JLC Report

Passive House Seeks Broader Appeal

The Passive House concept is an approach to energy-efficient building that — compared with conventional code-compliant construction — reduces energy use for heating and cooling by up to 90 percent. The "passive" part of the name is meant to emphasize that those savings are achieved through passive heat gain, building-envelope efficiency, and high levels of insulation, rather than through "active" strategies like on-site power generation or collection and storage of solar heat. While quite popular in northern Europe — particularly in Germany, where it was developed during the 1990s — the method has only recently drawn much attention from designers, builders, and homeowners in North America.

Some of that surge in interest can be traced to a December 2008 *New York Times* article that described Passive House as "part of a revolution in building design." While generally accurate, the story did stumble a bit coming out of the gate — it was titled "No Furnaces, but Heat Aplenty in 'Passive Houses'" — since most cold-climate Passive Houses do in fact include a heat pump, small furnace, or some other supplementary heat source.

Tight budget. The core of the Passive House concept is a clearly defined standard that holds structures to a strict energy budget based on their floor area: They must use no more than 15 kwh per square meter per year for heating and cooling, and no more than 120 kwh per square meter for all uses, including lighting, appliance use, and hot water. (The 120 kwh figure refers to primary energy, which accounts for energy lost in converting fossil fuels to electricity.) In addition, a Passive House must have an air-infiltration rate of no more than 0.6 ACH50, as measured by a standard blower-door test.

These numbers are inflexible with respect to latitude or climate zone. A structure in the Canadian interior, for example, is allowed no more energy for heating than one in a relatively mild climate, such as the Pacific Northwest. It's up to each project designer to work out a site-specific construction plan that will hold energy to an acceptable level.

Potentially net zero, but not necessarily green. That one-size-fits-all approach doesn't please everyone. The

■ Michigan has joined at least 26 other states in opting out of a provision in the 2009 IRC that mandates the installation of sprinkler systems in new homes (see "State Legislators Deal Blow to Residential-Sprinkler Codes," 10/10). In yanking the sprinkler provision from the forthcoming edition of the Michigan Residential Code, the state's Department of Energy, Labor, and Economic Growth cited studies said to show that fire-survival rates already exceed 99 percent in structures with working smoke alarms, and that sprinklers do not always operate effectively when present. A spokesman for the Michigan Association of Home Builders praised the move, noting that money "involuntarily spent on a sprinkler system wouldn't be available for improved medical care, better insurance, a safer and more fuel-efficient car, or retirement accounts."

■ OSHA is going back to the future by revoking its interim fall-protection guidelines — in force since 1995 — and replacing them with the older, pre-1995 guidelines. Under the interim guidelines, employers were permitted to use alternative methods of fall protection, such as slide guards or safety-monitor systems, whenever they believed that guardrails, personal fall-arrest systems, safety nets, or other conventional fall-protection measures were infeasible or created a greater hazard. Under the new directive, STD 03-11-002, employers will still have the option of using the alternative methods but will be required — as they were before 1995 — to provide a written fall-protection plan describing the alternative methods and explaining why conventional methods would be impractical or unsafe. The directive, which takes effect on June 16, also provides a clearer definition of the term "residential construction" than had been available previously. An OSHA fact sheet is posted at osha.gov/doc/fall_protection_factsheet.html.

standard calls for levels of insulation that some critics find excessive. Particularly in cold climates, they argue, mandated R-values may be so high, and heat losses so low, that it would be more cost-effective to cut back on insulation, buy a few solar panels with the resulting savings, and use them to power a slightly larger air-source heat pump — since such a backup heat source is ordinarily required anyway — to compensate for the small additional heat loss.

Cold-climate Passive Houses do indeed use eye-opening amounts of insulation. One northern Minnesota Passive House, for example, sits atop 16 inches of rigid polystyrene foam. But to Passive House loyalists, the cost-effectiveness argument is shortsighted. Insulation, they say, unlike heat pumps and PV arrays, is immune to mechanical failure, should last for the life of the building without any maintenance, and once installed is unaffected by rising energy costs.

Its reliance on conservation sets Passive House apart from the much more flexible net-zero approach to energy-efficiency, in which there's no limit to the amount of energy a building is permitted to burn through (as long as its consumption is offset by on-site generation from solar, wind, or some other renewable source). There's no inherent conflict between Passive Houses and net zero, however: Because a Passive House's energy use is so low, adding a relatively small PV array allows it to qualify as a net-zero building as well.

