Home Energy Opportunity Check List
Overview by Dan Gibson

A home energy audit is not a mystery; it is simply a systematic and scientific search for opportunities to save energy and money, while at the same time looking to make your home safer, more comfortable and more durable. You can easily perform some of the steps yourself, if you'd like. However, this is not a Do-it-Yourself course in home energy auditing. It is an outline of the key elements that should be included in a comprehensive home energy audit and a little insight into various aspects of the job, so if you are doing parts yourself or hiring someone else, you will know what is involved in a good job. If you want to learn more, there are many good books on home energy audits, Hudson Valley Community College offers specific training, and there will be more detailed articles on each of the steps at www.OEIC.us.

Note Well: If you don't fully understand what to do, aren't comfortable doing the work, or don't have the appropriate equipment (for safety's sake) for any of the tasks mentioned or described in this document, don't do it. Call an expert.

Since NYSERDA currently (Feb 2012) offers one free or low cost audit per NYS resident for their residential property, it makes sense to start with one of these. By understanding what is involved in a home energy audit you can be a more educated consumer and that is always a good thing. The first step in scheduling an audit should be to confirm exactly what will be covered, about how much time will be spent on you and your home, and what you will receive in writing, before you commit to a particular company.

When you have your results, then depending on your family's objectives & situation and the house's condition, exactly what makes sense to do varies. I'll explain some of those choices below. The key is to save energy and money by incorporating good building science practices and precautions in making your house safer, more comfortable, more durable and much more energy efficient. If you want a formal second opinion, I provide that as a service www.HomeEnergyAdvisors.com If you just have a quick question about your house or a question about this document, email me, I provide those answers for free to OEIC members in the Capital Region. Contact me at DanG@HomeEnergyAdvisors.com – be sure to put "Energy Question for Dan" in the topic, so I don't miss it amongst my ongoing struggle against spam.

Task Overview

1. Combustion Safety (Critical priority, due to health and safety concerns)

This is a critical priority because your health and safety are most important. Part of any home energy audit should include performing combustion safety tests. These test include at least: measuring CO levels throughout your house; inspecting your gas line and connections; performing combustion appliance tests; checking for CO detectors, and measuring CO emitted by other combustion appliances, such as gas stoves and heaters.

If you are planning to improve your house, you must test to be sure a dangerous situation does not exist before starting. After you finish the work, you need to perform the tests again to be sure you haven't created a dangerous situation. The reason for this is that when most houses were built a set of assumptions were given – primarily that the house would be leaky. As we tighten up the house, we begin to violate this assumption and the combustion equipment/processes may no longer operate safely. The house is a system and this is particularly true when it comes to combustion and air quality.

Once a year, it is strongly recommended that you have a complete set of combustion safety tests performed by a professional with the proper equipment to perform the tests. The NYSERDA home energy audit requires a full set of combustion safety tests to be performed with properly calibrated equipment. If it is not possible for you to get an audit or hire the tests separately, at least be sure you have fire, gas and CO detectors on each floor and they work, check that there is no smell of gas along your gas line, and check that combustion gases are venting up the chimney for water and space heaters.

All CO detectors are UL required to "alarm" (make noise) when the CO level in the air becomes elevated, the more elevated the sooner the alarm sounds. This is great, except that you can have what are considered harmful amounts of CO and the alarm will not sound. These alarms are to keep you from dying and minimize calls to the fire department and other authorities, thus most don't alarm until they reach 60 parts per million (ppm) for a period of typically four hours. ASHRAE states that more than 10 ppm is unhealthy, so get a digital detector/monitor and place is someplace where you pass at least daily and check it. The better units will accurately measure as little as 10 ppm, but all digital units will reliably show 30 or more ppm, and this is a lot better than not knowing or waiting until levels exceed 60 ppm. **Note:** If you have more than 10 ppm in your home you have a problem that needs to be fixed.

