HVAC and Home Performance

Home energy audit tips that can enhance services offered to your customers.

BY MARCO FORTUNATO, CM

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At the recent 76th Annual RSES International Conference in Pittsburgh, PA, there was consensus among attendees that technically minded mechanical RSES Members and HVAC contractors would like to increase their involvement with delivering home performance.

If you think of the whole home as a resource that provides shelter and comfort to its occupants then everything inside of it contributes to that resource, including the building shell. HVAC contractors who are looking for ways to expand their business should consider adding home performance services such as insulation and air sealing. Your firm might provide energy checkups on the home and then provide appropriate fixes and upgrades—or make informed referrals to local partners.

These services can be a focus in the lull between the peak heating and cooling seasons. You could train your regular technicians, engage a separate home performance staff, or use home performance subcontractors to become a hybrid business. Most HVAC companies are focused on the home's mechanical resources and performance. By expanding services to include the home-energy usage, weatherization and appliances, HVAC contractors can leverage their existing customer relationships to benefit by becoming home performance contractors as well.

Locally, contractors can engage with incentive programs that can help provide an excellent understanding in building science principles that help predict and optimize building performance and prevent building failures. HVAC contractors typically service heating and cooling systems for an established base of customers with routine scheduled preventive maintenance plans. This can provide an excellent marketing opportunity for home performance upgrades, especially when a technician has already developed a good rapport with the homeowner.

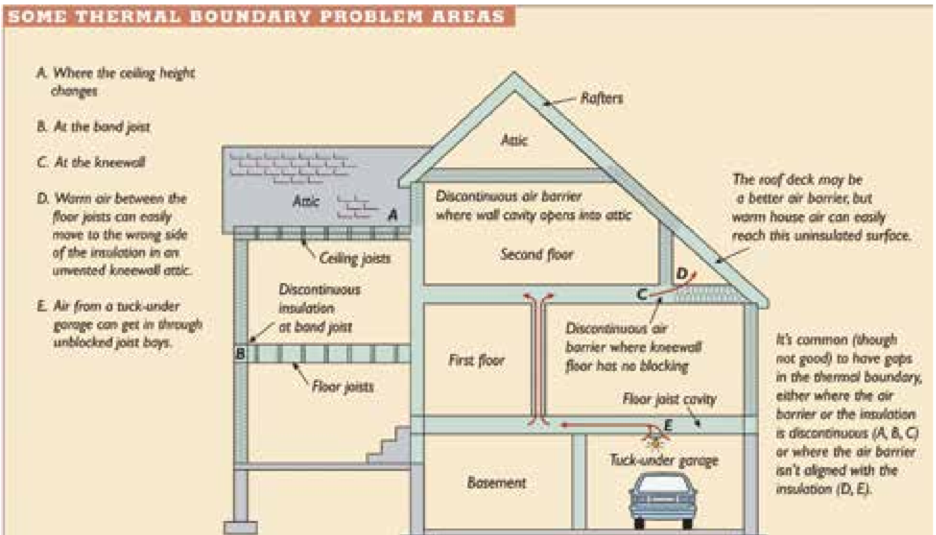
Houses are complex systems: energy, moisture, air, people, structure and mechanical systems all influence and affect each

Blower-door testing determines the air leakage rate of a structure, which can be used to estimate natural-air exchange rates and much more.

other. Customers tend to call the HVAC contractor when they have a comfort problem. However, the thermal boundary—the components of a building that separate indoor conditioned space from the outdoor space—can be the key factor in the system that may go unnoticed by the average HVAC contractor. For the greatest comfort and energy efficiency, it is important that the thermal boundary of the home be clearly defined. For example, common air flow paths in knee walls or between floors may chill the surfaces in a room and prevent comfort, regardless of how well the furnace and ducts are functioning.

Tips for getting started

Saving energy at home can fix some real problems. Ice dams on roofs, freezing pipes and mold growth from condensation in building cavities can all be reduced or eliminated by paying attention to energy flows and the house system. There are different strategies for approaching home performance. One idea is to create your own "customer facing" diagnostic report as a first step. You can divide the report into three sections: visual inspection, tests/energy efficiency and homeowner comfort.



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Visual inspection

Examine the interior and exterior of the home for signs of trouble. Common air bypasses can connect interior floor and wall cavities at knee-wall attics, cantilevered overhangs (especially when covered only with vinyl or aluminum soffit), porch or garage roofs or inset entries. A quick look in the attic can reveal huge openings into duct or chimney chases, plumbing wet walls, dropped soffits and other air leaks. Take some time to become familiar with these thermal bypasses so you can identify the big ones. Heavy concentrations of dust on carpets or frames of doors that lead to garages, attics or other unheated spaces can indicate large pressure differences created by unbalanced mechanical equipment. Duct leaks or unbalanced return systems can lose heat and cooling to unwanted places, as well as dramatically accelerate outdoor air exchange whenever the system fan is on.

