YAVAPAI'S GREEN BUILDING SUCCESS

Yavapai College's Residential Building Technology (RBT) program has been recognized many times over for its energy-efficient, green, and affordable homes—homes that are constructed by students in the program.

BY RICHARD PETERSON AND TONY GRAHAME

For a small school in north central Arizona, Yavapai College certainly gets big results. The college's Residential Building Technology (RBT) program has been recognized many times over for its energy-efficient, green, custom, and affordable homes—homes that are constructed by students in the program. This year, the program beat out national home builders to win two Gold Energy Value Housing Awards from the National Association of Home Builders Research Center.

Now in its 12th year, the Energy Value Housing Award (EVHA) program selects winning homes from various climate zones and housing types. Submissions must identify and verify their specific energy-saving details such as: advanced framing methods, correctly installed insulation, properly sized, located and installed HVAC systems, air sealing of thermal bypasses, high performance spectrally selective windows, and so on.

Other energy efficient practices used in this year's 12 winning homes included: higher insulation R-values in floors, walls, and attics; PV systems; more ducts and HVAC equipment located inside the conditioned space; and energy efficient lighting and water-heating systems. Yavapai took home two 2007 Gold EVHAs—one for Moderate Climate/Affordable Home and one for Moderate Climate/Custom Home.

YAVAPAI COLLEGE

The Longview House features insulated, pre-fabricated concrete walls for the exterior basement.

Longview House

The first of Yavapai College's Gold EVHAs was awarded in the Custom Home category. The Longview House was completed by Yavapai College students in the summer of 2005 and was sold the next year (with profits supporting the program and general scholarships). This 3,200 ft^2 home earned a 90.5 HERS score and a 5 Star+ rating, (meaning that it was 52.5% more energy efficient than the Energy Star reference home). It won a 90.7 platinum rating for Environments for Living, and it is Energy Star certified (see "Energy Features of the Longview House").

The Longview House was built on a sloping lot with a crawlspace and a walk-out basement. Insulated concrete form walls (PerformWall) were used for the unvented, semi-conditioned crawlspace with a 2-1/2 inch concrete slab over 6 mil plastic (vapor barrier) and 3 inches of gravel for a capillary break. Precast insulated panels (SuperiorWalls) were placed by crane for the basement walls.

The main level wood framed-wall system is continuously sheathed with plywood glued and nailed to the exterior 2 x 6, 24 inch on center stud framework to create an air barrier and 100% shear. Advanced framing techniques were used that allowed for more insulation and thus a higher effective R-value. Overall, the construction methodologies used resulted in an extremely tight building envelope (0.96 ACH_{50}, equivalent to a distributed leakage area of only 49 square inches for the entire building enclosure).

Heating and cooling mechanical equipment were right-sized according to *Manual J*. Because of the house air tightness, a balanced heat-recovery

Energy Features of the Longview House

Foundation: R-16 insulated concrete form crawlspace wall; R-33 precast concrete basement wall; R-5 slab-on-grade perimeter insulation

Wall Construction: 2 x 6 at 24 inches on center; exterior wall headers insulated with 1-inch rigid foam

Wall Insulation: R-21 spray-applied cellulose with R-5 XPS rigid foam insulation

Roof Construction: Raised-heel trusses

Ceiling Insulation: R-38 blown cellulose (cathedral); R-44 blown cellulose (flat)

Windows: Low-e, dual-pane, argon-filled; U-factor 0.30–0.35; solar heat gain coefficient 0.30–0.35

HVAC: 92 AFUE furnace; 14-SEER A/C; three-zone system sized with *Manual J*; balanced whole-house mechanical ventilation; thermostat with humidistat

Ducts: R-4.2; all in conditioned space; mastic sealed; six returns for pressure balancing

Water Heating: 40 ft^2 solar-thermal with electric backup; all faucets within 30 feet of storage

Lighting: 100% fluorescent

Appliances: Energy Star ceiling and ventilation fans, dishwasher

Blower Door Test: 0.96 ACH_{50}

HERS Rating: 90.5

Innovative Features: 2 kW PV system; solar hot water system; unvented semiconditioned crawlspace; light tubes; greywater plumbing; rainwater harvesting

ventilation unit was installed for fresh air exchange. All of the duct work was located entirely within the conditioned crawlspace and basement.

The energy efficiency of the Longview House was further enhanced with the installation of high-performance spectrally selective windows. The windows were selected specifically for the sunny, mixed-dry climate characteristic of the Prescott area. The windows are thermally broken, low-e, dual-pane, and argon filled.

The house was designed to take advantage of Arizona's abundant solar energy. The long axis of the house is oriented east-west. Spectrally selective glazing was used to achieve a sun-tempered upper-level. The concrete, decorative stained floor provides thermal mass that enhances passive-solar performance.

Solar systems installed on the house include a 2kW PV system and a solar domestic hot water system. The hot water storage tank is centrally located relative to the faucets and the rooftop solar collector, shortening plumbing runs and minimizing heat losses. In addition, the design and installation of the plumbing incorporates the principle of thermosiphoning. The buoyant hot water rises naturally in the piping system and displaces the cooler water, eliminating the need for a circulation pump.

The Longview House also includes 100% Energy Star-certified lighting, a rainwater catchment and storage system, and spot ventilation in each of the three bathrooms using Energy Star-certified Panasonic Whisper Ceiling ventilation fans, operating at 70 CFM. These fans are pleasantly quiet when they are running (0.3 sones). Even the garage has a motion-sensor-activated fan to exhaust auto fumes. All exhaust fan ducts have straight runs and no duct size reductions that could reduce fan efficiency.

