

Passive House Takes Root in the United States

by Mike Kernagis

It is abundantly clear that the building sector is a primary contributor of climate-changing pollutants to the environment. Knowing this, we must decide how best to square our building energy needs with those of our environment and of our pocketbook. The Passive House concept—which promises to slash heating energy consumption of buildings by an amazing 90%—represents today’s highest energy standard and most compelling option. Thousands of homes have been built or remodeled to meet the Passive House standard in Europe (see “Germany’s Efficient Homes,” p. 30). Widespread application of the Passive House design here in the United States would have a dramatic impact on energy use.

Passive House Born and Bred

The Passive House evolved from the superinsulated buildings of the 1970s, many of which were built in North America. (The Arkansas Project, the Small Homes Council of the University of Illinois, the Canadian National Research Council, and Minnesota’s Housing Finance Agency were some of the agencies that supported the construction of these prototypes.) The movement toward construction of a Passive House made a quantum leap in Europe during the late 1980s, beginning with the introduction of a lower energy standard for new buildings in Sweden and Denmark. Building on this standard, Swedish professor Bo Adamson and German physicist Wolfgang Feist developed the Passive House and built the

first prototype in 1990. The first Passive Houses had thick insulation, few or no thermal bridges, an airtight envelope, insulated glazing, and balanced energy recovery ventilation.

The Passive House, or Passivhaus in German, was so called because, in the Central European climate, the heating energy requirement of these houses was so small that a conventional heating system could be eliminated and replaced by a 1,000 watt electric-resistance heater. Such homes could be kept warm passively, that is, by using existing internal heat sources—such as people, lights, and appliances; solar energy admitted by the windows; and a fresh air supply that would be warmed by, for example, an earth tube, which is a passive geothermal heating-and-cooling system. The first prototype, a four-unit row house structure, was built in 1990 in Darmstadt, Germany. Monitoring of this and other early prototypes found the maximum heat load in the German winter to be less than 10 watts per square meter, or 0.9 watts per square foot, of floor area. Under these circumstances, the heat load could be comfortably supplied using fresh-air ventilation—and eliminating the need for a separate means of heat distribution—without any active-solar contribution.

With the support of research grants, Dr. Feist created detailed computerized simulations modeling the energy behaviors of wall and window assemblies and other construction elements. Then he systematically



The Fairview house—shown during and after construction—features 14-inch walls with high-density blown-in fiberglass.

varied these elements to arrive at the best possible construction packages, based on energy efficiency, installation expense, and sustainability. In 1995 American energy pioneer Amory Lovins visited the Passive House at Darmstadt. He was deeply impressed and encouraged Dr. Feist to view this project more as a practical means of meeting housing and energy needs than as a scientific experiment. All that was needed was some redesigning of the details to reduce construction costs.

In 1996, Dr. Feist founded the Passivhaus Institut (PHI) in Darmstadt. He still lives in the original prototype in Darmstadt and bikes to the PHI daily. The PHI has flourished under his leadership, designing, testing, calculating, certifying, and analyzing data on Passive Houses and their components. The Passive House Planning Package is the Institut’s energy-modeling program. The methodology used in this program is profoundly thorough and has been used to help design of hundreds of projects across Europe. The Passive



The Smith House in Urbana, Illinois, is the first house built to the Passive House standard in North America.

House standard is the most rigorous energy standard of Europe. It requires that a building use no more than 15 kilowatt-hours per square meter (1.35 kilowatt-hours per square foot) per year, in heating energy, and that its total primary energy consumption (primary energy for heating, hot water, and electricity) not exceed 120 kilowatt-hours per square meter (10.8 kilowatt-hours per square foot) per year.

The techniques and products developed for the Passive House were further popularized through the European Union-sponsored Cost Efficient Passive Houses as European Union Standards (CEPHEUS) project, which validated the concept in five European countries over the winter of 2000–2001. Today, thousands of Passive Houses have been built across Europe, as interest in these

homes' benefits has skyrocketed. The 11th annual International Passive House Conference, held in 2007 in Bregenz, Austria, broke attendance records and sold out its venue. And in 2007, the Austrian state of Vorarlberg passed a law requiring all new construction funded by the state to be built to Passive House standards.

Back in the USA

In the spring of 2002, German-born architect Katrin Klingenberg traveled from the United States, where she currently lives, to Germany to tour Passive Houses with Manfred Brausem, a premier builder there. An ardent advocate of sustainable architecture, Klingenberg was powerfully affected. She returned to the United States and began designing her own Passive House—the Smith House, which broke ground that October in Urbana, Illinois. (Coincidentally, Urbana is

the home of the storied Small Homes Council, where Wayne Schick is purported to have coined the term “superinsulation.”) In 2003, Klingenberg attended the Seventh International Passive House Conference, in Hamburg, where she met Dr. Feist. She returned to finish the Smith House, which became the first house in North America built to the Passive House standard. Monitoring devices installed at the Smith House after its completion show some pleasing numbers: The house uses only 11 kilowatt-hours per square meter (1 kilowatt-hour per square foot) per year in heating energy. The highest monthly power bill ever for space and water heating, appliances, lighting—in short, for all energy use—at the Smith House was \$45.

