National
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PUBLICATIONS
REFERENCE

# MAKING THE MOST OF YOUR ENERGY DOLLARS

## in home heating & cooling

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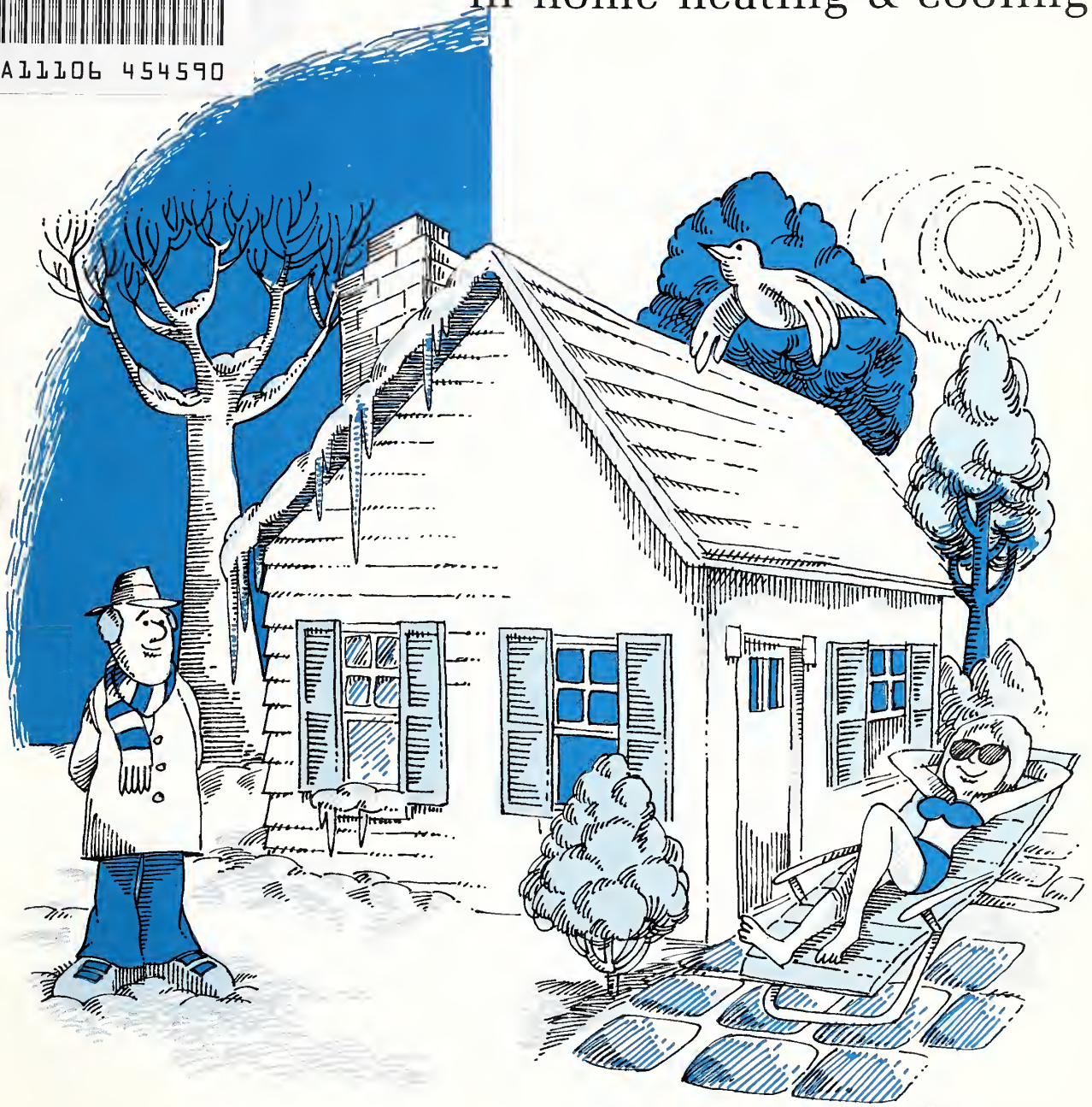


U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Energy Conservation Now

C13-8

# A WORD TO THE READER

During the height of the energy crisis many homeowners turned their thermostats down and wore heavy sweaters in an effort to save fuel. Today, with energy prices on the rise, saving energy also means saving money on monthly heating and cooling bills. As a result, many homeowners are thinking about more permanent ways to reduce their household energy consumption.

Energy can be conserved by making relatively simple improvements at home. Installing or adding insulation, fitting storm windows and doors and applying weather stripping and caulking are effective energy saving improvements. But many people are reluctant to invest in these improvements because of the cost. In general, homeowners have not been able to calculate the potential return on their investment.

By using this booklet you can determine the best combination of energy conservation improvements for your house—improvements that will give you the largest long-run return on your investment. The booklet also provides information on affording or financing your investment and tips on making the improvements.

This publication is based on the findings and methods presented in a technical report, entitled *Retrofitting Existing Housing for Energy Conservation: An Economic Analysis,* published earlier this year. The report resulted from a joint study conducted by the National Bureau of Standards and the Federal Energy Administration. The report was undertaken to determine what level of investment in home energy improvements would produce the maximum long run savings in home heating and cooling expenses.

This booklet is not a comprehensive "how-to-do-it" book. For more detailed information we recommend a new publication from the Department of Housing and Urban Development, entitled *In the Bank . . . Or Up the Chimney?*

We think *Making the Most of Your Energy Dollars* will convince you that investing in energy conservation improvements can help you offset rising energy prices. And that's good news for you! You'll be saving money and you'll also be doing your part to help conserve our nation's precious energy supplies.

Frank G. Zarb
Administrator
Federal Energy Administration

Richard W. Roberts
Director
National Bureau of Standards

# SAVING ENERGY IS SAVING MONEY

If you are a homeowner who wants to save energy and money without sacrificing comfort—this booklet is for you. It is not a "how-to" book, but a "how much" guide to energy conservation investments.

For your climate and the type of energy used to heat and cool your house, this booklet tells what combination of energy conservation improvements to invest in to get the largest, long run net savings in your heating and cooling bills.

Of course, there are many ways to save energy in your house. You can save energy by dialing down thermostats in winter and setting them higher in the summer, turning off lights, shutting drapes, closing off unused rooms, and tuning up your furnace every few years.

But there are other effective ways to save energy and money on your monthly fuel bills—and still keep your house at comfortable temperatures. By investing in the energy conservation improvements described in this booklet, you can *permanently* reduce the amount of energy used to heat and cool your house. These improvements include the installation of insulation in the attic and walls, under floors, and around ducts in unheated areas; storm windows and doors; and weather stripping and caulking.

These energy conservation improvements are wise investments if you can be sure they'll save you enough money on heating and cooling bills to pay for themselves. If you think that doing too much or too little can be a waste of your money, you're right!

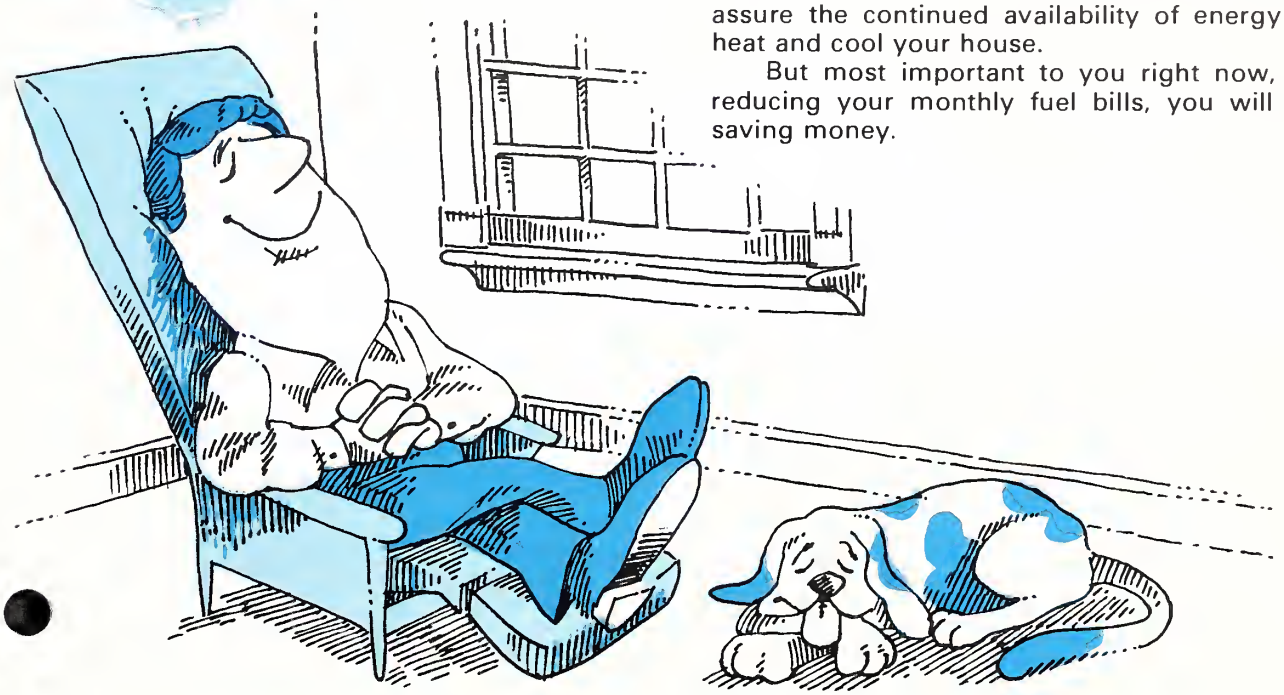
That's why the National Bureau of Standards, in cooperation with the Federal Energy Administration, has published this guide—to help you balance your energy budget and get the most for your money.

