems is the way that the pumps are powered and controlled. The Wisconsin system includes a flat-plate heat exchanger separate from the storage tank; fluids are circulated by two AC pumps connected to a differential temperature control (see Figure 7). The Massachusetts system has a heat-exchange coil inside the storage tank; the DC pump is connected to a small photovoltaic (PV) module.

Using AC pumps carries a significant energy penalty. Although the two houses collected similar amounts of thermal energy (8,750 MBtu per year in Wisconsin, and 8,590 MBtu per year in Massachusetts), the cost to run the AC pumps in Wisconsin was equal to 24% of the energy cost savings achieved by the solar collectors (see Table 2). No such penalty was incurred by the pump installed at the Massachusetts house; since the pump is PV-powered, it requires no electricity from the grid.

We'll Break Even *When*?

The researchers calculated that the Massachusetts system has a simple payback period of 58 years, while the payback period for the Wisconsin system, with its power-robbing AC pumps, is 76 years. Utility incentives and tax breaks shortened the payback periods to 47 years and 46 years, respectively. These payback calculations do not include maintenance costs; if the homeowners incur any maintenance costs, the payback period would, of course, be lengthened.

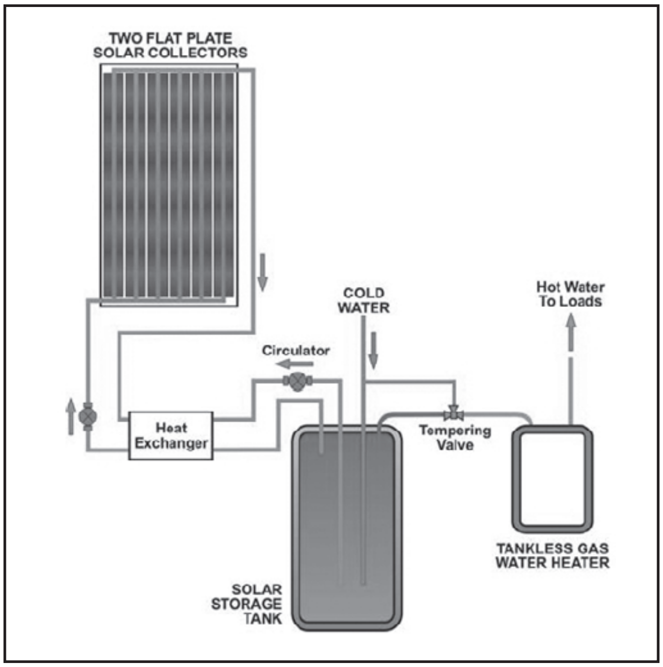

Figure 7. The solar hot water system at the monitored house in Madison, Wisconsin, includes two AC-powered pumps.

Researchers who have calculated shorter payback periods for solar hot water systems usually assume that solar hardware is cheaper, or that fuel is more expensive. "Calculations showing favorable cost-effectiveness for solar thermal systems usually consider low-cost systems in nonfreezing climates and/or inefficient or electric water heating as the reference," wrote Aldrich and Vijayakumar. "While this may be appropriate for some regions (in the Florida market, for example, electric water heating is standard and freeze protection is less critical), this is misleading in most of the country. In most US households (61%, EIA 2001) water heating is provided by natural gas, fuel oil, or propane. In addition, tankless and other more efficient water-heating technologies are becoming more common in American homes. Most parts of the country also require rigorous freeze protection for solar systems."

The researchers' conclusions are somewhat controversial. "Since I presented the paper at the ASES conference, I've received a lot of e-mails, and some hate mail, contesting my assumptions about the cost of solar thermal systems," Aldrich recently told ***EDU***. Aldrich noted that other analysts sometimes assume that a solar hot water system costs $2,000 to $3,000. "In fact, such systems cost $6,000 to $8,000 in New England," he said.

For more information, contact Robb Aldrich (raldrich@swinter.com) or Gayathri Vijayakumar (gayathri@swinter.com) at Steven Winter Associates, 50 Washington Street, Norwalk, CT 06854.

