Passive House on Protected Land

This Montana homestead is a study in environmental stewardship and sustainable building practices

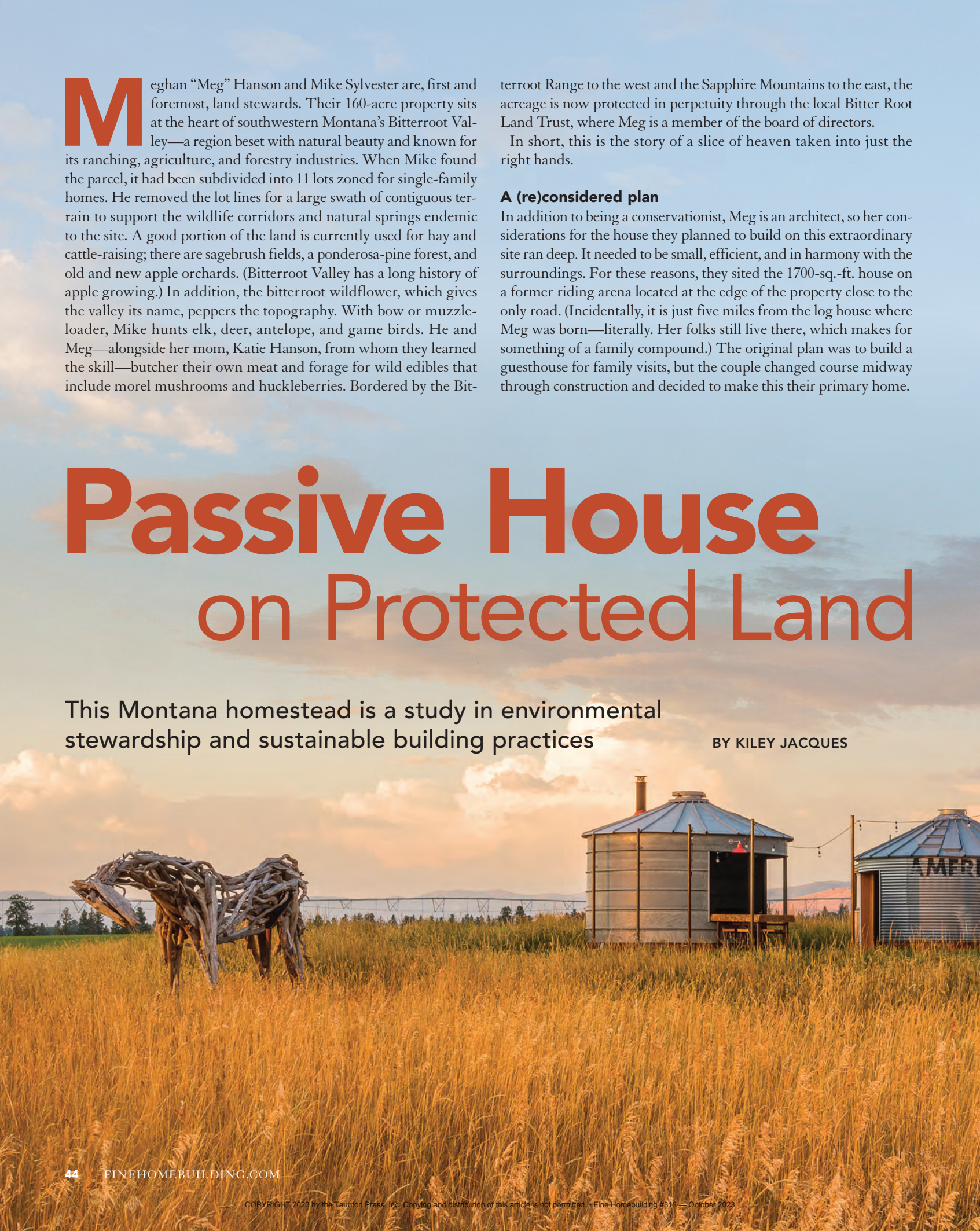
BY KILEY JACQUES

Meghan "Meg" Hanson and Mike Sylvester are, first and foremost, land stewards. Their 160-acre property sits at the heart of southwestern Montana's Bitterroot Valley—a region beset with natural beauty and known for its ranching, agriculture, and forestry industries. When Mike found the parcel, it had been subdivided into 11 lots zoned for single-family homes. He removed the lot lines for a large swath of contiguous terrain to support the wildlife corridors and natural springs endemic to the site. A good portion of the land is currently used for hay and cattle-raising; there are sagebrush fields, a ponderosa-pine forest, and old and new apple orchards. (Bitterroot Valley has a long history of apple growing.) In addition, the bitterroot wildflower, which gives the valley its name, peppers the topography. With bow or muzzleloader, Mike hunts elk, deer, antelope, and game birds. He and Meg—alongside her mom, Katie Hanson, from whom they learned the skill—butcher their own meat and forage for wild edibles that include morel mushrooms and huckleberries. Bordered by the Bitterroot Range to the west and the Sapphire Mountains to the east, the acreage is now protected in perpetuity through the local Bitter Root Land Trust, where Meg is a member of the board of directors.

In short, this is the story of a slice of heaven taken into just the right hands.

A (re)considered plan

In addition to being a conservationist, Meg is an architect, so her considerations for the house they planned to build on this extraordinary site ran deep. It needed to be small, efficient, and in harmony with the surroundings. For these reasons, they sited the 1700-sq.-ft. house on a former riding arena located at the edge of the property close to the only road. (Incidentally, it is just five miles from the log house where Meg was born—literally. Her folks still live there, which makes for something of a family compound.) The original plan was to build a guesthouse for family visits, but the couple changed course midway through construction and decided to make this their primary home.



"We had in mind a gathering place," Meg explains. "The idea was to be able to sleep people in various ways, so it's not a traditional layout—we don't have a dining room but rather a series of small eating spaces, and a lot of informal sleeping spaces." As a result, they have made creative use of outbuildings to accommodate their lifestyle.

