

# Building a Net-Zero Production Home

Low energy costs  
don't have to come  
at a high price

BY SEAN GROOM

Last year, *Fine Homebuilding* launched the ProHOME series with a custom-designed and custom-built demonstration house in Rhode Island. The ProHOME program was created as a resource for builders and designers. With an in-depth exploration of the different approaches builders take when constructing high-performance houses, we intend to foster a conversation about design, envelope assemblies, materials, and craftsmanship.

Building on the momentum from the 2016 project, this year's ProHOME is a production-built house in a small development of net-zero-ready houses in Wilder, Vermont, all with a focus on affordability and universal design principles. The design is intended to be quickly built and easily duplicated while meeting stringent air-sealing and performance standards and a strict budget. To remain competitive in their market, the houses in this area need to sell at approximately \$140 per sq. ft., even considering the lower heating and cooling costs of a net-zero house, so it is critical to drive construction costs as low as possible while maintaining performance. □

Sean Groom is a contributing editor.



## PROVEN PERFORMANCE

Production building is about balancing curb appeal and energy performance with adaptable and repeatable assemblies. The 2017 ProHOME is the second house in an eight-home net-zero-ready development where double-stud walls and Passive House-worthy air-sealing result in lower utility costs without high construction costs.



## THE DESIGN/BUILD TEAM

The 2017 ProHOME is an opportunity for *Fine Homebuilding* to showcase the construction of an affordable net-zero house. Last year, Paul Biebel worked with *FHB* on three articles related to high-performance building measures and costs. We feel his approach and the success of his homes is worth exploring and sharing in detail. As we cover the design, assemblies, and materials used in the ProHOME in the magazine, Tim Biebel will be covering the weekly progress and details of the building methods on the ProHOME blog.

[www.finehomebuilding.com](http://www.finehomebuilding.com)



Since starting Biebel Builders in Vermont in 1976, **PAUL BIEBEL** has grown his business from a two-man operation to a design/build firm specializing in energy-efficient

construction that utilizes solar panels to create net-zero housing. Even after 40 years in the business, Paul is still trying new things. In 2009, he launched the Prudent Living brand to focus on high-performance homes.



**TIM BIEBEL** has been vice president of Prudent Living since its founding in 2009. Prior to that, he worked in construction as a laborer and

foreman on a wide variety of projects. He holds certifications from building organizations such as the North American Board of Certified Energy Practitioners and the Building Performance Institute.

## AN INFILL DEVELOPMENT COMES WITH CONSTRAINTS

Paul and Tim Biebel are building an eight-home community of net-zero houses. Their site is in an established neighborhood, tucked behind an existing house and enclosed by roads along the front and back property lines. They purchased the development from a builder who had roughed-in a road and permitted the eight lots. To avoid the time and cost of getting new zoning approvals and permits, Prudent Living decided to work from the original permits. That means the lot sizes, layouts, and house footprints are fixed and are relatively unchangeable.

The small adjustments made to the preexisting site plan were driven by Paul and Tim's goal that each home be capable of net zero if the homeowner is willing to invest in a PV array: The orientation of each house was adjusted to align the roof ridges east-west to maximize southern exposure, and the homes were pushed far enough apart on the 0.3-acre lots to prevent solar shading of the house next door.

All storm-water runoff—even during so-called "100-year" events—has to be contained on the property. To make this work, each house will include a rain garden and be graded so additional runoff is captured by swales and channeled to the large catchment basin at the north end of the property. To limit hardscapes, the turnaround at the end of the street and the emergency-access path at the northern end of the development are constructed with pervious grass pavers. To limit hardscapes, the turnaround at the end of the street and the emergency-access path at the northern end of the development are constructed with pervious grass pavers.



**Tweaking an existing plan.** Working from existing zoning plans and permits, the builders were limited in the size and location of the houses. But to improve solar exposure, the footprint of each house was rotated for east-west alignment.

### ProHOME SPONSORS

The 2017 ProHOME is supported by a host of industry sponsors. As a brand, we're not comfortable telling you to put products in your homes that we wouldn't put in ours. We've worked with our build team to identify appropriate products to include in this project. Our sponsorship model is built on an invitation-only, first-come, first-served basis. A variety of methods and products are available to construct a home of this caliber, but we chose based upon what works best to meet the goals for this home. For a complete list of project partners and more information on the products and materials used in the 2017 ProHOME, visit [FineHomebuilding.com/prohome](http://FineHomebuilding.com/prohome).