Table 2 — Comparing Two Solar Hot Water Systems

	System installed in Hadley, Massachusetts	System installed in Madison, Wisconsin
Monitoring period	12 months of data (2005 calendar year)	11 months of data (beginning March 2005)
Average hot water use	64 gallons per day	71 gallons per day
Average solar fraction	61%	63%
Lowest monthly solar fraction (December)	28%	19%
Highest monthly solar fraction (August)	87%	93%
Solar energy collected	8,590 MBtu (12 months)	8,750 MBtu (extrapolated to 12 months)
Solar energy used	7,929 Mbtu (12 months)	7,870 Mbtu (extrapolated to 12 months)
Backup system	Oil-fired boiler with indirect water heater	Instantaneous natural gas water heater
Annual fuel savings	73 gallons of oil ($135)	96 therms of natural gas ($113)
Grid electricity used by solar system pumps	None	247 kWh per year ($27)
Net annual savings	$135	$86
System cost	$7,808	$6,493
Simple payback period	58 years	76 years
Incentive/rebate received by homeowner	$1,500	$2,496
Simple payback period including rebate	47 years	46 years

Table 2. Most of the information in this table was adapted from information in Table 1 and Table 4 in "Cost, Design and Performance of Solar Hot Water In Cold-Climate Homes," by Robb Aldrich and Gayathri Vijayakumar. The values for "solar energy collected" were provided by Robb Aldrich in an e-mail to ***EDU***.

NEW PRODUCTS

Using A Furnace For Hydronic Heat

In a home with a forced-air heating system, some homeowners request hydronic radiant floor heating in a single small zone—for example, in a basement slab or a bathroom. If most of the house is heated with a furnace, it makes little sense to install a boiler for one small zone, so such installations are typically handled by a water heater—either a dedicated water heater, or the same water heater that supplies the home's domestic hot water. (In the latter case, most plumbing codes require the installation of an external flat-plate heat exchanger.)

Now three Canadian inventors have developed a package of components that solves the problem a different way. The RadiantLink system consists of a finned hydronic coil installed in a furnace's supply-air plenum; the coil is connected to a thermostat-controlled circulator and a loop of radiant tubing (see Figure 8). By using a furnace, the RadiantLink system achieves a higher efficiency than would be achieved by the typical water-heater-based system.

A Coil, a Plenum, and a Control Panel

The RadiantLink system is assembled from parts produced by several manufacturers. The McQuay finned coil comes in a box plenum that is designed to sit

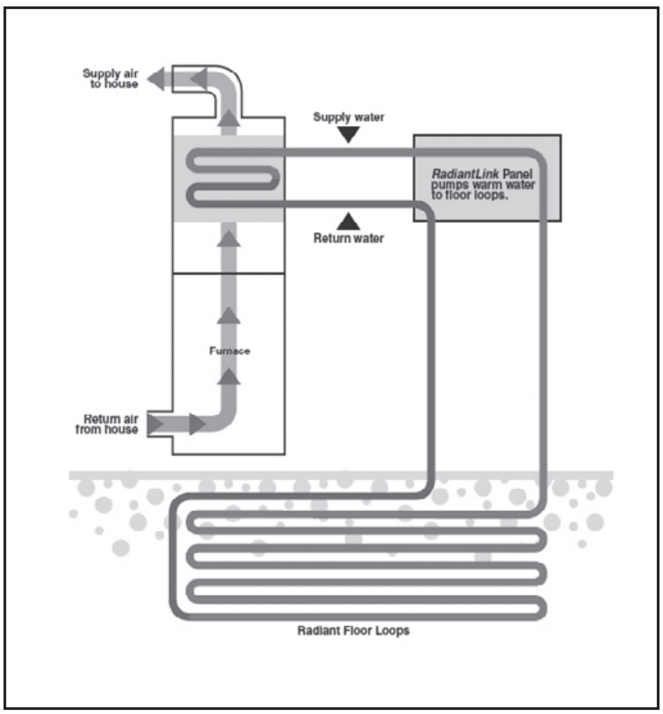

Figure 8. The RadiantLink system uses a hot-air furnace to heat water for a hydronic radiant floor.

on top of the furnace. The RadiantLink system also includes a Taco-manufactured "control panel" consisting of a galvanized sheet metal cabinet containing a circulator, expansion tank, automatic air vent, pressure relief valve, and fill hose connection; the control panel is designed for wall mounting (see Figure 9). The circulator turns on when the thermostat calls for heat and the furnace is firing.