You may be surprised to learn how much insulation you should install. In some parts of the country, when higher priced fuels are used, R-38 insulation (about 12 inches of mineral fiber batts) in the attic is recommended to give the best results. Even in milder climates, R-30 insulation (about 10 inches) may be economically justified if you use oil or electric heating at current high prices.

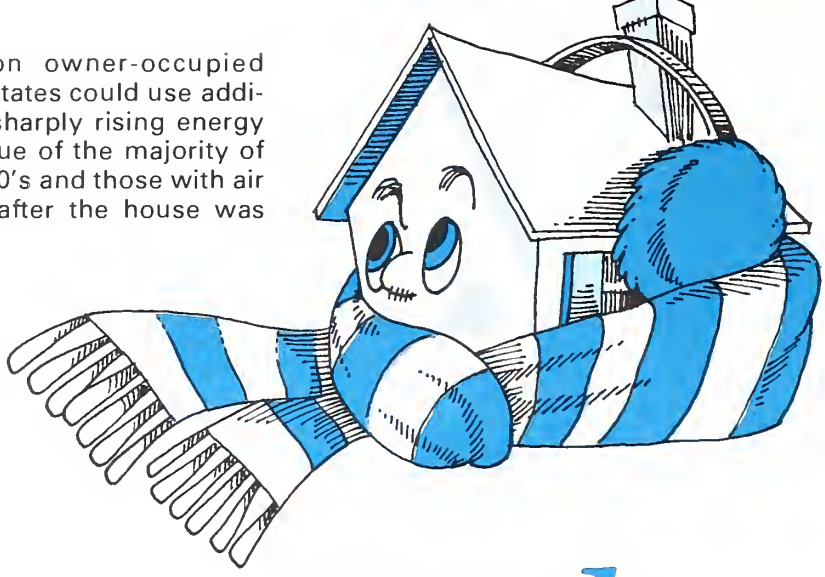
You may be just as surprised to learn that investing in energy conservation improvements now can earn you greater dividends than putting your money in the bank!

By using the guidelines in this booklet, you will be doing your part to help conserve our country's energy resources—which will help assure the continued availability of energy to heat and cool your house.

But most important to you right now, by reducing your monthly fuel bills, you will be saving money.



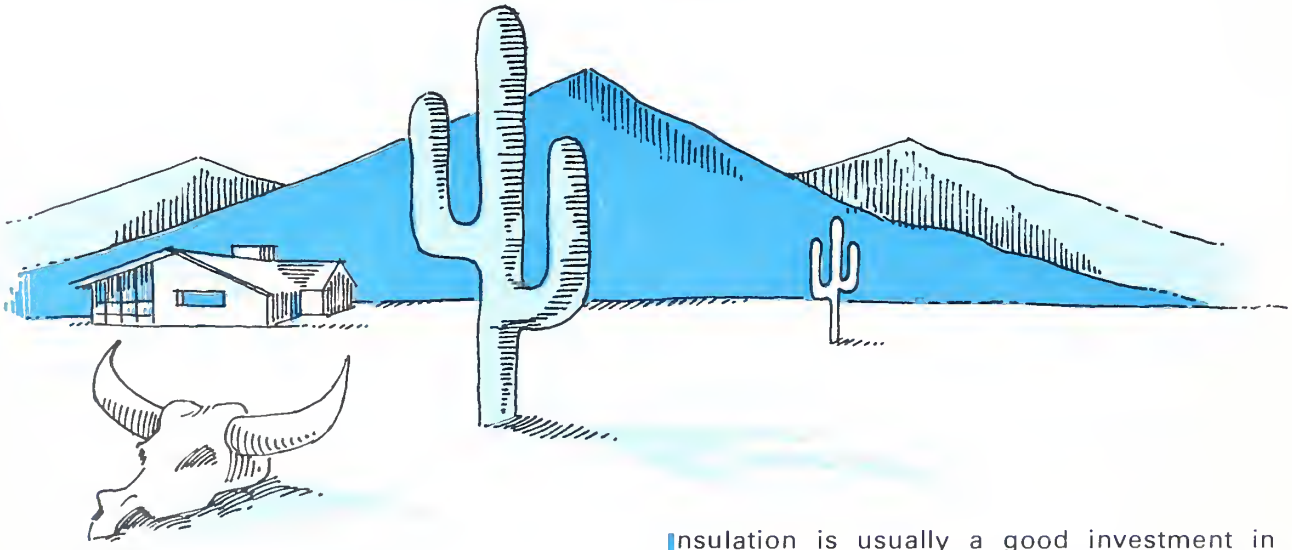
Most of the 40 million owner-occupied houses in the United States could use additional insulation to offset sharply rising energy prices. This is especially true of the majority of houses built before the 1960's and those with air conditioning units added after the house was completed.



# Did you

The more you pay for energy, the more you will save from increased investments in energy conservation improvements. Currently, electricity is generally more costly than fuel oil, and fuel oil is more costly than natural gas. As a result, even in the same climate, houses heated and cooled by different energy sources require different levels of investment.

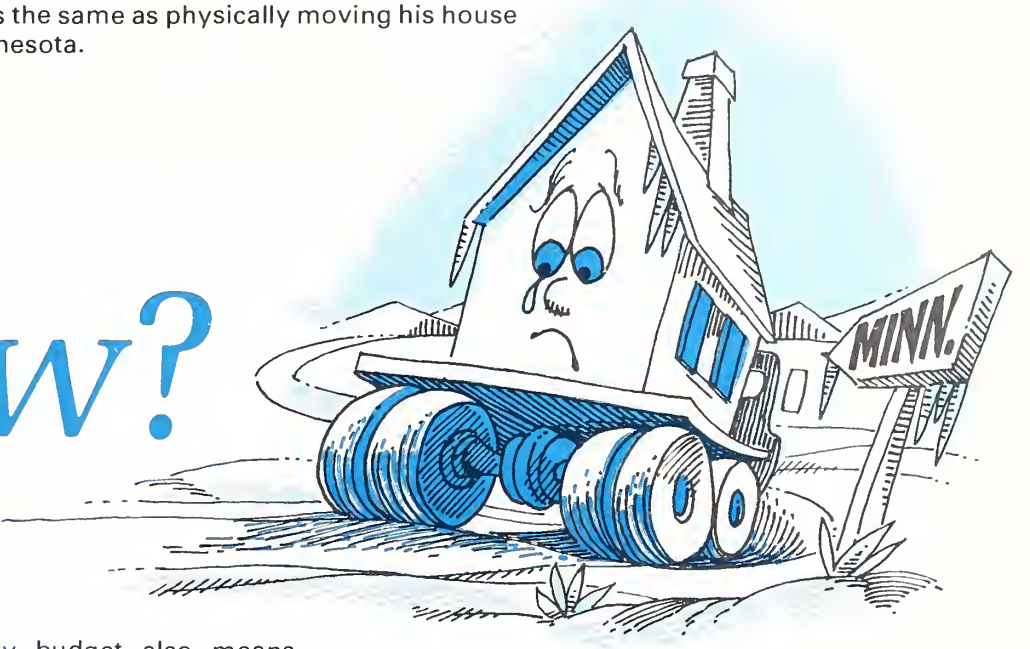
Balancing your energy budget means striking a happy medium between dollars spent on energy consumption and energy conservation improvements. A balanced budget gives you the greatest possible long run net savings on heating and cooling expenses. Your net savings are the total savings on fuel bills less the cost of improvements.



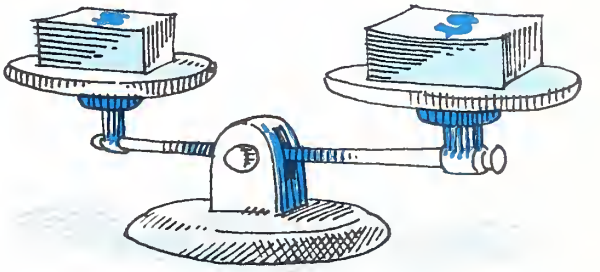
Insulation is usually a good investment in geographic areas that require a lot of air conditioning, even if heating requirements are low.

How much you should invest in energy conservation improvements depends equally on climate *and* energy prices. A doubling of energy prices has the same effect on a homeowner's energy budget as a doubling of heating and cooling requirements. For example, when prices for home heating oil doubled in Washington, D.C., the effect on a homeowner's heating bill was the same as physically moving his house to Minnesota.

# Know?




Balancing your energy budget also means using a balanced combination of energy conservation techniques. You may not be making the best use of your money if you invest only in attic insulation and neglect the use of storm windows or insulation in floors over unheated areas where these are economical.



Energy conservation improvements not only increase your family's comfort, but also cut down on unwanted, outside noise.

