Welcome to the Passive House Party

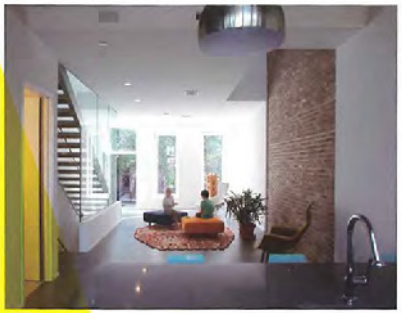
GREEN TYPOLOGIES
PASSIVE HOUSE

After a decades-long dormancy here in the United States, the alternative certification is ready for the limelight, and a survey of three recent projects proves that Passive House isn't constrained to one building type or climate.

By Kathryn Freeman Rathbone

The Belfield Avenue Townhomes, Philadelphia's first certified Passive House units, are set back from the street, creating space for contemporary planters and neighbor interaction. Inside, all electricity use is rigorously monitored.

PHOTO: SATOSHI ASAKAWA



A building's energy performance goes hand in hand with its design. In the United States, LEED has set the standards and certifications that many developers, architects, engineers, and builders aim to hit in each project they construct. Since the classification system's rollout in 1993, thousands of buildings worldwide have earned official LEED ratings, and "achieving LEED certification" has become a talking point so well known that it's commonplace even in popular culture. Yet LEED, which stands for Leadership in Energy and Environmental Design, is hardly the only standard in green building, and one in particular is on the rise: **Passive House**.

Passive House (sometimes spelled the German way, *passivhaus*), is a building standard that, although it shares its main goal with LEED—to help create a more sustainable world by reducing architecture's impact on the natural environment—predates the USGBC's prescriptive system. Its origins can be traced back to superinsulated homes developed in the US in the 1970s. To date, 30,000 buildings worldwide have been built to its strict energy performance specifications. It's the go-to standard for green building in Europe, but stateside, it's just now picking up steam.

Two primary institutions are responsible for developing the tools and applications central to Passive House construction. In Europe, the **Passivhaus Institut** (PHI), headquartered in Dormstadt, Germany, has been officially studying building practices and materials performance since 1996, using their findings to outline the Passive House building code. While other Passive House certifying organizations do exist in Europe, it is the PHI that sets research standards. In the United States, the **Passive House Institute US** has been adapting this code for the past seven years, taking the European principles and refining them so that Passive House buildings can optimally function in the varied American climatic zones. "It's just in its infancy here in the US," says **Julie Torres Moskovitz**, author of the 2013 book *The Greenest Home: Superinsulated and Passive House Design* and the principal of **Fabrica718**, which designed **Tighthouse**, New York City's first certified Passive House project. "It took 15 years in Germany for Passive House to take off. Here, it's just getting started."

To anchor the movement stateside, PHIUS has laid out a set of straightforward Passive House characteristics. According to the published standards, Passive House buildings "achieve overall energy savings of 60 to 70 percent and 90 percent of space heating without applying expensive 'active' technologies like photovoltaics or solar thermal hot-water systems." Their designs incorporate "superinsulation, airtight envelopes, energy recovery ventilation, [and] high performance windows" to accomplish this drastic energy reduction. Unlike with LEED, energy performance can be precisely predicted because energy consumption and output is carefully calculated for each Passive House structure using **Passive House Planning Package**

DETAILS

LOCATION New York City
Size 3,265 ft²
Completed 2012 (originally built in 1899)
Certification PHI
Climate Zone Cold
Energy Use Intensity 35.2 kBtu/ft²/yr
Architects Fabrica718 (Julie Torres Moskovitz, Minyoung Song, Michael Vanreusel, Natalya Egon, Kim Letven, Jade Yang, Corey Yurkovich) in conjunction with Studio Cicetti
Structural Engineer Anastos Engineering Associates
Passive House Consultant/Mechanical Designer ZeroEnergy Design
General Contractor WM Dorvillier & Co.

TIGHTHOUSE

Why it's notable: Tighthouse is New York City's first certified Passive House. It is so well insulated that a winter thermal image registered the home in all blue tones, meaning it leaked almost no heat. **Type of structure:** Tighthouse is actually a renovation of an original Brooklyn brownstone, proving that Passive House retrofits can be as effective as new homes. **Design elements:** The home's looks keep in line with its contemporary energy ambitions. The architect chose a sharp, dark gray for its exterior and finished its interior in bright whites to play up the sunlight that streams through the home's large windows. **Energy solutions:** To avoid air escape as much as possible, the Tighthouse's builders taped every joint for all the windows and doors. The process took two weeks to complete.

