A HOME ENERGY AUDIT

Adapted from the NY Energy Education Project

Overview: Provides students with information on energy efficiency in buildings and lets them conduct an energy audit.

Objectives:

Students will be able to…

- Recognize energy conservation design features in buildings
- Use energy conservation vocabulary
- Make and record observations
- Conduct a simple energy audit

Students will understand:

- 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.

Time:

- 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

Subjects: Science, Social Studies, Home Economics, Technology

Suggested Grade Level: Can be modified for grades 5 – 12

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

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.

A Home Energy Audit

PREPARATION & BACKGROUND

Background Information

For a nation with a small population (5% of the world's), the United States uses an enormous amount of energy – about a quarter of the energy produced each year on the planet.

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 energy resources, we must develop awareness and habits of conservation. This activity seeks to develop such habits and awareness.

The biggest energy consumer in the home is heating (space, water). 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 that 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. Information about home energy efficiency can also be found on the Alliance to Save Energy's website: http://www.ase.org/section/_audience/consumers/powersmart/.

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.

PROCEDURE

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.

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 examples.

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.

ASSESSMENTS

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.

RESOURCES

- The Alliance to Save Energy's website: www.ase.org
- The Department of Energy's Energy Efficiency & Renewable Energy website: http://www.eere.energy.gov/
- A home energy audit tool: http://www.homeenergysaver.lbl.gov/

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: Identity whatever helps or hurts energy conservation in a specific building. You can become a kind of detective looking for "culprits" 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; and
- Explain energy saving steps to a homeowner.

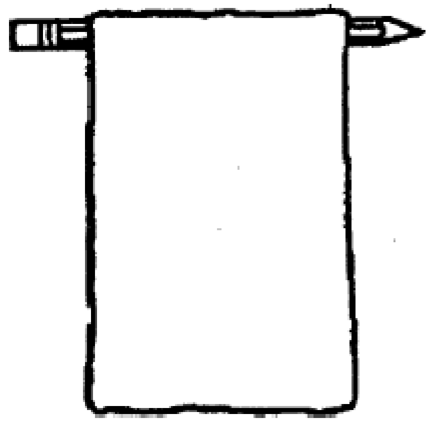
Skills and Knowledge You Need

- 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 alternatives whenever possible, so that the owner has choices in making conservation improvements.

5. Compare observations with other students in order to improve you 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.

EXTENSIONS

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 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

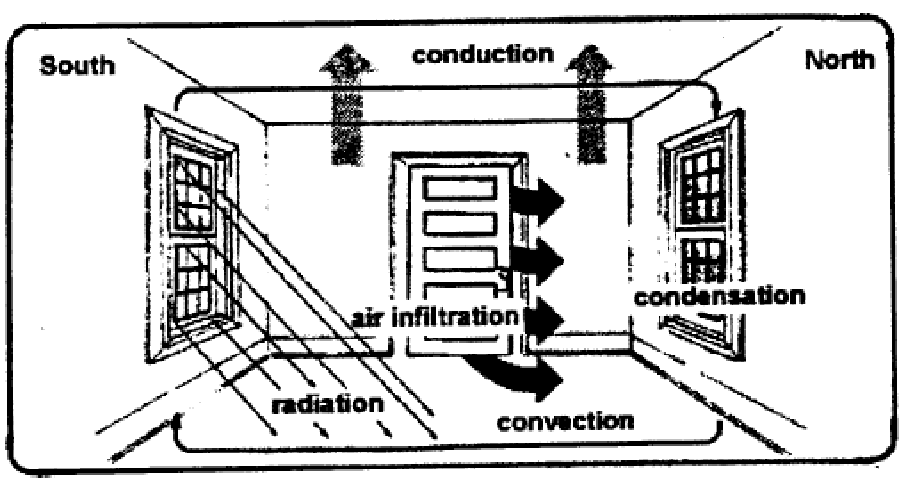
- **Radiation:** passage of energy through open space, like sunlight. During the daytime a building absorbs solar radiation, but after the sun goes down, it starts to reradiate heat to the cold outside air unless something is done to block the radiation.

