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

BUILDING TECHNOLOGIES PROGRAM

This 1940s pre-fabricated home was built with 2x2 studs, making the walls too thin for cavity insulation. Building America researchers recommended installing rigid foam insulation on the exterior of the house, under new siding. Computer modeling predicts that insulating the walls will cut the owner's energy bills by 33% and pay for itself in just 3 years.

Building America's Deep Energy Retrofit Research Project

Case Study: 1940s Pre-Fabricated Home

Richland, WA

Exterior insulation will help cut energy bills in half

Hundreds of houses in Richland, Washington, were hastily constructed by the federal government in the 1940s to serve workers on the Hanford Nuclear Reservation. This two-bedroom, 700-ft^2 cottage is one of those pre-fabricated, wood-framed homes. Its 2x2 stud walls were too thin for cavity insulation, and it has never had a heating system. Today, most of the walls are still uninsulated, the house is drafty, and energy bills are high for such a small house.

When researchers from the Pacific Northwest National Laboratory conducted a whole-house energy assessment, they confirmed what the owner already knew. The home needs wall insulation. The space heater the owner relies on in winter is inadequate and the "through-the-wall" air conditioner is old and inefficient. The researchers identified additional causes of energy loss—an inefficient water heater and a number of holes in the ceiling that allow conditioned air to escape to the attic.

The researchers from PNNL conducted the assessment in support of the U.S. Department of Energy's Building America program. They used computer modeling to identify the most cost-effective ways to fix the home's problems. Together, the recommended measures will cut the owner's energy bills an estimated 48% and can all be completed for about $8,800. The projected $557 annual savings means the project will pay for itself in 13 years. Meanwhile, the home will be much more comfortable.

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Insulating the walls will be much simpler than the owner expected. A few years ago, she gutted the bedroom walls from inside, then put a new stud in front of each existing stud to create cavities deep enough to hold insulation. However, in making the walls thicker, she lost 25 ft^2 in floor space. In her 700-ft^2 house, that is a big loss. To achieve comfort and energy savings, the owner assumed she would have to re-frame the rest of her house, further reducing her square footage. The Building America researchers identified an easier, more cost-effective way to insulate that will allow her to keep every inch of floor space.

The Home Energy Assessment

The assessment is part of Building America's Deep Energy Retrofit Research Project (see Sidebar). Researchers are identifying cost-effective technologies and strategies for reducing energy use in existing homes by more than 30%. When the upgrades are complete, the researchers will measure and analyze the results to develop best practices for deep energy retrofits in a variety of climates.

In the Richland home, the researchers evaluated insulation levels, conducted a blower door test to measure whole-house air leakage, and checked the energy-consuming appliances. Using audit data and computer modeling, they provided the homeowner with a list of upgrade options, giving estimated costs and projected savings. The researchers met with the homeowner to study the results and identify the best options for her needs and budget.

Problems, Options and Recommendations

Over the years, the home has had a few energy improvements. The attic and crawlspace were insulated, and the original windows have been replaced with double-paned, vinyl-framed ones. However, other problems—the uninsulated walls, the ceiling holes, and the lack of a heating system—make the home cold in winter and hot in summer.

Wall insulation. Rather than gutting and extending the walls to add insulation, the Building America researchers recommend installing exterior rigid foam insulation. Two inches of polyurethane or polystyrene foam board under new siding will insulate the walls to R-15. Rigid foam offers the highest R-value per inch of any insulation, and installing it will cause no disruption inside the house. The work will cost $1,100. Since it will save an estimated $358 a year in energy costs, the insulation will pay for itself in just three years.

Building America's Deep Energy Retrofit Research Project

This assessment is part of Building America's Deep Energy Retrofit Research Project, conducted by the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory, and other research partners. The researchers are coordinating deep energy retrofits for at least 50 residences throughout the United States.

Deep energy retrofits use comprehensive, whole-house strategies to reach the highest cost-effective level of energy efficiency. For each home, the Building America researchers identify a package of cost-effective technologies and strategies to reduce energy use by more than 30%.

A deep energy retrofit usually requires an investment of $7,000 to $20,000. Rebates, tax credits, and low-interest loans are often available.

Once upgrades are complete, the Building America researchers measure energy savings and improvements in comfort, health, and safety. Analysts will use the data to evaluate the benefits and cost-effectiveness of deep energy retrofits. These analyses will inform the U.S. Department of Energy's best practices for retrofitting homes in climate zones across the country.

