



Building America Best Practices Series

Builders Challenge Guide to 40% Whole-House
Energy Savings in the Marine Climate

Case Study: Quadrant Homes

Kentlake Highlands | Kent, WA

Quadrant worked with DOE's Building America BIRA (Building Industry Research Alliance) research team, to develop Quadrant's Energy Sound™ package.

BUILDER PROFILE

Builder's Name: Quadrant Homes, one of six Weyerhaeuser real estate companies

Where: Headquarters in Bellevue, WA, with showrooms in cities of Bellevue and Lacey

Founded: 1960s; acquired by Weyerhaeuser in 1969

Employees: approximately 130

Size: 300 units

Square Footage: Olympic 2011 plan—2,082 square feet

Development: Kentlake Highlands

Price Range: starting at \$248,900 for the Olympic 2011 plan

Energy-Efficient Commitment: Energy Sound™ package

Building America Helps Quadrant Develop its New Energy Sound™ Option

Bellevue, Washington, based home builder Quadrant Homes offers buyers of its “custom” production homes over 300 house plans and 10,000 feature options to choose from. With technical assistance from DOE's Building America program, Quadrant now offers homebuyers another option, one that pays buyers back. In 2007 Quadrant teamed with the Washington State University Extension Energy Office, a member of Building America's BIRA (Building Industry Research Alliance) research team, to develop Quadrant's Energy Sound™ package.

This energy-efficiency package helps homeowners achieve total energy savings of 40% over the Building America benchmark. The homes also qualify for the federal energy tax credit, achieving 50% in heating and cooling savings over the 2004 International Energy Conservation Code (IECC). The WSU Energy Office calculated utility bill savings of \$951 per year on a 2000-square foot Quadrant Energy Sound house. After subtracting \$159 in increased mortgage costs to cover the energy package, homeowners would still gain \$791 in net savings each year.

Quadrant Homes, one of six Weyerhaeuser real estate companies, is the number one residential homebuilder in the Pacific Northwest. Quadrant started 873 homes in 20 developments in Washington State in 2008. In the first six months of 2009 Quadrant sold approximately three homes a day, 85% of them to first-time buyers. Quadrant started building in the 1960s, and was purchased by the Fortune 500 forest products company Weyerhaeuser in 1969.



(top) All of the walls in Quadrant's homes start with panels assembled inside a factory so wood is dry, measurements and angles are precise, quality and worker safety are enhanced, and waste is minimized.

(bottom) Open-web trusses between the panelized walls of the first and second floor show why it is essential to properly seal ducts within this space.

"Our relationship with WSU [a Building America Partner] is beneficial both ways. I think we have been able to help them gather some research and data about the feasibility of putting ducts in conditioned spaces. They have helped us better understand the energy efficiency of our homes and what areas we need to improve on. We really enjoy working with them."

Quinn Wyatt, *assistant design manager at Quadrant homes*

A Process for Energy Efficiency

Before they began working with Building America, Quadrant already was offering ENERGY STAR as an upgrade which is at least 15% more energy efficient than a house built to code. "They were already exceptional with the overall air tightness of their buildings," noted David Hales, a building systems specialist with WSU. According to Hales, the typical infiltration for an ENERGY STAR builder in Washington State is about 4.5 air changes per hour at a pressure of 50 Pascals. "Quadrant often comes in under 3 ACH@50 PA," said Hales, who attributed the impressive rate to Quadrant's use of a panelized wall system and their recognition of the importance of a tight building envelope.

The Panelized Walls

The wall panels for all Quadrant homes are built in a factory by Woodinville Lumber and delivered to the job site pre-built. Craig MacKay, president of Woodinville Lumber, sees many advantages to this process. First, he cites efficient use of material. "Waste on the job site that might go into a dumpster or a landfill is immediately claimed in the factory for everyone's benefit."

Another advantage is the time saved. "While we are building the floor in the field in a more traditional manner, simultaneously we are building walls for the same house in a controlled environment factory. In a just-in-time way, when the flooring is done, the walls are done. So, instead of having to build the walls on site, which is a several-day process, those walls go to the site built," said MacKay.

The wood for the walls is cut and assembled using precise measurements that are computer calculated for each wall design. "It is uniform, very clean, very dry, and quick," said MacKay. "The structure is exposed to the weather for less time, and the quality of the walls is precise."

MacKay is quick to point out that "we custom build the walls for every home. There is no pre-build." Customer-selected options are entered into computer files developed for each home. From this electronic record, custom wall designs are generated for each house."

After the house is framed, other vendor partners air seal and insulate the walls. In the case of the Energy Sound (50% better than code) option, the walls are insulated using R-21 fiberglass batts within wall frames that are 2x6 16-inch on center.

Increased Insulation, Upgraded Furnace, and Ducts in Conditioned Space

Because the envelope was already tight, the WSU researchers analyzed Quadrant homes with computer models to determine what other big-gain options might be available for reaching 50% energy savings

over code. The modeling showed two areas for big gains. One involved upgrading the 80% AFUE (annual fuel utilization efficiency) furnace to a 94% AFUE furnace. Quadrant now provides this option on all Energy Sound™ packages.

The second potential for big gain—involved moving the ducts into conditioned space.

When considering this change, Quadrant and WSU relied on the expertise of the vendor partner Bob's Heating and Cooling, the company that installs the HVAC (heating, ventilation, and air conditioning) systems for all Quadrant homes. Wade Craig, a manager with Bob's Heating, explains that his team made changes to Quadrant's HVAC system about five years earlier, and these changes provided a clear path for moving the ducts inside.