More than 10% of houses with natural gas or propane have a gas leak. Luckily most are small, but they can get bigger and are dangerous. The gas company inserts chemicals that you can smell to know if there is a leak or the stove is on but not lit.. 90% of the gas leaks I found in the last five years could be smelled – I could smell them and I don't have a very good sense of smell. If you don't have a good sense of smell, get someone who does to "sniff" along your gas line. My mother-in-law had four gas leaks; we always thought is was just the way her house smelled. If you smell gas, call your utility company immediately. They will test your line and advise you on next steps. Any leak on your side of the meter is your responsibility for the costs to fix.

Assuming no leaking gas in your basement, the next basic test is to check that water heater combustion gases are venting up the chimney.

If you have a naturally vented (there is not a fan to push the combustion gases out) water heater, this unit can be vulnerable to poor drafting. Close all your windows (winter-like conditions). Turn on all your appliances that blow air out of the house, such as bath fans, stove vents, and clothes dryer; these appliances compete with your combustion appliances to vent air/combustion gases from the house. Trigger your water heater to fire – raise the water temperature set-point or run some hot water. Wait 45 seconds and then use a smoking match to see which way air is moving by the flue opening (draft diverter) at the top of your water heater. If after 60 seconds the match smoke is being blown into the house, instead of being sucked up the chimney your water heater is not venting properly – call an expert to inspect, diagnose (there are many possible causes of this condition) and correct. **Note:** Someday soon, naturally vented water heaters will be illegal because we will have new assumptions about our houses – that they are much tighter. Today, in some towns they must be installed with a spill switch that will automatically shut off the unit if combustion gases do not vent properly.

Perform the same test on your furnace or boiler, if it is naturally vented. Again, after it is operating for 60 seconds air should be drawn from your smoking match up the chimney, not blown back into the house. Call an expert if this is not the case to inspect and correct.

If you have any questions – email me!

Equipment needed to do a professional job: Gas Leak Detector, CO Meter, Manometer

2. **House Tightness / Air Sealing** (High Priority due to required sequence and possible damage)

First, you can't guess your house tightness. I've seen new houses worst than those built 50 years ago. And I've seen old house perform surprisingly well. The only DIY test I've seen is when you close an outside door forcefully, if the water level in the toilet "bounces" you probably have a pretty tight house – the door pressurizes or depressurizes the house momentarily and this affects the water level over the trap. Still this is not precise or quantitative. Incidentally, if you failed the draft test, this is another indication that your house may be tighter than typical, as there may not have been enough make up air available for safe natural drafting.

I highly recommend that you get a blower door test done on your house. Blower door tests show how much air leaves or enters your house when it is pressurized or depressurized to the industry standard 50 Pascals. The result is reported as XXXX CFM50. TheCFM50 stands for cubic feet per minute at 50 Pascals. The XXXX is the number of cubic feet per minute and is pretty meaningless, unless you know the house volume. If you know or calculate the house volume, you can calculate your house's Building Airflow Standard, which allows you to communicate its tightness meaningfully and helps make decisions about what should be done relative to house leakiness or tightness.

Building Airflow Standard = House Volume in cubic feet x 0.35 / 60 x n; where n = 19 for single story house, 15.4 for a two story house, and 13.7 for a three story house. Stories are heated levels above grade.

Unless your toilet level bounces as described above, it is pretty safe to assume your house is typical and that you will need to do or have done significant air sealing to minimize conditioned air leaving your home, costing energy and dollars, and to prevent significant warm moist air from moving to the attic and condensing, potentially causing rot and mold. NYSERDA home energy audits require a blower door test be performed by the auditor with calibrated equipment. Thus, this is one of the most important details to get from a home energy audit – be sure you confirm that you will receive your house CFM50 measurement and the volume the auditor used to evaluate it tightness.

The top priority for air sealing is not around the windows and doors. The top priority is the attic flat, followed by the rim joist area (I'll cover later). In a typical one or two story house, this is the ceiling below the attic or the floor of the attic. Special tests can be performed to see how connected the attic and the house are – they should not be connected at all, if possible. In other houses, such as capes, the "attic/house" connection can be more complicated, but still the same principle applies – prevent warm moist air from migrating from the conditioned space into the unconditioned space beneath the roof deck.

