

Energy Efficiency &

Renewable Energy

U.S. DEPARTMENT OF

ENERGY

Building America's research team lead Building Science Corporation helped Nelson Construction achieve HERS scores of 53 and 54 on ten homes in Farmington, Connecticut.

### **BUILDER PROFILE**

Builder: Nelson Construction www.nelsonconstructionct.com

Where: Farmington, CT

Founded: 1992

Employees: 12

Development: Hamilton Way

Construction Date: 2007–2009

Size: 10 two-story single-family homes, 2,960–3,540 ft<sup>2</sup>

Price Range: \$650,000+ (all 10 homes sold within 2 months of being listed)



### Building America Best Practices Series

Volume 12. Builders Challenge Guide to 40% Whole-House Energy Savings in the Cold and Very Cold Climates

# Case Study: Nelson Construction

Hamilton Way | Farmington, CT

Nelson Construction, the first builder to work with Building America in Connecticut, built 10 homes that received the U.S. Department of Energy's Builders Challenge certification. All 10 homes achieved energy savings of 50% over the Building America benchmark.

"We have been an ENERGY STAR builder as long as it has been around, and we wanted to push the limits for energy efficiency," said Chris Nelson, president of Nelson Construction. "Teaming up with Building Science Corporation through Building America gave us the confidence to push way beyond what we might have tried on our own."

Nelson Construction partnered with Building America's research team lead Building Science Corporation on the energy-efficiency design and analysis of the 10 homes located in the Hamilton Way development that Nelson built with Landworks Realty in Farmington, just outside of Hartford, Connecticut. Selling prices started at \$649,000. Each home has two stories (ranging from 2,960 to 3,540 square feet), four bedrooms,  $3\frac{1}{2}$  to  $4\frac{1}{2}$  baths, and heated basements (for an additional 1,404 to 1,653 square feet).

## **Energy-Efficient Features**

"Our first step is to do as much as we can [to achieve energy savings] for zero cost to the builder," said Peter Baker, a senior associate with BSC who worked with Armin Rudd, a principal at BSC, on this project.

Design-stage computer analysis estimated that 18.5% of the energyefficiency savings could be achieved by reducing air infiltration. "Chris Nelson is a very conscientious, high-quality builder," said Baker. "Previously, he was doing a full flash- and-batt approach, which involves using a thin layer of spray foam in all of the wall cavities."



(top) All lights were hard-wired for CFLs.

(*middle*) Sprayed urethane closed-cell foam provided a critical seal along floor joists separating the garage from the living space above. Further insulation was provided by unfaced batt.

*(bottom)* Nelson Construction sealed the rim joists with spray foam to air seal and insulate from foundation wall to subfloor.

"Teaming with Building America is a great marketing tool because we can honestly say we are building houses better. The HERS certificate from the DOE proves it."

Chris Nelson, president, Nelson Construction

Building America research showed minimal difference between spray foaming the entire opaque surface of a wall and simply spray foaming insulation into areas known for leaks. The team used this "critical seal" approach for reducing air infiltration and saving money. Urethane closed-cell foam was sprayed into the air gaps at the basement rim joists, at the rim joists between the first and second floors, around windows, and at any mechanical/electrical penetrations. Air tightness targets were set at 3.0 air changes per hour, and all of the homes tested approximately 25% below the target. The only place where full coverage was used was in the ceiling of the garage to ensure no potential air leakage to the living space above.

Building America analysis estimated 11.5% of the energy savings were possible through increased insulation. Nelson filled his 2x6 24-inch on-center wood stud wall cavities with R-19 damp-spray cellulose cavity insulation, and sheathed the walls with two inches (R-13) of foil-faced polyisocyanurate insulating sheathing, Tyvek wrap, and vinyl siding.

The vented attic has R-50 blown-in fiberglass insulation. Two inches of R-10 extruded polystyrene foam (XPS) is under the foundation slab. The basement walls use a Thermomass<sup>®</sup> System, consisting of 2 inches of XPS sandwiched between two 4-inch layers of concrete.

The improved thermal boundary (insulation and air barrier) enabled the team to downsize the HVAC system from two air handlers (one in the attic and one in the basement) to one in the basement that uses zone-control dampers for the first floor/basement and second floor. The first and second floors each contain one ducted return with jump ducts at the bedrooms.

Heat is supplied by a 94% AFUE sealed-combustion gas furnace. The 14 SEER air conditioner was downsized from 4.5 or 5.0 tons to 3.0 or 3.5 tons. "What we are hearing from the homeowners is that the systems are working great and very comfortable," said Baker.

Domestic hot water is provided by a 0.82-efficiency factor instantaneous gas water heater. The homes are 100% hardwired for CFLs.

To date, Nelson Construction has less than a year of utility data for the homes, but the data so far indicate that the homes are consuming 50% less energy than the Building America benchmark, a house built to the 1993 Model Energy Code. The homes achieved Home Energy Rating Scale (HERS) scores of 53 and 54.

