U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE

U.S. DOE CHALLENGE HOME 2013 WINNER Housing Innovation Awards

DOE CHALLENGE HOME CASE STUDY

Caldwell and Johnson

Exeter, RI

BUILDER PROFILE

Caldwell and Johnson
North Kingstown, RI
Dave Caldwell
401-885-1770
http:caldwellandjohnson.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Edies Lane House
- Location: Exeter, RI
- Layout: 3 bedrooms, 3 baths, 1 floor
- Conditioned Space: 2,046 ft^2, not including basement
- Climate Zone: IECC 5A
- Completion: Dec. 2012
- Category: Custom

Performance Data:

- HERS Index without solar PV: 46
- HERS Index with solar PV: NA
- Projected annual utility costs (without solar): $1,780
- Projected annual energy cost savings (compared to a home built to the 2009 IECC): without solar $2,890
- Builder's added cost over 2009 IECC: $8,000
- Annual energy savings: without solar 18 MMBtu

Why would a builder who already has a great reputation for building high-quality custom homes and more work than he needs sign up to be a U.S. Department of Energy Challenge Home builder? Ask Dave Caldwell, with Caldwell and Johnson, a custom home builder from North Kingston, Rhode Island, and he'll give you three good reasons: "It's the right thing to do. It gives us a competitive advantage in the marketplace. It's the top 1% and we want to be there," said Caldwell.

The company's first Challenge Home is a 2,046-ft^2 custom home on 1 acre in Exeter, Rhode Island, that was built for a realtor and her husband and should save its owners over $600 per year in energy costs compared to a home built to the 2009 IECC. The home also meets the National Green Building Standard ICC 700, silver level.

Although this is Caldwell and Johnson's first DOE Challenge Home, the builder knows a thing or two about energy-efficient homes. Caldwell was raised in a home built by his father that had solar heat and geothermal cooling by 1980. Dave Caldwell Senior, now 72, founded Caldwell and Johnson in 1968 and is still involved in day-to-day operations.

Caldwell and Johnson has committed to Challenge Home, green certification, and ENERGY STAR on all new homes it builds. The company, which Caldwell describes as a "big, small company," has eight full-time employees and builds about four to six new homes a year. The company also does about four to six energy-efficient remodels each year and has a reputation for quality renovation of Rhode Island's coastal vacation homes. They recently renovated an historic mansion that served as the governor's summer home during the post-Civil War era.

U.S. DEPARTMENT OF ENERGY CHALLENGE HOME

DOE Challenge Home builders are in the top 1% of builders in the country meeting the extraordinary levels of excellence and quality specified by the U.S. Department of Energy. Every DOE Challenge Home starts with ENERGY STAR for Homes Version 3 for an energy-efficient home built on a solid foundation of building science research. Then, even more advanced technologies are designed in for a home that goes above and beyond current code to give you the superior quality construction, HVAC, appliances, indoor air quality, safety, durability, comfort, and solar-ready components along with ultra-low or no utility bills. This provides homeowners with a quality home that will last for generations to come.

The unvented attic is insulated along the roof line to provide a conditioned space for the home's two mini-split heat pumps, which are individually ducted to each room. The 9 HSPF, 15.25 SEER heat pumps provide all the heating and cooling the home needs thanks to the super insulating properties of the open-cell spray foam that coats the inside of the attic ceiling, fills the wall cavities, and seals the foundation rim joists of the house.

CHALLENGE HOME CERTIFIED:

1 **BASELINE**
certified ENERGY STAR for Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

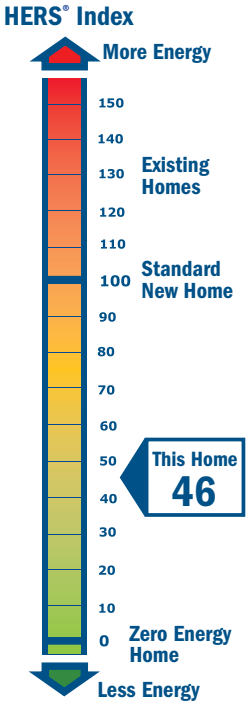
3 **DUCT SYSTEM**
located with the home's thermal boundary

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.