- **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 comes in contact with 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. With 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 as variety of forms: blankets, or batts, foam, boards, or small loose pieces.

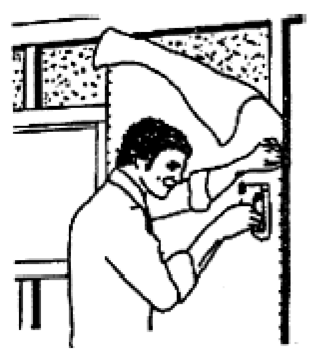
- **R-value:** the factor which tells how much resistance to heat flow a material has. The higher the R-value, the greater the insulating efficiency of the material. R-values are commonly stated per inch of building material. R-values are additive—thicker material or a combination of materials meaning 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	2.94-3.45*
Glass fiber or mineral wool	3.7-3.85**
Loose Fill	
Glass fiber and mineral wool	2.80-3.40
Cellulose	3.50-3.70
Vermiculite, expanded	2.13
Rigid Board	
Polystyrene, extruded	5.00
Expanded urethane, preformed	5.80-6.25
Glass fiberboard	4.00
Polystyrene, molded beads	3.85
Foamed-in Place	
Expanded urethane, sprayed	6.25

*Determined from ASHRAE Handbook, 2001
** Varies according to density and fiber diameter

R-value standards for a generic efficient house:
Ceiling: R-33; Exterior Wall: R-19, Floor: R-22
(note: appropriate insulation levels [R-values] are climate dependent, i.e. an efficient house in Boston would require more insulation [higher R-values] than an efficient house in San Diego)



- **<u>Vapor barrier</u>:** 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.

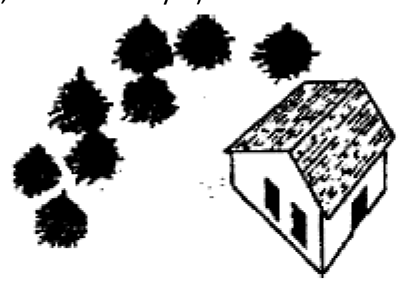
- **<u>Window treatments</u>:** Applications to the interior side of windows (blinds, shades, shutters, draperies), used to save energy by keeping heat in or out.

- **<u>Damper</u>:** a trapdoor or other device which controls the passage of air through a duct, chimney, or stovepipe.

- **<u>Flow restrictor</u>:** 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.

- **<u>Clock thermostat</u>:** a thermostat equipped with a timer to change temperature levels automatically at certain times of the 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.

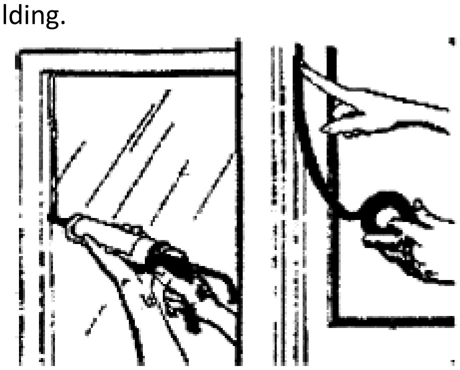
- **<u>Roof overhang</u>:** a solid horizontal or angled projection on the exterior of a building placed (ideally) so that it shades southern windows in summer only, when the sun is high in the sky. This saves on air-conditioning. (To determine the approximate size overhang needed, add the height of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



- **<u>Windbreak</u>:** 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.

- **<u>Air lock entry</u>:** 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.

- **<u>Caulk</u>:** a soft, semi-solid material that can be squeezed into non-movable joints and cracks of a building, thereby reducing the flow of air into and out of the building.



- **<u>Weather-stripping</u>:** 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.

