

## WHY HOME IMPROVEMENT EXPERT?

An easy way to get a quality job.

Research findings reveal significantly reduced energy savings and potential performance risks where home improvements are not properly installed. To help homeowners address this challenge, the U.S. Department of Energy has compiled world-class expert guidance from industry leaders and national laboratories in factsheets and checklists under the name **Home Improvement Expert**. Homeowners can leverage these expert recommendations to help ensure quality installation by attaching Home Improvement Expert checklists to vendor contracts and ensuring the vendor completes and signs the checklist before accepting the work.

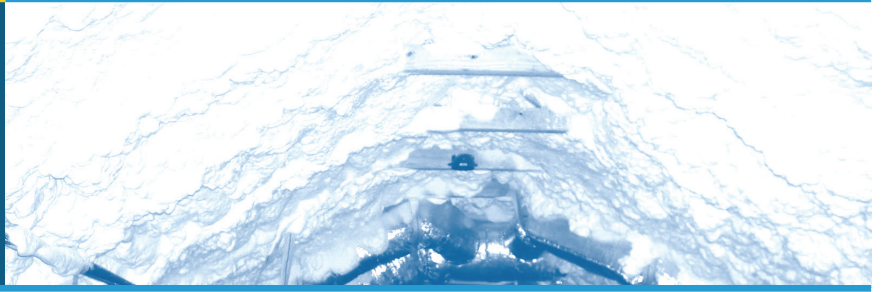
## READY TO DO MORE?

This factsheet and accompanying checklist cover one of more than 20 home improvements covered by the U.S. Department of Energy Home Improvement Expert. Use them to help optimize energy savings and improve performance related to comfort, health, safety, and durability.

To download other checklists: [basc.pnnl.gov/home-improvement-expert](https://www.basc.pnnl.gov/home-improvement-expert)

For more customized home improvement recommendations:

- Get your **Home Energy Score** from a qualified assessor ([www.home-energy-score.gov](https://www.home-energy-score.gov))
- Schedule an expert assessment through **Home Performance with ENERGY STAR®** ([www.energystar.gov/homeperformance](https://www.energystar.gov/homeperformance)).



## BENEFITS

Installed correctly, comprehensive vented-to-unvented attic upgrades can significantly reduce utility costs while improving comfort, indoor air quality, and durability of the attic structure.

In older homes, the attic/ceiling interface often has excessive holes and cracks, missing air barriers, and inadequate insulation that result in unwanted heat loss in cold weather, heat gain in hot weather, and infiltration of contaminants year-round. Additionally, attics provide a great opportunity to upgrade ducts located there for heating and cooling systems as well as exhaust fans. A comprehensive attic package can reduce an average home's total energy use by 10 to 15%, improve comfort by reducing drafts, keep contaminants such as moisture, dust, pollen, and pests from entering your home, and reduce moisture-related durability problems.

## RELATED HOME IMPROVEMENT CONSIDERATIONS

Before upgrading your attic, consider working with a qualified home energy assessor to evaluate other related home performance needs and opportunities that may involve work in the attic. This includes:

- testing for adequate combustion air with natural draft combustion equipment (e.g., furnace, boiler, and water heater) to ensure safety;
- integration of fresh air ventilation throughout the home;
- installation of exhaust fans in bathrooms to remove moisture; and
- installation of a high-capture efficiency exhaust fan in the kitchen to remove cooking emissions.

For more information on attic upgrades, please search the Building America Solution Center, [basc.pnnl.gov](https://www.basc.pnnl.gov).

## TIPS FOR HIRING A CONTRACTOR

- Look for licensed, insured, and certified contractors.
- Check references and reviews on home improvement web sites.
- Get multiple bids in writing.
- Check with your utility and state, local, and federal weatherization programs for rebates and incentives.
- Include the Home Improvement Expert™ checklist in bids and contracts to ensure quality installation.
- Consider using a Residential Energy Services Network (RESNET) certified Home Energy Rating System (HERS) rater, Building Performance Institute (BPI) certified Building Analyst, or other qualified professional (e.g., licensed engineer or architect) to inspect the work.