To bring natural light to all four levels of this renovated Brooklyn brownstone, New York City's first certified Passive House, staircases all fall within the light path of a large skylight and have perforated stainless steel treads.

Check out the Zehnder HRV unit used in this project on p. 128

PHOTOS: HUI ZHANG

"As a designer, once you've done one Passive House project, it's hard to go back. You can't help but apply its techniques to all your projects in the future."

JULIE TORRES MOSKOVITZ, FABRICA718

(PHPP) software, a program developed initially in Europe. Designers deploy PHPP in the early design phase, making energy performance central to each Passive House building. "It's similar to Excel," Torres Moskovitz says of the software. "It's all plug-ins and formulas that relate to building science. When you use it, you input all the details—a structure's materials, its design, its local weather—and PHPP runs the details and gives you a model that tells you about building decision trade-offs."

"It's really useful," she adds, "because you instantaneously see a building's performance results." Armed with the PHPP predictive model, designers can make informed decisions about each element that goes into a building's total design. And as a project evolves, different decisions can be made to counteract any other design changes that would otherwise increase energy output or consumption.

It's a smart checks and balances system of building, and it's been consistently proven to work. "Passive House is very simple because it's numbers based, so you have to be accountable," says **Tim McDonald**, a Passive House specialist whose firm, **Onion Flats**, developed the **Belfield Avenue Townhomes**, Philadelphia's first certified Passive House project. To McDonald, the numbers-don't-lie approach pushes architects to engage the question, "How do we get buildings to sustain themselves and hit net zero?" And when it comes down to actually answering that question, the extensive training required to become a Certified Passive House Consultant (CPHC) certainly makes architects, builders, and craftsmen well acquainted with all the numbers that go into a building's energy calculations.

PHIUS divides the rigorous CPHC program into two learning phases. Phase one requires 24 hours of classroom instruction, and introduces participants to heat transfer, air tightness, thermal bridge free detailing, superinsulation, highly efficient ventilation, and moisture control principles. Phase two teaches participants how to use the PHPP software via case studies that model real Passive House buildings. A final software competencies exam and take-home modeling case study compose the certification exam. "Learning how to track your work from the design side makes you rethink the process of how things get structured on the outside in relationship to the inside," McDonald says. More than one CPHC can work on a project, and often designers team up with other CPHC engineers and builders, minimizing the chance that a Passive House project will compromise its design intent.

Torres Moskovitz prefers this method of building a CPHC team. "I always want to work with a CPHC engineer because they understand the smallest ins and

"[Passive House] is a clearly measured metric that focuses closely on energy efficiency and uses sophisticated math to prove it. It's science, and it works."

LUKAS ARMSTRONG, LUKAS ARMSTRONG DESIGN + CONSULTING

PHOTO: SAMANTHA ARMSTRONG TORRES MOSKOVITZ

DIALOGUE
Lukas Armstrong

You grew up on a 160-acre, solar-powered ranch in British Columbia. How did that experience shape your views on energy use and dependency?

When you're dealing with solar power—and we had other alternative energy sources like wood and a little solar thermal—you really become intensely aware of the amount of energy that you have available and how hard it is to get. When I started designing buildings it only made sense to minimize energy use and thereby your costs.

When did you first learn about Passive House?

It was about two years ago, when I took the Passive House course offered by the Canadian Passive House Institute in Vancouver.

What made you want to get so involved?

When I started getting into residential design of my own, I looked around to see what was on the cutting edge and realized Passive House was the most aggressive energy-efficiency standard in the world.

Besides its stringent standards, what else about Passive House attracted you to it?

It's a clearly measured metric that focuses closely on energy efficiency and uses sophisticated math to prove it. It's science, and it works. So we're using science to create buildings that respond to our climate-change situation.

What are you doing to get others involved?

I've spoken both regionally and provincially on Passive House, and I expect to, at some point, through digital media, be able to reach out and influence the public and my peers. And, of course, marketing to my clients. I'm going to do anything I can to get the word out.

What sort of limitations do you think it has?

Potentially the only shortcoming is overcoming the legislation that allows bad buildings to be built. We need to educate the public, the building professionals, the contractors, the construction industry, and more importantly, we have to have our governments change legislation and insist on this building standard.

Interview by Christopher James Faludi

DIALOGUE
Vahid Mojarrab

When did you first learn about Passive House?
[It was] after reading an article on how you can heat your whole house with a hair dryer. I think that was the most brilliant marketing sentence I have ever read. It just hit the core with everybody. I participated in the first Passive House US training in Champaign, Illinois, in the summer of 2008, and I was among the first group of people that got trained in Passive House.

