

Passive House **NORTHWEST** 2016



Passive House
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2016

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Cover: Skidmore Passivhaus; photo by [JEREMY BITTERMANN](#)

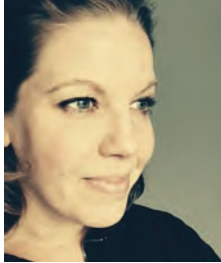
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FOREWORD

As North America's oldest Passive House community, the dedicated practitioners of Passive House Northwest (PHnw) have ensured that low-energy buildings are an established—and still growing—presence in the Pacific Northwest marketplace.

We at PHnw are proud of not only the quantity of local passive buildings, but their diversity too, in both size and locale: from small single-family homes to a growing list of multifamily projects, and from southern Oregon to the San Juans and over to eastern Washington. This book demonstrates beautifully the strong drive here in the Pacific Northwest to create better buildings.



Michelle Jeresek

2015 was another exciting year for PHnw. In February, we hosted Norwegian architect and builder Bjorn Kierulf, who presented his portfolio of handsome passive houses to five different audiences in Eugene, Portland, and Seattle, impressing us all with a trifecta of performance, beauty, and healthy low-carbon materials.

In March, we hosted our annual conference on Seattle's waterfront at the Bell Harbor Conference Center. As always, exemplary content was abundant. Keynote Günter Lang's return to the Northwest was timely. Only four years before, he had met with REACH Community Development staff and encouraged their pursuit of multifamily passive projects, which they did very successfully. Last summer we celebrated the grand opening of REACH's Orchards at Orenco, North America's largest multifamily Passive House, to date.

In the second half of the year, the PHnw Board of Directors worked to formalize a previously informal intent to be a 'big tent' organization, supporting the standards put forth by both the international Passive House Institute (PHI) and the Passive House Institute U.S. (PHIUS). With unified support of the broader goals of Passive House, local organizers were able to work together with the City of Seattle to incentivize passive building construction in the city's zoning code, with increased floor-area ratios allowed in low-rise passive buildings.

While we are proud of our accomplishments and the many fine projects in the Pacific Northwest that are showcased in this book, we are equally eager to see what more we can accomplish as we reach further together.

Onward!

Michelle Jeresek
President
Passive House Northwest

WHAT MAKES A PASSIVE HOUSE

It's not the style, it's what's not easily visible that counts. Here are the keys to creating a Passive House structure.

- A superinsulated building envelope, with a continuous layer of insulation on every surface of the building shell, including in the exterior walls, roof, and floor.
- High-performance windows and doors that have well insulated frames, with shading as needed in summer.
- An airtight building envelope, with meticulous attention to all connection details and use of the appropriate sealing materials to prevent air leaks at junctions in the air barrier.
- Mechanical ventilation with heat transfer between the separate fresh (intake) and stale (exhaust) air streams for superb indoor air quality without losing heat in winter or adding heat in summer. In some climates, moisture recovery in winter or rejection in summer is needed as well.
- High-efficiency hot water systems, space heating/cooling equipment, appliances, and lighting.
- Thermal bridge free construction, which requires careful detailing to minimize the thermal weaknesses in the building envelope where heat can pass quickly from inside to outdoors in winter or the reverse in summer.
- Use of precise software to model the building's energy losses: Passive House Planning Package (PHPP) for Passive House Institute building certification or WUFI Passive for PHIUS building certification.



Island Passive; Photo by Art Gray Photography

PASSIVE HOUSE ORGANIZATIONS AND STANDARDS

Both the international Passivhaus Institut (PHI) and Passive House Institute U.S. (PHIUS) are transforming the built environment by promoting the creation of extremely energy-efficient buildings. However, each organization has developed its own criteria for getting certified as a Passive House building.

PHI, which was created in 1996 by Dr. Wolfgang Feist, a physicist, and Dr. Witte Ebels, a mathematician, originally developed a single Passive House Standard for new buildings that combined simplicity and precision. PHI based its standard on the first experimental Passive Houses Feist and Ebels developed in 1991 in Darmstadt, Germany, including the one where they have lived for 25 years.

This succinct standard consisted of just three numerical limits: 1) space heating energy demand (or load), 2) building primary (source) energy for all uses, and 3) a strict air leakage limit of 0.6 ACH_{50} . While many in the building industry criticized these requirements as unreasonably strict, tens of thousands of buildings—and even entire neighborhoods—that meet this standard have been constructed worldwide.

In the intervening two decades, PHI's scientists have refined the standard, extending its applicability to all climates and buildings, including creating the EnerPHit Standard for retrofitting existing buildings.

In another refinement that addresses the need to transition from an economy based on fossil fuels to one running on renewable energy, PHI created a new renewable primary energy demand limit (PER) to replace the old primary energy (PE) limit, which was based on fossil fuel consumption. PER accounts for all local and regional electrical grid losses, including not only transmission losses, but also losses from short-term and seasonal energy storage. The PHI has developed specific PER factors for each of the climate data sets in its building energy modeling program, the Excel-based Passive House Planning Package (PHPP).

Finally, PHI promulgated additional classes, Passive House Plus and Passive House Premium, for Passive Houses that not only meet the Passive House Standard, but also have onsite renewable energy generation capacity or own offsite renewable energy generation.

Across the Atlantic from the PHI, architect Katrin Klingenberg was inspired after touring Passive Houses in Germany to break ground on her own home in Urbana, Illinois and complete the first Passive House in North America in 2003. Klingenberg and local builder Mike Kernagis cofounded PHIUS in 2007 and started certifying buildings to the Passive House Standard with PHI in 2009.

In 2011, PHIUS started its own building certification program, PHIUS+, based on the Passive House Standard with the addition of onsite quality assurance inspections by independent PHIUS+ Raters. In 2015, PHIUS completed years of research on the cost-effectiveness of the Passive House Standard for detached single-family homes with the Building Science Corporation (BSC) funded by the U.S. Department of Energy's Building America program. While PHIUS and BSC confirmed that Passive House principles are the best foundation for high-performance buildings, they concluded that the exact energy limits for each Passive House should be cost-optimized for its specific climate in order to lower the cost premium of building to passive standards and speed widespread adoption—yielding the large-scale energy reduction needed to avoid catastrophic climate change.

In its current PHIUS+2015 Passive Building Standard-North America (PHIUS+2015), the PHIUS technical committee generated sets of energy limits, including annual heating and cooling demand and peak heating and cooling loads, for roughly 1,000 locations in North America. In some locations, the limits are higher than PHI's, while in others, they are lower. PHI and PHIUS also use different reference areas for their energy limits and air leakage limits. And, instead of a static standard, PHIUS expects to review and potentially revise its limits in three years with a stated goal of reducing the limits as building product performance rises and product prices fall with widespread adoption.

PHIUS also offers PHIUS+Source Net Zero certification for buildings that produce enough renewable energy onsite to offset the source energy they consume on an annual basis and special recognition for buildings with supply air heating and cooling with sufficiently low peak loads allowing them to (in principle) deliver heating and cooling entirely via supply air with an average design ventilation rate of no more than 0.4 ACH . PHIUS also offers a retrofit standard. PHIUS, with the Fraunhofer Institute for Building Physics, developed WUFI Passive, a new design and certification software system.

While a comparison of PHI's Passive House Standard and the PHIUS' PHIUS+2015 is complicated, meeting either standard results in the construction of a building that uses far less space-conditioning energy than do conventional buildings—a crucial step toward cutting carbon emissions and avoiding catastrophic climate change.



Skidmore Passivhaus; Photo by Jeremy Bittermann



Prairie Passive; Photo by Chris DiNottia

ARTISANS Group

For Tessa Smith and Randy Foster of the Artisans Group, who are working on their 18th Passive House, it was a case of the early bird getting the worm.

Back in 2009 when Smith and Foster got certified as Passive House designers, hardly anyone had heard of Passive House in Olympia, much less in the state of Washington. Yet Artisans Group built two Passive Houses in 2010 and three the next year, with just five employees on staff. As the economy improved and Passive House gained recognition, so did Artisans Group, becoming increasingly busy with each passing year. Today, the firm employs 20 people, builds roughly six homes a year, and has expanded into the Seattle market and beyond.

While Artisans Group's Passive House expertise might impress, their graceful design solutions are their strongest selling point. As Smith says, their almost automatic incorporation of Passive House details from day one frees them up to stay visually focused during their integrated design and build process, delivering aesthetically pleasing, high-value Passive Houses.

"Our designs are lovely and practical," says Smith. "They express their form as simple and straightforward, honest structures." In keeping with the group's

sustainability ethos, they aim to build homes that transcend and that people will love, and therefore care for, for decades.

Their methods of creating those honest structures have shifted a bit over time. "When we first started building Passive Houses," says Smith, "it was a bit like the wild west." Every project had different details. They now have streamlined their approach, using generally one of two wall assemblies and one of several—not 10—mechanical systems.

One of their mainstay wall assemblies is a 2x6 wall with 4, 5, or 6 inches of exterior insulation. That insulation could be either foam or cork, depending on the client's budget, as cork has a significant upcharge. As a company, Smith says, they would like to get away from such petroleum-based products as foam, but that's not always possible.

The other assembly was devised in order to make a foam-free wall less expensive. This assembly starts with two sets of staggered 2x4s and 2x8 top and bottom plates. The cavity is filled with dense-pack cellulose. The exterior insulation can then be reduced to 3 to 4 inches of either foam or cork. By shrinking the amount of exterior insulation needed, the foam-free choice becomes affordable to more people.

The other incipient design modification is more externally driven. Like much of western Washington, Olympia is frequently gray and rainy—not a climate with a great need for air conditioning, until last year's record-breaking summer with several weeks above 90 °F and into 100 °F. Artisans Group's homes have never required cooling, but that may be changing. Fortunately they are well acquainted with mini-split systems, which are well suited to low-load homes and can deliver both heat and cooling.



ISLAND PASSIVE

Shaw Island,
Washington

Island Passive House defines indoor-outdoor living, blending almost seamlessly into this remote island site. The airiness of this house, the light that bounces around its uncluttered design, masks the careful planning and effort required to build this retreat for a retiring couple who had fantasized about it for years.

Because of its remote location, the home's mechanical core and walls were prefabricated off-site and trucked and then ferried to the site. The pre-plumbed and pre-wired mechanical core houses two bathrooms, a mechanical room, a laundry room, and the kitchen. Designed to emphasize long sight lines, the great room and two bedrooms circle this core, with sliding doors allowing unbroken access to all rooms. A plethora of maple cabinets reduces clutter and adds a custom touch.

TEAM

**Architect/Builder
and Certified Passive
House Consultant**
THE ARTISANS GROUP

Structural Engineering
CARISSA FARKAS
**STRUCTURAL
ENGINEERING**

Floor-to-ceiling triple-pane, wood-framed windows flood the great room with light. Built in exterior shades with aluminum louvers that are adjustable to allow summer shading without blocking views. The sculptural entryway, made of galvanized metal, acts almost as a sundial, tracking the sun's path.

The R-48 prefabricated walls are filled with dense-packed fiberglass, and the ceiling is insulated with cellulose. The home's sunken wood-framed floor, which sits over a 30-inch vented crawlspace, is insulated by a 16-inch layer of fiberglass. An air-to-water heat pump system supplies hot water for domestic use and heated fluid for the hydronic radiators. A heat recovery ventilator brings in the fresh air.

PRODUCTS

Windows
ZOLA

Air/Moisture Control
SIGA by **SMALL PLANET
SUPPLY**

Island Passive; Photos by Art Gray Photography



PERFORMANCE

Heating energy	3.5 kBtu/ft ² /yr	1.0 kWh/ft ² /yr	11.0 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	19.5 kBtu/ft ² /yr	5.7 kWh/ft ² /yr	61.5 kWh/m ² a
Air leakage	0.54 ACH ₅₀		

CEDAR HAUS

Olympia, Washington

Cedar Haus is well named, with its floating cedar tongue-and-groove roof whose generous overhangs appear to extend seamlessly, blending inside and out. Carpenters meticulously matched up cedar boards to create this continuous appearance. With headers hidden in the roof assembly, the dramatic windows extend to the top of the walls, giving a sense of grace and space to this 1,800-ft² Passive House. To keep the home comfortable, the roof assembly includes 30-inch parallel chord trusses packed with cellulose.

As the clients enjoy sleeping with the windows open and the breezes flowing, the master bedroom resides in an insulated, but unheated, sleeping porch. Dense-pack fiberglass fills the exterior walls' 2x6 studs, with an extra 6 inches of foil-faced polyiso foam adhered on the outside. A rain screen gap is finished off by picturesque shou sugi ban, or burned wood, siding, which has the added advantage of being pest, weather, and fire resistant.

TEAM

**Architect/Builder
and Certified Passive
House Consultant**
THE ARTISANS GROUP

Structural Engineering
CARISSA FARKAS



Built for a couple who want to stay there as they age, the flooring in the light-filled great room is a grey-washed cork, chosen in part because it is softer on older bones should any falls occur. The cork floor is supported by 16-inch TJIs insulated with dense-pack fiberglass. A basement, which is outside the thermal envelope, houses a large wood shop.

A highly efficient gas water heater supplies hot water for domestic use and heated fluid for four hydronic radiators, keeping the house plenty toasty. Should the house need cooling as the climate warms, it is pre-plumbed for a mini-split system.

Cedar Haus; Photos by Ramsay Photography

PRODUCTS

Windows
ZOLA

Air/Moisture Control
HANNO by **SMALL PLANET
SUPPLY**

PERFORMANCE

Heating energy	8.2 kBtu/f ² /yr	2.4 kWh/ft ² /yr	26 kWh/m ² a
Heating load	3.5 kBtu/hr/ft ²	1.0 Watts/ft ²	11 Watts/m ²
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	42.2 kBtu/ft ² /yr	12.4 kWh/ft ² /yr	133 kWh/m ² a
Air leakage	0.6 ACH ₅₀		





HEMLOCK HAUS

Steilacoom,
Washington

Hemlock Haus, as its name implies, resides in a forested site, surrounded by large evergreens. Designed for a family of four and to accommodate future aging in place, the single-story, three-bedroom, two-bath Passive House has a sleek, modern look that also honors its woodsy environment. The exterior is a marriage of tiger wood and fiber cement siding.

