# Window Treatments for Energy Savings

If you've every stood by a window on a sunny day or a cold night, then you know that windows have a lot to do with how comfortable your home feels. Heat moves from warmer to colder areas. Heat will enter through a window on a warmer day but escape through a window on a cold night.

Heat gets around in three ways. One way is radiation. Sunlight is radiation, and most of it passes directly through glass, warming the objects on the other side. Conduction occurs when heat is transmitted through an object. Glass is a good conductor, and transmits heat from warm air that touches it. Convection happens when heat is moved by moving air. When cold air slips in (infiltrates) around the cracks in a window frame, it displaces the warmer air in the room.

All three of these methods of heat transfer affect the comfort of people in houses and buildings. In this activity you will investigate the patterns of heat in your classroom and learn how windows affect a room's comfort. You will find out how to treat windows from the inside to make them more effective in conserving the energy needed to heat or cool your home.

## Objectives

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

- determine the areas in a room which are warmest and coldest and explain why,
- determine the places where air infiltration occurs in a room and explain why,
- list the functions of windows,
- list the kinds of energy-saving window treatments and explain the need for them,
- research energy-saving window treatments in current books and magazines, and
- recommend energy-saving window treatments for various situations, listing their advantages and disadvantages.

## Skills and Knowledge You Need

Reading a thermometer
Recording and graphing data
Researching information in current books and magazines
Taking notes

## Materials

- lamp with uncovered light bulb
- six Celsius thermometers
- string and masking tape
- colored pencils
- a sheet of plastic, paper, or tissue (15 cm x 15 cm)

- a pencil
- a fan
- current books, pamphlets and magazines containing window treatment information
- index cards

## Procedure

### Part 1: Collecting Data

1. Turn on the lamp. Cup your hands near the bulb. Describe what you feel.

   If possible, stand next to a sunny window. Describe what you feel now.

   *Caution: Do not touch the bulb. It may be very hot.*

2. Suspend six thermometers around the classroom using masking tape and string. Three thermometers should be hung close to the ceiling and three close to the floor. Make sure at least one thermometer is in front of a window. Record the position of each thermometer in Data Table 1 on Worksheet A.

   For example, Thermometer 2's position might be "on the back wall, 1 meter above the floor." Also record the outside weather conditions; for example, a partly cloudy day with a temperature of 5 C.

3. Divide the class into six groups. Each group should select a thermometer to read. Every 5 minutes read the temperature of your group's thermometer. Record the thermometer readings of all the groups in Data Table 2.

4. Graph the temperature data from each thermometer on the graph provided (Worksheet B). Use a different colored pencil for each set of data. Write the color used for each thermometer on the key.

5. Take a sheet of paper, plastic, or tissue and tape one edge to a pencil. Hold your "infiltration meter" 15 cm in front of the fan. Then hold it 15 cm behind the fan. Observe the results.

6. Hold this "infiltration meter" in various positions around the edges of several closed windows, either in the classroom or at home. Observe what happens.

7. As a class, make a list of the functions of windows. List as many reasons as you can for why we have windows in our homes.

8. Define radiation, conduction, convection, and infiltration.

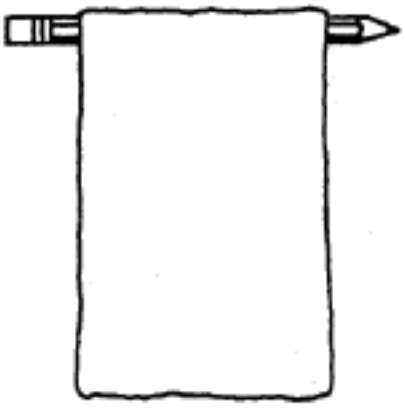


**Diagram 1**

**Part 2: Researching Window Coverings**

9. Discuss how and when heat is lost or gained through a window. Be sure to include in your discussion such factors as
    - solar radiation,
    - the direction of the window faces,
    - the time of day,
    - the season of year,
    - radiation, conduction and convection
    - ventilation,
    - infiltration, and
    - insulation

10. Do the Reading Activity provided on Worksheet C.

11. Research the kinds of window coverings which can be used to admit more sunlight when needed to help heat the house, to block sunlight when needed to help cool the house, and to reduce heat loss from windows at night or during cloudy periods. Use current books, pamphlets, and magazines. Use index cards to list and take notes on the kinds of window treatments available for solar energy and energy conservation.

