

## In Home Energy Evaluation Procedure

### Acronyms and Abbreviations

ACCA – Air Conditioning Contractors of America

AFUE – Annual Fuel Utilization Efficiency

ANSI - American National Standards Institute

ARI – Air Conditioning and Refrigeration Institute

ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

ASTM – American Society for Testing and Materials

BPI - Building Performance Institute

CAZ – Combustion Appliance Zone

CFL – Compact Fluorescent Lamp

CO – Carbon Monoxide

DOE – Department of Energy

DHW - Domestic Hot Water

EER – Energy Efficiency Ratio

EF – Energy Factor

EPA – Environmental Protection Agency

GAMA – Gas Appliance Manufacturers Association

IHEE - Home Performance Assessment

HPwES - Home Performance with ENERGY STAR

HVAC - Heating, Ventilation, and Air Conditioning

NFPA – National Fire Protection Association

SEER – Seasonal Energy Efficiency Ratio

SSE – Steady State Efficiency

QA – Quality Assurance

### Definitions

Evaluator – Individual qualified by TVA to perform an in-home evaluation for the *energy right*<sup>®</sup> In-Home Evaluation program.

Contractor – Individual qualified by TVA to deliver home improvement services for the *energy right* In-Home Evaluation program.

Inspector – Individual qualified by TVA to perform quality control inspections for the *energy right* In-Home Evaluation program.

Homeowner – Individual who owns the single-family dwelling and agrees to participate in the *energy right* In-Home Evaluation program.

## Section 1: In Home Energy Evaluation

### 1.1 Introduction

In order to offer the homeowner the opportunity to increase the energy performance and comfort of their home, all of the home's systems are holistically assessed to recommend improvements that work together to improve their home.

The In Home Energy Evaluation (IHEE) includes the activities (i.e. evaluations, tests, etc.) that are completed to assess a home's performance and prepare a recommended scope of work.

Evaluators and contractors that agree to participate in the program need to have clear direction on what services they are expected to deliver. These policies and procedures are intended to establish a minimum

level of service that can be marketed to homeowners by TVA and local power distributors and participating contractors. The required elements of the IHEE do not have to be completed in one home visit but must be completed prior to the commencement of home improvements. The IHEE guidance below is sequenced but it is not required that contractors deliver the components of the IHEE in the order provided.

## **1.2. Required and Recommended Elements**

### **1.2.1 Homeowner Interview**

The Evaluator is required to conduct an in-person interview to collect information about the home and homeowner's concerns, motivations and goals. The information gathered can vary based on climate, housing type, site layout, etc.; the objective is to begin to establish a good base of information from which to address the homeowners' concerns. Information that may be valuable includes:

- Age of home, years that family has lived there, number of occupants.
- Remodeling, additions, window replacement, bonus rooms.
- Basic information about HVAC system(s), type of fuel, age of systems (if known).
- Use of unvented fireplaces and space heaters (if used, educate homeowner on moisture, carbon monoxide and fire risks, and inform them that envelope improvement cannot be performed unless they are removed or vented with a retrofit kit, if applicable).
- Swimming pool – dates and hours/day of pump operation, heated or not, heating source(s) and location(s), ventilation strategy if indoors.
- Utility bills
- Comfort complaints (cold rooms/hot rooms, drafts, moisture and humidity).
- Ice damming, wet crawlspaces or other common climate-specific problems.

### **1.2.2 Building Envelope Evaluation**

The building envelope offers many opportunities for energy efficiency improvements. Therefore, participating contractors are required to conduct an evaluation of the building envelope:

#### ***Optional Steps for the Homeowner Interview***

##### ***Pre-Assessment Telephone Interview***

*When scheduling the IHEE, some participating Evaluators conduct a quick telephone interview with the homeowner to collect basic information on the home and the homeowner's concerns and motivations, so as to be more prepared, focused and time efficient during the home visit.*

##### ***Disaggregate Energy Bills and Discuss Analysis with Homeowner***

*If energy consumption history is available, it can be extremely valuable for the participating Evaluator in building an understanding of the home's energy performance and motivating the homeowner to invest in recommended measures. By breaking down the energy use, the Evaluator can more effectively identify the best energy improvement plan, educate the homeowner on the benefits of core air sealing, insulation, high-efficiency HVAC, water heating, and electric base-load measures such as lighting and appliances.*

