REDUCING ENERGY USE IN HISTORIC HOMES

BY JUDSON ALEY

PEER REVIEWED BY DAN KOLBERT

As a renovation contractor on the Connecticut coast, I get a lot of calls from clients looking to improve their historic homes. Many of these homes are 200 to 250 years old. Whether we're installing a new kitchen or bath or building an addition, my focus is on helping our clients save energy and make their homes more comfortable while creating the homes they've been dreaming about.

Over the past five years, my team and I have been tracking energy use from our projects both before and after renovation and seeing reductions in total energy use of up to 30% (see the case study in Figure 7 on page 34).

WINDOWS: REPAIR, DON'T REPLACE

Often, historic windows are high-quality pieces that should be upgraded rather than discarded. We have restored, weatherstripped and added storm windows to countless dozens of wood single pane windows over the years. This greatly improves the energy performance of the window. Restoring a single pane window typically involves stripping off most of the paint and old glazing compound (we use a steam oven for this); making repairs to the sash; priming with an oil-based primer; replacing broken panes and re-glazing (Figure 1).

After trying all kinds of weatherstripping products, we've had the best luck with spring bronze weatherstripping, which is historically accurate and will last 100 years or more. It seals well and is very forgiving to work with and install.

The other place to look at insulating and air sealing is in the weight pockets. In most windows, if you decide to restore the original pulleys and weights, you can pull the interior or exterior casing off and insulate the weight pockets with rigid sheet foam and seal the joints and corners with foil faced tape and spray foam, completely stopping the air leaking in from the pulleys. Another option is installing tape-style Pullman sash balances or mechanical sash pins in the stile of the sash to hold them open and then fully sealing the weight pockets with low expansion spray foam.

When it comes to adding storm windows, we have found that Harvey Tru-Channel triple-track storm windows are easy to install and offer the best value for the money. For a more historic look, we install custom-made wood storms with low-e glass. One reason people avoid using the wood storms is that during the warm months, they need to be swapped-out for screens. That is typically true, but we have found a couple of solutions to this. With the popularity of air conditioning, most people no longer open all of their windows in the summer, usually just a select few. If that is the case, one would only need to swap out the storms for screens on those windows. Another solution is to install hardware that allows someone to prop the wood storm window open for ventilation. The hardware acts a latch system when the storm windows are closed. We've also used a wood storm that has a removable screen and glass panels that someone can swap out from the inside depending on the season. We

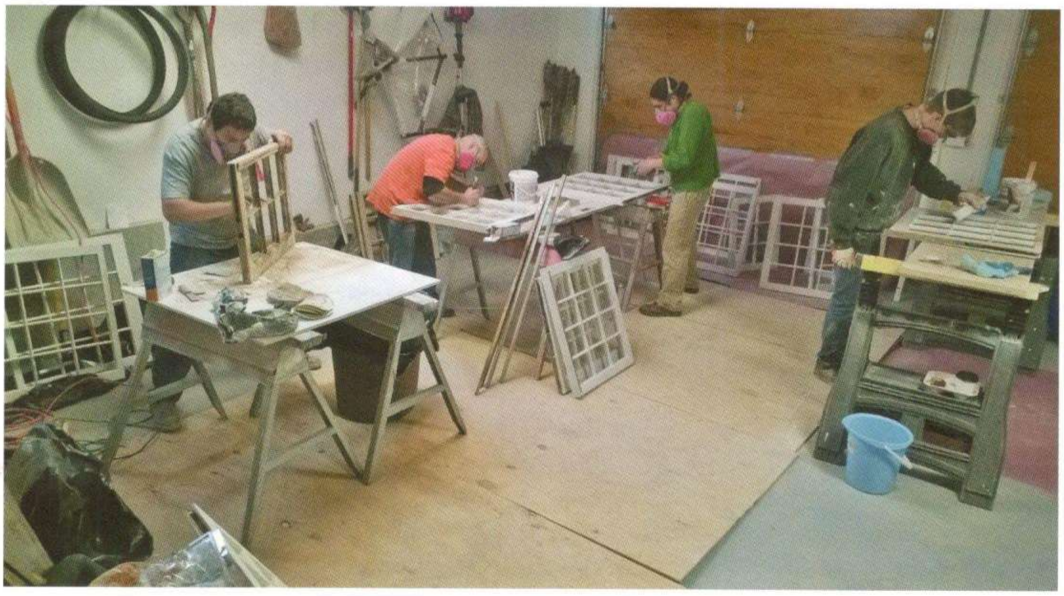

FIGURE 1: THE AUTHOR'S CREW RESTORING WOOD WINDOWS, A LABOR INTENSIVE TASK.
CREDIT: ALL PHOTOS BY AUTHOR

don't recommend using interior storms because they typically leak warm, humid air into the space between the interior storm and the original window; the humidity condenses on the cold exterior glass, freezes, thaws and rots the sash of the original window. (Also, personally, I think they look much worse than a well-fitted exterior storm).

