

A Home Energy Audit

We spend most of our time in buildings -- homes, schools, offices, and stores. But most people hardly notice details about the buildings, such as how they are designed, how they are built, and how well they are maintained. These details have a strong effect on how much we enjoy a building and how much it costs.

An "energy-efficient" building is more comfortable than a wasteful building. It needs less fuel for heat and less electricity for cooling. A building that is badly designed and poorly kept up wastes money. Why? Because it is trying to heat and air-condition the outdoors as well as the indoors.

This activity turns you into an instant BUILDING INSPECTOR. Your assignment: Identify whatever helps or hurts energy conservation in a specific building. You can become a kind of detective looking for "bad guys" that waste energy and money.

Objectives

At the completion of this activity, you should be able to

- identify the major construction, maintenance and design features that make a building energy efficient;
- define and use each of the vocabulary terms discussed in this unit;
- explain energy saving steps to a homeowner.

Skills and Knowledge You Need

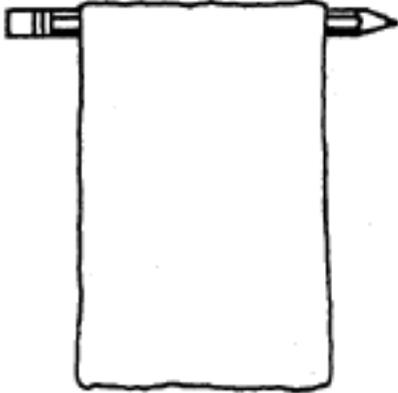
Ability to make observations and to record them

Materials

2 Vocabulary sheets: "Heat Bandits" and "Energy Savers"
2 Energy Audit Data Sheets: Interior and Exterior

Materials to make a draft detector as shown in the diagram: pencil, tape, and tissue paper or thin plastic

Procedure



1. Go over the two vocabulary sheets and discuss them with the rest of the class to be sure you understand each of them.
2. Make a draft detector to use during your energy audit.
3. Using the Interior and Exterior Data Sheets, complete the observations on your house, apartment, or a building suggested by the teacher. Use the draft detector to help locate air infiltrations.
4. Develop a set of recommendations for improving energy conservation in the house, apartment, or building that was studied. List alternative whenever possible, so that the owner has choices in making conservation improvements.
5. Compare observations with other students in order to improve your study. Revise your improvements sheet based on these discussions.

Questions

1. How many of the items on the Energy Savers list are inexpensive and easy to install?
2. Why are most building lots landscaped the way they are? Do good energy conservation principles generally seem to be used?
3. The locations of most windows in a dwelling are related to the need for light inside and the desire of those designing the home for balance and appeal. What effect would conservation practices have on window locations?
4. For what purposes is hot water really needed in a home? What are the reasons for many people using more hot water than they really need?
5. If a homeowner had only a limited amount of money, what energy savers do you think would help most for the least money?

Looking Back

You have just investigated some features which make a building an energy saver or an energy waster.

Most buildings have many places where heat escapes. Some of these can be easily patched or sealed at little cost. Other features will be more difficult and more expensive to alter. Investing in conservation saves money in the long run, though, and makes our houses, apartments, and workplaces more comfortable. Buildings of today and tomorrow will be constructed with much more energy awareness than there has been in the past.

Going Further

Take a list of recommendations you developed (Procedure, Step 4), and find out how much they would cost to implement. Take the necessary measurements, and check with a hardware or building supply center to get prices.

Take photos of good conservation practices and poor conservation practices related to a building that you have studied. Arrange the photos of poor practices next to diagrams that illustrate how they can be eliminated. Photos of good practices could be displayed with captions explaining why they are good.

In a single color, sketch the landscape around a building that you have observed. Using a contrasting color, sketch in plantings that may improve energy conservation by reducing air infiltration in the winter or providing shade in the summer.

Design a blueprint or model of a building which incorporates the energy conservation features you have identified.