##### ***Quick Walk-Through with Homeowner***

*Conduct a walk-through with the homeowner to ascertain additional information (homeowner has opportunity to bring up any issues or concerns that s/he has with any major items in the assessment). The contractor can take this opportunity to inspect major appliances and lighting with the customer and educate them on the benefits of replacing older appliances and lighting with ENERGY STAR qualified products.*

#### ***Optional Steps for Envelope Thermal Evaluation***

##### ***Exterior Wall Insulation Levels***

*An optic probe can often be used to determine wall insulation levels. It is usually inserted next to electrical outlets or behind wall hangings. This tool can also be used to inspect potential moisture problems found with an infrared camera*

##### ***Window Details***

*Some energy savings tools in particular require some details regarding window area and orientation, framing type, number of panes and/or presence of storm windows. Otherwise, such information is most important if it is known that replacement windows are to be included in the scope of work.*

- 1) Collect basic information on the envelope of the home:
  - Record house type, age and condition.
  - Note key features of home typical of house type (porch roof, multiple roof lines, cantilevers, bay windows, dormers, kneewall attics, attic access, crawlspaces, basements, attached garages).
  - Note configuration of home additions, if any.
  - Sketch house floor plan with orientation and exterior measurements; calculate floor area, and volume.
- 2) Note condition of external building envelope features (siding, trim, fascia, soffit areas, etc.):
  - Look for signs of moisture or ice dam damage (if applicable) on walls and soffits that may have resulted from building performance problems.
  - Check for roof moisture damage (stains, soft or rotted deck or rafters, wet or moisture-damaged insulation) from roof leaks or inadequate ventilation.
  - Note any issues with shading or exposure to sun (linked to issues with hot/cold rooms and can help prioritize window-related measures).
  - Note any grading features, downspout terminations, or sprinklers that may direct water towards the foundation or affect the performance of an exterior wall.
- 3) Envelope Thermal Characteristics
  - Determine the thermal boundary of the home and identify thermal bypasses.
  - Record type(s), amount and condition of insulation in all components of the thermal boundary. For guidance on default and de-rated R-values, see Building Performance Institute (BPI) Technical Standards<sup>1</sup>.
    - Attic flats, slopes, knee walls, knee wall flats, dropped soffits, etc., as appropriate for type of home and per configuration of additions.
    - Basement and crawlspace walls or ceilings.
    - Rim joists.
    - Attic staircase walls.
  - Window Evaluation: Note condition of windows, type, age, signs of moisture damage and air infiltration around windows.
  - Door Evaluation: Note type and condition of all doors to exterior (including garage) – especially note if doors are un-insulated, in poor condition, or if they are leaky and in need of weatherstripping or door sweeps.
- 4) Envelope air leakage characteristics
  - Visual evaluation of attic and basement to identify paths of air leakage
    - BPI Technical Standards are currently being modified and this Guide will be updated to reflect any revisions.
    - Attic: openings in wall top plates, electrical and plumbing runs, open areas around flues and chimneys, recessed light housings, around exhaust fans, open framing cavities, dropped soffits and ceilings.
    - Basement: openings around electrical and plumbing runs and around flue pipes and chimneys, accessible sill plate areas, basement windows, exterior doors, and accessible rim/band joist areas.
  - OPTIONAL Blower door test: This test is an effective way to locate air leaks and educate the customer on air leakage issues. When the recommended work scope includes air sealing, attic insulation, enclosed cavity insulation representing 15% of the total building envelope area, sealing of the ducts outside the thermal envelope, or replacing atmospherically vented combustion appliances with sealed combustion appliances, follow ASHRAE 119 standard on blower door test procedures.
    - With blower door depressurizing the home, identify major leakage areas in living area (e.g. window trim, baseboards, upper trim, cabinets, dropped soffits, pocket doors, recessed lighting, duct chases/plenums, band joists, transitions between porch roof and exterior walls, fireplaces, cantilevered floors, etc.).