The Passive House design details also pay tribute to the sylvan surroundings, with large, triple-pane windows on the southeast and east-facing façades to maximize the views and solar gains—with no shading needed—and a stained concrete floor. The floor's thermal mass helps even out diurnal swings in temperature. Under the

TEAM

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House Consultant**
THE ARTISANS GROUP

Structural Engineering
CARISSA FARKAS

concrete is 8 inches of foam insulation resting on a bed of sand. An in-floor hydronic heating system keeps the home warm.

The prefabricated 14-inch walls, built using a lattice-work of 2x4s and 2x8s, are insulated with dense-pack fiberglass. A taped layer of sealed OSB in the middle of the wall serves as the air barrier. The rain screen under the siding minimizes moisture penetration into the rest of the wall assembly and allows the siding to drain and dry out any wind driven moisture. The R-58 roof is insulated with cellulose.

Hemlock Haus; Photos by Art Gray
Photography

PRODUCTS

Windows
ZOLA

Ventilation
ZEHNDER AMERICA
by **SMALL PLANET SUPPLY**



PERFORMANCE

Heating energy	5.5 kBtu/ft ² /yr	1.6 kWh/ft ² /yr	17.3 kWh/m ² a
Heating load	3.3 Btu/hr/ft ²	0.97 Watt/ft ²	10.4 Watt/m ²
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	33.6 kBtu/ft ² /yr	9.9 kWh/ft ² /yr	106 kWh/m ² a
Air leakage	0.44 ACH ₅₀		



PRAIRIE PASSIVE

Olympia, Washington

The Prairie Passive, a two-bedroom, two-bath home with a bonus mother-in-law space in the basement, overlooks the harbor to the north. Despite the narrow lot and fairly public setting, the 1,850-ft² home still manages to feel private.

With strategically placed glazing, the floor plan optimizes views of the harbor while maximizing solar gains from the east. Selecting the solar heat gain coefficient for the east-facing windows was a careful dance between getting enough wintertime heat and avoiding overheating in the other seasons. Overhangs help to reduce the gains in summers and shelter the many decks offering easy outdoor living. An outdoor fireplace extends their appeal to all seasons.

TEAM

**Architect/Builder
and Certified Passive
House Consultant**
THE ARTISANS GROUP

Structural Engineering
MC SQUARED INC.

Fiberglass is the main insulation used throughout the house. The roof trusses are filled with 23 inches of fiberglass, and the 16-inch floor trusses that most of the house rests on are also insulated with fiberglass. The 2x6 walls are dense-packed with fiberglass and further insulated with 6 inches of EPS foam on the outside. The air barrier layer is OSB sealed with proprietary tape and liquid-applied flashing.

Hydronic radiators provide wintertime comfort. A 2-kW photovoltaic system reduces the home's electricity demand.

PRODUCTS

Windows
ZOLA

Air/Moisture Control
PROSOCO by **SMALL
PLANET SUPPLY**

Prairie Passive; Photos by Chris DiNottia



PERFORMANCE

Heating energy	9.9 kBtu/ft ² /yr	2.9 kWh/ft ² /yr	31.2 kWh/m ² a
Heating load	3.3 Btu/hr/ft ²	0.98 Watts/ft ²	10.5 Watts/m
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	39.6 kBtu/ft ² /yr	11.6 kWh/ft ² /yr	124.9 kWh/m ² a
Air leakage	0.8 ACH ₅₀		

QUEEN ANNE PASSIVE

Seattle, Washington

The Queen Anne Passive is sculptural, a cascade of cantilevered spaces that visually challenges more conventional concepts of passive buildings. With thorough planning of the details related to where the juxtaposed spaces meet, the clients will have the strikingly modern Passive House of their dreams. They are also getting views of the Puget Sound, privacy, and solar access on a narrow infill lot. In this historic neighborhood, the 2,600-ft² home respects the scale of the surrounding houses even as it creates a singular statement.

The tower that unites the spaces functions as both a stairwell and a light well, optimizing south-facing exposure. The exterior walls of the home are constructed with two rows of staggered 2x4s, insulated with fiberglass, and another 4 inches of EPS foam. The air barrier in these walls is a liquid-applied water-resistive barrier that has a

TEAM

**Architect/Builder
and Certified Passive
House Consultant**
THE ARTISANS GROUP
Structural Engineering
MC SQUARED INC.



sufficient perm rating to allow moisture migration and drying. The basement floor is concrete over structural foam layered on top of a bed of sand.

Heating is provided by a ducted mini-split system with distribution heads that fit discretely in the wall and ceiling cavities. Although modeling with the Passive House Planning Package shows that no cooling will be needed, this system has the advantage of being able to supply cooling, if and when climate change sufficiently boosts summertime temperatures.

PRODUCTS

Windows
ZOLA

Queen Anne Passive; Renderings by Artisans Group

PERFORMANCE

Heating energy	5.1 kBtu/ft ² /yr	1.5 kWh/ft ² /yr	16.1 kWh/m ² a
Heating load	3.4 Btu/hr/ft ²	1.0 Watt/ft ²	10.7 Watt/m ²
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	39.9 kBtu/ft ² /yr	11.7 kWh/ft ² /yr	125.9 kWh/m ² a
Air leakage	0.6 ACH ₅₀ (design)		



SAM RODELL ARCHITECTS

The work of Sam Rodell Architects is characterized primarily by thoughtful attention to the client and the site.

Passive House design and certification is simply presumed for any project that involves mechanical systems for space conditioning. For Sam Rodell, the firm's principal and a Certified Passive House Consultant since 2012, Passive House design has become a fundamental baseline expectation, similar to how good hygiene is an unquestioned and unquestionable expectation in a restaurant.

This embedded standard has been a strong draw for clients. The firm has become a Passive House advocate in the Spokane-Coeur d'Alene region and beyond, with a wide range of residential and commercial Passive House projects completed and in various stages of design or construction. Their 58-bed Sunshine Health Facilities resident building received top national honors last year from PHIUS as an institutional certified passive house project.

Rodell's leadership has ignited a growing interest in Passive House training among a number of builders across the Pacific Northwest. Their clients universally sing the praises of life in high-performance buildings. Maren Longhurst, who joined the firm in 2013, is also a Certified Passive House Consultant, and a budding WUFI geek extraordinaire.

WARNICK RETREAT

Issaquah, Washington

TEAM

Architect
SAM RODELL ARCHITECTS

Certified Passive House Consultant

Sam Rodell with consultant Dan Whitmore
HAMMER AND HAND

When the original cabin at this forested locale burned to the ground, the client opted to replace it with a more comfortable, Passive House retreat. Tucked between a ridge on one side and wetlands on the other, the 2,500-ft² home occupies a narrow site with breathtaking views. It's a home that will literally blend into its environment, as its shou sugi ban, or carbonized cedar, siding comes from the area's fire-damaged trees that are being milled, dried, and charred.

To make the most of the available footprint, the two stories of living space perch over the garage, which is not part of the Passive House envelope. The main level, which will house the master bedroom suite, kitchen, and living room, will open directly onto the yard, because of the way the house is set into the hillside.

The stairwell and mechanical room at the back of the garage will be part of the conditioned space. They are being separated from the garage by 5 inches of EPS foam.

Meeting the Passive House heating requirement was challenging in this shaded site. To maximize the available solar heat gains, the shed roof has been designed to slope away from the south, allowing for tall windows on that façade. The roof trusses are insulated with blown-in cellulose and topped with 12 inches of rigid foam.

Warnick Retreat; Rendering by Dustin Woehrlin and Will Metge, United Renderworks

PRODUCTS

Ventilation
ZEHRER AMERICA

PERFORMANCE

Heating energy	4.9 kBtu/ft ² /yr	1.5 kWh/ft ² /yr	15.6 kWh/m ² a
Cooling energy	0.9 kBtu/ft ² /yr	0.3 kWh/ft ² /yr	2.9 kWh/m ² a
Total source energy	5.6 kBtu/person/yr	1.6 kWh/person/yr	
Air leakage	0.6 ACH ₅₀ (design)		

RUTHERFORD RESIDENCE

Coeur d'Alene, Idaho

Set on a steep lakefront lot in northern Idaho, this lovely Passive House more than meets the owners' initial goal of an energy-efficient home that would facilitate greater self-sufficiency. The north facade features a stunning engineered rammed earth wall that encapsulates an 8-inch layer of EPS foam, providing insulation and mass while presenting a discrete front to the street.

As the views are fortunately toward the south, a floor-to-ceiling, high-performance triple-pane curtain wall on the south façade opens the house toward the lake and sun, optimizing panoramic views and solar gain. The house has generous overhangs, and the curtain wall has external shading that can be rolled down to prevent overheating on sunny days.

TEAM

Architect and Certified Passive House Consultant
SAM RODELL ARCHITECTS

Builder
EDWARDS SMITH CONSTRUCTION



The framed exterior walls were constructed using 2x6s that were insulated with blown-in cellulose. Four inches of EPS were added to the outside of the structural walls. The air barrier is ½-inch plywood sheathing sealed with a fluid-applied sealant. In some places an interior 2x4 furring wall, also insulated with blown-in cellulose, serves as a chase for plumbing and wiring.

A heat pump supplies heating and cooling, while a heat pump water heater delivers the hot water. A sealed-combustion natural gas fireplace, which is used mostly for ambience, can function as a backup heater when the electricity goes out.

PRODUCTS

Windows & Doors
UNILUX by WASHINGTON WINDOW & DOOR

Rutherford Residence; Renderings
by Greg Anderson

PERFORMANCE

Heating energy	3.6 kBtu/ft ² /yr	1.1 kWh/ft ² /yr	11.4 kWh/m ² a
Cooling energy	1.0 kBtu/ft ² /yr	0.3 kWh/ft ² /yr	3.2 kWh/m ² a
Total source energy	4.1 kBtu/person/yr	1.2 kWh/person/yr	
Air leakage	0.6 ACH ₅₀		





RICKEY RESIDENCE Elk, Washington

Sited on a rural lot just off the highway, this Passive House is delivering exactly what its owners were seeking: a peaceful home with predictably low energy bills. Its additional benefits are invaluable, although harder to quantify. Their first summer in the home, wildfires ravaged the area. Outdoors the air was smoky, but the indoor air quality remained pristine thanks to the filtered, fresh air supplied by the heat-recovery ventilator. And, when trucks roll by on the highway 100 feet from their home, the sound can only be heard when the windows are opened.

The structural walls in this roughly 2,000-ft², single-story house are 2x6s insulated with fiberglass batts. Mounted vertically on the

TEAM

**Architect and Certified
Passive House Consultant**
SAM RODELL ARCHITECTS

Builder

Gavin Tenold, **PURA VIDA HIGH
PERFORMANCE BUILDERS**

exterior are 14-inch TJIs that are insulated with blown-in cellulose. The roof holds 12-24 inches of blown-in cellulose, depending on the truss depth.

The south façade faces away from the highway, so it was an easy choice to cluster the triple-pane windows there. The living room and dining room alcove enjoy this southern exposure and the associated solar heat gain, as does the master bedroom suite that has both south- and west-facing windows.

A mini-split heat pump unit in the back hallway provides all the supplemental heat needed to keep the house warm, while also maintaining comfortable temperatures during their short cooling season. Hot water is supplied by a heat pump water heater. The couple has been thrilled to have their heating and cooling costs average only \$7 per month, with no monthly bill ever topping \$20.

Rickey Residence; Photos by Hamilton Studios



PERFORMANCE

Heating energy	7.6 kBtu/ft ² /yr	2.2 kWh/ft ² /yr	23.9 kWh/m ² a
Cooling energy	0.3 kBtu/ft ² /yr	0.1 kWh/ft ² /yr	0.9 kWh/m ² a
Total source energy	36.7 kBtu/ft ² /yr	10.7 kWh/ft ² /yr	115.8 kWh/m ² a
Air leakage	0.6 ACH ₅₀		



SUNSHINE HEALTH FACILITIES RESIDENT BUILDING

Spokane Valley,
Washington

TEAM

**Architect and Certified
Passive House Consultant**
SAM RODELL ARCHITECTS

Builder

Jon Hawley
**TAMARACK RIDGE
CONSTRUCTION**

Founded in 1949, Sunshine Health Facilities was built on the site of one of Spokane's first universities. The historic campus brought with it significant problems, including temperature extremes in the aging housing—a problem for medically fragile residents.

In planning for replacement housing, Rodell calculated the projected energy savings for this 58-bed, 25,000-ft² facility if it met Passive House requirements and found that operating cost savings would exceed \$120,000 annually over the next 30 years. At a completed cost of just \$134 per square foot, including soft costs, Passive House construction also proved to have a

lower initial cost than comparable mainstream construction—a dramatic justification for building a Passive House.

The big savings in construction costs came from shrinking the size of the mechanical equipment and applying those savings to better insulated walls and higher quality windows. Vertical 12-inch TJIs packed with cellulose cost-effectively contribute to the wall assembly's total R-value of 70. A wax-impregnated fiberboard serves as the weather-resistant barrier, and the whole assembly is finished with a vented rain screen and fiber cement siding.

The residence has three stories—with 29 rooms, nurses' stations, a day room, and laundries on each floor—and a full basement. Under the slab and footings are 10 inches of a structural foam.

The building was finished in early fall, and the heat didn't need to be turned on for months. Beyond the energy savings, the owner also appreciates the building's other attributes, its comfort, quiet, and "...purified air that eases respiratory problems for our clients," according to Nathan Dikes, CEO of Sunshine Health Facilities.