Air sealing is the practice and art of preventing air from moving out of the conditioned space, in this case into the attic, but also into walls or outside in other areas of the house. Start with the large openings – soffit openings, wire and plumbing chases, chimney (use approved materials here), wire and pipe holes (typically two or three times bigger than needed), and work to smaller cracks between framing and drywall. Any crack that is less than ¼" should be caulked; larger cracks can be foamed; gaps need to be closed with durable air proof material. This job can be done by anyone, but it requires a patience and attention to detail.

Equipment needed to do a professional job: Blower Door, Manometer and IR Camera

3. **Attic Insulation** (High priority because this is often the most cost effective big opportunity)

After your house is properly air sealed, the next best return is often in upgrading attic insulation. World class attic insulation levels are roughly R-60 in the attic/roof. In our area, we should have at least R-50 wherever we can "conveniently install it. R-60 is about 18" of properly installed cellulose or fiberglass; R-50 is about 14". So, if your attic has less, it is an opportunity to save energy.

But first, you must consider the venting aspects of your roof assembly. If you house is a typical house built in the last 50 years, it probably has a "vented roof assembly" – regular or continuous soffit vents, a ridge vent and/or gable vents. These are installed to minimize moisture that does escape into the attic space from condensing on the roof deck. (the inside plywood or board surface, where the shingles are nailed to the outside). Check the roof deck to see if there is significant mold or rot (incidental spots here and there are typical and usually not a problem). Check the nail points to see if they are rusting or have water droplets on them. Check the whole roof deck. If you don't see problems here, your roof assembly is probably vented sufficiently – you don't want to lessen the ventilation. If you do see problems, call a professional auditor to determine the cause and recommend solutions before you add insulation.

Earlier roofs were often built without venting – no soffit vents or ridge vent were installed; however, often there are gable vents. These houses were built with different assumptions – that the whole house was leaky and certainly little moisture would find it way up to the attic. And, if it did, the roof was probably slate and a lot of air moved through it to dry any encroaching moisture. Plus, back in the day, all the roofs were built with solid wood, which was less prone to mold or rot in the first place.

Before you add insulation you must be sure: 1) your house/attic interface is adequately air sealed; and 2) your roof is adequately vented. If so, proceed.

If not, then perhaps spray-in-place foam may be an appropriate solution. Over the last few years, spray-in-place foam has become increasingly price competitive with fiberglass and cellulose (fiberglass does not work to its rating on an open attic floor because air can move easily around it, IF it is not installed Perfectly). There are two reasons for foam being competitive with fiberglass and cellulose in attic installations: first we understand better all the "accessories" that are needed with fiberglass and cellulose, such as: soffit vents; proper vents; baffles; ridge, ridge and/or gable vents; air sealing the attic flat, including any recessed lights or other penetrations; air sealing and insulating any access hatches, doors or stairs. All of this is time consuming and sometimes nearly impossible to do well. One of the major advantages of spray-in-place foam is that most of the accessorizing is unnecessary because you are now building an "insulated roof assembly" and the foam is at least an air barrier. As a matter of fact, one of the big advantages of the spray-in-place foam is that it air seals the top of the house. **Note:** If you think spray-in-place foam is the right solution for you, this must be done by a professional. The cost of small two-part foam to be shipped with throw-away hoses and spay-gun costs more than it will cost to have a contractor come, apply more foam than you would have, and do the work and clean up. The second reason foam is more competitive is because there are more foam companies and contractors, thus learning curve and economies of scale are pushing the price down too.

Don't add fiberglass to the attic flat. Add cellulose because it can fill in the gaps between fiberglass and rafters to prevent air from wafting around the fiberglass and undermining its effectiveness. Plus, you can then cap on top of the existing fiberglass continuously to add R-value.

