BPI Home Energy Auditing (EA) Standard

1. Scope of the Energy Auditor Standard

The Building Performance Institute, Inc (BPI) publishes this Energy Auditing Standard to support BPI's Energy Auditor Certification and to provide guidance to the energy-auditing profession. This standard's goal is to advise and support whole-building, science-based energy improvements to existing low-rise residential buildings (single-family and multifamily). In this standard, these buildings are called "homes." An energy audit is an evaluation of a home's existing energy profile and the potential to improve its energy efficiency.

1.1. BPI Energy Auditors may perform the following energy-auditing functions and other functions as applicable.

- 1.1.1. Residential energy auditing and analysis.
- 1.1.2. Writing work scopes of energy-conservation measures (ECMs), along with cost estimates and contracts.
- 1.1.3. Acting as customer's point-of-contact for a contractor and/or energy program.
- 1.1.4. Sales of energy products and services.
- 1.1.5. Conducting in-progress and/or final inspections of ECMs for quality control.
- 1.1.6. Inspecting completed ECMs for quality control.
- 1.1.7. Conducting quality assurance inspections as a neutral third party.

1.2. These standards are necessarily general regarding specific measures and criteria, due to the following.

- 1.2.1. The auditor's role may vary depending on context. For example: the energy auditor may be an independent third party, a sales person working for a contractor, or a weatherization inspector.
- 1.2.2. Program requirements (including conditions for incentives), law or regulation, and applicable building codes or ordinances take precedence over these standards in setting requirements for energy audits, work scopes, and ECMs.
- 1.2.3. The policies and procedures of energy auditors' employers vary from company to company.
- 1.2.4. Regional climate, housing types, and market conditions vary.

2. General Energy Auditor Requirements

A BPI-certified energy auditor must fulfill the following requirements.

2.1. Act in an ethical and responsible manner at all times.

2.2. Be courteous and respectful of customers in their homes.

2.3. Understand local energy programs, incentives, regulations, electricity rates, fuel prices, and typical energy-consumption levels.

2.4. Understand energy and building-science principles and apply them to your work.

2.5. Understand building construction, thermal resistance, air exchange, residential mechanical systems, lights and appliances, and the interactions among these elements.

2.6. Understand baseload energy use and be able to advise clients on how to reduce it.

2.7. Work within the limits of your knowledge and ability; ask for help and support in unfamiliar situations.

2.8. Follow the policies and procedures of your company and any applicable program.

2.9. Be able to evaluate homes and specify energy conservation measures (ECMs). Be familiar with ECMs and installation procedures, and be able to write an appropriate work scope.

2.10. Be able to inform customers about energy-related home hazards and to specify solutions according to this standard.

3. Health and Safety Related Requirements

BPI's first principle is to do no harm. To avoid harm, a BPI-certified energy auditor must understand and communicate with customers and colleagues about common health and safety concerns related to energy systems and retrofit work. In the process of recommending ECMs and developing work scopes, auditors must strive to maintain or improve existing levels of health and safety, and to recommend mitigation of identified hazards to the customer. The energy auditor must fulfill the following requirements.

3.1. Identify and anticipate hazards that may be exacerbated by energy retrofits, and specify preventative measures.

3.2. Inform customers about identified and anticipated fire, health, and safety hazards related to energy systems and retrofit work.

3.3. Interview customers about energy-related home hazards.

3.4. Protect yourself and the building residents from identified and anticipated hazards during the energy audit and follow-up work.

3.5. Test combustion appliances for safety problems in accordance with this standard.

3.6. Inspect the home for signs of common moisture problems in accordance with this standard.

3.7. Evaluate ventilation requirements in accordance with this standard.

3.8. Specify that workers never disturb known or suspected lead, asbestos, or mold, unless the workers are qualified and using approved containment, cleaning, and/or abatement procedures.

3.9. Inform customers about potential radon risk. Recommend radon testing in accordance with EPA guidelines in every home.

3.10. Specify that identified electrical hazards, which may hinder planned energy conservation measures (ECMs), are mitigated in the work scope. Examples: some jurisdictions forbid insulation where knob-and-tube wiring is present; obsolete fuse boxes interfere with photovoltaic (PV) installation.