PRODUCTS

Windows
ZOLA

Ventilation
ULTIMATEAIR

Sunshine Health Facilities; Photo by
Hamilton Studios

PERFORMANCE

Heating energy	0.5 kBtu/ft ² /yr	0.15 kWh/ft ² /yr	1.6 kWh/m ² a
Cooling energy	0.7 kBtu/ft ² /yr	0.2 kWh/ft ² /yr	2.2 kWh/m ² a
Total source energy	44.3 kBtu/ft ² /yr	12.9 kWh/ft ² /yr	139.7 kWh/m ² a
Air leakage	0.4 ACH ₅₀		



SUNSHINE HEALTH FACILITIES ADMIN BUILDING Spokane Valley, Washington

TEAM

**Architect and Certified
Passive House Consultant**
SAM RODELL ARCHITECTS

Builder

Jon Hawley
**TAMARACK RIDGE
CONSTRUCTION**

Sunshine Health Facilities, in expanding the services it offers, outgrew its existing administrative offices. Although a retrofit of the old masonry building was considered, it wasn't possible to make that building meet present-day requirements. Having already experienced the benefits of Passive House construction in their residence building, Sunshine Health has chosen to have

its new 10,000-ft² administration wing, which will house offices and conference rooms on one main level, also designed to Passive House criteria. A thermally separated, and separately ventilated, section of the new building will contain a commercial kitchen that serves the whole campus with a laundry in the basement.

Mineral wool is being used as the exterior insulation in these walls, chosen for its positive environmental attributes and its cost effectiveness. The siding, fastened through a rain screen gap and the mineral wool, will be a mix of fiber cement and a high-density stratified wood board. The foundation walls are being covered on the outside with 2 inches of EPS, with an additional layer of open-cell spray foam applied to an interior 2x4 furring wall.

As the site is not conducive to much south-facing glazing, high-performance triple-pane curtain walls will brighten up the east façade, set mostly into deep overhangs to minimize possible overheating. Additional glazing on that façade will be shaded with fixed louvers. Ventilation will be provided by a commercial energy-recovery ventilator (ERV).

Sunshine Health Facilities Admin building;
Rendering by Roberto Pesce,
United Renderworks

PRODUCTS

Windows & Doors

UNILUX by **WASHINGTON
WINDOW & DOOR**

Insulation

ROXUL

PERFORMANCE

Heating energy	4.4 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	13.9 kWh/m ² a
Cooling energy	0.6 kBtu/ft ² /yr	0.2 kWh/ft ² /yr	1.9 kWh/m ² a
Total source energy	32.4 kBtu/ft ² /yr	9.5 kWh/ft ² /yr	102.2 kWh/m ² a
Air leakage	0.6 ACH ₅₀		

MINI-B PASSIVE HOUSE

Bothell,
Washington

Mini-B, a 300-ft² Passive House residence complete with kitchenette, bath, living room, bed loft, and closet, is a guest house for the Clearwater Commons.

TEAM

Architect and Certified Passive House Consultant
Joe Giampietro, **NICHOLSON KOVALCHICK ARCHITECTS**

Builder
WOOD TECHNOLOGY CENTER
of Seattle Community College
led by Frank Mestemacher

Structural Engineer
Matt Schmitter, PE
DAVIDO CONSULTING GROUP

Owner
CLEARWATER COMMONS



Mini-B; Photo by Steve Allwine
of Johnson Braund, Inc.

PRODUCTS

Windows
ALPEN HPP



PERFORMANCE

Heating energy	4.6 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	14.4 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	33 kBtu/ft ² /yr	9.7 kWh/ft ² /yr	104.1 kWh/m ² a
Air leakage	0.5 ACH ₅₀		

PARK PASSIVE

Seattle,
Washington

This beautiful 2,710-ft² single-family Passive House was built on an infill city lot in Seattle's Madison Park neighborhood. It features salvaged Ash woodwork from a site-harvested tree and zero-VOC finishes.

Park Passive; Photo by Aaron Leitz

TEAM

Builder
Sloan Ritchie, **CASCADE BUILT**

Architect
Lauren McCunney
NICHOLSON KOVALCHICK ARCHITECTS

Certified Passive House Consultant
Rob Harrison
HARRISON ARCHITECTS

PRODUCTS

Windows
INTUS

Water Heater
SANDEN

PERFORMANCE

Heating energy	4.75 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	15 kWh/m ² a
Cooling energy	4.75 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	15 kWh/m ² a
Total source energy	36.8 kBtu/ft ² /yr	10.8 kWh/ft ² /yr	116 kWh/m ² a
Air leakage	0.6 ACH ₅₀		

VIEW HAUS 5

Seattle, Washington

View Haus 5, Seattle's first townhome project inspired by Passive House, delivers healthy indoor air, thermal comfort, and quiet in the city's urban core. Its five individually designed, two-bedroom and three-bedroom townhomes, which range in size from 1,100 to 1,700 square feet, share views of the Cascade Mountains. With their reclaimed barn wood cladding, these homes also share a Seattle aesthetic.

TEAM

Builder

Sloan Ritchie

CASCADE BUILT

Architect and

Certified Passive

House Consultant

Joe Giampietro

NICHOLSON KOVALCHICK

ARCHITECTS



The R-38 exterior walls were built using 2x6 studs insulated with dense-packed fiberglass and 4 inches of mineral wool screwed to OSB sheathing on the exterior. The R-61 roof incorporates almost 12 inches of dense-packed fiberglass between TJI rafters, which are topped by OSB roof sheathing and 2.5 inches of polyiso rigid foam. Careful sealing of the OSB layers led to a final airtightness result of 0.5 ACH₅₀ in one townhome.

Individual heat-recovery ventilators bring fresh air to each of the townhomes, which are all three stories with an open floor plan. Heating and cooling is provided by a ducted mini-split heat pump. An 8-inch in-line ducted fan promotes air circulation from the top to the bottom floors and ensures even temperatures throughout.

PRODUCTS

Windows ZOLA

View Haus 5; Photos by Aaron Leitz

PERFORMANCE (ONE HOME)

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.7 kWh/m ² a
Cooling energy	2.1 kBtu/ft ² /yr	0.6 kWh/ft ² /yr	6.6 kWh/m ² a
Total source energy	33.9 kBtu/ft ² /yr	9.9 kWh/ft ² /yr	107 kWh/m ² a
Air leakage	0.5 ACH ₅₀		

PALATINE PASSIVE

Seattle, Washington

In a busy Seattle neighborhood, the Palatine Passive House brings tranquility to its residents from the moment of entering through its arched entranceway. Reminiscent of Scandinavian architecture, the thickened walls at the entrance shield the large windows just inside from passersby's eyes. The cedar siding, set in a herringbone pattern, was torched, wire brushed, and sealed in a traditionally Japanese treatment known as shou sugi ban.

The thickened roof, which is obscured from the street by the archway, is framed with 2x12s filled with blown-in fiberglass and topped with a premanufactured panel of 4 inches of polyiso adhered to ½-inch sheathing. The 2x8 walls also are insulated with blown-in fiberglass and an exterior layer of 3 inches of polyiso.

The house was built over a shallow crawlspace finished with a rat slab. Underfloor 16-inch TJIs were padded with blown-in fiberglass. A liquid sealant was applied to the subfloor, which serves as the air barrier layer.



TEAM

Architect/Builder

Tiffany Bowie

**MALBOEUF BOWIE
ARCHITECTURE**

Construction

BLUE & YELLOW BUILDERS

Certified Passive House Consultant

Dan Whitmore

HAMMER AND HAND



As the south side of the house faces the neighbors, the bulk of the solar gains come from triple-pane windows on the west façade. A heat-recovery ventilator brings in constant fresh air, and heat is supplied by a heat pump with two heads, one in the upstairs loft and one in the kitchen on the bottom floor.

The city of Seattle has requirements for managing roof water onsite. At this house, all of the rainwater that falls on the home or the carport flows into one of two landscaped rain gardens, with the overflow on heavy rain days going to an underground infiltration trench.

Palatine Passive; Photos by Shea Pollard
Photography

PRODUCTS

Air/Moisture Control
**ZIP SYSTEM SHEATHING
AND TAPE**

PROSOCO by
SMALL PLANET SUPPLY

PERFORMANCE

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.8 kWh/m ² a
Heating Load	7.8 Btu/hr/ft ²	2.3 Watts/ft ²	24.4 Watts/m ²
Cooling energy	NA		
Total source energy	29.6 kBtu/ft ² /yr	8.7 kWh/ft ² /yr	93.4 kWh/m ² a
Air leakage	0.6 ACH ₅₀		



Karuna House; Photo by Jeremy Bittermann

HAMMER & HAND

Hammer & Hand, a construction firm with 70 employees and offices in Portland and Seattle, has had a focus on sustainability since its beginnings two decades ago.

At that time sustainability meant an emphasis on good craftsmanship, building structures that would last and be appreciated. Then, six years ago, Sam Hagerman, a cofounder of Hammer & Hand along with Daniel Thomas, discovered Passive House, which in his mind brought together critical information about building science, building energy use, and sustainability into a cohesive rubric.

Hagerman, a longtime board member of the Passive House Alliance United States, helped steer the firm toward embracing Passive House principles wherever possible, whether that be in one exterior wall

exposed during a kitchen remodel or in an entire building project. The firm's Passive House praxis is now led by Dan Whitmore, a core curriculum developer and trainer for the national Passive House Institute US (PHIUS) Certified Builders Training and a board member of Passive House Northwest. Two dozen of the firm's lead carpenters recently completed the training and are on track to become certified passive builders.

Whitmore believes strongly that buildings, and the firms that make them, can be positive contributors to disrupting climate change. As he says, builders have a starring role to play in addressing the climate crisis by creating extremely energy-efficient buildings. It's an ethos that Hammer & Hand is not shy about sharing, even publishing a best practices manual that includes some of the firm's Passive House details.

These best practices were developed from extensive construction experience, including building or retrofitting eight Passive Houses so far, with all of the more recent projects certified by PHIUS to meet the PHIUS+ standard. Each Passive House project has given the team an opportunity to refine their envelope enclosure details and, in many cases, to simplify them. An exhibit featuring the evolution of their enclosures, as informed by building science best practices, will be on display at the Living Future conference in Seattle in May.



WALLINGFORD PASSIVE HOUSE Seattle, Washington

Nestled in an infill lot that has easy access to a multitude of neighborhood amenities, this new Passive House reflects a contemporary aesthetic. Constructed with modern materials that were chosen with an eye

TEAM

Architect
WHITNEY ARCHITECTURE

Builder
HAMMER & HAND

**Certified Passive
House Consultant**
Markus Kolb
at Whitney Architecture

to minimizing maintenance chores, this four-story residence is designed to meet the present and future needs of the owners, even incorporating a three-story elevator inside the building envelope.

Siding made from composite panels and pre-finished metal gives an ultra-clean look to the façade, which should require very little upkeep for 50 years. Behind the panels, a ventilated rainscreen provides significant drying capacity. Two 1.5-inch layers of mineral wool create a continuous thermal break around the building enclosure. Interior to the mineral wool, a layer of proprietary sheathing serves as the WRB and air barrier. Dense-packed fiberglass fills the 2x8 stud walls, which are finished with drywall on the inside.

The south- and east-facing windows on the top floor give generous views of Seattle to Lake Union and downtown. On those relatively rare hot days, when these windows' solar gains might lead to overheating issues, a ducted mini-split system, installed mostly to provide heating, can also supply cooling. Water heating and cooking is powered by natural gas.

A 3.3-kW photovoltaic array will partially offset electricity consumption through the year. The clients are thrilled with their infill home that is allowing them to age in place with a lighter environmental footprint.

Wallingford; Rendering by Shane Leaman

PRODUCTS

Windows & Doors
UNILUX by **WASHINGTON
WINDOW & DOOR**

Air/Moisture Control
**ZIP SYSTEM SHEATHING
AND TAPE**

Insulation
ROXUL

PERFORMANCE

Heating energy	3.9 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	12.3 kWh/m ² a
Cooling energy	0.7 kBtu/ft ² /yr	0.2 kWh/ft ² /yr	2.1 kWh/m ² a
Total source energy	19.3 kBtu/ft ² /yr	5.7 kWh/ft ² /yr	60.9 kWh/m ² a
Air leakage	0.38 ACH ₅₀		

MADRONA PASSIVE HOUSE Seattle, Washington

Madrona Passive House, set on a beautiful site overlooking Lake Washington, is simultaneously visionary—a model of climate-friendly design—and grounded in present-day construction practices. With its 9.8-kW photovoltaic array, the home is on track to be certified as a net zero energy building from the International Living Future Institute and will likely even be net positive, producing more energy than the home consumes. Designed to reach this goal cost-effectively, the home's construction was simplified by drawing on standard wall construction techniques.

The wall assembly starts with 2x6 studs surrounded by high-density fiberglass. Exterior to that a proprietary sheathing product serves as the air barrier layer while also offering insurance against any potential bulk water intrusion. An additional 3.5 inches of mineral wool blankets the

TEAM

Architect
SHED ARCHITECTURE & DESIGN

Builder
HAMMER & HAND

**Certified Passive House
Consultant**
Dan Whitmore, Hammer & Hand



home. Battens screwed on through the mineral wool create a rain screen channel, and 1x6 knotty cedar siding completes the assembly, which has a total R-value of 34.

In addition to minimizing energy use, the home has other climate-friendly features. Its garage is topped by a living roof that soaks up rainwater, reducing runoff, and the driveway features permeable paving. Planning for the future, the home was designed to easily be subdivided and transition to a 2,964-ft² main house and an 800-ft² accessory dwelling unit once the kids move on to college.