- Identify any significant misalignments of the pressure and thermal boundaries and ways to correct them.
- Inspect walls or ceiling between an attached garage and the living space for air leakage.

### **1.2.3 Heating, Ventilation, and Air Conditioning (HVAC) and Domestic Hot Water (DHW) Systems Visual Evaluation**

The HVAC and DHW systems can offer dramatic comfort and energy savings opportunities. Therefore, participating contractors will perform a basic visual evaluation of the HVAC and DHW systems in the home as follows:

1) Determine number and type of thermostats:

- Note number of heating and/or cooling zones.
- Note whether thermostats are programmable or manual.
  - If programmable, check status of setback periods and, if not being used, educate homeowner on the benefits of scheduled setbacks based on their lifestyle.

#### **Optional Steps for Evaluations during Blower Door Test**

##### **Use of Infrared Camera**

*Some of the more successful home performance contractors have learned that using an infrared camera during a blower door test is an effective way to identify where insulation and air sealing are needed. It is also an effective sales tool when the contractor has the customer(s) involved in the assessment. Showing the infrared images to the customer(s) and relating them to problems that were identified during the homeowner interview demonstrate expertise and builds trust, leading to higher customer motivation and stronger sales.*

##### **Zonal Pressure Differential Tests**

*Using the blower door and a manometer, conduct zonal pressure differential tests if needed to diagnose particular problem areas within the building (e.g., to determine how much an attic or garage is communicating with the living space compared to the outside). This test can help focus the evaluation and speed up the diagnostics tests.*

##### **Blower Door Test**

*Caution: Do NOT conduct this test if fireplace or wood stove has recently been used. Do NOT conduct this test if there is evidence of exposed and/or friable contaminants (asbestos, lead dust, bio-aerosols or other dangerous materials) that might become airborne or otherwise be introduced into the living space by conducting the test.*

2) Visually inspect heating system:

- Verify system information: age, model, heat in/out, general condition and maintenance history.
- Check for evidence of back draft/flame roll-out.
- If boiler, verify that pressure relief valve is present and not obstructed.
- If condensing unit, check the condensate line for signs of blockage or leaks.
- Check exhaust vent for proper fitting and termination.

3) Visually inspect air conditioning system:

- Verify system information: age, model, capacity (sometimes available on nameplate).
- Check condensate line(s) for blockage or leaks.
- Note any issues around compressor/fan unit in yard, such as recirculation/air flow obstruction from built features or plantings or problems with coil blockage from leaves, twigs or other debris.
- Record number of window or wall units, model and EER if available.
- Check for insulation on refrigerant line set.

4) Visually inspect distribution systems:

- Inspect air filter(s) and ask homeowner how frequently they are replaced.
- Verify presence of secondary overflow pans when air handling unit is within, above or adjacent to finished living space and verify presence of condensate drain line or float disconnect switch.
- If system is gas, note the presence of any ducts or air handlers in garages (this requires a recommendation to relocate or create air-tight enclosures to isolate them from garage and prevent transportation of carbon monoxide and other fumes from the garage to the living space).
- Record insulation level of ducts in unconditioned spaces.

- Check for ductwork leaks, disconnects, crimps, signs of moisture presence, return leaks near combustion equipment, damage or other atypical conditions (Evaluation will include inaccessible ducts to extent possible).
- For hydronic systems, record insulation levels and note opportunity for pipe insulation if practical, especially on long pipe runs if there are comfort issues.
- For baseboard systems, check for condition and positioning of covers and for presence of dust, webs and other material on the fins.

5) Visually inspect DHW system:

- Record approximate age, model, capacity, condition.
- Check for evidence of back draft/flame roll-out if water heater is non-electric.
- Verify that pressure relief valve is present and not obstructed.
- Note temperature setting on water heater. This is a good opportunity to educate homeowner on standby losses and scalding threats if it's above 120 degrees F, and reduce the setting if homeowner approves.
- Check for signs of leakage from water heater tank vessel.
- Conduct visual Evaluation of water heater and hot water pipes for efficiency improvements (presence or lack of insulation, convective loop, and feasibility of retrofitting insulation on tank and/or pipes).