What compelled you to get involved?
It was proven in Europe, and it just seemed to work. It has other benefits for us—it improves the indoor air quality, it forces the building to be built better so that it's longer lasting. For most of our projects, we try to achieve site-zero energy, and Passive House allows site-zero energy with little effort. It became compelling to present this to clients and tell them that by investing in 1.5- or 2-kilowatt photovoltaic systems they can attain site-zero.

Does the climate affect your approach?
[New Mexico is] in Climate Zone 5, which is a cold and dry climate, and we have the problem of overheating because of high solar gain. We're doing a project right now where we tried to play with the overhang for a particularly large picture window. Coming up with the perfect overhang is almost impossible. You either don't get enough solar gain, or you're overheating. So we chose to go to an active system—in this case, it was an exterior shading device. Then we hit the sweet spot in no time. That's something that might be different or unique to our region—many of our projects require exterior active shading to achieve the ultimate balance throughout the year.

How does your current work illustrate intelligent Passive House design methods?
When we talk about possible energy-efficiency improvements in the residential sector, we always hear about single-family homes. Multifamily housing has an automatic energy efficiency in some way designed into it. The whole geometry and sharing of walls make energy efficiency inherent with the multifamily. Less saving comes from the envelope or HVAC design, and more of it comes from the water-heating efficiency and appliances. It's a significant opportunity to bundle energy-saving methods.

Interview by Christopher James Paloflox

outs of the software," she says. "When it comes to building, I like to work with CPHC builders and tradesmen, too. It just makes accomplishing your Passive House goals that much easier when everybody understands why we're working toward Passive House certification on a project and how, when building, we can actually adjust the design to get there." Her point is a good one: a Passive House predictive model is only good if the Passive House building is actually built so that it can achieve its reduced energy numbers. Strong communication among the entire building and design team is essential. "When we were building Tighthouse, we put up a sign that said, 'Report any air penetration to the outside to Julie.'" she says. "It was a simple approach, but it helped everybody stay on track. I could tweak the design, and we could all work together to solve materials and construction problems so that we could make an airtight building."

At Tighthouse, hitting the Passive House numbers meant thwarting as many thermal bridges between inside and outside as possible—a common goal for all Passive House projects. The home is actually a retrofit of an old Brooklyn brownstone, and large doors and windows and doors puncture both its front and rear façades. Its design required taping around as many joints as possible so that the home could remain superinsulated. "We taped everything—especially around the windows—on every overlapping surface so that nothing was leaking," Torres Moskovitz says. The windows themselves are a tilt-and-turn model commonly used in Europe. Torres Moskovitz sourced them from a European company and had them imported because similar American-made models weren't available.

Which is common. Because Passive House building design is still relatively young in the US, architects and builders are forced to source PHI-approved materials from Europe. However, American building materials manufacturers are beginning to come to market with products certified by PHIUS. In 2013, **Marvin Windows and Doors**, based in Warroad, Minnesota, earned the PHIUS stamp of approval for its Ultimate Casement window. "It's been in the works for some time," says **Christine Marvin**, director of marketing for the family-owned business. "Marvin has always been focused on the voice of the customer. Years ago, we heard about Passive House from our customers, and we knew we had to respond with product options and find solutions to meet their needs. We also anticipated that the movement would pick up momentum in the US."

"We've been approached from Georgia to Portland," adds **Brenda Brunk**, a Marvin product planner behind the Passive House Ultimate Casement project. "People are very passionate about getting American products for Passive House projects." Working in tandem with PHIUS, Marvin's research and development team learned how to refine its traditional Ultimate Casement window design in order to meet the Passive House materials certification benchmarks. The Passive House Ultimate Casement model meets the standards for the climatic conditions of US Zone 3 and Marine South, and it's available in triple and quadruple glazing.

"[I learned about Passive House] after reading an article on how you can heat your whole house with a hair dryer—I think that was the most brilliant marketing sentence I have ever read."

VAHID MOJARRAB, WAMO STUDIO

As American-made products arrive on the market, architects can achieve Passive House designs that don't sacrifice style, an issue that's often raised as one of the standard's drawbacks. "There are many beautiful Passive Home buildings around the world," McDonald says. "One of the problems [in the US] is that there just aren't enough excellent architects designing Passive House buildings yet. But you really don't have to compromise style for a Passive House. It's a symbiotic relationship between one's design and the Passive House parameters."