PRODUCTS

Windows
ZOLA

Shading
HELLA by **PEAK BUILDING PRODUCTS**

Air/Moisture Control
ZIP SYSTEM SHEATHING AND TAPE

Insulation
ROXUL

Water Heater
SANDEN

Madrona; Photo by Mark Woods
Photography; Rendering by SHED
Architecture & Design

PERFORMANCE

Heating energy	3.5 kBtu/ft ² /yr	1.0 kWh/ft ² /yr	11.1 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	34.7 kBtu/ft ² /yr	10.2 kWh/ft ² /yr	109.5 kWh/m ² a
Air leakage	0.32 ACH ₅₀		





KARUNA HOUSE Newberg, Oregon

The Karuna House achieved a trifecta of certifications: Passive House (PHIUS+), Minergie-P-Eco, and LEED for Homes platinum. The owner opted for all three to embrace the energy efficiency of Passive House and the broader sustainability issues addressed by LEED and Minergie-P-Eco, which is a Swiss-based certification system encompassing passive building, ecological, and social requirements. The 9.9-kW photovoltaic array adjacent to the dramatically designed house enables it to also be net positive in energy use on an annual basis.

The home has three separate spaces: the ground-floor great room, the upstairs bedrooms, and a private guest suite. Floor-to-ceiling windows in the living room allow uninterrupted access to views of the Yamhill Valley below. Upstairs, a porch that is enclosed on three sides creates a cozy shelter for outdoor living in most seasons.

TEAM

Architect
**SHED ARCHITECTURE
& DESIGN**

Builder
HAMMER & HAND

**Certified Passive House
Consultant**
Dan Whitmore, Hammer & Hand

That coziness can be felt throughout the home, thanks to substantial insulation on all six sides of the home's various sections. Underneath the slab and footings are 8 inches of expanded polystyrene (EPS) geofoam topped by a 15-mil polyethylene vapor barrier. The vapor barrier is centered on top of the footing and embedded into the wall as the stem wall is poured. The R-51 walls, which include 5.5 inches of cellulose and three 2-inch layers of polyiso, are finished on the interior with lime plaster.

The three separate spaces created some conditioning challenges, resolved by installing a zoned, low-temperature hydronic radiant floor system. A heat pump water heater supplies hot water for this system and for all other uses in the house as well.

PRODUCTS

Ventilation
ZEHRER AMERICA
by **SMALL PLANET SUPPLY**

Karuna House; Photos by Jeremy Bittermann



PERFORMANCE

Heating energy	4.2 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	13.1 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	18.4 kBtu/ft ² /yr	5.4 kWh/ft ² /yr	58.0 kWh/m ² a
Air leakage	0.33 ACH ₅₀		

PUMPKIN RIDGE PASSIVE North Plains, Oregon

“When you put a little more thought and a little more attention into the engineering of the house, you have a house that’s really comfortable, that you really enjoy, that you can stay in for the rest of your life and that you don’t want to leave. I don’t know that I can say that for any other houses that I’ve lived in.”

– Owner

Pumpkin Ridge definitely benefitted from attentive planning and engineering. The home’s thickened wall dimensions, extended roof overhang, architectural exterior shades, and generous glazing are key elements of the home’s passive design.

TEAM

Architect
SCOTT EDWARDS
ARCHITECTURE

Builder
HAMMER & HAND

Certified Passive House
Consultant
SKYLAR SWINFORD



Opting for environmentally preferable building materials, the exterior walls are entirely insulated with dense-pack cellulose, with 5.5 inches blown into the 2x6 stud cavity and another 9.5 inches packed into external wood I-joists. Between the two cellulose-packed cavities, a layer of oriented strand board (OSB) with fluid applied at the seams functions as the air barrier.

Vapor and bulk water management was also carefully thought through. The assembly is vapor open in both directions. Bulk water that penetrates the cedar siding can drain away in the rain screen gap. A layer of tightly sealed wood-fiber panels on the interior side of the gap prevents any further penetration of water into the assembly.

PRODUCTS

Windows
ZOLA

Insulation
AGEPAN BY SMALL
PLANET SUPPLY

Pumpkin Ridge; Photos by Jeff Amram
Photography

PERFORMANCE

Heating energy	3.6 kBtu/ft ² /yr	1.1 kWh/ft ² /yr	11.5 kWh/m ² a
Cooling energy	0.1 kBtu/ft ² /yr	0.04 kWh/ft ² /yr	0.4 kWh/m ² a
Total source energy	36.9 kBtu/ft ² /yr	10.8 kWh/ft ² /yr	116.4 kWh/m ² a
Air leakage	0.33 ACH ₅₀		





GLASSWOOD Portland, Oregon

In dire need of an upgrade, this 100-year-old commercial building became the first in the United States to receive a Passive House makeover. The top floor was converted from residential to office use, while the ground floor houses a restaurant.

As the commercial code in Portland already required significant envelope improvements for fire and structural safety, the extra effort required to meet Passive House—air sealing and thicker insulation—wasn't much. Two inches of exterior expanded polystyrene (EPS) insulation were added to the walls, which was the maximum amount possible because

TEAM

Architect
SCOTT EDWARDS
ARCHITECTURE

Builder
HAMMER & HAND

Certified Passive House
Consultant
SKYLAR SWINFORD

of lot restrictions. The existing 2x4 stud cavity was filled with high density cellulose. Interior to that cavity, a second stud cavity was built and also packed with cellulose. A layer of taped oriented strand board (OSB) sheathing serves as the airtight barrier.

Because commercial kitchens with their large range hoods are challenging environments to make airtight and superefficient, only the 1,200-ft² top floor meets all the Passive House requirements for PHIUS+ certification. The two floors are isolated from each other by an airtight barrier of taped OSB, with high density cellulose to dampen sound transmission.

PRODUCTS

Ventilation
ZEHNDER AMERICA

Glasswood Commercial Retrofit; Photos by
Jeffrey Tan



PERFORMANCE

Heating energy	3.1 kBtu/ft ² /yr	0.9 kWh/ft ² /yr	9.8 kWh/m ² a
Cooling energy	0.9 kBtu/ft ² /yr	0.3 kWh/ft ² /yr	2.7 kWh/m ² a
Total source energy	35.7 kBtu/ft ² /yr	10.5 kWh/ft ² /yr	112.6 kWh/m ² a
Air leakage	0.39 ACH ₅₀		



O2Haus; Photos by Garrett Downen

PDX Living

PDX Living, LLC is the progeny of the entrepreneurial talents of its owners, Rob Hawthorne and Bart Bergquist, and the difficult economy in the late 2000s.

In 2009 Hawthorne, an architect, was becoming disillusioned with standard building practices and the uphill climb of persuading clients to opt for more sustainable, climate-friendly practices. He figured if he stopped chasing clients, he could create residences that reflected his own priorities: building quality over square footage, superinsulation, and harnessing passive solar energy.

Hawthorne voluntarily left the firm he had been working at, where business had slowed anyway, and teamed up with Bergquist, a seasoned builder, to translate his priorities and design ideas into practice. Some of those ideas could be traced to a year he spent in high school in Germany, living with a host family that included a practicing architect. He spent another year in Germany during college, impressed by the architecture he saw around him, but he hadn't heard of Passive House yet.

Hawthorne and Bergquist spent 10 months building their first speculative 1,600-ft² house. During the design process, Hawthorne encountered Passive House, took the training, and the spec house became a spec Passive House—a bold move. It was a learning experience for both men. Both enjoyed the process, and both were thrilled when they received multiple offers on the house before it was even finished.

It's been all Passive House ever since. Most of their projects are ones they develop themselves, but they also work directly with clients who want well designed, outstandingly efficient, comfortable homes with good indoor air quality—Passive Houses.

COREHAUS

Portland, Oregon

Built in 2010, the CoreHaus, a certified Passive House, is the first known speculative Passive House in the United States. The house was designed to demonstrate that extremely high goals for efficiency can be met at an affordable cost. Despite the difficult housing market at that time, the house sold with multiple offers before being completed, proof positive of a thriving market for high-performance, ultra-efficient homes.

In order to keep costs low and to aid with constructability, the architect designed the CoreHaus as a simple two-story, south-facing rectangle of approximately 1,600 square feet. Features outside the thermal envelope—sunshades, canopies, and a storage shed—add visual interest to the design. The 2x8 walls contain blown-in fiberglass insulation and have 3 inches of rigid polyisourethane on the exterior, resulting in a total value of R-44. The roof joists were upgraded from 12 inches to 16 inches to fit enough blown-in fiberglass insulation

TEAM

**Architect and
Certified Passive
House Consultant**
Robert Hawthorne

Builder/Developer
PDX LIVING, LLC



so that, with the addition of 4 inches of polyisourethane above the plywood roof deck, the roof attained an R-value of 78.

The buyer of the CoreHaus was so enamored with the house's comfort and environmental quality, and the Passive House concept generally, that shortly after moving in she joined the team at PDX Living, LLC. "It is a magnificent way to live," she says. "There are no drafts, no cold spaces, and even the concrete floors are pleasant year round. The space feels healthy and very peaceful."

PRODUCTS

Windows
ALPEN HPP

CoreHaus; Photos by Garrett Downen

PERFORMANCE

Heating energy	4.4 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	13.7 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	36.3 kBtu/ft ² /yr	10.6 kWh/ft ² /yr	114.5 kWh/m ² a
Air leakage	0.35 ACH ₅₀		





TREKHAUS

Portland, Oregon

The TrekHaus, a Passive House duplex on a tight urban site, was designed and built to meet the client's goal of net zero energy performance. Thanks to careful design and motivated occupants, the TrekHaus is performing better than predicted and is net positive. The owner lives in one of the 3-bedroom, 2-bath units and rents out the other.

One challenge of the project was how to fit the panels for the 4.7-kW photovoltaic (PV) on the roof without exceeding height limits. The team came up with a design that includes a low-slope membrane roof, which actually slopes to the north to give the south-facing living spaces higher ceilings. A PV racking system, attached to the roof parapets, holds the PVs without any roof

TEAM

Architect

Robert Hawthorne

Builder/Developer

PDX LIVING, LLC

Photovoltaic System

SOLARCITY

penetrations. The home is all electric, with heating and cooling provided by a ducted mini-split system.

As well as saving energy, TrekHaus' design accommodates the owner's wish to leave as much room as possible for growing produce. The building footprint was minimized and located far from the street to maximize south-facing garden space. Additionally, the owner chose to forgo garage space, opting instead for off-street parking. A workshop area in each unit provides space for storage and working.

PRODUCTS

Ventilation

ZEHNDER AMERICA

TrekHaus; Photos by Garrett Downen



PERFORMANCE

Heating energy	4.2 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	13.3 kWh/m ² a
Cooling energy	0.3 kBtu/ft ² /yr	0.1 kWh/ft ² /yr	1.0 kWh/m ² a
Total source energy	32 kBtu/ft ² /yr	9.4 kWh/ft ² /yr	101 kWh/m ² a
Air leakage	0.35 ACH ₅₀		

O2HAUS Portland, Oregon

The O2Haus, a speculative project that consists of two Passive House townhomes, succeeded spectacularly: both townhomes sold before they were even completed.

The project also succeeded in achieving net zero energy on an annual basis, despite a west-facing site and other space and design constraints that include no south-facing glazing in one unit.

The 2x8 walls are filled with blown-in cellulose and further insulated on the exterior with 4 inches of polyisocyanurate. Large west-facing windows harvest as much wintertime sun as possible, passively warming the homes. A ductless mini-split provides additional warmth during Portland's drizzly winter days, while a heat-recovery ventilator (HRV) supplies fresh air. On hot days electrically controlled exterior shades effectively

TEAM

Architect

Robert Hawthorne

Builder/Developer

PDX LIVING, LLC

Photovoltaic System

SOLAR UNIVERSE



block the sun to keep the homes comfortably cool.

The owners of one of the units rent out a bedroom to short-term guests, who get to experience the benefits of living in a Passive House. Guest reviews praise the home, with one saying: "All we had heard about Passive House proved true at Garret's home: great indoor air quality and thermal comfort, low interior noise from outside, and very efficient; it stayed at 73 °F with the thermostat off the entire time!"

PRODUCTS

Windows

INTUS

O2Haus; Photos by Garrett Downen

PERFORMANCE

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.9 kWh/m ² a
Cooling energy	0.4 kBtu/ft ² /yr	0.1 kWh/ft ² /yr	1.1 kWh/m ² a
Total source energy	30.9 kBtu/ft ² /yr	9.1 kWh/ft ² /yr	97.5 kWh/m ² a
Air leakage	0.34 ACH ₅₀		





leave it closed much of the summer.

On the mechanical side, the fresh air pulled in by the heat-recovery ventilator (HRV) can get free pre-cooling from the heat pump water heater on hot days; a thermostat located in the house controls duct dampers that can redirect the cool exhaust air from the heat pump water heater in the garage to the HRV intake, distributing cooler air throughout the house. Additional heating, and cooling when needed, is supplied by a ducted mini-split. A 5-kW photovoltaic system helps the owners with their net zero energy goal.

PRODUCTS

Windows
INTUS

CH2; Photos by Garrett Downen

CH2 Portland, Oregon

CH2, another speculative net zero energy Passive House project, started with some difficult initial conditions. The site is tight—just 50 feet by 50 feet—half the size of a conventional lot. The southern exposure is poor, with shading from trees and a neighboring house right up against the lot's south property line. Adding to these challenges, the team set out to meet the Passive House targets with a foam-free wall assembly.

To eliminate the need for petroleum-based exterior insulation, 9.5-inch non-structural I-joists were packed with cellulose and attached to the outside of a conventionally framed 2x4 stud wall. Plywood on the exterior face of the structural wall serves as the air barrier. A vapor-open fiberboard provides a weather-resistant barrier that doubles as the interior face of a rain screen channel.

A two-pronged strategy was used to ensure comfort during Portland's increasingly warm summers. The firm built a decorative and functional barn-door-style shading device that can be slid over to cover the south-facing glass on the first floor. It is 40% opaque, so the owners tend to

TEAM

Architect

Robert Hawthorne

Builder/Developer

PDX LIVING, LLC

Photovoltaic System

IMAGINE ENERGY



PERFORMANCE

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.7 kWh/m ² a
Cooling energy	0.7 kBtu/ft ² /yr	0.2 kWh/ft ² /yr	2.1 kWh/m ² a
Total source energy	33.3 kBtu/ft ² /yr	9.8 kWh/ft ² /yr	105.1 kWh/m ² a
Air leakage	0.33 ACH ₅₀		

BIRDSMOUTH Construction

Birdsmouth Construction grew from Josh Salinger's twin passions: carpentry and conservation.