The Passive House community also seeks to distance itself slightly from "green" construction methods, perhaps because Passive Houses rely heavily on the use of materials like plastic foam. The excellent introductory text *Homes for a Changing Climate: Passive Houses in the U.S.* — published by the Urbana, Ill.–based Passive House Institute U.S. (PHIUS) — puts it this way: "When comparing the costs of conventionally built homes and Passive Houses, there is a need to distinguish between costs associated with energy efficiency features and costs associated with green features. Energy-efficient construction costs less than building green. ... Construction costs for a house built to both Passive House and green standards will be significantly higher than construction costs for a house built to Passive House standards alone." In short, while Passive Houses are generally thought of as green — and *are* green, from the standpoint of their ongoing energy consumption — they

Proposed Code Changes Stir Controversy in North Carolina

Is a new building code necessarily safer than an old one? That question is at the center of a simmering dispute among North Carolina home builders, safety experts, and code officials.

Late last year, the North Carolina Building Code Council voted to adopt a series of code changes designed to improve energy-efficiency standards for commercial and residential buildings by 30 percent, which would bring the code in line with the recently approved 2012 International Energy Conservation Code (IECC). The North Carolina Home Builders Association (NCHBA), however, objected to the added cost of the energy improvements and threatened to derail the measure when it went to the legislature for approval.

After a series of meetings with Governor Bev Purdue's office, the association staked out a compromise position: It agreed not to oppose the efficiency requirement for commercial buildings provided that the residential upgrade was pared back from 30 to 15 percent, and that the cost of the energy improvements was offset by other cost savings — $3,000 per home — elsewhere in the state's building code. At the governor's request, NCHBA director of codes and construction Robert Privott drew up a list of 20 proposed cost-saving code changes, including the elimination of a requirement for fire sprinklers in some apartment buildings, approval of the use of battery-powered smoke alarms rather than hard-wired ones in some applications, a reduction in the required width of foundation footings, and removal of the requirement for felt or other weather-resistant material behind some types of siding.

Privott defends the proposed code changes as an economic necessity that won't necessarily affect safety. "The governor has said we need to get housing back on its feet in North Carolina," he says. "Most of the offsets are things that we had before in previous editions of the code. If your house was built to the 1999 CABO code, does that mean it's less safe than one built to the 2009 IRC? I'm not sure that it does. A lot of those older houses have not fallen down."

Others disagreed. In an editorial titled "Safety Traded for Energy Efficiency," the *Winston-Salem Journal* declared that the arrangement "reeked," calling it an "example of the incestuous, inside deal-making that so often occurs in Raleigh."

The slate of proposed cost-cutting measures is now back before the 17-member Building Code Council, with a final up-or-down vote by the legislature unlikely to come up for several months at the earliest — and possibly not until next year. — *J.V.*

The compact form of this Oregon Passive House helps minimize heat loss and is typical of homes that adhere to the standard. More complex floor and roof plans are possible, though at a sharply higher cost.

may or may not contain only green building materials.

Planning, certification, and training. During the planning phase, Passive House builders rely heavily on energy modeling software called the Passive House Planning Package (PHPP). It's a detailed spreadsheet that accepts user-supplied input values for insulation, glazing, framing characteristics, hvac equipment, and other characteristics, merges them with data on local temperatures and solar radiation, and provides an assessment of the expected energy performance of the completed building.

"The planning package is really complex," says Belfast, Maine, builder Alan Gibson, whose design-build company recently completed the first certified Passive House in the state. "I've seen some architects look at it and just throw up their hands, and I have my own energy-loss and solar-gain spreadsheet that's much simpler to use. But the PHPP is super detailed — it goes to the level of calculating the heat loss between your hot-water tank and individual faucets."

The PHPP is available from PHIUS for $225. A simplified trial version can be downloaded for free from the PHIUS website at passivehouse.us/passivehouse/designtools.html.

In addition to supplying software and acting as a general clearinghouse for information, PHIUS certifies (for a variable fee) the energy performance of buildings that have been tested and found to meet its standard. The organization also conducts nine-day training sessions —in Urbana and other places across the U.S. and Canada — in the use of its software and energy-efficient construction methods. Accreditation as a certified Passive House consultant is available to participants who complete the training program — which costs about $2,000 — and pass an exam. According to PHIUS founder and director Katrin Klingenberg, more than 350 people have so far completed the training, among them architects, designers, builders, and more than a few homeowners.

Technically, it's not necessary to take the training program to build a certified Passive House. Anyone can buy the planning software, use it to build a structure that meets the standard, and have its performance verified by PHIUS. In practice, though, that's seldom done, and it's not encouraged by the organization. "We try not to do that anymore," says Klingenberg. "It's been done successfully, but it tends to require a lot of hand-holding from us."

Finding a niche. There's no doubt that the Passive House approach works. Experience shows that buildings constructed to the standard do use dramatically less energy than conventional structures. They offer excellent air quality, resist excessive solar heating, and maintain comfortable levels of temperature and humidity with little effort on the part of their occupants.

