Passive House: An Old Idea, Reinvented for the Homes of Tomorrow

BY SAMANTHA WRIGHT
PHOTOS BY BRETT SCHRECKENGOST

For more than thirty years, Ridgway builder Brad Wallis of BTB Construction and Consulting, Inc., has been building and designing high efficiency structures designed to last for the long haul.

"There's been a lot of greenwashing going on lately, but the truth is that, when you build a home, it is not an ecologically positive event. It takes a lot of resources," Wallis pointed out.

"But the good news is that a home that's well-built should have a life cycle of at least a hundred years, if not more. In our disposable society, where your cell phone breaks and you throw it away, a well-built house isn't like that. A well-built house will serve many people over many, many years."

Wallis has a background in passive solar design, including "envelope" homes, earth-sheltered homes, Nudura and Rastra building systems (utilizing insulated concrete form blocks) as well as SIPs panel construction (structural insulated panels consisting of an insulating layer of rigid core sandwiched between two layers of structural board).

Since relocating to Ridgway in 2008, he has also developed a "net zero" home cut into a hillside on County Road 12 as his

Brad Wallis's latest building project is the Silbert-Courson house north of Ouray. As far as he knows it is the first home on the Western Slope to fully embrace Passive House criteria.

own residence. Thanks to its PV panels, geothermal ground-source heat pumps and innovative building materials and design, the home actually produces more energy than it consumes. He also recently completed a SIPs panel home with a friend near Ouray.

Clearly, he is an all-of-the-above kind of guy when it comes to building techniques and materials that make a home more efficient and less of an environmental burden over the course of its life.

But he's especially passionate about the "Passive House" (Passivhaus) design criteria coming out of Germany, and how that may affect quality building practices in the Four Corners region going into the future.

The concept of the Passive House has been around in Europe for about 20 years, where roughly 40,000 structures meet Passivhaus criteria. "It's really all about super-insulation," Wallis explained, "so the building doesn't have to have solar exposure. It can be on the north side of a skyscraper, and still perform well, because it's about energy retention, not all of the fancy alternative ways of making energy."

Wallis likens Passive House technology to the ice houses of a century ago. "If you

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look into them, it's like they built a log cabin, and then built another one a foot or two outside of it and filled the space between the walls with sawdust," he explained. "They cut off chunks of ice from the lakes, put them in there, and it would last all summer."

Modern Passive Houses employ continuous insulation and an extremely airtight building envelope in much the same way, to prevent infiltration of outside air and loss of conditioned air.

PHIUS, a 501(c)3 organization, provides research, technical standards, training, certification and design tools for Passive House construction in the U.S. But the movement has not caught on in a big way – yet – for one reason. Until about 16 months ago, nobody in the U.S. sold doors and windows that met Passive House standards.

"So you had to import the doors and windows from Europe in order to get Passive House certification," Wallis said. "And when you do that, the price is exponentially greater."

But about 16 months ago, a couple of American manufacturers started building windows and doors that meet the strict standards. One of them, Alpen High Performance Products, is based in Boulder.

At 1,250 square feet, the design of the Silbert-Courson house reflects the just-enough-space, "bigger isn't better" philosophy.

The finished house will have an extra-thick envelope of insulation in its walls, ceiling and floor to make it super-energy-efficient.

That's where Wallis got the windows for his current project.

A MODEST, YET GROUNDBREAKING HOME

The custom home that Wallis is working on right now, on County Road 23 in the Idlewild subdivision north of Ouray, looks modest, cozy, charming – and normal – from the outside. But under its skin, it is really something special. It is the first house of its kind in southwestern Colorado that Wallis is aware of that fully utilizes the super-insulation design criteria developed by the Passive House movement.

Wallis is a man on a mission, who speaks of the Passive House concept with intense, almost religious zeal. "This house should be able to heat and cool itself with 80 to 85 percent less energy consumption than a house that is not built to Passive House standards," he said. "And it's not powered by special gizmos or hamsters underneath the floor. It's just really well insulated and carefully built."

The house's owners are Diedre Silbert and Jim Courson. The couple moved to Ouray County in spring of 2012 from

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Flagstaff, Ariz., seven or eight years after buying the land upon which their house is now being built. "It was the land that pulled back us to the area," said Silbert, who now works for the Town of Ridgway. Courson, a hospice nurse, now works at HopeWest Hospice.