The RadiantLink coil is not designed to heat an entire house. "We've developed a standardized unit for a furnace with an airflow of 1,200 cfm," says Murdoch MacPherson, one of the developers of the RadiantLink system. "With this unit we can easily do a 1,200-square-foot basement."

According to the RadiantLink specifications, the RadiantLink coil causes a static pressure drop in the supply airflow of 35 pascals @ 1,080 cfm. If the hydronic fluid enters the coil at 79°F, it leaves the coil at 90°F, assuming a fluid flow rate of 6 gallons per minute and a supply air temperature of 120°F. Under these conditions, the furnace supply air leaves the coil at 81°F.

Redistributing Furnace Heat

Although the specifications show that the RadiantLink coil can significantly lower the furnace's supply air temperature, MacPherson claims that such a significant drop in air temperature rarely occurs in typical

Figure 9. The RadiantLink box plenum is installed on top of a hot-air furnace. A separate wall-mounted box (the "control panel") contains a circulator and an expansion tank.

operation, and that the RadiantLink system does not result in comfort problems in rooms with forced-air heating. As the hydronic fluid warms the floor where it is directed, the temperature of the circulating fluid rises, reducing the amount of heat pulled from the furnace supply air. "In most cases, the coil will decrease the supply air temperature by about 10 degrees—it's not enough to be noticeable in the rest of the house," says MacPherson. "The furnace will run longer, until everything reaches a steady state."

According to MacPherson, the RadiantLink system is particularly effective at warming basement floors, where the advantages of floor-level heat are particularly welcome.

Summer Cooling, Too

Some Canadian customers with a RadiantLink loop in the basement slab circulate the hydronic fluid through the furnace coil during summer heat waves. As long as the basement slab is uninsulated, the temperature of the hydronic fluid is often low enough to provide some space cooling, at least until the slab warms up. "You can grab some cooling from the ground," says MacPherson. "It's effective for about two or three days in a hot spell."

According to MacPherson, the contractor's installed cost of the RadiantLink system in a typical home is about $5,500 Canadian (US $4,875).

The RadiantLink system was developed by three partners from Regina, Saskatchewan: Murdoch MacPherson of MacPherson Engineering, Brent Smith of HVAC Sales Limited, and Doug Christie of Christie Mechanical.

For further technical information, contact Murdoch MacPherson, MacPherson Engineering, 220-2365 Albert Street, Regina, SK S4P 4K1, Canada. Tel: (306) 586-7972; Fax: (306) 586-5568; Email: m.macpherson@mac-eng.ca.

For RadiantLink sales, contact HVAC Sales Limited, 1362 Lorne Street, Regina, SK S4R 2K1, Canada. Tel: (306) 721-7980; Fax: (306) 721-7982; E-mail: sales@embodiedenergy.ca; Web site: *http://embodiedenergy.ca*.

Walls Without Housewrap

An OSB manufacturer has developed a new wall sheathing panel that qualifies as a water-resistive barrier (WRB) when its seams are sealed with a proprietary tape (see Figure 10). Huber Engineered Woods, the manufacturer of AdvanTech OSB, is marketing its Zip System wall sheathing with the slogan, "Say goodbye to housewrap forever."

The Zip System consists of two components: a special 7⁄16-inch thick OSB (the Zip System panel) and a 3 ¾-inch-wide polyolefin tape with an acrylic adhesive (Zip System tape). The manufacturer explains that Zip System panels differ from AdvanTech OSB, although the nature of the difference is not explained. Marketing materials note that Zip System panels include "Stormex." When ***EDU*** inquired further, Huber's marketing manager, Patrice Dyckes, explained that Zip System panels are "specially formulated" and that "Stormex is an overlay that is incorporated into the board during the primary manufacturing process."

The International Code Council Evaluation Service has issued a report recognizing Zip System wall sheathing as an alternate to code-required WRBs *(www.huberwood.com/zip/zipwall/pdfs/ESR-1474.pdf)*. The main advantage of Zip System sheathing, according to the manufacturer, is ease of installation: "Simply install the panels, tape the seams, and you have a complete structural wall system and a water-resistive barrier all-in-one."