12. Read the three case studies provided on Worksheet D.

13. Use your notes and the Reading Activity to recommend a window treatment for each case study situation. Explain why you chose each window treatment.

14. As a class, discuss the advantages and disadvantages of the window treatments recommended for each activity.

## Questions

1. What form of heat transfer (radiation, conduction, or convection) were you feeling when you placed your hands near the light bulb? When you stood next to the sunny window?

2. What happened when you held the "infiltration meter" in front of the fan? In back of the fan?

3. What happened when you held the "infiltration meter" at different positions around windows?

4. What caused the results you obtained when holding the "infiltration meter" around meters?

5. Describe the results you obtained from graphing room temperatures. Where was the room warmest? Coldest?

6. How did the temperatures in front of the window compare with those in other parts of the room? Why?

## Worksheet A
# Changes in Room Temperatures

### Data Table 1- Thermometer Positions

Outside Weather Conditions (°C) _____

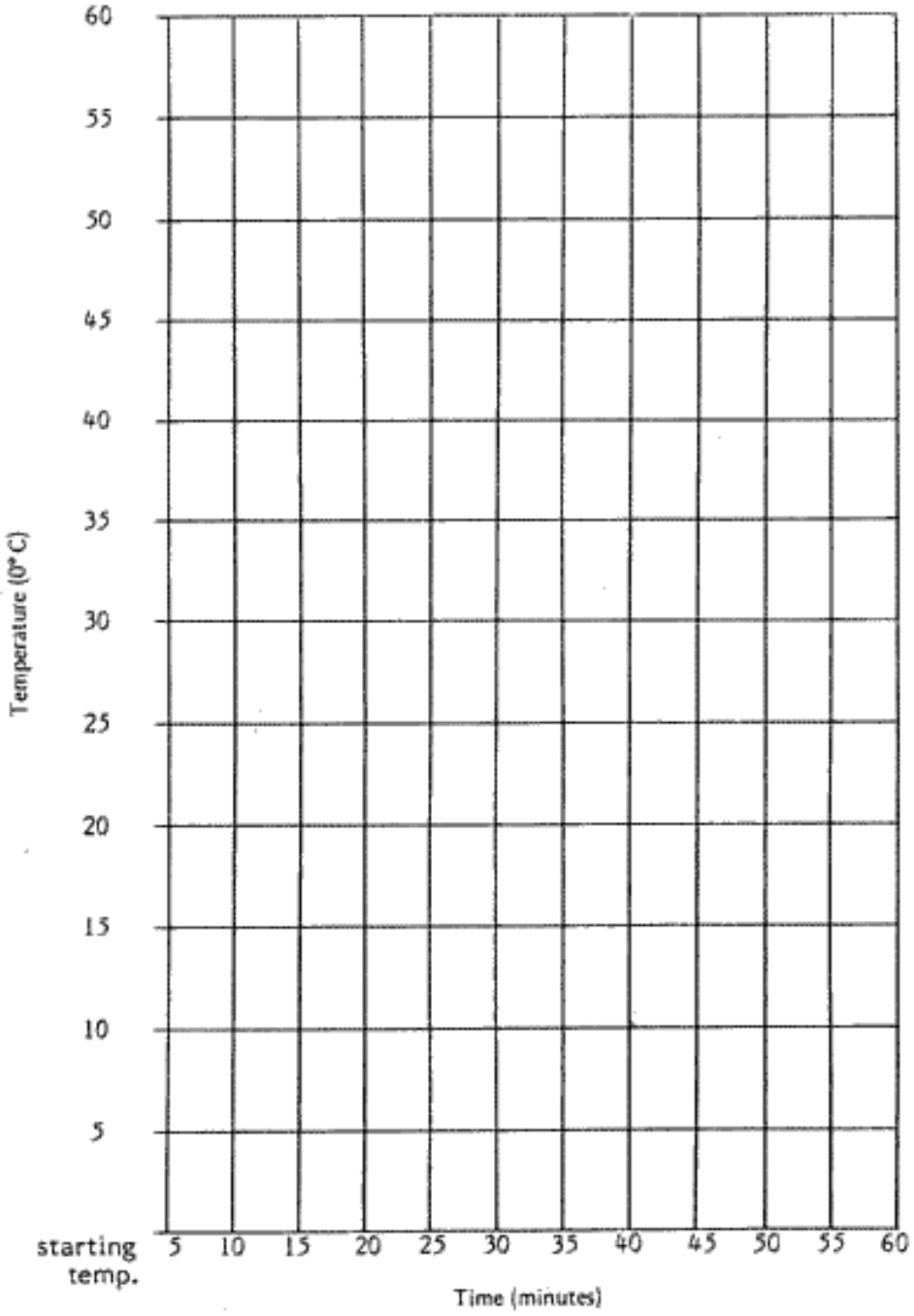
| Thermometer | Position |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

