BetterBuiltNW

High-Performance Homes: Where fire-resistance meets energy resilience

Many energy-saving upgrades carry additional benefits, like improved comfort and safety. With the increasing effects of wildfires, it's a good time for builders and homeowners in the Northwest to consider investing in energy-saving measures that also carry fire resiliency benefits.

This case study looks at examples of energy-saving measures that can also help keep a home safe in the event of a wildfire. It features advice from scientists in the Building Systems group at the Pacific Northwest National Laboratory (PNNL) and studies from the Insurance Institute for Business and Home Safety (IBHS).

Unique fire safety challenges in the Northwest

Dry conditions and proximity to forests play a role in fire risk, which is a focus for scientists at PNNL. PNNL collaborates with academia in fundamental research and with industry to transition technologies to market. Terri Gilbride is a scientist in PNNL's Building Systems group. The group develops and deploys energy-efficient technologies, economic policy, and analyses that enable informed planning and decision making. The group's research and advice on topics such as wildfire resiliency are available on the website Building America Solution Center.

Gilbride says the Northwest faces some unique challenges when it comes to wildfire resiliency.

"Our Northwest summers are hot and dry—unlike other parts of the United States, like the Midwest and East Coast, which get considerable rain during the summer months," she said.

It's time to build for wildfire safety

Wildfires are most common in dry, mountainous areas across the West, and the effects of wildfires are worsening. The longer, hotter dry summers experienced across much of the western United States has increased vulnerability to wildfires.

According to a Congressional Research Service study, the number of acres burned in the United States has doubled in the last 30 years—averaging 7 million acres burned annually since 2000. That's up from an annual average of 3.3 million acres in the 1990s. In 2020 alone, more than 10 million acres burned, making it the worst year since 1960.

Wildfires pose additional risk to homes located in the wildland-urban interface (WUI)—the transitional areas where human development and wildlands meet. In the Northwest, construction along the WUI is increasing. According to the USDA, since 1990, more than 60% of new homes in California, Oregon, and Washington were built in the WUI. Washington has more homes located in the WUI than any other state according to Headwater Economics. And the National Academy of Public Administration predicts a 40% increase in WUI homes between 2001 and 2030.

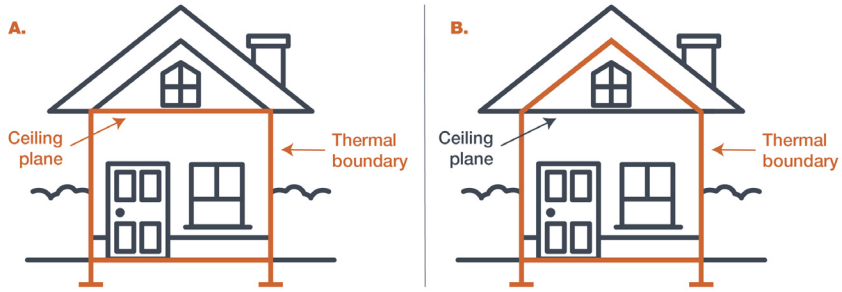
As communities grow closer to forested areas, more homes are near potential forest fires, Gilbride says.

The remoteness of such locations and the difficult terrain contribute to longer fire response times. In addition, there are limited water resources, which means some firefighters must rely on water trucks, nearby ponds, pools, and other nonstandard sources to extinguish flames. Once ignited, it only takes 10 to 15 minutes for a structure fire to become established and spread throughout the home, making it unsalvageable.

The following are best practices that can mitigate fire risk during the weeks of fire season and provide long-term energy benefits all year.

Build unvented attics

The location of the thermal boundary in a roof-attic assembly—including the thermal barrier (insulation) and the air barrier (like caulked sheathing or mudded-and-taped drywall)—can have fire resiliency and energy-saving benefits. In an unvented attic, the thermal boundary exists at the roof line, which creates a sealed, conditioned attic space. Vented attics have the thermal boundary at the ceiling plane, which leaves the attic uninsulated.



