

Caldwell and Johnson

Church Community
Housing Corporation
Charlestown, RI



BUILDER PROFILE

Caldwell and Johnson
North Kingstown, RI
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Church Community Housing Corporation 1
- Location: Charlestown, RI
- Layout: 3 bedrooms, 1.5 baths, 2 floors
- Conditioned Space: 2,244 ft² with basement
- Climate Zone: IECC 5A, cold
- Completion: July 2014
- Category: Affordable

Performance Data:

- HERS Index: without PV 47
- Projected Annual Utility Costs: without PV \$2,362
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): without PV \$1,294
- Annual Energy Savings: without 10,551 kWh, 34 therms natural gas

For custom home builder Dave Caldwell, getting his first affordable home qualified as a U.S. Department of Energy Zero Energy Ready Home was an opportunity to prove a point to himself and to the Rhode Island building community.

“There is no reason why this level of construction can’t be done across the board,” said Caldwell, who has built DOE Zero Energy Ready Homes in the high-end, middle-income, and now affordable ranges. Caldwell’s firm, Caldwell and Johnson, cofounded by his father in 1968, has gained a reputation for high-end custom homes and historic renovations in coastal Rhode Island. He will complete eight custom homes this year, most of them certified as DOE Zero Energy Ready Homes, but his first certified home was a modest 2,000 ft² rancher completed in 2012, that cost \$400,000 to build and saves its homeowners an estimated \$2,890 a year in utility costs (compared to a home built to the 2009 International Energy Conservation Code).

The DOE Zero Energy Ready Home program saves energy by requiring builders to meet a suite of energy, health, and durability requirements including those of ENERGY STAR Certified Homes Version 3.0 and the U.S. Environmental Protection Agency’s Indoor airPLUS program, as well as the hot water distribution requirements of the WaterSense program. In addition, they must meet DOE Zero Energy Ready Home prescriptive or performance requirements, and a checklist of “renewable-ready” solar power measures that encourage wiring the home for solar photovoltaic panels.

Since certifying his first home in 2013, Caldwell has committed to aiming to meet these requirements on every home he builds, regardless of the price range. “High-end houses are fun, they have all the bells and whistles, but I wanted to show that you can do this with affordable housing too. You don’t have to get carried away with the fancy stuff. You just need a tight envelope and good HVAC,” said Caldwell.



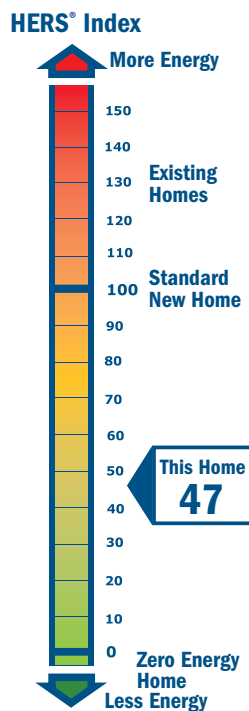
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE’s Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0 for an energy-efficient home built on a solid foundation of building science research. Advanced technologies are designed in to give you superior construction, durability, and comfort; healthy indoor air; high-performance HVAC, lighting, and appliances; and solar-ready components for low or no utility bills in a quality home that will last for generations to come.

The walls are filled with 5.5 inches (R-23) of 2-lb open-cell spray foam. Open-cell spray foam coats the underside of the roof deck providing an insulation value of R-50 in the attic. Closed-cell spray foam coats the inside walls of the basement and covers the ground under the 12-inch concrete slab, providing both a vapor barrier and an R-12 insulation layer. Open-cell spray foam insulates and air seals the rim joist under the first floor.



What makes a home a DOE ZERO ENERGY READY HOME?

- 1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0
- 2 **ENVELOPE**
meets or exceeds 2012 IECC levels
- 3 **DUCT SYSTEM**
located within the home's thermal boundary
- 4 **WATER EFFICIENCY**
meets or exceeds the EPA WaterSense Section 3.3 specs
- 5 **LIGHTING AND APPLIANCES**
ENERGY STAR qualified
- 6 **INDOOR AIR QUALITY**
meets or exceeds the EPA Indoor airPLUS Verification Checklist
- 7 **RENEWABLE READY**
meets EPA Renewable Energy-Ready Home.