Home Energy Audit Data

Name or location of building inspected: ___________________________________

Interior ===========================	**Yes**	**No**	**Does Not Apply (Or Comments)**
1. Are the ceilings insulated? (In apartments, ask the superintendent or building owner for details.)			
2. How thick is the insulation? (Check with ruler in attic or crawl space. Tell in inches—last column.)			
3. Is there a vapor barrier (plastic, aluminum, or heavy brown paper) on the indoor side of the insulation?			
4. If the building is on a slab or has an unheated basement, does the first floor have insulation under the floors?			
5. If the basement is heated, are the basement walls insulated?			
6. About how much of the floor is covered with rugs, padding, and carpeting? (per cent of fraction)			
7. Are heating and cooling equipment (ducts, grilles, radiators) block by furniture, rugs drapes, etc.?			
8. Are walls and ceilings light enough in color to reflect light well?			
9. Are these insulating drapes or other tight window treatments such as framed shades in place?			
10. If there is a fireplace, does it have a damper and glass doors?			
11. Is the damper closed when the fireplace is not in use?			
12. Are the glass doors kept closed during fireplace use to keep warm room air from escaping up the chimney?			
13. Does the draft detector move when placed along edges of doors and windows on calm and windy days?			
14. On windy days does the draft detector show air currents through electrical out? Is it placed on outside walls?			
15. Check other openings for drafts, and make a list of drafty openings. EXAMPLE: plumbing pipes entering walls, exhaust fans in kitchen or bathroom while OFF, chimney pipes exiting through walls or ceilings.			
16. Are hot water faucets free from drips?			

17. Have flow-restrictors been placed in pipes connected to showerheads?			
18. Is there a clock thermostat adjusted to “set back” (lower) temperatures automatically at bedtime?			
19. Check the cellar for exposed hot water or steam pipes. Are they all insulated?			
20. Check cellar or attic for ducts carrying heated air. Are they wrapped with insulation?			
21. Check baseboard-type radiators. Are openings or metal fins inside blocked or filled with dust			
22. Is the exhaust hose from the clothes dryer detached from its vent and run through a filter to keep warm, damp air inside the house?			
23. Has the furnace been cleaned and serviced in the last year?			

Home Energy Audit Data (continued)

Exterior ============================	Yes	No	Does Not Apply (Or Comments)
1. Are there fewer windows on the north side of the building?			
2. Are the north windows smaller than those on the other sides?			
3. Does the roof on the south side extend out from walls and windows?			
4. Will the roof overhang the lower winter sun to warm south walls and windows?			
5. Are there storm windows in place and tightly sealed? (If large amounts of moisture condense on the inside of windows and freeze on coldest days then storm windows are not working properly.)			
6. If there are no storm windows, are there temporary (plastic) barriers installed? (They should create an air space about ¾ of an inch thick between inner and outer glazings.)			
7. Are evergreen shrubs and trees planted as windbreaks around the north and west sides of the building?			
8. Are deciduous (leaf shedding) trees planted on the south side for summer shade and winter sun?			
9. Does snow melt more quickly on your roof than it does on similar houses nearby? (Indicates need for more ceiling insulation).			
10. Can you see spaces for air leaks between the house and its foundation, broken windows, rotted boards or other sources of cold air leaks into the cellar or crawl space? 11. Are cellar doors insulated and tight-sealing?			
12. Are attic vents open summer and winter? (Unless the attic is paneled and occupied, vents should be open. Ceiling insulation should keep your house warm, not a sealed attic. Vents from ceilings of rooms below into the attic should be open in summer, but closed and insulated in winter.)			
13. Are cracks and joints around windows, doors, stairways, pipes, and electrical wires caulked?			
14. Is there weather-stripping around the inner and other doors? Around the windows?			
15. Are cracks in walls and foundations sealed and holes plugged in?			
16. Is there an air lock entry hall, double door, or insulated storm door at each outside entrance?			