

# TODAY'S ENERGY AUDIT

A first-hand account of how audits can help homes.

BY BILL SPOHN, P.E.

*Images courtesy of the author and Rhett Major (The Energy Doctor).*

*[Editor's Note: This feature has been left in first person to maintain the author's personal experience.]*

What do you envision when you hear the term “energy audit?” If all you imagine is a 20-minute walk through with a clipboard and tape measure, then you need to recalibrate your thinking. (I should know. My thinking continues to be recalibrated.)

Early this year, the owners at TruTech Tools voted to contribute toward an energy audit for all employees' homes. Since I have been talking the “energy talk” for years, I finally bit the bullet this spring and had a full blown energy audit done on my home. I learned a lot by watching and participating in the process. In fact, as I write this, the insulators are here. Actually, the insulators spent most of today air-sealing (air-sealing...what's that you say?).

While the focus for this feature will be on the residential level, these same concepts morph into the commercial and industrial levels as well.

## Defining moment

Before we get too far, let's cover a few definitions first:

**Building Performance Contracting (BPC)**, in the simplest sense, is the business of performing standard contracting work in buildings (construction, insulation, windows, HVAC, electrical/lighting, etc.) with detailed attention paid toward how all the building component and systems interact with each other during operation.

**Home Performance Contracting (HPC)** is the subset of BPC that deals with homes. In most cases, the lines are



⚡ **Blower-door tests (in/out) place the house under a negative pressure to check for air tightness and enhance thermal imaging, all parts of a proper energy audit.**

blurred and contractors that are engaged strictly in HPC describe themselves as BPCs. Several standards exist for HPC (residential) and additional standards are being developed for multi-family and commercial buildings. In fact the Building Performance Institute ([www.bpi.org](http://www.bpi.org)) just released a new set of ANSI-accredited advanced Home Energy Professional (HEP) certifications: Energy Auditor, Retrofit Installer Technician, Crew Leader and Quality Control Inspector.



« During the energy audit, the inspector walked the perimeter of the property and noted things like gaps in the envelope and snow-melt patterns (seen here).

If you think this is a fad, keep in mind that realtors (several state's Multiple Listing Services) and codes (2015 International Energy Conservation Code) are incorporating the RESNET ([www.resnet.org](http://www.resnet.org)) home "Energy Rating Index."

Furthermore, BPCs work with high-performance building standards, processes and techniques that address health and safety, building durability, energy-efficiency and comfort issues using applied building science in concert with advanced, yet readily available, measuring equipment.

Depending upon their business model and training/certification, the various types of services performed by a BPC/HPC include: air-sealing; insulation; energy modeling; Energy Star homes; HERS ratings; heating and A/C installation or tune-ups; blower-door testing; infrared/thermal imaging; air balancing; and duct-leakage testing.

### House as a system

System interaction is a key phrase here. The main systems in the house include the building envelope (shell), HVAC equipment and the occupants. The first level of interaction is obvious. We all know the HVAC system and other appliances are designed to provide comfortable, safe living conditions for the occupants, and the building shell is supposed to efficiently and safely contain the "expensive air" that the HVAC system has created. It is the other levels of interaction that are often overlooked.

After teaching combustion diagnostics for more than a decade, I've concentrated the main take away of my class to "it's about the air," which plays right into home performance.

“The ventilation air is mainly for the occupants' health and comfort.”

I think of the three main sources of air in a house as ventilation, infiltration and make-up air. The ventilation air is mainly for the occupants' health and comfort. The make-up air required for safe and efficient operation of all the combustion appliances and their vent systems that "breathe" the air in a home. Appliances often include: furnace/boiler (excluding high efficiency), water heater, wood stove/fireplace/combustion space heating, and cooking ovens. The infiltration air is basically out of control. It moves in and out of the building shell via pressure differences (stack effect, wind, HVAC and fans), carrying in and out whatever comes along with it. Infiltration air carries out the "expensive" air that the HVAC system made. It carries in unconditioned air (often with improper temperature and humidity levels, then takes energy to be conditioned), pollutants, dust, pollen and noise to dilute the expensive air.

>> A dirty evaporator coil (shown here) is one of many reasons for a system to not run effectively or efficiently.



These three types of air get used in different ways, mainly for combustion, dilution (for flue-gas vent systems) and breathing, and are often in a balance of sorts—because if you mess with one, you may affect the other. A drastic change in infiltration air, via air-sealing or weatherization will positively affect the infiltration air, thus reducing energy costs and improving comfort. But if that infiltration is also supplying combustion air or dilution air, inefficient or dangerous conditions could develop.

## Doing the dance

Our energy audit was performed by The Energy Doctor (Rhett Major) of Irwin, PA, on a cold day late in March. The first step was a walk around the house looking for exterior signs of energy loss (gaps in the envelope, snow-melt patterns, etc.) and building durability issues (such as water infiltration). The next step was a walk around the entire house, from basement to attic, paying special attention to pathways for air infiltration. Photo documentation is essential in remembering all the details (197 photos were taken during my audit).

