

NEW YORK TIMES – THE ENERGY CHALLENGE

No Furnaces but Heat Aplenty in ‘Passive Houses’



Rolf Oeser for The New York Times

Berthold Kaufmann and his wife, Dorte Feierabend, with their daughters in their "passive house" in Darmstadt, Germany.

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DARMSTADT, Germany — From the outside, there is nothing unusual about the stylish new gray and orange row houses in the Kranichstein District, with wreaths on the doors and Christmas lights twinkling through a freezing drizzle. But these houses are part of a revolution in building design: There are no drafts, no cold tile floors, no snuggling under blankets until the furnace kicks in. There is, in fact, no furnace.

In Berthold Kaufmann’s home, there is, to be fair, one radiator for emergency backup in the living room — but it is not in use. Even on the coldest nights in central Germany, Mr. Kaufmann’s new “passive house” and others of this design get all the heat and hot water they need from the amount of energy that would be needed to run a hair dryer.

“You don’t think about temperature — the house just adjusts,” said Mr. Kaufmann, watching his 2-year-old daughter, dressed in a T-shirt, tuck into her sausage in the spacious living room, whose glass doors open to a patio. His new home uses about one-twentieth the heating energy of his parents’ home of roughly the same size, he said.

Architects in many countries, in attempts to meet new energy efficiency standards like the Leadership in Energy and Environmental Design (LEED) standard in the United States, are designing homes with better insulation and high-efficiency appliances, as well as tapping into alternative sources of power, like solar panels and wind turbines.

The concept of the passive house, pioneered in this city of 140,000 outside Frankfurt, approaches the challenge from a different angle. Using ultra-thick insulation and complex doors and windows, the architect engineers a home encased in an airtight shell, so that barely any heat escapes and barely any cold seeps in. That means a passive house can be warmed not only by the sun, but also by the heat from appliances and even from occupants’ bodies.

And in Germany, passive houses cost only about 5 to 7 percent more to build than conventional houses.

Decades ago, attempts at creating sealed solar-heated homes failed, because of stagnant air and mold. But new passive houses use an ingenious central ventilation system. The warm air going out passes side by side with clean, cold air coming in, exchanging heat with 90 percent efficiency.

“The myth before was that to be warm you had to have heating. Our goal is to create a warm house without energy demand,” said Wolfgang Hasper, an engineer at the [Passivhaus Institut](#) in Darmstadt. “This is not about wearing thick pullovers, turning the thermostat down and putting up with drafts. It’s about being comfortable with less energy input, and we do this by recycling heating.”

There are now an estimated 15,000 passive houses around the world, the vast majority built in the past few years in German-speaking countries or Scandinavia.

The first passive home was built here in 1991 by Wolfgang Feist, a local physicist, but diffusion of the idea was slowed by language. The courses and literature were mostly in German, and even now the components are mass-produced only in this part of the world.

The industry is thriving in Germany, however — for example, schools in Frankfurt are built with the technique.

Moreover, its popularity is spreading. The [European Commission](#) is promoting passive-house building, and the [European Parliament](#) has proposed that new buildings meet passive-house standards by 2011.

The United States Army, long a presence in this part of Germany, is considering passive-house barracks.

“Awareness is skyrocketing; it’s hard for us to keep up with requests,” Mr. Hasper said.

[Nabih Tahan](#), a California architect who worked in Austria for 11 years, is completing one of the first passive houses in the United States for his family in Berkeley. He heads a group of 70 Bay Area architects and engineers working to encourage wider acceptance of the standards. “This is a recipe for energy that makes sense to people,” Mr. Tahan said. “Why not reuse this heat you get for free?”

Ironically, however, when California inspectors were examining the Berkeley home to determine whether it met “green” building codes (it did), he could not get credit for the air-to-air heat exchanger, a device that is still uncommon in the United States. “When you think about passive-house standards, you start looking at buildings in a different way,” he said.

Buildings that are certified hermetically sealed may sound suffocating. (To meet the standard, a building must pass a “blower-door test” showing that it loses minimal air under pressure.) In fact, passive houses have plenty of windows — though far more face south than north — and many can be opened.

Inside, a passive home does have a slightly different gestalt from conventional houses, just as an electric car drives differently from its gas-using cousin. There is a kind of spaceship-like uniformity of air and temperature. The air from outside all goes through HEPA filters before entering the rooms. The cement floor of the basement isn't cold. The walls and the air are basically the same temperature.

Look closer and there are technical differences: When the windows are swung open, you see their multiple layers of glass and gas, as well as the elaborate seals around the edges. A small, grated duct near the ceiling in the living room brings in clean air. In the basement there is no furnace, but instead what looks like a giant Styrofoam cooler, containing the air-to-air heat exchanger.

Passive houses need no human tinkering, but most architects put in a switch with three settings, which can be turned down for vacations, or up to circulate air for a party (though you can also just open the windows). “We’ve found it’s very important to people that they feel they can influence the system,” Mr. Hasper said.

The houses may be too radical for those who treasure an experience like drinking hot chocolate in a cold kitchen. But not for others. “I grew up in a great old house that was always 10 degrees too cold, so I knew I wanted to make something different,” said Georg W. Zielke, who built his first passive house here, for his family, in 2003 and now designs no other kinds of buildings.

In Germany the added construction costs of passive houses are modest and, because of their growing popularity and an ever larger array of attractive off-the-shelf components, are shrinking.

But the sophisticated windows and heat-exchange ventilation systems needed to make passive houses work properly are not readily available in the United States. So the construction of passive houses in the United States, at least initially, is likely to entail a higher price differential.

Moreover, the kinds of home construction popular in the United States are more difficult to adapt to the standard: residential buildings tend not to have built-in ventilation systems, and sliding windows are hard to seal.

Dr. Feist's original passive house — a boxy white building with four apartments — looks like the science project that it was intended to be. But new passive houses come in many shapes and styles. The Passivhaus Institut, which he founded a decade ago, continues to conduct research, teaches architects, and tests homes to make sure they meet standards. It now has affiliates in Britain and [the United States](#).

Still, there are challenges to broader adoption even in Europe. Because a successful passive house requires the interplay of the building, the sun and the climate, architects need to be careful about site selection. Passive-house heating might not work in a shady valley in Switzerland, or on an urban street with no south-facing wall. Researchers are looking into whether the concept will work in warmer climates — where the heat exchanger could be used in reverse, to keep cool air in and warm air out.

And those who want passive-house mansions may be disappointed. Compact shapes are simpler to seal, while sprawling homes are difficult to insulate and heat. Most passive houses allow about 500 square feet per person, a comfortable though not expansive living space. Mr. Hasper said people who wanted thousands of square feet per person should look for another design.

“Anyone who feels they need that much space to live,” he said, “well, that’s a different discussion.”