Also, generally attics should not be used for storage in our climate. We really need about 14" of insulation on the flat and that makes installing a storage deck difficult but not impossible. If you really want/need storage in the attic or if you have AC installed in the attic, consider insulating the roof deck with foam. This will be a much better job in providing air sealing and insulation and in providing the storage space or climate for running the AC unit.

If you are going use cellulose (usually the most cost effective and quite suitable), it is important to maintain or improve the roof ventilation system. And it is important to be sure the air from the soffit vents do not "wash" through the insulation by installing baffles at the edge of the soffit. And it is important to prevent the insulation (especially cellulose) from falling into the soffits by installing proper vents. Plus, as mentioned above, it is important to fully insulate and air seal the attic hatch or door. This is often best done with two layers of 2" rigid foam board. Then after installing the insulation, you should air seal the hatch and you are done.

4. Wall Insulation

Infrared Cameras are very helpful and no professional audit should be done without one, but they are not the gold standard for determining what is in a wall – a ½" hole drilled in an inconspicuous spot is the best way to be sure. A camera is nice because if you see all the walls are the same, then just one or two drilled holes will pretty much confirm what the opportunity is.

You never know what you will find in a wall. Some older houses have bricks. The theory was that the bricks were thermal mass and would keep the house cool in the summer. I'm not sure what the theory was for the winter. You may find a single inch of fiberglass or radiant barriers. If you are lucky you will find it stuffed with fiberglass or cellulose or you will find it empty. It is difficult or impossible to add cellulose to partially filled cavities. If you do need to add cellulose, this is a job for professionals; it takes special tools and experience to dense pack the walls without drilling through wires, popping the drywall, or filling closets and cupboards with cellulose.

Another note about walls. Generally they are limited to the original design – 3.5 or 5.5 inches. However, if you need new siding and windows, this is a perfect time to do something extraordinary – add 2" of polyisocyanurate to the outside of your exterior walls, and fill the cavities if needed. This improvement will bring your walls up to Energy Star standards today. The difficulty will be in the reworking the trim, but it can be done and your house will be much better for the effort.

Equipment needed to do a professional job: IR camera

5. Rim Joist

Inspect the rim joist area. If this is empty and hasn't been air sealed, you have a fairly easy and large opportunity for improvement.

There are three ways to perform this job (Good, Better, Best): 1) air seal with caulk and foam, then stuff fiberglass in plastic bags and insert in each cavity; 2) cut 2" polyisocyanurate (special foil faced rigid foam) ¾" shorter than the cavity's height and width, place two beads of foam on the bottom section, then stand the foam up against the outside surface and foam the other three sides; 3) have the cavities filled with spray-in-place foam. This task can be done for about the same or a little less by buying the foam for an outfit like www.Tigerfoam.com You will need at least 600 BF.

6. Basement Walls

If your basement or crawl space has heating equipment and uninsulated ducts or pipes, there is a lot of heat moving through the space. You don't realize it because much of it is out the walls as quickly as it comes off the equipment, via radiation. Concrete sucks up heat like a sponge, it has an R-value of about 1 per foot, block (because of the cores) is about R-2 per foot – while structurally sound, thermally it is like having a single pane of glass around your entire basement. Many ask if it is a good idea to insulate the basement ceiling and the pipes/ducts. The thinking is that it is a smaller area and perhaps easier to DIY. But it is not a good idea. It is better to insulate the walls, at least the top four feet or at least two feet below grade. Generally, I like doing four feet because if the wall is smooth, you can use 2" thick foil-faced polyisocyanurate 4'x8' sheets and have little waste. Attach with tap-con screws or concrete nails (glue takes too long to set up, but if you are not in a hurry it can be the easiest). Be sure to caulk the bottom seam; if any water gets behind it, it will find a way out, so don't worry about that. Perhaps the best job to improve your basement is to install the wall foam first and then spray-in-place foam in the rim joist area to insulate and air seal and connect directly to the wall foam.

If the wall is not smooth, i.e. an old rock foundation, spray-in-place foam is an excellent choice. If you use spray foam, it has an economizing advantage of being able to spray 3" at the top and taper it down to 1" at the bottom of the four feet. This gives you more insulation where it is colder – concrete exposed to the outside. Also, you can install five feet down, if that makes sense, with no waste of material.

