



Performance Driven: Perspectives on the DOE Zero Energy Ready Homes

Lois B. Arena, PE
EEBA 2014

ZERHomes Verified



20 homes



11 townhomes



11 of 25 homes complete



First of 7 homes



Under construction

...and more coming

The Performance House



Old Greenwich, CT



Size: 2,700 ft² (excluding basement)

HERS Index: 42 (20 with PV)

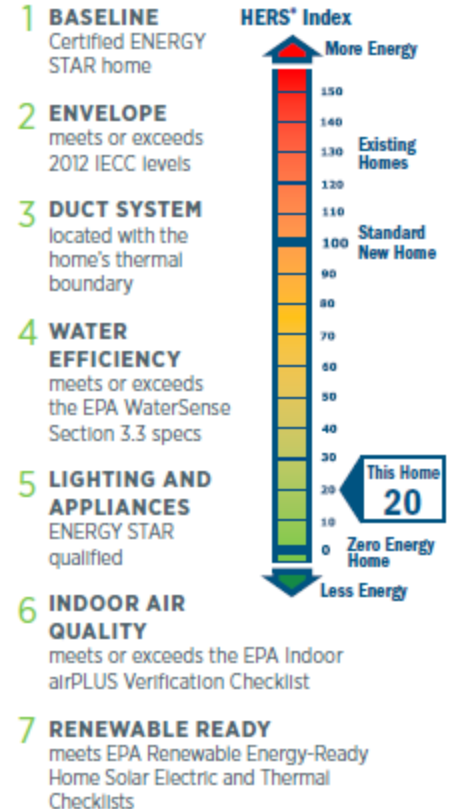
Key Features:

- 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, ACH₅₀ = 1.0
- Whole-House ERV with CO₂ override control

Steven Winter Associates, Inc.

NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CHALLENGE HOME CERTIFIED:

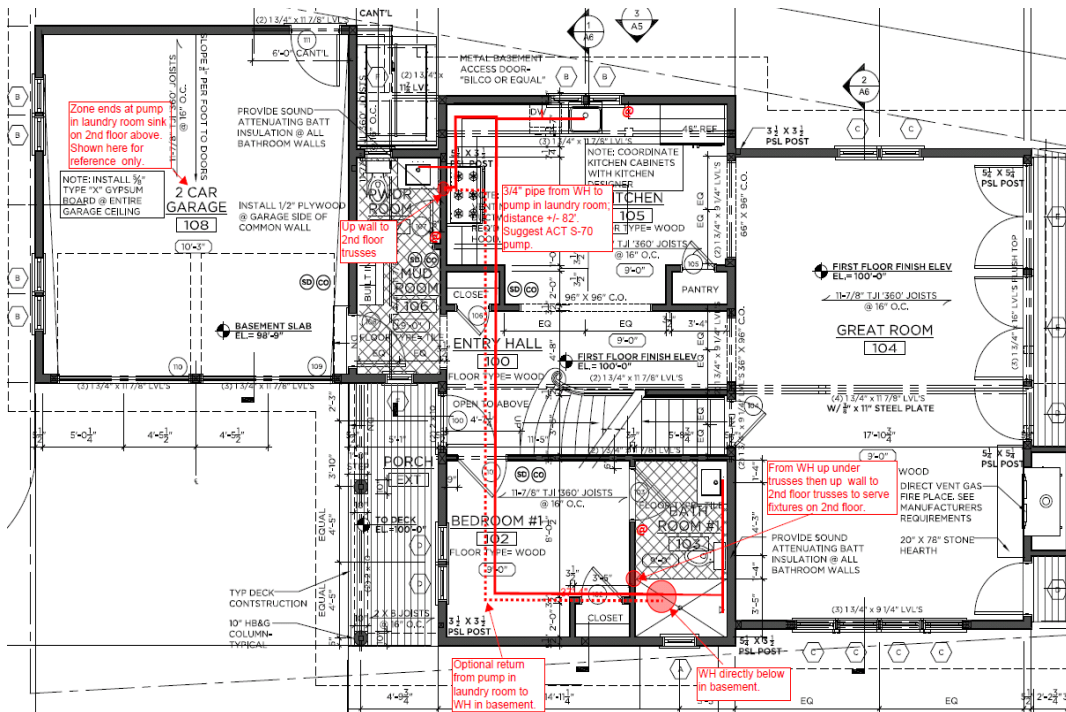


While the home does use natural gas for heating and hot water, the homeowners have not had to pay for any electricity beyond the monthly service charge.