6) Combustion appliance zone (CAZ) safety evaluation:

- Make sure that there are no flammable or explosive materials near any combustion source. This is a good opportunity to recommend moving them to a safe place.

7) Living space safety Evaluation:

- Note number, location and operability of CO detectors and smoke detectors in living space. Codes in some jurisdictions may require them.

*Note:* If any heating system, water heating or kitchen appliance uses propane or natural gas as the fuel source, the home shall have an operating Carbon Monoxide (CO) monitor(s) for program participation. The evaluator shall visually inspect the monitor to confirm the unit is working and will discuss with the customer the importance of properly operating monitors especially if the home is tightened through weatherization. *The Participant is not eligible for any incentive if there is gas present in the home but no operating CO2 monitor.* The monitors must be present and operating before any weatherization improvements are made.

If a distributor elects to include high efficiency air conditioning in their program and the home has a gas (either propane or natural) system that is not going to be replaced, the Evaluator shall explain the importance of having the existing heating system tested for safety. CO2 monitors shall be recommended at the time of the Evaluation. If weatherization is also being performed on the home, the Participant is not eligible for any incentive if there is gas present in the home and no operating CO2 monitor. The monitors must be present and operating before any weatherization improvements are made.

- Note presence of unvented gas fireplaces and propane or kerosene space heaters and discuss with and educate the homeowner – explain that envelope work cannot be performed unless they are removed or vented with a retrofit kit.

8) Inspect mechanical exhaust ventilation:

- Check whether mechanical exhaust venting systems in bathrooms and kitchen, if present, are designed, installed and terminated properly.
- If garage is attached, note whether exhaust fan is present and operable in garage.
- Note presence and operability of power attic or whole-house exhaust fans and inform homeowner of correct operation.
- Determine required ventilation rate per ASHRAE 62.2-2007 or BPI Technical Standards<sup>2</sup>.

**Optional Steps for HVAC System Evaluation**

*In addition to a basic visual evaluation of the HVAC system, there is additional information that may be needed in order to produce energy savings estimates for replacement measures. This information can include:*

**Thermostat Settings:**

*Ask the homeowner about average thermostat settings for both summer and winter (this information can be important for analyzing energy consumption and savings).*

**Heating and Cooling Systems:**

- 1) Review maintenance records and/or ask homeowner about frequency, type and last occurrence of maintenance.*
- 2) If the heat pump or air conditioner is more than 10 years old or the furnace or boiler is more than 15 years old consider recommending replacement with ENERGY STAR qualified equipment.*
- 3) Estimate AFUE of heating system and HSPF/SEER of heat pump/cooling system via product nameplate information, looking product up in Gas Appliance Manufacturers Association (GAMA) or Air Conditioning and Refrigeration Institute (ARI) directories instrumented testing (see next section) or a combination thereof. Having a good understanding of operating efficiency helps the contractor produce a more accurate estimation of energy savings. Some energy modeling software will require a good estimate of AFUE, HSPF and SEER in order to predict accurate energy savings.*
- 4) Check central air conditioning systems for proper refrigerant charge and airflow across the indoor coil to determine if they are in balance to operate as efficiently as possible. EPA refrigerant certification is required to handle refrigerants and most jurisdictions may require this be completed by a licensed HVAC contractor.*

**Air Handlers and Ductwork:**

- 1) Determine condition of air handler and coil and need for cleaning.*
- 2) Conduct a test to determine adequacy of air flow, using one of the following methods: Duct Blaster® or other plenum pressure-matching air flow test, flow plate, flow hood, static pressure test, and/or temperature rise/drop tests.*
- 3) If ducts or an air handler are located outside of home's pressure boundary and cannot be relocated inside, conduct a test to determine duct leakage, using a metered and calibrated duct pressurization device.*
- 4) Inspect for condensation moisture or damage from condensation on exterior of duct liner (in hot humid climate) or interior of A/C only ducts (in cold climate) for ducts outside conditioned space.*
- 5) Check air return grills are properly sized.*

**Water Heater:**

*Estimate Energy Factor (EF) of water heater based on model number. Most energy modeling software will ask for EF for the purpose of estimating energy consumption.*