An example of a thermal boundary for a gable roof. House A has a vented attic with thermal boundary at the flat ceiling. House B is unvented with boundary at the roof line. (Source: Building Science Corporation (BSC))

According to IBHS, wind-blown embers are the principal cause of building ignition, and IBHS testing has demonstrated that vents mounted on vertical walls and surfaces are vulnerable to the entry of embers. These vents include gable-end and foundation vents, vents in the blocking of open-eave construction, and unprotected soffit vents.

An unvented attic is less susceptible to ember entry and can have other weather-related benefits. Unvented attics are protected from the entry of wind-blown rain and from wind washing (when wind enters the soffit vents and pushes insulation back from the eaves, leaving top plates more exposed to cold and heat). Unvented attics are less susceptible to wind uplift pressures in high-wind events. Unvented attics also provide a protected, conditioned space for any HVAC equipment installed in the attic, greatly reducing the temperature extremes to which ducts would be exposed during hot and cold weather. According to the U.S. Department of Energy, the additional heat loss and gain of ducts in unconditioned, vented attics increases energy use for heating and cooling 10% or more, and estimates of duct air leakage commonly exceed 20% of conditioned airflow. This duct leakage can be a source of heating and cooling loss to a vented attic, and a source for pulling unfiltered hot or cold attic air and dust into the home.

Learn from PNNL how to prevent ember entry with unvented attics.

Retrofitting a vented attic

Ed Louie is a senior associate energy efficiency engineer in PNNL's Building Systems group and works with Gilbride. He has advice for upgrading vented attics.

"An easy retrofit is to replace existing soffit and ridge vents with flame-resistant vents containing a honeycomb of intumescent material that will swell up and close off when exposed to high heat," Louie said. "This prevents wildfire embers, that can travel more than a mile ahead of a wildfire, from entering the roof and starting a fire."

According to Louie, the installation process may present energy savings too.

Resources to build for fire safety and energy efficiency

Across the Northwest, there are several state agencies and programs that offer incentives and resources to build for fire safety and energy efficiency. We encourage you to explore the following resources available in your state and stay up to date on new offerings by contacting the organizations below.

Montana

Montana State Energy Office: Contact the Montana State Energy Office to explore what fire and energy resiliency programs and resources may be available for you.

Montana Department of National Resources & Conservation—Reduce Your Wildfire Risk Site Visit Request: Local fire professionals in Montana offer free site visits to assess your property and provide recommendations on how you can reduce your wildfire risk.

Flathead Electric Cooperative (FEC) Wildfire Mitigation Planning: As an electric utility, FEC is focused on developing and maintaining a Wildfire Mitigation Plan to protect their equipment, members, and communities. FEC encourages homeowners to develop a wildfire plan as well and has compiled a list of resources to develop your own fire mitigation plan.

"When the old soffit vent covers are removed, the ventilation of the attic can be checked," he said. "If insulation baffles are not present, they can be added to prevent wind washing of fibrous insulation materials, which significantly reduces its insulating properties. The removal of soffit pieces to retrofit the vents can allow one to reach into the attic and help guide the positioning of the insulation baffles. Inadequate ventilation causes a vented attic to get very hot, making the HVAC system work much harder. Installing insulation baffles can ensure adequate ventilation into a vented attic to keep it cool."

Gilbride added that there are additional options, like closing off gable end vents and replacing plastic or vinyl soffit vents with metal venting that has mesh holes that are 1/8" or smaller, or adding 1/8" metal screening behind vent holes in existing soffits. Homeowners and builders can also consider "closing off open rafters under eaves with fiber cement panels to prevent up-drafted embers from lodging in the rafters," she said. "When reroofing," she noted, "add a metal drip edge that covers any wood fascia above the gutters and cover gutters with leaf screening to prevent debris from collecting in the gutters, where it can become a source of kindling when dried out."

