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

DOE Re-Siding-Window Retrofit Case Study

Jackson, MS: **Railroad Renovation**

This 820-ft^2 home built in Jackson. Mississippi, in 1955 needed extensive renovation in addition to new siding and windows.

Builder Profile

C & C Services
Jackson, MS
Cleo Nichols
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Project Home

- Name: Railroad Renovation
- Location: Jackson, Mississippi
  Layout: 3 bdrm, 1 bath, 1 fl, 820 ft^2
- Climate: IECC 3A, hot-humid
- Year Built: 1955
- Retrofit Completed: June 2022

Performance Data:

- Home Energy Score:
  pre-retrofit: 1
  post-retrofit: 9
- Estimated Annual Energy Costs,
  post-retrofit: $839
- Estimated Annual Energy Savings,
  post-retrofit: $798
- Decibel Reading:
  pre-retrofit: 73.7
  post-retrofit:

Every retrofit comes with its own unique set of challenges. A pandemic, rising materials costs, supply and labor shortages, and a very questionable foundation conspired to do this one in, but builder Cleo Nichols of C & C Services in Jackson, Mississippi, persevered, determined to give the owner a decent home that would meet code and stand up to the elements. When Nichols heard about the U.S. Department of Energy's re-siding and window retrofit study, he volunteered the home as a case study project hoping to learn more about the installation of continuous exterior insulation, which is an uncommon retrofit in Mississippi.

The owner, who lives out of state, had purchased the 70-year-old, one-story 820-ft^2 home in Jackson as a home for his daughter and as a reminder of his great grandmother, who had once lived there. While the roof and siding had been replaced in the recent past, a thorough investigation by Nichols revealed serious structural concerns that indicated a gut rehab was needed to bring the home up to code.

The foundation was a very shallow crawl space of randomly sized boards set on bricks and concrete block over a bare dirt floor. The walls consisted of 1x6 and 1x8 wood plank sheathing attached to inconsistently spaced 2x4 studs. There was interior drywall but no cavity insulation or exterior tar paper or house wrap. Aluminum siding was stapled to the boards. The windows included a mix of single-hung wood-framed and fixed metal-framed single-pane clear-glass windows. Some were missing glass. Extensive rot was evident around the frames and sills of several windows. The attic had no insulation. The ceiling and some walls were lined with wall paper possibly to serve as a vapor barrier under the ceiling drywall and wall drywall or paneling. The roof was asphalt composition shingle.

After assessing the existing state of the building, Nichols recommended a tear-down but the owner was optimistic that the building could be saved. Structural changes included removing flooring to straighten and strengthen the foundation by adding additional piers and floor joists. These changes would likely adjust the alignment of the roof rafters

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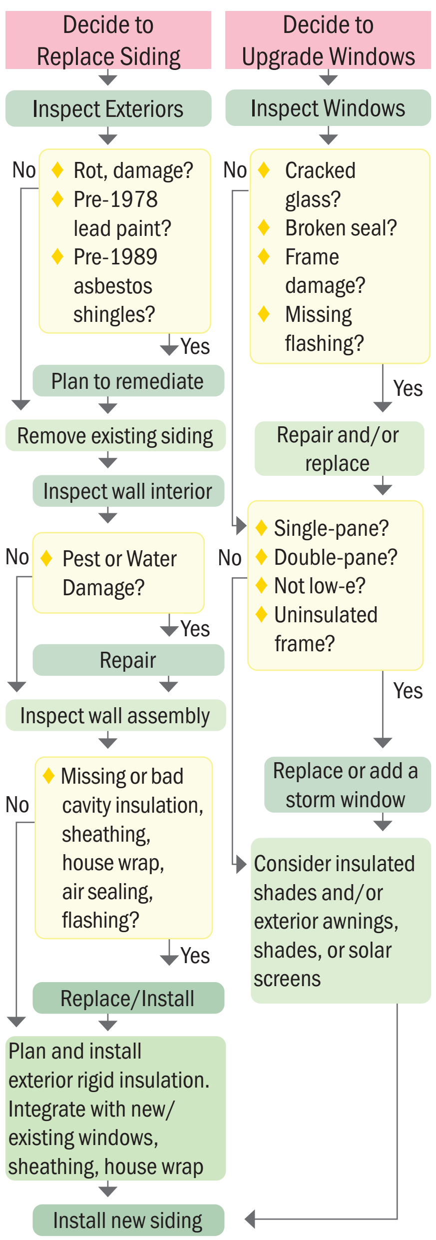
The U.S. Department of Energy's Building Technologies Office is working in partnership with national laboratories, the building industry, and other stakeholders to develop cost-effective energy-saving technologies and strategies to reduce building energy consumption. In support of this effort, Pacific Northwest National Laboratory, in partnership with Building Science Corporation and Earth Advantage, conducted a series of techno-economic studies to evaluate the home performance contractor business case for including window and wall insulation upgrades as part of conventional home siding replacement projects. Five existing homes were selected for study that were already scheduled for siding replacement. These homes represented a variety of U.S. climate zones and existing wall assemblies. DOE management oversight was provided by Marc LaFrance, Manager for DOE's Residential Buildings Integration Market Transformation Program.