### Data Table 2- Room Temperatures over Time Temperature (°C)

| Time (in minutes) | Thermometers | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Starting temperature | | | | | | |
| 5 | | | | | | |
| 10 | | | | | | |
| 15 | | | | | | |
| 20 | | | | | | |
| 25 | | | | | | |
| 30 | | | | | | |
| 35 | | | | | | |
| 40 | | | | | | |
| 45 | | | | | | |
| 50 | | | | | | |
| 55 | | | | | | |
| 60 | | | | | | |

# Worksheet B

## Changes in Room Temperatures over Time



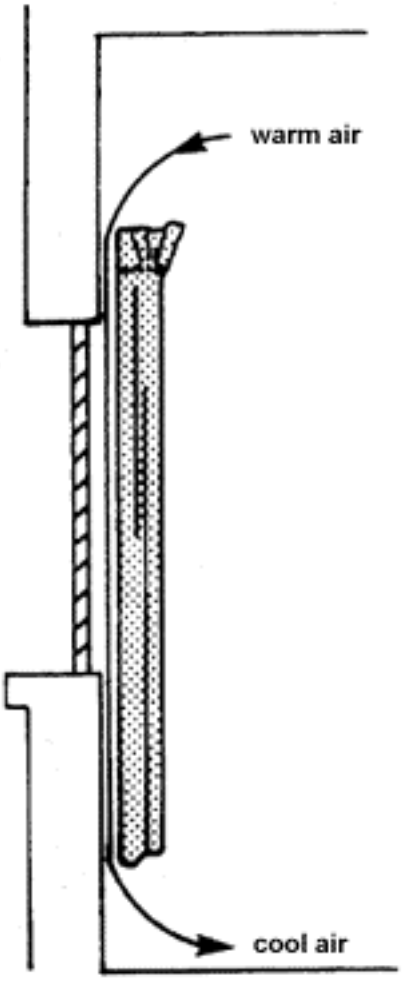

KEY

| Thermometer | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Color | | | | | | |

## Worksheet C
# Reading

### Interior Window Treatments

**Diagram 2** Conventional Draperies

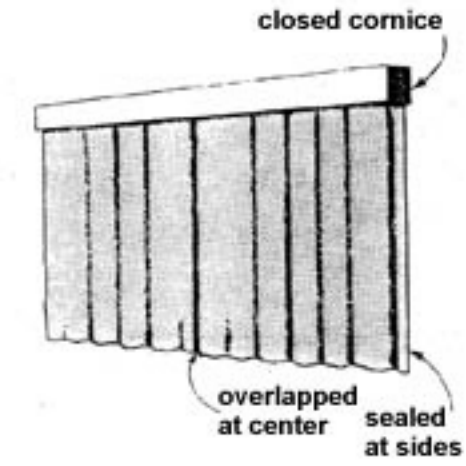



### Draperies

One common window treatment is the use of draperies. When drawn during cold weather or at night, draperies can reduce heat loss from a warm room. They can also be opened when the sun is striking the windows to take advantage of its heating effect. During warm weather draperies can be closed to help keep the room cool.

