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

Siding & Window Retrofit Case Study

Bellingham, WA: **Cedar Siding Retrofit**

This 1970s split-level home in Bellingham, Washington, was made of cedar but unfortunately was not built to last.

Builder Profile

[bundle] design studio
Dan Welch
dan@bundledesignstudio.com

Project Home

- Name: Cedar Siding Retrofit
- Location: Bellingham, WA
- Layout: 4 bdrm, 2.5 bath, 2 fl, 1,959 ft²
- Climate: IECC 4C, marine
- Year Built: 1977
- Retrofit Completed: Dec. 2021

Performance Data:

- Home Energy Score:
  pre-retrofit: 1
  post-retrofit: 3
- Estimated Annual Energy Costs
  $1,480
- Estimated Annual Energy Cost Savings $228
- Blower Door:
  pre-retrofit: 11 ACH 50
  post-retrofit: 8 ACH 50
- Decibel Reading:
  pre-retrofit:
  post-retrofit:

In the damp, cool Pacific Northwest, cedar has been valued for centuries as a building material that can handle constant moisture, but even cedar can't beat bad design. This 1970s split-level cedar-sided home in Bellingham, Washington, was experiencing advanced deterioration in several areas due to poor detailing.

An initial walk-through of the project revealed that the siding had significant water damage and the home's double-pane windows "were the thinnest double-pane windows I've ever seen" said Dan Welch, owner of [bundle] Design in Bellingham, Washington, who was hired by the homeowner to oversee the renovation. When Welch heard about the re-siding and window upgrade field study being conducted by the U.S. Department of Energy, he volunteered the home as a case study project because exterior insulation and window upgrades were high on his list of recommendations to the home owner. Welch worked with Chris Lett of Lett Design/Build on the remodel.

When Welch and Lett removed the siding, they found extensive damage. The cedar siding was installed diagonally on several walls and grooves in the siding directed the surface water runoff into the trim joints, where it eroded the trim, while wet debris from overhead trees collected in the corners and exacerbated rotting of the siding. Other areas of the home lacked overhangs and water was flowing directly behind the siding due to lack of drip edge flashing and a poorly designed fascia. The poorly flashed cedar-covered chimney had extensive damage as did the entry deck, which was installed tight to the siding with no drainage gap or effective cap flashing. Splash back and build up of pine needles and cedar tree droppings along the wall was rotting the siding next to the deck as well. A poorly placed dryer vent under a kitchen window bump-out was causing rot below the window while the top of the bump-out was rotting due to missing trim. Lack of a drained air gap behind the siding contributed to its inability to dry out.

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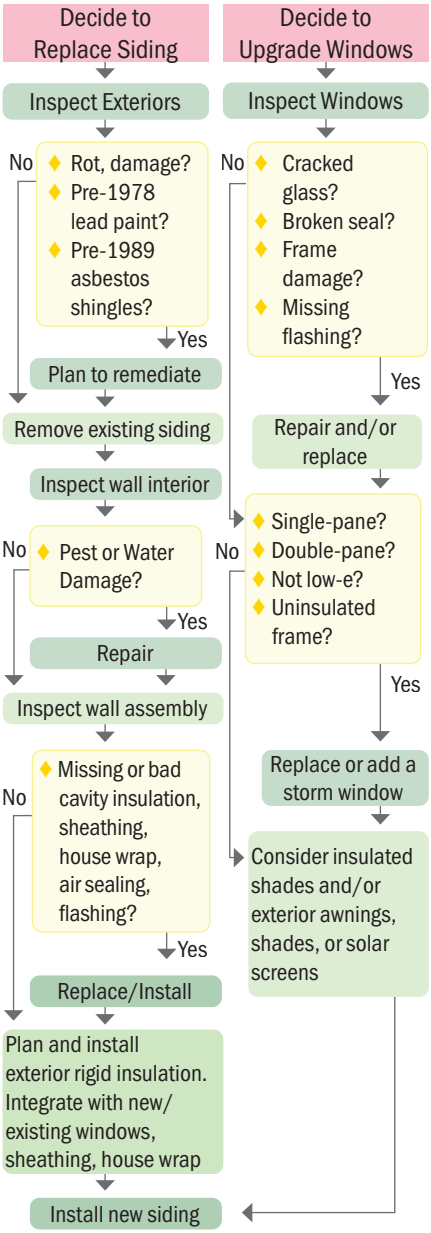
The U.S. Department of Energy's Building Technologies Office is working in partnership with national laboratories, the building industry, and other stakeholders to develop cost-effective energy-saving technologies and strategies to reduce building energy consumption. In support of this effort, Pacific 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 entryway deck had been attached directly to the cedar siding with no drainage gap or ledger board, leading to extensive rotting. The “more mold than wood” decking was removed and the damaged siding was pulled off revealing wet sheathing underneath. There was also extensive moisture damage around the chimney and rotten fascia along the roofline due to missing flashing.