3.11. Specify appropriate safe work practices in the work scope, for example: scaffold and lead-containment equipment.

4. Disclosure and Ethics

A BPI-certified energy auditor must provide clear and accurate information to customers about ECMs, health-and-safety improvements, and the business model under which the energy auditor is operating. This information helps customers choose home improvements based on their relative benefits, including improved health-and-safety, comfort, home durability, and energy savings. To this end, the energy auditor must fulfill the following requirements.

4.1. Disclose any potential conflict of interest to the customer and any interested third parties, such as program sponsors or lenders.

4.2. Disclose any products and services your company provides in addition to energy auditing.

4.3. Communicate as accurately as possible the cost-effectiveness and feasibility of recommended ECMs.

4.4. Communicate the relative importance of each recommended health-and-safety improvement.

4.5. Energy audits don't save energy. The BPI-certified energy auditor must connect the customer with one or more contractors (BPI-accredited or equivalent), who perform diagnostic testing and retrofit work as applicable based on the work scope.

5. Cost Benefit Analysis

Consumers and third-party funding sources often require an accounting of ECM costs and savings, energy savings, demand savings, and/or emissions reductions. A BPI-certified energy auditor must fulfill the following requirements.

5.1. Follow in good faith your company policy and also conform to the policies of any participating program sponsor or funding source, as applicable, concerning energy-savings estimates and cost-benefit analysis.

5.2. A comprehensive package of ECMs must be selected using one of the following three methods of cost-benefit analysis.

5.2.1. Computer analysis using software, approved by DOE.

5.2.2. Computer analysis using software that is accredited by the Building Performance Institute (BPI) for conducting an analysis of energy savings and developing an appropriate work scope.

5.2.3. When specified by a program sponsor, use a priority list developed using computer analysis of regional housing stock and current energy prices. The priority list must specify both seasonal and baseload ECMs and identify the type of housing covered by the priority list.

5.3. When energy-consumption records are available, you must analyze energy consumption records (at least 12 months) to justify estimates of energy savings from installed ECMs.

6. Work Scope

As part of an energy audit, a BPI energy auditor must develop a work scope detailing proposed ECMs. This work scope must be based on an evaluation of the whole house according to the requirements of this standard and the objectives of the customer. The work scope must not be based primarily on a narrow product line of a contractor or on convenience. The objective of the work scope is to optimize home performance cost-effectively, while maintaining or improving health and safety and satisfying customer objectives. The energy auditor must fulfill the following requirements.

6.1. Interview the customer to understand his/her priorities for the audit and goals for home improvements.

6.2. Prioritize health-and-safety improvements according to their urgency and importance.

6.3. Prioritize ECMs, building repairs, and renovation according to cost-effectiveness, feasibility, and customer objectives.

6.4. Meet the requirements of any third-party sponsor or funding source regarding recommended ECMs, including pre-work and post-work verification (such as diagnostic testing).

7. Combustion Appliance Testing

BPI-certified energy auditors must inspect combustion systems for common safety problems that may be related to ECMs. Specify remediation of conditions as required by the following procedures. Specify that post-retrofit combustion-appliance testing be conducted. Note: When an auditor acts as the agent of a BPI-accredited contractor and offers a work scope in the form of a binding contract or contract offer, pre-work combustion appliance testing may be deferred and specified as part of the work scope. When the contract specifies that a combustion appliance is removed or replaced, pre-work testing isn't required for that appliance.

7.1. Identify, communicate, and suggest appropriate solutions to emergency problems — such as a gas leak or a dangerous level of carbon monoxide — clearly and immediately to the customer, landlord, utility representative, and/or your supervisor.

7.2. Test for gas leakage at connections of natural-gas and propane piping systems. Specify repair for leaks and replacement for hazardous or damaged flexible gas connectors.

7.3. Inspect for oil leakage in oil-fired heating and water-heating systems.

7.4. Inspect combustion venting systems for damage, leaks, disconnections, and other safety hazards.

7.5. Conduct combustion-appliance-zone (CAZ) pressure tests, carbon monoxide (CO) tests, and spillage tests on all combustion appliances venting into atmospheric chimneys, including fan-assisted gas appliances, as follows.

