# Home Performance with Energy Star Audit

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***Client concerns:*** The owners' primary concern is winter discomfort. The first floor in general and the kitchen in particular are uncomfortably cool during the winter. Reducing utility costs is also desired.

***Overview:*** The home is about 109 years old, having been built circa 1900, and the current owners have resided in it since 2001. The home's side walls are stick built with 2 x 4 studs and covered with a brick façade, excepting the rear covered porch which has wood siding, the 2 window bump outs and 2nd floor bow window which have painted wood facades, and the attic dormers which have a slate/stone façades. The 1st and 2nd floor walls are uninsulated except for a small section of kitchen wall that the current owners insulated with rigid foam board, and the stairwell walls. The prior owners also had insulation blown between the 2nd floor ceiling and 3rd floor, which isn't desirable if the 3rd floor is used as conditioned, occupied space. But it would be quite expensive and messy to undue. The 3rd floor and attic were insulated with blown in cellulose by Mincin two years ago, including the attic slopes, flats, knee walls, and gable and dormer walls. Visual inspection showed appropriate levels of properly applied insulation.

There are several different types of windows, with the majority being wood framed, single pane units with fitted exterior glass storms. Although they won't perform as well as properly installed, new Energy Star rated double pane low-E windows, storm covered single pane windows can come reasonably close. There are some newer, metal double pane windows in the rear and some wooden single pane windows with no storms, notably in the basement. The home is fairly large, measuring 39,418 cu ft in internal volume, including the conditioned 3rd floor and semi-conditioned basement. The slate shingle roof is in fair-to-average condition. No attic venting is visible.

Heat is provided by a 30 year old (1979 installation), atmospheric draft Burnham P-210-W gas-fired boiler with standing (always on) pilot. The boiler is located in the basement and has a large 299,000 BTU input rating and 213,000 BTU output rating. When new, it was 70% efficient, but as the decades have passed the efficiency has no doubt declined a few percent. There are four fireplaces but only the living room gas log stove with standing pilot is used. Additional supplemental heat in the kitchen is provided by a plug-in electric space heater.

A 20 year old (1988 installation) Carrier 38EH024320DL central a/c unit of undetermined tonnage provides 1st floor cooling. The split system's air handler is located in the basement and the fan coil unit is on the home's left side. An efficient (13 SEER), 3 ton Carrier 40AQ024300BU with Puron coolant, installed in 2007, cools the 3rd floor through attic mounted, insulated high velocity ducts, and also the 2nd floor. The fan coil is located just in front of the other a/c system's unit, with the air handler attic mounted.

Supplemental cooling for the 2nd floor office is provided by a fairly new, Energy Star rated window a/c unit that is left in year 'round.

Hot water is provided by an approx 10 year old 50 gallon, atmospheric draft water tank, a Ruud P-50-2 with a 36,000 BTU input rating located in the basement on the other side of the wall from the boiler and vented in common with it.

Most of the main appliances are fairly new and efficient or are only moderately used, with the notable exception of the basement refrigerator.

About half of the home's main incandescent lights have been replaced with efficient compact fluorescent lights (CFLs).

***Utility bill analysis:*** The owners have an alternate electricity supplier. The cost adjusted electric analysis showed a moderate base load (everyday use not related to heating or cooling) of 660 kWh, or $93 at the current Duquesne Light residential rate. This isn't bad for a family of four, especially considering the $10/month cost of the radon fan.

The peak usage is cooling driven. The highest summer monthly read was 1920 kWh ($257) or about $165 over the base load. This is a bit on the high side considering the new, efficient a/c unit and the reasonable 76 degree or above thermostat setting. The uninsulated side walls, older, less efficient central a/c unit, unvented attic (with heat gain impacting the attic mounted ducts and air handler), and basement dehumidifier use all are contributing factors.

The winter use peaks at 1128 kWh ($154) or about $60 over the base load. About $20 of that rise is attributable to the boiler circulator pump, which means most of the remaining $40 is due to the use of the electric space heater.