By the way, you can safely tighten up and insulate the basement even if you haven't finished air sealing the attic flat. However, in all situations you need to be sure you do not increase the migration of dampness from the basement up through the house. Dirt floors are of particular concern, especially if often wet. If you have a water problem, eliminate incoming water as close to the source as possible but use whatever means are necessary to prevent it from migrating upward – including dehumidification. We will talk more about this in the future.

7. Distribution System

If you have ducts they probably leak. A great weekend project is to buy a bucket of duct mastic a little nylon screen and spend a couple afternoons inspecting and sealing all your ducts. Use a flashlight and mirror to inspect on the top sides – I've found some wide open, i.e. no top panel installed. Don't use duct tape – you know the stuff that has 1001 uses; it is great for many things but sealing ducts is not one of them. It dries, leaks and falls off.

If your ducts/pipes are not insulated, you are heating your basement. As noted above, you may not notice it, but a lot of heat is passing out of the house. If you do not appreciate heat in the basement (no laundry, no clothes drying, exercise area, playroom or shop) then you may want to minimize the heat entering this space. By insulating the pipes or ducts you can save a good bit of energy. Still it is better to insulate the walls and rim joist first, as this will raise the temperature of the space, is generally better for the equipment and any stored items and the house – comfort (floors are warmer) and durability (things stay dryer).

8. Heating System

If you have a new system that has PVC pipe for air coming in and combustion gases going out, you have a high efficiency unit (Annual Fuel Utilization Efficiency or AFUE of 90+%) and while it may not be the best available today, it won't make economic sense to update it until it needs to be replaced.

If you have a standing pilot light on your gas boiler or furnace, it probably has an AFUE of 70% or less. These units should be replaced as soon as you can afford to do so. Don't wait until they need to be replaced; some old boilers can last for forty or more years!

If you have a fairly recent oil boiler (10-15 years old) with an automatic damper, it probably has an AFUE of 85%. It is not worth upgrading until necessary to replace because the best you can reasonably get is a 90% AFUE.

There are many boilers and furnaces in the middle range (75 – 90%). Often you can get a model number off your unit and find the spec sheet on the internet or by calling a distributor or your service provider to determine its efficiency. When you ask/look for the efficiency, you want the AFUE not the SSE (Steady State Efficiency). The AFUE is a measure of seasonal efficiency and takes into account jacket loses, cycling loses and heat up the flue. SSE is just the amount of heat taken out of the combustion gases before they exit via the flue. Whether or not you will want to replace one of these units should be based on the actual AFUE, its age, competing opportunities and your budget.

If you have oil or propane hot air, a very effective strategic move might be to switch to a geothermal heating system. While the investment is large, there is a 30% Federal Tax credit and the resulting cost to operate gives you the lowest cost of delivering BTUs to your house today, a little less than natural gas which had always been the cheapest. Compared to oil or propane today, geothermal tomorrow may be all the difference between being comfortable or being squeezed. One of our sponsors, Thermal Associates in Glens Falls has been installing geothermal systems for over thirty years – Give Marty DeVitt a call at 798-5500.

Equipment needed to do a professional job: Combustion Analyzer

9. Water Heating

Water heating today is primarily accomplished in our region with gas and electric tank type water heaters. While the electric water heater is typical 90+% efficient in the home, electricity is manufactured by power plants that are just 33 to 42% efficient and electricity is the most expensive fuel to heat with. Natural gas water heaters are typically less than 60% efficient. There are also so propane and oil tank type heaters; they too are in the 60% efficiency range.

Naturally vented, tank-type natural gas, propane and oil heaters have the concern about venting properly, especially as a house is tightened, see 1. Combustion safety above.