Regardless of architectural style, the mechanical nuts and bolts of each Passive House project remain relatively constant. Unsurprisingly, superinsulated buildings require high performance insulation that keeps heat transfer to a minimum; for most of the US, a Passive House thermal envelope typically requires at least twice the R-value as required by the building code. Superinsulated Passive Home projects, since they are so well sealed, also require a special ventilation system—what McDonald refers to as a "lung" for the building—that also provides energy recovery. The energy recovery ventilator, or ERV, works by bringing in fresh air from the outside, while exhausting stale air out. "The air from the outside absorbs the heat from the exhaust air as it's vented into the house, leaving the air that's vented outside a cooler temperature," McDonald explains. This, of course, reduces energy losses to the exterior, and the constant air exchange works in tandem with the superinsulation so that buildings do not need to be heated and cooled to such extremes. The goal is to construct a structure that's so well insulated and regulated that it remains a constant temperature, even when heating and cooling are cut.

McDonald used an ERV in his project, but Torres Moskovitz used a heat recovery ventilator (HRV) in her project, which is similar and can become an ERV by just switching out a part. The energy reductions in both projects' PHPP models have so far proven accurate. "The Tighthouse owners are amazed by their utility bills," Torres Moskovitz says. "In that project, we literally monitor the electrical load of every circuit so we can adjust anything that's off." McDonald's experience has been similar in the Belfield Townhomes, where he also monitors all electrical circuits and compares electrical usage across the three-unit complex. "Since we have a multifamily complex, we like to

Vahid Mojarrab designed Andalusia in New Mexico to Passive House guidelines, but the multiunit component of the project also helps save on energy because of the efficiency inherent in shared walls.

SITE PLAN ANDALUSIA

ANDALUSIA

Why it's notable: Andalusia mitigates New Mexico's temperamental climate with an exterior sun-shading system. The screen covers the building's façade so that perfect solar radiation levels can be achieved and the natural energy can be harnessed to fuel the complex's energy needs.
Type of structure: Composed of two buildings, the multifamily complex features both an existing structure and a more modern building that sits adjacent.
Design elements: The new building references the renovated structure, deploying minimal finishes and square volumes that are typical to the area. Parking is also planned in a lane and streetscape style, eliminating the need for a large surface lot and keeping the complex integrated with the neighborhood's street grid pattern.
Energy solutions: The sunscreen and solar array optimizes solar energy capture, eliminating the need for additional large power sources.

DETAILS

LOCATION Clovis, NM
Size 2.4 acres
Completed Under construction
Certification PHIUS (expected)
Climate Zone Mixed-dry
Energy Use Intensity Not applicable
Client City of Clovis
Architect WAMO Studio (Vahid Mojarrab and Carol Ware)

show each of the families and the landlord all the statistics so they can see and compare how they're using energy," he says. "The key to all of this is to educate people about value of understanding their energy consumption, something that's not common in this country."

It's this clear, results-oriented approach, coupled with the movement's scalability and long-term financial practicality, that's inspiring architects and builders to adopt Passive House practices. "The amazing thing about Passive House is that it works," McDonald says. "You design a building, run it through the software, build it, and it just works. Occupant behavior, however, is the greatest variable, but this comes with education."

Both architects are hopeful for the Passive House movement's success, and they're confident that it won't take much more time to really take off. "More young people who are designing homes or who are having them designed are moving toward Passive House because they see it as a tool, not as a hindrance," Torres Moskovitz says. "As a designer, once you've done one Passive House project, it's hard to go back. You can't help but apply its techniques to all your projects in the future."

"The amazing thing about Passive House is that it works. You design a building, run it through the software, build it, and it just works."

TIM MCDONALD, ONION FLATS

McDonald phrases this idea a bit differently, but the sentiment is the same. "Passive House is a standard that really allows buildings to be what I call 'Net-Zero-Energy-Capable,'" he says. "And if you look at a project holistically, as we do, they don't have to cost any more money. If you can design and build a building that can achieve net-zero energy at a zero premium, there should be zero debate."

This is the ultimate Passive House goal, and as the building industry continues to green itself, it's a safe bet that many will do so through the calculated, cost-effective strategies outlined by the Passive House standard. gb&d

BELFIELD AVENUE TOWNHOMES

Why it's notable: Commissioned by the Philadelphia Redevelopment Authority, the Belfield Townhomes actually are affordable housing. The complex houses three families and, at completion in 2012, became Philadelphia's first Passive House-certified project.

