Case Study

BioBased Insulation®
Division of BioBased Technologies®

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Energy-Efficient Retrofit Case Study

Results from a year-long research study in East Tennessee shows that energy-efficient upgrades can pay off for homeowners by reducing heating costs by 35 to 75%. The study uses three similar homes in the same development to gather real-world data about various energy-efficient improvements that can be made to an existing home.

While the study focuses on improvements to existing homes, new, unoccupied homes were used in order to keep the results as unbiased as possible. The houses are typical two-story models built on insulated slabs with similar solar orientation, lot slope, wall areas, wind exposure and size. Computers and instrumentation are programmed to simulate occupancy, including opening refrigerator doors, automatic clothes washing and drying, showers, lights and plug loads in all three homes. But that's where the similarities end.

The control or builder home was built to meet current building codes and earned a Home Energy Rating System score of 102, which would be equal to a typical code-compliant home. It is equipped with two heat pumps, one for each floor, that have a total capacity of 4.5 tons.

The retrofit house includes energy-efficient upgrades that focus on the building envelope and mechanical equipment. These allowed the HVAC system to be reduced to one, three-ton heat pump located inside the conditioned envelope. The retrofit home earned a HERS rating of 68—a better score than the builder's home.

Detailed data measurements were taken at 15-minute intervals for a year to track the effectiveness of the upgrades. The retrofit unit provided 42% percent measured energy savings from the builder home, yet offers a package of technologies that are considered to be a reasonable upgrade for many homes in the United States.

Improvements to the home include installing low-E gas-filled windows, changing all light bulbs to compact fluorescents, and replacing the ceiling insulation with spray polyurethane foam insulation on the underside of the roof deck and attic walls to make it an unvented, semi-conditioned space.

"An unvented attic is particularly helpful in climates where heating and cooling equipment is located in the attic," said Chris Porter, building science manager for BioBased Insulation®. "Modifying the attic to create an indirectly conditioned space helps significantly reduce energy consumption and improves mechanical equipment performance."

BioBased Insulation® donated the insulation for the study, and an approved contractor donated the labor to install the product.

High-performance improvements to the third home made it a near zero energy home with a HERS rating of 34 and a measured space heating energy savings of 75% compared to the builder home.

While more extensive, some of the improvements could still be made to a deep retrofit of an existing home. They included 2.5 kW solar panels, solar hot water heater, triple-layered windows with an R-value of 7, structurally insulated sheathing and BioBased Insulation® in the walls, and R49 attic insulation with radiant barrier sheathing. The builder was able to downsize to one, two-ton heat pump because of the
envelope improvements.

So how much do energy-efficient upgrades cost? The upgrades included in the retrofit home cost $4 per square foot or about $9,800 more than the control home. Upgrades to the near zero energy home cost $21 per square foot or $51,576 more than the control home. Based simply on projected energy savings, homeowners who implement the retrofit upgrades would recoup their costs in eight and one-half years. It will take homeowners who implement the near zero energy upgrades 22 years to recoup their costs.

The study is sponsored by the Tennessee Valley Authority and has been conducted in cooperation with researchers from the Oak Ridge National Laboratory. For more information on energy-efficient tax credits for homeowners and how BioBased Insulation® can help, visit www.biobased.net.

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