There are several options: solar hot water, tankless electric or gas, and heat pump water heaters. The best option for your family depends on a number of issues, including primarily your access to natural gas and the amount of hot water your family "needs." If you don't have access to natural gas and have a typical family of 4 or more then solar should be considered. If you have access to natural gas then a tankless water heater will probably prove most cost effective, especially if there are 3 or less in the household. Still water heating is a difficult subject because very few know how much hot water they use or how much energy goes into it. See our Renewable Energy blog category for several articles on solar hot water.

Electric heat pump hot water may make sense, especially in homes where heat is not appreciated in the basement – they essentially take heat out of the basement air and put it into the hot water at about half the cost of using electric to heat directly.

Insulating hot water pipes helps save energy by getting hotter water to the point of use and allowing the water heater to be turned down a few degrees.

10. Windows & Doors

There are a lot of reasons to replace windows and doors, but to save energy cost effectively is usually not one of them. The main reason for this is that windows and doors are relatively expensive, they cover a relatively small area and the thermal improvement is modest.

If you have single pane windows in wood sashes that are leaky, new windows probably make economic sense as a long-term energy efficiency measure.

If your windows are deteriorating, the main reason to replace them is because your exterior walls are at risk of water damage and that will cost a whole lot more to repair than good, energy efficient windows cost.

Comfort and energy efficiency are not always related. Windows that suck heat off your body due to their cold surface and radiation should be considered for replacement. A window at your back when eating, or the kitchen window you stand in front of are good candidates. Also consider covering a window with an insulated shade.

When you do replace your windows, invest in the best windows you budget permits. Consider U-value (thermal efficiency), SHGC (solar heat gain coefficient), the frame's structural strength and durability, and the contractor's reputation, in addition to its installed price.

In our climate, all new windows should have a U-value of .32 or less. This is very close to Energy Star standards today. The reason for this U-value is that windows at this level will produce very little condensation with our typical winter temperatures and appropriate levels of indoor humidity (40-50%).

Bathroom windows should be even better and fiberglass or vinyl make sense in the bathroom, if not anywhere else due to their durability in wet environments.

Windows with higher SHGC allow more heat to enter the house. Higher values are especially valuable on the south side to reduce heating loads; but can add to cooling loads on the west side.

11. Lighting

While I am not an advocate for legislating what we can and can't buy, using incandescent light bulbs ought to be rationed, if not against the law (IMHO). 90% of the energy that goes into the bulb produces heat; only 10% produces light! On the other hand, there are applications where neither CFLs or LEDs are nearly as ascetically pleasing (and I have a pretty low ascetic priority). When I think about these types of reasons for incandescent bulbs I always seem to drift to: Do I want a little beauty or clean air?

CFLs use just 33% of the electricity for heat and LEDs use just 10%. As a matter of fact, LEDs are the first source of light that does not burn something to produce light – they emit.

If you are just starting, focus on your most used lights and replace them with CFLs or LEDs. LEDs are still pricey, but they last a very long time (definitely keep your receipts for the warranty). On the other hand, CFLs are becoming much less expensive.

Often people object to CFLs because they have mercury in them. Well they have a lot less than they used to, and the clinching factor for me was: The extra electricity produced to generate equivalent amounts of light in an incandescent vs. a CFL assures that more mercury will get into the air. With the recently passed EPA clean air act, this won't be true, but still it will take a while for the power plant modifications to occur AND we now can easily and safely recycle CFLs at Lowes and Home Depot and other places.

Another factor people often cite as reason for heating their house with incandescent bulbs in the summer is the quality of the light. CFLs are improving in this area too. Most bulbs today come in packages indicating the K or the Kalvin temperature rating of the light emitted. While there are no standards (xK = a midsummer day) at least we are getting an idea of that aspect. Plus, manufacturers are improving the phosphorus coatings to improve color. My recommendation is still to buy a bunch of quality bulbs and try them in the more used locations. If you need more light, use a higher watt CFL than the "equivalent" and save just 60% instead of 75% but have the light you want/need. Put bulbs that don't work out in high use areas in low use areas – basement, closets, etc.

A good first pass is to replace every light that is used 2 hours a day. Second pass, replace any light used every day no matter the duration. Consider LEDs for your highest use lights. Replacing your most used lights is typically the best investment in money to save energy, unfortunately, it is a limited opportunity.

