OAK RIDGE NATIONAL LABORATORY FACT SHEET
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Habitat for Humanity Test Houses Demonstrate Remarkable Near "Net-Zero Energy" Performance

The Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy is focusing considerable effort on affordable "net-zero energy" residential buildings with the potential of marketability by 2015. "Net zero" is defined as a home that returns as much energy to the power grid as it uses. These houses will ultimately be equipped to annually export more energy produced on site than imported from off-site. Enabling production technologies include solar photovoltaics, biomass-microturbines, fuel cells, and thermal and electric storage.

Recently, Oak Ridge National Laboratory (ORNL), in partnership with two of DOE's Building America Project teams (BSC and IHP), designed, helped to build, and initialized performance monitoring and analyses of an approaching-net-zero Habitat for Humanity house (Fig. 1). The house is equipped with integrated heating, cooling and appliance technologies to maximize energy savings.

Figure 1. Habitat for Humanity house.

A Very Productive Collaboration by Industrial and Utility Partners

Other participating organizations included the Structural Insulating Panel Association, which provided panels for the floors, walls, and roof; the Metal Roof Alliance, which provided a hidden raised-metal-seam roof and clips to avoid roof penetration for mounting the solar collectors; and the Tennessee Valley Authority (TVA). TVA provided a grid-connected, 2-kW solar photovoltaic (PV) system, designed and installed by Big Frog Mountain of Chattanooga, Tennessee. Under its Green Power Switch Generation Partner Program, TVA, along with Lenoir City Utilities Board, has offered the homeowner $500 plus $0.15/kWh for all the alternating current (AC) solar power generated for at least 10 years. The buy-back offer is 2.4 times the residential retail rate for electricity. Andersen Windows provided high-efficiency windows, which were used (along with structural insulating panels) in an earlier ORNL laboratory air-tightness test (Fig. 2). The results of the test found 95% more air tightness potential than that of a dimensional wood-frame construction (blower door tests found the actual whole house was 85% tighter). Du Pont donated the weather barrier system and installed the windows. Enviromaster International (EMI) provided the heat-pump water heater, which is integrated with the refrigerator, unvented crawl space, and the heating, ventilation, and air conditioning (HVAC) system.

Figure 2. Test Room Being Tested in ORNL's Buildings Technology Center Simulator.

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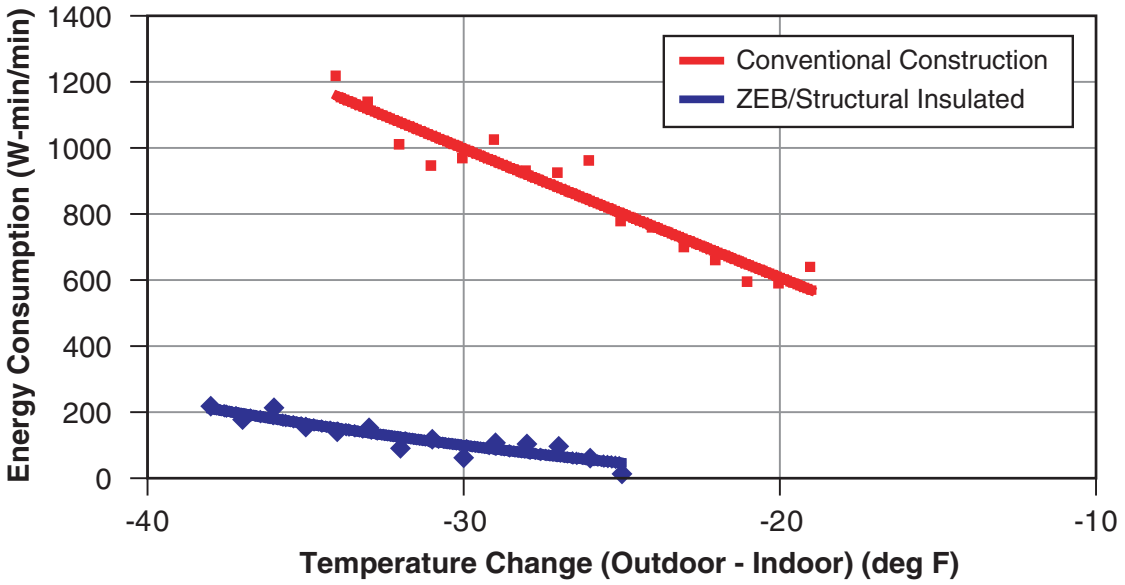
House Features New Technologies

Without the added integration, EMI's heat-pump water heater reduces the energy for hot-water heating by about 60% compared with conventional electric resistance. Data being collected on a heat-recovery shower show the energy savings for heating water of 7%. The house has 40 sensors installed to monitor thermal performance. These near-real-time data can be found at http://www.logger.fsec.ucf.edu/cgi-bin/wg40.exe?user=baihppsp.

Data Show Exceptional Energy Performance

East Tennessee's 2002/2003 winter was colder than normal. Up until March 27, 2003, the cumulative heating degree days were 3351, which is 130 degrees above a typical winter. The average cost to heat the newly constructed 1057-ft2 house from November 26, 2002 until March 27, 2003 was $0.54/day. The data show (Fig. 3) that the heating energy of the zero-energy building (ZEB)/structural insulated panel (SIP) house is about a tenth of that compared to the base house in the same neighborhood. The total energy cost for the all-electric house was $1.42 per day. When TVA pays $0.15/kWh for the Green Power Switch Program solar energy, this brings the cost down to $1.24 per day. The cost per day is decreasing as the year progresses. As of July 21, 2003, the house collected 1286 kWh. In a year, this 2-kWp solar system will collect between an estimated 1800 and 2000 kWh. The total energy cost for this house after 254 days of measured performance is estimated to average $25 per month, which includes plug loads.

Figure 3. Heating the ZEB/SIP House takes 1/10th that of the Conventional Habitat House Across the Street



Two More Houses Planned

Under DOE's Building America Program, ORNL and another Building America team (IBACOS), have designed two more efficient net-zero homes to be constructed in July 2003. The walls will be installed on July 29; the roof on July 30; and the weather barrier, windows, and metal roof on July 31 (see http://www.ornl.gov/btc for more details). The next two ZEB houses will have better building envelopes, integrated appliances demand-responsive ventilation, geothermal heat pumps, cool-roof coatings, innovative ductwork, advanced SIPS and end-use of solar direct current power, avoiding DC/AC energy conversion losses.

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