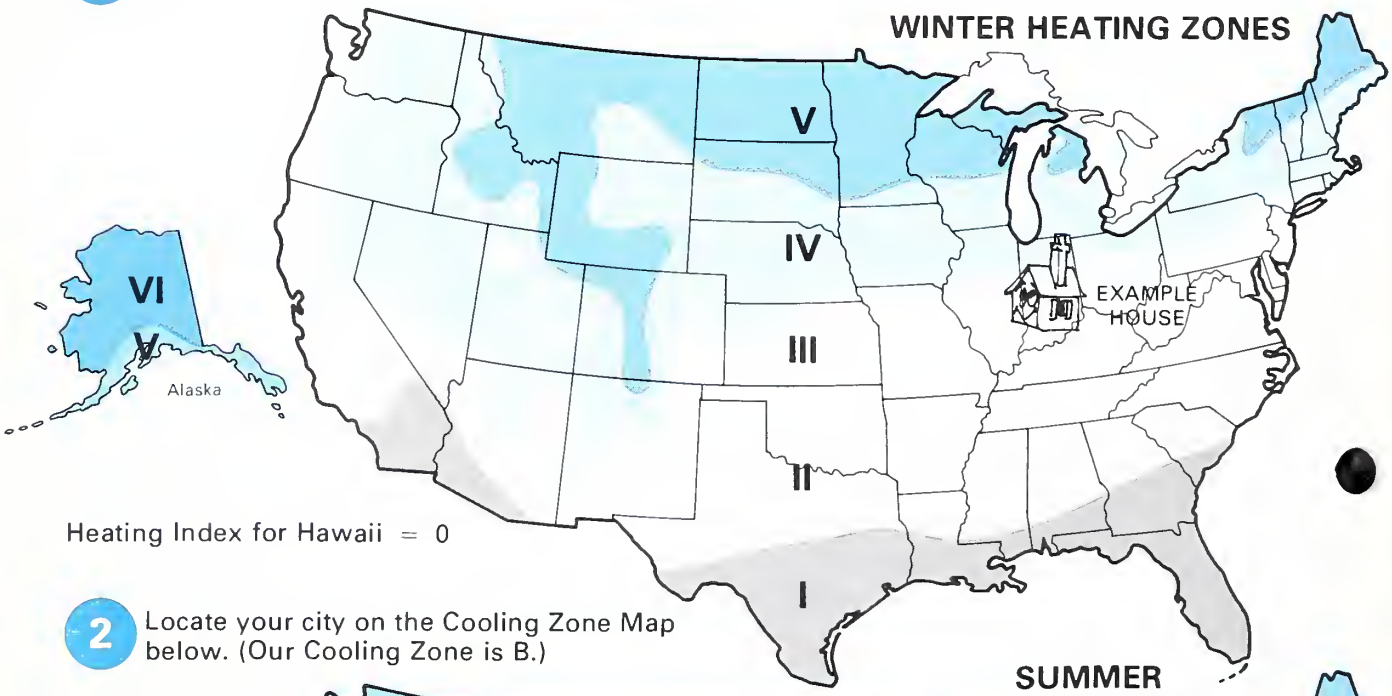
# FIGURING YOUR ENERGY CONSERVATION BUDGET

To find the "best combination" of energy conservation measures for your climate and fuel prices, use the tables on the following pages. This best combination gives you the largest, long run net savings on your heating and cooling costs for your investment. By comparing this best combination with what already exists in your house, you can figure out how much more needs to be added to bring your house up to the recommended levels.

The recommended improvements apply to most houses to the extent they can be installed without structurally modifying the house. Recommended improvements are based on sample costs given in Table 7. If your costs are substantially different, see page 9.

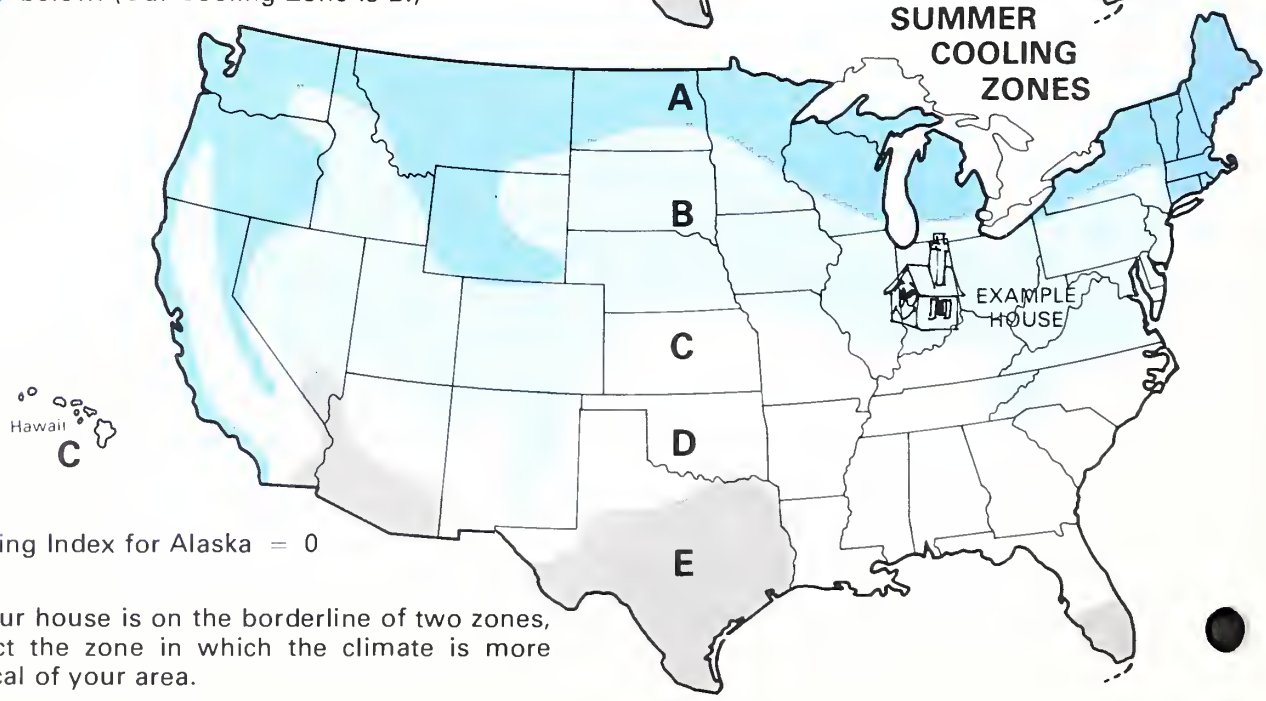
Follow the steps outlined below and fill in the information for your house on Worksheet A. We have filled in the information for a typical house located in Indianapolis, Indiana.

**1** Locate your city on the Heating Zone Map below. (Our house is located in Heating Zone III.)




Heating Index for Hawaii = 0

**2** Locate your city on the Cooling Zone Map below. (Our Cooling Zone is B.)




Cooling Index for Alaska = 0

If your house is on the borderline of two zones, select the zone in which the climate is more typical of your area.

**3** Our house currently uses fuel oil at a cost of 34¢ a gallon to heat. It uses electricity at 4¢ a kilowatt hour to cool. Obtain your unit heating and cooling costs from the utility companies as follows: Tell your company how many therms (for gas) or kilowatt hours (for electricity) you use in a typical winter month and summer month (if you have air conditioning). The number of therms or kilowatt hours is on your monthly fuel bill. Ask for the cost of the last therm or kilowatt hour used, including all taxes, surcharges, and fuel adjustments. For oil heating, the unit fuel cost is simply your average cost per gallon plus taxes, surcharges, and fuel adjustments.

**4** Locate your Heating Index from Table 1 by finding the number at the intersection of your Heating Zone row and heating fuel cost column (to the nearest cost shown). (Our house has a Heating Index of 20.)

If your house is air conditioned, or you plan to add air conditioning, find your Cooling Indexes from steps 5 and 6. If your house is not air conditioned and it is not planned, your Cooling Indexes are zero.

**TABLE 1 HEATING INDEX**

| Type of fuel: | | Cost per unit* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas (therm) | | 9¢ | 12¢ | 15¢ | 18¢ | 24¢ | 30¢ | 36¢ | 54¢ | 72¢ | 90¢ |
| Oil (gallon) | | 13¢ | 17¢ | 21¢ | 25¢ | 34¢ | 42¢ | 50¢ | 75¢ | $1.00 | $1.25 |
| Electric (kWh) | | | | | 1¢ | 1.3¢ | 1.6¢ | 2¢ | 3¢ | 4¢ | 5¢ |
| Heat pump (kWh) | | 1¢ | 1.3¢ | 1.7¢ | 2¢ | 2.6¢ | 3.3¢ | 4¢ | 6¢ | 8¢ | 10¢ |
| HEATING ZONE | I | 2 | 2 | 3 | 3 | 4 | 5 | 6 | 9 | 12 | 15 |
| | II | 5 | 6 | 8 | 9 | 12 | 15 | 18 | 27 | 36 | 45 |
| | III | 8 | 10 | 13 | 15 | 20 | 25 | 30 | 45 | 60 | 75 |
| | IV | 11 | 14 | 18 | 21 | 28 | 35 | 42 | 63 | 84 | 105 |
| | V | 14 | 18 | 23 | 27 | 36 | 45 | 54 | 81 | 108 | 135 |
| | VI | 22 | 28 | 36 | 42 | 56 | 70 | 84 | 126 | 168 | 210 |

Note: In Tables 1-3, if your fuel costs fall midway between two fuel costs listed, you can interpolate. For example, if our fuel oil costs were 38¢ a gallon, our Heating Index would be 22.5.

**5** Locate your Cooling Index for Attics from Table 2 by finding your Cooling Zone and cooling cost to the nearest cost shown. (Our house has a Cooling Index for Attics of 5.)

**6** Locate your Cooling Index for Walls from Table 3 by finding your Cooling Zone and cooling cost to the nearest cost shown in the table. (Our house has a Cooling Index for Walls of 2.)