Emerson Passive House; Photo by Apolinario Ancheta, Birdsmouth Construction

His love of carpentry started at an early age, when he was helping his Dad on weekends and during summers, fixing up an old lakefront home. His environmental values were honed while earning joint degrees in conservation and zoology at University of Wisconsin-Madison. About 8 years ago, he realized he could combine his values with his love of building and problem solving, and voilà: Birdsmouth Construction was born.

With Salinger's scientific bent and thirst for learning, it didn't take him long to discover Passive House. As he points out, it is a science-based methodology with a proven track record in Europe. It is empirical, and it makes sense, says Salinger. He got certified as a Passive House builder and has an architect on staff who is a certified Passive House designer. "My ultimate reason for building passive is global warming," he says. "If we can make Passive House the

common way to build, we can make a huge difference."

Salinger is doing his best to make that difference with the next several projects that his company is slated to work on. Each will strive for Passive House, net zero energy, or ideally both.

Salinger is also promoting Passive House construction more broadly in the region, having served as a board member of Passive House Northwest since 2015. In addition to helping organize conferences and other events, his role there gives him the opportunity to proselytize about Passive House to local and state officials. To further educate architects and builders, Salinger is developing a course about passive building principles and techniques that will be offered through Earth Advantage, a regional nonprofit accelerating the creation of high-performance buildings.

EMERSON STREET PASSIVE HOUSE

Portland, Oregon

From the living roof planted to attract pollinators to its permeable driveway, the Emerson Street Passive House beautifully and intentionally promotes Passive House and net zero energy building. Choosing to invest in the community and improve local housing resources, the owner transformed a moldy, boxy house into an exemplary single-family house with an attached accessory dwelling unit (ADU).

It was a retrofit with crazy challenges. The black mold coating all the roof sheathing meant the roof had to go. No rebar in the foundation dictated that had to be rebuilt. Even with careful deconstruction, there wasn't much worth saving. What did have to be preserved, given the small lot size, were the original orientation and footprint, which weren't helpful. The long axis runs from north to south.

With these challenges, meeting the Passive House standard required strict adherence to the home's airtightness goal and optimizing the mechanical equipment's efficiency. Thanks to careful design and execution, Birdsmouth Construction succeeded in hitting its airtightness target.

The exterior wall assemblies, which are almost all wood, reflect the owner's commitment to environmentally friendly building. Most of

TEAM

Builder
**BIRDSMOUTH
CONSTRUCTION**

Architect
Ben Valentin
Birdsmouth Construction

**Certified Passive House
Consultant**
Jeff Stern
IN SITU ARCHITECTURE



the house uses 2x6 advanced framing surrounded by dense-pack cellulose. A proprietary sheathing system functions as the airtight and vapor control layer, a weather-resistant barrier (WRB), and structural sheathing, which is a requirement in this earthquake zone. Exterior to the sheathing is a blanket of 3 inches of cork insulation, a 3/4-inch rain screen gap, and then clear cedar siding. The ADU features aluminum siding.

An advanced heat pump water heater that uses CO₂ as the refrigerant delivers both the heat and hot water with an overall coefficient of performance (COP) of 5. The home's new and very efficient heat-recovery ventilator (HRV) achieves a sensible efficiency of 93%. A 6.8-kw PV array on the roof offsets the home's energy usage.

Emerson Passive House; Rendering by Ben Valentin, Birdsmouth Construction; Photo by Apolinario Ancheta, Birdsmouth Construction

PRODUCTS

Windows
**TANNER WINDOWS
AND DOORS**
by **SMALL PLANET SUPPLY**

Air/Moisture Control
**ZIP SYSTEM SHEATHING
AND TAPE**

Insulation
THERMACORK by **SMALL
PLANET SUPPLY**

Ventilation
VANAIIR DESIGN

Water Heater
SANDEN



PERFORMANCE

Heating energy	6.7 kBtu/ft ² /yr	2.0 kWh/ft ² /yr	21.1 kWh/m ² a
Heating load	3.1 Btu/ft ² /hr	0.9 Watts/ft ²	9.7 Watts/m ²
Cooling energy	NA		
Total source energy	32.5 kBtu/ft ² /yr	9.5 kWh/ft ² /yr	102.5 kWh/m ² a
Air leakage	0.30 ACH ₅₀		

WHISLER PASSIVE HOUSE

Portland, Oregon

Whisler Passive House benefits from a relatively rare commodity in Portland—great solar exposure. Situated at the back of a large lot, it has no nearby neighbors to shade it, and there's only one giant sequoia in a far corner of the lot. Overheating could have been a problem, but deep overhangs on the south and west sides squashed that concern.

The overhang on the south side serves a dual function, providing shelter for a deck area graced with a combination brick oven and Argentine-type grill. The owner is an enthusiastic cook with a particular passion for grilling. Concerned about the smoke and particulates given off while grilling steaks, Birdsmouth Construction decided the best place for that activity in a Passive House was just outside the kitchen. Placing the induction cooktop on the other side of the sliding doors to the deck means that the owners can easily juggle grilling beef and sautéing vegetables.

Keeping the indoors comfortable are 2x6 framed walls insulated with cellulose with another 4 inches of mineral wool outside of that. A taped proprietary sheathing system serves as the airtight and vapor

TEAM

**Builder and Certified
Passive House Consultant**
**BIRDSMOUTH
CONSTRUCTION**

Architect
Ben Valentin
Birdsmouth Construction



control layer. To the interior of the reclaimed barnwood siding a vented rain screen provides a drying out channel for bulk moisture. The 24-inch roof trusses are packed with loose fill cellulose, and 8 inches of EPS foam thermally isolate the slab from the ground.

Whisler Passive House; Renderings by Ben Valentin, Birdsmouth Construction

PRODUCTS

Windows
**TANNER WINDOWS
AND DOORS**
by **SMALL PLANET SUPPLY**

Air/Moisture Control
**ZIP SYSTEM SHEATHING
AND TAPE**

Insulation
ROXUL

Water Heater
SANDEN

PERFORMANCE

Heating energy	4.8 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	15.1 kWh/m ² a
Cooling energy	NA		
Total source energy	28.6 kBtu/ft ² /yr	8.4 kWh/ft ² /yr	90.2 kWh/m ² a
Air leakage	0.5 ACH ₅₀ (design)		



FULL PLANE PASSIVE HOUSE

Portland, Oregon

This two-story, 1,729-ft² house had a solid advantage when it came to meeting the Passive House standard: it is sited on a south-facing slope. Three 8-foot-by-8-foot glass sliders on the south façade capture all available solar gains, which the ground-floor concrete slab collects and releases over the day.

The home's double walls create a 12-inch-deep cavity that is packed with cellulose insulation, resulting in R-values in the mid 40s. Heating, and the occasional cooling, is provided by a 9,000-Btu ductless mini-split system with two indoor units—one on each

TEAM

Architect/Designer

Michelle Jeresek while partner at Departure Architecture (now principal at **IVON STREET STUDIO**)

Builder

James Ray Arnold
JRA GREEN BUILDING

floor. The indoor units have an infrared sensor that reads a variety of different surfaces to continually monitor room temperature and adjust it accordingly.

Aided by a 5-kW photovoltaic system, the house was designed to also achieve the Living Building Challenge targets of net zero energy and water. Composting toilets and a gray water processing system reduce water use, while an 11,000-gallon potable water cistern underneath the carport cuts the need for city-supplied water.

PRODUCTS

Ventilation

ZEHNDER AMERICA

Full Plane Passive: Photos by Mitchell Snyder Photography



PERFORMANCE

Heating energy	2.2 kBtu/ft ² /yr	0.7 kWh/ft ² /yr	7.0 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	34.4 kBtu/ft ² /yr	10.1 kWh/ft ² /yr	108.5 kWh/m ² a
Air leakage	0.6 ACH ₅₀		

SKIDMORE PASSIVHAUS Portland, Oregon

Located in an existing neighborhood of modest post-war houses, Skidmore Passivhaus merges contemporary design with extreme energy efficiency. Designed to provide an optimal live/work situation, the building encompasses two connected spaces. The two-story “live” volume features an open plan with a loft-like master bedroom suite, while the single-story “work” volume incorporates two working studios and a shared bathroom.

The space created between the volumes, while inside the thermal envelope, acts as an extension of the outdoors, connecting the front porch through to the rear deck. The house presents a closed facade to the street, yet opens generously to the sunny back yard and garden. An extensive green roof helps manage all stormwater on site and provides habitat for birds and insects.

The construction approach balanced economy and efficiency. The boxy abstract forms are kept void of cantilevers or other architectural devices. Balloon-framed walls and roofs are built on a standard module,

TEAM

**Architect, Certified
Passive House
Consultant,
and Contractor**
Jeff Stern
IN SITU ARCHITECTURE



wrapped in polyisocyanurate insulation, and clad in stained rough sawn cedar. Blown-in fiberglass fills the cavities in the walls and roof trusses.

A high ratio of south-facing, triple-pane glazing maximizes solar gains for most of the year. Motorized exterior aluminum shades can be lowered to block unwanted summer heat gain, keeping temperatures extremely comfortable year round. Highly efficient lighting and appliances keep electrical consumption to a minimum, and a roof-mounted 4.3-kW photovoltaic array generates about 75% of the annual site energy used.

PRODUCTS

Windows
ZOLA

Air/Moisture Control
SIGA by **SMALL PLANET
SUPPLY**

Skidmore Passivhaus; Photos by Jeremy Bittermann

PERFORMANCE

Heating energy	4.2 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	13.3 kWh/m ² a
Cooling energy	0.3 kBtu/ft ² /yr	0.09 kWh/ft ² /yr	0.9 kWh/m ² a
Total source energy	36.2 kBtu/ft ² /yr	10.6 kWh/ft ² /yr	114.2 kWh/m ² a
Air leakage	0.3 ACH ₅₀		





18TH AVENUE HOUSE

Portland, Oregon

Situated on a standard 50-ft x 100-ft lot in southeast Portland, 18th Avenue House is a smart, modern home designed for the inner city. The compact form with cantilevered balconies provides a welcoming front porch, while the detached shed will offer convenient bike storage and create privacy for the back garden. A roof-mounted 6.1-kW photovoltaic array will provide enough electricity to result in a net zero and truly sustainable building.

The main floor of the house steps up from the yard to mimic the typical neighborhood bungalow, allowing a basement to sit comfortably under part of the house. The basement foundation is made from an insulated wood chip/cement block that is manufactured locally. The living room is being set at the level of the yard and features an exposed slab on grade and a large triple-pane lift-and-slide door that opens to the patio.

TEAM

Architect, Certified Passive House Consultant, and Contractor
Jeff Stern

IN SITU ARCHITECTURE

The house is being constructed using wood stud framing with continuous exterior rigid mineral wool insulation over a taped plywood air barrier. The 2x6 walls are being dense-packed with cellulose, as are the roof cavities. The simple form and careful detailing are providing for an extremely airtight envelope.

Generous amounts of south-facing glazing will maximize solar gains for most of the year, while operable screens will block unwanted summer heat gain. The custom wood screens are fitted with simple barn door hardware to allow their position to be manually adjusted as needed. A heat-recovery ventilator (HRV) will provide continuous mechanical ventilation.

PRODUCTS

Windows

EuroClima/Geisler

EUROPEAN WINDOWS

Heating/Cooling

FUJITSU

18th Avenue; Rendering by In Situ Architecture



PERFORMANCE

Heating energy	6.3 kBtu/ft ² /yr	1.9 kWh/ft ² /yr	19.9 kWh/m ² a
Cooling energy	0.6 kBtu/ft ² /yr	0.2 kWh/ft ² /yr	1.9 kWh/m ² a
Total source energy	31.1 kBtu/ft ² /yr	9.1 kWh/ft ² /yr	98.1 kWh/m ² a
Air leakage	0.6 ACH ₅₀		

PHOENIX PH-01 Portland, Oregon

TEAM

**Architect, Builder,
and Certified Passive
House Consultant**

Scott Kosmecki

HINGE BUILD GROUP

Phoenix PH-01 is a 1940s-era bungalow that grew up to become a contemporary Northwest home. Part remodel and mostly new addition, the 1,900-ft² home is sided in FSC-certified cedar. Reclaimed wood sheathing from the original house is used to visually connect the outside wood features to the inside and to tie the new home to its past. The wood tones soften the otherwise sleek, modern look of the 3-bedroom, 3-bath home and anchor it squarely in its temperate rainforest ecosystem.

Just under that siding, a ¾- to 1½- inch rain screen gap protects the assemblies from that rainforest weather. That rain screen continues from the walls up along the roof to the ridge vent to help keep the roof assembly dry as well. The wall and roof assemblies include 9.5-inch modified Larsen trusses filled with blown-in cellulose, with additional mineral wool insulation where needed. A wax-impregnated fiberboard functions as the weather barrier, while a taped plywood is the air barrier.

Fortunately the foundation was in good enough shape to reuse with modifications, saving over 20 yards of new concrete. The crawlspace that the house sits on was separated thermally from the home by enveloping



the existing 2x8 joists in cellulose and then affixing 6 inches of mineral wool and a thin dust barrier to the bottom of the joists.

With all the air sealing and insulating work, the home needed only the smallest available mini-split upstairs to keep it comfortable—and the smallest is still probably overkill—with one additional electric resistance heater downstairs. The home's modern bungalow look fits nicely in this Portland neighborhood, but its extreme comfort makes this Passive House outstanding.