**ENCLOSURE UPGRADES**

Attic Air Sealing and Insulation

Basement Wall Insulation

Comprehensive Attic Package

Framed Wall Insulation

Masonry Wall Insulation

Home Air Sealing

Vented to Unvented Attic

Vented to Unvented Crawl Space

Window Replacement

**HEATING & COOLING**

Air Conditioner Replacement

Gas Furnace Replacement

Heat Pump Replacement

Duct Sealing and Insulation

Oil or Gas Boiler Replacement

**HOT WATER HEATING**

Gas Tank Water Heater

Gas Tankless Water Heater

Heat Pump Water Heater

**FRESH AIR SYSTEM**

Bathroom Exhaust Fan

Kitchen Exhaust Fan

Balanced HRV/ERV

Balanced Supply plus Exhaust

Supply Integrated with HVAC

**PROPER SEQUENCING OF HOME IMPROVEMENTS**

Through the U.S. Department of Energy's Building America research program, expert guidance has been developed for optimizing whole-house energy-efficiency upgrades. This includes a recommended sequence for home improvements (shown below) to help ensure homeowners get the most out of their upgrade investments while minimizing potential harm from safety, indoor air quality, and moisture issues.

**STEP 1: ENSURE SAFE AND DURABLE**

Have experts assess opportunities to improve energy efficiency and identify comfort, moisture management, health, and safety issues.

**STEP 2: ENSURE FRESH AIR**

Ensure effective ventilation before increasing air tightness.

**STEP 3: ENSURE MOISTURE CONTROL**

Ensure adequate water protection before reducing the ability of walls to dry by adding air sealing and insulation.

**STEP 4: ENSURE DRAFT-FREE**

Capture air sealing opportunities not accessible after insulation is installed.

**STEP 5: ENSURE THERMAL COMFORT**

Insulate at least to the latest national code recommendations for your location after addressing related safety, indoor air quality, and moisture management issues.

**ANYTIME: EQUIPMENT UPGRADES**

Replace heating and cooling equipment, water heaters, windows, appliances, lighting, fans, and electronics when they fail or become out of date with ENERGY STAR® qualified products or better, and improve systems to operate more efficiently.



This U.S. Department of Energy checklist includes important specifications that can contribute to a complete and quality installation. All work shall comply with these specifications, all relevant codes and standards, and all manufacturer installation instructions. The contractor shall check each box on the checklist below and sign and date at the bottom to certify the work is completed.

## PREPARATION

<input type="checkbox"/>	<b>P.1:</b> The attic shall be inspected for water leaks and moisture, structural, or pest damage. A list of all needed repairs shall be provided to the homeowner before attic work begins so remediation can be fully addressed as necessary.
<input type="checkbox"/>	<b>P.2:</b> If there is active knob and tube wiring present in the attic, the homeowner shall be directed to hire a licensed electrician to inspect the wiring and provide a list of any necessary repairs to the homeowner. The work shall not begin until the homeowner provides written notice that all necessary repairs in the attic are completed.
<input type="checkbox"/>	<b>P.3:</b> The attic shall be inspected for the presence of any existing HVAC duct insulation or vermiculite attic insulation, and if present, the work shall not proceed until the homeowner can document that it does not contain asbestos or that it has been safely removed according to EPA requirements and guidelines.
<input type="checkbox"/>	<b>P.4:</b> A combustion safety test is recommended to be performed if any natural draft combustion equipment exists in the home to ensure there is no backdrafting or spillage. If performed, any combustion safety issues not addressed by installation measures included in this checklist shall be addressed before proceeding with the installation.
<input type="checkbox"/>	<b>P.5:</b> All exhaust fan ductwork in the attic shall be inspected for proper installation including no excessive length and sagging, no kinks, and termination to outdoors (i.e., exhaust fans shall not vent directly into the attic). Required modifications shall be identified and included in this scope of work.
<input type="checkbox"/>	<b>P.6:</b> The contractor shall remove existing attic insulation (insulation at the attic floor) to minimize wintertime condensation risks in the attic.
<input type="checkbox"/>	<b>P.7:</b> If there is a vapor retarder on the attic floor, it shall be removed to allow proper drying of the insulated assembly.
<input type="checkbox"/>	<b>P.8:</b> All existing attic ventilation openings including ridge vents, gable vents, and soffit vents shall be closed off with solid sheathing or other weather-resistance material and sealed and patched to match existing exterior finishes (e.g., roofing, siding, or soffit).
<input type="checkbox"/>	<b>P.9:</b> All wood-to-wood framing joints and penetrations exposed to exterior conditions shall be sealed with caulking or foam. Maximum gap dimensions to be sealed shall be consistent with sealant manufacturer's specifications. Alternately, if polyurethane spray foam is used, covering or "encasing" these wood-to-wood joints with the spray foam is acceptable.
<input type="checkbox"/>	<b>P.10:</b> Any existing whole-house fan shall be removed or disconnected from the switch and electric power. The whole-house fan ceiling opening shall be fully patched and refinished to match the existing ceiling (e.g., drywall).
<input type="checkbox"/>	<b>P.11:</b> Care shall be taken not to block, remove, or disable kitchen or bathroom fan exhaust vents, water heater or furnace flues, radon vent pipes, and plumbing vent pipes.
<input type="checkbox"/>	<b>P.12:</b> Any heating and cooling and exhaust ducts located in the attic shall be inspected. Any separated or disconnected ductwork shall be secured with mechanical fasteners (e.g., screws and clamps). Damaged ducts restricting air flow or with visual leaks shall be repaired or replaced. Flexible ducts with excessive length shall be cut to proper length to ensure maximum sag is ½ inch per foot. Sharp bends shall be corrected so bends are greater than or equal to one duct diameter radius. All accessible unsealed seams in ductwork shall be sealed with UL-approved mastic, UL 181 tape, or equivalent.
<input type="checkbox"/>	<b>P.13:</b> All unsupported horizontal heating and cooling duct runs shall be supported with hanger strap or saddle supports that are at least 1.5 inches wide and spaced no more than 4 feet apart, in accordance with the Air Conditioning Contractors of America (ACCA) Manual D and manufacturer's recommendations. Additional supports shall be provided before and after sharp bends in the ductwork. The maximum permissible sag between supports shall be ½ inch per foot.