Vocabulary Sheet Heat Bandits

radiation

passage of energy through open space, like sunlight. During the daytime a building absorbs solar radiation, but after the sun goes down, it starts to reradiate heat to the cold outside air unless something is done to block the radiation.

conduction

passage of heat through a material. Some materials, like glass and metal, conduct heat (and lose it) easily. Insulation helps to block conduction of heat. If ceilings and walls are poorly insulated, they conduct heat from the house to outside.

convection

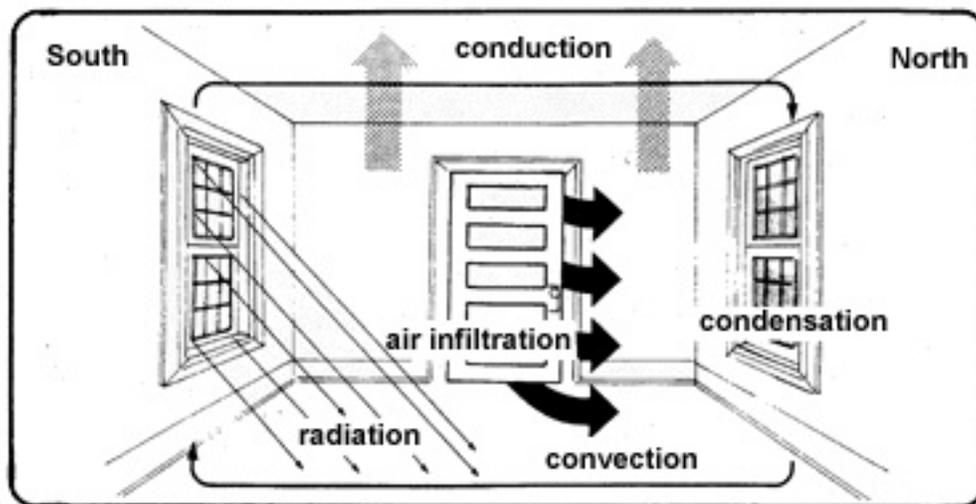
transfer of heat by movement of air. As heated air contact cold surfaces such as windows, it loses heat. The cooled air is denser than warm air, so it tends to settle, pushing warm air toward the ceiling. These temperature changes and air movements form a pattern. Warm, light air from the ceiling area is chilled along the window, becomes heavier and drops to the floor. It moves across the floor, is reheated, moves up the opposite wall, (away from the window), across the ceiling and down past the window again. Each cycle the air loses heat. Heat must be supplied from a sunny window, a furnace, stove, or other heater to maintain a comfortable temperature.

condensation

beads of moisture that form on surfaces as warm, moist air is cooled. Moisture condensing from room air (showers, breathing, cooking, etc. provide the moisture) shows up most on the cooled areas. Wet or frozen windows are reminders of wasted heat. The cures are double or even triple glazing of windows, heavy drapes, insulating shades, or sliding panels.

air infiltration

air seepage due to wind. Air pressure pushes cold air in through tiny openings on the windy side and draws heated air out of the opposite side of the house. Drafts occur through wallboard cracks, gaps around paneling (top, bottom, and sides), cutouts for pipes and wiring, poor seals for window sashes, badly weather-stripped doors, and loose molding at bottoms of walls.



Vocabulary Sheet

Energy Savers

insulation

material with high resistance (R-value) to heat flow. Some commonly used materials for home insulation are fiberglass, cellulose, rock wool, and styrofoam. The resistance to heat flow is provided by the many small dead air spaces between the fibers or particles. Insulation comes in a variety of forms: blankets, or batts, foam, boards, or small loose pieces.

R-value

the factor which tells how much resistance to heat flow a material has. The higher the R-value, the greater the insulating efficiency of the material. R-values are commonly stated per inch of building material. R-values are additive - thicker material or a combination of materials means increased resistance to heat flow.

