



Building America Case Study

Lancaster County Career and Technology Center Green Home 3

Mount Joy, Pennsylvania

PROJECT INFORMATION

Construction: New home

Type: Single-family

Partners:

Builder: LCCTC, Mt. Joy, PA,
apprenticegreenhomes.com

Home Innovation Research Labs,
homeinnovation.com

Size: 2,384 ft² above grade; 4,768 ft²
conditioned area

Sale Price: \$320,000

Date Completed: June 2013

Climate Zone: Cold (IECC CZ-5A)

PERFORMANCE DATA

HERS Index: 45 (ENERGY STAR®
Target Index: 60; DOE Zero Energy
Ready Home Target Index: 52)

Projected annual energy cost savings:
44%; \$1,018

Incremental cost of energy efficiency
measures: \$18,348

Incremental annual mortgage: \$1,182

Annual cash flow: -\$164 (Note: at 3.5%
interest over 30 years, the annual cash
flow is neutral)

Through a unique vocational school program, high school students in Lancaster County, Pennsylvania, are gaining hands-on construction experience in building high performance homes. They receive help from the U.S. Department of Energy's (DOE) Building America team, Home Innovation Research Labs. This collaboration resulted in the Green Home 3, the third in a series of high performance homes for a neighboring community.

The Building America team partnered with Lancaster County Career and Technology Center (LCCTC) on new construction test houses in Apprentice Green, a community next to the school, in Mount Joy, Pennsylvania. LCCTC is a vocational high school with a Construction Technology program that prepares students for careers in the construction trades. As one of LCCTC's key educational strategies for gaining practical experience, students are involved in building real houses that incorporate state-of-the-art energy efficiency and green technologies. With two homes already completed, the Green Home 3 achieved a 44% whole-house energy savings over the Building America New Construction B10 Benchmark, DOE Zero Energy Ready Home (formerly Challenge Home) certification, and National Green Building Standard Gold-level certification.

The Green Home 3 is a single-story design with a full conditioned basement, vented attic, and detached garage. This project features insulated concrete form (ICF) walls. ICF construction provides structural and thermal components: block forms, consisting of rigid foam insulation panels separated by plastic ties, are stacked and then filled with concrete. ICF walls are well insulated, durable, and inherently tight, and provide consistent thermal performance, minimize thermal bridging, attenuate sound well, and resist fire and wind. This research project evaluates ICF walls, heating and hot water alternatives, and mechanical ventilation systems. The analysis and results can benefit builders as they develop energy solution packages for cold and mixed-humid climates.

Key Features

HVAC

- High efficiency two-stage air source heat pump system: 16 seasonal energy efficiency ratio, 9.8 heating season performance factor
- Simplified compact return duct design improved performance and reduced installed costs
- Equipment and duct distribution system entirely in conditioned space
- Duct leakage to outdoors: 0 cubic feet per minute at 25 Pascals
- Energy recovery ventilator provides whole-house mechanical “fresh air” ventilation

ENVELOPE

- R-22 ICF foundation walls and above-grade walls
- The ICF wall is continuous at the rim joist area, so this critical area is well insulated and airtight
- R-49 cellulose insulation in the vented attic
- Wood clad low-e windows
- U 0.30/solar heat gain coefficient 0.28
- Tested house leakage: 1.1 ACH50

LIGHTING, APPLIANCES, AND WATER HEATING

- Solar-thermal preheat domestic hot water system
- Cross-linked polyethylene manifold plumbing distribution system
- 100% compact fluorescent lamps and light-emitting diodes
- ENERGY STAR appliances
- 3,500-gallon rainwater collection and integrated distribution

For more information, see the Building America report, *Insulated Concrete Form Walls Integrated With Mechanical Systems in a Cold Climate Test House*, at: buildingamerica.gov

Image credit: All images were created by Home Innovation Research Labs.



ICF wall construction



Air-sealed top plates before attic insulation

Lessons Learned

- ICF wall construction merits consideration as a practical and energy-efficient alternative to conventional high performance foundations and above-grade walls in cold climates.
- Careful air sealing at the ceiling plane, penetrations, and framed cavities, in conjunction with the ICF walls, resulted in a very tight building envelope (1.1 air change per hour at 50 Pascals [ACH50]).
- Intermediate testing for house leakage (after drywall but before attic insulation and interior finishing) allowed for simple and inexpensive mitigation that significantly improved energy efficiency.
- For optimum energy performance in a cold climate, investing more in the building enclosure can reduce the required investment in the mechanical systems.
- Without incentives, solar thermal domestic hot water systems may be less cost effective than other water heating technologies.
- The importance of effective mechanical ventilation merits a deliberate duct layout design, similar to those used for heating and cooling duct layouts, to ensure airflows meet design expectations.

“The students take this practical experience into their careers, but the educational component goes beyond a more knowledgeable workforce. Houses with this level of energy efficiency are not common in this market. These houses are open to public inquiry during construction, and there is a high level of interest from vendors and manufacturers to participate in these high visibility projects. The Building America program has been instrumental in the school’s Construction Technology program and benefits by accelerating energy-efficient construction into the community.”

– Michael Dodson, Senior Building Project Coordinator
LCCTC Construction Technology Program