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

Steven Winter Associates, Inc.

NEW YORK, NY | WASHINGTON, DC | NORWALK, CT





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.



© Steven Winter Associates, Inc. 2014

Additional Observations



Supply
Run

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

11 of 25 Single-Family Homes Completed



15 Unit Multi-Family Under Construction



Size: 1,256 ft²

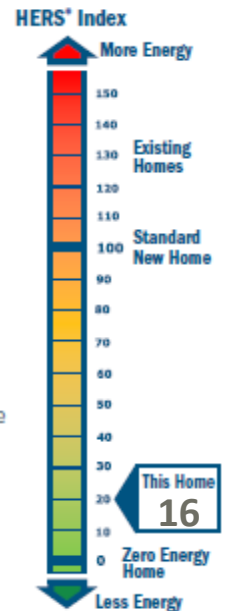
HERS Index: 39 (16 w/ PV)

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

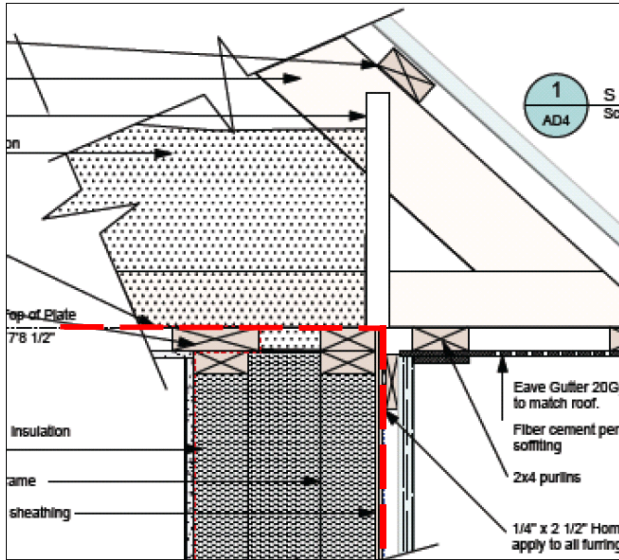
CHALLENGE HOME CERTIFIED:

- 1 BASELINE**
Certified ENERGY STAR home
- 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 Solar Electric and Thermal Checklists





Continuous Air Barrier



Low Loads

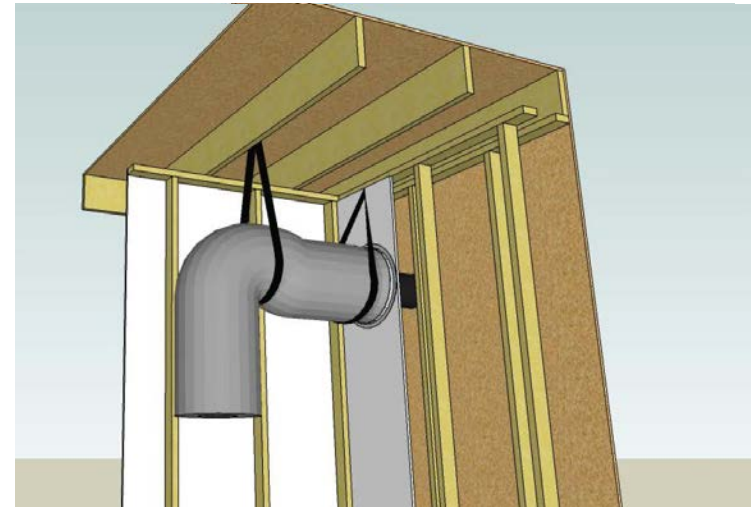


Design Heating Loads in this Passive House are so small (4-6 kBtuh) that the most effective and economical solution was electric resistance baseboard.