Natural gas is provided by Dominion Peoples. The base load use is in the typical 1-2 MCF range, primarily from use of the (gas fired) water tank, dryer, and stove. The winter use peaks at a moderately high 35 MCF, or $500 at the current rate. The uninsulated side walls, high degree of leakiness (discussed later), and old, inefficient boiler all contribute.

***Utility Recommendations:*** It's worth checking out current alternate gas supplier rates as some have been significantly lower than those offered by the gas companies. Most recently the rates have been close, but the PUC website includes the particulars, including the important "price to compare" at:

http://www.puc.state.pa.us/utilitychoice/listofsupp.aspx?ut=nc.

***Health & Safety Concerns:***

The building and gas appliances passed all the safety checks:

--There were no gas line leaks detected.
--The gas oven didn't put out excessive carbon monoxide (CO) after achieving the set temperature.
--There wasn't an excessive ambient CO level measured in the home.
--The Combustion Area Zone (CAZ) wasn't excessively depressurized in the worst case.
--Neither the boiler nor the water tank spilled flue gas past one minute after start.
--Both the boiler and the hot water tank had sufficient draft.
--Neither the water tank nor the boiler put off excessive CO during steady state operation.

Ideally, gas stoves should have a range hood vented to the outside to remove combustion products and cooking odors. The oven here has one.

We recommend that all (full) bathrooms have an exhaust fan vented to the outside to eliminate any moisture related problems and to help maintain good indoor air quality. The two full bathrooms are vented and show no signs of moisture problems.

The home has sufficient smoke detectors but just one CO detector in the basement. It's recommended that each occupied floor have both smoke and CO detectors, so we recommend adding CO detectors on the upper floors.

***Mechanical Equipment / Appliance Recommendations:***

1) The basement refrigerator is an old, inefficient 21 cu ft GE TBF21DWB. Recommend replacement with a new, Energy Star rated fridge that would consume only one-half to one-third the electricity of the current model, reducing the electric base load some $10-15/mnth.

2) The dehumidifier is over a decade old now and also not as efficient as new, Energy Star rated models. It ran enough while I was there to indicate that it's a significant part of the electric bill. As such, it's worth considering replacement with a new model if it remains necessary to run a dehumidifier.

3) The boiler is very inefficient compared to new models that, like furnaces, can be had in sealed combustion, high efficiency (90+ % AFUE) versions. Such a model would provide a quick 20% savings in gas consumption. We recommend doing the home insulation and air sealing measures first, which allow whatever heating system is installed to use less fuel, then consider replacement. Doing weatherization measures first also often allows a replacement model to be downsized, saving more fuel and reducing installation cost.

4) The standing pilot on both the boiler and gas log stove can be shut off during the summer, saving a small amount of gas and reducing stack effect related air exfiltration.

5) The radon mitigation fan runs continuously, which not only adds background noise but adds a good $10/mnth to the electric bill. As the PVC vent pipe no longer runs to the roofline, it may not be necessary to have such a large (1.32 A, 158 watt) fan connected. It's worth checking if smaller, more efficient fan could be retrofitted in. Alternately, especially after basement air sealing, radon testing can be redone to determine if it's still necessary to run the system.

***Lighting Recommendations:***

Lighting is typically 15-20% of the electric bill, so it makes sense to (continue) replacing any burnt out incandescents that are on for 2 or more hours every day with 75% more efficient (and much longer lived) CFLs. Dimmable, flood, and decorative (globe covered) CFLs are now available.

***Basement Recommendations:***

Addressing basement air sealing and insulation issues should help make the 1st floor and kitchen more comfortable during the winter.