The home had irregular board sheathing attached to the inside face and outside face of the wall studs which were not evenly spaced. Wallpaper was installed on the ceiling possibly to serve as a vapor barrier over the board sheathing on the ceiling. The top and bottom plates consisted of several small pieces of 2x4s. The floor joists were irregular and were resting on stacks of bricks or concrete block, providing a low and unstable crawl space.

Wall-Window Retrofit Decision Tree



voiding the roofing warranty and requiring that a new roof be installed. The drywall, paneling, and interior board sheathing were removed from the walls and ceilings and studs were added as needed to create 16-inch on-center spacing. Additional upgrades included replacing the electrical and plumbing, replacing the electric baseboard heating and air conditioner with a new 14 SEER central air conditioner and a 90% AFUE gas furnace, and new rigid ducts in the attic, and installing new interior finishes and appliances.

Pre- and Post-Retrofit Conditions

Jackson	Pre-Retrofit	Post-Retrofit
Vintage	1955	2022
Wall Assembly	Aluminum siding stapled to studs. Stud framing inconsistently spaced in walls and ceiling. 1x6 board sheathing on interior and exterior of studs. On exterior aluminum siding was stapled to board sheathing, no house wrap. On interior, the boards were covered with wall paper and drywall or paneling.	Removed old siding and interior board sheathing, drywall, and paneling. Kept exterior board sheathing but where damaged replaced with OSB. Repositioned studs for 2x4 at 16-inch on-center spacing. Installed house wrap, rigid foam with taped seams and new vinyl siding. On interior, filled wall cavities with fiberglass batts then covered with new drywall.
Windows	11 original windows: some were aluminum-framed single- or double-pane, some were single-pane wood framed.	Triple-pane vinyl-frame windows installed after house wrap and rigid foam were installed.
Other Retrofits	Old wiring, old plumbing. Shallow uneven wood-on-brick crawlspace. Old appliances and flooring. Baseboard heat. Window-unit air conditioning.	Added new piers and floor joists. Opened all interior walls and replaced electrical and plumbing. Installed new appliances, HVAC, rigid ducts in attic, flooring, and interior finishes. Removed old attic insulation, air sealed, installed new blown fiberglass.

The home's original single-pane metal or wood-framed windows were in poor shape. Some were cracked, several were water damaged. All of the windows were replaced with triple-pane windows. Although the hot-humid climate of Jackson may not warrant high R-value windows for energy savings alone, the home's location near an active railroad line meant the sound-dampening effects of the triple-pane windows would be greatly appreciated.