Originally the furnaces were in the unconditioned garage and the ducts were in the crawlspace. For smoother production and cost savings, the furnaces were moved up into the attic. Also, at about this time, as explained by Ryan Kerr, Quadrant switched to open-web trusses between the first and second floors of their homes. This was originally done to enable the floors of the homes to be panelized, like the walls. The company no longer uses panels for floors, but it kept the open-web trusses between the floors. Now, for almost all house plans (with the exception of some one-story homes) the ducts are located in conditioned space within the open-web trusses between the first and second floor. The supply ducts provide HVAC to the first story through registers in the ceiling and to the second story through registers in the floor. The return ductwork is in the attic and is insulated to R-8, per Washington Building Code, and surrounded by additional insulation.

“So, in the first step, we put the furnaces up into the attics,” said Craig. “It was a step in the right direction, but we still had concerns.” These concerns included access, placement because of the pitch of some roofs, lighting, and adequate platforms. “So, the next step was to put the furnace in a closet inside the house,” said Craig.

For almost all Quadrant homes, the furnace is now in a mechanical closet on the second floor, where installation and servicing is easier. As Kerr explains, “The mechanical closet is actually built to outside-space code requirements (with insulated walls and door) to accommodate an 80-AFUE furnace with nondirect venting. A 90+ AFUE furnace, as required by ENERGY STAR, would not require this feature, although it would require other features, such as a gas condensation drain.”

Finally, to reach the 50% energy savings goal, Quadrant also increased the blown-in cellulose attic insulation from R-39 to R-49, hardwired 50% of the light fixtures to only accept compact fluorescent light bulbs, and provided ENERGY STAR appliances as options (a refrigerator, dishwasher, and clothes washer).

Energy-Efficient Features

(based on the Olympic 2011 model, which is 2,082 square feet, with an Energy Sound upgrade)

- **HERS:**
68 HERS rating
- **Walls:**
2x6 16-inch on center with R-21 batts
- **Attic Insulation:**
R-49 blown-in cellulose
- **Wall insulation:**
R-21 batts, 2x6 16-inch on center
- **Roofing Material:**
Asphalt shingles medium
- **Foundation:** Vented crawlspace with R-30 batts in the crawlspace ceiling
- **Ducts:** Inside conditioned space within open-web trusses between the 1st and 2nd floors
- **Air Handler:** Within a 2nd floor closet in conditioned space
- **Air Sealing:**
Tested envelope as 3.4 ACH 50
- **HVAC:** 94% AFUE furnace; SEER 13 air conditioner
- **Windows:** 13.5% whole-house window area, U-29 (0.29), double-pane, low-e, vinyl-framed
- **Water Heating:**
62% efficient gas tank
- **Ventilation:** 100% ASHRAE 62.2; upgraded bathroom exhaust
- **Green features:**
Built Green Certified
- **Lighting and Appliances:**
Hardwired 50% CFLs, ENERGY STAR refrigerator, dishwasher, and clothes washer
- **Commissioning/Certification:**
Northwest Energy Star, \$2,000 Federal Tax Credit, and Built Green certified



Building America recommended that Quadrant put the furnace and ducts in conditioned space to increase energy savings.

Quality Management Solutions

In 1996, Quadrant changed its building process. Before then, the company used the traditional model of “if you build it, they will come” in which the company constructed an inventory of speculative homes and waited for buyers to buy. Today Quadrant pre-sells its homes driven by the choices of the homebuyer. It follows a strict 54-day just-in-time and lean manufacturing process that starts with a customer qualifying for a loan. Following qualification, the homebuyer selects a specific development, lot, and floor plan. The process ends on day 54 with the customer receiving the keys to their completed home.

Within this process, Quadrant focuses on first-time homebuyers. During the first 6 months of 2009, 85% of their homebuyers were buying their first home, and they paid an average of \$280,000. “People value the process of buying a home at Quadrant,” said Quinn Wyatt, assistant design manager at Quadrant Homes. “They get to create the house that they have always dreamed of. They get to make the choices. It is all very personalized.” Surveys of homebuyers show that 96% are willing to refer friends.

In addition to meeting the needs of its customers, the process ensured the company did not carry a housing backlog during the economic downturn. Before the downturn, the company built seven homes a day. In 2008, two a day were built. In fall 2009 that number was up to three a day.

“Most of the big builders got caught with huge amounts of unsold inventory, but Quadrant’s business model helps avoid having unsold inventory,” said Hales.

Dollars and Sense

In 2009, with Quadrant selling its homes at an average price of \$280,000 to first-time homebuyers, the company was as committed as ever to keeping its operating and construction costs low. A 2008 BIRA report shows an approximate \$2,000 cost to the company for building to the Energy Sound level. In 2009 according to staff at a Quadrant showroom, the Energy Sound upgrade for a 2000-foot house was \$2,250, which includes all installation costs.

For More Information

Contact the EERE Information Center
1-877-EERE-INF (1-877-337-3463) or
visit eere.energy.gov/informationcenter.



Bottom Line

“We don’t pretend to know what each homebuyer wants,” said Wyatt. “We like to provide choice and let people build the house of their dreams.” However, Wyatt sees the need for education about energy efficiency. “One of the things we find surprising is how little knowledge there is still out there about energy efficiency and green building in general. So, we do a lot of educating in our showrooms. A lot of people know what the ENERGY STAR logo is [but] they don’t know much more than that [about what an ENERGY STAR home is].”