

PASSIVE

Within Reach



THE RIGOROUS APPROACH TO HOME BUILDING IS BECOMING MORE AFFORDABLE—AND MORE NECESSARY—THAN EVER BEFORE

This spread: Ivin Serrano

by LYDIA LEE



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NEW MODULAR SYSTEMS, LOWER-COST PRODUCTS, AND CONSUMER INTEREST IN ENERGY EFFICIENCY ARE BRINGING A 30-YEAR-OLD GERMAN-BASED CONSTRUCTION METHOD INTO THE MAINSTREAM. ¶ WHILE ITS EARLY ADHERENTS MAY HAVE BEEN THOUGHT OF AS ECO-WARRIORS INTENT ON SAVING THE EARTH, THE PASSIVE HOUSE TECHNIQUE IS NO LONGER ON THE FRINGES OF RESIDENTIAL BUILDING. IN FACT, DRIVEN BY STRICT ENERGY CODES, THE PRACTICE IS ON TRACK TO BECOME COMMONPLACE IN SOME PARTS OF THE COUNTRY LIKE CALIFORNIA, WHICH FACES A RESIDENTIAL NET-ZERO MANDATE IN 2020.

Among sustainable building advocates, Passive House represents the gold standard for its demanding requirements and rigorous verification process. Launched in Germany as Passivhaus, the approach was inspired by energy-efficient, passive-solar homes built in the U.S. in response to the 1970s oil crisis. The first Passivhaus homes were built in 1990; since then, more than 2,000 certified buildings have been

constructed worldwide, according to the International Passive House Association.

The building system uses very low amounts of energy for heating and cooling, which it achieves with a tightly sealed building envelope, high levels of insulation without thermal bridging, high R-value windows, and mechanical ventilation. The passive approach has a notably high requirement for airtightness, a maximum of 0.06 air

Poppi Photography



changes per hour (0.6 ACH 50). Because of its exceptional efficiency, it makes getting a home to net-zero energy that much easier and minimizes the need for heating, which accounts for about 40% of residential energy use and causes seasonal spikes in energy consumption—making a passive home intrinsically more sustainable.

According to the Passive House Institute US (PHIUS), homes built to passive standards use 50% to 70% less energy than typical houses. They are also known for their high comfort levels, since they maintain a consistent temperature while providing a steady supply of clean, fresh air. Due to their tight envelopes, the homes can also stay comfortable even during extended power outages. (See “Resilient Measures,” right.)

About 1,000 U.S. professionals have been trained to design and/or build Passive House-certified homes, PHIUS says. Some have made it the cornerstone of their practice, like Mela Breen, founder and principal designer at Atmosphere Design Build in Nevada City, Calif., whose projects are located mainly in the state’s mountainous Gold Country. The firm has completed one official Passive House-certified home and uses the principles to guide all of its projects. (As with LEED, it is possible to use the passive approach without actually pursuing certification.)

In another sign that the technique is becoming more accepted in the U.S., its tenets are sanctioned by the U.S. Department of Energy. “We are big fans of Passive House,” says Sam Rashkin, chief architect of the Building Technologies Office at the DOE. “It represents the highest level of energy-efficient enclosure that you can build.” In fact, the DOE has aligned its own standard for

RESILIENT MEASURES

The weather has dominated global headlines lately, breaking records for new extremes. One of the latest U.S. disasters, Hurricane Michael, downed powerlines across the eastern seaboard in October, leaving 3.3 million homes and businesses from Florida to New York without electricity for days.

Whether caused by storms or other issues, major power outages can make homes uninhabitable even if they remain structurally intact after a storm. In the days after Hurricane Katrina in 2005, architect and building science expert Alex Wilson wondered how to mitigate situations like the sweltering conditions at the Louisiana Superdome, which overheated without electricity. He saw that even homes that the floodwaters spared were without power for weeks.

Wilson and other building industry leaders are responding with a new idea that can help homeowners not only survive but also be comfortable in their homes for long periods of time without electricity. With the right tactics, builders can create resilient homes that stand up to wind, rain, and snow, and then maintain occupant comfort for as many as seven days without power—even in extreme hot or cold conditions.