“There is a perception that energy-efficient construction is too expensive to be affordable,” said Caldwell. “I like the DOE Zero Energy Ready Home program because it’s not just about high-end homes. It’s about good construction technique. You don’t have to reinvent the wheel. All you have to do is follow DOE guidance. It’s already mapped out for you.”

Caldwell has the opportunity to share this message through the Rhode Island State Builders Association. He serves as association secretary and sits on the Low and Moderate Income Housing Committee where he is involved in state policy on affordable housing.

“I think we are not paying enough attention to low-income housing,” said Caldwell, which is one of the reasons he jumped at the chance to bid on this affordable project in Charlestown, Rhode Island. The project will eventually include seven homes on property jointly acquired by Church Community Housing Corporation (a nonprofit that supports local affordable housing) and South County Habitat for Humanity. Caldwell completed construction on the first affordable home in the development in June 2014, and will complete construction on the second home, also DOE Zero Energy Ready Home certified, in December 2014. He also plans to bid on two more homes for Church Community Housing.

“Church Community Housing Corporation was very interested in building to the DOE Zero Energy Ready Home Certification,” said Caldwell. “I believe the greatest value of this type of building technology is for low-income occupants. Upper income clients like it, but it doesn’t have such an impact on their finances. For low-income buyers, that extra \$50 a month is something they can really use. If you can save them \$1,000-1,800 a year and they are making only \$30,000 a year, that savings has a significant impact on their finances.”

“I’m meeting with another community development agency this month. They saw our project and said ‘we can’t get this level of construction for this price.’ They want to know how we did it,” said Caldwell.

Caldwell kept the costs down by using a simple, two-story rectangle design and streamlining processes. After the basement was dug and the footing and foundation walls were poured, a spray foam contractor came in and sprayed 2 inches (R-12) of 2-pound, closed-cell spray foam directly on the ground and up the inside of the basement walls. This foam provided an R-12 insulated bowl in which to pour the 4-inch-thick concrete floor slab. The closed-cell foam also



The home's walls are constructed with a 2x6 insulated stud product consisting of 2x4 lumber with 1.5 inches of extruded polystyrene (XPS) rigid foam glued to one end and covered with .5-inch OSB, which serves as a nailing surface on the inside of the wall. The rigid foam serves as a thermal break preventing heat transfer through the studs.

served as a vapor barrier, preventing moisture from wicking through the walls or into the slab. The closed-cell foam stiffens to a smooth white coating on the interior basement walls. This hardened foam is painted with an intumescent paint, which serves as a code-required ignition barrier. "It looks like stucco," said Caldwell, who left it uncovered for the homeowner to frame and drywall later if they choose.

The walls were constructed with a 2x6 insulated stud product consisting of 2x4 lumber with 1.5 inches of extruded polystyrene (XPS) rigid foam glued to one end and covered with half-inch-thick OSB, which serves as a nailing surface on the inside of the wall. The rigid foam serves as a thermal break preventing heat transfer through the studs. "We found this to be a less expensive option than covering the entire exterior wall with a layer of rigid foam. We are investigating another product, a coated OSB with an adhered layer of rigid foam, that might be even more economical from an installation standpoint because it includes sheathing, insulation, and drainage plane in one step," said Caldwell.

The 2x6 wall cavities were filled with 5.5 inches (R-23) of 2-pound open-cell spray foam, which air seals and insulates the walls, achieving the same effect as caulking the sheathing to the studs, but eliminating the labor of that step. This open-cell spray foam was also applied to the underside of the roof deck, providing an insulated, unvented attic space. The spray foam was applied to a thickness of 12 inches and covered all of the attic rafters to eliminate thermal bridging at the rafter, minimize air leakage, and provide an R-50 insulation value.