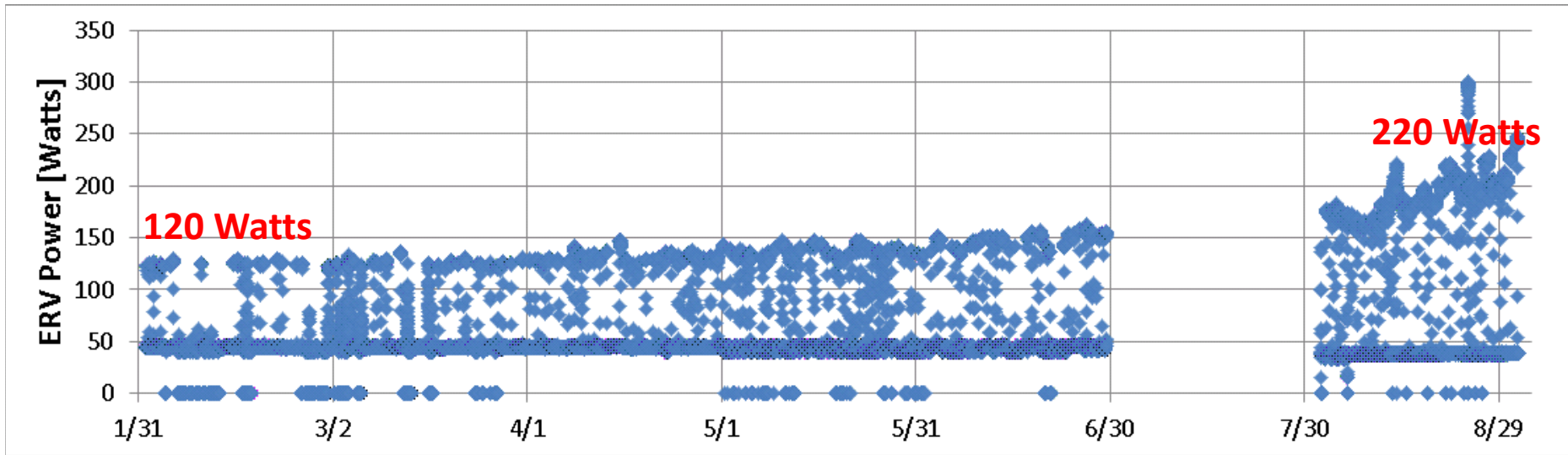


© Steven Winter Associates, Inc. 2014

Whole-House Ventilation



Whole-House Ventilation



Steven Winter Associates, Inc.
NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CALL US 866.676.1972 | SWINTER.COM

Brookside Development



Derby, CT



Size: 2,891 ft² (above-grade)

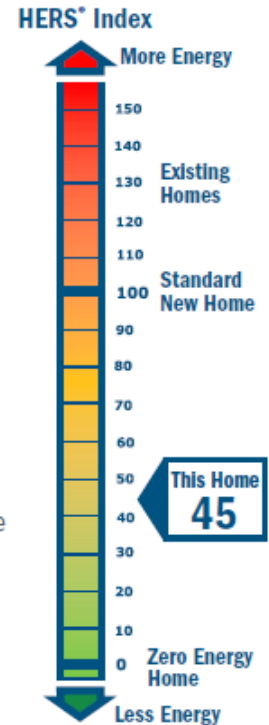
HERS Index: 45 (26 with PV option for homebuyers)