PRODUCTS

Windows and Exterior Doors
HH WINDOWS AND DOORS

Insulation
**AGEPAN BY SMALL PLANET
SUPPLY**
ROXUL

Phoenix House; Photos and Rendering by Hinge Build Group

PERFORMANCE

Heating energy	4.4 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	13.9 kWh/m ² a
Cooling energy	0.9 kBtu/ft ² /yr	0.3 kWh/ft ² /yr	2.8 kWh/m ² a
Total source energy	37.5 kBtu/ft ² /yr	11.0 kWh/ft ² /yr	118.3 kWh/m ² a
Air leakage	0.5 ACH ₅₀ (design)		





FAMILY FUTUREFIT Portland, Oregon

Although Tad and Maria Everhart's home was nearly state-of-the-art in energy-efficiency in 1998, it wasn't nearly a Passive House, as Tad discovered during the CPHC training he took in 2008.

With Tad's plans, Maria's blessings, and a home equity loan, in Autumn 2009 the Everharts embarked on what they thought would be a quick retrofit to demonstrate Passive House in their community and make their home fit for a low-emission future for their two girls.

Carpenters added 10-inch thick Larsen trusses packed with cellulose to the exterior walls that winter. However, labor costs, new windows, and a new heat-recovery ventilation (HRV) system drained the Everhart's budget.

Fortunately, with help from many friends, the Everharts were able to complete the next phases largely D-I-Y: in 2010 sealing air leaks

TEAM

General Contractor

Garth Everhart

Structural Engineering

Mark Butler

BUTLER CONSULTING, INC.

Certified Passive House Consultant

Hayden Robinson Architect and **TAD EVERHART**

Moisture Analysis

Dylan Lamar

GREEN HAMMER

Architect

Christopher Nestlerode

BARRY R. SMITH, PC

and super-insulating the ceiling/attic and ground floor; in 2011 installing insulating trim around the windows; in 2012 super-insulating foundation walls with EPS and foam glass blocks; and in 2013-14 installing LED lighting, interior thermal window blinds, and a clothes drying cabinet.

While carpenters completed long-overdue finish work in 2015, the Everharts planned their final phase: replacing their gas water heater and electric resistance in-duct space heating system in 2016 with a CO₂ refrigerant heat pump water heater.

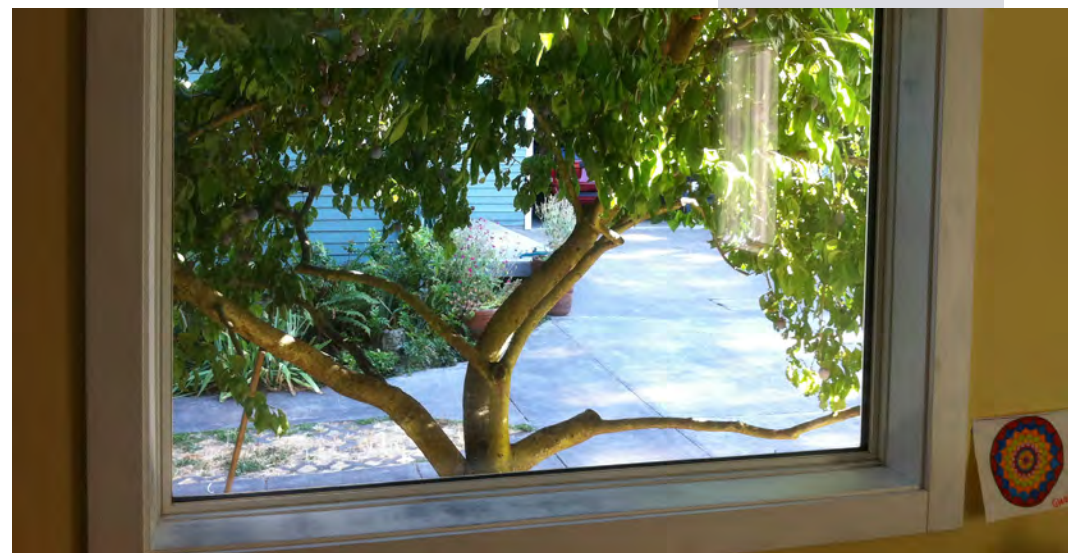
In their journey to a low-emission home, the Everharts cut space heating energy consumption by 70% and total site energy consumption by 45%. With the heat pump system, they anticipate 90% space heating site energy reduction and freedom from fossil fuels. At completion, their EnerPHit will cost \$70/ft² (and thousands of hours of their work).

Their 7-year journey will be winding up just as Gwen, their oldest daughter, leaves for college. Both girls have gotten to live through the home's monumental changes and understand firsthand the efforts needed to avert catastrophic climate change.

PRODUCTS

Windows
ALPEN HPP

Family FutureFit; Photos by Mark Peterson, Redux



PERFORMANCE

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.7 kWh/m ² a
Cooling energy	NA		
Total source energy	28.1 kBtu/ft ² /yr	8.22 kWh/ft ² /yr	88.5 kWh/m ² a
Air leakage	0.75 ACH ₅₀		

GREEN Hammer

Stephen Aiguier, founder of Green Hammer, a Portland-based design-build firm, has been emphasizing stewardship since the firm's inception in 2002.

For him stewardship means creating buildings that are healthy to live in and that tread lightly in the environmental footprint arena.

In pursuit of that agenda, six years ago Aiguier and Alex Boetzel, chief operation officer, took the Passive House training. There they met Dylan Lamar, architect and certified Passive House consultant, who joined the firm less than a year later. Although their design-build and remodeling work embraces a spectrum of sustainability goals, the stern of the company's ship, as Lamar would say, has been set strongly toward Passive House and is continuing to trend in that direction.

Green Hammer now has 16 employees. Four of those—Aiguier, Boetzel, Lamar, and Mike Beamer—are certified Passive House consultants. In addition to their own residential Passive House design-build projects, Green Hammer develops Passive House design solutions for other firms, typically consulting on larger-scale projects.



Tacoggna-Donnough Residence; Photo by Green Hammer

One such project was Orchards at Orenco, a 57-unit affordable housing development, the largest Passive House project in the United States when it was finished. More recently, Green Hammer helped Rocky Mountain Institute perfect its airtightness strategy for its new Innovation Center in Basalt, Colorado. Thanks in part to its successfully low air leakage rate of 0.36 ACH₅₀, the building met the requirements for PHIUS+ certification.

While Green Hammer's keen eye for collaboration and familiarity with tackling complex problems help them shine in the consultant realm, these qualities also come into play with smaller-scale projects. Starting from the first communication with a client, Green Hammer works to elucidate a client's goals regarding water and energy use, indoor health, and social aspects as well. They work with clients to help them fine tune and balance their sustainability objectives with their budget realities.

ANKENY ROW

Portland, Oregon

TEAM

**Designer, Builder,
and Certified Passive
House Consultant**
GREEN HAMMER

The Ankeny Row cohousing community grew out of a desire to create an environmentally friendly, socially engaging living space. Its five townhouses, one loft apartment, and community hall surround a central courtyard, whose gardens have become a warm gathering place for the residents. By using the Passive House Planning Package to sharply reduce each building's demand, the cohousing community is on track to achieve its goal of being Net Zero Energy, with only a 25-kW photovoltaic system on the back building's south-facing roof.

The community's three buildings were sited so the courtyard could get the most sun penetration, and great consideration was also given to maximizing the building's solar heat gains in winter while preventing overheating in summer. Deep overhangs shade the large, south-facing windows on the topmost floor, while awnings protect the lower and ground-floor windows. For supplemental heating and



the small amount of cooling needed, all units come equipped with mini-split heat pumps.

To minimize the environmental impact of the building materials, roughly 90% of the buildings' components are made from wood or cellulose. The R-50 wall assemblies include I-joists that are 9.5 inches deep filled with cellulose. The monosloped wood trusses in the roof assembly are 28 inches deep and are filled with cellulose insulation. All of the lumber and most of the finished wood is Forest Stewardship Council (FSC)-certified.

PRODUCTS

Windows
ZOLA

Air/Moisture Control
**HANNO by SMALL
PLANET SUPPLY**

Ankeny Row; Photos by Jon Jenson Photography

PERFORMANCE

Heating energy	1.4 – 2.1 kWh/ft ² /yr	14.8 – 22.5 kWh/m ² /a
Cooling energy	0.1 – 0.2 kWh/ft ² /yr	0.7 – 2.3 kWh/m ² /a
Total source energy	12.1 – 14.8 kWh/ft ² /yr	130 – 160 kWh/m ² /a
Air leakage	0.5 – 1.0 ACH ₅₀	

CASH-DARIENZO PASSIVE HOUSE Portland, Oregon

TEAM

**Designer, Builder,
and Certified Passive
House Consultant**
GREEN HAMMER

Taking an architectural cue from a traditional saltbox house and giving it a modern twist, this compact home in an infill lot maximizes the square footage under the roof. The two-story home makes the most of its Passive House features, achieving net zero energy with a 3.2-kW photovoltaic array. Thanks to rainwater capture, the home also almost achieves net zero water use.

The home's south-facing patio, which faces the street, brings life to the front of the house. Generous windows overlooking the patio bring light and heat to the great room, while awnings and a vine-covered trellis that borders the patio prevent overheating in summer. South-facing windows also warm the upstairs bedrooms, and heat



recovery from the shower's drain water further reduces the home's heat load. As the clients wanted a house that could work for them as they aged, the ground floor is wheelchair accessible and includes an age-in-place bedroom.

In an innovative detail, Green Hammer figured out how to thermally isolate the interior slab from the exterior stem wall in this house without enveloping the stem wall in a bathtub of foam. They raised the slab up above the top of the stem wall, so that underslab foam could connect continuously with the cavity insulation of the exterior wall.

PRODUCTS

**Drain Water
Heat Recovery**
RENEWABILITY
ENERGY INC.

Cash; Photo by Green Hammer

PERFORMANCE

Heating energy	4.3 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	13.6 kWh/m ² a
Cooling energy	3.5 kBtu/ft ² /yr	1.0 kWh/ft ² /yr	11.0 kWh/m ² a
Total source energy	28.1 kBtu/ft ² /yr	8.2 kWh/ft ² /yr	88.6 kWh/m ² a
Air leakage	0.3 ACH ₅₀		

TACOGGNA-DONNOUGH RESIDENCE

Dundee, Oregon

TEAM

**Designer, Builder,
and Certified Passive
House Consultant**
GREEN HAMMER

The Tacoggna-Donnough Residence is an exemplary model of a Passive House constructed for a moderate budget. The clients are very environmentally conscious and wanted the greenest, net zero energy, age-in-place home they could get.

Super-insulation on all sides of the envelope helped them reach their goal. The 2x6 framed walls are encircled by Larsen trusses filled with dense-packed cellulose. A taped plywood layer forms the air barrier. The shed roof's assembly includes 30-inch trusses packed with cellulose, and the slab is encased in foam. As the roof slopes to the north, a rack system was needed to ensure optimal exposure for the 4-kW photovoltaic system.

The big south-facing, triple-pane windows, which help cut the home's heating bills, are shaded by overhangs and awnings to prevent summertime overheating. High ceilings and clerestory windows extend daylighting far into this one-story home. Opening those clerestory windows purges the home of summer heat and is the primary cooling method. A 93% efficient heat-recovery ventilator (HRV) supplies continuous fresh air, while a mini-split heat pump provides heating in winter.

Other design tactics to reduce the heating loads included building a fully insulated, but unconditioned, vestibule on the north side to house the pantry, wine cooler, washer, and dryer. The highly efficient refrigerator's compressor is vented into the room



where the heat pump water heater lives, so that the heat output from the refrigerator can be sourced by the water heater.

The clients are extremely happy with their comfortable home. Energy monitoring has confirmed that the house is performing within 15% of what was expected, with space heating using slightly less energy than predicted and water heating using more.

PRODUCTS

Ventilation
ZEHNDER AMERICA

Tacoggna-Donnough Residence;
Photo by Green Hammer

PERFORMANCE

Heating energy	4.2 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	13.3 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	39 kBtu/ft ² /yr	11.4 kWh/ft ² /yr	123 kWh/m ² a
Air leakage	0.48 ACH ₅₀		



CAPACES LEADERSHIP INSTITUTE Woodburn, Oregon

The CAPACES Leadership Institute (CLI) is a training center and networking hub for nine organizations addressing farmworker and immigrants' rights in the northwest. With a design that was optimized for cost-effectiveness, and substantial volunteer labor during construction, the CLI was able to achieve its Passive House goal without incurring any debts to burden the organization's future.

The 2x6 structural walls are filled with dense-pack cellulose and surrounded on the exterior by Larsen trusses, also filled with cellulose. The interior walls are concrete masonry units (CMUs), which were hand plastered, to bring thermal mass to the building and absorb daily temperature swings. The added cost of the concrete walls was worthwhile, as CLI's busiest times hosting conferences—late summer and fall—coincide with peak heat spells.

TEAM

Designer
COMMUNITECHURE

Builder
By **OWNER** with Green Hammer consulting

Certified Passive House Consultant
GREEN HAMMER

Window design prioritized affordability, generally specifying fewer, larger windows to bring in maximum heat and light. The three large conference rooms have operable clerestory windows for daylighting and to help with flushing the heat from the building. The building was designed for passive ventilation cooling, with extension levers that ease access to these clerestory windows and operable transoms above all doors—exterior and interior. A green roof, constructed and planted entirely by volunteer labor, tops a roof assembly that includes 30 inches of dense-packed cellulose, greatly moderating heat gains and losses. A separately ducted mini-split heat pump provides the heating and back-up cooling for the building.

In its first full year of operation the CLI hosted a series of fully packed conferences in the early fall. Even with unexpectedly high attendance, the actual energy use for the year came in at just 17% greater than the energy use predicted by the Passive House Planning Package (PHPP).

PRODUCTS

Windows
ZOLA

CLI; Photo by Communitecture



PERFORMANCE

Heating energy	4.3 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	13.5 kWh/m ² a
Cooling energy	0.3 kBtu/ft ² /yr	0.1 kWh/ft ² /yr	1.1 kWh/m ² a
Total source energy	32.8 kBtu/ft ² /yr	9.6 kWh/ft ² /yr	103.5 kWh/m ² a
Air leakage	0.49 ACH ₅₀		



The house is wrapped in a blanket of cellulose from the roof to the floor trusses. The butterfly-pitched roof is supported by 28-inch trusses stuffed with cellulose. The walls feature a 9.5-inch TJI wall assembly filled with dense-pack cellulose, exterior to a 2x6 framed wall that is also insulated with dense-pack cellulose.