7.5.1. Monitor for ambient CO during combustion testing, and discontinue testing if ambient CO level exceeds 35 parts per million (ppm).

7.5.2. Measure baseline pressure in the CAZ with reference to (WRT) outdoors.

7.5.3. Activate exhaust fans, clothes dryer, and air handler to maximize negative pressure in the CAZ. Don't activate whole-house fans designed for night cooling.

7.5.4. Open or close interior doors as needed to maximize negative pressure in the CAZ.

7.5.5. Measure the change in CAZ pressure WRT outdoors that is induced by exhaust fan, air handler, and door position, as compared to the baseline pressure obtained in 7.7.2. If the change in pressure is more than 5 Pa in the negative direction, specify measures to mitigate that induced negative pressure in the CAZ.

7.5.6. Operate open-combustion appliances, beginning with the smallest input, and test for spillage at the draft diverter, barometric draft control, or burner inlet (fan-assisted appliances). If a combustion appliance spills for longer than 1 minute, specify measures to mitigate spillage.

7.5.7. Test for CO in undiluted flue gases of combustion appliances. If CO in undiluted flue gases is more than 100 ppm as measured or 200 ppm air-free measurement, specify service to reduce CO to below these levels (unless your CO measurement is within manufacturers specifications).

7.6. Conduct a CO test on all sealed-combustion and power-vented appliances (without atmospheric chimneys).

7.7. When cost-effective and feasible, recommend replacing open-combustion equipment with high-efficiency, sealed-combustion equipment or power-vented equipment (or non-combustion equipment such as a heat pump).

7.7.1. CO testing is required for newly installed sealed-combustion and power-vented appliances.

7.8. Test gas ovens for CO.

7.8.1. If ovens produce more than 200 ppm of CO (or 400 ppm air-free measurement) in undiluted flue gases tested in the oven vent, specify service or replacement.

7.8.2. Specify that every kitchen be ventilated as required in Section 8.7.

7.9. Specify smoke alarms for homes that don't already have them installed.

7.10. Specify CO monitors/alarms in homes with combustion appliances or attached garages, one per floor level.

7.11. Specify final combustion testing at project completion, to ensure compliance.

8. Indoor Air Quality and Ventilation

BPI-certified energy auditors must strive to assure that their work scopes maintain or improve indoor air quality. Energy auditors must evaluate each home, and specify improvements to reduce pollution sources and to provide adequate ventilation as follows.

8.1. Discuss identified sources of indoor air pollution with customers, and recommend removal or control.

8.2. Verify that exhaust fans and clothes dryers vent to outdoors.

8.3. When an attached garage exists, specify sealing of air leaks between the garage and house, and specify sealing of air handlers and ducts that are located in the garage.

8.4. Use the following approach — based on ASHRAE Standard 62.2 – 2007 — to determine mechanical ventilation requirements.

8.4.1. As an alternate, a legacy approach based on ASHRAE 62-1989 is permitted; see Appendix A. This alternate is permitted for new work scopes until July 1, 2013.

8.5. Specify whole-house mechanical ventilation for all homes based on ASHRAE Standard 62.2 – 2007, Section 4, as follows:

8.5.1. Determine nominal fan size to continuously provide airflow in cubic feet per minute (CFM), based on the number of bedrooms and the conditioned floor area of the home. Determine the fan's CFM by using either the formula or the table that follows. The formula for CFM fan flow is:

CFM = (0.01 x conditioned floor area) + 7.5 (number of bedrooms + 1)

The table for CFM fan flow follows:

Table 1: Accepted Sizing for Continuous Ventilation Fans

	Number of Bedrooms				
Floor Area (sq. ft.)	0-1	2–3	4–5	6–7	>7
< 1500	30	45	60	75	90
1501–3000	45	60	75	90	105
3001–4500	60	75	90	105	120
4501–6000	75	90	105	120	135
6001–7500	90	105	120	135	150
> 7500	105	120	135	150	165
From ASHRAE Standard 62.2-2007, Table 4.1					

8.6. The following exceptions can reduce or eliminate the need to install a whole-house ventilation system.

8.6.1. Whole-house ventilation systems aren't required for homes in International Energy Conservation Code (IECC) Zones 3B or 3C; or for homes without mechanical cooling in IECC Zones 1 and 2; or for homes that are conditioned for less than 876 hours per year. These exceptions all require that the local jurisdictional authority determines that windows are an acceptable method of ventilation (ASHRAE Standard 62.2 – 2007, Section 4.1).