In addition to providing a superb sound-deadening, continuous insulation blanket for the entire home, the spray foam also made the home very airtight. A blower door test showed that the home achieved an airtightness of 0.79 air changes per hour at 50 Pascals pressure difference (ACH 50), well below the 7 ACH 50 required by the 2009 IECC.

Caldwell selected especially high-performance R-5 triple-paned windows with low-emissivity coatings, argon gas fill, insulating spacers, and vinyl frames. The appliances were all ENERGY STAR-rated. The lighting fixtures were all high-efficiency LED- or CFL-based fixtures.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

ENERGY STAR Certified Homes
Version 3.0

EPA Indoor airPLUS

EPA WaterSense

National Green Building Standard,
bronze



Every DOE Zero Energy Ready Home combines a building science baseline specified by ENERGY STAR Certified Homes with advanced technologies and practices from DOE's Building America research program.



The home's heat pump water heater is located in the basement directly below the hot water fixtures on the first and second floors. The wall behind the water heater is covered with closed-cell spray foam painted with an intumescent ignition-barrier paint. The spray foam has a smooth hard surface similar to stucco.

"The mini-split system cost about \$8,000 installed. That was cheaper than the hydronic heat and hot water combo system, and the heat pump gives the homeowner cooling as well as heating," said Caldwell.

Caldwell installed an air-source heat pump water heater in the basement. Although the model installed typically costs \$1,100, rebates brought the cost down to \$300.

Caldwell estimated that the home cost about \$4,000 more than a similar sized home built to state code. "Nearly all of the extra money in the house is in the foam. But that's where all the savings are. And you've made back that extra cost in about 3 years," said Caldwell.

The triple-pane windows were a bit of a splurge, but at only a few hundred dollars extra for the R-5 insulation value, Caldwell felt they were worth it. He noted that costs savings were gained in other areas by value engineering and making tradeoffs when options were available that didn't sacrifice performance, such as with the doors and trim.

"The cost difference between building a DOE Zero Energy Ready Home and building a home to code is about 2%. As the cost to build code-complying houses goes up, that gap will get even smaller," said Caldwell. For the homeowner, the DOE Zero Energy Ready Home is cheaper to own than a code built home because of the monthly energy savings.

"I think it's a winner, its time has come," said Caldwell.

Photos courtesy of Caldwell and Johnson.

Photovoltaic panels have not been installed but, in keeping with DOE Zero Energy Ready Home requirements, the west-facing roof deck of 560 ft² has been constructed to accept photovoltaics in the event that a future homeowner is able to install them.

Although the original specifications called for a propane boiler, Caldwell chose to install a ductless mini-split heat pump system instead. The heat pump system has one outside compressor/condenser unit and four inside air handling units that are mounted on the walls in the three bedrooms and the open living area on the main floor.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** Framed 16 in. o.c. with insulated 2x6s (2x4s w/ 1.5 in. XPS + .5 in. OSB); 5.5 inches (R-23) 2-lb open-cell spray-foam cavity insulation; house wrap
- **Roof:** Roof insulated along underside of roofline with R-50 open-cell spray foam that covers rafters; light grey asphalt shingles
- **Foundation:** Concrete basement insulated along inside of walls and under slab with R-12 closed-cell spray foam
- **Windows:** Triple-pane, argon-filled, vinyl-framed. U=0.22, SHGC=0.27
- **Air Sealing:** 0.79 ACH 50
- **Ventilation:** Timed bathroom exhaust fans set up for continuous low-speed operation with a high-speed boost.
- **HVAC:** Mini-split air-source heat pump (8.5 HSPF, 18 SEER), 1 outside unit, 4 indoor units
- **Hot Water:** 2.4 EF air-source heat-pump water heater in basement
- **Lighting:** 50% LED, 50% CFL
- **Appliances:** ENERGY STAR-rated clothes washer, dishwasher, refrigerator
- **Solar:** Solar ready with wiring installed
- **Water Conservation:** EPA WaterSense plumbing fixtures