“It’s called passive survivability,” says Wilson, president of the Resilient Design Institute in Brattleboro, Vt. “It’s

about building homes that remain habitable if they lose power.”

Homes built with passive survivability in mind include a super-efficient envelope with good insulation and air sealing, and energy-efficient windows that take advantage of passive solar gain and natural ventilation. Solar panels and home batteries can further improve a home’s resilience during an outage. Passive House principles are the best path to follow when building this type of home, Wilson says.

These homes can maintain a habitable temperature independent of their mechanical heating and cooling systems (and without backup generators), allowing homeowners to shelter in place in case of a lengthy power outage.

“The idea is to create houses that will passively keep people safe during extended power outages or loss of heating fuel,” says Wilson. “It’s the right time for these ideas to come to the forefront.”

Zola Windows

(Left) With its oversized windows and light-filled interior, the Madison Passive house in Olympia, Wash., boasts extreme energy efficiency wrapped in a modern shell.

Architect/Builder: Artisans Group

(Below) After Hurricane Katrina, thousands of New Orleans residents faced sweltering conditions inside the Louisiana Superdome, which lost power during the storm.



(Bottom right) U.S. Navy photo by Mate First Class (AW) Brian Aho

TIME SAVERS

These days, it's not uncommon for builders to construct homes from panels. They provide an attractive combination of customization, factory quality control, and reduced construction time—at a point when the industry is facing a nationwide shortage of skilled labor. All these benefits make panelization ideal for building Passive House homes, which are technically sophisticated and require more precise construction.

Panelized Passive House systems are fairly new, but builders say the approach pays off. "Our airtightness numbers have dramatically improved since we've moved to panelization," says Sean Ritchey of Kingston, N.Y.-based Threshold Builders. "The shop lends itself to better quality control than a construction site, since we're designing the whole building as a system. But you have to invest in the facilities and equipment like framing tables to switch to an off-site construction set-up, which is pretty expensive."

Another option is to outsource the panels from a company like Bensonwood, which specializes in panelized timber-framed buildings and has a 110,000-square-foot factory in Keene, N.H. It recently launched its PHlex panels for architects and builders.

"It's intended to be a flexible system, designed around the idea that Passive House is a performance metric—it's not just '20 in the foundation, 40 in the wall, 60 in the roof,'" says Rheannon DeMond, a certified Passive House consultant at Bensonwood, referencing a home's R-values. "It can adapt to the amount of glazing, the climate zone, or whether it's a residence or multifamily or commercial building."

The company's wall, floor, and roof panels are shipped

to the site with pre-installed doors and windows; Bensonwood sends out a supervisor to help a local construction crew assemble the weatherproof, airtight building shell.

Perhaps the one downside to panelization is that it is much more difficult to fix a mistake. "If you have a window in the wrong place, it's typically going to be discovered when there's a more complete assembly already," says Ritchey. "That's where super-meticulous planning is such a critical part of the approach, which is true for Passive House in general."

FACTORY BUILT

Panelized companies that offer passive systems include:

Bensonwood
bensonwood.com

BuildSmart
buildsmartna.com

Ecocor
ecocor.us

Threshold Builders
threshold.builders



Threshold's panels are set on the jobsite.



Sean Ritchey

energy-efficient homes, called Zero Energy Ready, with Passive House. Zero Energy Ready is now a prerequisite for gaining Passive House certification in the U.S., and encourages builders to continue on to the next step. Zero Energy Ready itself requires a well-insulated, tightly sealed enclosure; Passive House adds a higher standard for airtightness and a whole-house ventilation system.

With a sharp focus on low energy usage, Passive House principles also have gained increased acceptance with U.S. multifamily builders and developers. The 26-story House at Cornell Tech, a student housing project completed in 2017 in New York City, is the tallest and largest residential Passive House high-rise in the world. And in San Francisco, the Passive House-certified Sol Lux Alpha condo runs completely off the grid, producing enough energy on-site to power the entire building.

COSTS COMING DOWN

Building a house that is comfortable year-round and uses a minimum of energy for heating and cooling is not significantly more difficult or costly, according to experienced builders. As with any state-of-the-art building technique, there are extra costs involved—about 5% to 10% more, according to PHIUS. However, as Passive House builders tell their customers, the investment in the building is offset by reduced utility bills.