Knowing that the best way to promote Passive Houses in the United States was to get them built and monitored, Klingenberg started the Ecological Construction Laboratory (e-co lab) in 2004.

E-co lab was established as a nonprofit community housing development organization with the mission of designing, building, selling, and monitoring Passive Houses for low-income home buyers. E-co lab's first such project, the Fairview House, was started in early 2006 and built primarily by myself. It was built to perform in the rigorous climate of Illinois, with 14-inch walls of high-density blown-in fiberglass and an airtightness measuring 0.24 air changes per hour at 50 pascals of pressure in a blower door test administered by the Building Research Council. It was sold in November 2006 to a woman who had been displaced from New Orleans by Hurricane Katrina. She's very pleased that her power bills are affordable. (This home's energy use is being monitored. IBACOS, our Building America partner, is currently compiling the results, but they are not yet available.)

In 2005 Klingenberg met Stephan Tanner, a Swiss-born architect who was working on another American Passive House, the BioHaus in Bemidji, Minnesota—an even more challenging climate. Designed as a learning facility

for the German-language Concordia Village, the BioHaus succeeded in meeting the Passive House standard and was certified by the PHI in 2006.

In October 2006, Klingenberg and Tanner teamed up to organize the first North American Passive House conference at the BioHaus. It was attended by a number of Midwestern building science professionals—architects, engineers, builders, and energy industry professionals—but there were also attendees from New England and the Southwest. New projects have begun to emerge.

Climate-Changing Opportunity

For some years now, Klingenberg has steadily promoted Passive Houses at symposia, workshops, and conferences from coast to coast. But “This past year,” she says, “we’ve seen a dramatic increase of interest in the technique. In April, we founded the Passive House Institute United States (PHIUS) to promote the development of Passive House knowledge and construction in the United States. This summer’s ACI Summit on moving existing homes toward carbon neutrality was fantastic. We’ve barely scratched the surface of Passive House retrofits here in the United States.”

One of the few such retrofit projects in the United States is architect Nabih Tahan’s treatment of his own home, currently under way in Berkeley, California. Tahan has seen the success of Passive Houses at first hand, having lived and worked for several years in Austria. Energy calculations and design specifications have been drawn to achieve Passive House standards in the relatively mild climate of the Bay Area. Most other Passive House construction to date consists of new buildings, not retrofits. Passive House projects are under way in climates as varied as Martha’s Vineyard, Massachusetts; Duluth, Minnesota; and Taos, New Mexico. Entire Passive House communities in Colorado and

Michigan are also currently being developed.

Last December PHIUS became the official certifier for PHI of the Passive House standard in the United States. Klingenberg is involved with several projects in Illinois and around the country. She’s currently designing and employing prefabricated components that can be used to achieve the Passive House standard in order to reduce costs. “It has to be affordable,” says Klingenberg. “As Amory Lovins says, ‘We need to tunnel through the cost barrier.’ There is a lot of work that needs to be done, on a lot of levels, to make the necessary reductions in greenhouse gas emissions possible. But there’s a lot of opportunity there, too. Our thing is energy efficiency. There’s so much to be conserved, and we’d like to see that valued appropriately. Let’s get as much as we reasonably can out of efficient design, and then apply active-solar elements. This way we are in a position to have Plus-energy homes, while running the most climate-neutral buildings we can.”

E-co lab and PHIUS held the second North American Passive House conference in Urbana, Illinois, last November. Among the presenters there were long-time trailblazers Harold Orr, Bill Rose, Marc Rosenbaum, and German Passive House builder Manfred Brausem. They were joined by presenters of projects that are either completed or under way in California, New Mexico, Minnesota, Illinois, and Massachusetts. The developers of the communities in Colorado and Michigan presented as well. A Sunday tour included the three existing Passive Houses in Urbana. Attendance increased dramatically over attendance in 2006, with participants from 21 different states. We welcome



The Fairview House’s well-sealed 14-inch thick walls make for a very low energy home and very affordable energy bills.

the rapidly growing interest in Passive Houses in the United States.

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Mike Kernagis is the construction manager at e-co lab as well as cofounder, with Katrin Klingenberg, of the Passive House Institute United States (PHIUS).

For more information:

For more about the e-co lab, go to www.e-colab.org.

The Passive House Institute United States (PHIUS) is an energy calculating, consulting, and research firm working to further the implementation of Passive House standards nationwide. For information about the institute, go to www.passivehouse.us.