DOWN AND DIRTY IN THE CRAWLSPACE

Many of the homes we work on have a dirt crawlspace or basement floor. Humidity and soil gas from the ground can easily build up in the basement and in the house above; as a result, you'll see foundation vents installed to try to "dry out" the basement. However, our approach is to bring the basement within the conditioned space of the home. We close up and air seal any vents, then we pour a concrete slab over a vapor barrier (ideally 6 mil poly over 2" of rigid foam to insulate the slab from the ground) and we build (on site) and install an exterior, insulated door at the bottom of the bulkhead entry (Figure 2). Typically, this door is made from four inches of polyiso sandwiched between two sheets of half-inch plywood. We then fully weatherstrip these doors and install a latch mechanism to compress the door closed against the weatherstripping. This door at the bottom of the bulkhead is probably the single best thing we can do for an old house owner as it closes up an opening, often about four-feet-by-seven-feet, that is only shielded from the outdoors by a steel or wood bulkhead. Next, we seal the sill plate or rim joist to the foundation and then seal up all the gaps, cracks and holes in the rim joist. If there is a rim joist as opposed to just a timber sill plate, we insulate the rim with one layer of a batt of R23 Rockwool.

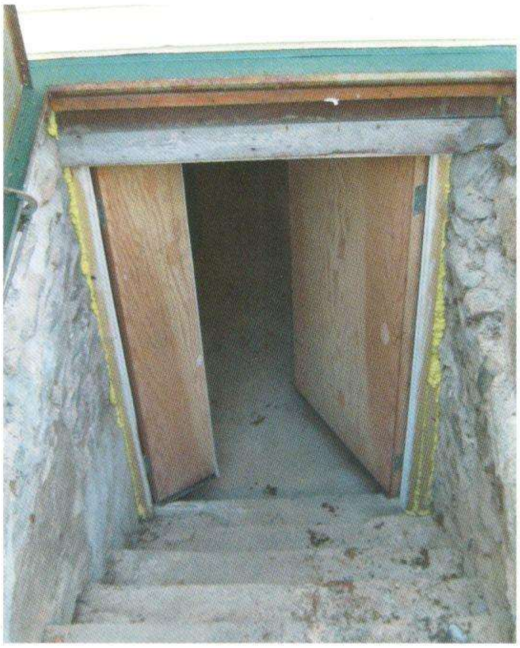

FIGURE 2: SITE BUILT INSULATED DOOR AT THE BOTTOM OF THE BASEMENT BULKHEAD.

HEAT HOT WATER EFFICIENTLY

While we're down in the basement, we usually also take a look at the plumbing. When possible, we recommend installing a heat pump hot water heater. Not only do these use a lot less energy to heat domestic hot water, but they also work as a dehumidifier. Some of these units are tall and can't fit in basements with low ceilings, but we've been able to find an 80 gallon unit from A.O. Smith and a 65 gallon unit from Vaughn that are a bit shorter than other brands and work in low ceiling situations.

UP IN THE ATTIC

Sealing air leaks and adding insulation to an attic is usually where we can have one of the biggest impacts on energy use. The rafters on most 18th and 19th century homes in our area (often just logs with on side flattened with an adze) are typically 36 inches to 42 inches on center, which makes insulating the roof with anything but spray foam difficult. We try to avoid using spray foam as much as possible: we will sister the existing rafters with

FIGURE 3: NEW RAFTERS ADDED BETWEEN ORIGINAL TIMBER RAFTERS MAKE IT SIMPLE TO INSTALL ROCKWOOL BATTS.