Wall-Window Retrofit Decision Tree



After removing and saving whatever cedar boards could be salvaged, removing the windows, and removing and replacing any rotted plywood sheathing, Lett installed self-adhered water-resistant membrane over the walls to provide both a moisture barrier and air sealing. Over this Lett installed 2-inch-thick cork exterior insulation. Furring strips of borate-treated 2-inch-by-8-foot plywood strips were installed to provide a drainage gap behind the cedar, fiber cement, and metal siding. For this home, the siding contractor installed the cork layer first, then did a second pass around the house to install the furring strips. He felt that on future installs he could save time by installing the first course of cork, then the furring strips, then tucking additional rows of cork, which comes in roughly 2x3-ft pieces, behind the furring strips and attaching both with the same fasteners as they work up the wall.

Pre- and Post-Retrofit Conditions

Bellingham	Pre-Retrofit	Post-Retrofit
Vintage	1977	2022
Wall Assembly	Split-level 2-story, 2x4 16-inch on-center walls, with some rockwool and fiberglass batts, plywood or asphalted fiberboard sheathing, tar paper. Siding is the original shiplapped cedar wood siding, stained and installed on diagonal with a lot of rot.	Kept drywall, 2x4s, rockwool batts, plywood. Replaced tar paper with self-adhered, vapor-permeable water-resistive membrane. Added 2 inches cork exterior insulation and ¾-inch borate-treated plywood furring strips for drainage gap. Siding is re-used flipped cedar, fiber cement, and metal at areas with no overhang.
Windows	Double-pane, clear glass, uninsulated aluminum-frame windows.	New triple-pane, aluminum-clad wood-framed insulated windows.
Other Retrofits	Water damage at cathedral ceiling, roof fascia, deck, chimney, around windows due to bad detailing. No insulation in cathedral ceiling.	Installed new vented roof over existing roof with new insulation, sheathing, soffit and ridge vents, ice & water shield, and asphalt shingles.