Because the west-facing view of the Bitterroot Range is the most spectacular, capturing it while mitigating heat gain was a lead design objective. The plan orients the house east-to-west, with a long south wall largely covered in triple-glazed glass; operable steel shutters on the south-wall windows help to keep interiors cool. Sliding doors open onto a covered patio facing the west mountains; custom outdoor shades can be fastened to the steel support posts—fabricated from railroad tracks stamped with dates from the early 1900s—on the patio for protection against the hot lowering sun.

Food was another key design driver. "We focus our life around cooking," Meg explains. "As much as we love hunting, gathering, growing, and preserving, we love to make food for people." This informed the decision to move two on-site 14-ft.-wide grain silos closer to the house; one houses a pizza oven and smoker—on which Mike cooks most often, year-round—and the other is a fully insulated bathhouse. (Notably, this is the fourth time Meg has integrated silos into a home design, so fond is she of the agrarian aesthetic.) When used for grain storage, silos are traditionally set on grade and a concrete pad is poured inside; to move each of them, they cut the silo above the concrete pad. To create headroom for the repurposed applications, they built 18-in.-tall Corten-steel stem walls and reset the silos atop those.

The two silos have their own 100-amp subpanel for power. Because achieving net-zero operations was a priority, they wanted to track energy consumption beyond the house. After reading the *Fine Homebuilding* article "Smarter Energy Tracking" (*FHB* #311), Meg bought the Emporia Vue monitor and hooked it up to the silos in order to track their energy use. To date, she notes that the wall heater in winter and the water heater are the largest energy draws, which is no

PASSIVE PROBLEM SOLVED From a passive-solar design perspective, installing expanses of glass on the west doesn't make good sense because of the potential for heat gain, but a key objective was to optimize views by pointing west. The solution was to elongate the house on the south and put the "front" to the west with a covered porch and the option of additional shades.

surprise. Next, she plans to move the sensor to the home panel to learn what the draws are there.

