

**Small home, big benefit.** Duke Street Cottages make up a “pocket neighborhood”—a venue for sustainable workforce housing aimed at first-time and low- to middle-income buyers.



PHOTOS COURTESY OF HOWARD BUILDING SCIENCE

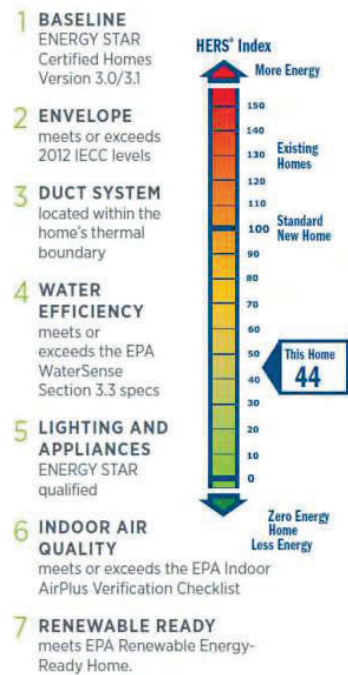
## Project Info

**PROJECT NAME:** Duke Street Cottage Two Bedroom, Granite Falls, North Carolina

**BUILDER:** Howard Building Science, Granite Falls, North Carolina,  
[howardbuildingscience.com](http://howardbuildingscience.com)

**COMPLETED:** January 2023

### What makes a home a DOE ZERO ENERGY READY HOME?



# Housing for All

This 'pocket neighborhood' and others like it may become a big deal in housing development.

Builder Rob Howard first heard the term "pocket neighborhoods" in 2018. Now he's close to realizing his dream of building one with completion of the ninth of 11 small homes on a 1.25-acre parcel he's dubbed Duke Street Cottages in Granite Falls, North Carolina.

For Howard, pocket neighborhoods are the perfect venue for what he refers to as workforce housing—homes aimed at first-time and low- to middle-income buyers. "Our goal is to provide more housing choices with small homes that anyone can afford, including recent college graduates with student loan debt and retirees on a fixed income," says Howard.

"We are building towards a sustainable future where everyone has a safe, healthy place to call home," says Howard. "We believe that everyone deserves to live in the SHADE: a Sustainable, Healthy, Affordable, Durable, Efficient home."

Howard's roadmap for getting there is the U.S. Department of Energy (DOE)'s Zero Energy Ready Home (ZERH) program. Every one of the 11 Duke Street Cottages will be certified to the program's criteria.

Howard achieved a DOE Housing Innovation Award in 2024 for one of the homes, an 800-square-foot, two-bedroom, one-bath, one-story home in one of two floor plans built to date at Duke Street. The compact home epitomizes Howard Building Science's company motto: "Proving that Sustainable is Attainable."

"Every decision we make about construction materials and processes has to pass a cost-effectiveness test," says Howard. "This cost-benefit analysis was burned into my brain from 15 years with Habitat for Humanity. We cannot just throw money at

the problem of attainable housing. We have to optimize the material and labor resources to achieve the highest performance for the lowest cost."

## SMALL BUT MIGHTY

The Duke Street Cottages may be small in volume, but they are big on performance. The DOE program has ENERGY STAR and EPA Indoor AirPlus home certification and the latest energy codes as its baseline, so every certified home provides its home buyers with the health, resiliency, and utility bill savings these programs offer.

The DOE program offers multiple performance paths and builders are free to choose what building assembly methods and tradeoffs they will use to meet their performance targets.

For the first nine homes, Howard chose a panelized wall assembly. The panel product for this home consists of a 3.5-inch-thick closed-cell polyurethane foam core adhered to an inside-facing layer of OSB and an exterior layer of OSB with a coating that serves as a water-resistant air control layer.

The panels came to the site precision cut to the dimensions of the home's design. This particular product uses inter-locking camlocks that ensure fast, foolproof connection of the panels. Spray foam was applied at the panel edges before connecting for airtight joints. Factory-formed corners provide for a complete air seal and continuous insulation at this otherwise hard-to-detail juncture. Pre-framed openings contribute to a fast assembly time, even with unskilled labor.