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, ACH₅₀ = 2.0

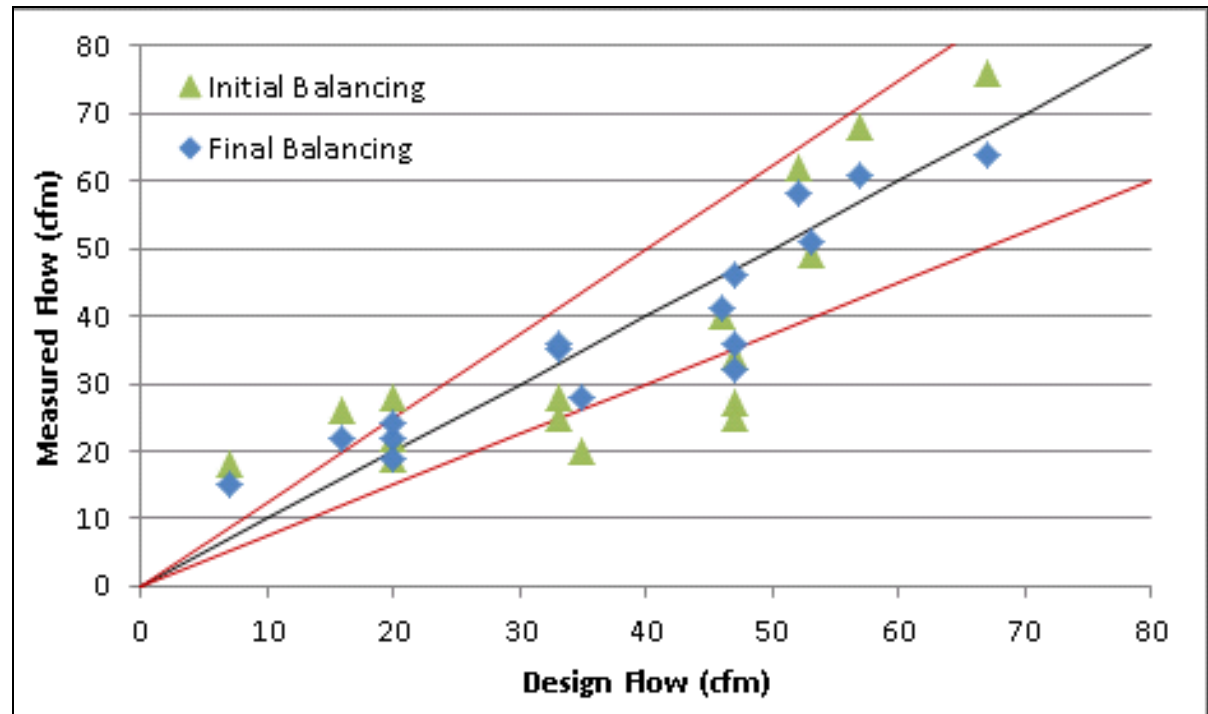
CHALLENGE HOME CERTIFIED:

- 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.





Airflow Balancing



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.

Steven Winter Associates, Inc.