Among the changes made to the original plans was the addition of a north-facing window on the second floor. They have deemed it "Mike's Window" for the pleasure he takes in overlooking the hayfields. "Glazing to the north is a Passive House taboo because it loses more heat than any other aspect," Meg explains. "It helps to think of your windows as a hole in the house when thinking about energy use. Even the best triple-glazed windows have an insulating value of about R-10, compared to our surrounding wall at R-50." But the change was worth it for the view. Meg worked with mechanical engineer Skander Spies when modeling the home, and the solution was to add a same-size window on the south to get the energy model to rebalance. Despite these additions, Meg was conservative with glazing in accordance with Passive House practice; fewer windows means fewer building-envelope penetrations, which means fewer opportunities for air leaks and subsequent energy losses.

Suitable materials

In Meg's mind, the rural setting called for natural materials wherever possible. Meg also wanted to give the house a "Scandinavian modern" treatment, accenting a simple form with clean lines. To that end, she chose cypress siding and integrated accents of Corten steel for its rusted look. Because Mike worked for years at a wood-manufacturing company that made railroad ties and telephone poles, he has connections to major U.S. lumber suppliers and was able to source "a phenomenal truckload of wood," as Meg describes it. "We could essentially have anything we wanted, and having spent much of his life in the South—Mississippi and West Virginia—Mike chose cypress for the siding. It is like cedar in its ability to be outside long-term, and it grays to a beautiful silver." All the lumber used is Forest Stewardship Council–certified. (FSC sets the standard for responsible forestry worldwide.)

Regarding the use of Corten steel, Meg says, "I know a lot of people have Corten fatigue, but when used in moderation and in unique ways, I think it's great. It's an indestructible material." She also notes that none of the exterior materials should require much maintenance.

Combining their tastes meant that Mike's love of wood is on view. Walnut, oak, cherry, and maple (railroad ties are often made of high-grade hardwood) were used for the ceiling, cabinetry, and stair treads. Meg's preference for the modern Scandinavian style shows up in the white interiors, black windows, and sealed concrete floor. She used waxed steel on the threshold of the double-slider doors; it also runs the full width of the wall, which was done not only because it looks handsome but because the floor is an isolated floating slab—4 in. of foam between the slab and exterior foundation wall—so the steel covers the foam, which is the thermal break. She used waxed steel on some countertops too. "It's a beautiful, inexpensive material, and you can do things like wrap corners—where you come across the top of the counter and then wrap it vertically," she explains. "One of my pet peeves is looking at the ends of cabinets, and this solves for that."

Producing a Passive House

Mike and Meg's is the first house in Montana to receive Passive House U.S. (Phius) certification, a distinction that Meg, a Certified Passive