Five years or so ago, they started working with Silbert's brother, a Boulder-based architect, on the design for their future home. "Our goal was for it to be a small, energy-efficient home with passive solar. We knew we wanted it to be heavily insulated, but we didn't know about super insulation and the double wall system," Silbert said.

They adopted the Passive House model, "mostly because Brad is a big believer of that. He had to sell the idea to us," she admitted. But it turned out to dovetail perfectly with the plans they had already laid for their home's design.

"For us, it was a natural," Silbert said. Even though the home is not a certified Passive House, it is being built completely to those standards. "Everything on the list was stuff we thought was important."

Even in its partially built state, the single-story, two-bedroom/two-bath house has curb appeal galore (not that there are any curbs to speak of, out here in Idlewild's bucolic Ponderosa-dotted meadows). Classy touches like arched windows and stone sills add visual interest, but there is nothing weird or Earthship-y about it. Eventually, its exterior will be finished off with a coat of stucco.

But the design is not what is really important here. "You can design a Passive House any way you want," Wallis explained. "It can be a French colonial. It can be a Santa Fe. It can be a Victorian. It can be whatever. It's about the amount of insulation, and the way the structure is built."

The thing that really sets the house apart is its extra-thick walls.

When Wallis talks with potential clients about a building project, he presents them with five different wall systems. They can choose from Integrated Concrete Foam blocks, SIPs panels or three different types of double wall, varying in thickness, designed specifically to allow higher insulation values.

Silbert and Courson opted for a mid-range double wall, 12 inches from front to back. (Wallis also offers one that's thinner and one that's wider, with accordingly different R-values).

When people first hear about the double-wall system, they invariably conclude that the house will cost twice as much to build.

"But that is not the case," Wallis said emphatically.

For one thing, the overall scope of the house must be taken into consideration. The Silbert-Courson house, for example, is quite small. At 1,250 square feet, its design embraces the just-enough-space, "bigger isn't better" philosophy outlined in leading residential architect Sarah Susanka's groundbreaking book, *The Not So Big House* (Taunton Press, 1998), which so far as Wallis is concerned, is required reading for all of his clients.

More importantly, Wallis pointed out, it's generally the finishing details – appliances, cabinets, etc. – that increase the cost-per-square-foot in a new home. By comparison, the construction materials needed to build an extra layer of wall are relatively cheap. "It does take a little more labor," Wallis acknowledged. "But it is not exponentially more expensive."

The gap between the two walls is filled first with two-inch-thick spray foam to create an air seal (which enhances the value of the insulation) followed by blow-in, high-density cellulose insulation that completely fills up the remainder of the void, leaving no space for air from the outside to leak in, or vice versa.

"This will be an R-50 wall," Wallis said – two to five times more insulated than a code-compliant single-walled home insulated with fiberglass batting.

(The R-value is a measure of resistance to heat flow through a given thickness of material.)

The ceiling, meanwhile, features oversized joists for added insulation space. It gets four inches of spray foam, and the cavity is again filled with cellulose. "That will give us an R-60 ceiling," Wallis said.

The home's inch-and-a-half thick concrete floor, coupled with an insulated crawl space and integrated concrete foundation underneath, offers an R-Value of 38. The concrete floor has built-in radiant heat and also enhances the passive solar capability of the house. "If the mass that you are trying to heat is already gaining heat from the windows, then you need less energy to bring it up to temperature," Wallis said.

Proper windows are a critical part of Passive House design. As Wallis pointed out, it's pointless to build a well-insulated house if its windows lose a lot of heat. The energy efficiency of windows is rated through something called U-value – a measure of the window's resistance to air flow. The lower the U-value, the better the window. The Silbert-Courson house has windows with a U-value of .19 – three times more efficient than a standard window.

And they were not that much more expensive. Wallis was able to purchase Passive House certified windows for the project from Alpen, in Boulder, for a total of $13,000 compared to the $9,000 it would have cost to outfit the house with standard windows.

Since the house is so airtight, a state-of-the-art heat recovery ventilation system keeps heat in while moving stale air out.

"Thermally, it's a very strong package," Wallis said.