**TABLE 2 COOLING INDEX FOR ATTICS**

| Type of air conditioner: | | Cost per unit* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gas (therm) | | 9¢ | 12¢ | 15¢ | 18¢ | 24¢ | 30¢ | 36¢ |
| Electric (kWh) | | 1.5¢ | 2¢ | 2.5¢ | 3¢ | 4¢ | 5¢ | 6¢ |
| COOLING ZONE | A | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | B | 2 | 2 | 3 | 4 | 5 | 6 | 7 |
| | C | 3 | 5 | 6 | 7 | 9 | 11 | 13 |
| | D | 5 | 6 | 8 | 9 | 12 | 15 | 18 |
| | E | 7 | 9 | 11 | 14 | 18 | 23 | 27 |

**TABLE 3 COOLING INDEX FOR WALLS**

| Type of air conditioner: | | Cost per unit* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gas (therm) | | 9¢ | 12¢ | 15¢ | 18¢ | 24¢ | 30¢ | 36¢ |
| Electric (kWh) | | 1.5¢ | 2¢ | 2.5¢ | 3¢ | 4¢ | 5¢ | 6¢ |
| COOLING ZONE | A | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | B | 1 | 1 | 2 | 2 | 2 | 3 | 4 |
| | C | 2 | 2 | 3 | 4 | 5 | 6 | 7 |
| | D | 3 | 3 | 4 | 5 | 7 | 8 | 10 |
| | E | 4 | 5 | 6 | 8 | 10 | 13 | 15 |

*Cost of last unit used (for heating and cooling purposes) including all taxes, surcharges, and fuel adjustments.

**7** Find the sum of your Heating Index and Cooling Index for Attics. (Our sum is 25.)

**8** Find the sum of your Heating Index and Cooling Index for Walls. (Our sum is 22.)

Energy savings result from decreasing the heat flow through the exterior shell of the building. The resistance, or "R," value of insulation is the measure of its ability to decrease heat flow. Two different kinds of insulation may have the same thickness, but the one with the higher R value will perform better. For that reason, our recommendations are listed in terms of R values with the approximate corresponding thickness. R values for different thicknesses of insulation are generally made available by the manufacturers.

**9** Find the resistance value of insulation recommended for your attic and around attic ducts from Table 4. (For our house the recommended resistance value is R-30 for attic floors and R-16 for ducts.)

**TABLE 4 ATTIC FLOOR INSULATION AND ATTIC DUCT INSULATION**

| INDEX Heating Index Plus Cooling Index for Attics | ATTIC INSULATION Approximate Thickness R-Value | Mineral Fiber Batt/Blanket | Mineral Fiber Loose-Fill** | Cellulose Loose-Fill** | DUCT INSULATION* R-Value | Approximate Thickness |
|---|---|---|---|---|---|---|
| 1-3 | R-0 | 0" | 0" | 0" | R-8 | 2" |
| 4-9 | R-11 | 4" | 4-6" | 2- 4" | R-8 | 2" |
| 10-15 | R-19 | 6" | 8-10" | 4- 6" | R-8 | 2" |
| 16-27 | R-30*** | 10" | 13-15" | 7- 9" | R-16 | 4" |
| 28-35 | R-33 | 11" | 14-16" | 8-10" | R-16 | 4" |
| 36-45 | R-38 | 12" | 17-19" | 9-11" | R-24 | 6" |
| 46-60 | R-44 | 14" | 19-21" | 11-13" | R-24 | 6" |
| 61-85 | R-49 | 16" | 22-24" | 12-14" | R-32 | 8" |
| 86-105 | R-57 | 18" | 25-27" | 14-16" | R-32 | 8" |
| 106-130 | R-60 | 19" | 27-29" | 15-17" | R-32 | 8" |
| 131— | R-66 | 21" | 29-31" | 17-19" | R-40 | 10" |

* Use Heating Index only if ducts are not used for air conditioning ** High levels of loose-fill insulation may not be feasible in many attics. ***Assumes that joists are covered; otherwise use R-22.

**10** Find the recommended level of insulation for floors over unheated areas from Table 5. (Our house should have R-19.) Using Table 5, check to see whether storm doors are economical for your home. Storm doors listed as optional may be economical if the doorway is heavily used during the heating season.

**TABLE 5 INSULATION UNDER FLOORS AND STORM DOORS**

| INDEX Heating Index Only | INSULATION UNDER FLOORS* R-Value | Mineral Fiber Batt Thickness | STORM DOORS |
|---|---|---|---|
| 0-7 | 0** | 0"** | None |
| 8-15 | 11** | 4"** | None |
| 16-30 | 19 | 6" | Optional |
| 31-65 | 22 | 7" | Optional |
| 66— | 22 | 7" | On all doors |

* If your furnace and hot water heater are located in an otherwise unheated basement, cut your Heating Index in half to find the level of floor insulation.
**In Zone I and II R-11 insulation is usually economical under floors over open crawlspaces and over garages; in Zone I insulation is not usually economical if crawlspace is closed off.

**11** Find the recommended level of insulation for your walls and ducts in unheated areas from Table 6. (Our house should have full-wall insulation if none existed previously and R-16 insulation around ducts.) Table 6 also shows the minimum economical storm window size in square feet for triple-track storm windows. (Our house should have storm windows on all windows 9 square feet in size or larger where storm windows can be used.)

**TABLE 6 WALL INSULATION, DUCT INSULATION, AND STORM WINDOWS**

| INDEX Heating Index Plus Cooling Index for Walls | WALL INSULATION (blown-in) | INSULATION AROUND DUCTS IN CRAWLSPACES AND IN OTHER UNHEATED AREAS (EXCEPT ATTICS)* Resistance and Approximate Thickness | STORM WINDOWS (Triple-Track) Minimum Economical Window Size |
|---|---|---|---|
| 0-10 | None | R-8 (2") | none |
| 11-12 | Full-Wall Insulation Approximately R-14 | R-8 (2") | 20 sq. ft. |
| 13-15 | | R-16(4") | 15 sq. ft. |
| 16-19 | | R-16(4") | 12 sq. ft. |
| 20-28 | | R-16(4") | 9 sq. ft. |
| 29-35 | | R-16(4") | 6 sq. ft. |
| 36-45 | | R-24(6") | 4 sq. ft. |
| 46-65 | | R-24(6") | All windows** |
| 66— | | R-32(8") | All windows** |

* Use Heating Index only if ducts are not used for air conditioning. **Windows too small for triple-track windows can be fitted with one-piece windows.

**12** Weather stripping and caulking. Regardless of where you live or your cost of energy, it is almost always economical to install weather stripping on the inside around doors and windows where possible and to caulk on the outside around doors and window frames—if you do it yourself. This is especially true for windows and doors which have noticeable drafts.

YOU NOW KNOW your best combination of energy conservation improvements. Of course, the size of your investment depends on your existing insulation and the size of your house.

In addition, some of the recommended improvements in this booklet are not appropriate for all houses. For instance, insulation cannot be added under floors in houses built on concrete slabs. In such cases, the other recommended improvements should still be added to the extent indicated in this booklet. Similarly, R-30 insulation may be recommended for your attic although only R-19 may fit at the eaves or in areas where the attic is floored. In this case, you should still put R-30 insulation wherever it fits.

Use Worksheet B and Table 7 (or your own cost information) to calculate how much you need to add to reach your best combination and how much this will cost. We have provided this information on Worksheet B for our example house. Our house only has R-11 attic insulation, some wall insulation, and R-8 attic duct insulation to begin with. To reach our best combination, the improvements would cost about $1200.

REMOVE THIS SHEET FOR YOUR RECORDS

## WORKSHEET A

| EXAMPLE: | | YOUR CALCULATIONS: | |
|---|---|---|---|
| Climate: | | Climate: | |
| Heating Zone | III | Heating Zone | |
| Cooling Zone | B | Cooling Zone | |
| Fuel Costs: | | Fuel Costs: | |
| Heating Energy | Oil | Heating Energy | |
| Cost per Unit | 34¢/gal. | Cost per Unit | |
| Cooling Energy | Electric | Cooling Energy | |
| Cost per Unit | 4¢/KWH | Cost per Unit | |
| Indexes: | | Indexes: | |
| Heating | 20 | Heating | |
| Cooling (Attic) | 5 | Cooling (Attic) | |
| Cooling (Wall) | 2 | Cooling (Wall) | |
| Heating + Cooling (Attic) | 25 | Heating + Cooling (Attic) | |
| Heating + Cooling (Wall) | 22 | Heating + Cooling (Wall) | |

| BEST COMBINATION | | | BEST COMBINATION |
|---|---|---|---|
| Attic Insulation (Batt) — R-30 (10 inches) | FROM TABLE 4 | | Attic Insulation |
| Duct Insulation (in attics) — R-16 (4 inches) | | | Duct Insulation (in attics) |
| Insulation Under Floors — R-19 (6 inches) | FROM TABLE 5 | | Insulation Under Floors |
| Storm Doors — optional | | | Storm Doors |
| Wall Insulation (blown-in) — full-wall R-14 (3½ inches) | FROM TABLE 6 | | Wall Insulation (blown-in) |
| Duct Insulation (in unheated crawlspaces, etc.) — R-16 (4 inches) | | | Duct Insulation (in unheated crawlspaces, etc.) |
| Storm Windows (minimum size) — 9 sq. ft. | | | Storm Windows (minimum size) |
| Weather strip and caulk windows and door frames — all | | | Weather strip and caulk windows and door frames |

See page 12 for recommendations on combining insulation batts to make up greater thicknesses than 6 inches.