Contractors can make sure major home appliances that burn gas or oil—such as furnaces, boilers, hot-water heaters and stoves (combustion appliances)—are working properly and safely. Carbon monoxide and combustion appliance zone (or CAZ) testing should always be performed as part of the home assessment.

Tests/energy efficiency

Most mechanical contractors are familiar with basic energy-efficiency ratings: SEER and EER for air-conditioners, AFUE for furnaces and boilers and HSPF for heat pumps. Each is a different scale, but higher ratings mean higher efficiency for each of these systems. But there are other key measurements in evaluating a home's efficiency, such as shell air leakage and duct leakage.

When it is approved and published, BPI-1200-S-201x Standard Practice for Basic Analysis of Buildings (currently a draft standard under the ANSI public review process) will provide a complete set of procedures to evaluate the performance of homes. Key areas will include building shell evaluation (including blower-door testing), ventilation and air quality, HVAC performance (including duct-leakage testing)

Ice Dams

If you live in snow country, you've seen houses with ice dams clinging to the eaves. To help prevent ice dams, thorough attic air-sealing should always be a top priority. Note that in areas of high snowfall, the snow itself acts as insulation. In very snowy, cold climates, even a superinsulated, air-tight ceiling or attic has enough heat flow to melt snow at the roof surface, and ice dams can still form. In heavy snow areas, the underside of the roof deck must be vented (regardless of how the attic is sealed and insulated) to cool the sheathing and reduce melting.

How Ice Dams Form

Air leakage is the biggest source of the heat loss that causes ice dams; poorly installed insulation comes in second. Ice dams form when snow melts and runs down the roof to the eaves, where it refreezes and seals tightly to the shingles. This leaves no escape route for further meltwater, which then backs up into the eaves or the house, causing damage.

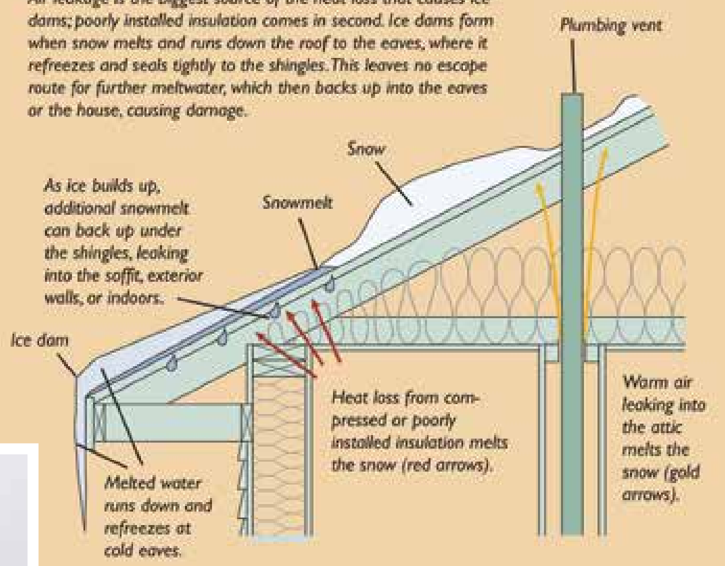

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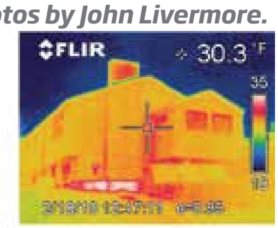
Photo by Bruce Harley.

and base-load evaluation. Section 7 of this standard features the complete step-by-step process for fossil-fuel combustion-safety test for building depressurization. The test procedure sets limits on the amount of CO and spillage under standard worst-case conditions. Combustion air requirements are further described under the subhead "Insulate tight, ventilate right." Familiarity with the procedures in BPI-1200 will be one way an HVAC contractor can ensure they are prepared to spot any kind of home performance problems.

Infrared testing helps a home performance contractor "see" behind walls and into inaccessible areas. It can be used to identify large areas where insulation is missing or ineffective. It can also be used in conjunction with the blower door, to find sources of air leakage that may not otherwise be visible.

Photos by John Livermore.

Before.



After.

The two infrared images show a house before and after a superinsulation retrofit. In the "before" image, the white areas represent the highest heat loss, followed by red, orange and yellow. Notice the difference after insulating the walls to R-30, replacing the windows with triple-pane low-e glass, and insulating the ceiling and attic. This successful project reduced heating consumption by almost 70%, bringing the house very close to net-zero carbon emissions. Not every house will see this kind of improvement, but knowing what is achievable helps motivate people and puts more potential work on the table in any situation.

