Performance Driven: Perspectives on the DOE Zero Energy Ready Homes

Lois B. Arena, PE
EEBA 2014
ZERHomes Verified

20 homes

11 of 25 homes complete

First of 7 homes

11 townhomes

Under construction

...and more coming
The Performance House

Old Greenwich, CT

Size: 2,700 ft² (excluding basement)
HERS Index: 42 (20 with PV)

Key Features:

• 2x6 wood framed walls with spray applied elastomeric sealant, R-21 blown cellulose cavity insulation, membrane-coated OSB sheathing, 1.5” XPS rigid insulation (R-7.5), mesh rain screen, fiber cement siding
• Unvented attic with ~4” ccSPF, 3” fire-rated mineral wool batt, and 3.5” foil-faced fiberglass batt (total R-52).
• Foundation is insulated with 2” ccSPF under the slab and 3” ccSPF on the interior walls
• Tightly sealed house, $ACH_{50} = 1.0$
• Whole-House ERV with $CO_2$ override control

While the home does use natural gas for heating and hot water, the homeowners have not had to pay for any electricity beyond the monthly service charge.
Water Efficiency

• To minimize hot water waste (improve comfort), a two trunk structured plumbing configuration was used and an on-demand recirculation system was installed for use in the bathrooms, kitchen, and laundry room.

Distribution System Designed by Gary Klein
Observation from the Field

Instead of:
- full cavity spray foam or
- flash-and-batt cavity strategy to air seal the framing,

Less expensive strategies:
- a spot applied elastomeric sealant system or
- exterior liquid-applied air barrier are being used to air seal prior to wall cavities being filled with dense-packed blown insulation.
Additional Observations

Builders are using the exceptions for ducts completely within the conditioned space. In this case, a duct running in the garage ceiling to the office above was sealed with spray foam prior to the floor cavity being fully filled with cellulose insulation.

Builders and homeowners still want fireplaces, but often the heating loads are so small that the room overheats with several minutes, making the fireplace unusable.
EcoVillage

Ithaca, NY

Size: 1,256 ft²
HERS Index: 39 (16 w/ PV)

Key Features:

• 12” double stud wall assembly with 3.5” of ccSPF in the outer stud and the remainder dense packed with cellulose – R-52, or 12” double stud wall assembly dense packed with cellulose – R-43

• Raised truss heel is spray foamed, vented attic filled with R-90 blown cellulose and spot spray foam to provide critical air seal of ceiling plane

• Tightly sealed house, ACH₅₀ = 0.6
Continuous Air Barrier

- Eave Gutter 20G to match roof.
- Fiber cement per soffiting.
- 2x4 purlins

1 1/4" x 2 1/2" Hmr
apply to all tnrng
Low Loads

Design Heating Loads in this Passive House are so small (4-6 kBtuh) that the most effective and economical solution was electric resistance baseboard.
Whole-House Ventilation
Whole-House Ventilation

- **ERV Power [Watts]**
  - 120 Watts
  - 220 Watts

Graph showing the ERV power usage from 1/31 to 8/29 with two distinct peaks at 120 Watts and 220 Watts.
Brookside Development

Derby, CT

Size: 2,891 ft² (above-grade)
HERS Index: 45 (26 with PV option for homebuyers)

Key Features:

- 2x4 wood framed walls, 16 in o.c., OSB, R-18 cavity insulation with 2'' ccSPF & 2'' compressed FGB, exterior ci R-6.5
- Vented attic with R-60 cellulose, spot applied spray foam for critical air seal @ ceiling plane
- Tightly sealed house, $ACH_{50} = 2.0$

The ceiling plane was selectively sealed with spray foam.
In the initial testing, after slight adjustments to balancing dampers to reduce the amount of airflow going to the second floor supplies, all supply registers were within 25 cfm of the design (heating, high speed) flow rate. Still there was a desire to balance the system within 20% of design flows to ensure that critical rooms, like the main living space (the open concept living room, dining room, and kitchen) and master bathroom, were adequately supplied.
Water Efficiency

Initial design discussions with the plumber on the program requirements were ignored and the end result was a system that had excessive stored water in the DHW distribution system due to the use of a central trunk that runs from the basement up to the 2nd Floor for all branch take offs.
To meet the water efficiency requirement, a recirculation pump was installed at the furthest location (2nd Floor Bathroom) and wired to on-demand buttons at all fixtures except Master Bathroom.
Additional Observation

We often find these Indoor airPLUS requirements often trip project teams up:

- Green Guard carpeting and pad
- low formaldehyde & certified composite/sheathing

So make sure to remind the project team throughout the design and construction process about these material selection requirements.
BPC Green Builders

Danbury, CT

Size: 1,680 ft$^2$ (above-grade)
HERS Index: 35 (no PV)

Key Features:

- 2x6 wood framed walls, 24 in o.c., ½” plywood with taped joints, R-20 cavity insulation with dense pack cellulose, two layers of exterior R-38 rigid insulation
- Vented attic with R-68 blown cellulose, spot applied spray foam to provide critical air seal of ceiling plane
- Tightly sealed house, ACH$_{50}$ = 0.42
- Single mini-split heat pump in central living space. Internal fan to circulate air throughout home.
Gainfort-McKay

New Fairfield, CT

Size: 3,052 ft²
HERS Index: 39 (no PV)

Key Features:

- Double wall construction (2x6 outer wall, 2x4 inner wall with offset studs), R-33 blown cavity insulation
- Flat roof with R-72 total (R-33 cellulose between joists, plus R-39 polyiso above roof deck)
- Foundation consists of R-20 under slab insulation and 3” XPS on exterior of foundation walls, plus 1.5” XPS on interior.
- Triple-pane, argon-filled, low-e coated fiberglass-framed windows (U-0.2, SHGC-031)
- Tightly sealed house, $ACH_{50} = 0.45$
Murphy Brothers

Greenwich, CT

Size: 4,100 ft²
HERS Index: 40 (27 with PV)

Key Features:

- Insulated Concrete Forms (R-21) make up the foundation and exterior walls.
- The attic is a cathedralized, unvented attic (R-70) that encloses the mechanical room thereby bringing the HVAC equipment and ductwork inside the conditioned envelope.
- 4-5” of ccSPF under slab
- Tightly sealed house, $ACH_{50} = 0.96$
- Nest Thermostats

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Value to Consumer

“As a family business owner and a family man I am vitally concerned with the impact of our work on future generations. I think this house is a step in the right direction to showcase energy-efficient construction and its future in residential construction. I would encourage others to join the effort and building a DOE Zero Energy Ready Home is a great way to jump in!”

- Chris Murphy, Murphy Brothers Contracting, Inc.

“People have a sorts of misconceptions about the sacrifices that they need to make in a high performance and it is completely untrue. It is exactly the opposite. The even temperatures, the lack of drafts, the feeling of warmth, comfort, and right levels of humidity and fresh air, they are unrivaled in existing homes. Comfort is something you have never experience properly in a home until you have a high performance home.”

- Mike Trolle, BPC Green Builders, LLC.
Thank you.
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QUESTIONS?