# WORKSHEET B

## OUR EXAMPLE:

### ATTIC INSULATION

| | |
|---|---|
| 1. Attic area (sq. ft.) | 1200 |
| 2. Recommended level | R-30 (10") |
| 3. Existing level | R-11 (4") |
| 4. Add | R-19 (6") |
| 5. Cost/sq. ft. | $.25 |
| 6. Total cost (1 · 5) | $300 |

### WALL INSULATION (BLOWN-IN)

| | |
|---|---|
| 1. Wall area (sq. ft.) | 900 |
| 2. Recommended level | full wall |
| 3. Existing level | some |
| 4. Add | 0 |
| 5. Cost/sq. ft. | $.60 |
| 6. Total cost (1 · 5) | 0 |

### FLOOR INSULATION

| | |
|---|---|
| 1. Floor area (sq. ft.) | 1200 |
| 2. Recommended level | R-19 (6") |
| 3. Existing level | 0" |
| 4. Add | R-19 (6") |
| 5. Cost/sq. ft. | $.30 |
| 6. Total cost (1 · 5) | $360 |

### DUCT INSULATION (ATTIC)

| | |
|---|---|
| 1. Length (ft.) | 30' |
| 2. Perimeter (ft.) | 2' |
| 3. Area (1 · 2 · 1.5)* | 90 sq. ft. |
| 4. Recommended level | R-16 (4") |
| 5. Existing level | R-8 (2") |
| 6. Add | R-8 (2") |
| 7. Cost/sq. ft. | $.30 |
| 8. Total cost (3 · 7) | $27 |

### DUCT INSULATION (OTHER AREAS)

| | |
|---|---|
| 1. Length (ft.) | 30' |
| 2. Perimeter (ft.) | 2' |
| 3. Area (1 · 2 · 1.5)* | 90 sq. ft. |
| 4. Recommended level | R-16 (4") |
| 5. Existing level | 0" |
| 6. Add | R-16 (4") |
| 7. Cost sq. ft. | $.50 |
| 8. Total cost (3 · 7) | $45 |

### STORM WINDOWS (over 9 sq. ft.)

| size (sq. ft.) | number | cost each | sub-total |
|---|---|---|---|
| 20 | 2 | $35 | $ 70 |
| 15 | 4 | 30 | 120 |
| 12 | 3 | 30 | 90 |
| 9 | 2 | 30 | 60 |

Total cost $340

### STORM DOORS

| | |
|---|---|
| 1. Doors Needed | 1 (optional) |
| 2. Cost per door | $75 |
| 3. Total cost | $75 |

### WEATHER STRIPPING (MATERIALS ONLY)

| | |
|---|---|
| 1. Linear feet | 200 |
| 2. Cost per foot | $.10 |
| 3. Total cost | $20 |

### CAULKING (MATERIALS ONLY)

| | |
|---|---|
| 1. Variable costs | $20-50 |
| 2. Estimated cost | $33 |

Total cost of all improvements $1200

## YOUR ESTIMATES:

### ATTIC INSULATION

1. Attic area (sq. ft.) _____
2. Recommended level _____
3. Existing level _____
4. Add _____
5. Cost/sq. ft. _____
6. Total cost (1 × 5) _____

### WALL INSULATION (BLOWN-IN)

1. Wall area (sq. ft.) _____
2. Recommended level _____
3. Existing level _____
4. Add _____
5. Cost/sq. ft. _____
6. Total cost (1 × 5) _____

### FLOOR INSULATION

1. Floor area (sq. ft.) _____
2. Recommended level _____
3. Existing level _____
4. Add _____
5. Cost/sq. ft. _____
6. Total cost (1 × 5) _____

### DUCT INSULATION (ATTIC)

1. Length (ft.) _____
2. Perimeter (ft.) _____
3. Area (1 × 2 × 1.5)* _____
4. Recommended level _____
5. Existing level _____
6. Add _____
7. Cost/sq. ft. _____
8. Total cost (3 × 7) _____

### DUCT INSULATION (OTHER AREAS)

1. Length (ft.) _____
2. Perimeter (ft.) _____
3. Area (1 × 2 × 1.5)* _____
4. Recommended level _____
5. Existing level _____
6. Add _____
7. Cost/sq. ft. _____
8. Total cost (3 × 7) _____

### STORM WINDOWS

| size (sq. ft.) | number | cost each | sub-total |
|---|---|---|---|
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |

Total cost _____

### STORM DOORS

1. Doors needed _____
2. Cost per door _____
3. Total cost _____

### WEATHER STRIPPING (MATERIALS ONLY)

1. Linear feet _____
2. Cost per foot _____
3. Total cost _____

### CAULKING (MATERIALS ONLY)

1. Variable costs _____
2. Estimated cost _____

Total cost of all improvements _____

REMOVE THIS SHEET FOR YOUR RECORDS

*1.5 is an adjustment factor for increased width of insulation needed to fit around duct.

## TABLE 7 SAMPLE IMPROVEMENT COSTS

These sample costs were used in estimating the best combination of energy conservation improvements for the various climates and fuel prices covered in this booklet. They include an allowance for commercial installation, except in the case of weather stripping and caulking which is considered to be a do-it-yourself project. While these costs are typical of 1975 prices, there may be considerable variation among specific materials, geographic locations, and suppliers. It usually is worth your time to obtain several estimates for materials and installation before making any purchase. Many of these items can be purchased at substantial discounts if you watch the advertised sales. Considerable savings may be made by installing these yourself, where possible.

### ATTIC INSULATION (ALL MATERIALS)

Installed cost per square foot of attic:

| | | | |
|---|---|---|---|
| R-11 | = 15¢ | R-44 | = 57¢ |
| R-19 | = 25¢ | R-49 | = 64¢ |
| R-22 | = 29¢ | R-57 | = 74¢ |
| R-30 | = 39¢ | R-60 | = 78¢ |
| R-33 | = 43¢ | R-66 | = 86¢ |

### WALL INSULATION (ALL MATERIALS)

Installed cost = 60¢ per square foot of net wall area*

### FLOOR INSULATION (MINERAL FIBER BATT)

Installed cost:

R-11 = 20¢
R-19 = 30¢
R-22 = 34¢

### DUCT INSULATION (MINERAL FIBER BLANKET)

Installed cost per square foot of material:

| | | | |
|---|---|---|---|
| R-8 | = 30¢ | R-32 | = 90¢ |
| R-16 | = 50¢ | R-40 | = $1.10 |
| R-24 | = 70¢ | | |

### STORM WINDOWS (TRIPLE-TRACK, CUSTOM-MADE AND INSTALLED**)

Up to 100 united inches (height + width) = $30.00
Greater than 100 united inches = $30.00 + $.60 per united inch greater than 100"

### STORM DOORS (CUSTOM-FITTED AND INSTALLED**)

All sizes = $75.00

### WEATHER STRIPPING AND CAULKING

Prices vary according to material used. Use the most durable materials available.

* Price includes allowance for painting inside surface of exterior walls with water vapor-resistant paint.

**Prices may be considerably less for stock sizes, homeowner-installed.

If you find that the costs of any of the improvements to your house are substantially different from the sample costs in Table 7, you can easily compensate for the difference.

Take the Index Number appropriate for the improvement in question, multiply this by our sample cost, and divide the result by your cost. This will give you an Adjusted Index Number with which you can find the best level of investment for that particular improvement.

$$\frac{\text{Original Index} \times \text{Our Cost}}{\text{Your Cost}} = \text{Adjusted Index}$$

### EXAMPLE

For our example house, we might find that we can get good quality storm windows for $20 apiece instead of our $30 estimate. Our Index Number for storm windows was 22. Our new Adjusted Index Number for storm windows would be:

$$\frac{22 \times \$30}{\$20} = 33$$

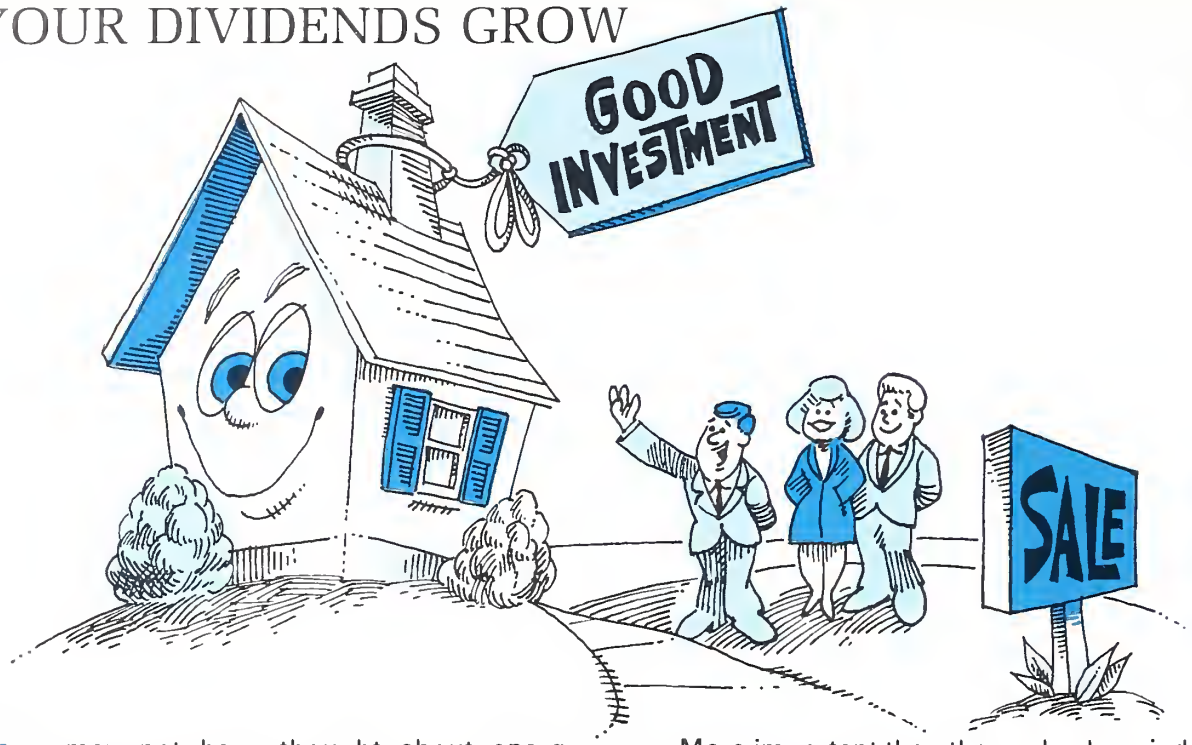
Using our Adjusted Index Number of 33 we find that storm windows are economical on all windows 6 square feet in size or larger, instead of 9 square feet in size. In other words, if your costs are substantially less than ours, you will want to go beyond the recommended level.

