The Auditor's Handbook

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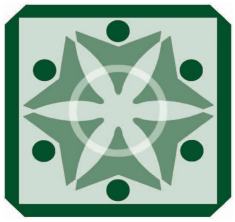

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Why Do Energy Audits?

There are two primary reasons why someone would do an energy audit. The first is Environmental Impact. The second is money.

Performing or getting an energy audit on a building is a great way to reduce the impact that your building has on the environment. It will give you a list of simple ways to reduce your water usage, paper usage, waste production, and carbon footprint. You can get rid of almost all of the needless waste of resources that comes from having an inefficient building.

The second reason to have an energy audit is that is helps reduce the amount you spend on resources. Using simple tricks, you can save as much as 25% on your yearly fuel bills, you can reduce your electricity by about half, and you can save money on trash by reducing waste, reusing, and recycling.

How to Use This Guide

This handbook gives you a basic understanding of what to look for when performing an energy audit. So you walk into a room that you want to audit, what do you do? This guide will tell you basic tests to do, as well as common problem areas and how to spot them. But it is incomplete on its own.

We have included a sheet for you to fill out as you are auditing, places where you can input notes and problems in each room. There is also a form for the head of the building to fill out, with basic information like the amount of money they have budgeted for energy improvements.

The data that you collect from your audit is designed to be input into the spreadsheet included. This will analyze the data and organize it into a series of graphs and reports. Certain pages of this report will be printed out, and combined with photocopies of the notes you took during the audit, and given to the head of the building.

Required Tools and Materials

Recommended

- ✔ The forms included, both those for you and those for the head of the building.
- ✔ A small compass (the kind that finds north, not the kind that draws circles)
- ✔ A bottle of normal food coloring
- ✔ A normal one dollar bill
- ✔ A pencil and paper (and possibly clipboard)
- ✔ Appropriate outdoor clothing

Optional

- ◆ A Kill-A-Watt energy meter, costing about $20 to $30
- ◆ A roll of brightly colored masking tape or stickers
- ◆ A pair of latex gloves

Beginning the Energy Audit

The first step in performing an energy audit is to find a contact/liaison at the building that you want to audit. If you want to perform an energy audit at a school, you should probably get into touch with the principal; for a home you would want to contact the home owner.

Next you need to gather some basic information about the building that you are auditing. We suggest using the form provided along with this guide. This serves two purposes; it gives you some direction as well as providing a useful analysis of the building, such as the occupancy graph and the budget.

Audits are best performed on a cold day. This helps the auditor feel any drafts or problems with sealing.

Part I : Inside

The audit will begin on the inside of the building, later in Part II you will take a look at the outdoor and landscaping portion of the audit.

You will enter a room, and proceed with all the steps in Part I, in order, without leaving that room. If a step does not apply to a room it may be omitted. However, when you proceed to the next room, make sure to include any steps that apply, even if they were omitted in the last room.

Small closets or alcoves may be included in the examination of the main room, large or walk-in closets should be treated as their own room, and examined separately.

You may use any organizational system that you choose to make sure that you examine every room in a building; this is the system that we personally recommend. Start at the building's primary entrance. Examine the atrium, foyer, or hall which that entrance opens into. Then, starting at the door through which you entered the room, turn right and follow the wall until you enter a new room. Examine this next room. Starting where you left off, follow the wall until you enter a new room. Skip over elevators, staircases, and exterior doors. In this manner, following the wall and always turning right you will be able to systematically examine every room on the ground floor (there are some buildings – with a circular central hallway – where this process will not take you to every room, but for the majority of buildings you will encounter this system will work). Walk around the ground floor to make sure that you didn't miss any rooms, then proceed to the next level. After you have examined the building's highest level, proceed to to the basement or sub-ground levels and work your way down.

Step 1: Lighting

Look at the lights in a room.