"With a small crew made up of two skilled carpenters and three college students, we were able to set the wall and roof panels in three days," says Howard. Howard added

1-by-4 furring strips to the exterior of the SIPs to create a drainage plane and nail base for the engineered wood siding.

The same panel product was used to provide the roof, although the panels were thicker with a 5.5-inch core of closed-cell spray foam providing an R-40 roof in a simple gable design that was topped with asphalt shingles.

## MORE FOR THE MONEY

Howard took many steps toward making the house as energy efficient—and cost effective—as possible.

The home sits on a crawlspace constructed of concrete masonry unit (CMU) blocks, insulated on the interior with R-10 rigid insulation; the ground is lined with a 10-mil vapor barrier. A dehumidifier is installed in the crawlspace to control relative humidity and prevent mold growth. Temperature and humidity sensors are also placed in the crawlspace to monitor conditions and send alerts remotely to homeowner's mobile phones.

In the foundation, Howard has really been able to optimize costs. "We considered using precast insulated concrete wall panels or ICFs for the foundation walls but determined that we could achieve the same performance at a much lower cost by using a combination of CMU and rigid foam insulation," he says. "We hired subcontractors to do our first crawlspace encapsulation but quickly realized that we could buy the materials and install them ourselves for a lot less money."

The double-pane windows provide an insulation value of U-0.25 and have a low solar heat gain coefficient of 0.19 to minimize solar heat gain in this mixed-humid IECC 4A climate zone.

### Annual Energy Costs

**\$900**

(without PV)

**N/A**

(with PV)

### Annual Energy Cost Savings\*

**\$600**

(without PV)

**N/A**

(with PV)

### Annual Energy Savings

**5,800 kWh**

(without PV)

**N/A**

(with PV)

### Savings in the first 30 years

**\$25,650**

(without PV)

**N/A**

(with PV)

\* vs typical new homes



## Key Features

**AIR SEALING:** 2.76 ACH50; closed-cell foam sill gasket; flashing tape on panel seams; stretch tape and liquid flashing around windows and doors; all penetrations sealed with spray foam and liquid flash.

**ATTIC:** Unvented, 5.5-inch R-40 panels with closed-cell spray foam core. 400-square-foot storage space.

**FOUNDATION:** Unvented crawlspace, concrete masonry unit walls insulated along interior with R-10 rigid foam. 10-mil vapor barrier on ground.

**HOT WATER:** Heat pump water heater, 50 gallon, 3.75 UEF. Core plumbing design.

**HVAC:** Ductless mini-split heat pump, 11.1 HSPF, 26.3 SEER. Dehumidifier in enclosed crawlspace.

**ENERGY MANAGEMENT SYSTEM:** Ventilation system controlled by sensors that monitor humidity, VOCs, smoke, carbon dioxide, and PM 2.5.

**ROOF:** Panels, gable roof: exterior face of panel is coated OSB.

**VENTILATION:** ERV, distributed system. Sensors to monitor humidity, VOCs, smoke, carbon dioxide, and PM 2.5.

**WALLS:** Panels, R-26 total: Closed-cell spray foam core, exterior face of panel has an integrated coating for rain screen and water control.

**WINDOWS:** Double-pane windows,  $U=0.25$ , SHGC=0.19.

**OTHER:** Electric vehicle charging station.



Howard took several steps to minimize drafts and air leakage in the building envelope, including taping the seams of the coated OSB, using a closed-cell foam sill gasket under the bottom plates, applying spray foam at the panel joints and around the windows and doors, installing stretch tape and liquid flash around the windows and doors, and sealing all penetrations in the building envelope with spray foam and liquid flash. Blower door testing is required on every ZERH-certified home and this home tested at 2.76 air changes per hour at 50 Pascals pressure differential.