Similarly, if R-30 insulation in the attic costs 65¢ per square foot instead of our 39¢ price, the Index Number of 25 for attic insulation would be adjusted to

$$\frac{25 \times 39¢}{65¢} = 15$$

From Table 4 we find that R-19 insulation is now recommended instead of R-30. In other words, if your costs are substantially greater than ours, you may want to use a little less than the recommended level.

# YOUR DIVIDENDS GROW




You may not have thought about energy conservation this way, but investing in these improvements is better than most alternative low-risk, long-term investments you can make. When you invest in energy conservation improvements, you immediately begin to earn dividends in the form of reduced utility bills. These dividends not only pay off your investment, but they pay "interest" as well. And unlike dividends from many other investments, these are not subject to income taxes.

At current fuel prices, the recommended improvements will pay for themselves many times over during the life of the house. The energy conservation improvements for a house similar to our example house in Zone III B will pay for themselves in seven to nine years—and even more quickly if the improvements are installed by the homeowner. If the index numbers were higher, the improvements also would pay off more quickly. For example, with a Heating Index of 50, instead of 20, the recommended improvements (R-44 attic insulation, full-wall insulation, R-22 floor insulation, R-24 duct insulation, and storm windows on all suitable windows) would take only three to four years to pay back for this same house. Similarly, the more poorly insulated the house is to begin with, the shorter the payback period.

On the other hand, if the Heating Index number were less than 20 or if the house were better insulated to begin with, the payback period would be a little longer.

More important than the payback period are net savings. In our example house, R-19 insulation in the attic would cost less and pay back faster than the recommended R-30. But the long run net savings are greater with R-30 because each additional resistance unit—up to the recommended level—pays back more than it costs. The best combinations shown in this booklet have varying payback periods, but they always yield the *greatest net savings* over the long run.

Even though utility bills rise as energy prices increase, the rise will be much less than it would have been without increased insulation. In fact, you might think of energy conservation improvements as a hedge against inflation. (Are you beating inflation with your after-tax dividends from other investments?)

Even if you don't plan to live in your house long enough to reap the full return on your investment in the form of lowered utility bills, it will probably still pay to invest in energy conservation improvements now. Because of higher energy prices, a well-insulated house is likely to sell more quickly and at a higher price than a poorly-insulated house that costs a lot to heat and cool. Show your low fuel bills to prospective buyers. They will find the small increase in monthly mortgage payments will be more than offset by monthly fuel bill savings, possibly bringing the cost of living in the house within their reach. The increased value of the house alone might cover the cost to you of making the investment in energy conservation improvements.

# CAN YOU AFFORD YOUR INVESTMENTS?
## (Can you afford not to invest?)

You may have found that the amount of money needed to finance the best combination of energy conservation improvements is more than you can pay for all at once. If this is the case, you might consider taking a low-cost, long-term home improvement loan.

Whether it is to your advantage to borrow money depends to some extent on the existing condition of your house. A house that is poorly insulated compared to the levels recommended in this booklet requires a greater investment in energy conservation than a house which is close to these recommended levels. However, the poorly-insulated house will yield much greater savings on fuel bills after the improvements are made. This means that your investment will generally pay back fast enough to cover the monthly payments on a long-term home improvement loan. Once the loan is paid off, the additional savings are free and clear!

If you feel you just can't afford to invest in the best combination of energy conservation improvements for your house, you can still make the most of a limited energy conservation budget. Keep in mind the idea of a "balanced" combination—not spending too much on one improvement in relation to the other improvements.

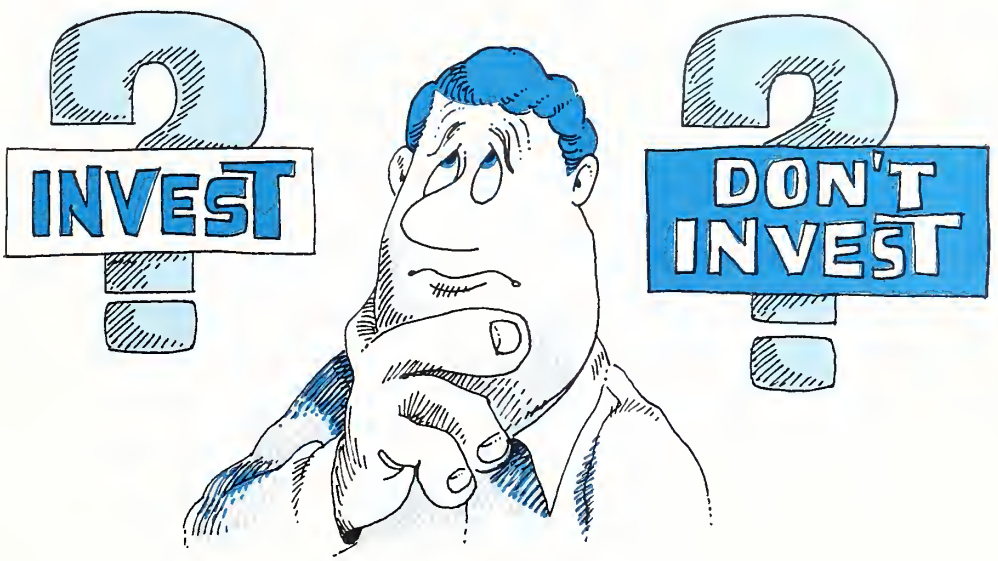
To find this less costly, but still balanced, combination of improvements, decrease each of the index numbers you used in Tables 4, 5, and 6 by the same percentage, say 20 percent. Use the new index numbers to find a new combination of improvements in these tables. Keep reducing your index numbers by the same percentage increments until you reach a balanced combination you can afford.

In the example house, we used index numbers of 25 in Table 4, 20 in Table 5, and 22 in Table 6. Reducing these by 40 percent, for instance, gives us new index numbers of 15, 12, and 13, respectively. Using these numbers gives us the following balanced combination:

| | Less Costly Combination | Best Combination |
|---|---|---|
| Attic insulation (batts) | R-19 | R-30 |
| Duct insulation (attics) | R-8 | R-16 |
| Floor insulation | R-11 | R-19 |
| Storm doors | none | optional |
| Wall insulation (blown-in) | full-wall | full-wall |
| Duct insulation (other areas) | R-8 | R-16 |
| Storm windows (minimum size) | 12 square feet | 9 square feet |

Based on our existing level of insulation, this new combination would cost about $750, compared to $1200 for the best combination. If this is still more than we can afford, we might reduce our index numbers by 50 percent or even 80 percent.

On the other hand, if you think that you will eventually add all of the recommended improvements in your best combination, but that it will take a year or two to get them all in, it is usually best to start with those which provide the first level of protection—such as insulation in places where none exists, storm windows, and weather stripping and caulking, where you have poorly fitting windows and doors. Add the others as you can afford them.



# Things you should know before

THE RECOMMENDED levels of insulation and other energy conservation improvements in this booklet will only return the maximum energy and dollar savings if they are properly installed. If you're not a do-it-yourself homeowner, check with several reliable contractors before deciding on a contract. If you plan to make these improvements yourself, always follow the manufacturer's instructions. For a step-by-step description of proper installation procedures, we recommend *In the Bank . . . or Up the Chimney?,* published by the Department of Housing and Urban Development (see inside back cover). But whether you do it yourself or use a contractor, there is some basic information you should know before you invest in energy conservation improvements.

## INSULATION RATINGS

It is always best to select insulation on the basis of cost per resistance unit—the so-called "R" value (usually made available by the manufacturer)—rather than on cost per inch. Durability and resistance to flame spread and vermin should also be considered.

Energy savings are provided by resistance to heat flow and not thickness *per se*. Two different kinds of insulation may have the same thickness, but the one with the higher R value will perform better. For example, loose-fill mineral fiber (glass fiber or rock wool) insulation may have an R value as low as 2.2 per inch, while mineral fiber batts have an R value of about 3 per inch. Even if batts cost 30 to 40 percent more than loose fill per inch, they might be a better investment.

Insulation batts are generally available in R-11 (about 4 inches thick), R-19 (about 6 inches), and R-22 (about 7 inches). If more than R-19 is recommended for your house, batts should be combined to make up the desired resistance. For example, R-30 may consist of an R-11 and an R-19 batt. Note that R values are additive.