- Are the bulbs fluorescent or incandescent? ***How to Tell:*** *Fluorescent bulbs are whiter, usually tube-shaped lights. They take a moment to light up after you flip the switch on and they emit a faint hum when lit. Incandescent bulbs are usually the traditional "light bulb" shape. They have a much yellower light, with a visible glowing filament in the middle.* Fluorescent bulbs use only a fraction of the electrical load that incandescent light bulbs do. Any incandescent bulb can be replaced with a fluorescent bulb having about 1/4 to 1/3 the wattage. Hence, a 60 Watt incandescent bulb can be replaced with a 15 to 20 Watt fluorescent bulb.
- Are lights on dimmer switches or motion detectors? ***How to Tell:*** *If the light switch a circular knob then it is a dimmer switch. Try playing with the light switch, if you are able to adjust the brightness of the light, it can be considered a dimmer switch. The easiest way to know if the light is on a motion detector is to ask someone.* If the lights are on dimmer switches, the level of artificial light can be adjusted to balance the level of natural light. This saves electricity. Lights that are on motion sensors will automatically shut off after a certain amount of time if they do not detect motion in the room. They will turn back on when they see someone come back into the room.
- Are they left on unnecessarily? ***How to Tell:*** *Lights are frequently left on. In some cases it is fine to leave lights on – for example in halls or common areas – but more often than not lights can be turned out in boiler rooms, basements, unused rooms, and even bathrooms.* As simple an act as turning out the lights when you leave a room can save a significant amount of energy over the course of a year. When you leave the building take time check that all the lights are turned out.

Step 2: Windows

Check the windows in a room, focusing on exterior windows. Include any windows or

windowpanes in doors.

- Do the windows have drapes blinds or shades? This category is pretty self explanatory. Shades can be closed to create another layer of still air between the window and the room, this increases the insulation capacity (R-value) of the window. Closing blinds is an easy way to minimize heat loss through a window. There are products that are manufactured to do this specifically, for example tracked shades or window blankets.
- Which direction do the windows face? ***How to Tell:*** *Stand looking directly out the window, hold your compass so that it lies flat in your hand. Check for any magnets (including computers and televisions) or large metal objects in the vicinity, as these may throw your reading off. The compass needle will point north. You need not take a degree bearing, just approximate the direction you are facing.* Windows that face south and south-west will probably get direct sunlight during the day. The blinds on these windows should be opened during the day to capture heat from the sunlight, also known as "passive solar gain". The blinds can still be shut at night to prevent heat loss.
- Are the windows panes well sealed? ***How to Tell:*** *Wear your latex gloves so that you don't get fingerprints on the windows. Place your hand firmly on each windowpane and try to move the pane, both horizontally and vertically. If the pane remains stationary then it is well sealed, if it rattles or moves then it should be re-caulked. Feel for any drafts or cold air coming in around the frame. Mark any loose panes with masking tape or stickers.* Windows are one of the most direct ways for warm air to escape the home, be making sure all windows are adequately sealed you prevent heat loss through convection.
- Are the windows insulated to their full potential? ***How to Tell:*** *Look to see if there is a storm window (another layer of glass on the outside). Feel the windowpanes; they should feel cool but not cold. Look for condensation* inside *the window, between the window panes. This means that the seal on the window has been lost.* The more layers of glass that are on the window, the more layers of dead airspace there are. These layers of dead airspace help insulate the window to prevent heat loss through conduction.

Step 3: Exterior Doors

Examine all of the exterior doors in a room.

- Are the doors sealed against convection? ***How to Tell:*** *Are the doors loose on their hinges? You should not be able to rattle exterior doors. Are there gaps around the door? Check the weatherstripping, especially under the door. It should make a tight seal with the floor so that no light can be seen under the door.* You would be amazed how many exterior doors are not properly weatherstripped. These doors allow cold air in through gaps large enough to see light through. Treat any windows in the door as normal windows.
- Are the doors insulated against conduction?***How to Tell:*** *Are there storm doors mounted? Feel the inside surface of the door. It should feel cool but not cold.* Storm doors and certain layers inside the door help prevent heat loss when the door is shut, if these things are absent then the door will feel cold.

Step 4: Walls

Examine the walls in a room, particularly the walls that border on the outside.

- How well are the walls insulated? ***How to Tell:*** *The easiest way is to ask someone, however, frequently the head of the building will not know. In this case feel the wall at about chest height spaced at intervals of about three feet. The wall should be a uniform temperature, cool but not cold.* If insulation is degrading or patchy then the walls will feel cold or not be a uniform temperature.
- How well are the walls sealed? ***How to Tell:*** *Feel for drafts in all of the following places: light switches, outlet covers, wall plates and mail slots, along baseboards, around wall and window mounted AC units, around the point where wires or pipes pass through the wall, around fireplace dampers, around attic and basement hatches.* Sealing in and

around these areas can cut down on heat loss through walls. You do not need to heat your walls, so hot air that seeps into the walls is hot air that is wasted.

