“Use less energy” is the mantra of a stringent German building standard that’s catching on

BY JEFFERSON KOLLE

Parative House is a performance-based building standard that can result in a house that consumes as little as 10% of the total heating and cooling energy used by a house built to the 2006 building code. If you’re an architect or builder, imagine the reaction you’ll get from clients when you tell them that you can either build a house that uses energy by the dollar or one that uses it by the dime.

To achieve these impressively low levels of energy consumption, certified Passive Houses rely on proper solar orientation, an airtight envelope, lots of insulation, mechanical ventilation, and the reuse of heat.

Designing and building a Passive House requires using proprietary energy-load software aimed at keeping energy use low and includes construction that can be painstaking. A flubbed detail can mean the difference between reaching the standard or not.

Lower lifetime energy use

The Passive House standard was developed in Germany (where it’s known as “Passivhaus”) in 1996 by physicist Wolfgang Feist, who was inspired by and fully acknowledges the influence of the groundbreaking, superinsulated houses built in the United States and Canada in the 1970s. In this country, Feist’s work has been championed by German-born architect Katrin Klingenberg, who started the Passive House Institute US, also known as PHIUS (www.passivehouse.us) in Urbana, Ill.

Upwards of 20,000 Passive Houses have been built in Europe, and while there are fewer than two dozen in this country, there are many on the drawing board, and the

THREE REQUIREMENTS MAKE IT SIMPLE

The standard is strict (it’s German, after all!), and the performance numbers are very low. Unlike other programs that have multiple criteria for certification, the Passive House focuses on just three things: air infiltration, Btu consumption, and kwh usage. The new energy-efficiency section of the International Residential Code (IRC) deals only with air infiltration, and the government’s Energy Star program, while more strict than the IRC, is still a long way from the Passive House standard. Here’s the nitty gritty.

Air infiltration

The Passive House standard for air infiltration can be no greater than 0.6 air changes per hour (ACH) at 50 pascals, which means the house is virtually airtight. The IRC’s current energy code requires 7 ACH at 50 pascals. Energy Star requires less than 5 or 6 ACH, depending on the climate zone.

Btu consumption

The annual energy use for heating and cooling cannot exceed 4755 Btu per sq. ft. annually. The average new home built to current code consumes nearly 10 times that amount, which is why air infiltration is so important. The IRC’s current energy code requires 7 ACH at 50 pascals. Energy Star requires less than 5 or 6 ACH, depending on the climate zone.

Energy usage

The maximum total energy use of the house, which includes heating, cooling, and electricity, cannot exceed 11.1 kwh per sq. ft. While there are no specific energy use standards for code-built and Energy Star homes, estimates put their usage around 30 kwh and 20 kwh, respectively.

Passive House Green Without Gizmos
movement has gained converts quickly as energy prices have increased.

Armed with the mantra “First, use less energy,” Passive House advocates say that rather than getting hung up on the amount of energy it takes to build a house, it is more important to look at how much energy the home will use during its lifetime. Statistics differ, but on average, a typical code-built home will use 10 times more energy to heat, cool, and operate its various systems for 40 years than the amount used to build it.

To get an idea of how little energy a Passive House uses, it helps to look at the Home Energy Rating System (HERS) index, a software-generated number that predicts a house’s energy based on its design.

Houses built to the 2006 International Energy Conservation Code (IECC) score a 100 on the HERS index. Energy Star and LEED homes can’t surpass 80 or 95, depending on their climate zone. Net-zero homes score the lowest, at 0. A Passive House scores between 20 and 30 on the HERS index.

Starting at the foundations, Passive Houses employ a massive amount of insulation, upwards of 16 in. of rigid foam, between the ground and the concrete slab. Exterior-wall systems, which are as thick as 16 in., can be built with double-stud 2x4s or 2x6s, or vertical I-joists used as studs. In some climates, insulated concrete forms (ICFs), structural insulated panels (SIPs), and even straw-bale walls have been used. Roof systems are typically framed with I-joists of varying depths. Because of their air-permeability, fiberglass batts are not often used. Preferred choices are dense-pack fiberglass and cellulose, and polysyrene and spray-foam insulations.

Passive House builders spend a lot of time detailing housewrap are a building envelope much like the foundation. Building designers start with the site to maximize solar gain, but solar orientation goes only so far toward achieving the Passive House Institute’s performance requirements. A well-insulated envelope is the real news here. Building thick walls, incorporating air-tight drywall techniques, and carefully detailing housewrap are a few ways builders and designers achieve these goals. Mechanical ventilation is a must, of course, as are triple-pane windows. Eliminating thermal bridging is also important. To achieve certification, building designers start with a building envelope much like the one shown here.