12. Refrigerator

This can be the easiest decision or the hardest. Some people just can't imagine replacing an appliance that is still functioning – my Aunt is one. Still, the economics are very easy to get and the math is simple.

Buy a kill-a-watt meter (every house should have one). If you have just one, get a P4460, it retains its readings if the power is interrupted. There is nothing more annoying than to have a meter on a something for 28 days, looking for the monthly total, when the power blinks and you have to start all over again! The P4460 now cost less than $30. The P4400 is simpler to use and costs about $20.

Plug the kill-a-watt meter into the wall and plug the refrigerator into the meter. In 3 hours you will have a good rough estimate, but in a week you will have a great estimate. Still, a week in the summer and a week in the winter will be your best estimate, but you don't need to wait, especially if your extrapolated result is over 1000 kWh per year!

Here is how to extrapolate .55 kWh used during 3 hours and 45 minutes to an annual kWh amount: 1) Convert HH:MM to hours (minutes/60= decimal hours) and add the decimal (fractional part) to the whole hours. For example: if your meter was on 3:45, divide 45/60=.75 and add the .75 to the 3 hours + 3.75 hours. 2) Find out how many of those periods are in a full 24 hour day (24/metered hours). For example: 24/3.75 = 6.4 (6.4 x 3.75 = one 24 hour day). 3) Extrapolate kWh used in metered period to a full year (kWh consumed x periods in 1 day x 365 days/yr). For example: 0.55 kWh x 6.4 x 365 = 1284 kWh. This refrigerator should be replaced, whether it is still running or not!

I always meter a refrigerator for at least 3 hours, during an audit. Some programs accept a single hour measurement. But if you are doing it at home, I'd suggest that you read your meter after 3-5 hours and do the math just for fun, and then read it again after a week for a better estimate. Refrigerators have a lot of short intermittent cycles – compressor to cool, and heating elements to defrost, so a longer period averages all this out better. When you do the weekly calculation, the hours will be in just hours, no minutes and the period will be a less than 1, so for example after 6.5 days you might read 22.10 kWh and 156 hours. 1) all hours no minutes displayed, no need to convert to hours. 2) How many of those periods are in a full day. For example: 24/156 = .154 (use three decimal places). 3) Extrapolate. For example: 22.19 x .154 x 365 = 1242. This is a little less than your original estimate; it could be because the original estimate got just a little extra defrost cycle than average, you kept the door closed more than during the short test period, etc. The 1242 is probably the more accurate estimate, but both indicate to replace.

If your refrigerator uses less than 500 kWh/Yr then it is in the Energy Star class and replacing will save only a little if anything at all. If the annual use is between 500 and 1000 (after a week measurement) then replace it only if you don't have other, better places to save energy. For example: it may cost $1000 to save 350 kWh a year (800 estimated kWh – new estimate 450 kWh). By the way, you can typically add 10% to whatever the Energy Star label says if you have kids – they open the door a lot more than the Energy Star testing protocol! 350 kWh per year saves about $58. You can save a lot more than $58 if you have a lot of incandescent lights or need to do some air sealing, for a lot less than $1000.

This brings up the issue of energy modeling your home. It can be a valuable effort, if you are looking at a lot of options, some very costly options (foaming the roof deck, geothermal, etc.) or if you are very concerned about investing in only the best opportunities. Otherwise, rough estimates and common sense should suffice in picking worthy projects, especially if you are looking to do any of the work for more than "just" saving energy – environment, comfort, health and safety come to mind.

Equipment needed to do a professional job: kill-a-watt meter

13. Clothes Washer

Energy Star clothes washers save energy by: using less hot water, spinning faster so clothes need less drying, and with a more efficient motor.