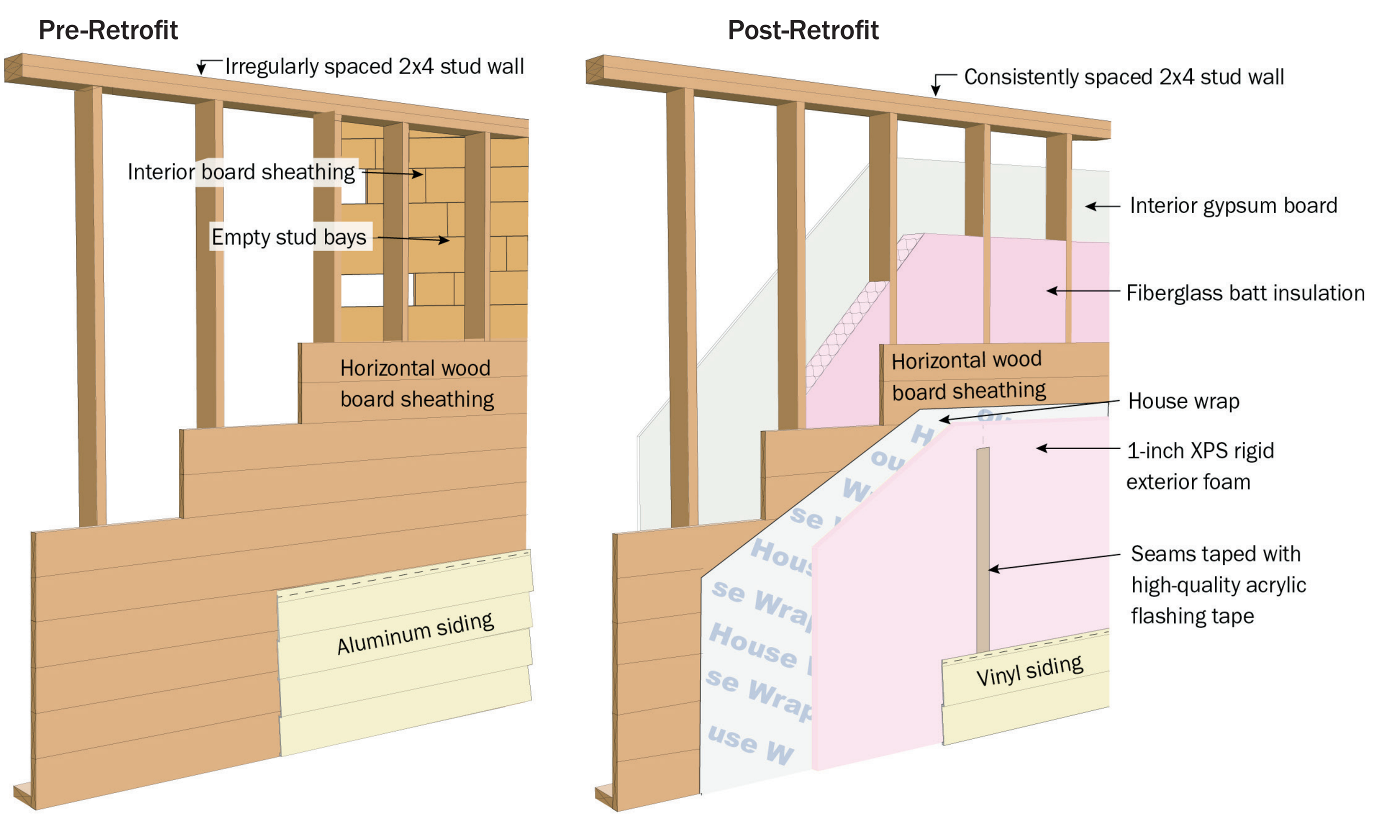
Nichols worked with project staff from Pacific Northwest National Laboratory, Earth Advantage, and Building Science Corporation to discuss wall/window retrofit options:

1. Install OSB sheathing on the studs, house wrap, and 1 inch of rigid foam (extruded polystyrene (XPS)) then install vinyl siding nailed through to the OSB.
2. Install OSB sheathing on the studs, then 1 inch of rigid foam with seams taped so the foam is the water and air barrier, then install vinyl siding nailed through to the OSB.
3. Install an insulated structural sheathing product with a taped air- and water-barrier coating.
4. Install an OSB product with adhered rigid foam and an integrated water-resistant coating with seams taped; this is another type of all-in-one product.

"Adding new windows and 1 inch of rigid foam was not hard to do and cost less than I expected. If home owners understand how this will cut utility bills, why wouldn't you want to do it?"