8.6.2. An infiltration credit may be applied to reduce whole-house mechanical ventilation requirement. The credit may be determined using ASHRAE Standard 62.2-2007, Section 4.1.3, if the building enclosure has been tested with a blower door. When the infiltration credit is larger than the nominal fan size specified in 8.5.1, a whole-house mechanical ventilation system isn't required.

8.7. Specify local (spot) ventilation for kitchens and bathrooms according to ASHRAE Standard 62.2 – 2007, Section 5. There are two options for complying with the kitchen and bathroom requirements. Both bathroom and kitchen requirements may be met by dedicated exhaust fans and/or a central ventilation system.

8.7.1. *Option 1*: Specify that each bathroom receives a minimum of 50 CFM of intermittent exhaust (with appropriate controls), or 10 CFM of continuous exhaust. Also specify that each kitchen receives a minimum of 100 CFM of intermittent exhaust or 5 air changes per hour (ACH) of continuous exhaust.

8.7.2. *Option 2*: If existing ventilation equipment can't be used to fulfill Option 1, and new equipment isn't specified, then airflow from the whole-house ventilation system may be increased to compensate, according to ASHRAE 62.2 – 2007, Appendix C.

9. Moisture Control

Excessive moisture contributes to mold, indoor air pollution, and building durability problems. BPI-certified energy auditors must inspect each home for moisture problems and specify prevention and remediation, as applicable to proposed ECMs.

9.1. Inspect for evidence of exterior water intrusion, such as roof leaks, foundation leaks, and ground-water intrusion.

9.2. Inspect for evidence of interior water sources, such as plumbing leaks.

9.3. Inspect the building for effects of water damage, such as mold, mildew, insect damage, efflorescence, and stains.

9.4. Inspect for existing vapor retarders, flashing, or other moisture-control strategies.

9.5. Specify measures to prevent potential moisture problems or mitigate identified moisture problems, as applicable, in the work scope.

10. Building Enclosure Performance

A BPI-certified energy auditor must evaluate the performance of the building enclosure, and recommend upgrades as appropriate according to Sections 5 and 6 of this standard, as follows (Program or incentive guidelines may require you to specify certain measures or conduct certain tests).

10.1. Evaluate the building enclosure for air leakage. The energy auditor must conduct a blower-door test to evaluate air leakage as part of the energy audit. Note: When an auditor acts as the agent of a BPI-accredited contractor and offers a work scope in the

form of a binding contract or contract offer, pre-work blower-door testing may be deferred and specified as part of the work scope.

10.1.1. When enclosure air sealing is specified, specify or conduct a blower-door test when work is completed, or as part of the final inspection.

10.2. Estimate R-values of opaque building components.

10.2.1. Evaluate insulation retrofits for feasibility and energy savings.

10.3. Estimate U-factors and solar heat gain coefficients (SHGCs) of windows and doors.

10.3.1. Evaluate window treatments, including replacements, for improvements in thermal resistance and/or shading.

10.4. Evaluate the feasibility and energy savings of shading and reflectivity retrofits for the roof and/or wall in homes with mechanical cooling systems.

10.5. If infrared thermography is conducted, follow RESNET standards for the thermal inspections of buildings.

11. Heating and Cooling (HVAC) Efficiency

A BPI-certified energy auditor must evaluate the performance of the building mechanical systems, and recommend upgrades as appropriate according to Sections 5 and 6 of this standard, as follows (Program or incentive guidelines may require you to specify certain ECMs or conduct certain tests).