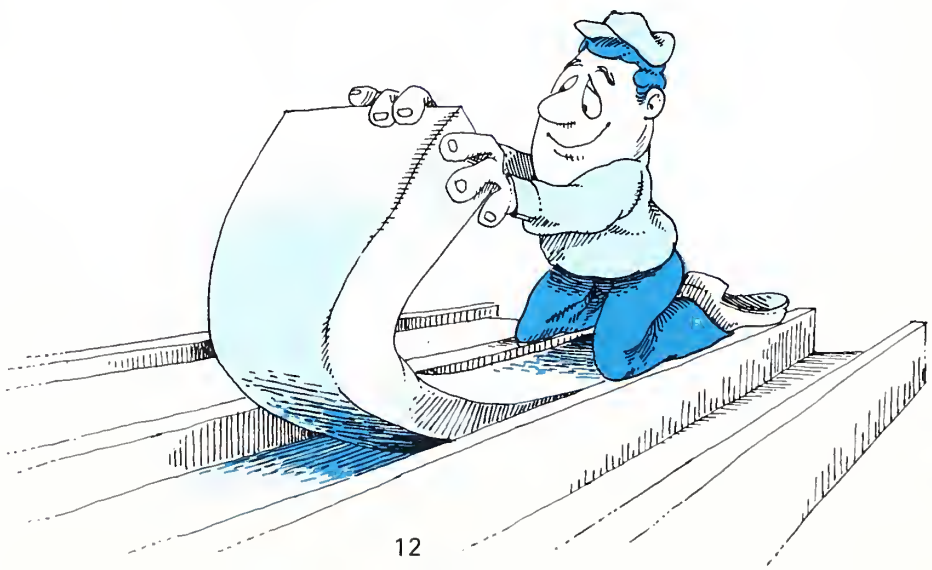
When adding insulation batts to existing insulation, you may not be able to get to our recommended levels exactly. In this case, try to get as close as you can—a little under or over won't make a large difference in your net savings.

## MOISTURE CONTROL

Insulation batts can be purchased with or without a "vapor barrier." This is the paper or foil covering on one side of the batt. The barrier retards water vapor, normally present in the house, from passing through or condensing in the insulation. The vapor barrier should face the living quarters of the house, unless a competent air conditioning specialist advises otherwise.

When combining batts or adding batts to existing insulation, additional vapor barriers should not be used beyond the barrier immediately facing the living quarters. If batts without vapor barriers cannot be found or cost more than faced batts, strip off the vapor barrier or slash it to allow any water vapor to pass through freely.

Before you install insulation in closed cavities (such as wallspaces), consult an insulation specialist about possible moisture problems. If water vapor is allowed to condense in the insulated space, it will lower the performance of the insulation and could damage the structure. In general, moisture problems can be prevented with proper installation of vapor barriers and adequate ventilation, but high humidifier settings should be avoided.



# you proceed

## INSULATION IN ATTICS AND CRAWLSPACES

Two basic kinds of insulation are available for floors of unheated attics. Both will do the job if they are properly installed. One type is preformed mineral fiber (glass fiber or rock wool) batts or blankets. The other type is cellulose or mineral fiber in loose-fill form.

When installing insulation in attics, you don't have to stop at the ceiling joists if the attic has no flooring, but insulation should not touch the roof at the eaves.

If you have a finished attic, check with an insulation specialist or one of the recommended books on the inside back cover for the proper procedure for installing insulation. In this case there may not be room to use the amount of insulation we recommend.

Preformed insulation batts may be more economical than loose-fill materials in an unobstructed attic area without flooring, if they fit snugly between the joists and you do the work yourself. You can add insulation to your attic in one afternoon using batts—they can be laid out easily and there is no need to staple them down.

Once the area between the joists is fully insulated, the greatest source of heat loss in the attic is through the joists themselves, which may cover as much as 10 percent of the attic. For this reason, when adding insulation batts above the level of the ceiling joists, cover the joists completely if possible.

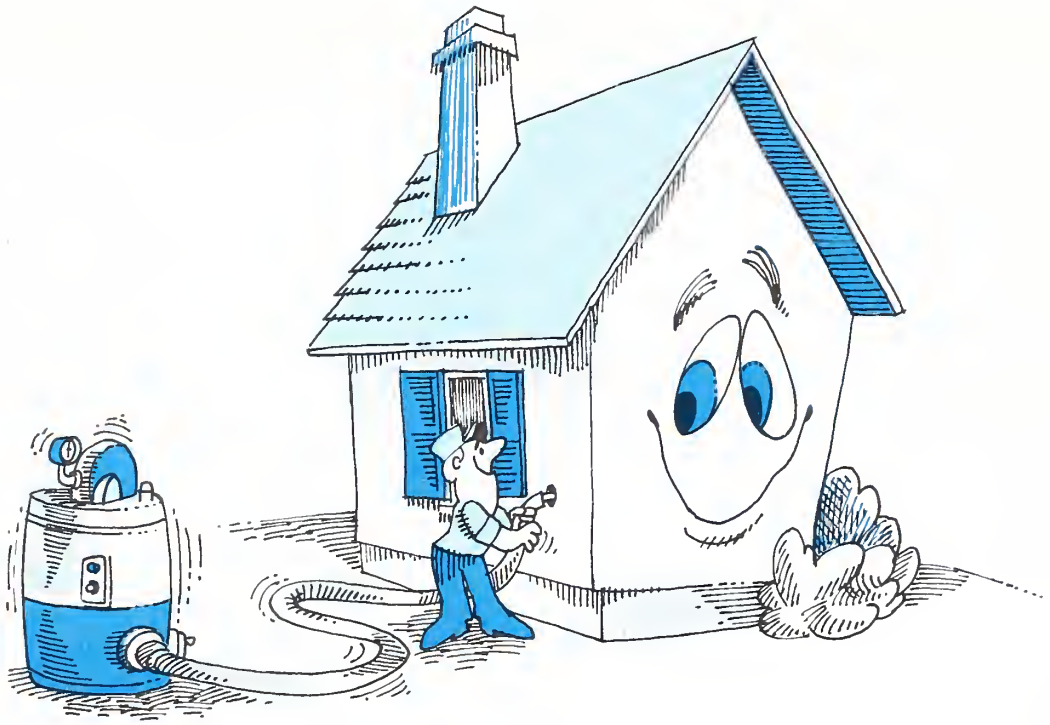
If you want to add R-19 or R-22 insulation to your existing insulation, it is usually best to add R-11 batts up to the level of the joists and cover the entire area with another layer of R-11 batts. Place the batts as close together as possible to prevent air from circulating between them.

Loose-fill insulation may be better if the access to your attic is difficult or if it has a floor. If flooring is present in an otherwise unfinished attic, you may have to remove some of it temporarily to allow insuation to be blown in. Loose insulation is usually blown into the attic through flexible tubing by a small machine which puffs up the insulation as it pushes it through the tube. This may cause some settling after the insulation is in place so you should take that into account when measuring the depth. Small holes should be drilled into tight fitting flooring at one-foot intervals to allow passage of any water vapor that may rise from the rooms below.

Density of loose-fill insulation is extremely important in assuring the proper resistance to heat flow. The manufacturer will generally specify the number of bags of loose-fill materials needed to achieve a given R value over a specific area. If a contractor is insulating your attic, you should verify that the proper number of bags has been used.

A well-insulated attic should also be well ventilated to prevent moisture accumulation problems. Never block ventilation ports and always provide at least two vent openings, located in such a way that air can flow in one and out the other. A good rule of thumb is to provide at least one square foot of opening for each 300 square feet of attic floor area.

During the inspection of your attic, you may notice interior wall spaces open to the attic, allowing cold air from the attic to fall down into the wall spaces or duct wells. These areas should be sealed off and covered with insulation.



## INSULATION IN EXTERIOR WALLS

Three or 4 inches of insulation properly placed in the air space can reduce the heat transfer through the walls by as much as two thirds. The best time to install insulation in the air space is while the house is being built. When the wall is open, it is almost always economical to fill the wall space with batt insulation. For example, unfinished garage walls next to heated areas of the house should be insulated with R-11 batts, except in the mildest climates.

Once a wall is finished off, it is usually difficult to reach the air space and insulation has to be blown or injected into the wall through small holes drilled between the wall studs. (This can be done from the outside or the inside, depending on the ease of sealing the holes and refinishing the surface.) Loose-fill materials, usually mineral fiber or cellulose, are the insulation forms best suited for this job. While this process is much more costly than adding batt insulation during construction, it may still be a good investment in many cases if done properly. Only an experienced contractor should be employed, however, as the process can be quite complicated and poor workmanship will greatly lower the quality of the finished work.

Loose-fill wall insulation is recommended in this booklet only for exterior walls with an air space at least 3 to 4 inches wide and with no existing insulation.

In some older houses, access can be gained to the wall space from the attic. In this case, loose-fill insulation material can be dropped into the space from above at very low cost, making this economical in all but the mildest climates with low fuel prices. (Make sure the insulation doesn't fall all the way into the basement!)

A potential problem with insulation in closed cavities in some climates is the possibility of moisture accumulation. This may be difficult to detect until moisture begins to show through the wall. If moisture problems occur, they can be minimized, however. The interior surface of the wall can be made vapor resistant with a paint or covering that has low-moisture permeability. Cracks around windows and door frames, electrical outlets, and baseboards should be sealed at the surface facing the room. Outside surfaces should not be tightly sealed but allowed to "breathe."

Another potential problem which you may encounter with blown-in insulation is settling or shrinkage. Generally, this problem can be avoided if the insulation is properly installed. Calculating the number of bags of material needed per square foot of wall area and assuring that these have been installed is the best way to avoid this problem.

## INSULATION UNDER FLOORS

Floors over unheated areas, such as crawlspaces, garages, or basements, can be a major source of heat loss in an otherwise well-insulated house. Everyone knows that hot *air* rises, but remember, heat flows to cold through solid surfaces in any direction— up, down, or sideways.

Water pipes in unheated areas should also be insulated if there is danger of freezing after the floor insulation has been installed. Crawlspaces can be closed off in winter, but must be well ventilated in summer to prevent the build-up of moisture from the ground and from the rooms above. In many areas it is a good idea to cover the ground under a crawlspace with plastic sheeting to reduce the moisture level in this area.

If your house is built on a concrete slab, it is sometimes possible to insulate around the edges of the slab. Consult an insulation specialist to find the best way to do this.