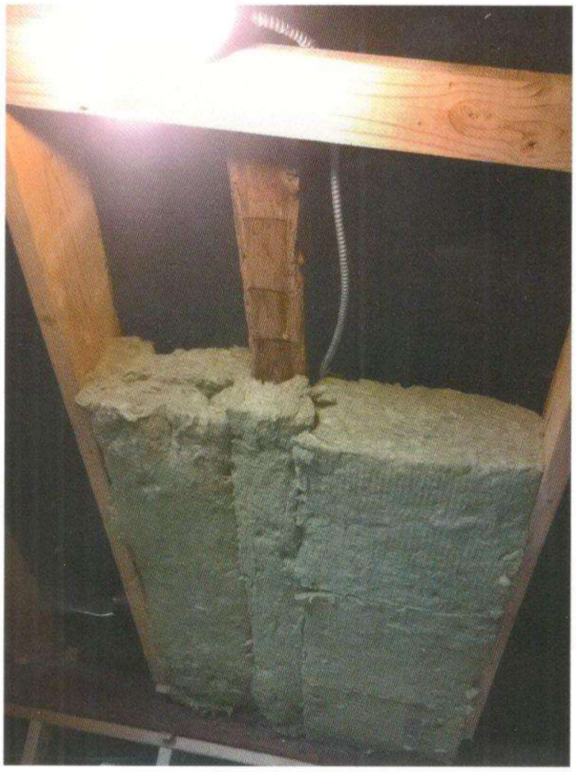

FIGURE 4: ROCKWOOL BATTS PRESS FIT BETWEEN NEW RAFTERS.

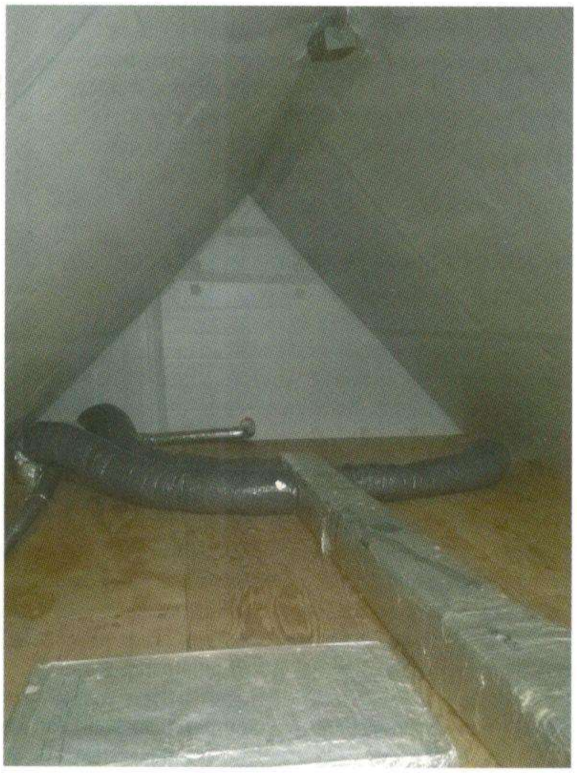

FIGURE 5: COMPLETED ATTIC WITH POLYISO.

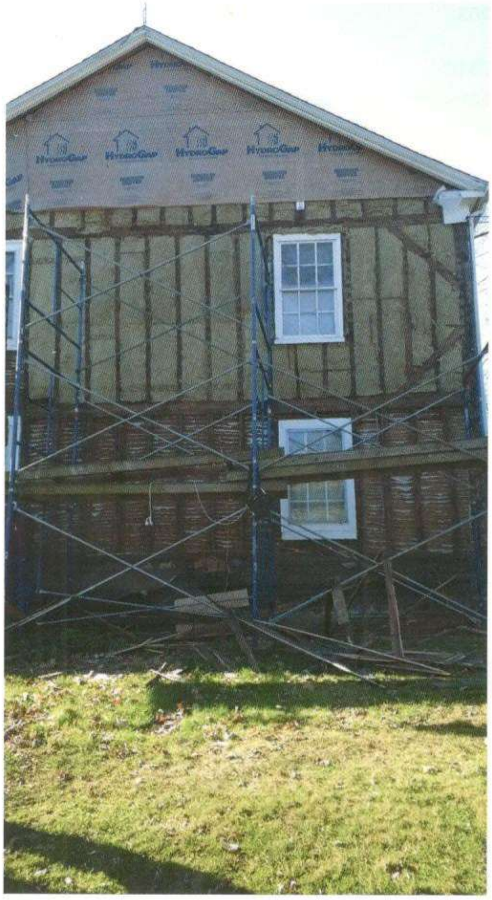

FIGURE 6: INSULATING FROM THE EXTERIOR USING ROCKWOOL AND ADDING NEW SHEATHING.

two-by-six or two-by-eight lumber as close to 16 inches on center as possible (Figure 3). Now we have a workable dimension for modern batt insulation and a much stronger roof frame which will be needed to deal with increased snow loads since the snow will no longer melt off the roof. Next, we install rafter vents and Rockwool R-23 batts between the new rafters (Figure 4). After the Rockwool is in place, we install two-inch thick polyiso foam board on the inside of the rafters (Figure 5). The foam panels are carefully taped and air sealed to provide an air barrier and because the polyiso spans across the rafters it reduces thermal bridging. While this attic insulation system is a lot more expensive than blowing in 18 inches of loose-fill cellulose on the attic floor, it allows the attic space to remain accessible for storage and to accommodate a fully ducted HVAC system.