Step 5: Water

Examine the water usage in a room.

- Look for aerators on sinks and showers. ***How to Tell:*** *They come in all different shapes and sizes, and can look just like a regular faucet or shower head. Run the water in the faucet. If the stream of water is clear and smooth then there is no aerator. If the stream of water has lots of little bubbles mixed in with it and is opaque then chances are there is an aerator. Shower heads should have fewer or smaller holes in them.* Aerators mix air in with the stream of water, so they increase the water pressure while decreasing the amount of water used.
- Look to see if sinks or shower heads drip. Self explanatory. Dripping faucets can waste gallons of water a week.
- Test the seal on toilets. ***How to Tell:*** *First look at the toilet to see if it has more than one flush option. Some toilets have option for different flushes that use different amounts of water. They should say this either on the toilet or on the flushing handle. Open the tank and put a few drops of food coloring in the tank. Wait ten to fifteen minutes and then look in the toilet bowl. If there is coloring in the toilet bowl then the seal on the toilet leaks.* When a toilet leaks, water from the tank is constantly trickling into the bowl. This is even worse than a dripping sink in terms of wasting water.

Step 6: Waste Disposal

Look for trash cans, recycle bins, and compost buckets in a room.

- Look for any recycling bins in the room. If you don't see any ask someone if there is a recycling program at the building. Check to see if there are reusable materials in the recycling. ***How to Tell:*** *Look for things in the recycling bin that can be used again. For*

example plastic bottles with tops can be used for water bottles, and paper with printing only on one side can be used for notes or unimportant documents.

- Look for any compost bins in the room. If you don't see any ask someone if there is a composting program at the building. Check to see if there non-composting materials in the compost. ***How to Tell:*** *Anything that is plastic or glass should not be composted. Some people try to avoid putting meat or citrus peels in their compost, but that is a matter of personal preference.*
- Look at any trash can in the room. Look for anything recyclable in the trash can *(cans, bottles, and paper)*. Look for anything compostable in the trash can *(food)*. Look for anything that might be reused in the trash can *(zip-lock bags, plastic bottles, etc.)*.

Step 7: Phantom Load

Look for any appliances that might create phantom load.

- Look for any appliances that might create phantom load. Check to see if these devices are plugged in. ***How to Tell:*** *Phantom load is electricity used by appliances whenever they are plugged in, even when they are not turned on. Any appliance that has a light or clock on it that remains lit up when the appliance is off, or any appliance that can be turned on with a remote, will create phantom load. Common examples of appliances that create phantom load are televisions, microwaves, VCRs, and CD players.* Any appliance creating phantom load should be plugged into an easily accessible power strip instead of directly into the wall. This way, when the appliance is not in use it can be switched off completely with the power strip.
- Look at any computers in the room. Are they on screen saver? ***How to Tell:*** *Any computers that have been sitting for a while will probably display a screen saver. If you have access to the desktop you can check in the personal preferences.* Screen savers are waste of energy because they are using memory to calculate the fancy screen saver effects, and they are using energy to display said effects. It is far more energy efficient to

just set the monitor to turn off after five or ten minutes.

Step 8: Appliances

Look for any appliances in the room

- For any appliance in the room ask the following questions: *"Is this appliance used regularly?"*, *"Are there other appliances nearby that could accommodate the load if this appliance were not here?"*, and *"So is this appliance really necessary?"*.
- Check the seal on all refrigerators in the room. ***How to Tell:*** *Close an ordinary dollar bill in the door of the refrigerator. Try to pull the dollar bill out without opening the door. If the dollar bill comes out easily then the refrigerator seal is too loose. If it is difficult to pull out the bill, then the refrigerator makes a good seal.*
- Look at any washing machines and dryers in the room. Ask the following questions about them: *"Do these appliances have an Energy Star sticker on them?"*, *"If the washing machine a front-loader (since these use less water than top-loading washing machines) ?"*, and *"Is the lint screen on the dryer cleaned regularly (since this saves energy) ?"*.
- Look for any printers or copiers that use paper. Ask yourself the following questions *"There evidence that this appliance is used for jobs that aren't really necessary (stacks of unused copies or printouts of long websites) ?"*, *"Is this appliance set up to use low priority paper (scrap paper, or paper with printing already on one side) ?"*, and *"Is this appliance set to use draft quality or low-toner printing as the default ?"*.