11.1. Evaluate furnace performance and efficiency, as applicable.

11.2. Evaluate air-conditioning and heat-pump performance and efficiency, as applicable.

11.3. Evaluate duct performance, including filter effectiveness and duct sizing, as applicable.

11.4. Evaluate air duct systems that are partially or fully outside the conditioned space for air leakage and thermal insulation, as applicable. The energy auditor must follow one or more of the following two (2) duct-testing requirements. Note: When an auditor acts as the agent of a BPI-accredited contractor and offers a work scope in the form of a binding contract or contract offer, pre-work duct testing may be deferred and specified as part of the work scope.

11.4.1. Evaluate duct systems that are no more than 25% outside conditioned space with a pressure-pan test to identify useful duct sealing opportunities. Conduct this test with a blower door depressurizing the building enclosure to 50 Pa. If the pressure at any duct register is more than 3 Pa or the average of all registers is more than 1 Pa, duct-sealing opportunities are likely and further testing is recommended.

11.4.2. When ducts are more than 25% outside conditioned space, you must conduct a duct-pressurization test to evaluate duct leakage as part of the energy audit, or specify a duct pressurization test prior to beginning duct-sealing work.

11.5. When duct sealing is specified, specify or conduct a duct-pressurization test when work is completed, or as part of the final inspection.

11.6. Evaluate duct location and R-value; evaluate feasibility and energy savings of retrofit duct insulation, as applicable.

11.7. Evaluate evaporative-cooler maintenance, installation, and performance, as applicable.

11.8. Evaluate boiler performance and efficiency, as applicable.

11.9. Evaluate steam-heating distribution performance, as applicable.

11.10. Evaluate hot-water space-heating distribution performance, as applicable.

11.11. Evaluate hot-water heater and hot-water distribution performance, as applicable.

11.12. Evaluate the feasibility and energy savings of HVAC equipment replacement. Specify that replacement systems comply with Air Conditioning Contractors of America (ACCA) *5 QI HVAC Quality Installation Specification*.

11.13. For equipment that isn't specified for replacement, specify cleaning, tuning, adjustment, control upgrades, and repair, as applicable, in the work scope.

12. Baseload Energy Efficiency

A BPI-certified energy auditor must evaluate baseload energy uses and recommend upgrades as appropriate according to Sections 5 and 6 of this standard, as follows (Program or incentive guidelines may require you to specify certain ECMs or conduct certain tests).

12.1. Advise the customer about behavioral changes that reduce energy consumption.

12.1.1. Evaluate plug loads and explain associated electricity costs.

12.1.2. Calculate baseload energy consumption by disaggregating the following energy uses from one another: baseload, water heating, space heating, cooling, and other seasonal consumption such as pool heaters and pumps.

12.1.3. Tell the customer how household baseload energy use compares with similar homes in the region.

12.1.4. Explain the value of turning off lights, televisions, and other loads when not in use.

12.2. Evaluate refrigerator and freezer performance.

12.3. Evaluate lighting efficiency, and educate the customer regarding efficient alternatives.

12.4. Inspect clothes dryer vents for restrictions, lint build-up, or indoor termination.

12.5. Evaluate pool and spa energy consumption, and evaluate conservation strategies, as applicable.

12.6. Evaluate the efficiency of other major baseload energy users.

12.7. Recommend appropriate replacements or alternatives to appliances, as applicable.

13. Renewable Energy Evaluation

Renewable energy retrofits provide additional opportunities for customers with energy-efficient homes. A BPI-certified energy auditor may perform a renewable energy evaluation if the customer wants this service, or if substantial incentives are available. Solar photovoltaic electricity and solar thermal systems may be cost-effective for some customers.

13.1. Understand national and regional rebates, tax credits, and other incentives for installing renewable energy systems.