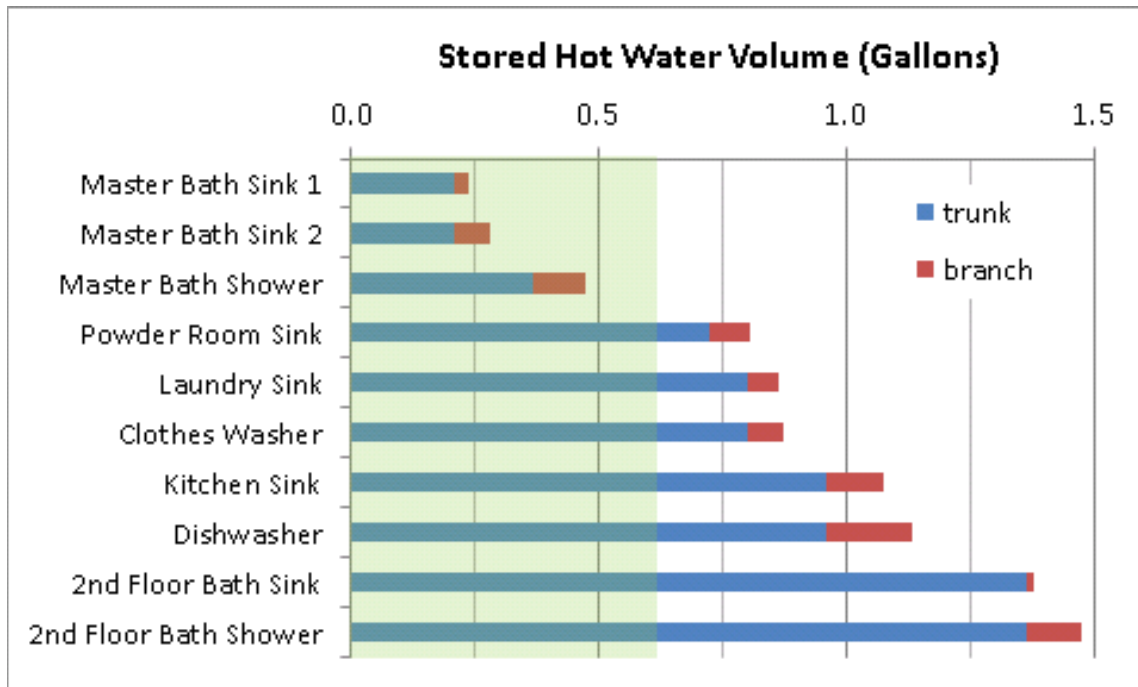
NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CALL US 866.676.1972 | SWINTER.COM

Water Efficiency



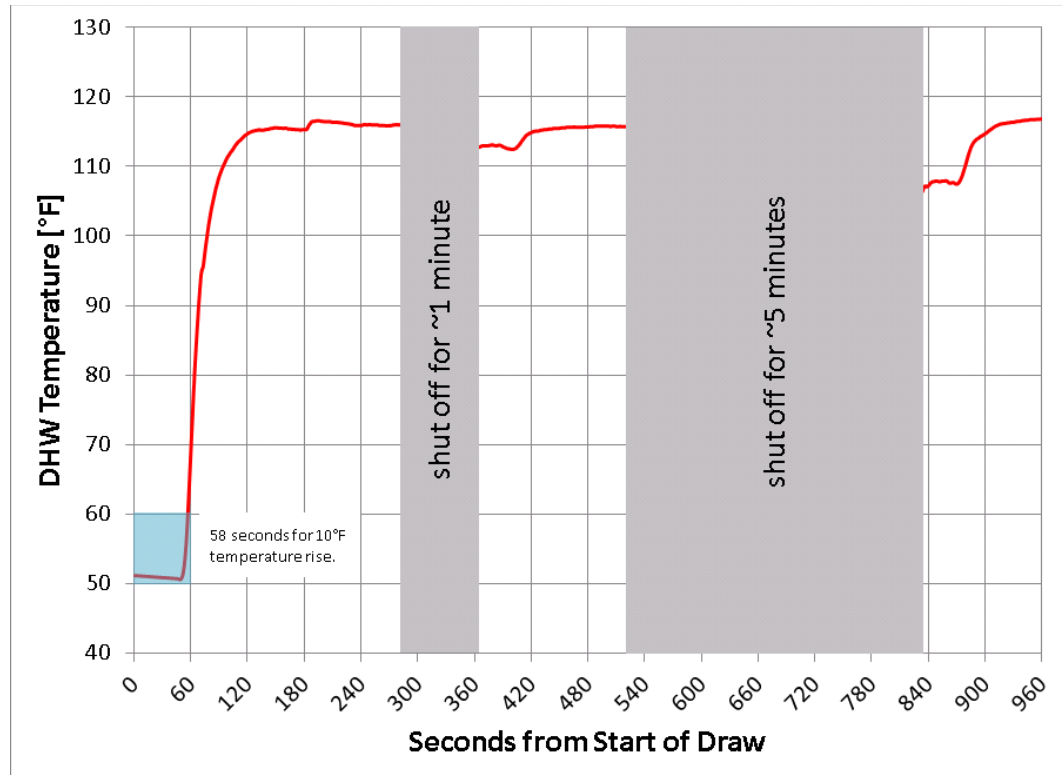
Initial design discussions with the plumber on the program requirements were ignored and the end result was a system that had excessive stored water in the DHW distribution system due to the use of a central trunk that runs from the basement up to the 2nd Floor for all branch take offs



Water Efficiency



2nd Floor Bathroom



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 ft² (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, ACH₅₀ = 0.42
- Single mini-split heat pump in central living space. Internal fan to circulate air throughout home.

