Building America Case Study
Whole-House Solutions for New Homes

Rural Development Inc.

Wisdom Way Solar Village | Greenfield, MA

PROJECT INFORMATION

Construction: New home

Type: Single-family, affordable

Builder: Rural Development, Inc.
Greenfield, MA, 413-863-9781
www.ruraldevelopment.org

Size: 1,140-1,770 ft^2

Price Range:
$110,000 (subsidized) to $240,000

Date Completed: 2010

Climate Zone: Cold, IECC 5A

Team: CARB

PERFORMANCE DATA

HERS Index: 8-18 with PV

Added first cost of efficiency measures:
$11,844 without PV

Annual mortgage increase:
$1,050

Annual net cash flow to homeowner:
$1,142

Billing data: Nov to April high-performance homes' natural gas bill averaged <$500/home vs avg $1,930 oil heating bill for a local standard-construction home.

With design assistance and energy analysis from the U.S. Department of Energy's CARB Building America research team, led by Steven Winter Associates, the nonprofit builder Rural Development, Inc., built Wisdom Way Solar Village, a community of 20 energy-efficient solar duplexes in western Massachusetts in 2010. The homes achieve HERS scores of 8 to 18 with a highly insulated enclosure, energy-saving equipment, and solar water heating to give home owners heating savings of nearly $2,200 per year. The solar electricity produced by rooftop PV yielded negative electric bills in the first six months of occupancy (Nov 2009–April 2010).

Blown-cellulose was dense packed to R-42 in the double-stud walls and to R-40 in floor joist cavities under the first floor, and blown loose to R-50 in the vented attic. Air tightness was confirmed with blower door testing, which showed 1 to 1.5 air changes per hour at 50 Pascals. Because the homes are so well insulated, RDI was able to meet the design heat load of 12,000 Btu per hour with a natural gas-fired space heater centrally located on the first floor. The 83% AFUE heater is two stage with a capacity of 10,200 Btu per hour on low fire and 16,000 Btu per hour on high. The sealed combustion heaters vent to and draw combustion air directly from the outside, greatly reducing the likelihood of backdrafting. There is no traditional duct system. Instead, an exhaust fan was located in the living room ceiling above the space heater to "exhaust" warm air into each of the upstairs bedrooms through PVC "ducts" to registers in each of the bedrooms.

"If you can get the building shell this well insulated, you are going to see significant heating energy savings, almost regardless of what heating system you choose."

Robb Aldrich, Steven Winter Associates, CARB

Building AMERICA® U.S. Department of Energy

(Photo top left) The 20 duplexes built by Rural Development, Inc., in Greenfield, Massachusetts, with help from Building America's CARB team have HERS scores of 8 to 18.

KEY ENERGY-EFFICIENCY MEASURES

HVAC:

- Small (10,200/16,000 Btu) sealed-combustion 83% AFUE gas-fired space heater
- No air conditioning
- Continuous exhaust fan

Envelope:

- Attic: vented, R-50 blown cellulose
- Walls: double 2x4 stud, R-42 dense-pack cellulose
- Foundation: Uninsulated basement, R-40 dense pack in first-floor cavity
- Windows: East, north, and west: vinyl-framed, triple-pane, U = 0.18, SHGC = 0.23. South: double-pane, U = 0.26, SHGC = 0.37
- Whole house air leakage: 200-350 cfm at 50 Pa

Lighting, Appliances, and Water Heating:

- 100% hard-wired fluorescent lighting
- ENERGY STAR® refrigerator and dishwasher
- Solar thermal water heater with tankless gas backup
- Solar Photovoltaics: Roof-mounted 2.8- or 3.4-kW of PV panels on each home

For more information, please visit:
www.buildingamerica.gov

(left) The double-stud wall consists of two 2x4 16-inch on-center framed walls set 5 inches apart. *(right)* A vapor-permeable mesh is stapled to the inside surface of the inside wall forming a 12-inch-deep cavity to hold R-42 of dry-blown cellulose insulation.

Lessons Learned

- Double-wall construction uses familiar, readily available, and relatively inexpensive building materials to achieve very high wall R values. CARB provided onsite installer training.
- CARB estimated that RDI spent about $11,800 more to add energy-efficiency features compared to a house built pre IECC 2006. Triple-pane windows cost $3,000 over standard construction. The largest expense was $9,750 to purchase and install the solar water heating system. The $11,800 does not include the PV panels, which cost $25,000 at market rate (although RDI got local, state, and federal grants to cut the costs). Two sizes of systems were installed: a 3.4-kW system (that can generate $635–$700 of electricity/year at $0.17/kWh) and a 2.8-kW system (that can generate $525 to $575 of electricity/year).
- This unit was $5,000 cheaper than the gas or oil-fired boilers and radiators often used in western Massachusetts construction.
- CARB and RDI could not find triple-pane windows with a low U-value and a high solar heat gain coefficient to allow in solar heat on south-facing windows, so they settled for two window types: for south-facing walls—a double-pane window with U = 0.26, SHGC = 0.37, and a low-e coating on the third surface; for north, east, and west-facing walls—triple-pane windows with U = 0.18, SHGC = 0.23, and low-e coatings on the second and fifth surfaces.
- RDI chose to insulate under the floor joists with R-40 of blown cellulose held in place with mesh stapled to the I joists, after energy modeling showed that insulating the basement walls would cost considerably more, requiring 3 inches of rigid insulation to get the same performance plus gypsum to meet local fire code.

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

For more information, visit:
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