Approximate R-value per inch of thickness for common insulation materials:

Material	"R" per inch thickness
Flexible	
Cellulose fiber with vapor barrier	3.20-4.00**
Glass fiber or mineral wool	3.00-3.40**
Loose Fill	
Glass fiber and mineral wool	2.80-3.40
Cellulose	3.50-3.70
Vermiculite, expanded	2.13
Rigid Board	
Polystyrene, extruded	5.26
Expanded urethane, preformed	5.80-6.25
Glass fiberboard	4.00
Polystyrene, molded beads	3.57
Foamed-in-Place	
Expanded urethane, sprayed	6.25

* Determined from ASHRAE Handbook, 1972

** Varies according to density and fiber diameter

R-value standards for an efficient house:

Ceiling: R-33; Exterior Wall: R-19; Floor: R-22;

vapor barrier

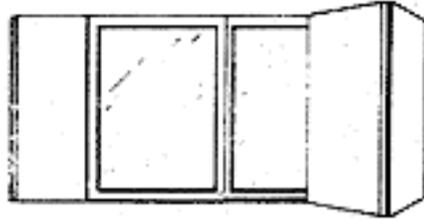
a waterproof liner used to prevent passage of moisture through the building structure. Vapor barriers in walls and ceilings should be located on the heated (indoor) surface of the building. Some insulations come with a vapor barrier attached.



Insulating Interior Shutter

window treatments

applications to the interior side of windows (blinds, shades, shutters, draperies), used to save energy by keeping heat in or out.



damper

a trapdoor or other device which controls the passage of air through a duct, chimney, or stovepipe.

flow restrictor

a device attached to a water nozzle or shower head to reduce the flow of water while maintaining the pressure of the spray. This saves energy by cutting down on the amount of hot water being used.

clock thermostat

a thermostat equipped with a timer to change temperature levels automatically at certain times of day. It helps to save energy by turning down the heat at night and during the hours when people are usually out of the house.

roof overhang

a solid horizontal or angled projection on the exterior of a building placed (ideally) so that it shades southern windows in summer only, when the sun is high in the sky. This saves on air-conditioning. (To determine the approximate size overhang needed, add the height of the window to the distance from the top of the window to the overhang, and divide by 2.)

windbreak

a dense row of trees, or a fence or other barrier that interrupts and changes the local path of the wind. Windbreaks located on the north and west sides of a building can save heat by reducing wind chill and air filtration.



air lock entry

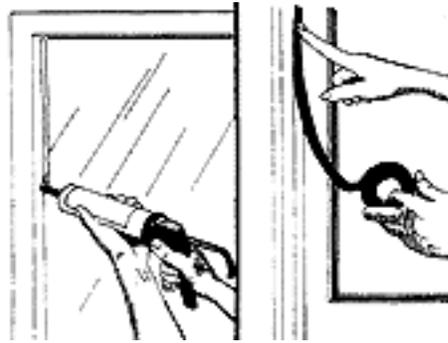
a porch, vestibule, or entry hall with an inner door and an outer door at the entrance of a house or building. The two doors save energy by cutting down on air exchange when people go in or out.

caulk

a soft, semi-solid material that can be squeezed into nonmovable joints and cracks of a building, thereby reducing the flow of air into and out of the building.

weather-stripping

material which reduces the rate of air infiltration around doors and windows. It is applied to the frames to form a seal with the moving parts when they are closed.



Teacher Information

A Home Energy Audit

Suggested Grade Level and Discipline

Grades 7-9
Science
Social Studies
Home Economics
Technology

Skill Objectives

Recognizing energy conservation design features in buildings
Using energy conservation vocabulary
Making and recording observations
Conducting a simple energy audit

Major Understandings

Many buildings are poorly designed from an energy standpoint

Heat loss takes several forms; conduction, convection, radiation, and air infiltration all contribute to heat loss.

There are many useful steps that can be taken to reduce building heat loss, increase comfort and save energy and money.

Background

For a nation with a small population (6% of the world's), the United States uses an enormous amount of energy, about a third of the energy produced each year on the planet. As Wilson Clark stated in his book *Energy for Survival: the Alternative to Extinction*, "it's as if every American citizen had 300 laborers working 24 hours a day for him alone."

Such a situation cannot continue to exist. There are many alternatives, but not all are very attractive. To give ourselves the best chance of maintaining a comfortable standard of living without monopolizing the world's resources, we must develop awareness and habits of conservation. That is what this activity seeks to develop.