Rashkin breaks down the expense like this: "It costs roughly \$4,000 to \$8,000 more per home [to do Zero Energy Ready]. That results in a \$20 to \$40 increase in a monthly mortgage payment, but a \$40 to \$90 savings on the utility bill. So it's truly cost-effective."

Breen says there's a misconception about passive construction being super-expensive, when it just takes

commitment. “What makes it cost-effective is a simple design and buy-in from the builder and subs. If you look at other custom-designed houses with comparable finishes, we’re building them for the same price,” she says.

Depending on a builder’s current techniques, it might represent a relatively small step instead of a big leap, says Steve Bluestone, a builder and former partner at New York-based developer Bluestone Organization, which builds both multifamily and single-family Passive House-certified projects.

“If you are building a crappy building today that’s just energy-code compliant and you want to make it [passive], you have to do a lot,” Bluestone says. “Passive House is real simple—it comes down to insulation, air sealing, and ventilation. For one of our multifamily projects, our walls were already at that level. But instead of installing a \$75 exhaust fan, we had to install an energy recovery ventilator that cost us \$750 to \$1,000 per unit.”

Meeting the blower door test can be tricky for builders who are accustomed to building with wood and materials that move and shrink and dry, because higher-performance homes have multiple layers and each step has the potential for failure, says Bluestone.

“The reason we were able to hit the standard for very little cost is almost entirely because we’ve been building with ICF [insulated concrete forms] since 2008. It’s the best bang for the buck for building up to 25 floors.” Bluestone is also a fan of using AAC (autoclaved aerated concrete) for building to passive requirements.

MORE CHOICES

A few builders have turned to prefabrication to make meeting passive standards cost-effective while improving quality. Leveraging their experience with stick-built passive homes, companies including Bensonwood, BuildSmart, Ecocor, and Threshold Builders have panelized the building envelope, producing Passive House-level insulated walls, floor, and roof components in their factories for quick assembly on site. The first three companies offer their panels to architects and builders as a commercial product, which are custom-built for a particular design and can be shipped to sites nationwide. (See “Time Savers,” p. 68.)

“We’re taking advantage of best practices in the manufacturing industry as well as automobile and boat design, test, and fabrication,” says Sean Ritchey, co-founder of Threshold Builders in upstate New York, which launched its panelized system in early 2018. The company has panelized the hydrothermal envelope, foundation, walls, and roof, constructing them from standard off-the-shelf components such as wood studs and cellulose insulation.



“We can make a home passive for about 1% to 2% more than code-built, a price premium that can pay itself back in just a few years,” says Ritchey. “Using a 20-year financial model, Passive House is going to save the homeowner a shocking amount of money in this Northeast cold climate, because it’s so efficient.”

Other new building technologies promise to make Passive House-levels of performance easier and more cost-effective. For instance, new strides in air sealing are making a difference for passive building. Prescott, Ariz.-based Mandalay Homes is using a new air sealing process called AeroBarrier to reach passive airtightness levels in hours. The automated system uses a fine mist of caulking material that gravitates to air leaks and seals them off. In Arizona, where dust is a significant issue, the fine-grained air sealing also helps keep home interiors clean.

As passive building continues to grow in popularity and relevance, more cost-saving measures are sure to follow. The biggest innovation on the horizon, according to Rashkin, is a new triple-pane insulated window that offers R-5 and R-7 for only a slight price increase and a 50% performance gain from R-3. The window uses krypton gas and ultra-thin glass for the middle layer, allowing the triple-pane window to fit into the same extrusion as a standard window. Andersen Windows has committed to working with Lawrence Berkeley National Laboratory to bring the technology to market in a couple of years.

In the near future, all of these technologies and standards will result in a very self-sufficient home. Says Rashkin: “The buildings themselves need to be able to withstand a whole bunch of disaster events, have systems that can store energy and keep them operable afterward, and buy homeowners time by slowing infiltration by the weather.” **B**



Luxury condominium building Sol Lux Alpha in San Francisco’s Mission District is the city’s first Passive House certified multifamily building.

Architect:
RG-Architecture

Builder:
Sarter Construction
& Design