Steven Winter Associates, Inc.
NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CHALLENGE HOME CERTIFIED:

- 1 BASELINE**
Certified ENERGY STAR home
- 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 Solar Electric and Thermal Checklists



CALL  U.S. Department of Energy

Gainfort-McKay



New Fairfield, CT



Size: 3,052 ft²

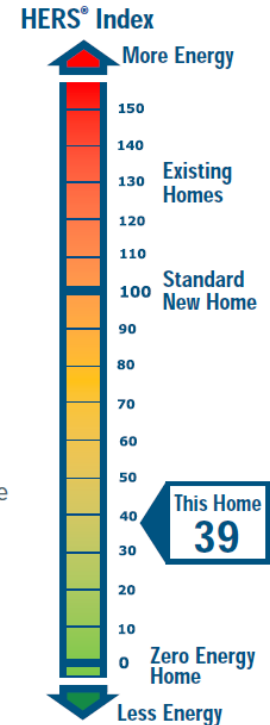
HERS Index: 39 (no PV)

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, ACH₅₀ = 0.45

CHALLENGE HOME CERTIFIED:

- 1 BASELINE**
Certified ENERGY STAR home
- 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 Solar Electric and Thermal Checklists



Murphy Brothers



Greenwich, CT



Size: 4,100 ft²

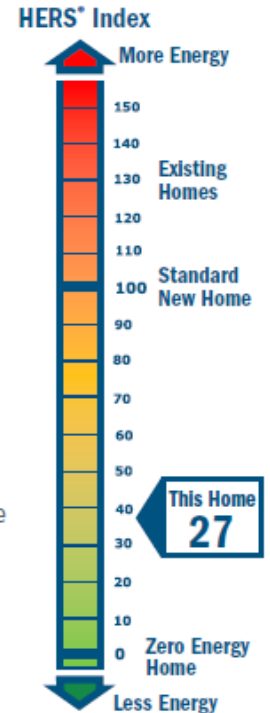
HERS Index: 40 (27 with PV)

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

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.



Steven Winter Associates, Inc.

NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CALL US 866.676.1972 | SWINTER.COM

Value to Consumer



“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.

“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.



CARB SEARCH

[HOME](#) [BUILDING AMERICA](#) [TAKE THE CHALLENGE](#) [ABOUT US](#) [CONTACT US](#)


WELCOME TO CARB-SWA:
LEADERS IN ADVANCED RESIDENTIAL BUILDING RESEARCH & DESIGN


The Consortium for Advanced Residential Buildings' (CARB) goal is to develop and promote home-building innovations that lower the amount of energy consumed in American dwellings.

[MORE](#)

BUILDING AMERICA - FEATURED RESOURCES

[Profiles](#) [Research](#) [Details](#) [Guides](#) [Contact Us | 888.676.1972](#)

 **Chamberlain Heights Redevelopment - Meriden, CT**
A large scale, cold climate study of affordable housing retrofits.
[Download report.](#)

 **Wisdom Way Solar Village - Greenfield, MA**
A new community of affordable, sustainable homes moves toward zero energy.
[Download Report](#)

[See More Profiles](#)



Thank you.

Lois B. Arena, PE

larena@swinter.com

QUESTIONS?

Steven Winter Associates, Inc.

NEW YORK, NY | WASHINGTON, DC | NORWALK, CT

CALL US 866.676.1972 | SWINTER.COM