Certain Limitations Apply

Zip System wall sheathing cannot be used under all types of siding. The manufacturer notes that it should not be used under stucco or EIFS. It can be used under wood

Figure 10. According to Huber Engineered Woods, a house sheathed with taped Zip System panels does not require housewrap or asphalt felt.

siding, but only if the siding is back-primed or back-painted before installation. It can be used behind brick or masonry, but only if the mason maintains a ½-inch air gap between the sheathing and the masonry. (In a warranty dispute, it is unclear how a Huber rep would rule if mortar droppings were discovered in the ½-inch air space.)

Zip System tape cannot be installed in rainy weather, nor in weather colder than 20°F. Once the tape has been installed, it must be protected by siding within 90 days.

No Lapping Possible

According to Huber Engineered Woods, window heads and penetrations should be not be flashed with Zip System tape, which is too narrow for the purpose. The manufacturer recommends that openings and penetrations should be flashed with an adhesive-backed flashing tape that meets ICC-ES acceptance criteria for flashing materials (AC148).

Builders who switch to Zip System wall sheathing will have to change many of their flashing details. Those who usually install conventional housewrap are accustomed to lapping the housewrap over window and penetration flashings, so that gravity helps keep their walls dry. With Zip System wall sheathing, on the other hand, keeping the wall dry depends on chemistry—that is, on the adhesive component of Zip System tape and AC148 flashing tape.

No Warranty On the Tape

Builders who worry about the longevity of Zip System tape will not be reassured by the Zip System warranty, which includes the following exclusion: "Certain other components may be sold with the Zip System Wall panels, possibly as part of a package or system, that are not manufactured by Huber, including Zip System Tape. This Limited Warranty does not cover such third party manufactured components, and all such third party manufactured components are sold by Huber 'as is.' Huber is not responsible for warranties, if any, given by any third party manufacturers for such components, and Huber does not make any warranties, express or implied, with regard to such third party components, including any implied warranty of merchantability or fitness for a particular purpose." In other words, even though the tape is part of the system, the Huber warranty does not cover tape failure.

John Straube, a professor of Building Envelope Science at the University of Waterloo in Ontario, is familiar with the Zip System components. "It's a high quality tape," Straube told ***EDU***. "It's better than any other tape I've seen before." Yet Straube is reluctant to speculate on the longevity of the tape's bond. "The quality of the installation depends on the adhesion and on workmanship," he says. "At the end of the day, we don't know how it will adhere in the long run. It is an unanswerable question."

According to Straube, one of the Zip System's best features is one that the manufacturer doesn't mention: "I believe it is a wonderful air barrier." As most builders of energy-efficient homes realize, that's nothing to sneeze at.

For more information, contact Huber Engineered Woods, One Resource Square, 10925 David Taylor Drive, Suite 300, Charlotte, NC 28262. Tel: (800) 933-9220 or (704) 548-5255; Web site: *www.huberwood.com.*

INFORMATION RESOURCES

New Passivhaus Web Sites

When ***EDU*** first reported on the European Passivhaus standards (see ***EDU***, February 2004), almost all of the Web sites and articles with technical information on Passivhaus buildings were written in German. Recently, however, a few useful English-language resources on Passivhaus buildings have begun to appear.

PassivhausUK

In the United Kingdom, the Building Research Establishment now maintains an English-language Web site, PassivhausUK (*www.passivhaus.org.uk*). According to specifications on the Web site, a Passivhaus building in Britain should have floors, walls, and roofs insulated to R-38 or better. Whole-window U-factors should be 0.14 or lower. In Britain, as in the US, finding windows that meet this stringent Passivhaus specification is the most difficult hurdle facing aspiring Passivhaus builders.

The Web site includes a link to a searchable database of photos and construction details of hundreds of European Passivhaus buildings (*www.passivhausprojekte.de/projekte.php*).

Promotion of European Passive Houses

A new organization, PEP (Promotion of European Passive Houses), is a consortium of partners supported by the European Commission. The PEP maintains a useful English-language Web site at *www.europeanpassivehouses.org*. Among the interesting facts noted on the Web site: a Passivhaus building should not include an active cooling system. (This requirement may need to be modified if the Passivhaus movement ever reaches Houston.)