An energy recovery ventilator (ERV) was installed to provide fresh air to the tight home while exhausting stale air. The ERV uses a heat exchanger to warm or cool the incoming air, which passes through a MERV 13 filter. Room sensors continually monitor humidity, VOCs, smoke, carbon dioxide, and PM2.5, and they can increase ventilation rates if sensors detect high levels of these air quality factors. A smart switch in the

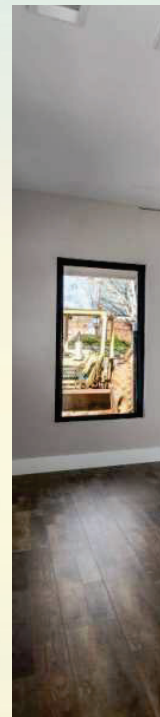
bathroom monitors relative humidity and automatically controls the bath exhaust fan.

The ERV also helps distribute conditioned air from the home's single ductless mini-split heat pump which is installed in the living room/dining room. The high-performance heat pump has a cooling efficiency of 26.3 SEER2 and a heating efficiency of 11.1 HSPF2 and performs well even at cold outdoor temperatures.

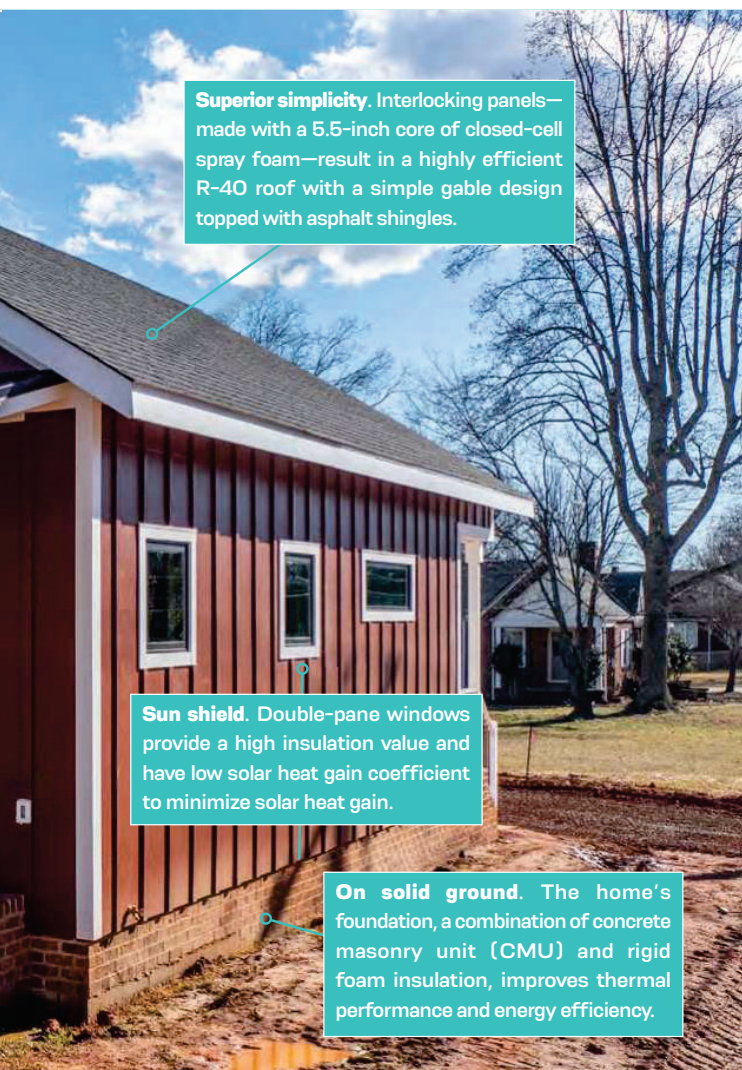
The home's 50-gallon heat pump water heater provides domestic hot water with an efficiency of 3.75 UEF. A core plumbing design was used to keep hot water distribution as compact as possible. Energy Star-labeled appliances and lighting, and a heat pump clothes dryer and induction cooktop add to energy savings.