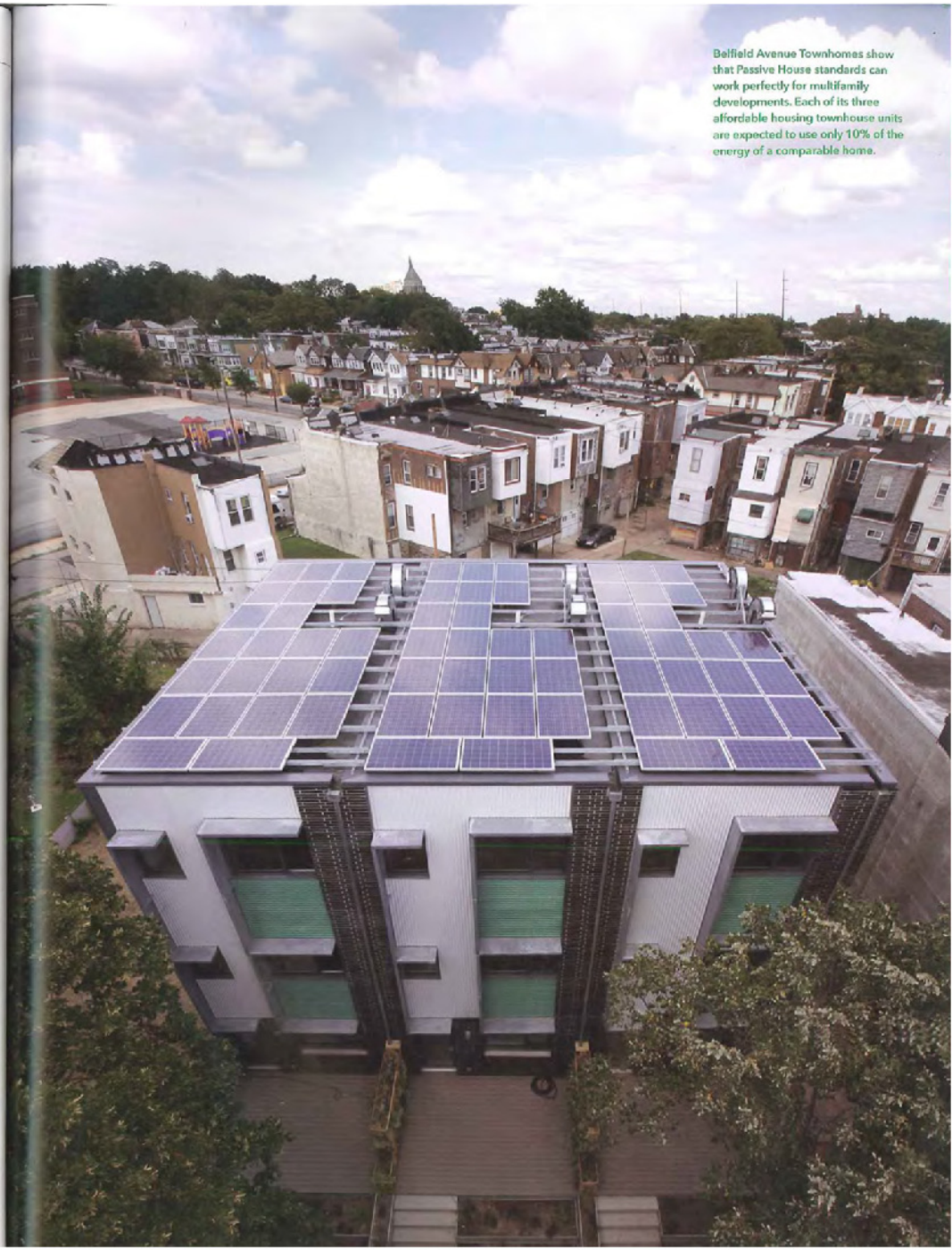
Type of structure: The walk-ups clock in at nearly 6,000 combined square feet. Each townhome contains four or five bedrooms, and the structures themselves are composed of modular, factory-built units.

Design elements: A pared-down aesthetic pays homage to the complex's modular construction, and big front stoops let the Belfield tenants connect with their neighbors.

Energy solutions: McDonald and his team monitor every electrical circuit in all three homes so that energy use can be carefully controlled. A solar array also helps power the units.

DETAILS

LOCATION Philadelphia
Size 1,920 ft²
Completed 2012
Certification PHIUS+ Passive House
Climate Zone Cold
Energy Use Intensity 38 kBtu/ft²/yr (expected)
Client Raise of Hope, Philadelphia Redevelopment Authority
Developer/Architect Onion Flats/Plumbob (Tim McDonald, Howard Steinberg, Ted Singer, Dan Magno)
General Contractor JIG Inc.



Belfield Avenue Townhomes show that Passive House standards can work perfectly for multifamily developments. Each of its three affordable housing townhouse units are expected to use only 10% of the energy of a comparable home.

PHOTOS: SAM OBERTER