Step 9: Thermostats

Look at any thermostats in the room.

- Are the thermostats analog or digital? ***How to Tell:*** *Analog thermostats are round, you set the temperature by turning the thermostat. The temperature is indicated by a needle*

pointing to various gradations. Digital thermostats are small plastic boxes mounted on the wall. Temperature is indicated with digital numbers (like on a digital watch). Digital thermostats are much more accurate, they waste less fuel and keep the temperature steadier.

- Are the thermostats programmable? *How to Tell: The best way to tell is to ask someone. Only digital thermostats are programmable. In general, if the thermostat has far more buttons than it would take just to set the temperature, it is probably programmable.* Programmable thermostats allow you to set the temperate according to a schedule. For example the thermostat will automatically turn down the temperature when you go to bed, or when you leave for work. This saves energy without the inconvenience of turning the heat down by hand.
- What are the thermostats set to? Thermostats should be set no higher than 55º at night or when there is no one in the building; 50º is preferable (unless there is significant danger of pipes freezing). When the building is actively occupied the temperature should be no higher than 70º, preferably lower.

Step 10: Heat Distribution

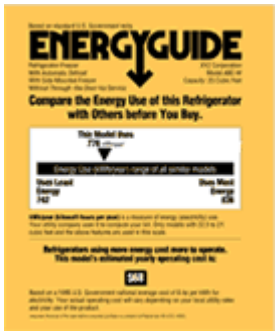
Look at any vents, grates, registers, or baseboard radiators in the room.

- Are these vents and registers clean and free of dust? Dust builds up in vents and registers and particularly in baseboard radiators. This dust clogs the registers and prevents heat from dissipating into the room. Simply vacuuming the dust from these areas can increase your furnace's efficiency.
- Are vents and registers covered or blocked? Covered or blocked vents obstruct the flow of warm air into the room, but the heating system still tries to force air through the duct, using more energy. Uncovering vents is a simple way to boost the efficiency of your furnace.

Step 11: Heating Units

Look at any fans, space heaters, furnaces and boilers in the room.

- Look for ceiling fans in the room. In rooms, especially those with tall ceilings, warm air collects near the ceiling. The room is heated from the ceiling downward, and there is usually a large temperature difference between the floor and the ceiling. Fans mix the various layers of air, making the room feel warmer without burning more fuel.
- Look for space heaters in the room. Space heaters are made for convenience, not energy efficiency. All space heaters, but particularly the electric ones, are inefficient. It is generally much better to use the building's internal heating system, rather than using a space heater.
- Look to see whether the buildings heating system is electric. ***How to Tell:*** *Baseboard radiators are heated either electrically or with hot water. If you see baseboard radiators, ask someone which they are. The heating system will probably not be electric unless it was installed before 1965.* Electric heating systems are hugely inefficient. It is much better to have a furnace. It is best to have your furnace run on natural gas, but even fuel oil is preferable to electric.
- Look at any furnaces or boilers in the room. Note down the fuel type of the furnace or boiler. Look on the side of the furnace/boiler for a yellow "Energy Guide" sticker. The sticker should show a range on the AFUE (Annual Fuel Utilization Efficiency) rating scale, with an arrow marking the AFUE of the specific furnace/boiler. Note the AFUE of the furnace/boiler. If you cannot find the AFUE, take note of the furnace/boiler make and model and look this information up at a later time. The sticker should look like the one to the right:



The AFUE percentage is the percentage of fuel that is converted to heat. For example if a furnace has 85% AFUE, then for ever $100 spent on fuel, $15 goes right up the chimney without heating the house. With AFUE, higher is better.

Step 12: Room Design

Look at various elements about the design of the room, walls, floors and ceiling.

- Look at the walls. Are they painted with pale colors? Paler colors on the walls reflect the light more than darker colors. This makes the room brighter with less artificial light.
- Look at the floors. Are there area rugs or bare floors? Most of the time floors should be covered with carpeting or area rugs. Possible exceptions to this rule are when the room is heated with radiant heating (pipes of hot water embedded in the floor), or when the room has large south-facing windows. Feel the floor to see if it feels cold.

Part II: Outside

The second phase, the outside phase of the audit, is relatively simple. There are two major components: insulation testing, and the AC unit. Since we recommend that the audit take place on a cold day, the auditor should bring warm clothing.

Part II is not broken up into steps. We recommend that you start at the main entrance, working your way around the perimeter of the building. Check for insulation as you go. If you come to the exterior portion of an AC unit, examine that, then proceed around the perimeter of the building, checking insulation.

To check insulation feel for warm drafts from the inside of the building in all of the following places: at corners of the building, under eaves (where you can reach), joints between buildings, and where the siding meets exposed portions of the foundation. Note down any places where you can feel warm air, possibly marking them with masking tape as well. *NOTE: Certain appliances like AC units and clothes dryers intentionally vent warm air outside. This is expected. If the warm air is coming out of a vent ignore it. You may want to advise the building to install a heat exchanger there, but it is not an insulation problem.*

To examine the exterior portion of an AC unit, look to see whether it is dirty. A little dirt is fine, but if there is a lot of dirt on the outside, it is likely there is a lot of dirt inside too, reducing performance and wasting energy. Recommend that the building wash the exterior portion of their AC unit with a hose. Look to see if the AC unit will be in direct sunlight over the course of the day (does it have direct southern exposure with no shade from trees or other buildings?). Shading the AC unit will also dramatically increase it's efficiency.

Good luck auditing!

Energy Usage

The following table shows typical watt-hour loads for many household appliances. Use it to evaluate the energy usage of appliances, and as reference when writing your report.

Description	WATTS	Description	WATTS	Description	WATTS
Refrigeration		AC submersible pump (1/2 hp), 40' well depth	1000	Guitar amplifier: (avg. volume)	40
4-yr.-old 22 cu. ft. auto defrost (approximate run time 7-9 hours per day)	500	DC pump for house pressure system (typical use 1-2 hours per day)	60	(Jimi Hendrix volume)	8500
New 22 cu. ft. auto defrost (approximate run time 7-8 hours per day)	200	DC submersible pump (typical use 6 hour per day)	50	*General Household*	
12 cu. ft. Sun Frost refrigerator (approximate run time 6-9 hours per day)	58	*Shop*		Typical fluorescent light (60W equivalent)	15
4-yr.-old standard freezer (approximate run time 7-8 hour per day)	350	Worm drive 7 1/4" saw	1800	Incandescent light	As indicated on the bulb
Dishwasher: Cool dry	700	AC table saw, 10"	1800	Electric clock	4
Hot dry	1450	AC grinder, 1/2 hp	1080	Clock radio	5
Trash compactor	1500	Hand drill, 3/8"	400	Electric blanket	400
Can opener (electric)	100	Hand drill, 1/2"	600	Iron (electric)	1200
Microwave (.5 cu. ft.)	900	*Entertainment/Telephone*		Clothes washer (vertical axis)	900
Microwave (.8 to 1.5 cu. ft.)	1500	TV (27-inch color)	170	Clothes washer (horizontal axis)	250
Exhaust hood	144	TV (19-inch color)	80	Dryer (gas)	500
Coffeemaker	1200	TV (12-inch black & white)	16	Dryer (electric)	5750
Food processor	400	Video games (not incl. TV)	20	Vacuum cleaner, average	900
Toaster (2-slice)	1200	Satellite system 12-ft dish/VCR	30	Central vacuum	1500
Coffee grinder	100	Laser disk/CD player	30	Furnace fan: 1/4 hp	600
Blender	350	AC powered stereo (avg. volume)	55	1/3 hp	700
Food Dehydrator	600	AC stereo (home theater)	500	1/2 hp	875
Mixer	120	DC powered stereo (avg. volume)	15	Garage door opener: 1/4 hp	550
Range, small electric burner	1250	CB (receiving)	10	Alarm/security system	6
Range, large electric burner	2100	Cellular phone (on standby)	5	Air conditioner: 1 ton or 10,000 BTU/hr	1500
Water		Cordless phone (on standby)	5	*Office/Den*	
AC jet pump (1/3 hp), 300 gal per hour, 20' well depth, 30 psi	750	Electric piano	30	Computer	55

Description	**WATTS**	**Description**	**WATTS**	**Description**	**WATTS**
17" color monitor	100	Fax machine (plain paper)		*Hygiene*	
17" LCD "flat screen" monitor	45	standby	5	Hair dryer	1500
Laptop computer	25	printing	50	Waterpik	90
Ink jet printer	35	Electric typewriter	200	Whirlpool bath	750
Dot matrix printer	200	Adding machine	8	Hair curler	750
Laser printer	900	Pencil sharpener	60	Electric toothbrush (charging stand)	6