### FROM THE POCKET

Howard has been interested in pocket neighborhoods since first hearing the term used by architect Ross Chapin, author of "Pocket Neighborhoods: Creating Small







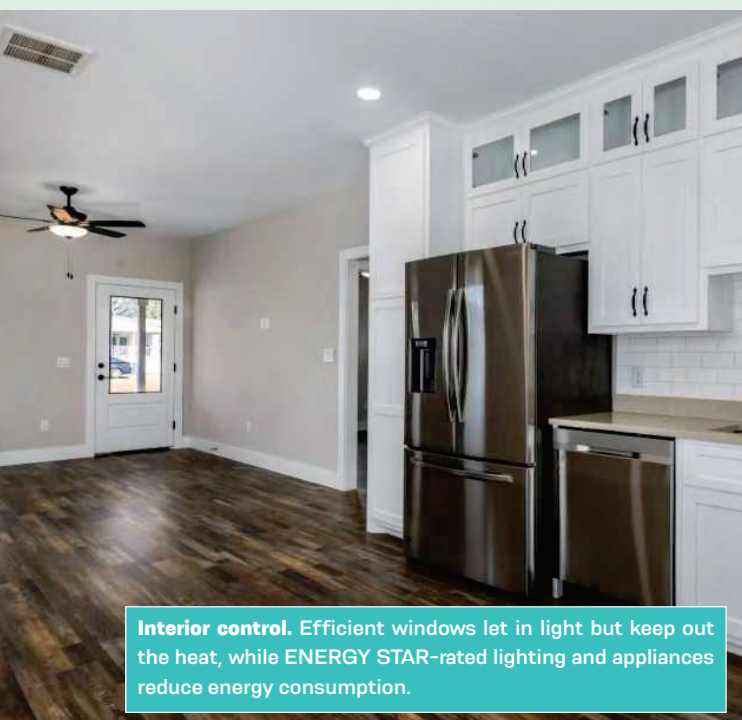
**Superior simplicity.** Interlocking panels—made with a 5.5-inch core of closed-cell spray foam—result in a highly efficient R-40 roof with a simple gable design topped with asphalt shingles.

**Sun shield.** Double-pane windows provide a high insulation value and have low solar heat gain coefficient to minimize solar heat gain.

**On solid ground.** The home's foundation, a combination of concrete masonry unit (CMU) and rigid foam insulation, improves thermal performance and energy efficiency.



**Compact gear.** Energy-saving appliances abound throughout Duke Street Cottages, such as this space-saving, stackable washer-dryer laundry hub with smart features.



**Interior control.** Efficient windows let in light but keep out the heat, while ENERGY STAR-rated lighting and appliances reduce energy consumption.

Scale Community in a Large Scale World,” at a conference in 2018. Howard already has plans for two more pocket neighborhoods in the works on property he has acquired.

But first he wants to finish Duke Street Cottages. Nine of the 11 homes have been built and sold so far; homes 10 and 11 will be modular construction. “That was not the original plan, but I ran into a right-of-way conflict with the railroad that backs up to our property,” Howard says. “I had to shrink the footprint of the last two homes from 24 feet wide to 16 feet wide. I realized you can only ship home modules up to that smaller size.” He also found a factory partner in South Carolina who would construct the modular homes to DOE ZERH standards.

Howard’s first foray into pocket neighborhoods has generated a lot of interest. Once he started building

the Duke Street Cottages, word got around. “Builders and developers just show up at the site to see what I’m up to—a lot of them are intrigued by this idea,” says Howard. “One morning I came out at 8 a.m. and there was someone walking the site. He was in town visiting family. He and his wife are now my business partners.”

Although the home does not have solar installed, it is roughed-in for a future solar array on the roof. “We are currently talking to LG about testing its new *Home 8 Energy Storage System* on one of the homes at Duke Street Cottages. With batteries and an 8-kW PV array, we can achieve net-zero energy with minimal dependence on the grid,” says Howard. “Our ultimate goal is for all of our homes to achieve net-zero energy.”