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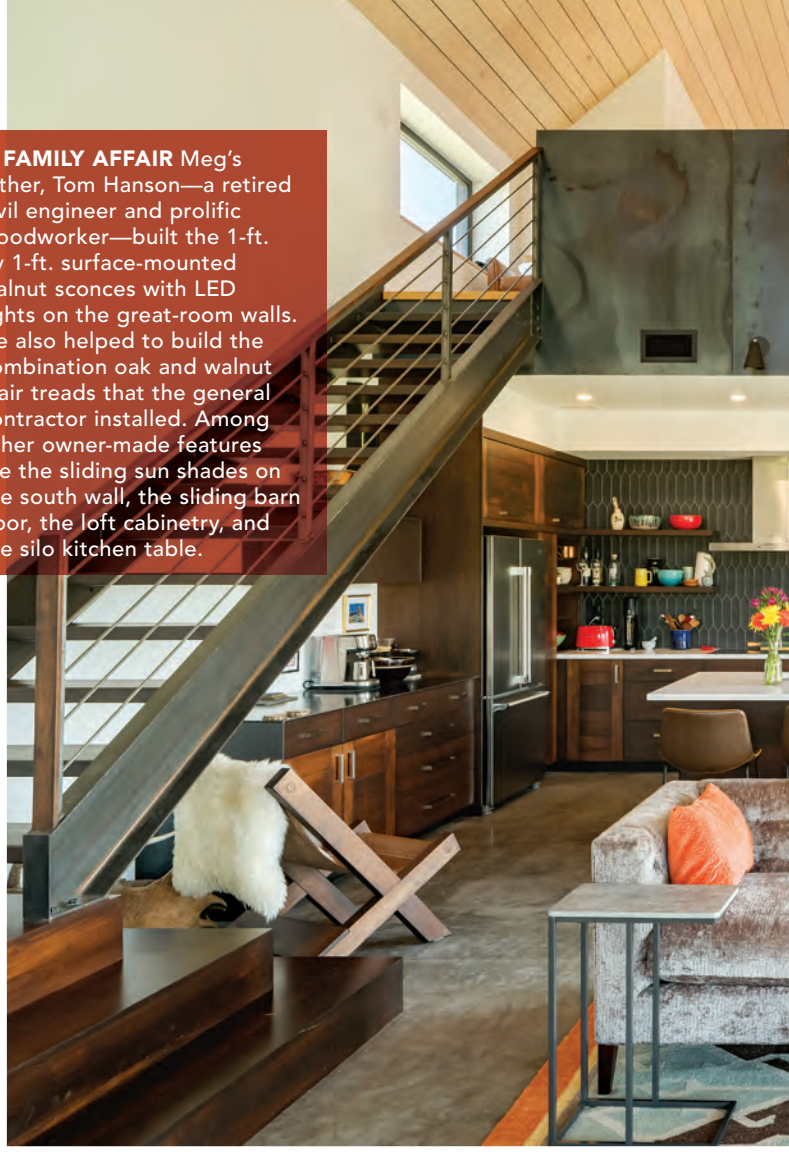
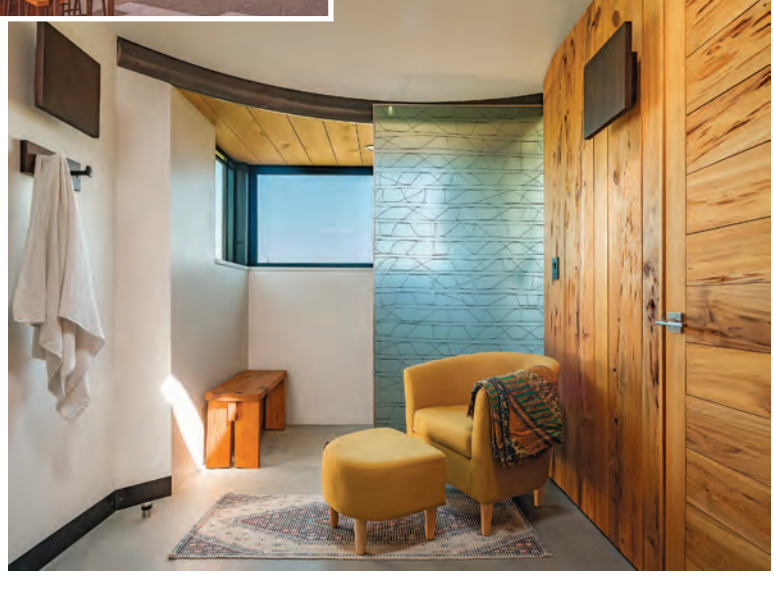


A FAMILY AFFAIR Meg's father, Tom Hanson—a retired civil engineer and prolific woodworker—built the 1-ft. by 1-ft. surface-mounted walnut sconces with LED lights on the great-room walls. He also helped to build the combination oak and walnut stair treads that the general contractor installed. Among other owner-made features are the sliding sun shades on the south wall, the sliding barn door, the loft cabinetry, and the silo kitchen table.