Nelson offered a photovoltaic option, and three homeowners chose the 7-kW photovoltaic systems. "They are making way more energy than they are using. They are 8 months into the year, and they are so far ahead of the utility company that they will not pay utility bills this year other than service charges," Nelson said.

#### CASE STUDY: NELSON CONSTRUCTION



# Health, Durability, Sustainability

With such air-tight construction, it was essential to design in ventilation. The team decided on a semi-balanced approach using a controlled fresh air intake with exhaust fans. For supply ventilation, an Aprilaire VCS 8126 brings outside air into the home through a duct to the return side of the air handler. A flow regulator provides fixed outside air-supply quantities independent of air-handler blower speed, and the HVAC system provides circulation and tempering. Stale air is exhausted through a fan in an upstairs bathroom. This 1-sone-rated fan is connected to the main space with a 6-inch jump duct. The laundry room has a transfer grille installed to provide pressure relief during dryer operation.

The supply system is sized to meet ASHRAE 62.2 ventilation rates. To avoid the potential for cold air complaints when the fan blows without the furnace firing, BSC recommends that not more than 125 cubic feet per minute (CFM) be supplied per register in bedrooms and not more than 500 CFM be supplied per register in other rooms. To achieve this, an 8-inch to 10-inch supply duct to the master bedroom should be split into two 6-inch or 7-inch supply ducts. Homeowners should be educated to keep their winter thermostat set points at 70°F or above.

# **Dollars and Sense**

Hamilton Way experienced a high volume of sales in a market where sales had almost completely stopped. All 10 Builders Challenge homes in the development sold within 2 months of completion.

"It only costs about \$18,000 extra per house [to make the energy-efficient upgrades]. That is about 4% [of the sales price] to achieve about \$250 a month in energy savings," said Nelson. "If you take the added mortgage on \$18,000 at 5% interest, it is costing you \$80 to \$90 a month, but you are saving \$250 a month in utility costs."



*(left)* The basement walls use a Thermomass<sup>®</sup> system, which is 2 inches of extruded polystyrene foam sandwiched between 4 inches of concrete

(*right*) In this heating-dominated climate, the 94% AFUE sealed combustion gas furnace helps ensure enough heat on the coldest days.

### **Energy-Efficient Features**

- HERS scores 53-54
- 24-inch-on-center advanced framing of 2x6 studs
- Wall insulation: 2-inch foil-faced polyisocyanurate sheathing (R-13) and stud cavities filled with R-19 cellulose
- Attic insulation: R-50 blown fiberglass
- Foundation insulation: R-10 2-inch extruded polystyrene foam (XPS) below slab; R-10 2-inch XPS cast in walls (Thermomass)
- Windows: Double-glazed, lowemissivity, argon-filled, vinyl-framed; U = 0.32, SHGC = 0.27
- Air sealing tightness: infiltration of 3.0 to 3.3 air changes per hour (ACH) at 50 pascals
- 94% AFUE sealed-combustion gas furnace
- 14-SEER cooling split system
- 0.82 EF (energy factor) instantaneous gas hot water heater
- Ducts in conditioned space with less than 5% leakage (R-6 flex runouts in dropped ceiling or in floor joists)
- 100% hardwired CFL lighting

#### **BUILDING AMERICA BEST PRACTICES SERIES**



Each of the 10 DOE Builders Challenge homes sold within 2 months of completion.

"We sold all the homes in less than two months. The people who were buying our homes wanted to buy something that was built better."

Chris Nelson, president, Nelson Construction

The largest single cost upgrade resulted from the two inches (R-13) of foil-faced polyisocyanurate insulating sheathing at a cost of \$10,000 per home. The approximate incremental cost per square foot of all energy upgrades was \$6.97.

Building America analysis predicted between \$2,429 and \$3,447 annual utility savings compared to the Building America benchmark, depending on the house plan. When the annual mortgage increase is subtracted from the savings, results still yield a positive cash flow to homeowners of \$1,392 per year for the building (see Table 1).

### Table 1. Added Costs and Savings of Energy-Efficient Measures for Nelson Construction

Energy Savings vs Benchmark	48%
Annual Mortgage Payment Increase (without PV)*	\$2,055
Annual Utility Savings	\$3,447
Annual Net Cash Flow to the Homeowner	\$1,392

\*The annual mortgage payment is an estimate calculated by BSC and is based on a 30-year mortgage with a 7% fixed interest rate.

## The Bottom Line

"This experience has definitely helped us raise the bar on all the houses we build. It has become part of our company identity that we build energy-efficient, healthy, sustainable homes," Nelson added. "Now we have a marketing advantage. We are looked at as one of the experts in the industry related to energy efficiency. From a developer's side, it helps us get approvals, which is really a big deal and nothing we were thinking about when we decided to do this. Towns want to work with builders who are doing things better."

### For More Information

www.buildingamerica.gov EERE Information Center 1-877-EERE-INF (1-877-337-3463) eere.energy.gov/informationcenter



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