1) Blower door testing confirmed significant air leakage in the basement and from the band joists (sill boxes) that run along both sides of the home for approx 80 linear feet. The edges of each sill box where the 2 x 10 joists meet the wood framing should be air sealed with caulk. Then pieces of fiberglass batting cut to size can be installed in the boxes to increase insulation value. For the best insulation value, pieces of 1" thick foam board cut to size can be friction fitted into each sill box and then caulked into place over the batting. This also creates a very effective barrier against air infiltration.

2) All pipe and wiring penetrations and any other holes or gaps in the basement joist area, notably: above the panel box; at the duct above the washer; and along the rear wall, especially under where the duct attaches to the 1st floor register, should also be air sealed with caulk and/or expanding foam for larger gaps.

3) The basement door to the outside stairwell has a barrel bolt that is very hard to latch shut and needs adjustment. The blower door induced large air leakage along the bottom of the door, especially where the cement flooring is missing. Recommend patching the floor and replacing the door's bottom sweep.

4) There was leakage through the gaps along the two sides of the new porch flooring, where it meets the support beams. These can be air sealed with caulk or foam. Also, the underside of the flooring itself should be insulated with foam board.

5) The other 3 pulley openings seem to be sealed, but the right most pulley opening of the right double hung window was leaky and should be sealed.

6) There was a significantly leaky, jagged settlement crack in the bricks along the rear wall that should be mortared.

7) The section of basement ceiling beneath the rear porch should be insulated with foam board or fiberglass batting.

8) The four wooden, single pane awning windows were well air sealed (probably painted shut) but offer poor thermal performance. Other than the more expensive replacement option, these can be upgraded to close to double pane performance by adding exterior Plexiglas storm windows. The two double hungs above the wash tub can be fitted with interior storms. There are firms that you can hire to do this. A local installer is:

ABC Installation
456 Three Rivers Blvd.
Pittsburgh, PA 12345
Phone: (412) 987-6543

There are also DIY kits available online, such as: www.windowsaver.com.

9) Insulate the first 6 feet the cold water line coming off the water heater with foam pipe insulation; touch up the existing insulation on the hot. The lines are 1" in diameter.

***1st Floor Recommendations:***

1) Have the side walls blown with dense packed cellulose insulation. If doable, the two bump outs should be insulated, as well as the rear porch ceiling, which is below conditioned space. There is some active knob and tube (K & T) wiring in the basement, but it seems limited to supplying one or two floor mounted 1st floor outlets. If K & T is present in the walls it complicates the insulation process since it's not supposed to be in direct contact with insulation.

2) The dining room fireplace was fairly well air sealed, but the foyer one was not. The existing chimney blockers (newspaper filled bags; fiberglass batting) can be refitted in more tightly and perhaps expansion foamed or caulked around the edges to make them seal better – although fiberglass by itself is an insulator and not an air barrier. Alternately, foam board can be cut to size and fitted in lower down in the flue. Or purpose made chimney blockers can be used, such as this model:

http://www.batticdoor.com/fireplacedraftstopper.html

http://home.comcast.net/~fireplaceplug/fireplace_plug_video-2.wmv (installation video)

The gas log stove chimney was the leakiest of them all, but since it's used care has to be taken that only fire rated air sealing materials come into contact with the hot flue pipe.

3) Air seal the pocket doors – at least the one to the foyer, which was the leakier of the two.

4) Since the owner mentioned feeling coldness along the periphery of 1st floor, recommend caulking the floor/ baseboard juncture wherever it's accessible and hasn't already been caulked. Clear or wood colored caulk can be used if desired.

5) The pulley openings of virtually all the older windows were leaky. Temporarily or permanently air seal them.

6) The rear door has weather stripping, but the door was leaky, primarily along the handle side. All of the older weather stripping can be replaced – or at least that section – and a sweep added at the bottom. Likewise with the weather stripping around the front door, a door which the owner mentioned as feeling drafty sometimes.

7) The main living room front window is leaky where the sashes meet at the center, along the sides where the chain enters the jamb at the top of the lower sash, and at the pulley openings. These areas should be air sealed to the degree possible. If the window isn't ever opened, caulking those areas will effectively and semi-permanently seal them.