## INSULATION OF HEATING AND COOLING DUCTS IN UNHEATED AREAS

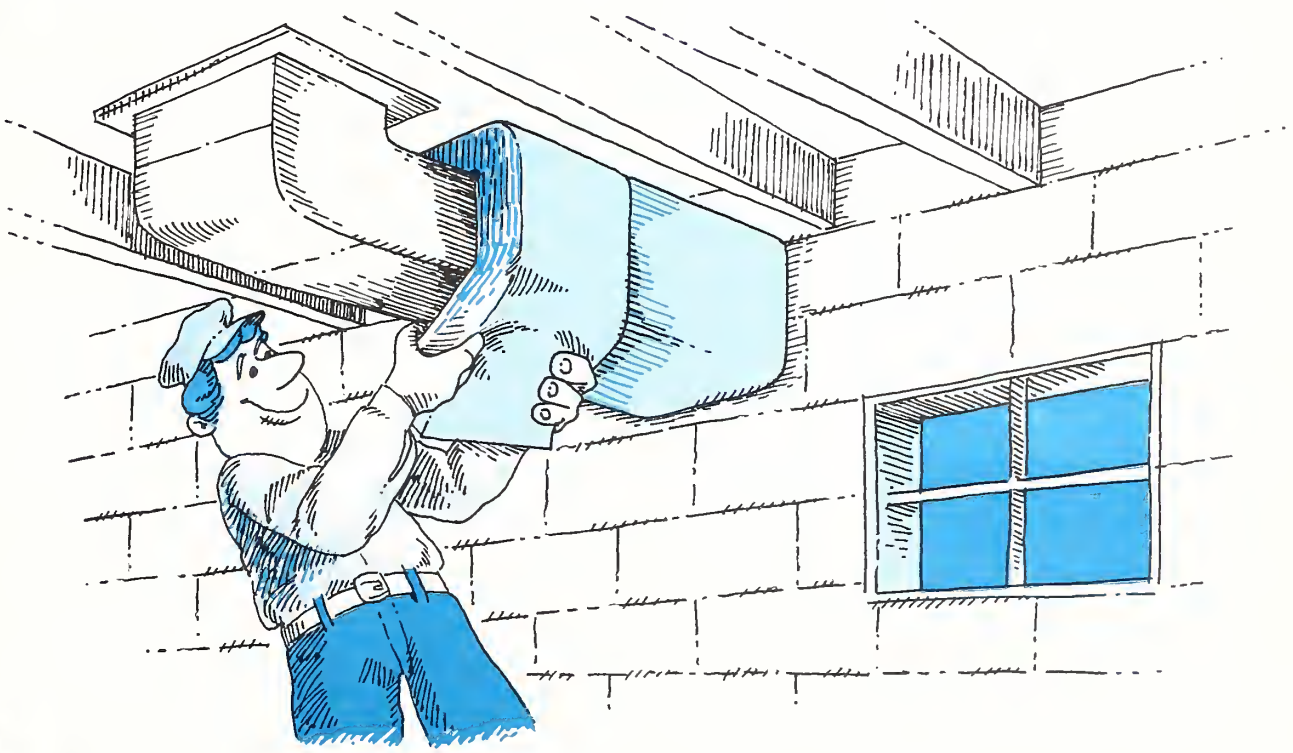
Heating and cooling ducts in attics, crawlspaces, and garages should be well insulated. Even if a sufficient amount of insulation exists, you might want to loosen it temporarily at the joints to check the condition of the ducts. Escaping air indicates the need for retaping of the duct joints.

Most houses have no more than 1 or 2 inches of insulation wrapped around ducts in unheated areas. As Tables 4 and 6 show, more is often desirable. Duct wrap in layers of 2-inch thicknesses may be used to insulate ductwork. As an alternative, ordinary mineral fiber batts can be placed around the ducts. Avoid crushing the insulation because this lowers its resistance to heat flow.

Where ductwork is used for heating purposes only, a vapor barrier is not usually needed. However, if ducts are used for air conditioning as well as heating, a vapor barrier is required around the outside of the insulation to prevent condensation on the ducts. In either case, some protective covering should be used. Check with insulation manufacturers for the correct procedure for your climate.

## STORM WINDOWS AND DOORS

Storm windows and doors vary widely in basic design, durability, and cost. Storm windows range from single glass panels, that must be put in place each fall and removed each spring, to permanent triple-track assemblies, which include sliding upper and lower windows and a



screen. Triple-track windows can be used both during heating and cooling periods and can be opened for natural ventilation at other times. Because they are left in place permanently, wear and tear and the chance of breakage is minimized.

You should be aware that it is not the storm window itself that keeps the warmth inside in winter and outside in summer. It is actually the dead air space—at least 3/4 inch—between the two windows that saves energy. For this reason a plastic sheet, placed over the window in such a way to create a dead air space, will work nearly as well as more permanent storm windows. If you want to put off buying storm windows for a year or so, you might consider this as a temporary solution.

The size of the storm window is determined by the size of the window frame and not by the glass area. Storm windows should be properly installed and fit tightly to do the most good. To assure a tight fit, permanent storm windows should be sealed to the outer window frame with caulking compound or other sealing material. Storm window frames should have a tiny opening at the bottom to allow water vapor to escape.

Storm windows are generally more economical than double pane windows in existing houses, because they usually cost less to install and they reduce infiltration of air around the window sash. Where double pane windows already exist, it may still pay you to use storm windows over the larger windows (15 to 20 square-foot range) when your Index Number in Table 6 is greater than 50.

Storm doors may not always be economical when considered for winter heating savings alone unless the doorways are frequently used. However, they may still be a good investment, since they can be used as a screen door in the summer months if they have interchangeable glass and screen inserts. If your house already has a screen door, it generally will not pay to replace it with a storm door unless it is shown to be economical for your Index Number in Table 5. Storm doors over doors with inset glass areas save more energy than those over solid doors.

Storm windows and doors vary greatly in price. In general, custom-made windows and doors are more expensive, but they may fit better and last longer.

## WEATHER STRIPPING AND CAULKING

In a well-insulated house the largest source of heat loss is from air leaks, especially around windows and doors. Good weather stripping and caulking of exterior window and door frames will not only reduce the heat loss in winter and heat gain in summer, but they will reduce uncomfortable drafts as well.

Weather stripping and caulking are generally economical in all climates, if you install them yourself. This is especially true for drafty windows and doors.

Weather stripping is available in a wide selection of shapes and materials. Caulking materials vary greatly in quality as well. More durable varieties will not have to be replaced as often, which is an important consideration.

When weather stripping, don't overlook hatches to your attic. Even small cracks allow large amounts of warm air to be lost during a heating season.

## VENTILATION

Some people think that a tightly sealed, well-insulated house does not allow sufficient air circulation to maintain a healthy environment. In most houses, 70 to 100 percent of inside air is exchanged with outside air every hour. Actually, only a 20 percent hourly air change is needed for normal ventilation purposes. It is most unlikely that an existing house could be sealed up that tightly by these energy conservation improvements alone.

In new houses with tight construction it may be necessary to provide a separate combustion air inlet to the furnace. In both existing and new houses it is more economical to remove moisture and odors from kitchens and baths by localized exhaust fans than to provide continuous, uncontrolled air infiltration.

# PLANNING AHEAD

We hope this booklet has provided some fresh insight into energy conservation planning in your house. Our basic purpose has been to save you—the homeowner—the maximum number of dollars in heating and cooling your house. Because energy prices are on the rise, most homeowners can't afford to overlook the potential savings from energy conservation measures over the years to come. Investing in the energy conservation improvements described in this booklet will not only reduce your monthly fuel bills, but will give you the greatest, long run net savings. By planning ahead, you can make the most of your energy dollars.

# FOR MORE INFORMATION . . .

**General information on energy conservation in home heating and cooling operations**

| | |
|---|---|
| *7 Ways to Reduce Fuel Consumption in Household Heating—Through Energy Conservation,* | published by the National Bureau of Standards, U.S. Government Printing Office, Washington, D.C. 20402 (C13.2:F95), $0.35. |
| *11 Ways to Reduce Energy Consumption and Increase Comfort in Household Cooling,* | published by the National Bureau of Standards, U.S. Government Printing Office, Washington, D.C. 20402 (C13.2:EN2), $0.40. |
| *Energy Efficiency in Room Air Conditioners,* | published by the National Bureau of Standards, single copies free from the Consumer Information Center, Pueblo, Colorado 81009. |
| *Tips for Energy Savers,* | published by the Federal Energy Administration, free from the Office of Public Affairs, Federal Energy Administration, Washington, D.C. 20461. |

**Specific information on making energy conservation improvements in existing houses**

| | |
|---|---|
| *Insulation Manual, Homes/Apartments,* | published by the National Association of Home Builders Research Foundation, Inc., P.O. Box 1627, Rockville, Maryland 20850, $4.00. |
| *In the Bank . . . Or Up the Chimney?* | For information write to the Department of Housing and Urban Development, Washington, D.C. 20410. |
| *How to Save Money by Insulating Your Home,* | published by National Mineral Wool Association, 382 Springfield Avenue, Summit, New Jersey 07901, $0.30. |

For more information on mineral wool insulation write to the National Mineral Wool Association, 382 Springfield Avenue, Summit, New Jersey 07901.

For more information on cellulose insulation write to the National Cellulose Insulation Manufacturers Association, 400 West Madison Street, Chicago, Illinois 60606.

For more information on storm windows and doors write to Architectural Aluminum Manufacturers Association, 35 East Wacker, Chicago, Illinois 60611.

The policy of the National Bureau of Standards is to encourage and lead in national use of the metric system, formally called the International System of Units (SI). For the convenience of the homeowner this booklet uses customary units since building materials in the United States almost always are sold in this manner.

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