Conventional draperies, though, will not prevent much heat exchange through a window. The reason is simple. Draperies stand away from the window, leaving a space between drapery and window. In winter, for example, the air in this space is cooled by the window, drops toward the floor, and is replaced by warm air at the top. (See Diagram 2.) This continuous action creates a convection current, reducing room temperature near the window. In fact, a conventional drapery reduces heat loss from a room by only 10%.

**Diagram 3** Insulating Draperies




To prevent this convection current from being set up, draperies should be fitted at the top or bottom. Most simply, this can be done by letting the draperies fall onto the windowsill or floor. For maximum effectiveness, the draperies should also be fitted at the top (with a cornice or by placing the drapery against the ceiling), sealed at both sides, and overlapped at the center. (See Diagram 3.) Velcro or magnetic tape can be used to attach drapes to the wall at the sides and bottom. This kind of drapery can reduce heat loss as much as 25%. Thermal draperies, with two layers separated by an air space, will reduce heat loss even further.

**Diagram 4** Roller Shades, Summer Use

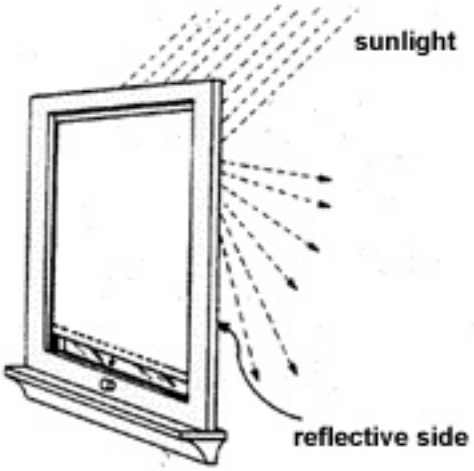
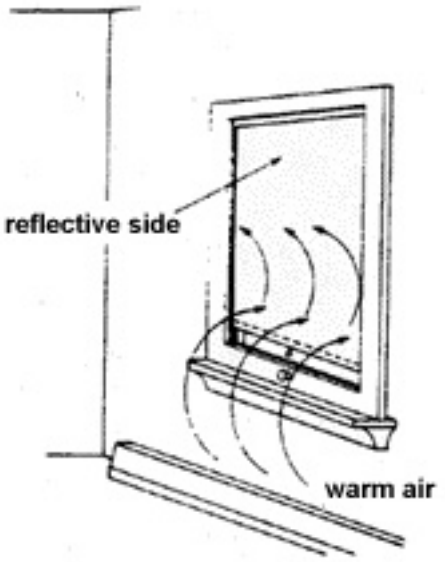



