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

BUILDING AMERICA TOP INNOVATIONS 2014 PROFILE

INNOVATIONS CATEGORY:
Advanced Technologies and Practices
Building Science Solutions
Thermal Enclosure

INNOVATOR:
ARIES Collaborative

Cost-Optimized Attic Insulation Solution for Factory-Built Homes

This low-cost, low-tech attic insulation technique is immediately applicable to the nearly 125,000 new manufactured homes built each year. With widespread adoption, this one measure could save home owners over 6 trillion Btus by 2030, equal to $190 million in savings that would go into the pockets of families with modest incomes.

BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

Increasing attic insulation in manufactured housing has been a significant challenge due to cost, production and transportation constraints. The simplicity of this dense-pack solution to increasing attic insulation R-value promises real hope for wide-spread industry adoption.

The U.S. Department of Energy's ARIES research team, led by The Levy Partnership Inc., partnered with Clayton Home's Southern Energy Homes division and Johns Manville Corporation to develop and test a new attic insulation method that involves dense packing the shallow attic space in manufactured homes with blown fiberglass insulation.

With this new method of applying dense-pack insulation, installers are able to achieve a much higher attic insulation R-value than is typically installed in manufactured homes.

Specifically, Southern Energy Homes has achieved an overall average attic R-value of R-44.6 and an R-value of R-54.6 at the center or peak of the attic using this innovative new dense-packing method. For comparison, a home certified to the ENERGY STAR Qualified Manufactured Homes program typically has an average R-value of between R-30 and R-38 in the ceiling. The typical ceiling insulation level in a manufactured home in HUD Code zone 1 is around R-22 at the peak.

The method was tested in a home built by Southern Energy to the performance criteria of the DOE's Zero Energy Ready Home program, which seeks to achieve whole house energy performance that exceeds the requirements of the 2012 International Energy Conservation Code.

The home is being monitored for 15 months at Clayton's Russellville, Alabama, plant in side-by-side testing with homes built to ENERGY STAR and to the U.S. Department of Housing and Urban Development's Manufactured Home Construction and Safety Standards (commonly known as the HUD code).

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(top left) The dense-pack roof insulation technique is being tested in a side-by-side comparison with two other manufactured homes—one built to ENERGY STAR and one built to the HUD code. The homes are undergoing 15 months of performance testing by the DOE's ARIES research team and National Renewable Energy Laboratory.

To dense pack the attics, workers at the manufactured home plant use a "mold" consisting of a sheet of perforated hardboard (pegboard) 24 inches wide by 48 inches long, with a flange at one end and a hole in the center to receive the insulation tube. The mold is sized to span one rafter bay.

The installers start at one end of the house and work their way down, filling each rafter bay from the eave out 4 feet to the flange in about 23 seconds. In the test home, the fiberglass insulation, which would have had an average R-value of R-33 if loosely blown, is dense packed at the eaves using the mold to achieve an overall average R value of 44.6 in the attic. Once compacted, the fiberglass fibers tend to stay together so filled bays can be left exposed as the installer moves down the bays. After dense packing all the eaves, the remainder of the attic is filled with loose blown fiberglass to the desired depth. Baffles are then installed above the insulation to provide a clear path for air to flow from the soffit vents to the roof vents. Then the house moves to the next construction station in the assembly line where sheathing and roofing are installed.

For the manufacturers, the beauty of the technique is its simplicity, and adaptability to current plant production processes. As a result, this new high-R attic insulation innovation is positioned to overcome the considerable challenges in an industry reluctant to make changes that could increase production time, cost, or complexity.

The technique addresses many industry barriers:

- First cost: Affordability is an industry-defining characteristic. Even significant energy-efficiency improvements that could increase the home's long-term affordability are shunned if they will increase initial home price.

  The dense-pack technique uses an insulation product that the builders felt provides the highest thermal benefit at the lowest cost. The insulation blower is already in use at most factories and the cost of the hardboard is negligible. The small cost associated with the dense-packing measure is recovered immediately in reduced overall home operating costs, and the materials have a simple payback of less than 3 years.

- Dimensional limitations: Because manufactured homes are transported over roads, they are subject to strict height restrictions. For example in California the maximum height allowed is 14 feet including the wheels, undercarriage, walls, and roof. Therefore, attics are low, ranging from 2 to 3.5 feet at the peak and tapering to a heel height of 2.5 to 7.5 inches above the top plates, leaving very little room for insulation.

  The dense-pack technique conforms to the constrained space and encourages consistent coverage in every rafter bay.

- Production speed: Manufacturers avoid using new products or building methods if they are likely to slow the pace of production, require staff training to build it right, and/or are susceptible to defects and recalls.

  The dense-pack technique uses insulation materials manufacturers are already familiar with in a way that minimizes impact on product flow. The method is simple, easy to learn, and it is easy to verify quality. These are major advantages in a high-paced production setting. Adoption could be implemented immediately on a large scale across companies without the need for retooling or other process changes.

An employee at Clayton's Southern Energy Homes plant uses a perforated hardboard "mold" to dense pack blown fiberglass insulation into the eaves of a manufactured home. The light-weight mold is 4 feet long and just wide enough to span the rafter bay with a hole in the middle for the insulation tube. A flange at the far end holds the insulation in place as it is blown in.

Installers start at one end of the house and work their way down, filling one bay at a time in about 23 seconds per bay.

After all of the eaves are dense packed, the remainder of the attic is filled with loose fill to the desired height.

REFERENCES

Gilbride, TL. 2014. *DOE Zero Energy Ready Home Case Study: Southern Energy Homes, First DOE Zero Energy Ready Manufactured Home*, Russellville, AL, PNNL-SA-105453, http://energy.gov/eere/buildings/housing-innovation-awards