Improve indoor air quality and comfort with sealed envelopes

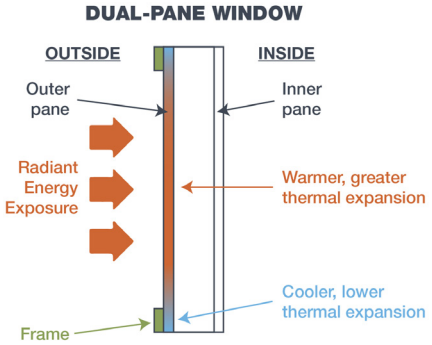
During fires, surrounding areas experience degraded air quality due to increased levels of particulates in the air.

Louie at PNNL said that all air-sealing techniques employed in weatherization efforts will help to prevent smoke from entering the home while also saving energy. This includes simple best practices like installing and maintaining weatherstripping on doors and windows. For larger projects, he recommends working with a contractor to locate leaks with a blower door test and a smoke pencil.

"Once the leaks are found, the best material to seal the leak depends on the location and size of the leaks," Louie said. "The most often used materials include spray foam, caulk, mastic, tape, or weatherstripping. For larger holes—those in attics that may have never been covered with solid air-barrier materials—the opening should be closed off with a solid material such as rigid foam board material, oriented strand board, or plywood sealed into place with caulk or canned spray foam. Areas over soffits or at the wall plane between the attic space and the space over a covered porch would similarly benefit from being covered with solid materials. We also recommend installing portable air cleaners for use indoors when outdoor particulate matter concentrations are very high."

Choose dual-pane, tempered-glass windows

If the glass in the window breaks or if a combustible frame ignites, embers and flames can enter the home.



How thermal stresses cause windows to break. (Source: University of California Agriculture and Natural Resources)

Resources continued

Oregon

Oregon Department of Energy's Energy Efficient Wildfire Rebuilding Incentive: More than 5,000 structures and more than 1 million acres were burned in the 21 wildfires that devastated Oregon communities over Labor Day weekend in 2020. The Oregon Legislature allocated $10.8 million to Oregon Department of Energy to provide funding to incentivize energy-efficient rebuilding efforts.

Energy Trust of Oregon: Energy Trust of Oregon has programs and services that support rebuilding homes and commercial buildings with energy efficiency and solar in mind. Specifically, the EPS New Home Construction program offers enhanced cash incentives to help displaced homeowners and participating trade ally builders construct new EPS rated homes that are efficient, resilient and can help homeowners save on utility costs for years to come.

Idaho

Idaho Governor's Office of Energy & Mineral Resources: The Idaho Governor's Office of Energy and Mineral Resources can guide you through the fire and energy resiliency resources available to you.

Windows can break in a fire due to the thermal stress from temperature differences between the home's indoor temperature and the outdoor temperatures the window may be exposed to from direct flame or the radiant heat from an approaching fire. Just as dual-pane windows limit heat transfer for energy-savings, they can help protect the inner pane of glass from breaking by reducing the temperature extremes the inner glass pane experiences in a fire.

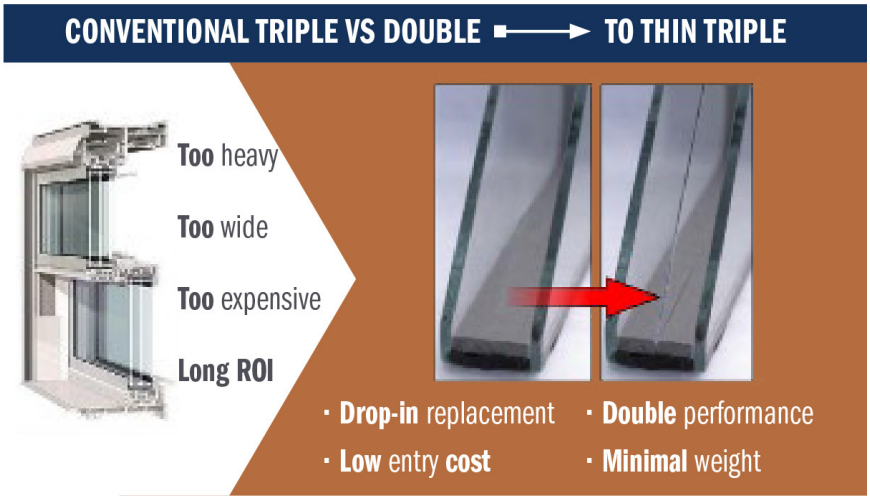
"Choosing tempered glass greatly increases resiliency, since tempered glass resists breakage from both mechanical and thermal stresses much better than non-tempered glass," said Louie. "Tempered glass is about four times more resistant to breaking during a wildfire," Louie said.