For builders struggling to keep their businesses afloat in difficult times, all of that is secondary to a more fundamental question: Is climbing aboard the Passive House bandwagon a sound business decision? With only a tiny handful of Passive Houses in the U.S. so far (fewer than 20, by most counts), it's much too soon to draw any firm conclusions. But according to several seasoned builders who have recently completed Passive House projects of their own, the answer is a cautious "yes."

Salem, Ore., custom home builder Blake Bilyeu enrolled in a Passive House consultant training course offered in Portland in the summer of 2009. "A client had already asked us to design and build a Passive House," he says. "I actually did the design work for the house as part of the nine-day training session." The bulk of the training program, Bilyeu notes, was devoted to the nuts and bolts of working with the PHPP software, with much less coverage of hands-on building methods.

Fortunately, Blake and his father, Larry, had already been building high-performance homes for a number of years, including a LEED Platinum home and another built to the Oregon High Performance Home standard. As a result, Blake found the actual construction to be fairly straightforward. "We've built plenty that are a lot better than code or Energy Star, and this one just took us a little further," he says. The Bilyeus' framing sub was already familiar with the system chosen for the Passive House — double-stud walls on a modified crawlspace foundation, with a raised-heel truss roof. "A big part of making it work out was looking for methods that were most cost-effective and not foreign to our subs," he says.

Construction of the three-bedroom home began in late August 2009 and was

The Passive House energy-modeling software considers heating loads and site-specific climate data to ensure that passive solar gain through south-facing glazing — as in this coastal Maine home — doesn't lead to overheating.

completed in May of the following year. According to Bilyeu, the $300,000 home was one of the company's more profitable recent projects, which are typically priced between $140 and $175 per square foot (at $159 per foot, the Passive House fell squarely in the middle of that range). "We didn't give it away for the experience of building one," he says. "Passive House isn't going to help anyone if it's not affordable or profitable for the builder. There are so many standard homes on the market that you can't build a new one for the same price even without a profit margin. Right now, you really need a niche."

Does certification matter? Alan Gibson is among the few builders who have completed a certified Passive House project without formal training. The three-bedroom SIP structure, built at a cost of $160 per square foot, was constructed as a prototype for a 36-unit co-housing project that's still in the planning stage, and it now serves as office space for Gibson and his partner.

"Hiring a Passive House consultant is sort of like bringing in a mechanical engineer to work with the builder and architect to design the heating system," Gibson says. "But we decided not to do it that way. We've used a lot of energy-modeling software, so we just got the PHPP and started filling out the spreadsheet. The training would definitely have made it easier, but we were able to do it on our own."

Gibson's company, G-O Logic Homes, has other Passive House projects in the works as well. It was recently awarded a contract to build a Passive House–certified residence hall at a local college. "We wanted to be the first Passive House in Maine, and we get a certain amount of mileage from that," Gibson says.

Still, he doubts that the term "Passive House" is familiar enough to make much of an impression on the public at large. "What really gets people excited is hearing that we can build them a house they can heat with the equivalent of a couple of hair dryers," he says. "If you said anything about kilowatt hours per square meter, they'd say, 'huh?'" For the time being, Gibson suggests, builders in some markets might consider using the Passive House building methods and planning software without seeking certification — and without holding energy use to the extremely low level called for by the standard.

"If someone came along and wanted us to build them a certified Passive House we'd be happy to do that," Gibson says. "But if someone had a lesser energy goal, we'd be happy to do that, too." It's possible, he observes, to fall far short of the strict Passive House standard and still have a very efficient house. "I did some numbers once, and as I recall, the difference between meeting the standard for heating and using half again as much as it allowed was a matter of something like $100 worth of heat over the course of a year."

Paddling into the mainstream. As freshly credentialed Passive House consultants continue to emerge from the PHIUS training program, it will be interesting to see what the next few years bring. Klingenberg believes that the steady increase in the number of certified consultants will jump-start demand for their services. "Consultants have an interest in getting a certified project done," she says. "To keep their certification, they need to finish a project within two years. We want to focus on training people who will use it."

The strategy seems to be paying off. According to Klingenberg, more than 100 Passive Houses are under construction or in the process of having their plans pre-certified. "Things are happening fast," she says. "It took many years to get to this point in Europe. In the U.S., growth is already exponential."

There are an estimated 25,000 Passive Houses in Europe, most of them in Germany and Scandinavia. While even that is a relatively modest number, it has attracted the attention of building-product manufacturers. Passive House builders in Europe have a wide range of mission-specific products and material at their disposal, such as foams, tapes, sealants, and spectacularly well-insulated (and expensive) wood-framed windows. Hvac equipment designed to handle extremely low heating and cooling loads is also widely available overseas, including so-called "magic box" appliances, which combine an air-source heat pump, a heat-recovery ventilator, and a hot-water tank in one engineered package. Passive House boosters are hoping that a similar "mainstreaming" process could happen here, and that it will lead to thousands of U.S. and Canadian Passive Houses within a very few years. — *Jon Vara*