PEP has prepared a 50-page document, "Passive House Solutions," posted online at *http://erg.ucd.ie/pep/pdf/Passive_House_Sol_English.pdf*. The document provides information on existing construction practices in eight European countries (Austria, Belgium, Denmark, Germany, Ireland, Netherlands, Norway, and the United Kingdom). According to the data provided, building standards in Europe vary widely from country to country; standards are highest in Austria, Denmark, Germany, and Norway. At the other end of the spectrum, building performance (especially airtightness) is at a relatively low level in Belgium and the United Kingdom.

According to "Passive House Solutions," the floors, walls, and roofs of existing Passivhaus buildings in Europe have R-values ranging from 38 to 63. Mechanical ventilation rates in these buildings range from 0.22 to 0.69 air changes per hour.

A Persistent Half-Truth

Both the PassivhausUK Web site and the PEP Web site repeat a persistent half-truth: that "a Passivhaus does not need a traditional heating system." The oft-repeated statement is usually misunderstood. Virtually all European Passivhaus buildings include some method of space heating; typical heat sources include electric resistance heating, an air-source heat pump, a ground-source heat pump, or a wood stove. The catch: in Europe, any heat source other than a gas-fired boiler is considered "untraditional."

READERS' FORUM

DuPont Is Reviewing Its ThermaWrap Literature

Dear Mr. Holladay:

This letter is an updated response to your new product review in the September 2006 issue of ***EDU*** and our ensuing conversations. Thank you for your ongoing dialog to help clarify the data about DuPont™ Tyvek® ThermaWrap™.

DuPont regrets any lack of clarity in its DuPont™ Tyvek® ThermaWrap™ literature, as well as the incomplete nature of the information supplied to ***EDU***. As a result of ***EDU***'s inquiries, DuPont is currently reviewing its DuPont™ Tyvek® ThermaWrap™ literature to improve the completeness of its claims and materials. Attached, you will find the current fact sheet you were originally seeking.

DuPont™ Tyvek® ThermaWrap™ is a unique product in that it combines the high water resistance, airflow resistance and vapor permeability of a DuPont™ Tyvek® water-resistive barrier with a low emissivity surface. DuPont™ Tyvek® ThermaWrap™ is approved as a water-resistive barrier under ICC-ES evaluation report ESR-1993. The metallized surface has an emissivity of .2 and when installed facing a ¾" airspace provides the thermal management benefits which are detailed on the attached insulation fact sheet.

Arturo Horta, Ph.D.
DuPont Roofing Business Manager
Wilmington, Delaware

What's the Solution?

Dear Martin,

Regarding "Choosing High-Solar-Gain Windows" [November 2006]: Excellent summary. You certainly defined the problem very well. Now we need a solution!

Chris Barry, director of technical services
Pilkington Glass
Toledo, Ohio

Not Their Job?

Dear Martin,

"Choosing High-Solar-Gain Windows": Nice job! I'm not sure whether I should be happy or sad at the dumbing down of the building industry. It's certainly true that at least for those of us "relics" (as Douglas Balcomb almost calls us passive solar designers in his recent article in *Solar Today*) who understand how to produce results with passive solar, the window trends in the US are not encouraging.

An architect I know and occasionally work with in Louisville told me the basic problem, at least among architects he knows, is unwillingness to do the calcs. Maybe "scariness of math" is part of this problem. After all, US students routinely do poorly in math compared with other nations. I gave a lecture a couple years back at the College of Design, Architecture, Art & Planning at the University of Cincinnati on how I use various calculator and computer assessment methods to ascertain various kinds of building performance before getting to simulation time. The professor took me out to lunch afterward, apologizing for the students' (seniors) apparent lack of interest. He said most of his students didn't think any of that was their job. He said they think they'll just send their designs off to engineers who'll deal with those issues for them.

Two points you seemed to miss in the article. First, you made no mention of triple-pane clear with argon. I'm routinely using this option from Loewen for south-facing passive solar windows, then picking triple low-e argon for all non-south orientations.

Second, there was no mention of the importance of picking larger undivided windows to improve solar heat gain coefficient (SHGC). Consider that the published SHGC for a 2′ x 4′ triple-pane clear argon Loewen casement window is 0.47. For the same glass in a 4′ x 6′ picture window, SHGC jumps to 0.58—23.4% higher! This also applies to Andersen's low-e1 argon double-panes, where SHGC rises from 0.33 to 0.41 just with the size adjustment.