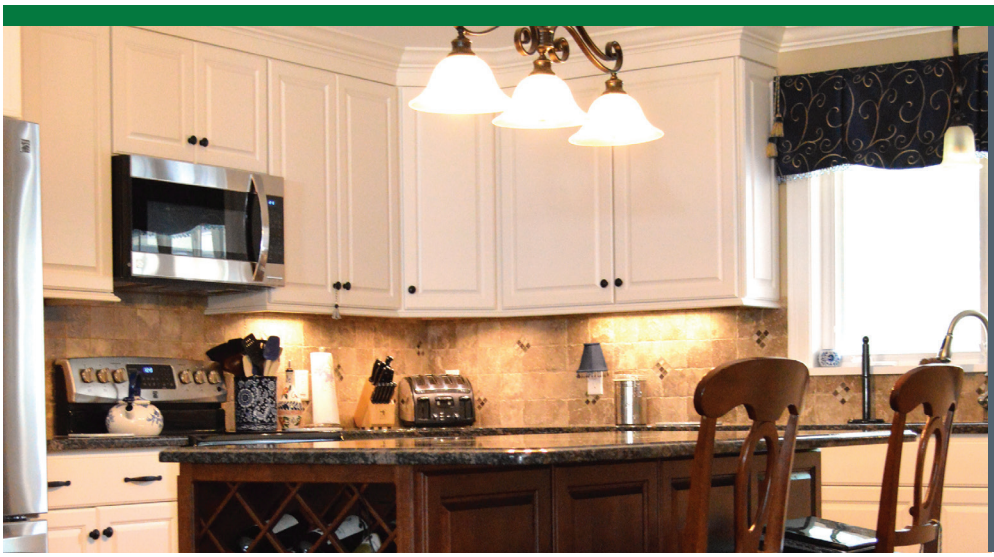
The company has gotten progressively more focused on energy-efficient and green construction over the years. "We are committed to trying to be the best builder we can be," said Caldwell.

After earning an MBA from the University of California at Irvine and serving as a commissioned officer with the U.S. Marine Corps in Iraq, Dave Jr., returned to home building and earned certifications as a LEED Accredited Professional and a Certified Green Professional. He now serves as a board member of Housing Works Rhode Island (RI), a board member of Grow Smart RI, a residential advocate for the RI Green Building Council, and an instructor for the Certified Green Professional Program through the NAHB University of Housing. He also serves as Director of the RI Builders Association, and is active with the RI Chapter of the U.S. Green Building Council. Dave Sr., a veteran with the Naval Seabees, serves as an appointed member of the RI Building Contractors Registration and Licensing Board and a Director of the RI Builders Association, along with membership in a host of volunteer organizations.

While the Caldwells enjoy giving back to the community, when it comes to construction, they like being in the lead. "I like pushing the envelope," said Dave Jr. "We are staying a step ahead of the competition."

The Challenge Home they've built is a great example. The home has achieved a Home Energy Rating System (HERS) score of 46 without solar panels. For comparison a home built to the 2006 IECC code would earn a score of 100. The remarkably low HERS score was achieved with some ordinary construction methods carefully applied.

The walls are standard 2x4, 16-inch on-center construction with OSB sheathing. The wall cavities are filled with 3.5 inches (R-13) of open-cell spray foam. On the exterior, the walls are further insulated with 1.5 inches of rigid-foam polyisocyanurate that is foil-faced on both sides. The rigid foam is taped at the seams with a proprietary tape so that it can serve as the drainage plane. A high-grade vinyl siding covers the walls. All trim is made from long-lasting PVC.



WaterSense faucets in the kitchen and bathrooms save water and energy. The water is heated by an air-source heat-pump water heater, which is located in the basement. More than 50% of the home's lighting is provided by highly efficient LEDs.

The attic is sprayed along the underside of the roof deck with R-46 spray foam. The basement foundation walls are cast-in-place concrete. Because the basement walls are uninsulated, the basement is thermally separated from the house by spray foaming all holes through the subfloor and spray-foam insulating the rim joist and stairway, then insulating under the first floor with R-30 batts.

While spray foam has excellent insulating qualities, it also provides exceptional air sealing. When this home was tested for air leakage with a blower door test, it showed total air leakage of only 0.65 air changes per hour at 50 Pascals pressure, well below the 2.0 ACH50 maximum allowed by Challenge Home requirements for the climate zone.