SIGNATURE SILOS Two 14-ft.-dia. grain silos were moved from nearby on the property and repurposed as an outdoor kitchen and an insulated, heated bathhouse.

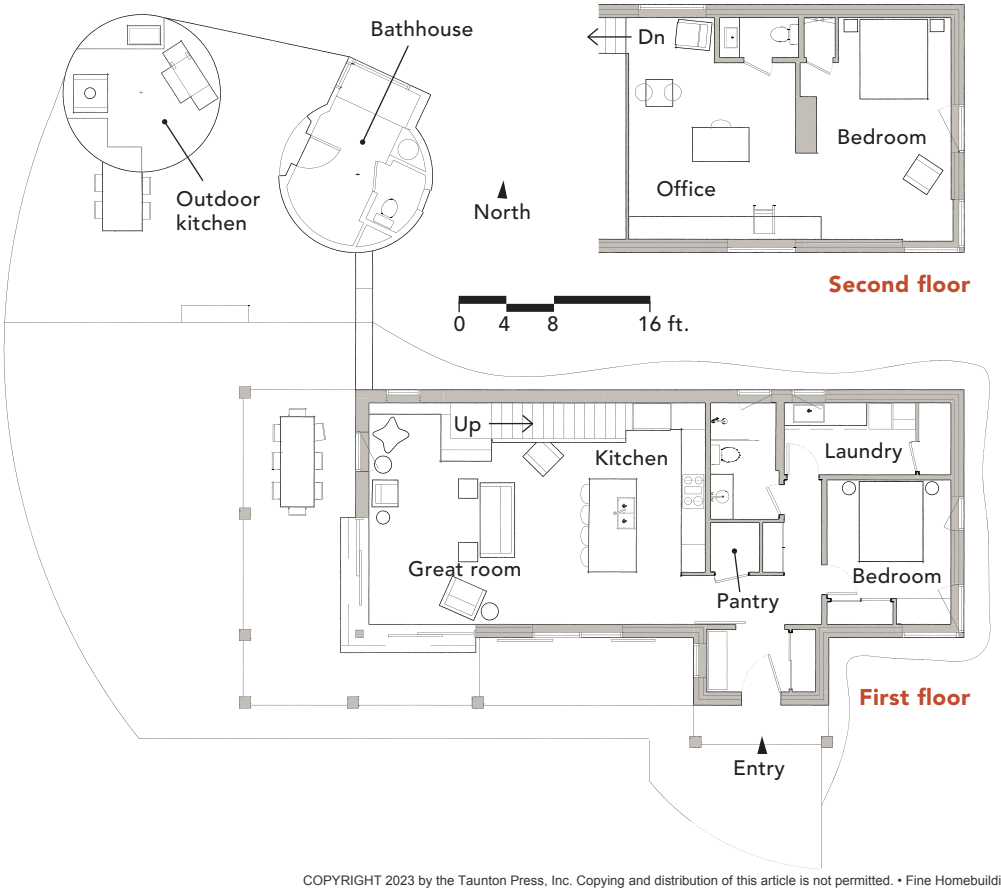


Floor-plan drawing: Newhouse Design

SIMPLE STRUCTURE FOR A PASSIVE PLAN

A bare-bones building shape supports a Scandinavian-modern aesthetic. Desirable views and passive-solar design principles determined the locations of interior spaces. The lower-level bedroom is on the southeast for the morning light. Glazing is maximized on the south for wintertime passive-solar heat gain. The mechanicals and laundry room are on the north side—a good section of a Passive House for utilitarian purposes because of its limited natural light and warmth.

The bathroom was put at the center to concentrate and shorten plumbing runs. The kitchen/great room is shrunk in scope relative to conventional designs; it eliminates space for a dining room table in favor of a large island. The living area includes a series of small tables for casual entertaining.