I also didn't see any mention of window style. Most windows around my region are double-hungs, which not only have uniformly lower SHGCs (due to more busy framing) but also dramatically increased air leakage.

I recently consulted on an architect's passive solar design in which he'd picked Pella double-hungs. I had to tell him that Pella double-hungs not only have the lower SHGC glass but also that their air infiltration ratings of 0.30 cfm per square foot under 25 mph wind pressure make them the air-leakiest new wood window currently sold in the Greater Cincinnati market (with the code only allowing up to 0.32 and ACEEE recommending nothing over 0.06 in its "Consumer Guide to Home Energy Savings"). Since this architect had not done any calcs to size his passive solar glass area, he had way too much glass, too. I also asked about how close the next house to the south was, asking, "Wouldn't it force his home's owner to apply privacy curtains which would lower the solar gains?" He hadn't thought of that. Before I'd left, I'd recommended lifting the window sills (to reduce area and loss of privacy), reducing the glass area, and changing the window styles and manufacturer. I also suggested doing some calcs, but he didn't bite.

I thought it was weak for some of those interviewed in your article to bash the builders. I certainly didn't and don't. When I'm teaching or consulting or designing, I always make my point that just as we don't want auto assembly-line workers making design and specifications decisions when they're assembling your car, we don't want builders making design decisions when they're building your house. Make sure those specs are in-hand beforehand.

John F. Robbins
Morningview, Kentucky

Editor's Reply

Thanks for the helpful tips on maximizing SHGC for south-facing windows. As a former builder, I'm sensitive to builder-bashing, and I agree that it's important to avoid generalizations that lump all builders together. However, I cannot agree that "we don't want builders making design decisions when they're building." Very few US homes are designed by architects, and, like it or not, builders make design decisions every day. Although design calculations are sometimes essential, passive solar design principles are simple enough to be reduced to rules of thumb, and are therefore not beyond the ability of most US builders.

Your encounters with examples of "math fear" are certainly instructive. Anyone involved in residential construction—including builders, architects, and engineers—should be alert to signs of craven surrender to math fear, in ourselves or in those with whom we consult. Experienced builders should be able to recognize when an unusual house requires special design calculations; if these calculations are beyond the abilities of a builder or architect, a passive solar designer or engineer should be consulted. —Martin Holladay

BACK PAGE

Save 72% On Your Energy Bill, Guaranteed

The R-value of the insulated concrete forms (ICFs) manufactured by Phoenix, a Nebraska manufacturer, is fairly typical: about R-23. (Phoenix ICFs have two layers of 2 ⅛-inch-thick EPS foam.) But the energy-savings claim made on Phoenix's Web site is anything but typical: "Phoenix has an industry-leading energy savings warranty of 72%. Click here for details."

A click to the next Web page yields promising information: "72% Energy Savings Warranty – on a home built foundation to eaves with Phoenix ICF and having other building components at a minimum level specified by the company. That's 72% total annual energy savings (require 28% or less total annual energy consumption) for heating and cooling, compared to the energy consumption required to heat and cool a similar sized and designed home ('comparison home') having the same energy source and otherwise built to the company's specific standards. Both these standards and the requirements for the Phoenix home are available on request."

Okay, just one more click for all the details. The Phoenix ICF home must include "high efficiency double-glazed windows (at minimum)" and "minimum R-40 attic or roof structure insulation." Moreover, it must conform "to CABO and all applicable local building code standards." We also learn that "the comparison home … [is one] built to the following standards:

1. 2"x4" wood framed walls with R-13 fiberglass batt insulation.
2. R-19 fiberglass batt insulation in the floor and roof systems.
3. Single-glazed windows with storm windows attached.
4. Minimum applicable code efficiency HVAC equipment at the time of its installation.
5. A whole-house natural air exchange rate of 0.7 or higher."

So, Phoenix says you'll save a lot of energy if you build a house with ICFs—compared to an illegal house with half as much attic insulation, obsolete windows, and above-average levels of air infiltration. For the record, a 1999 study by the NAHB Research Center comparing the energy performance of two ICF homes with an adjacent stick-framed home found: "The two ICF homes were approximately 20% more energy efficient than the wood-frame house."

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