13.2. Evaluate the potential for photovoltaic solar electricity.

13.3. Evaluate the potential for solar thermal systems.

Appendix A: Alternate Ventilation according to ASHRAE 62–1989

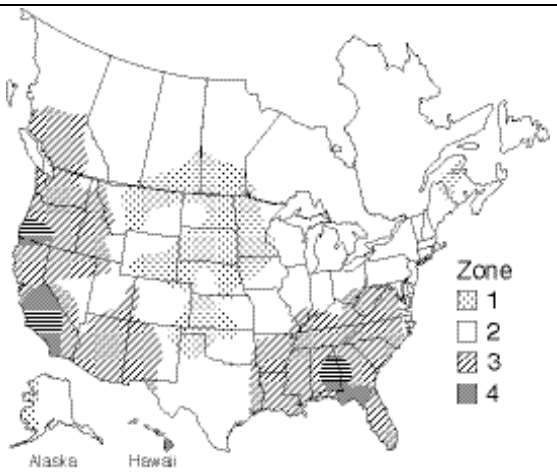
ASHRAE Standard 62-1989 is a legacy standard allowed in Section 8 of this Standard as an alternate to ASHRAE 62.2-2007 until July 1, 2013. ASHRAE Standard 62-1989 requires homes to have at least 0.35 air changes per hour (ACH), and at least 15 CFM per person.

13.4. According to standard ASHRAE 62-1989, ventilation must be satisfied by a combination of mechanical ventilation and/or the enclosure air leakage. The ventilation contributed by air leakage may be estimated by conducting a blower door test. The CFM50, needed to meet this requirement without mechanical ventilation, is referred to in this standard as Minimum Ventilation Requirement or MVR (previously called “Building Airflow Standard” BAS).

Follow these steps to determine the MVR and determine ventilation needs:

13.4.1. Determine the number of occupants by choosing whichever is larger:
- (a) Actual number of occupants
- (b) Number of bedrooms plus one

13.4.2. Find the zone from the map shown below.



Determining N-Factor

	Number of Stories			
Zone	1	1.5	2	3
1	18.6	16.7	14.9	13
2	22.2	20	17.8	15.5
3	25.8	23.2	20.6	18.1
4	29.4	26.5	23.5	20.6

13.4.3. Using the table above, choose the factor “N” corresponding to the building’s stories and shielding factor for each geographic zone. This factor converts estimated natural air flow to 50-pascal flow (CFM50) using the following equations. MVR is in units of CFM50 (CFM at 50 Pa):

(1): $$MVR = 15 \times Occupants \times N$$

(2): $$MVR = \frac{0.35 \times Volume \times N}{60}$$

13.4.4. Calculate MVR using each formula and choose the larger CFM50 result as the MVR.

13.4.5. Make recommendations for whole-house ventilation based on the table below:

Recommendations for Home Ventilation (Legacy BPI)

Blower Door Measurement*	Recommendation
Final blower door measurement is greater than the calculated MVR.	Air leakage is acceptable for whole house ventilation and air sealing may be conducted down to calculated MVR. Require local (spot) ventilation in kitchen and baths by a whole-house ventilation fan, a local exhaust fan, or operable windows.
Final blower door measurement is between 70% and 100% of the calculated MVR.	Recommend continuous whole house mechanical ventilation, sized to provide the following CFM: (MVR - CFM50) / N
Final blower door measurement is less than 70% of the calculated MVR	Recommend continuous whole house mechanical ventilation, designed to provide the larger of the following: (MVR - CFM50) / N or (15 x Occupants)

* If the anticipated tightness after work is completed is likely to be at or below MVR, ventilation must be recommended in the work scope.

Building Performance Institute Home Energy Audit Standard – Referenced Documents

Item	Date	Website	EA Standard Section
EPA Guidelines for Radon Testing			3.9
RESNET accredited software			5.2.2
RESNET standard for thermal imaging	2006		10.5
ASHRAE Standard 62.2.-2007	2007		8.4, 8.5, 8.6.2, 8.6.2, 8.7, 8.7.2, 14, 14.1
ASHRAE Standard 62-1989	1989		8.4.1, 14
International Energy Conservation Code	2006 *(or 2009?)*		8.6.1, *insert in 10.2. (compare component R-values to those specified in IECC)*
ANSI/ACCA 5 QI-2007, HVAC Quality Installation Specification	2007		11.12
ANSI Standard Z223.1-2002, Annex H, Recommended Procedure for Safety Inspection of an Existing Appliance Installation	2002		*Insert in 7.5*
National Fuel Gas Code or International Fuel Gas Code			*Insert in 7.2 (procedure for testing gas or propane leakage in piping systems)*
ANSI/ASTM E779-03, Standard Test Measure for Determining Air Leakage Rate by Fan Pressurization	2003		*Insert in 10.1*