SPECS

Bedrooms: 2 (plus 120-sq.-ft. bunkhouse)

Bathrooms: 2 (plus 150-sq.-ft. bathhouse)

Size: 1700 sq. ft.

Cost: $350 per sq. ft. (excluding outbuildings)

Completed: 2022

Location: Bitterroot Valley, Mont.

Architect: Meghan Hanson

Builder: Hone Architects + Builders

7 WAYS TO TIE HOME TO LAND

1 Make site orientation the first priority. Orientation is the first aspect of a design that affects a home's energy usage. Generally, elongating a building east-to-west will help optimize light and passive heating by maximizing southern exposure; in this case, it also helps with cooling, as winds are typically from the south. Of course, desirable views can impact orientation, as with this site. With generous west-facing glazing to capture views, it was necessary to integrate deep covered porches; plantings can also be used for shading against low western sun.

2 Study the site from several different aspects. This includes things like microclimates and possible wildlife corridors. Consider keeping the best land for wildlife and agriculture or as a natural place to enjoy rather than building on it. Existing buildings or infrastructure present opportunities to expand square footage beyond the house while saving land.

6 Use exterior materials and forms that are in keeping with the local vernacular. Natural woods and rusted and galvanized metal are common to this area, which has a long agrarian history, so shed forms and repurposed grain silos fit well. Siting the house near the hayfield was also important, as it reflects tradition.

3 Design different outdoor spaces for different seasons and conditions. This property includes a covered east-facing deck designed for hot summer evenings when shade is welcomed. The west-facing patio is partially covered, and integrated shades can be rolled down to block harsh sunlight. The uncovered southwest outdoor area is meant for use in spring, fall, and mild winter weather.

4 Place windows to optimize views and passive conditioning. Conventionally, windows are installed with a head height of 7 ft. to 8 ft. for standard viewing. Consider placing windows to help direct the view, even at atypical wall heights. Use windows on the north and west sparingly, if possible. Windows on the south have the added benefit of heat gain in winter and are easy to shade in summer.

5 Consider smaller buildings, and optimize their use. For an active family with lots of recreational gear (skis, bikes, camping equipment, etc.) that doesn't require conditioned space within the home, outbuildings are helpful storage spaces, and they can help to keep the house scale in check—as can forfeiting the standard garage.

SITE SPECIFIC While camping out on the property, the owners determined that 5° to 15° east of south was the optimal orientation for the house, which would allow for both passive-solar gains and protection from the harsh western sun.

7 Think of landscaping differently. Rather than using highly ornamental plantings, go with natives to blend cultivated areas into the natural surroundings. Consider opportunities for food production and outdoor art.

CONSTRUCTION DETAILS
FOR PASSIVE HOUSE PERFORMANCE

Meeting Passive House standards of performance in a cold climate requires superinsulated walls and a very tight building envelope. To reach those goals, this house was built with double-stud walls—a 2x6 exterior wall and a 2x4 interior wall—with a 5-in. space between them for continuous insulation. The walls are filled with R-50 damp-sprayed cellulose. The roof is framed with 24-in. raised-heel, parallel-chord trusses. The air barrier transitions from the exterior sheathing plane to the interior of the roof beneath the trusses. Outside, the air barrier is taped structural sheathing. Inside, it's the taped Intello membrane seen here. Bringing the air barrier to the interior allowed for a vented roof assembly. The roof is insulated with R-92 dense-packed fiberglass insulation. The vapor-control layer is provided on the interior by vapor-retarding primer on the exterior wall's drywall and on the ceiling by the Intello, which is a responsive, or variable-perm, membrane.

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House Consultant (CPHC), was keen to earn. Although pleased with achieving the certification, Meg says that she was too focused on it, and if she were to do it over again she'd likely forfeit it.