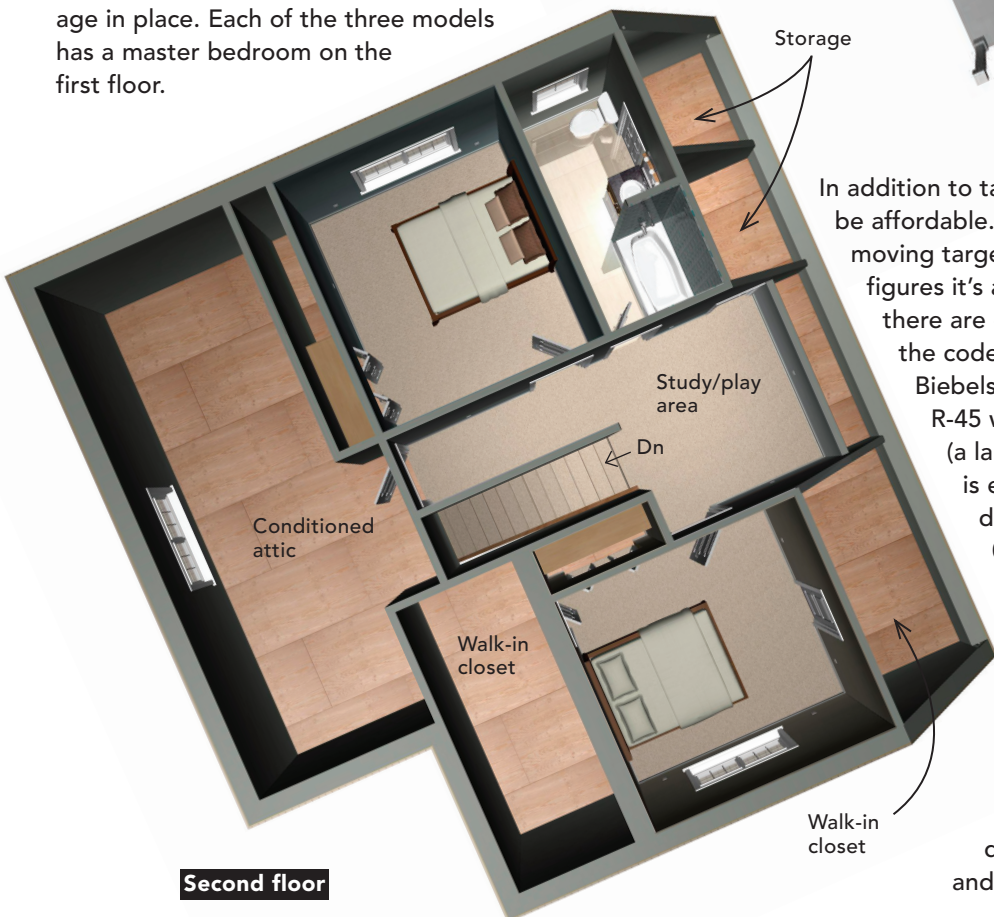
## AFFORDABILITY BALANCES DESIGN AND PERFORMANCE

Prudent Living has bet on the appeal of net-zero housing. That means design is driven by energy performance. Paul is convinced that the up-front cost of a net-zero house will not only pay for itself inside the first decade of ownership, but that the home will be more valuable over time. He asks potential buyers to think about the value of a code-built home compared to a net-zero home 15 years from now when it's selling in a market where new homes are built to more stringent codes than they are today.

The 2017 ProHOME is a spec house, which means Paul and Tim had to ask themselves, "Who is the likely customer for a net-zero house?" Based on the inquiries they see on the custom-home side of their business, they decided that all the spec houses in the development have to appeal to people who are downsizing and should allow them to age in place. Each of the three models has a master bedroom on the first floor.



**First floor**



**Second floor**

In addition to targeting empty nesters, the houses have to be affordable. "Affordable" is both a nebulous term and a moving target in the building world: In their market, Paul figures it's about \$300,000. With a net-zero-ready house, there are costs involved in raising performance above the code-mandated minimum. In the ProHOME, the Biebels have invested in R-15 subslab insulation, R-45 walls, and an R-60 roof. Plus, additional time (a labor cost) goes into air-sealing. This house is expected to match the performance of the development's model home, which tested at 0.55 ACH50. To control costs, the houses have slab-on-grade foundations and builder-grade finishes like engineered flooring, carpeting, and fiberglass tub surrounds. As with most production-built developments, the buyer has an allowance for finishes. In the ProHOME, the finishes will be higher quality (and therefore more costly) than the typical house in the development, but the floor plan, framing plan, and envelope details are all the same.