**Diagram 5** Roller Shades, Winter Use



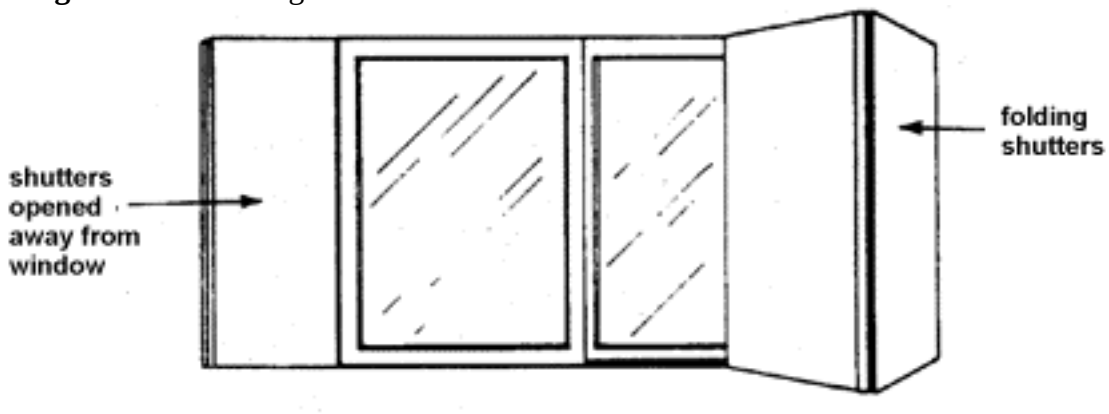

## Roller Shades

This most common window treatment is an effective energy saver when properly installed and used. The shade blocks air flow and forms an insulating layer of air between the shade and the window. A roller shade reduces heat exchange by as much as 28%. By adding side tracks, tape, or closures to seal the shade to the window frame, heat exchange can be reduced by 45%. If the shade is made of or covered by a reflective material, this heat exchange can be reduced even further.

For greatest efficiency, a shade should be reversible, reflective on one side and dark-colored on the other side. The reflective material should always face the warmer side -- outward in summer and inward in winter (See Diagrams 4 and 5).

In summer, shades should be lowered on sunlit windows to reduce solar heating. In winter, shades on the south side of a house should be raised during the day to increase solar heating, then lowered at night to reduce heat loss.

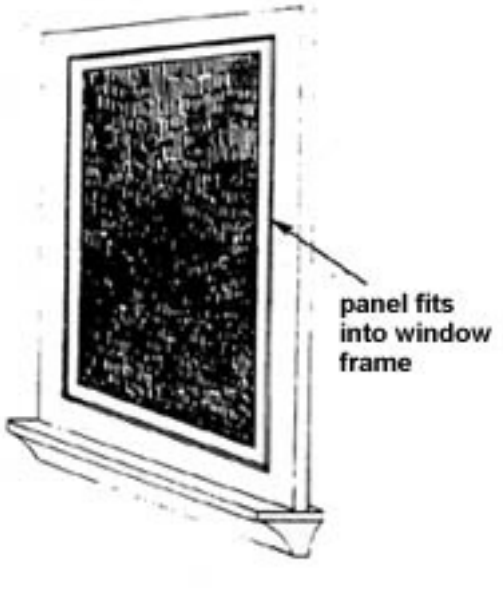
**Diagram 6** Insulating Interior Shutters




## Insulating Shutters

Insulating shutters are a very expensive form of window treatment, but may reduce heat exchange by as much as 80%. They consist primarily of insulation, plywood or wood panels, a vapor barrier, and a decorative covering. Insulating shutters should fit tightly to the frame on all sides to prevent convection currents and to trap an insulating layer of air between the shutter and the window.

**Diagram 7** Insulating Panels




## Insulating Panels

Insulating panels, or pop-in shutters, are normally made of rigid insulation. They are inexpensive, whether you buy a kit or make your own. These panels can be popped into the windows as needed, but require storage space when not in use. They can be covered with decorative fabric or posters to make them more attractive. Insulating panels are made so that their edges seal tightly against the window frame. Seals can be made of magnetic tape or velcro strips. This type of window treatment can reduce heat exchange by as much as 85%.

**Diagram 8** Plastic Interior Storm Windows


## Interior Plastic Storm Windows

A simple and inexpensive way to reduce heat exchange is the interior storm window. It can be made of polyethlyene (like clear garbage bags) or rigid plastic. This window treatment can remain in place all winter and will reduce heat loss by as much as 50%. Flexible plastic can be easily and quickly taped to the window frames. Rigid plastic storm windows must be mounted in the same manner as insulating panels.