## INSTALLATION: EXHAUST FAN DUCTWORK MODIFICATIONS

<input type="checkbox"/>	<b>I.1:</b> Exhaust fan ductwork shall be modified as required for the most direct route to the outdoors, with as few bends as possible. To reduce noise, no bends should occur in the first three feet from the fan housing.
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**INSTALLATION: EXHAUST FAN DUCTWORK MODIFICATIONS** *(continued)*

<input type="checkbox"/>	I.2: The exhaust duct outlet vent shall be located on the exterior of the home at least 10 feet from any air inlet and where it does not direct air flow onto a walkway. If the exhaust duct outlet needs to be relocated to meet these requirements, the existing opening shall be closed off with solid sheathing or other weather-resistant materials and be sealed and patched to match existing finishes (e.g., exterior roofing, siding, or soffit).
<input type="checkbox"/>	I.3: All unsealed exhaust duct seams and connections shall be sealed with UL-approved mastic, UL 181 tape, or equivalent.
<input type="checkbox"/>	I.4: Where the exhaust fan terminates with a wall cap, verify the presence of a damper that closes when the fan is not operating. If there is none, a damper shall be installed per local building code requirements.

**INSTALLATION: AIR SEALING ROOF SHEATHING AND GABLE WALLS**

<input type="checkbox"/>	I.5: All sealants used shall be compatible with their intended surfaces. Maximum gap dimensions shall be consistent with sealant manufacturer's specifications.
<input type="checkbox"/>	I.6: Gaps around masonry chimneys, flues, or combustion appliance vents shall be sealed with sheet metal and high-temperature-rated caulk or foam. Insulation dams shall be constructed around chimneys, flues, and combustion appliance vents as needed with combustion clearances using heat-safe materials in accordance with local building code requirements. A masonry chimney typically requires a 2-inch clearance to combustibles; a Type-B (double wall) gas vent pipe typically requires 1-inch clearance to combustibles. The air barrier may be metal that is air sealed using high-temperature rated caulk. Cellulose and fiberglass insulation are considered combustible. Local building code may allow mineral wool to contact a masonry chimney but not a metal gas vent.
<input type="checkbox"/>	I.7: A continuous airtight seal consisting of caulk, liquid membrane coating, mastic, spray foam, and/or equivalent shall be applied at seams, cracks, joints, and edges, and around all penetrations and vents at all sheathing at roof and vertical gable walls to the exterior.
<input type="checkbox"/>	I.8: If the existing attic extends over unconditioned spaces (garages, exterior porches), this area must be separated from the conditioned attic with insulation and an air barrier. Typical practice is to build a stud wall with sheathing at this conditioned attic boundary, insulate the wall, and provide air barrier detailing at the perimeter and penetrations.

**INSTALLATION: INSULATING THE SLOPED ROOF AND GABLE WALLS**

<input type="checkbox"/>	I.9: Insulation that meets or exceeds prescriptive R-values specified for roof/ceiling insulation by local building code requirements for new construction shall be installed at all roof surfaces with less than 2% gaps, voids, and compression.
<input type="checkbox"/>	I.10: Insulation that meets or exceeds prescriptive R-values specified for above-grade walls by local building code requirements for new construction shall be installed at all gable and other wall surfaces adjoining the exterior with less than 2% gaps, voids, and compression.
<input type="checkbox"/>	I.11: All local building code requirements for air-permeable and air-impermeable insulation at the roof sheathing shall be fully met (IRC §R806.5 or equivalent).
<input type="checkbox"/>	I.12: If plastic foam insulation (e.g., spray foam) is used at the roofline, all local building code requirements for a fire ignition barrier at the insulation surface exposed to the attic shall be fully met.