BEEFING UP THE WALLS

Many of the homes we work on have no insulation in the wall cavities. On many projects, we use dense pack-cellulose to fill the wall cavity. This can be done from the outside by removing a few strategically located clapboards, drilling a hole through the sheathing, and then replacing the clapboard. Occasionally, if the existing siding is in really bad condition, we've removed all of the exterior siding and sheathing (sometimes there is no sheathing, just clapboards nailed directly to the framing). Once the walls are opened up from the outside, we air-seal the gaps and cracks, insulate with Rockwool, install new plywood sheathing, tape the plywood joints, install a drainable house wrap (like Benjamin Obdyke Drain Wrap) and finally install new siding (Figure 6).

HEATING SYSTEMS

Two relatively low-cost strategies we've used are to install a Honeywell circulating thermostat in homes with forced air

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CASE STUDY: FAGAN RESIDENCE
WESTPORT, CT
YEAR HOME WAS BUILT: 1840
SIZE OF HOME: 3,473 S.F.

Over a period of four years, we were able to achieve an almost 30% reduction in energy use. The original blower door test showed air leakage of 9,850 cubic feet a minute with the blower door set to the industry standard of 50 pascals. We performed a second blower door test, which revealed that air leakage had been reduced to 7,200 cfm, for a reduction of 27%.

This project involved installing storm windows, installing an insulated concrete slab in the crawlspace under the kitchen, building a custom insulated and weather stripped basement door to the bulkhead, insulating the rim joist, replacing and relocating flex duct with solid duct, insulating the cupola and installing weather stripping on cupola windows, blowing in loose fill cellulose insulation in accessible ceiling areas, removing clapboards and original sheathing, insulating with rockwool from the outside, installing plywood sheathing and air sealing walls, installing drainable house wrap and new cedar clapboard siding, converting furnace from oil to high efficiency gas, and installing an 80 gallon heat pump hot water heater.

FIGURE 7: THIS CASE STUDY DEMONSTRATES THE SUCCESS OF THE METHODS THE AUTHOR HAS OUTLINED IN THIS ARTICLE.

systems and to downsize the nozzle on an oil boiler or furnace to the next smaller size. The first strategy uses the blower fan on the furnace to circulate air through the ducts on a timer. Typically, the blower fan comes on for 20 minutes out of every hour. This works especially well in homes where one part of the house is really warm (from passive solar gain or a wood stove) and other parts are always cold. It helps distribute the warm air through the house throughout the day without firing up the furnace. If we use this strategy, we make sure we have an ECM motor on the furnace so that the electric use is minimal.

Most oil boilers or furnaces are oversized and burn more fuel than needed to heat the house, but they are not cost-effective to replace if they are still in good condition, so we replace the nozzle on the burner with the next smallest size instead. Generally, with oil fired hot water boilers and warm air furnaces, the smallest firing rate that will adequately heat the house on the coldest day is the proper size to use and the most economical. With an oversized nozzle, the oil furnace or boiler will "short-cycle," running on and off for short periods of time over the course of the day, resulting in low efficiency.

PUTTING IT ALL TOGETHER

When someone buys a historic home, it is likely because of the way it looks, and they will want to maintain those beautiful historic features and quirks. It's very difficult to reach the energy efficiency levels of a newly built net-zero home or deep energy retrofit without destroying most of the original character.

Knowing this, our goal is to preserve the historic features of the structure for future generations while also making sure it meets the needs of a modern family. If we do our job right, we can make the home more comfortable, significantly reducing energy use and maintaining the historic character that enticed the owners to purchase the home in the first place.

ABOUT THE AUTHOR

Jud Aley *is the owner of R.J. Aley Building Contractor and specializes in the renovation, repair and maintenance of older and historic homes. Jud is a second-generation builder and lives with his family in historic Village Creek in South Norwalk CT.* BUSINESS MEMBER

ABOUT THE PEER REVIEWER

Dan Kolbert *is a building contractor in Portland, ME. He and Jud were on the same construction delegation to Nicaragua in the mid-80's, and reconnected years later as New England builders. Dan has written articles for* Journal of Light Construction *and* Fine Homebuilding *and has moderated a monthly Building Science Discussion Group in Portland for the last decade. He has been a member of NESEA's Bottom Lines peer network since its founding.* BUSINESS MEMBER