Attic insulation. The Building America researchers recommend sealing the holes in the attic floor where pipes and wires penetrate. For additional attic insulation, the researchers offer two options: The attic floor currently has two layers of R-19 fiberglass batts, equivalent to R-38. Blowing loose fiberglass over the existing batts would insulate the attic to R-60. Alternatively, the attic vents could be sealed, and 6 inches of closed-cell spray foam insulation could be applied to the roof deck for a total R-value of 74.

The Building America researchers recommend adding insulation to the attic at either the floor or ceiling level. This will yield only minor savings but will increase comfort in the rooms below.

Measure	Estimated Reduction in Energy Bills	Estimated Cost	Estimated Savings	Payback Period	Payback Period (after incentives)*
Add loose fiberglass insulation at ceiling level	2%	$540	$17/yr	31 yr	28 yr
Add spray foam insulation at roof deck	2%	$833	$30/yr	27 yr	25 yr

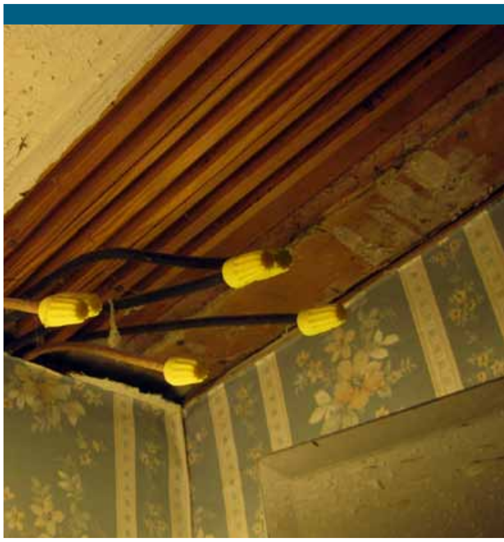
*Federal tax credits and locally available incentives reduce the cost of some projects.

Heating and cooling system. Installing a central heating system will bring a major improvement in comfort. It will also cut the owner's energy bills by an estimated 22%. Since the home has no ducts, the Building America researchers recommend installing a mini-split heat pump. This innovative system has an outdoor unit like any heat pump. Instead of connecting to ducts, however, the outdoor unit sends compressed gas through small-diameter, insulated refrigerant lines to one or more indoor units. Mounted on a wall or ceiling, these units heat or cool the house. This small house needs only one or two indoor units.

A federal tax credit and local incentives will reduce the cost of the heating and cooling system to about $6,500, so it should pay for itself in 20 years. Meanwhile, the efficient system will increase the home's value and provide comfortable temperatures year-round.

Water heating. The home's electric water heater is 23 years old and inefficient. Replacing it with a high-efficiency model will cost about $700. It will save an estimated $87 a year in energy bills and pay for itself in just 8 years.

The home has never had a heating system. Building America researchers recommend installing a ductless, mini-split heat pump that will bring a year-round improvement in comfort. Wall-mounted units like this one will provide heating and cooling.



A number of holes in the ceiling allow conditioned air to escape to the attic. This gap should be covered and sealed.

The Bottom Line

With a total investment of less than $9,000, the homeowner can make all these improvements and cut her energy bill nearly in half. Since she plans to stay in this home for the rest of her life, the improvements will benefit her for years to come. When the 13-year payback period is up, the annual energy savings will be money in her pocket.

Measure	Estimated Reduction in Energy Bills	Estimated Cost	Estimated Savings	Payback Period	Payback Period (after incentives)
Insulate walls	33%	$1,102	$358/year	3 years	3 years
Add loose fiberglass insulation to attic floor	2%	$540	$17/year	31 years	28 years
3/4 ton SEER 16 mini-split heat pump	22%	$6,469	$238/year	27 years	20 years
EF 0.95 electric water heater	8%	$700	$87/year	8 years	8 years
TOTAL SAVINGS*	48%	$8,811	$522/year		13 years

* Total savings is not simply the sum of savings from each measure because the changes are interactive. Actual savings will depend on which measures are implemented, as well as any changes in usage patterns. Costs are calculated with data from the National Residential Efficiency Measures Database, assembled by the U.S. Department of Energy's National Renewable Energy Laboratory. These values are compared to local prices and quotes. Savings are modeled with Energy Gauge software, based on the local electric rate of $0.068/kWh. A simple payback period is used, without adjustments for interest, inflation, or depreciation. Federal tax credits and locally available incentives reduce the cost of some projects.

For More Information

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