Because of the sloping site, the house sits over a crawlspace. The concrete stem walls were insulated on the interior with 5.5 inches of EPS, rather than on the exterior, to better protect that insulation over time. The foam minimizes any potential thermal bridging at the intersection between the stem wall and the crawlspace floor truss.

PRODUCTS

Windows

ZOLA

Air/Moisture Control

HANNO by **SMALL PLANET SUPPLY**

Heating/Cooling

FUJITSU

Cowhorn Residence; Photos by Green Hammer

COWHORN RESIDENCE

Jacksonville, Oregon

TEAM

Designer

GREEN HAMMER /Jan Fillinger

Builder and Certified

Passive House Consultant

GREEN HAMMER

This project—a residence for the owners of Cowhorn Vineyard whose tasting room is next door—testifies to the flexibility of the Passive House standard, which doesn't require design compromises even in the face of some stiff challenges. The site is a north-sloping hillside that is mostly forested, with minimal solar gains. The 1,950-ft² building also has too much surface area relative to its floor area to ever be described as compact. Still, by opting for the highest performance standards in the components used, the home is a stylish, certified Passive House with extensive amenities.

Modeling with the Passive House Planning Package (PHPP) showed that beefing up the window performance would be more effective than varying the design-build firm's standard Passive House wall assembly, so the windows are quadruple pane with a U-value of .06 for glazing and .14 for frames. Those windows are inset within the wall to further boost their performance. To optimize the mechanical equipment, the heat-recovery ventilator has the highest efficiency available.



PERFORMANCE

Heating energy	4.3 kBtu/ft ² /yr	1.3 kWh/ft ² /yr	13.6 kWh/m ² a
Cooling energy	3.5 kBtu/ft ² /yr	1.0 kWh/ft ² /yr	11.0 kWh/m ² a
Total source energy	28.1 kBtu/ft ² /yr	8.2 kWh/ft ² /yr	88.6 kWh/m ² a
Air leakage	0.3 ACH ₅₀		



ORCHARDS AT ORENCO

Hillsboro, Oregon

The Orchards at Orenco is a 57-unit affordable housing development that will deliver comfort and low energy bills for decades to come. The owner, REACH CDC, made Passive House a project goal from the start, after touring many Passive House social housing developments in Europe. Establishing this goal from the outset was critical in allowing the project team to collaborate on cost-effectively meeting the insulation, airtightness, and mechanical design challenges.

The three-story, L-shaped building frames a prominent street corner in the highly walkable Orenco Station neighborhood. The project includes a fully insulated, thickened-edge slab. The walls were built using 2x10 studs with

TEAM

Design Architect

Bill Wilson
**WILLIAM WILSON
ARCHITECTS, PC**

Architects of Record

Michael Bonn
**ANKROM MOISAN
ARCHITECTS, INC.**

Certified Passive House Consultant

Dylan Lamar,
GREEN HAMMER

Builder

Mike Steffen
WALSH CONSTRUCTION CO.

blown-in fiberglass cavity insulation and 1.5 inches of mineral wool insulation on the exterior. On the roof 12 inches of polyisocyanurate foam sit atop an open web truss.

The mechanical system, which is housed in three insulated roof-top pods, consists of three energy-recovery ventilators (ERVs), each of which is coupled to a single heat pump for primary heating and summer tempering. Back-up heating through electric radiant cove heaters in each unit facilitates tenant control of their environment.

PRODUCTS

Windows

EUROLINE WINDOWS INC.

Insulation

ROXUL

Orchards at Orenco; Photos by Casey Braunger



PERFORMANCE

Heating energy	5.5 kBtu/ft ² /yr	1.6 kWh/ft ² /yr	17.4 kWh/m ² a
Cooling energy	0.1 kBtu/ft ² /yr	0.04 kWh/ft ² /yr	0.4 kWh/m ² a
Heating load	2.4 Btu/hr/ft ²	0.7 Watts/ft ²	7.5 Watts/m ²
Cooling load	2.2 Btu/hr/ft ²	0.6 Watts/ft ²	6.9 Watts/m ²
Total source energy	37.2 kBtu/ft ² /yr	10.9 kWh/ft ² /yr	117.4 kWh/m ² a
Treated floor area	42,584 ft ²		
Air leakage	0.13 ACH ₅₀		

MARK O. HATFIELD BUILDING

Portland, Oregon



Central City Concern (CCC) is a nonprofit agency serving single adults and families in the Portland metro area who are impacted by homelessness, poverty and addictions. In 2009, CCC implemented a “Portfolio Efficiency Project” aimed at preserving affordability and services across its portfolio of 26 buildings. Due to poor energy performance, the Mark O. Hatfield Building was one of the first buildings identified for a major energy retrofit.

Originally built in 1910, the Mark O. Hatfield provides 106 units of Section 8 housing to low-income individuals. A 2011 feasibility study had

identified Passive House as the most direct path to achieving major energy savings at the Hatfield. Due to limited funding availability, however, a complete Passive House rehab of the Hatfield was unrealistic, and a phased approach was required to achieve CCC’s energy goals.

The first phase in the building’s retrofit was undertaken in 2012, starting with replacing the extensive aluminum-frame glazing with high efficiency triple-pane windows. Other key improvements included a high efficiency domestic water heater, a transition to electric heat, air sealing, ventilation improvements, lighting upgrades, and a low-flow toilet retrofit.



The 2012 rehab provided readiness for future measures to be installed as funding becomes available. Readiness for these measures included designing the window flashing to easily accept an exterior insulation finishing system (EIFS), placing each heater on its own circuit to allow for future submetering, and sizing the framework of the roof-mounted exhaust fan to support the installation of a heat recovery ventilation unit.

Average post-rehab heating energy use shows a 62% savings compared to pre-rehab heating energy use. Total building energy use savings are just over 50%, resulting in annual carbon emissions reductions of 37%.

TEAM

Owner
CENTRAL CITY CONCERN (CCC)

Architect
KASA ARCHITECTS, INC.

Certified Passive House Consultant
Dylan Lamar
GREEN HAMMER

Engineers
PAE CONSULTING ENGINEERS, INC.

General Contractor
WALSH CONSTRUCTION COMPANY

Mark O. Hatfield; Photos by Central City Concern

PERFORMANCE (design maximum limits)

Heating energy	7.92 kBtu/ft ² /yr	2.3 kWh/ft ² /yr	25 kWh/m ² a
Cooling energy	7.92 kBtu/ft ² /yr	2.3 kWh/ft ² /yr	25 kWh/m ² a
Total source energy	38.0 kBtu/ft ² /yr	11.1 kWh/ft ² /yr	120 kWh/m ² a
Air leakage	1.0 ACH ₅₀		



KILN APARTMENTS

Portland, Oregon

In planning for a corner site in an evolving inner-city neighborhood, the owner's requirements were a straightforward call to arms: set a precedent for optimized energy use and deliver that package in an attractive exterior. The owner also asked for exceptional apartments flooded with an abundance of natural light. From there, Kiln Apartments was born.

Kiln Apartments is an 18,000-ft² multifamily building featuring 19 apartments and ground-floor retail. The building is located on a very narrow site along one of Portland's most prominent bike boulevards. Instead of on-site vehicle parking, 21 bicycle stalls support residents' active lifestyles. To encourage residents to use the stairs rather than the elevator, local artists were commissioned to paint murals in the building's stairwell.

Thoughtful design makes the apartments feel much larger than their 660 average square feet, enabling more people to inhabit this tight site—a measure of true sustainability. Exterior amenity decks were provided on the top levels to complement each resident's modest individual space and provide a visual connection with the neighborhood.

TEAM

Architect
GBD ARCHITECTS

Contractor
**LORENTZ BRUUN
CONSTRUCTION**

**Mechanical, Electric,
Plumbing Engineer**
**SOLARC ENGINEERING
AND ENERGY+
ARCHITECTURAL
CONSULTING**

Optimizing thermal comfort, outdoor views, cross-ventilation, and daylighting was integral to the apartments' design. Although strict numbers describe a relatively low glazing of 23%, post-occupancy conversations with residents paint an impressive picture of enormous views and light-filled spaces thanks to windows 4 feet wide and 7 feet tall. To facilitate natural cross-ventilation and passive cooling, the building was designed with four of six apartments per floor as corner units. The apartments do not contain traditional cooling systems.

Thanks to an R-70 roof assembly, R-52 exterior walls, and R-21 under the slab, heating is being provided through efficient wall-mounted, hot water radiant heaters with pre-heated water from roof-mounted solar thermal panels. A 10-kW photovoltaic system generates enough electricity to meet an estimated 20 percent of the building's total energy use.

Kiln Apartments; Photos by Pete Eckert

PRODUCTS

**Windows
and Exterior Doors**
**HH WINDOWS AND
DOORS, INC.**

Ventilation
ULTIMATEAIR



PERFORMANCE

Heating energy	4.2 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	13.2 kWh/m ² a
Cooling energy	0.7 kBtu/ft ² /yr	0.2 kWh/ft ² /yr	2.3 kWh/m ² a
Total source energy	35.9 kBtu/ft ² /yr	10.5 kWh/ft ² /yr	113.2 kWh/m ² a
Air leakage	0.67 ACH ₅₀		
Treated Floor Area	11,993 ft ²		

PITNEY PASSIVE HOUSE

McMinnville, Oregon

The owners of Pitney Passive House started with a vision of a very sustainable, net-zero, reasonably priced home that could be a model for their community. By adhering to a fairly simple form and keeping the Passive House detailing straightforward, the designer succeeded in realizing his clients' vision and demonstrating that the Passive House standard can be achieved for a relatively small single-family home within a modest budget.

A big factor in this project's success—and in keeping the costs within budget—was the elimination of a separate heating system, relying instead on the ventilation system's post-heater to deliver comfortable temperatures.

Sticking with familiar construction approaches, the R-54 dual-wall assembly for this 1,014-ft² home includes two 2x4 walls with a 3-inch gap between them. Outside of the structural walls and air barrier

TEAM

Designer

Matt Daby

M.O.DABY DESIGN

Builder

John Mead

**CELLAR RIDGE
CONSTRUCTION**

Certified Passive House Consultant

Scott Kosmecki

HINGE BUILD GROUP



membrane are 3 inches of mineral wool rigid insulation, a ventilated rain screen, and corrugated metal siding.

The roof assembly was designed for easy constructability, with an innovative detail that includes a flat OSB layer atop the ceiling joists creating a platform onto which pre-manufactured raised heel roof trusses were dropped. Blown-in fiberglass in the attic contributes to a roof R-value of 70.

As part of their commitment to sustainable living, the couple chose an inner-city lot for their affordable home, so they could walk to stores and more. A great room with south-facing, triple-pane windows and a glazed door gives on to the yard where the couple will grow vegetables. A 5.2-kW photovoltaic system will cover their home's energy use plus charge their electric car, sharply reducing their overall carbon footprint. Nine thousand gallons of rainwater storage and reuse contribute to meeting the couple's sustainability goals.

PRODUCTS

Windows

INTUS

Insulation

ROXUL by **SMALL PLANET
SUPPLY**

Pitney Passive House; Photo and Rendering
by m.o.daby design

PERFORMANCE

Heating energy	3.7 kBtu/ft ² /yr	1.1 kWh/ft ² /yr	11.7 kWh/m ² a
Cooling energy	0.9 kBtu/ft ² /yr	0.3 kWh/ft ² /yr	2.8 kWh/m ² a
Total source energy	53.9 kBtu/ft ² /yr	15.8 kWh/ft ² /yr	170.0 kWh/m ² a
Air leakage	0.5 ACH ₅₀		





ARMSTRONG PASSIVE HOUSE

Sisters, Oregon

The two-story Armstrong Passive retains a traditional farmhouse look while far exceeding traditional comfort levels in the face of long, snowy winters and hot summers in this high-desert locale. Seven triple-pane windows on the south-facing façade bring in abundant light and solar heat in winter, while black granite sills help to retain that heat. Eyebrow roofs over the windows prevent overheating in summer. A beautiful tile floor in the gracious ground-floor great room adds thermal mass, modulating temperature swings year-round.

To cut the home's conditioning energy demand, the owner opted to pre-heat and pre-cool the incoming ventilation air with an earth tube system, which moderates the outdoor air temperature using the more consistent temperatures found in the ground. The 150 feet of earth

TEAM

Designer

Paul DeJong

**INDIGO ARCHITECTURE
& INTERIORS**

Builder

John Nordquist

**NORTH BRANCH
CONSTRUCTION**

Certified Passive House

Consultant

Glenn Haupt

SOLAR CRAFT LLC

tube piping, which the outdoor air is drawn through, runs alongside deeply set footings.

The home's foundation walls were built using insulated concrete forms (ICFs). A 6-inch thick reinforced concrete slab rests on a double layer of 4-inch foam board. Double 2x4 walls with a 3.5-inch gap between them pack in the insulation: 7 inches of soy-based closed cell foam and 3 inches of blown-in fiberglass. The R-values in the roof range from 70-80 due to a minimum of 11 inches of closed cell foam.

A small wood stove with separately ducted makeup air is the main source of supplemental heat. Thermostat-controlled electric radiant heat mats under the tile floor downstairs can deliver a cozy feeling to the feet.