If you wash 5 or more loads a week, often using hot or warm water, and dry with an electric clothes dryer, you should probably get a Energy Star front loading clothes washer. I believe you save more money by reducing your drying costs than you save reducing your hot water costs, but I don't have any data to prove it. But, as you use more cold and warm water, this becomes more obvious, and today's soap and today's lifestyles are in line with using more cold water. And most people machine dry all their clothes; some communities even have ordinances against outdoor clothes lines! Now here is a human rights issue!

If you use almost only cold water and line or rack dry, then the old washer is probably just fine. We have been using solely LSD (linear solar dehydrator) and drying racks (mostly during the winter) for over six years now. Yes, it is less convenient and you need to pick your battles, but we have managed (mostly my lovely wife has managed, and the kids are learning!). We use almost exclusively cold water. Only occasionally using hot for whites. An Energy Star clothes washer is not very high on our list, but when we replace our existing washer we will get one.

Energy Star clothes washer do more than save energy. They use a lot less water! They generally wash clothes better and they are more gentle on your clothes. The other big difference is the spin rate – some spin 1200 RPM, other spin at 1000 RPM, some spin slower, some may spin even faster. Definitely check into the spin rate of the model you are looking at. Faster spin means less water remaining when finished, which means less drying energy and faster drying time!

14. Solar Electricity

Every home energy audit should include an initial solar assessment. People really should start using the sun. And if you see your solar opportunity, you can at least start thinking about the sun! An initial assessment doesn't take long. Just a compass can be acceptable, but a Solar Path Finder is a far better tool for showing a little detail – solar window, seasonal solar angle, hours of sunshine, and maybe which trees are most offending. Solar applies to more or less windows (passive solar heat and day-lighting), to solar hot water, and mostly to solar electricity (PV).

Investing in solar electricity makes a lot of sense! Solar costs have come down and there are still solar incentives and tax breaks. Plus, energy costs are going up. In the last 30 years energy costs have risen nearly twice as fast as the general consumer price index, in spite of the fact that most of the goods and services we buy have some element of energy cost in them.

I'd advise you to insist that your home energy audit included a solar site assessment, but I know that most don't. This is a shame, but its the product of solar incentive programs and home performance programs being separate. Still you should think about using the sun. It is unlikely that there will ever be a charge for or tax on sunlight. It is very likely that energy costs will continue to increase, especially oil.

NYSERDA allows an electric car to be an appliance when calculating your annual load for solar incentives. An electric car gets a bit more than 3 miles per kWh. An "extra" 3,000 kWh would allow you to drive nearly 10,000 miles a year without oil. How cool would that be?

We have two articles extolling the economics of PV, please take a look under Renewable Energy for them and others that are sure to follow.

Equipment needed to do a professional job: Solar Pathfinder and Software to calculate monthly power

Summary

What I have covered is the basics for "typical" houses. Unfortunately many houses are not typical and the real benefit of an audit is to address the "special" issues of your home as it relates to your family's situation and future plans. One of the special issues that corps up more than I'd like to see is a house that has been built up over time and is very difficult to air seal sufficiently. Or any house that is difficult to air seal, for that matter. In these homes air sealing should take on a higher level of priority initially and air sealing should become an ongoing and underlying part of any house project. Caulking, foaming, blocking air passages should be done whenever there is an opportunity. Some houses lose as much heat through conditioned air leakage as through all the surfaces combined. Plus, leaking conditioned air is dangerous to the house because of the potential for mold and rot.

Another special situation is excess humidity. This is often caused by water in the basement. If this water is allowed to migrate upward it can cause problems. It is always better and usually cheaper to address water as close to the source as possible. If you have a water problem, don't ignore in; get it fixed.

Another often encountered special situation is how to deal with cathedral ceilings. They were often built with only minimal concern for energy conservation. There are options, but what is best depends…

Finally, home energy improvement is almost never a single project. Opportunities should constantly be sought, depending on improvements in processes, materials and knowledge. With energy becoming more critical and expensive, I suggest you perform your own home energy audit every two or three years and see what new opportunities present themselves. As your Home Heating Index goes down there will be less to do, but there will always be something to improve – efficiency, comfort, health & safety or durability.

Good luck in your efforts,

Dan