8) There are several sections of flooring with gaps directly down into the basement that should be sealed, such as around the dual boiler pipes in the kitchen, in the powder room, and the hole to the left of the gas log stove, above the basement gas line.

The range hood was mentioned as a source of kitchen coolness in the winter, but the blower door didn't show it to be especially leaky and the side wall vent flapper operated properly, opening when the exhaust fan was on and closing otherwise.

***2nd Floor Recommendations:***

1) Have the side walls blown with dense packed cellulose insulation.

2) Air seal the pulley openings on windows having them.

3) The door to the (former) balcony was an owner concern, but it actually was fairly airtight, except at the lock. That section of weather stripping might be able to be adjusted to form a better air seal.

4) The office fireplace opening is covered by a piece of foam board. The fireplace can be made less leaky, however, by also air sealing the perforated metal bottom panel.

5) The side skirts of the window a/c are leaky and uninsulated. Recommended cutting foam board to size and friction fitting/ taping it into place over the skirts to address both problems.

6) The bathroom fixtures can be updated to the current low-flow standard to save a bit on gas used to heat water and the water and sewage bills.

***3rd Floor/ Attic Recommendations:***

1) The attic has no visible venting. As mentioned, this can cause excessive summer heat buildup, impacting the attic mounted air handler and duct work and increasing heat gain down into the 3rd floor. The slate roof makes it difficult to add vents without risking water leaks. Recommend adding one or two roof vents to the rear dormer's small asphalt roof. The dormer attic appears to be connected to the main attic and this is where the a/c air handler is located, so venting should help.

2) Air seal the pulley openings on windows having them.

3) The attic access panel is insulated but is moderately leaky. Install weather stripping around it to reduce leakage.

4) The storage room was quite leaky. Recommend air sealing the various ceiling penetrations (high velocity ducts and electric boxes) and also keeping the storage room closet door closed at all times.

***Blower Door Comments:***

In addition to helping find specific sites of air infiltration, mentioned in the sections above, the blower door provides a standardized measure of a building's overall "tightness" (or "leakiness").

This home measured a fairly leaky 8700 CFM 50. The Building Airflow Standard for this home (the CFM 50 reading below which a building shouldn't be tightened without adding mechanical ventilation for the sake of healthy indoor air quality) worked out to 2989 CFM 50. That means that the building can be made 66 % tighter -- a 5711CFM 50 reduction -- before bumping up against the standard. As a practical matter, all the recommended air sealing measures can be done without much likelihood of exceeding the standard.

***Resources:***

A lot of the recommended weatherization work can be done by reasonably handy homeowners. Certain tasks, though, (or all of them) may be beyond owners‟ capabilities or desire to do. Fortunately, there are local firms that can be hired do such work. Most will provide free estimates. We recommend getting multiple bids for any hired work, checking contractor insurance and references, etc. More can be found in the phone book or with an online search engine using "weatherization" or "insulation contractors" with "Pittsburgh," but these are a few firms to consider.

Company A, Inc.
1234 Street A
Pittsburgh, PA 15xxx
Phone: 412 xxx-xxxx

Email:

Company B, Inc.
1234 Street B
Pittsburgh, PA 15xxx
Phone: 412 xxx-xxxx
Website:

Company C, Inc.
1234 Street C
Pittsburgh, PA 15xxx
Phone: 412 xxx-xxxx
Website:

Company D, Inc.
1234 Street D
Pittsburgh, PA 15xxx
Phone: 412-xxx-xxxx
Website:
Email:

Company E, Inc.
1234 Street E
Pittsburgh, PA 15xxx
Phone: 412-xxx-xxxx
Website:
Email:

(For furnace or boiler repair/ replacement)
Company F, Inc.
1234 Street F
Pittsburgh, PA 15xxx
Phone: 412-xxx-xxxx
Web site: