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ABSTRACT

An energy audit is an effective method to determine how much energy a home uses each year, whether the energy is being used efficiently, and where a home wastes energy. This fact sheet describes tools and techniques used for home energy audits, as well as how to perform a do-it-yourself audit. It discusses professionals who conduct home energy audits, how to carefully select a professional home auditor, and what to do when your home is being audited. Also included are detailed illustrations and a bibliography with 21 references. (YP)

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U.S. Department of Energy Information

Home Energy Audits

Conservation and Renewable Energy
Inquiry and Referral Service

Department of Energy
Silver Spring, MD

March, 1989

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U.S. DEPARTMENT OF ENERGY

Information

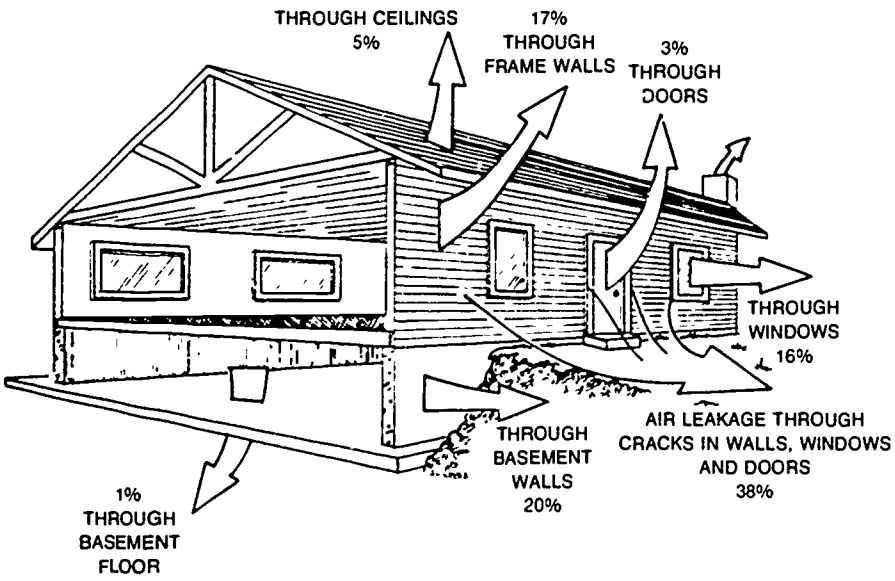
CONSERVATION AND RENEWABLE ENERGY INQUIRY AND REFERRAL SERVICE

Home Energy Audits

The main purpose of an energy audit is to determine whether your home wastes energy, and to pinpoint where energy is being lost. Audits also determine the efficiency of your home's heating and cooling systems, and ways to conserve hot water. Audits can be very detailed, using specific tools and techniques to pinpoint air leaks, or can be as simple as a do-it-yourself audit.

Tools and Techniques

Professional audits can be simple or complex. The most frequent type of audit is a walk-through. More complex audits often use tools such as blower doors, infrared cameras, digital surface thermometers, and smoke pencils to detect leaks in the building's envelope. A building pressurization test measures the leakiness of the building envelope, and a thermographic inspection reveals the often hard-to-detect areas of infiltration and areas where insulation is missing. However, these tests tend to be expensive so most homeowners do not invest in such detailed audits.



Air Leakage in a Home

Walk-Through

A walk-through is the most common method of conducting an energy audit. It involves a room-by-room examination of a residence, as well as a thorough examination of past heating and cooling bills. A walk-through takes note of the amount of insulation in attics, crawl spaces, unconditioned basements, and other visually accessible parts of the building envelope, type of building construction, types of windows and doors, the occupants' energy-use habits, and other factors that may affect energy consumption.

Thermographic Inspection

A thermographic inspection may be performed as part of an energy audit. Thermography measures surface temperatures using specially-designed infrared cameras with heat sensitive film. Images on the film record the temperature variations of the building's skin, ranging from deep red for warm regions to blue for cold regions. These pictures are termed thermograms. Thermography has many applications. Thermograms of electrical systems can detect abnormally hot or cold electrical connections, wires, or components. Infrared scans of mechanical systems can detect excessive friction. Energy auditors use thermography to detect thermal radiation, conduction, and air leakage in building envelopes.

Infrared scanning can be used to check the insulation in a building's walls. The resulting thermograms help auditors determine whether insulation is needed, or as quality control, to insure that insulation has been installed correctly. In addition to using thermography during an energy retrofit, a scan can be performed before purchasing a house, even new houses can have unexpected problems. Sometimes a

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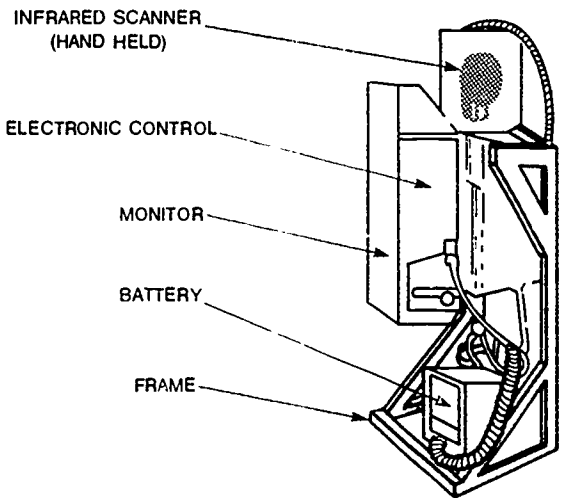
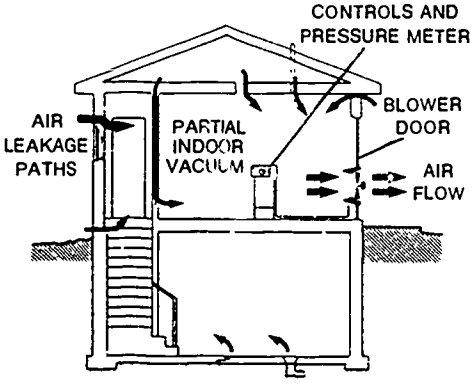


Infrared Scanner

clause requiring a scan of the house to document how well the house is insulated is included in the contract. Thermograms are valid documentation in legal proceedings, but only when the inspection is performed by a certified, trained technician.

Infrared scanning consists of either an interior or exterior survey. An exterior survey has a number of drawbacks. Warm air escaping from a building does not always move through the walls in a straight line. Heat loss detected in one area of the outside wall might originate at some other location on the inside of the wall. Air movement also affects the ability to determine temperature differences. The greater the wind speed, the harder it is to detect temperature differences on the outside surface of the building. Thus, interior surveys may be more effective due to reduced air movement.



Schematic of a Building Pressurization Test

Building Pressurization

Building pressurization tests may also be performed as part of an energy audit. These tests use a blower door to determine the susceptibility of a home to air infiltration. These tests can also be used during retrofits to help establish an appropriate level of airtightness within the building's envelope. Several reasons for establishing the proper building tightness are: to reduce energy consumption due to air leakage; to avoid moisture condensation problems; to avoid uncomfortable drafts caused by cold air leaking into the airspace; and to assess the need for mechanical ventilation.

A blower door is a powerful fan that mounts into the frame of a door leading outside. It is important that the blower door has access to the outside so it can evacuate air from the interior of the house. When the fan is turned on, it pulls air forcefully out of the house, creating a partial vacuum inside the house. The higher outside air pressure will then force outside air in through all unsealed cracks and openings. Blower doors are either calibrated or uncalibrated. The calibration device on the fan measures the amount of air flowing through the house and out through the fan. Uncalibrated blower doors can be used to help locate leaks in homes, but a calibrated door provides more specific information that can be used to evaluate the overall airtightness of the home.

Who Conducts An Energy Audit

You can conduct your own do-it-yourself audit, or you can have your local utility or company contracted by the utility, or a team of "house doctors" conduct the audit. Most firms perform simple audits which generally consist of a questionnaire to determine how energy is used in the home, and a walk-through to point out areas of energy loss.

Do-It-Yourself Audit

Much of the audit is easy enough for you to do yourself. When auditing your home, make a list of obvious leaks. Make a note of any broken windows and be sure to check basement windows for looseness or broken panes. Determine whether fireplace dampers, basement doors, attic doors, and garage doors close tightly. There are many potential sites for air to leak into or out of your home, including: windows and doors, gaps around pipe and wire feedthroughs, electrical outlets, foundation seals, mail slots, exhaust fans, attics, garage doors, siding cracks, and old caulking. Here are some simple steps for conducting an audit.

Room-By-Room

Check for indoor air leaks such as gaps along the baseboard or edge of the flooring, and at junctures of the walls and ceiling. See if air is flowing out through electrical outlets and switch plates. Note whether exterior walls are insulated. Compare the R-value of your home's insulation with the minimum R-value required for your region.

Inspect windows and doors for air leaks. See if you can rattle them, since movement means possible air leaks. If light shines around door and window frames, or if a piece of paper slides easily between the frame and door or sash, the door or window is leaky. These leaks can be sealed by caulking and weatherstripping. Note whether existing caulking and weatherstripping has been properly applied and is in good condition.

If you are having difficulty locating leaks, you may want to conduct your own building pressurization test. First, close and lock all doors, windows, and fireplace flues. Then turn on all ventilating fans (generally located in the kitchen and bathrooms). This will increase infiltration through cracks and leaks, making them easier to detect. Punk, incense sticks, or your damp hand work well for locating these leaks. Moving air will cause the smoke to waver, and a breeze will be easily felt as it cools your damp hand.

In the Attic

Note whether the attic insulation meets minimum R-value standards for your area. If the attic hatch is located above a heated or cooled area, see if it is properly insulated and weatherstripped Determine whether openings for items such as pipes, ductwork, and chimneys are properly sealed

During retrofit work, any gaps should be stuffed with insulation and caulked whenever possible However, never cover light fixtures with insulation Allow a 3-inch space around these fixtures to avoid fire hazards

Check to see if there is a vapor retarder under the attic insulation If there is no vapor retarder, during the retrofit you may want to consider painting the interior ceilings with vapor retarder paint to reduce the amount of humidity that passes through the ceiling Moisture can reduce the effectiveness of insulation If you have vents in your attic, be sure they can be closed tightly to prevent heat loss in winter, and that they are not blocked by insulation

In the Basement

If unheated basement areas are located under living spaces, determine whether there is insulation under the flooring Inspect the caulking and insulation between the basement and floor of living spaces Insulation where the top of the foundation meets the floor should have an R-value of 11 or greater If the basement is heated, the exterior walls should be insulated Check windows for broken panes, cracks, or loose frames Note whether all hot water pipes and ductwork are insulated

Outside

Inspect the caulking wherever two building materials meet Look for cracks in places such as the mortar, foundation, and siding. Other places to look for leaks include all exterior corners, the spaces between chimneys and siding or brick, areas where the foundation meets the bottom of exterior brick or siding, holes or service entries for faucets, pipes, electric outlets, and wiring Check exterior caulking around doors and windows, and see whether exterior doors seal tightly See if air is escaping around or through your wall or window-mounted air conditioner(s).

Heating/Cooling Equipment

Check to see if filters are clean They should be changed about once a month during periods of high usage Have a professional test the efficiency of your equipment

Residential and Commercial Conservation Program

Energy audits may be available to you from your local utility company through the Federal Residential and Commercial Conservation Program (RCCP) The RCCP requires that large gas and electric utilities perform energy audits of their customers' homes upon request and provide other related information to their customers States are allowed to adopt alternative residential conservation plans, and utilities can seek waivers from the RCCP requirements, so you will need to check with your local utility or state energy office to see if RCCP audits are available in your area The RCCP will end on June 30, 1989 Many utilities, however, will continue to offer similar programs

The cost of an RCCP audit ranges from no cost to a maximum of $15 Under the RCCP, home audits must include an inspection of windows, doors, caulking, weatherstripping, insulation of walls, attics, and floors, water heater insulation, ducts, heating pipes, and heating systems The auditors may or may not use a blower door or infrared camera The utility company is required to monitor the quality of any retrofit work done after the audit

If you are interested in receiving an audit from your local utility, there are several questions to research Does your local utility provide home energy audits? How much will it cost? Will the audit include testing the efficiency of your furnace? Will it include general conservation, or just conservation of the utility's fuels? If the utility does not conduct audits, you may want to call your state energy office to find out what other options are available to you

House Doctors

House doctors usually work in teams to audit a home using a blower door, infrared cameras, furnace efficiency meter, and sometimes a digital surface thermometer The advantage of house doctors is that they carry out some energy-conserving measures on site at the time of the audit, so your payback period begins immediately A house call consisting of a 4 to 8 hour audit and follow-up retrofit work costs around $300 to $500 The house doctor will perform tasks such as sealing hard-to-find leaks in walls and attics, installing insulating blankets around the hot water heater, adjusting the calibration on the thermostat or installing a dual-setback clock thermostat, putting flow restrictors on faucets, tuning the furnace, and recommending more extensive retrofit work if necessary The average savings in heating and cooling bills after a call ranges from 5 to 30 percent annually, and the home is generally more comfortable afterwards due to fewer drafts

Before making a visit, the house doctor usually analyzes the home's fuel bills, and asks questions about thermostat settings, number and types of appliances, number of occupants, and other pertinent information From this the doctor establishes what to look for during the audit The team examines the outside of the home to size the structure and catalog the important features (e.g. number and size of windows) They may take pictures and measurements of the house to have a record of the size and details of the structure The team notes the obvious energy problems, such as cold rooms, inadequate insulation, and leaky windows They conduct a room-by-room survey to determine how well the temperature is balanced and whether the thermostat is functioning properly

As with selecting any contractor, choosing a house doctor requires some effort and planning House doctors will probably be listed under "Energy Conservation" in the Yellow Pages Before contracting with a house doctor, there are several items you should verify

1 Ask for at least three references, and contact all three Ask the references if they were satisfied with the work

2 Call the local utility and ask for any insights on the company's reputation

3 Check with the Better Business Bureau for any records of complaints about the company

4 Make sure the company uses a calibrated blower door, since this is the only way to measure the effectiveness of the work done

5 Make sure that they conduct a thermographic inspection, or contract another company to conduct one

6 Don't let yourself be pushed into a contract Take your time and pick a firm with which you feel comfortable.

What To Do When Your Home is Being Audited

1. Make a list of any problems, questions, or upgrades that you might want to discuss with the auditor. Have copies or a summary of the year's energy bills for all fuels. (Your utility should have a set of your records.) Make a note of occupant behavior. Some questions to consider are: Is anyone home during working hours? What is the average thermostat setting for summer? For winter? Are there any conservation tips that he can offer? Does he have any advice on specific projects that you may be undertaking?
2. Walk through your home with the auditor as he measures spaces, checks the condition of caulking, weatherstripping, and insulation, and looks for areas of infiltration. Ask any questions you may have as you go along. The auditor may use a smoke pencil to demonstrate air leaks.
3. Ask what the findings show Does the auditor have any suggestions for improving the energy efficiency of your home, such as recaulking, adding storm windows, or putting in additional insulation? What would be the cost and payback periods of any improvements that he suggests? Does the company offer any financing or other incentives for more expensive retrofits?

Summary

Energy audits can be as simple as a do-it-yourself or a walk-through and examination of your annual energy bills, or as involved as a full audit using thermography and building pressurization. Energy audits are important in determining how much energy your home uses each year, and whether this energy is used effectively. Your state energy office or local utility company may be able to provide you with workbooks and instructions on conducting your own energy audit. They should also be able to provide you with a list of companies that can audit your home in more detail. Many utilities will provide the homeowner with an audit at a low cost

Implement any audit measures that you can afford and that appear to offer reasonable payback (i.e. less than 6 years). This will free up money that would otherwise be spent on energy bills. It will also ensure that the time, money, and effort that went into your audit were worthwhile. Many improvements can be adjusted to your preference or lifestyle, but any improvements will help lower your energy bills

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Source List

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161

CORRECTION

On page 3, column 1, paragraph 3, the last sentence "If you have vents in your attic, be sure they can be closed tightly to prevent heat loss in winter, and that they are not blocked by insulation" should read "If you have vents in your attic, be sure that they are not blocked by insulation."