A Passive House is set carefully on a building envelope that’s virtually airtight and designed for passive-solar and internal-heat gains.

The Passive House standard disallows site-generated alternative-energy sources into the calculations. The standard calls on drywall technique, which calls on caulk to seal every perimeter of the interior walls, keeps air from escaping to the outside and throughout the house, yielding a more balanced air pressure inside.

The envelope makes it possible

A Passive House is set carefully on the site to maximize solar gain, but solar orientation goes only so far toward achieving the Passive House Institute’s performance requirements. A well-insulated envelope that’s virtually airtight is the real news here. Building thick walls, incorporating airtight drywall techniques, and carefully detailing housewrap are a few ways builders and designers achieve these goals. Mechanical ventilation is a must, of course, as are triple-pane windows. Eliminating thermal bridging is also important. To achieve certification, building designers start with a building envelope much like the one shown here.
Architect Nancy Schultz designed and built her own Passive House in some of the coldest country in North America. Even with R-55 walls and some of the coldest country in North America, Schultz was skeptical that the house would perform as predicted by the Passive House Institute’s planning software. A bit skeptical that the house would perform as predicted by the Passive House Institute’s planning software. A brief spell last winter without power or any other backup air equipment means going to the test. After two weeks without heat, the house still held at 50°F. ‘Now I’m a believer,’ Schultz says.

Location: Upstate, Minn.
Architect: Nancy Schultz
Builder: Ron and Sons Carpentry
Passive House consultant: Ingersoll-Tigges, Minneapolis (www.conservtech.com)
Size: 2100 sq. ft. heated
Annual heating/cooling cost: well below $0 when alternative energy is included

NEAR-ZERO PASSIVE

Windows and doors have always been a weak link in energy-efficient buildings, but major improvements have led to the development of triple-pane windows with an extremely low U-factor. Historically, European windows have been more efficient than those made in this country, but some Canadian and U.S. manufacturers have started making windows with U-factors as low as 0.13.

Because Passive Houses are designed to maximize solar-heat gain when and where it is wanted, and minimize that gain when and where it is not. Passive House design also maximizes the amount of natural lighting in a building, which makes for more pleasant living spaces while reducing artificial-lighting costs.

Software minimizes guesswork. Not surprisingly, planning a Passive House involves no guesswork; rather, it’s based on an energy-modeling program called the Passive House Planning Package (PHPP). The program calculates by taking into account almost every aspect of a house, including the site’s weather patterns and solar orientation, the type of construction and the materials used; the window designs and locations; the ventilation-system design; and the total loads of appliances, lighting, and other mechanisms. PHPP will even predict the finished house’s carbon-dioxide emissions.

The program allows the user to make small design changes and immediately see how they affect the building’s energy use.

Getting accredited

Unlike some of the energy-efficient building programs—LEED and NAHB Green, for example—the Passive House standard doesn’t assign a rating or use a point system for the materials and methods used during construction. Instead, the Passive House standard is based wholly on a building’s performance. If a house meets the standards, it is considered to be a Passive House.

Not surprisingly, the steps needed for accreditation are regimented, and although only three are required, many more are recommended. It is not mandatory to work with a trained consultant when building a Passive House, but in the long run, it’ll be quicker, easier, and less expensive than doing it on your own.

Certification starts at the planning stage; all specifications are reviewed to make certain that no major errors exist.

After the house is built, before the walls are insulated, blower-door tests are done to ensure the airtightness meets the Passive House standard. As Holmes pointed out, the first test reveals leaks that can be corrected while the walls are open. After a certain leak is fixed down, and fixes them, a second or even third test occurs.

Contractors are required to submit an “as-built” photograph to PHIUS that show the house was built to the specifications agreed upon during the precertification stage. Along with the photos, the general contractor has to submit a declaration that guarantees the house was built as planned.

Finally, a last blower-door test is performed. If the house passes the 0.6-air-changes-per-hour grade, a certificate is issued by PHIUS that says the building is a Passive House.

The cost of certification depends on whether you’ve used a Passive House consultant throughout the project. If you haven’t used one, you’ll probably need to hire one to walk you through the processes and the software at the going rate of about $150 per hour. But if you’ve used a consultant, or become one yourself, the cost is under $1000.

There are several reasons why the pioneering energy-efficient houses of the past century didn’t catch on. Politics played a part, as did the limited range of technology of the time, which, fortunately, have been surpassed by today’s better windows, doors, and ventilation systems. The arguments for reducing houses’ energy use were certainly valid in 1974 when architect Wayne Schick coined the term “passive house.” Though its roots, on, the reasons are all the more compelling. The big question is how to make the ideas really take hold this time around.

Jefferson Kolle is a freelance writer and former editor at Fine Homebuilding.