Homeowner comfort level

It is all about comfort. Many existing heating and A/C systems have been designed to heat or cool a home at a specified capacity. If a homeowner's thermostat has to be set much higher than normal to maintain comfort to compensate for a fault in the building shell, their energy bills will be higher.

A blower door creates a uniform pressure across a house shell in order to measure the leakiness of the shell. Blower-door testing determines the air-leakage rate of a structure, which can be used to estimate natural-air exchange rates, but it does much more. Using a smoke generator or just a hand, the pressure created by the blower door fan can be used to find the big leaks and to demonstrate that they are sealed up once work is completed. The post-work measurement of reduced leakage rates can also be used to estimate energy savings.

Whether you decide to purchase a blower door and use it on selected jobs, or you look for likely air-leakage problems and refer those customers to a "shell contractor" who can do the testing, the added value is high. When a client notices how much warmer and more comfortable their house is before you leave the site (after finding and sealing big leaks) that happy customer provides valuable referrals that set you apart from the competition.

Insulate tight, ventilate right

Insulation, air sealing and ventilation go hand in hand. Insulation does not work if there is air blowing through it. Random air leaks cost in energy bills, but they do not provide reliable fresh air, and they provide significant pathways for unintended moisture transport. The objective is to tighten a house as much as possible, and also to provide a simple ventilation system that meets ANSI/ASHRAE Standard 62.2-2013. The following steps outline the process:

1. Determine base whole-house continuous fan requirements using base formula:
7.5 x (No. of bedrooms + 1) + (floor area x 0.03) = cfm_{design}
Example of 1,200-sq-ft, two-bedroom home:
(7.5 x 3) + (1,200 x 0.03) = 22.5 + 36 = 58.5 cfm_{design}

2. Calculate local ventilation adjustment:
- →Bathrooms require 50 cfm
- →Kitchens require 100 cfm

Example of one bath w/20 cfm measured = 30-cfm deficit:
deficit ÷ 4 = cfm adjustment
From Step 1 + Step 2 results: cfm_{design} + cfm adjustment = whole-house cfm required
58.5 + 7.5 = 66 cfm

3. Calculate infiltration credit:
- →Blower door cfm50 can provide cfmn credit
- →(cfm50 / N-factor) x height correction = cfm_n
- →Infiltration credit = cfm_n (equivalent natural cfm)
- →cfm final = base cfm requirements + local ventilation adjust – infiltration credit
- →Results are, 66 – 46 = 20 cfm whole-house continuous fan

Use the correct ventilation ANSI/ASHRAE 62.2-2013 N-factor lookup per location.

Combustion air

Most HVAC professionals are familiar with the standard method for proper combustion air requirements. If the home's air tightness is less than 0.4 ACH_n (air changes per hour), combustion air requirements should follow the KAIR method.

Standard Method:
(Btu input ÷ 1,000) × 50 = required volume (cu ft)

Remember the ACH_{50} calculation results from the leakage rate at cfm 50 (blower door result) x 60 (one hour) ÷ the whole house volume.
ACH_{50} ÷ weather factor N factor = ACH_n (natural)

NFGC (National Flue Gas Code) air tightness threshold is 0.4 ACH_n. This only applies to Category I appliances.

Threshold appliances calculate combustion air with the KAIR method (known air-infiltration rate).

KAIR method for Natural Draft Appliances:
(21 cu ft ÷ ACH_n) × (Btu input ÷ 1,000) = required volume (cu ft)

KAIR method for Fan-Assisted Appliances:
(15 cu. ft. ÷ ACH_n) × (Btu input ÷ 1,000) = required volume (cu ft)

Building science is not outside of the HVAC contractor's wheelhouse. Take advantage of technical information and accrediting tools (certifications) available to expand your knowledge. Saving energy, and creating happy, comfortable customers in the process, is one of the best things you can do for yourself, your successors and the environment.

References:

- →*Building Performance Institute, www.bpi.org;*
- →*Affordable Comfort, www.affordablecomfort.org; and*
- →Insulate and Weatherize for Energy Efficiency at Home, *by Bruce Harley, available at www.csgrp.com/homeowners-renters/efficiency-tips-energy-info/insulate-and-weatherize.*

For 25 years, Marco Fortunato, CM, has been associated within the HVACR industry, most recently, as a Senior Technical Support Analyst for Conservation Services Group, a provider of residential energy-efficiency programs in the U.S. His primary role is as a technician-on-call, providing expertise in training and technical guidance to A/C contractors to increase the general knowledge of their field technicians and to introduce them to CSG's approach to evaluating system operation, diagnosing short-comings and improving system capacity. For more information, visit www.csgrp.com.