Building America Case Study

Whole-House Solutions for New Homes

Affordable Cold Climate Infill Housing with Hybrid Insulation Approach

Wyandotte, Michigan

PROJECT INFORMATION

Construction: New home

Type: Single-family, affordable

Builder: City of Wyandotte with various local homebuilders
www.wyandotte.net

Size: 1,150 to 1,500 ft^2

Price Range: $113,000–$138,000

Date completed: 2012

Climate Zone: Cold

PERFORMANCE DATA

HERS index:

- 2009 IECC = 102
- Case study house 1,475 ft^2
- With renewables = NA
- Without renewables = 75

Projected annual energy cost savings: $604

Incremental cost of energy efficiency measures: $30,947 (including GSHP and well)

Incremental annual mortgage: $2,631/yr

Annual cash flow: -$1,375

Billing data: Not available

Even builders who are relatively new to energy-efficient construction can consistently reach a target whole house airtightness of 1.5 air changes per hour at 50 Pascals (ACH50) with high R-value enclosures that use a hybrid insulation approach.

The City of Wyandotte, Michigan, started a construction program in 2010 to build affordable, energy-efficient homes on lots in existing neighborhoods. A goal of the program was to engage local builders in energy-efficient construction and be able to deliver the new houses for less than $100/ft^2. By the end of 2012, approximately 25 new houses were built by five local builders under this program.

To help builders consistently achieve the airtightness target, a local architect worked with researchers from Building Science Corporation, a U.S. Department of Energy Building America team, to develop a technology specification with several key pieces. A high R-value wall and roof assembly made use of 2×6 advanced framing and a hybrid insulation approach that included insulating sheathing to control thermal bridging and closed cell spray polyurethane foam insulation (ccSPF) for its airtightness and vapor control benefits. This approach allows the air barrier to be completed and tested before any finishing work occurs, ensuring that problems are spotted and corrected early in the construction process.

Wyandotte, Michigan, is building a district GSHP system that will eventually link all of the houses in the project area. The payback on this investment will take some time, but providing low, fixed rates for heating and cooling will help keep operating costs low

Key Energy Efficiency Measures

HVAC

- Heating and cooling by GSHP (3.7 coefficient of performance, 18 seasonal energy efficiency ratio)
- All ductwork located inside conditioned space. Ducts sealed with mastic. Return air jump ducts in all bedrooms.
- Supply-only system with 33% duty cycle: 10 minutes on; 20 minutes off, 50 cubic feet per minute average flow
- Kitchen and bath fans vented to outside

ENCLOSURE

- R-51 roof: R-30 ccSPF insulation to underside of roof sheathing, R-21 batt insulation in rafter cavity
- R-34 walls: 2 in. (R-10) extruded polystyrene sheathing, 2 in. (R-12) ccSPF in cavity, 3.5 in. (R-12) fiberglass in 2×6 advanced frame wall
- R-13 basement: 2 in. polyisocyanurate (R-13) or 2 in. (R-12) ccSPF full height
- Double-pane, low-e3, vinyl windows. U = 0.28, solar heat gain coefficient = 0.29
- Tightly sealed house, less than or equal to 1.5 ACH50

LIGHTING, APPLIANCES, AND WATER HEATING:

- 100% Compact fluorescent lighting
- ENERGY STAR® refrigerator
- Tank electric hot water heater (Energy Factor=0.98), desuperheater

For more information, see the Building America report, *Michigan Neighborhood Stabilization Program: A Cold Climate Study,* at: *www.buildingamerica.gov*

Image credit: All images were created by the BSC team.

Advanced framing techniques such as two-stud corners and stacked framing (above left) save labor and materials, but they also simplify the installation of spray foam insulation and reduce the number of air leakage paths. However, complex framing to create architectural details (above right) needs to be considered carefully in order to ensure continuity of the air barrier system.

A ground source heat pump (GSHP) system paid for by Wyandotte Municipal Services was specified for each new house. The long-term goal is to create a district system that will link the wells to provide heating and cooling for both the new houses and existing homes in the community.

Lessons Learned

As the Wyandotte project developed, some key refinements were made to the design and construction process to help ensure consistent results on site:

- Framing/heating, ventilating, and air conditioning coordination plans and detail drawings that show and label all air barrier components help to both spot and correct potential installation problems before the plans leave the drawing board.
- If the entire air barrier system is completed early in construction, airtightness testing (i.e., the blower door test) can be used to provide instant feedback to trades and to find and fix problems on the spot.
- A "high R-value" enclosure is typically not a "one trade" technology—airtightness, control of thermal bridging, and insulation installation quality all depend on communication and quality control that spans multiple trades and inspectors. High performance enclosures need the whole team.

Other similar projects in a cold climate should also consider:

- Other heating system options, including air source heat pumps and hot water/space heating combo systems to reduce the total construction cost.
- Heat recovery ventilators, which are becoming more affordable and should be considered with mechanical system options.

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

For more information, visit:
www.buildingamerica.gov

The U.S. Department of Energy's Building America program is engineering the American home for energy perfomance, durability, quality, affordability, and comfort.

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.

DOE/GO-102013-4076 • November 2013