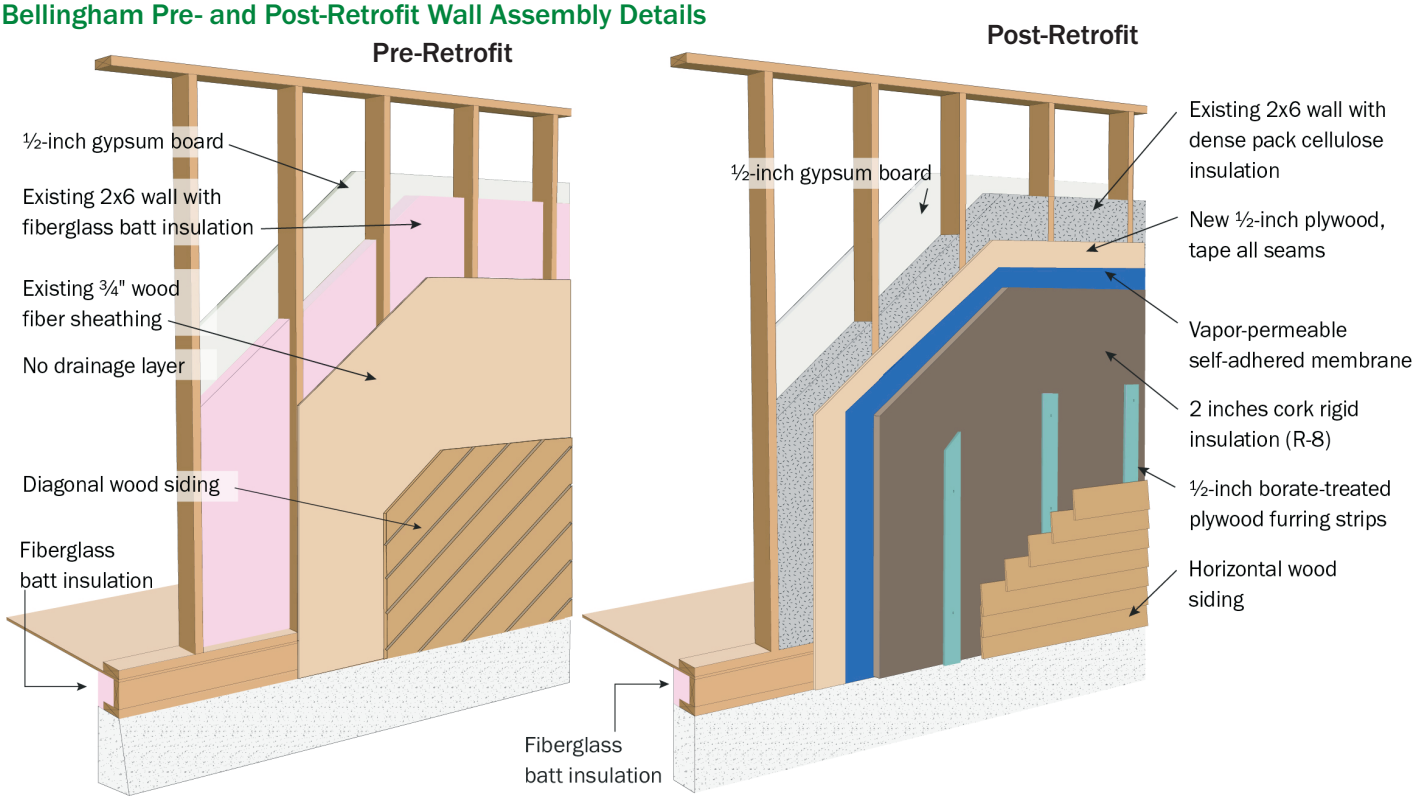
All of the double-pane, clear-glass, uninsulated metal-framed windows were removed. After sheathing and trim were repaired, new aluminum-clad wood-framed insulated triple-pane windows were installed and properly flashed with flexible butyl tape. Welch installs center-of-plane windows so the contractors don't need to build window bucks. This home was constructed with 2x4 cedar trim around all of the windows and doors, giving the contractors 3.5 inches of space to work with for installing the rigid insulation.

Due to Bellingham's damp environment, Welch prefers a rigid insulation with vapor permeance and his favorite is cork. Welch noted that cork, a natural product harvested from trees in Portugal, comes in two varieties. The tighter-grained variety sheds bulk water (it can actually be used as an exterior siding material) but it is vapor open, making it ideal for the damp Northwest climate. Other insulation products Welch sometimes uses include graphite-enhanced polystyrene (GPS), which is more cost effective than cork, mineral wool, or a wood-fiber insulation imported from Europe. When originally interviewed in July 2021, Welch estimated the following prices for these products in Bellingham: Cork was $2.35/ft^2, wood-fiber insulation was $2.25/ft^2, rockwool was $1.90/ft^2, GPS was $1.50/ft^2, and EPS was $1.40 /ft^2 for 2-inch-thick insulation boards.

"We love how much less humid and drafty the house feels."