Diamond Valley House

The second of Yavapai's Gold EVHAs was awarded in the Affordable Home category for the college's Diamond Valley House. This home was built in partnership with the Prescott Area Habitat for Humanity (HFH), with the goal of demonstrating the affordability of green and energy-efficient building. Students and HFH volunteers built the home in two semesters.

Construction on the Diamond Valley House began in August 2005 and was completed in June 2006; the owner/occupants moved in just one month later. Before construction could begin, however, the existing lot, which was substandard because it was located in a flood plain, had to be engineered to bring it up to code. During construction, Yavapai minimized the disturbed area and preserved as many native trees and shrubs as possible. They avoided the use of toxic insecticides by using integrated pest management strategies instead.

The slab-on-grade 1,189 ft^2 home has a HERS rating of 57, or 5 stars, making it 43% more energy efficient than the Energy Star reference home and far exceeding the minimum required for Energy Star certification. The house has an extremely tight building envelope—the blower door test measured 103 CFM at 50 Pascals, which is equivalent to 0.63 ACH. The house also takes advantage of passive-solar heating, since the long axis is oriented east-west.

The Diamond Valley House utilizes slab edge rigid insulation to minimize heat loss from this critical boundary. There are 8 inches of R-32 spray foam insulation on the underside of

the roof deck. The attic is part of the conditioned space; it is unvented, with cathedralized insulation.

The exterior 2 x 4 frame walls are fully insulated with wet-spray cellulose and 1-inch extruded polystyrene (XPS) rigid insulation. The common wall separating the conditioned space from the garage is insulated like an exterior wall; the garage also has an unvented attic with cathedralized insulation so that it may be converted to living space if desired. Advanced framing allows for more additional insulation in the wall system, improving thermal performance while conserving resources.

The project also used products that included recycled content (such as the composite decking and the cellulose insulation), and all cardboard and metal construction materials were recycled.

The Diamond Valley House features double-pane, low-e, argon-filled windows. All interior and exterior lighting conforms to Energy Star standards. Other Energy Star products include the dishwasher, the refrigerator, and a 14-SEER air conditioning system. The HVAC system provides balanced whole-house ventilation with high efficiency particle arrester (HEPA) filtration, with a wall-mounted control unit adjacent to the HVAC controls. The gas furnace is a 40,000 Btu, 92 annualized fuel utilization efficiency (AFUE), sealed-combustion, single-zone unit. The home also features a solar domestic hot water system.

Energy efficient features in the Longview House include insulated, prefabricated concrete walls; advanced framing. and rim joist insulated with rigid insulation.

Active solar systems on the Longview House include a 2kW PV system and 4 ft. x 10 ft." solar collector for hot water. Note that the roof overhang shades with windows in this photo taken on the summer solstice.

An Outstanding Program

These award-winning houses show what the Yavapai College RBT program is capable of accomplishing. The program has been in existence for over 27 years, and each year it has taught students how to design and build a house—a house that is energy and resource efficient, comfortable, healthy, affordable, durable, and green; and a house that integrates current building science principles with mainstream construction practices.

In one year, students can earn a certificate in residential design, residential construction management, or residential building technology. In two years, they can earn an associate of applied science degree in residential building technology, and can prepare for transfer to a four-year university. Professionals currently working in the construction industry can enroll in individual courses to upgrade their existing skills and/or stay current with the latest advances in building technologies. The program is open to everyone who wants to learn about house building, design, and management.

Construction as a Teaching Tool

When the college purchases a lot in a local subdivision, Residential Design students are given the assignment of designing a house specifically for that lot. This is no easy task. For the past nine years, the college has used the comprehensive City of Scottsdale Green Home Rating Checklist as a guideline for houses constructed in the program.

Each student is given a list of building requirements and specifications, and of specific technologies to be incorporated into his or her design. These required technologies include (among others) a balanced air distribution system, a sealed duct system within the conditioned space, a superinsulated and airtight building enclosure, and a heat recovery ventilation system with HEPA filtration. Among the requirements are passive-solar design, a solar domestic hot water system, photovoltaics, high-performance windows, sealed-combustion appliances, and

energy-efficient lighting. Zero- or low-volatile organic compound (VOC) interior finishes are required, as well as rainwater catchment and graywater plumbing.

During the two semesters it takes to complete the design, faculty spend considerable time going over the requirements and technologies with the students' input. Faculty and classmates critique the designs to simulate the client/architect relationship. Students are encouraged to be creative while meeting the client's needs. It's a major challenge for students to incorporate these technologies into their design. At the end of the year, the client selects a completed design, to be constructed by the students the following semester. Students work at the site 20 hours a week for 15 weeks in a semester.

The finished houses measure approximately 2,000 square feet (or 3,000 square feet, if the home is built with a basement). Longview House is 3,200 square feet and sold for approximately $595,000. The profit goes toward scholarship funds.

It's no fluke that this small college has won such prestigious awards. As a matter of fact, Yavapai's RBT program has won five national awards over the past four years. They include, besides the two 2007 Gold EVHAs discussed above, the 2006 NAHB Green Building Award for Single Family Research Project/Custom Home; the 2005 Gold EVHA for Moderate Climate/Custom Home; and the 2004 NAHB Green Building Award for Green Building Project of the Year/ Custom Home.

Through the RBT program, students learn hands-on how to design and build a healthy, comfortable, and efficient living space. At the same time, by partnering with groups such as Habitat for Humanity, and by using local subcontractors, the RBT program is educating Arizona residents in the philosophy and practice of green building. Yavapai College's RBT program stands as one of the most progressive residential construction programs in the country. Where do we go from here? The RBT's next project is a zero net energy house!

For more information:

To learn more about Yavapai College and its RBT program, contact Tony Grahame, program director. Tel: (928)717-7726; E-mail: tgrahame@yc.edu; Web site: www.yc.edu/rbt/.