**RESILIENCE RECOMMENDATIONS**

<input type="checkbox"/>	R.1: In Hurricane-Prone Regions, two-part closed-cell polyurethane spray foam is recommended at all points where roof decking meets rafters and at seams in the roof deck. This upgrade can increase roof resistance to uplift by up to 300%.
<input type="checkbox"/>	R.2: In Hurricane-Prone Regions, it is recommended that gable walls be reinforced and two-part closed-cell polyurethane spray foam be applied to help increase structural resistance to collapse in high-wind events. Additional guidance on reinforcement can be found in FEMA documentation (see Wind Retrofit Guide for Residential Buildings FEMA P-804).



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### INSTALLATION: ATTIC DUCT SEALING

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|--------------------------|--|
| <input type="checkbox"/> | <b>I.13:</b> All accessible duct leaks, connections, and plenums shall be sealed with UL-approved mastic, UL 181 tape, or equivalent (e.g., aerosol sealant) used in strict accordance with manufacturer's instructions.                             |
| <input type="checkbox"/> | <b>I.14:</b> Duct boots located at the attic-ceiling interface shall be sealed to finished surfaces with caulk, spray foam, or other approved sealants consistent with sealant manufacturer specifications.  |
| <input type="checkbox"/> | <b>I.15:</b> If the air filter is installed in a filter box attached to an air handler located in the attic, the filter access panel should be fitted with an air-tight gasket, and a MERV 8 or higher filter shall be installed in the filter rack. |

### COMMISSIONING

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|--------------------------|--|
| <input type="checkbox"/> | <b>C.1:</b> Unvented attics shall be supplied with air for space conditioning per local building code requirements. If not addressed by local building codes, for unvented attics with only air-permeable insulation in IECC Climate Zones 1, 2, and 3, HVAC supply and return grilles shall be added to the attic that provide a minimum air flow rate of 1 CFM/20 ft <sup>2</sup> of attic floor area where ducts are accessible to the attic. Where HVAC supply or return ducts are not accessible to the attic, a supply fan shall be provided between the attic and living space below that provides an air flow rate of 1 CFM/20 ft <sup>2</sup> attic floor area when the HVAC system is operating. |
| <input type="checkbox"/> | <b>C.2:</b> The owner shall be informed that, at next replacement of HVAC system, increased system capacity may be needed to maintain comfort, especially if new conditioned attic volume is converted to living space.  |
| <input type="checkbox"/> | <b>C.3:</b> The home shall be inspected for the presence of a whole-house ventilation system. If one is present, the actual air flow shall be tested and verified to meet a target ventilation rate based on house size as follows: 50 cfm for up to 1,500 ft <sup>2</sup> , 70 cfm for 1,501 to 2,500 ft <sup>2</sup> , and 100 cfm for over 2,500 ft <sup>2</sup> . If the home has no whole-house ventilation system, or if the existing system does not meet the target ventilation rate, recommendations shall be made to the homeowner to either install a new system or repair the existing system to meet the target ventilation rate.   |
| <input type="checkbox"/> | <b>C.4:</b> If an exhaust vent was installed in a wall, the wall cap damper shall be checked to ensure it is operating correctly.  |
| <input type="checkbox"/> | <b>C.5:</b> In EPA Radon Zone 1, a radon test kit shall be provided to the homeowner at the completion of the work with a recommendation to initiate a radon remediation strategy if post-retrofit radon measurements exceed EPA acceptable levels (see <a href="https://www.epa.gov/radon">https://www.epa.gov/radon</a> ).   |
| <input type="checkbox"/> | <b>C.6:</b> After completion, a combustion safety test shall be performed if any natural draft combustion equipment exists in the home, to ensure there is no backdrafting or spillage. After attic air sealing, a natural draft furnace or water heater located in the home may no longer have sufficient combustion air. Recommendations shall be made to the homeowner to install direct-vent equipment at the time of replacement for any natural draft combustion equipment.  |

I hereby certify that, to the best of my knowledge and ability, all checked items on the above checklist have been accomplished as part of completion of this home upgrade.

Contractor Signature: \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Contracting Organization: \_\_\_\_\_

THE U.S. DEPARTMENT OF ENERGY DOES NOT WARRANT OR ENDORSE THE WORK, PRODUCTS, OR SERVICES OF ANY OF ITS PARTNERS.