—Builder and Remodeler Cleo Nichols

Jackson Pre- and Post-Retrofit Wall Assembly Details



For the finished wall assembly, Nichols chose to re-position the 2x4 studs to a consistent 16 inches on-center, kept the exterior board sheathing but replaced with OSB where the boards were damaged, then covered the boards with house wrap, 1 inch of XPS rigid with taped seams, and vinyl siding. He had originally planned to use fiber cement but was concerned about the weight as vinyl siding could be nailed to the board sheathing whereas fiber cement would need to be nailed through to the studs. He also liked the inherent drainage gap behind vinyl siding and felt it was more forgiving of house movement, noting that with an active railroad track within 100 yards of the home, there would always be ground movement at the site. On the interior, Nichols removed board sheathing, filled the stud bays with fiberglass batts, and installed drywall.

For windows, the PNNL team recommended ENERGY STAR Most Efficient (Southern Climate Zone) triple-pane windows to ensure both sound reduction and year-round energy savings. The original windows were a mix of wood- and metal-framed, single- and double-pane windows. Nichols noted that he had to re-frame every window opening before installing the vinyl-framed, argon-filled, triple-pane windows. Nichols followed the DOE team's recommendation to install the house wrap and rigid foam first, then to install the windows.

Despite experiencing delays in obtaining the windows and the rigid foam, both of which were uncommon in his market, and despite severe labor shortages (Nichols' crew dropped from 8 to 2 over the course of the project), Nichols was still upbeat about the assembly methods chosen and felt that he could both sell it to customers and make a profit from it. "When people realize their utility bills will be lower and their house will be much less drafty and better prepared for the hotter and colder weather we are getting, why wouldn't they want this? It's not harder to build and it doesn't add much to the cost," said Nichols.

Contractor Expectations and Reactions

What worked well?
Repositioning the wall studs, along with adding piers and floor joists and other changes made the home more structurally sound and brought it up to code.

How much time did it add to a typical residing job?
Installing the foam board on this house added 4 days and 4 people. But we went up the roof line at the gables and had to notch around all of the cornices. If we didn't have to do so much cutting we could have done it in 2 days + 2 days to install the vinyl siding. Replacing triple-pane windows added no more time than installing regular windows. We use 3 guys per window now — 2 outside to hold and level it and 1 inside to center it.

How much did it cost?
Cost for foam was 31 sheets at $25/sheet = $775. Cost of flashing tape was $200. The triple-pane windows were $6,902, about twice the cost of double-pane windows. Labor was $3,200 (4 guys X 8 hours X 4 days x $25/hr). Note – all of the triple-pane windows were made with tempered glass, which increased their cost.

What were the most challenging aspects of the job?
Labor and materials shortages, costs, extensiveness of scope.

Can you sell this to homeowners? If not, why not?
I would tell clients, this is part of the package I do. You are spending $1,000 more for this insulation to ensure you got an energy-efficient home. Who wouldn't want this? Our electric bills have doubled and gas bills have tripled here.

Could you make a profit at this?
Yes, If the job were just adding house wrap and insulation while replacing siding, I think I could sell this on the energy savings and increased comfort, from the air sealing as much as from the insulation.

What would you do differently next time?
I'd keep the existing drywall or sheathing if it's in good shape. Before anything is done in the interior, I'd tackle the structural and the exterior first.

Jackson Project	Siding[1]	Windows[2]
Planned Material Cost	$2,600	$3,378
Planned Labor Cost	$1,600	$800
Total Planned Cost	$4,200	$4,178
Added Upgrade Material Cost	$975	$3,524
Added Upgrade Labor Cost	$3,200	$0
Upgrade Incremental Cost	$4,175	$3,524
Total Project Cost with Upgrades	$8,375	$7,702

[1] Add 1 inch of foil-faced polyiso continuous exterior foam insulation.
[2] Install interior low-e storm windows.

Key Take-Aways

- Set realistic expectations for homeowner.
- Educate homeowner on extent of time and cost of whole retrofit to bring building up to code based on current conditions.
- Address the structural and exterior issues first before dealing with the interior.

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