PRODUCTS

Air/Moisture Control
**ZIP SYSTEM SHEATHING
AND TAPE**

Ventilation
ULTIMATEAIR

Armstrong Passive House; Photos by Mark Armstrong



PERFORMANCE

Heating energy	4.8 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	15.1 kWh/m ² a
Heating load	3.5 Btu/hr/ft ²	1.0 Watt/ft ²	11.1 Watts/m ²
Cooling load	1.6 Btu/hr/ft ²	0.5 Watts/ft ²	5.0 Watts/m ²
Total source energy	30.7 kBtu/ft ² /yr	9.0 kWh/ft ² /yr	96.8 kWh/m ² a
Air leakage	0.4 ACH ₅₀		

STELLAR APARTMENTS

Eugene, Oregon

As one of the largest providers of low-income housing in the area, St. Vincent de Paul Society of Lane County (SVdP) strives to provide high quality, affordable rental housing to its low-income residents. Energy efficiency, and the resulting lower energy costs for residents, is key to delivering that quality, so SVdP decided to set themselves the challenge of building to meet the Passive House standard in one 6-unit building at Stellar Apartments. An identical 6-unit building was constructed to meet the Earth Advantage standard, a regional high-performance building standard.

While design changes were needed to meet Passive House, the project team wanted to keep the building frame as conventional as possible. For that reason, the approach taken was to install 4 inches of polyiso foam insulation outside of their typical 2x6 walls, which are filled with blown-in fiberglass. Although more exterior insulation might have been helpful, available test data demonstrating the

TEAM

Architect
BERGSUND DELANEY
ARCHITECTURE AND
PLANNING

Builder
Curt and Gary Meili
MEILI CONSTRUCTION
COMPANY

Certified Passive House Consultant
Win Swafford
ECOBUILDING
COLLABORATIVE

Monitoring and Research
Alison Kwok
University of Oregon



ability of the cladding to hang outside the foam limited the foam layer to 4 inches. Taped plywood sheathing is the air barrier layer.

The roof is a conventional wood truss with enough blown-in fiberglass insulation in the attic to add up to an R-value of 84. The ceiling of the upper floor contains a plywood lid, which helps to support all the insulation and also provides air barrier continuity to the exterior walls. The foundation's footings are wrapped in 4 inches of EPS foam inside and out.

To date, a study conducted by the University of Oregon of the two Stellar Apartment buildings is finding that the Earth Advantage units consume on average roughly 40% more energy for heating than the Passive House units do. Occupant behavior also made a difference in energy use.

PRODUCTS

Ventilation
ULTIMATEAIR

Stellar Apartments; Photo by Bergsund DeLaney
Architecture & Planning

PERFORMANCE

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.9 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	37.8 kBtu/ft ² /yr	11.1 kWh/ft ² /yr	119.2 kWh/m ² a
Air leakage	0.5 ACH ₅₀		



NEBRASKA STREET PASSIVE HOUSE

Salem, Oregon

TEAM

**Builder and Certified
Passive House Consultant**
BILYEU HOMES, INC.

One of the earliest Passive Houses in the Northwest, this 1,885-ft² home was built on a corner lot with terrific southern exposure. As the Passive House approach was unfamiliar to almost all subcontractors at the time, the builders specified familiar building elements and then tweaked them to achieve superior performance.

Two 2 x 4 stud walls, separated by a 3-inch space, form a 10 1/2-inch-thick sandwich that is insulated with dense-packed cellulose. Both walls are framed 24 inches OC, but are offset from one another by 12 inches. The exterior sheathing, which is 1/2-inch plywood, forms the primary air barrier. The framed walls are covered with 2 inches of expanded polystyrene (EPS) foam, over which are layered a weather-resistant barrier, wood battens, and fiber cement lap siding. The R-value of the wall assembly is 45.

The wall air barrier layer ties directly to a plywood subroof ceiling air barrier and to the plywood subfloor as well. In the crawl space, the I-joists that support the subfloor are insulated with dense-packed cellulose. The joists terminate at an interior rim that is separated from the exterior rim by 3 inches of XPS foam. The underside of the floor joists is covered with 1 1/2 inches of EPS foam, with the joints and all penetrations sealed.

To keep their clients' whole family happy, the builders searched for and found an extremely well-sealed pet door. Installed in the back door, the dog has been traveling happily ever since.

Nebraska St. Passive House; Photos by Sea Legs Media

PRODUCTS

Windows
ALPEN HPP

Ventilation
ULTIMATEAIR



PERFORMANCE

Heating energy	4.08 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	12.9 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	22.8 kBtu/ft ² /yr	6.7 kWh/ft ² /yr	71.9 kWh/m ² a
Air leakage	0.20 ACH ₅₀		

WINDY VIEW PASSIVE HOUSE

Philomath, Oregon

TEAM

Architect
NATHAN GOOD
ARCHITECTS, PC

**Builder and Certified
Passive House Consultant**
BILYEU HOMES, INC.

Perched atop a steep, sparse hill, the Windy View project posed a unique challenge for both architect and builder to accomplish the clients' desire for a passive home without compromising the sweeping views of the town of Philomath—a small town 20 miles west of Corvallis—the Willamette Valley, and Mary's Peak in the Oregon Coast Range. On a barren hillside devoid of natural sun protection, the home's design incorporated numerous large windows equipped with external, motorized sunshades on the south- and west-facing windows. These shades help to avoid overheating in the warm summer months, but can be retracted to allow the low-angled winter sunlight to enter the home.



The home's unique sunburst design incorporates a truncated floor plan, with a small room in the front that acts as a seasonal sunroom. The builder accommodated the building's truncated geometry by using appropriately thick wall and roof assemblies, enhancing the insulation, and by minimizing thermal bridging. A bank of clerestory windows provides additional daylight into the core of the home.

The client requested the ability to age in place in the home, including having the home be fully wheelchair accessible, should that become a necessary amenity in the future. The home includes several features that allow a wheelchair operator to perform daily functions more easily, such as knee spaces under the stove and kitchen sink, lower countertops, fully accessible bathrooms, 36-inch wide doors, and an open floor plan for ease of movement.

PRODUCTS

Windows
ALPEN HPP

Shading
HELLA by **PEAK**
BUILDING PRODUCTS

Windy View Passive House; Photos by Sea Legs Media

PERFORMANCE

Heating energy	4.7 kBtu/ft ² /yr	1.4 kWh/ft ² /yr	14.7 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	31 kBtu/ft ² /yr	9.1 kWh/ft ² /yr	97.8 kWh/m ² a
Air leakage	0.31 ACH ₅₀		





KUGLER HAUS

West Linn, Oregon

The owners, designer, and builder of Kugler Haus set out to build a superinsulated, highly efficient home with great indoor air quality—within a limited budget—and far exceeded their goals.

TEAM

Builder
ETHAN BECK HOMES INC.

Designer
Ted Nickell

Certified Passive House Consultant
Dylan Lamar
GREEN HAMMER

Heating and Ventilation
CONNER HEATING AND COOLING LLC

Framing and finish work
SKYLINE CONSTRUCTION INC

Kugler Haus; Photo by Mitzi Kugler

SANTA MARIA PASSIVE HOUSE

Newberg, Oregon

Located on a large family-managed organic farm, Santa Maria Passive House is a design collaboration between the owners and builders and maximizes both efficiency and passive survivability.

TEAM

Designer and Builder
BILYEU HOMES, INC.

Certified Passive House Consultant
Blake Bilyeu

PRODUCTS

Ventilation
ZEHNDER AMERICA

Santa Maria Passive House; Photo by Bilyeu Homes, Inc.



PERFORMANCE

Heating energy	3.95 kBtu/ft ² /yr	1.2 kWh/ft ² /yr	12.5 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	28.7 kBtu/ft ² /yr	8.4 kWh/ft ² /yr	90.5 kWh/m ² a
Air leakage	0.30 ACH ₅₀ (preliminary)		

PERFORMANCE

Heating energy	3.0 kBtu/ft ² /yr	0.9 kWh/ft ² /yr	9.5 kWh/m ² a
Cooling energy	0 kBtu/ft ² /yr	0 kWh/ft ² /yr	0 kWh/m ² a
Total source energy	36.5 kBtu/ft ² /yr	10.7 kWh/ft ² /yr	115.1 kWh/m ² a
Air leakage	0.20 ACH ₅₀		

PASSIVE HOUSE RESOURCES

PASSIVE HOUSE NORTHWEST (PHNW): Working since 2010 to promote highly energy-efficient construction through implementation of the Passive House standard.

PASSIVE HOUSE INSTITUTE U.S. (PHIUS): A 501(c)3 educational organization incorporated in 2009 to train and certify passive house consultants.

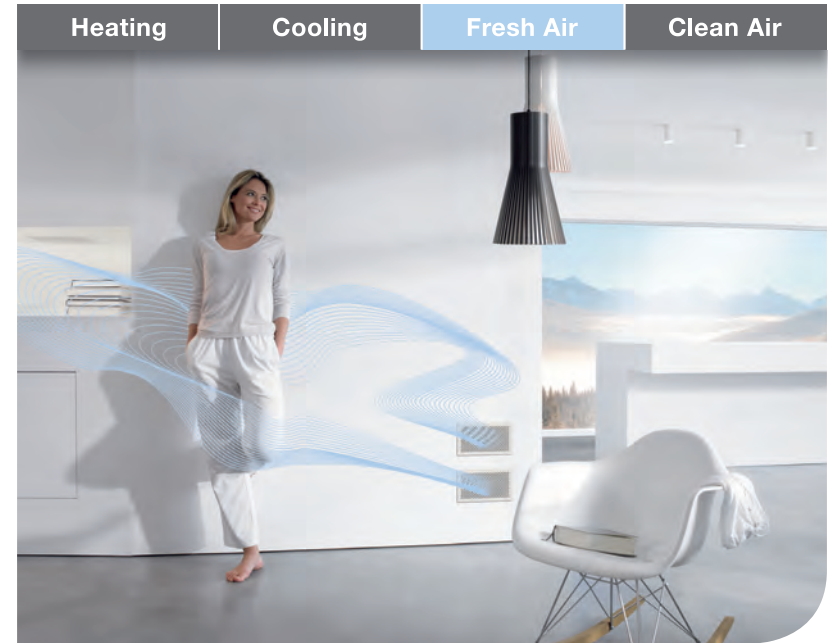
PASSIVE HOUSE ALLIANCE U.S. (PHAUS): A program of PHIUS providing support to passive building professionals in the United States.

NORTH AMERICAN PASSIVE HOUSE NETWORK (NAPHN):
A cooperative of North American regional Passive House organizations sharing the common mission of promoting the international Passive House Standard to the general public and building industries of North America.

PASSIVE HOUSE INSTITUTE: An independent research institute that has played an especially crucial role in the development of the Passive House concept.

INTERNATIONAL PASSIVE HOUSE ASSOCIATION (IPHA): A global network for Passive House knowledge, promoting the Passive House Standard and connecting stakeholders.

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Orchards at Orenco, courtesy of Ankrom Moisan

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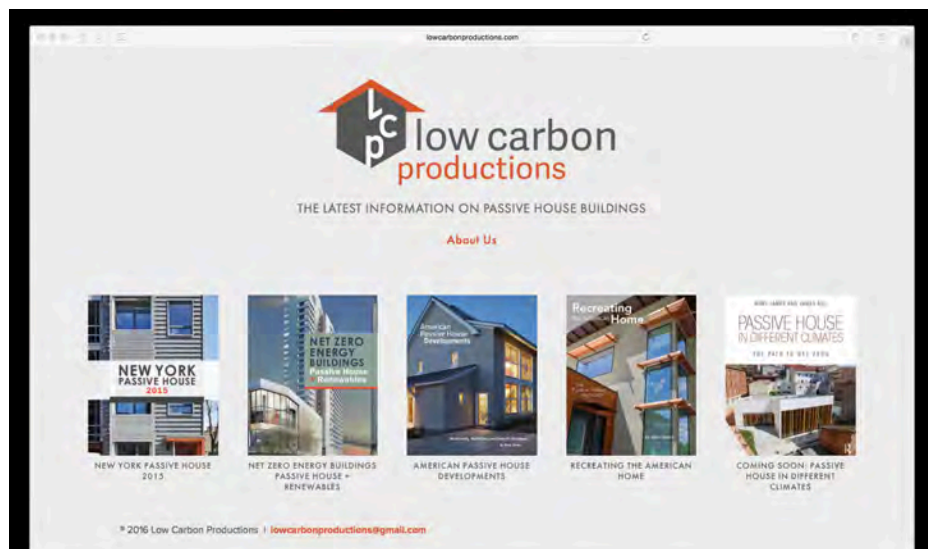
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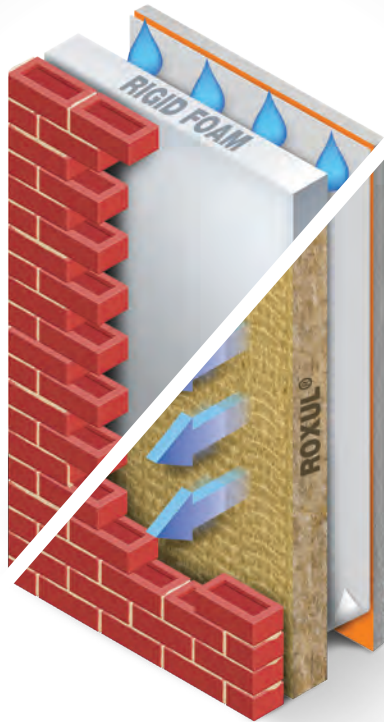
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Breathe easy with ROXUL®. Conventional insulation systems using rigid foam create a double vapor barrier system that can potentially trap moisture. CAVITYROCK® and COMFORTBOARD™ stone wool insulation boards are vapor permeable, allowing your building envelope to dry. Reduce your risk – protect your buildings and your reputation.

Visit us at roxul.com/CommercialApplications

ROXUL®
The Better Insulation™

PASSIVE HOUSE NORTHWEST 2016

showcases a diverse range of Passive House buildings in the Pacific Northwest: from small single-family homes to a growing list of multifamily projects, and from southern Oregon to the San Juans and over to eastern Washington.

As North America's oldest Passive House community, Passive House Northwest has ensured that low-energy buildings are an established—and still growing—presence in the Pacific Northwest marketplace.

Passive
House
Northwest

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