Square footage, wall area and interior volume were determined and calculated, in our case from the house plans (built in 1989). These factors are used later when comparing the home performance to standards, norms, and before and after tests. Next, the home was set up—all air moving (such as the HVAC system and fans) and combustion appliances (such as domestic hot-water heaters) were disabled and all windows and doors closed. The house was placed under a negative pressure (50 Pascal or 0.2 in. wc) with a blower door to check for



⤵ In addition to a new attic hatch cover being built, blown-in cellulose was added to increase effective attic deck R-value to about 49.

air tightness and enhance thermal imaging. The auditor then walked systematically around the inside of the house (“always take right turns”) taking thermal and visual images of the walls that exhibited the most energy loss. Major calls this the blower door/thermal dance. Next, the blower-door test results were recorded and the HVAC system was fired up and air flow (supplies and returns) and static pressure was checked.

## Oops/double oops

In 1999, when we bought this 10-year-old, 4,400-sq-ft, custom-built home, we saw a lot of value: siting, layout and interior features, plus 5/8-in. wall board, a 12-course block basement, more closely spaced studding and a 100,000-Btuh high-efficiency furnace with 4-ton, 10-SEER A/C (top notch for 1989), just to name a few things. However, this energy audit revealed some shocking results.

The Energy Doctor actually produced four different audit reports (at my request). He pointed out areas for improvement and target costs and payback periods. Since our main purpose was to make our home more comfortable, we realized that the payback for some of the recommended measures was not a leading factor.

We were stunned to see air leakage was nearly 5,000 cfm (at 50 Pascal). Standard calculations indicate that is about 650 sq in. (cumulative) of leakage area to the outside. Similar to leaving a window sash open 24/7/365. The goal was to cut it down to 3,711 cfm (at 50 Pascal).

Additionally, the 24-year-old furnace had a blocked evaporator coil and lousy return air flow from most rooms. The decision was made to replace the HVAC system, as the cleanup and servicing would be costly. Plus, the (future) tighter home will produce less load and efficiency and comfort factors of HVAC systems have changed drastically in the last quarter century.

## Tighten up

After deciding from the menu of choices and paybacks, Major sub-contracted Andy Haak of Insulwise (Pittsburgh, PA) to fix the primary sources of air leakage: huge openings above the two upstairs shower enclosures (just a bit of fiberglass laid in, no wall material at all), and chases around the wood-stove flue and waste stacks. Secondary, but more numerous, were all the gaps in the dry wall

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>> A separate fresh-/combustion-air supply was installed near the catalytic wood-burning stove. Its location close to the stove should address cold drafts due to pulling from air infiltration points around the home.



and penetrations for wiring in the attic deck plus rim-joint leakage in the basement sill plate area.

Additionally, a new attic hatch cover was built, which helped to eliminate the 10-Pascal connection between the attic and house, while the blown-in cellulose was added to increase effective attic deck R-value to about 49.

Jim Bergmann, my business partner at TruTech Tools and HVAC contractor and educational expert, was contracted to do the HVAC sizing (load calculation) and replacement work. We ended up reducing our system size by about 25% with a 95.3% efficient furnace at 75,000 Btuh (with an ECM) and a two-stage 15.5-SEER A/C at 3 tons with a beautiful, touch-screen, “learning” thermostat (with outdoor sensors).

### Mileage may vary

Rarely do energy reports and ratings precisely predict improved energy usage, but they are darn good at projecting percent change when you have previous utility bills to compare. But that is not a flaw in process or execution. The same home, with different occupants, may consume drastically different amounts of energy due to the way it is “driven.” The occupants will dictate how the mechanical and building systems (appliances, HVAC, doors, windows, etc.) are “driven.”

Our blower-door test out numbers beat the goal of 3,711 by achieving 3,554 cfm at 50 Pascal, which is about a 30% reduction in air leakage. This should reduce load by 30% and match well with the HVAC-system size reduction of 25%.

Since we supplement our heat with a catalytic wood-burning stove, a separate fresh-/combustion-air supply was installed near the wood stove. Its location close to the wood stove should address cold drafts due to pulling from air infiltration points around the home.

### Rebate, rebate

We qualified for a few federal (high-efficiency furnace, ECM) and local utility (ECM, programmable thermostat, higher SEER) rebates. However, the 16-SEER level for a federal rebate amount did not justify the installed cost coupled with our cooling-season usage.

So far, we have noticed a higher level of comfort from the HVAC system (installed for one month when writing this feature) and a less drafty and quieter feel to the house from the air sealing (installed for less than one week). In addition, the attic penetration and rim-joint sealing will help keep out pests such as stink bugs, Asian beetles, yellow jackets and mice.

I will be happy to provide a brief update after we have lived with the changes for one year, and also answer any questions directly. ☺

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