The windows are custom-made, locally built, double-pane, argon-filled, and vinyl-framed, with low-emissivity coatings, an insulating value of U=0.29, and a solar heat gain coefficient of 0.30.

For heating and cooling, the home is equipped with mini-split heat pumps, which have heating and cooling efficiency ratings of 9 HSPF and 15.25 SEER. The two indoor air handlers are ducted using flex ducts located in the conditioned attic; one heat pump serves the master bedroom and the great room and one serves the rest of the house. The ducts were tested for air leakage and showed 30 cubic feet per minute at 25 Pascals of total air leakage with 0 cfm leakage to the outside.

Because the home is so airtight, it was especially important to have a good ventilation system that brings fresh air into the home as well as exhausting stale air. The home was equipped with a heat recovery ventilator that has its own ducting, independent of the HVAC ducts. The home was also equipped with timered exhaust fans that are set for continuous low-speed operation but that can be switched to a higher speed after showering.

An air-source heat-pump water heater located in the basement provides hot water to the home.

HOME CERTIFICATIONS:

DOE Challenge Home

ENERGY STAR Version 3

NAHB National Green Building Standard – Silver

Every DOE Challenge Home combines building science specified by ENERGY STAR for Homes and advanced technologies and practices from DOE's Building America research program.

Most of the home's lighting uses LED sources; incandescent bulbs were used in a chandelier and a bathroom fixture at the homeowner's request. ENERGY STAR appliances and EPA WaterSense-rated plumbing fixtures contributed to resource efficiency.

No solar panels were installed on the home, but electrical wiring was installed to prepare the home for the installation of an 11.64-kW photovoltaic system.

"There really isn't anything exotic on this house. It's a nice home that has been designed with good HVAC, good insulation, and good air sealing," said Dave Jr. "I like this program (DOE Challenge Home) because that is the point of it, you can get to a really high-performance home without a lot of extra effort. There is more of an emphasis on energy and air quality than on material selection and finishes."

"Most of our business comes from word of mouth," said Caldwell. "When the recession hit, we used that time to push our energy efficiency. And we've gotten a lot of notoriety because of it. We can document green construction. We have demanding customers and we can show them the energy efficiency."

To provide fresh air to the remarkably air-tight home, a heat recovery ventilator was installed in the attic with its own supply and return ducts to the main living areas of the home. The HRV brings fresh air into the home. The incoming air is passed through a heat exchanger where it is warmed or cooled by outgoing air before being circulated through the home.

KEY FEATURES

- **Path:** performance
- **Walls:** 2x4 16-inch on-center framing, 3.5 inches (R-13) open-cell spray-foam cavity insulation and 1.5 inches (R-10) foil-faced polysiocyanurate rigid foam for R-23 total wall insulation. Vinyl siding, PVC trim.
- **Roof:** roof insulated along underside of roofline with R-46 open-cell spray foam
- **Foundation:** uninsulated concrete basement walls and slab. Spray foam at rim joists and all walls of staircase. Spray foam at all ceiling penetrations. R-30 batt between floor joists.
- **Windows:** low-E, double-pane, argon-filled, vinyl-framed. U=0.29, SHGC=0.30
- **Air Sealing:** 0.65 ACH50
- **Ventilation:** heat recovery ventilator in attic with supplies and returns to main living area, independent of HVAC ducts. Bathroom exhaust fans set up for continuous low-speed operation with a high-speed boost. HVAC has MERV 8 filter.
- **HVAC:** mini-split air source heat pump (9 HSPF, 15.25 SEER), 1 outside unit, two indoor units located in attic with supply ducts to all rooms and returns from the main living area. 30 cfm total duct leakage, 0 cfm leakage to the outside
- **Hot water:** 2.4 EF air-source heat-pump water heater in basement
- **Lighting:** >50% LED recessed lights
- **Appliances:** ENERGY STAR-rated clothes washer, dishwasher, refrigerator
- **Solar:** solar ready with wiring installed
- **Water Conservation:** timer-controlled irrigation
- **EPA WaterSense:** showerheads, faucets, toilets

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