**Mechanical Ventilation:**

*Educate homeowner on the benefits of a timer-operated or humidity controlled bathroom exhaust fan.*

#### **1.2.4 Moisture Evaluation**

- *Check basement and crawlspace for moisture deposition or damage on basement floors, walls, sill plate area, around basement windows and bulkhead doors.*
- *Determine whether there is continuous moisture barrier in the crawlspace.*
- *Check around exterior of foundation for signs of moisture deposition from such sources as faulty gutters or watering too close to the foundation.*
- *Check attic for moisture deposition or damage on roof deck, rafters, joists, and insulation (wet or moisture-compacted insulation).*
- *Inspect condition of windows and look for signs of condensation or other conditions that could cause damage or affect durability.*
- *If there is evidence of high moisture levels in the living space, check for discoloration on walls behind headboards, furniture – corners of closets on exterior walls, and other areas of stagnation and cold temperature for moisture deposition or damage and conditions that promote fungal growth.*

**Gas Leak Test**

*Ask the homeowner for documentation of any tests performed by the local gas company.*

**Optional Appliance and Lighting Evaluation**

*1) Record approximate age, type and condition of major appliances and showerheads. If applicable, determine number, age and condition of room air conditioners (check with homeowner if the assessment is performed outside of the cooling season and they could be in storage).*

- *If homeowner has any older (>10 years) appliances, discuss benefits of replacing them with ENERGY STAR qualified appliances.*
- *Educate homeowner on water and energy savings from low-flow showerheads and toilets.*

2) Inspect high-use lighting areas for any obvious opportunities to upgrade to ENERGY STAR compact fluorescent lamps (CFLs) or fixtures. Check with homeowner to get estimated daily burn-time for lighting to be recommended for replacement (important for estimating energy savings calculation).

### **1.2.5 IHEE Summary Report**

Reviewing the findings with the customer is the culmination of the IHEE process. This is the opportunity to present the homeowner with the improvement opportunities discovered during the IHEE and solutions for improving the performance of the customer's home. Therefore, the participating contractor will discuss evaluation findings and present a recommended scope of work to the homeowner. At a minimum, the following elements are required to be included in an IHEE Summary Report provided to a homeowner after the IHEE has been completed:

- Participating Evaluator name, contact information, and name of technician completing the IHEE.
- Assessed home's address.
- Date assessment was performed.
- Existing conditions:
  - Air leakage visual evaluation or diagnostic results.
  - Insulation levels for walls, attic, rim-joists, and foundation (crawl, basement, or slab).
  - Approximate age and condition of HVAC equipment (heating, cooling, and ventilation fans), water heating equipment, and condition of exhaust flues for HVAC or water heating equipment that consumes fossil fuel.
  - Type and condition of windows and doors.
  - Duct system visual evaluation findings.
  - Approximate age and condition of appliances.
  - Any signs of moisture deposition, building performance failures or conditions affecting the
  - Durability of the home.
- A set of recommendations that is reasonably comprehensive in identifying measures that save energy, address combustion safety, comfort, moisture deposition, durability or other building performance problems.
- Recommendations in the comprehensive work scope must address air leakage between the house and attached garage due to the potential for infiltration of carbon monoxide and other fumes.
- An estimate of energy savings from recommended improvements and improvement installation cost.

## **Section 3: Quality Control Evaluation**

### **2.1. Introduction**

One of the features that distinguish The IHEE as a value-added service for residential customers is the evaluations or possibly instrumented tests that the inspector performs after the improvements have been made to a home. These tests support the "do-no-harm" principal which is a hallmark of home performance contracting. Some of the tests provide valuable information on the effectiveness of air and duct sealing measures installed.

### **2.2. Required and Recommended Elements**

*To be developed.*

## **Section 3: Summary Report**

### **3.1 IHEE Summary Report (Findings and Recommendations)**

The IHEE summary report will include findings of existing conditions and recommendations to improve the performance of the home. This review would verify that:

- Compliance with IHEE delivery requirements.
- Recommendations provided to the homeowner are reasonably comprehensive and consistent with the findings of the IHEE.
- Recommendations include an estimate of energy savings from the proposed improvements.