Additionally, when it does fail, tempered glass breaks into small pieces rather than sharp shards.

Consider thin triple-pane windows.

Fire resiliency benefits are further increased by choosing triple-pane rather than dual-pane windows. The third pane adds another layer between the interior of your home and a wildfire outside, offering greater resiliency, especially if the glass is tempered. If triple-pane windows will require design changes to the walls, consider thin triple-pane windows instead. Thin triple-pane windows have roughly the same insulation value (about R-5) as conventional triple-pane windows but without the added frame thickness and weight, as they have a thin glass pane in the middle. They use the same glazing unit dimensions as a double-pane window but are 40% more energy-efficient without affecting internal trim details or how the window is framed.

Read the BetterBuiltNW fact sheet on the benefits of thin triple-pane windows.



Conventional Triple-Pane vs Double-Pane vs Thin-Triple Pane Windows (Source: BetterBuiltNW)

Install exterior rigid insulation and fire-resistant siding

According to the U.S. Department of Energy, heating and cooling account for 50% to 70% of the energy used in the average American home. Proper insulation and air sealing techniques can typically achieve whole-house energy savings of 10% to 20%.

Installing a continuous layer of insulation on the outside surface of a building can increase the R-value of the walls and reduce thermal bridging, creating a thermally resistant home. Louie said for fire

Resources continued

Washington

Washington State Energy Office: The Washington State Energy Office can help you learn what fire and energy resiliency programs and resources may be available for you.

resistance, choose rigid insulation products that are naturally resistant to flame—such as mineral wool, fiberglass, or cork–or protect foam board with a layer of exterior-rated gypsum board. For added fire safety, choose Class A fire-rated siding products. “The most important aspect of an exterior wall assembly for fire is not the continuous insulation layer but the siding material,” Louie said. “It is important to choose a siding material that is noncombustible or fire-resistant and not susceptible to melting. Concrete, fiber-cement panels or siding, stucco, masonry, and metal are recommended materials. With these coverings, the covering itself should not ignite and fuel the fire. Exterior fire-retardant-treated wood siding or panels can also work but are maintenance intensive to remain fire-retardant.”

Gilbride notes that roofing should also be Class A rated for fire resistance. Also, attachments to the home—decks, railings, fencing—should be made of fire-resistant materials. She also noted that, while shade trees and shrubs are sometimes recommended as an energy-saving measure, in wildfire-prone areas, large trees should be spaced widely apart with crowns preferably 30 feet or more away from the home and limbs trimmed up 10 feet from the ground. Also, shrubs within 30 feet of the home should be minimal and no burnable vegetation should be located within 5 feet of the home. Non-burning ground covers or watered lawns should be used instead.

Install solar to improve energy resilience

We often think about the energy-saving and decarbonization benefits of solar. However, communities at risk for wildfires can also incorporate solar to improve their energy resiliency for emergency situations. Gilbride at PNNL says that solar can help with multiple power-related issues that occur due to fires.

“Especially for homes in remote areas, having solar with a battery backup and a solar system specifically wired to work when the grid power shuts down can be especially beneficial for powering well pumps, as well as providing other critical electrical functions like refrigeration, heating, cooling, and ventilation for homes whose power is cut off by downed trees,” she said.