How much did all of this cost the owners? "When you think about the cost of doing a highly efficient house versus a regular house, it does cost more," Wallis acknowledged. "It costs approximately 10 percent more to build a highly efficient structure versus a normal structure."

Yet remarkably, the Silbert-Courson house is actually projected to come in well under the $200/sf median cost for newly built single-family homes in the region – at a mere $175 per square foot.

"This home is being built for less than the median square foot cost, and yet it is way, way more efficient," Wallis said proudly.

Wallis's "net zero" home near Ridgway actually produces more energy than it consumes.

THE TEST OF TIME

To measure how energy-efficient a home is, energy auditors use a tool called a blower door, comprised of a calibrated fan (plus a mounting system to attach the fan to an exterior door), and a manometer which measures air pressure.

The blower door test measures the amount of air needed to keep a house at an elevated pressure of 50 Pascal. The leakier the house, the more air is required to maintain the pressure. (Think of how much harder you would have to blow into a leaky balloon to keep it inflated.)

Blower door test results can be expressed in a few different metrics. The most common one is air changes per hour (ACH), or how many times a house's air is completely replaced in a given hour. The lower the number, the more energy-efficient the home.

A blower door test conducted in October 2014 gave the Silbert-Courson house a rating of .90. Wallis was ecstatic.

"A rating of 5.0 is considered a very tight house," he said. "Most homes built for high efficiency rate at between 2.0 and 3.0, so we were very happy to see that this project rated so well! This

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Wallis designed his own house to make the most of solar gain, and encourages his own clients to do the same. Building a modestly-sized house saves money that can be lavished on finishing details like beautiful wood trim.

is the lowest ACH rating I have ever heard of, and in ACH ratings, the lower the better. Now on to drywall and interior finish!"

Silbert and Courson are equally thrilled that their house is shaping up to be so energy-efficient. The last time *Shelter* checked in with them was in late November. Winter had arrived and the temperatures had plummeted, but the house was still very much under construction and its natural gas-powered in-floor radiant heating system had not yet been activated.

"The most amazing thing is that we have been heating the house and keeping it above 60 degrees using two oil filled portable radiators meant to heat 100 square feet each," Silbert said. "We keep the heaters on low, and not even all the time."

In other words, she said, the Passive House system "totally works, even on these cold days and nights."

They can't wait to move in, come March.

Wallis first became interested in Passive House technology in the 1970s, when the Canadian government did a government-sponsored survey of super-insulated houses. "They built like a dozen houses

Wallis hopes to inspire other builders throughout the region to construct highly efficient homes that new generations will still want to live in, years down the road.

and insulated the heck out of them. And it was a rousing success. They did really well, but because energy remained cheap, it just never became that important to anyone," he said.

The current pattern in the housing market "of building the biggest house you can, on the assumption that energy is cheap, won't hold up well in the future," Wallis predicted.

"I think that energy is going to escalate and become more and more expensive," he said. "And so, if we have the ability to build highly efficient houses, I think it's a social imperative to do so. I think that energy is going to become less available and much more expensive through the coming years. And if a house doesn't last for a hundred years, then you don't know how to build houses."

ACCORDING TO PASSIVE HOUSE INSTITUTE U.S., A PASSIVE BUILDING IS DESIGNED AND BUILT IN ACCORDANCE WITH SIX BUILDING-SCIENCE PRINCIPLES:

1. It employs continuous insulation through its entire envelope without any thermal bridging.

2. The building envelope is extremely airtight, preventing infiltration of outside air and loss of conditioned air.

3. It employs high-performance windows (typically triple-paned) and doors.

4. It uses some form of balanced heat- and moisture-recovery ventilation and uses a minimal space conditioning system.

5. Solar gain is managed to exploit the sun's energy for heating purposes and to minimize it in cooling seasons.

6. Passive building principles can be applied to all building typologies – from single-family homes to apartment building to offices and skyscrapers.

Passive design strategy carefully models and balances a comprehensive set of factors including heat emissions from appliances and occupants – to keep the building at comfortable and consistent indoor temperatures throughout the heating and cooling seasons. As a result, passive buildings offer tremendous long-term benefits in addition to energy efficiency.

To learn more, visit www.phius.org