"The process was challenging," she says. "Our third-party rater had to travel four hours and had never done one before. It involved a lot of teamwork and head-scratching and time." But for professional-development reasons, she wanted to know what it took and what it cost so that she could talk knowingly with her clients, most of whom are in the Teton Valley, which has an elevation of 6500 ft. It can be hard to convince them of a Passive House–level build because of the high cost of construction methods needed for extremely cold climates.

To ensure Passive House performance, two blower-door tests were done, one after air-sealing but before insulation, and one upon completion. "The reason you do two—and why it is important to do the first one at that time—is so you can correct any leaks," says Meg. "Our general contractor was always thinking about the details to stop air leakage." She points to the example of the hot-water pipe that comes from beneath the slab to feed the kitchen island. The insulation around that pipe also comes up through the concrete, and the insulation has holes in it; the builder cut the insulation down to the pipe, air-sealed with tape to the pipe, and then reinstalled the insulation to block that tiny air leak.

Despite on-site energy production, the house is tied to the grid. Meg and Mike produce enough energy to power the main house, but they require more energy for the outbuildings. In fact, additional solar panels were recently added to the existing south-facing shed's roof to increase power. However, that will be the maximum allowed by law.

Meg offers two interesting side notes on working with energy providers as part of a co-op: "Even if we produce all of our own energy, we still need to pay a monthly membership fee, so it's not free energy." Second, she and Mike wanted a net-zero, solar-powered, pivot-style

Photos this page left: courtesy of Meg Hanson

A WELL-LIT LOFT Despite potential energy penalties, skylights were an important inclusion for their ability to harvest natural light in the lofted space.

PROS AND CONS

High-performance European windows

Ultrathick walls are great for optimized insulation values and sound attenuation, but integrating European tilt-turn windows—the go-to for high–performance home builders—has its challenges. Since such units allow for only a slight inward turn, they don't come anywhere near reaching the inside of a 14-in.-thick wall when open, which means the volume of air they allow in is restricted. Additionally, this style of window opens inward only, which means finding shades that work is difficult; moreover, they have "free-hinge" or sling-style hardware, meaning they aren't fixed when in the open position, so cross breezes can make them slam shut. And, of course, the financial and environmental costs of importing windows from overseas are significant downsides. That said, European windows have their merits. Key among them is their U-factor, a measurement for heat transfer that is calculated using the rate of energy transfer through one square meter of a structure divided by the difference in temperature at either side of the structure. For example, a German-imported triple-glazed window has a U-factor of 0.95—which is ideal for energy efficiency. The construction of European windows is also regularly touted as superior to that of windows made in the United States.

irrigation system to water about 70 acres, but the local utility won't allow solar to be used for agrarian irrigation, so their system runs off the grid.

In addition to her deepened knowledge of Phius certification, Meg shares with her clients the benefits of induction cooking—something she learned in this house. "Now I can talk intelligently about induction ranges, as we are seeing a big push in that direction," she says. "It's like cooking with gas in terms of the reaction, but you don't have to clean those annoying gas cooktops. Induction is superclean, better for indoor-air quality, and safer; things aren't hot in the same way. Plus, it boils water so much faster. There is a learning curve for using it, though."

Meg offers one last lesson: Had the house been designed initially to be their primary residence rather than a family getaway, she would have made the first-floor bedroom a true owner's bedroom, with more closet space.

Picturesque and sustainable

Keeping the house small was a priority for cost savings and energy efficiency but also for utilitarian purposes; the couple travels a lot and wanted vacating for long stretches to be easy. They installed just one thermostat that can be set to vacation mode, and the heat-pump water heater offers the same setting.

In setting out to design a house in this agrarian landscape, Meg and Mike have created a holistic haven. It is at once picturesque and practical, unique and universal. It is an inspired example of how to build sustainability into our lives and homes. It starts with respect for nature. As Meg puts it, "The reason we did everything we did with the house—small, eco-groovy, Passive House performance—was to protect the land." □

Kiley Jacques is Green Building Advisor senior editor. Photos by Chuck Collier Schmidt, except where noted.