### Teacher Information

# Window Treatments for Energy Savings

### Suggested Grade Level and Discipline:

Grades 6-9
Home Economics
Science
Technology

### Skill Objectives:

Recording, graphing, and interpreting data

Researching and taking notes

Analyzing window needs and recommending window treatments to meet those needs

Determining advantages and disadvantages of particular window treatments

### Major Understandings:

Windows transmit solar energy. They can be used during cold weather to provide heat by admitting solar energy, but during warm weather solar energy should be blocked in order to prevent excessive heat gain.

Windows also transmit heat energy. During cold weather, heat should be prevented from escaping through them, but, in warm weather, heat should be prevented from entering through them.

Window treatments that reduce heat loss or heat gain and also reduce air infiltration can save energy. These treatments vary in cost, effectiveness, durability, ease of installation and use, and attractiveness.

Energy-saving window treatments include draperies, shades, shutters, panels, and interior storm windows. Different windows require different treatments, depending on their size, shape, orientation, and placement. The factors of personal taste and expense also determine the choice of window treatments.

Every window treatment has advantages and disadvantages.

## Background

Windows provide light, ventilation, and a view of the area outside. They also transmit solar and heat energy. As the price of energy increases, we will be forced to seek methods of maximizing solar gain and minimizing heat loss during cold weather, and of minimizing solar and heat gain in warm weather, in order to conserve the energy needed to heat and cool our homes.

Windows on the south side are of great value as heat collectors, but only on cold, sunny days. At night they lose heat, and during warm weather they can cause a room to overheat. Windows facing in other directions experience a net heat loss on cold days and a net heat gain when outside temperatures are warmer than inside temperatures. Windows can transmit 20 times more heat than an insulated wall of the same size.

Heat is transmitted through windows in several ways:

Radiation occurs when heat is transferred as infrared radiation from one object to another through space. Heat is radiated from your body to objects such as windows.
Conduction occurs when heat passes through an object from particle to particle. Glass is a good heat conductor and transmits heat from the warmer air touching it.
Convection occurs when heat is transferred by the movement of air. In a building, air movements called "drafts" are caused by conduction or by air infiltration. Warm air touching cold window glass, for example, conducts heat to the glass; the air becomes cooler and more dense, and drops toward the floor. Warm air replaces it from above, and a current is set up. A convection current is set up. A convection current can transfer substantial amounts of heat. Infiltration occurs when air leaks through windows and doors around the glas and frame. Infiltration produces drafts and can be eliminated by caulking, weather-stripping, and airtight insulation.

Insulating window treatments will reduce unwanted heat exchange. As long as they can be removed or opened on the south side to permit solar gain when needed, they are an effective means of reducing energy costs and conserving fossil fuels.

## Advance Planning

Duplicate all necessary worksheets.

Obtain copies of magazines, pamphlets, and books containing information on window treatments. Arrange with the school librarian to use magazines and The Reader's Guide to Periodical Literature. Check the references listed at the end of this activity and obtain materials from them. Rodale's New Shelter, Hudson Home Magazine, Solar Age, Blair and Ketchum's Country Journal, your cooperative extension agent, and state energy office, are excellent sources of articles and information.

Obtain inexpensive thermometers, a fan, and a lamp.

If desired, suspend the thermometers in the classroom in advance of the activity.

Prepare a lesson heat loss and gain through windows and prepare to lead discussion in Step 9.

## Suggested Time Allotment

1 period to collect data and begin discussion
1/2 period to graph and analyze data
1/2 period to do Reading Activity
2 to 3 periods to conduct research and take notes
1/2 period to complete case studies
1/2 period to answer questions and discuss

## Suggested Approach

The discussion in this activity will need much teacher direction. Prepare for leading class discussion.

To prevent the temperature reading from becoming monotonous, use the time between the 5-minute readings to do the lightbulb experiment and the infiltration meter experiment, and to begin Part 2 of the procedure (steps 7 and 8).