--Homeowners

Bellingham Pre- and Post-Retrofit Wall Assembly Details



The existing windows were double-pane, clear-glass windows with uninsulated metal frames. Welch removed these to replace them with triple-pane windows. This also allowed him to properly flash the window frames and to integrate the flashing with the new wall layers. When replacing windows or installing windows in new construction, Welch always recommends triple-pane windows. “You'd have to go to R-20 or higher on the wall insulation to beat the insulating value boost provided by U-0.20 or better windows,” said Welch.

Welch prefers fiberglass windows to vinyl-framed windows because he felt that, although more expensive, fiberglass-framed windows are repairable, while vinyl windows often need to be pulled and replaced if damaged. Also, pultruded fiberglass frames have a coefficient of thermal expansion that matches glass, reducing seasonal movement and joint stresses. On this project, due to supply chain issues, he went with aluminum-clad wood-framed windows. After repairing or replacing rotted sheathing and framing, the new windows were set in line with the sheathing.

The installer Lett felt that using triple-pane instead of double-pane windows did not increase the labor costs. “The triple-pane windows were heavier but we typically use two people to install most windows anyway and none of the windows were bigger than 3x5 so weight was not an issue.”

"The added costs for both upgrades were less than $5,000 each (see table).

Bellingham Project	Siding[1]	Windows[2]
Planned Material Cost	$6,800	$8,954
Planned Labor Cost	$5,750	$1,450
Total Planned Cost	$12,550	$10,404
Added Upgrade Material Cost	$3,847	$3,555
Added Upgrade Labor Cost	$1,100	$0
Upgrade Incremental Cost	$4,947	$3,555
Total Project Cost with Upgrades	$17,497	$13,959

[1] Add 2 inches of cork rigid insulation.
[2] Use triple rather than double pane. No window larger than 3X5 on this project, so no incremental labor cost as installation still manageable with two people.

Contractor Expectations and Reactions

What worked well? The cork insulation was a good choice. Cork can go behind anything. It also allows for some outward drying. (At 2.5 to 4 perm, it's a Class III vapor retarder.) That’s good from a liability standpoint. It’s also more dimensionally stable than foam so you can use one 2-inch layer rather than two 1-inch layers. And it’s water tight so you don’t need as much flashing. We just use corrugated plastic rainscreen strips at top and bottom to keep bugs out of rain screen vent.

How much time did it add to a typical residing job? How many crew? Maybe 1 or 2 days of install for 1 or 2 people. We could probably cut the time in half by installing the cork and furring together instead of in separate passes.

How much did it cost? On a 1,500-ft^2 house, adding the exterior insulation would take 2 installers 1 day or 1 installer 2 days, at a cost of about $2.50 to $3/ft^2 in materials. and about $1,000 for labor. We could probably cut labor costs to $600 if we streamlined installation to one pass.

What were the most challenging aspects of the job? Finding faster ways to install the cork. Supply chain issues.

Can you sell this to homeowners? If not, why not? I would highly recommend adding exterior insulation for someone looking to replace their siding. It will give the customer a much better R value. It all depends on their budget. For window upgrades, on new construction we prioritize windows over exterior insulation. You’d need at least R-20 in the walls to catch up with better windows. In retrofits, if the existing windows are single-pane or uninsulated double-pane aluminum-frame, then replacing the windows always makes sense. If the windows have been upgraded to insulated double-pane, then a wall insulation upgrade may make more sense. Cascadia Windows has a good walls vs windows calculator.

Could you make a profit at this? For renters and flippers these improvements don’t cost out. For clients working on their forever home, it makes sense. Even if ROI doesn’t work in our mild climate, it makes sense from a durability, air quality, and comfort standpoint.

What would you do differently next time? There is not much we would change.

What would make it easier next time? Installing cork and furring together.

Key Take-Aways

- Welch felt polyiso performs best in a warm climate. Cork performs well in all climates.
- In Bellingham’s marine climate with always wet but moderate temperatures, renovate for durability, indoor air quality, and moisture resistance as much as for energy savings.
- Improving windows can have a bigger impact than improving wall insulation if original windows are poor performers.

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