The biggest energy consumers in the home are space and water heating. Conservation measures that affect those two factors can make a marked difference in the energy consumption and comfort level of buildings. The owner of an older home or building can save as much as 50% on heating bills by adding insulation and storm windows. Although there is an initial cost, most energy conservation improvements pay for themselves in five years or less. Add to that the energy conservation tax credits that begin to be available when energy supplies are scarce, and you begin to realize that heating a poorly insulated house is like burning money.

Advance Planning

Obtain class sets of brochures on home energy conservation from your local utility.

A supply of tissues, tissue paper, or thin plastic and tape should be made available for students making their draft meters.

Collect samples of insulation, caulk, and weather-stripping, and pictures of these items being installed. Many hardware and building supply stores have free "how-to" pamphlets and samples for prospective customers.

Ask a builder, energy manager, building superintendent, or other person familiar with building materials to talk with the class about the problems of energy conservation in buildings.

Suggested Time Allotment

One class period for discussion of vocabulary

One weekend homework assignment for collecting data

One class period for developing the sheet of recommendations

One class period for discussing and revising the sheet of recommendations

Suggested Approach

Be sure that students are familiar with the vocabulary used in the exercise. Demonstrate making and using the draft meter. Describe the techniques that students will use in making the necessary observations in their homes.

Consider using a set of photographs or a "home-like" classroom such as the home economics suite as a preliminary exercise to give students some initial experience.

If possible, have samples of insulation, caulk, and weather-stripping for students to become familiar with.

Where possible, allow students to make observations in pairs.

Precautions

It is advisable to notify parents of your students in advance if inspection of their homes is planned.

Students who are apartment dwellers should also be provided with a form letter to the landlord or building superintendent, explaining the project.

If a commercial building is to be studied, obtain permission well in advance of the observation.

Points for Discussion

Why were buildings built for so long without regard for energy conservation? Why are some buildings still being constructed that way?

Did our ancestors, in colonial times or in other countries, use energy conservation to make their homes more comfortable? Give example.

What "Energy Savers" are most important for summer cooling?

How could convection be used to help with summer cooling?

What useful energy conservation building features were not covered in this activity?

Describe the "Energy Efficient House of the Future." How would it be designed, oriented, landscaped, and managed?

Typical Results

Observations will vary depending on upon the design, age, and maintenance of the buildings under examination.

Students should be able to list several methods to conserve energy in homes, based upon their analyses.

Evaluation

Ask students to show you their completed Data Sheets before preparing the recommendations.

Collect and examine the recommendation sheets for appropriateness and feasibility.

Prepare a survey six months subsequent to the activity to identify any improvements made in home energy conservation by your students.

Modifications

While this activity focuses upon residential dwellings, slight modifications of procedures and checklists could make it appropriate for industrial, commercial, or agricultural buildings.

Have students do an energy audit of the school and share the recommendations with the administration or school board.

References

All Through the House: A Guide to Home Weatherization, Thomas Blandy and Denis Lamoureux.

(McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1980, \$6.95/paper.)

Energy Savers Catalog, Consumer Guide Editors.

(G.P. Putnam's Sons, 1050 Wall St. W., Lyndhurst, NJ 07071, 1977, \$6.95/paper.)

547 Easy Ways to Save Energy in Your Home, Roger Albright.

(Garden Way Publishing Co., Charlotte, VT 05445, 1978, \$5.95/paper.)

Home Energy for the Eighties, Ralph Wolfe and Peter Clegg.

(Garden Way Publishing Co., Charlotte, VT 05445, 1979, \$10.95/paper.)

The Home Energy Guide: How to Cut Your Utility Bills, John Rothchild and Frank Tenney, Jr.

(Ballantine Books, Inc. 400 Hahn Rd., Westminster, MD 21157, 1978, \$1.95/paper.)

Save Energy; Save Money!, Eugene Eccli and Sandra Eccli.
(Superintendent of Documents, U.S. Government Printing Office, Washington DC
20402, 1977.)

Window Design Strategies to Conserve Energy: NBS Building Science Series 104, S.
Robert Hastings and Richard W. Crenshaw.
(Superintendent of Documents, U.S. Government Printing Office, Washington,
DC 20402, 1977, \$3.75/paper.)

"Tips for Energy Savers."
(U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak
Ridge, TN 37830, 1978, free.)