If possible, collect temperature data in front of a window which receives direct sunlight during the class period. Conducting the activity on a partly cloudy day will provide the most dramatic results. Repeating the activity on sunny or cloudy days or in different seasons will also emphasize the dual role of windows in heat loss and solar gain. Extrapolate results to other weather conditions and times of day.

Seek out resource people in you community who are knowledgeable about window treatments. These may include homemakers, store managers, building suppliers, cooperative extension agents, and interior decorators. Ask them to share their information with class members.

## Points for Discussion

For maximum effectiveness in heating, how can window treatments be used to manage solar gain?

What are some exterior window treatments which would conserve energy?

What are the factors which determine the treatment for any window?

What kinds of treatments could be prepared for classroom windows? For windows in your home?

## Typical Results

The graphs should show that the classroom will be warmest at the window when sunlight is penetrating it; will be coolest at the window on cloudy, cold days; and will be warmer as height above the floor increases.

## Evaluation

Observe students' participation in class discussion.

Check data tables and graphs for completeness and accuracy.

Check notes for completeness.

Ask students to list kinds of insulating window treatments and to explain the need for them.

Give students a new case study and ask them to recommend a window treatment, listing the advantages and disadvantages of their choice.

## References

All Through the House: A Guide to Home Weatherization, Thomas Blandy and Denis Lamoureaux.
(McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1980, $6.95/paper.)

Energy Efficient Interior Design: a Videotape Series and Teacher's Guide, Barbara A. Flannery.
(Minnesota Curriculum Services Center, 3554 White Bear Ave., White Bear Lake, MN 55110, 1982, free loan, $63.75 purchase.)

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

Energy Saving Window Treatments, Regina Rector.
(Cooperative Extension Programs, Cornell University, Martha Van Rensselaer Hall, Ithaca, NY 14853, write for price.)

547 Easy Ways to Save Energy in Your Home, Roger Albright.
(Garden Way Publishing Co., Charlotte, VT 05445, 1978, $5.95/paper)

Movable Insulation, Bill Langdon.
(Rodale Press, 33 E. Minor St., Emmaus, PA 18049, 1979, $9.95/paper)

The Passive Solar Energy Book, Edward Mazria.
(Rodale Press, 33 E. Minor St., Emmaus, PA 18049, 1979, $12.95/paper)

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.)

"Insulating Shutters and Shades," Larry Gay.
(Blair and Ketchum's Country Journal, 205 Main St., Brattleboro, VT 05301, January 1981, pp.60-65.)

"The Least Expensive Solution," Wayne Shick.
(Rodale's New Shelter, 33 E. Minor St., Emmaus, PA 18049, October 1980, pp. 34-35.)

"A Mini-Catalog of Products," Roger Rawlings.
(Rodale's New Shelter, 33 E. Minor St., Emmaus, PA 18049, October 1980, pp. 36-39.)

"The New Look in Window Blinds."
(Hudson Home Magazine, Hudson Publishing Co., 289 South San Antonio Rd., Los Altos, CA 94022, November 1980, pp. 98-101.)

"New Wrinkles in Window Insulation," William Langdon.
(Solar Age, Solar Vision, Inc., Church Hill, Harrisville, NH 03450, August 1979, pp.20-23.)

"A Shade and A Shutter: Insulating Window Covers You Can Make."
(Solar Age, Solar Vision, Inc., Church Hill, Harrisville, NH 03450, August 1979, pp.24-30.)

"A Shade You Pull Down."
(Rodale's New Shelter, 33 E. Minor St., Emmaus, PA 18049, October 1980, pp. 30.)

"A Shutter You Pop In," Roger Rawlings.
(Rodale's New Shelter, 33 E. Minor St., Emmaus, PA 18049, October 1980, pp. 31-33.)

"The Trouble with Windows (And What to Do)," Michael LaFavore.
(Rodale's New Shelter, 33 E. Minor St., Emmaus, PA 18049, October 1980, pp. 27-29.)