energy conservation for virginia homes

tech tran report

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ACKNOWLEDGMENT

Most of the information in this publication is taken from a study report issued by the National Bureau of Standards entitled, "Retrofitting Existing Housing for Energy Conservation: An Economic Analysis", written by Stephen R. Peterson. This report is technical in nature and was not intended to be a homeowner's guide to improvements for energy saving.

This publication is intended to do two things: (1) simplify the information in the NBS report so it can be understood by non-technical personnel; and (2) adopt the results specifically to the climatic conditions of Virginia.

virginia state technical services

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INTRODUCTION

This publication provides a method for determining optimum investments for reducing energy use in residential space heating and cooling. It provides proof that more investment in thermal improvements for both existing and new buildings makes good sense in terms of long-term energy and dollar savings. The homeowner who responds to his best economic interests will, in most cases, increase his energy conservation efforts.

Only those energy conservation methods which offer substantial energy savings have been considered.

These are:

(1) Attic Insulation

(2) Wall Insulation

(3) Floor Insulation

(4) Duct Insulation in Unheated Areas

(5) Storm Windows

(6) Storm Doors

(7) Weather Stripping

It is of major importance to note that the procedure outlined herein is not set up to determine in a general nature the amount of insulation for homes, but rather provide a system whereby each individual homeowner can determine the optimum for his situation. The procedure can be used for either a new house being constructed, or for existing houses.

ECONOMICS

The economic goals are directed toward two basic applications. The first is to determine the most profitable application of specific energy conservation methods. The second is to select the most economical combination of energy conservation methods for any given investment size. No other combination will generate greater dollar energy savings for the same or lesser total cost, and the last dollar spent on each method will generate the same energy savings.

TECHNIQUES FOR USING DATA

Climatic Zones

The data in this publication is based on degree-days which are determined as follows: The degree-day unit is based on temperature difference and time with 65^{0} F. as the base. For any day when the average temperature is below 65^{0} F., the difference between 65^{0} F. and the average temperature equals the number of degree-day units for that day. Thus, on a day when the average temperature is 40° F., there are 25 degree-days. The number of degree-days, of course, varies from year to year, so degree-day charts show an average over some number of years.

The state of Virginia has been divided into two climatic zones. Zone III has an average of 5,000 degree-days per year while Zone II has 4,000. For further convenience, the line between these zones has been drawn along county lines. This climatic zone map for Virginia is shown in Figure 2, page 11. The zones are numbered in accordance with a national map developed by the National Bureau of Standards.

ENERGY COSTS

After the proper climatic zone has been determined, the homeowner must next determine energy costs per 100,000 Btu from Table I, page 12. First, depending on the type heating system used, energy costs must be determined per kilowatt hour for electricity, per gallon for fuel oil, per therm for natural gas, or per ton for coal. Fuel oil costs are generally known. However, the cost of natural gas and electricity may have to be calculated from the monthly bill by dividing kilowatt hours into the total cost for electric bill, or therms into total cost for natural gas. Cost ranges for these fuels at present are shown below.

Natural Gas $/therm	#2 Fuel Oil $/gal.	Electricity $/kwh	Coal $/ton
.15-.30	.35-.45	.02-.05	40-60

After determining the unit energy cost, the next step is to determine from Table I the cost per 100,000 Btu. This is done by locating the type heating system used, then moving horizontally until the unit energy cost is found. If the exact cost is not shown, the next closest value should be used. Move vertically upward to the row marked "cost per 100,000 Btu delivered" and note the cost shown there.

If either a natural gas or a fuel oil furnace is used, the efficiency of the unit must be estimated before cost per 100,000 Btu can be determined. Generally, if the furnace is several years old and has not been cleaned or maintained on a yearly basis, a 50% efficiency factor should be used. If it has been cleaned and checked regularly by a reputable heating contractor, a 70% factor should be used.

As an example, consider a ten year old home with an oil furnace that has not been cleaned and maintained yearly, and assume fuel oil costs of 39 cents per gallon. Using line 2 of Table I, it is determined that 39 cents lies between .32 and .42, therefore, the 42 cent value should be used. Following this column vertically to the top of the chart, it is determined that the cost per 100,000 Btu is 60 cents. This figure plus the climatic zone number is then used for entrance into the tables for optimum energy conservation combinations.

OPTIMUM ENERGY CONSERVATION COMBINATIONS

Tables II through V have been developed to provide energy conservation techniques that are balanced to provide equal dollar return for each technique. By determining the climatic zone, the energy costs per 100,000 Btu's, and whether or not the house is air conditioned, the homeowner can determine from these tables the optimum combination of conservation methods for his specific application. These tables provide the recommended amount of insulation for the attic, walls, floor and exposed ducts as well as recommendations on storm windows and storm doors. The pay back period in years for each of these catagories is also provided.

The first column under the heading of Attic provides information for attics that have no insulation, and the homeowner is given three (3) options of materials that he may use. These are shown as (A), (B), and (C) under the subheading, None, and are specified in the footnotes. The next column under attic is designated R-11 and is to be used for attics which have an insulation material equivalent to 3 1/2 inches of glass fiber blanket. The inches of insulation shown in this column are those recommended to be added to the existing insulation, and again, the homeowner has the option as to the type of insulation he prefers.

The next column entitled Walls, deals with insulation in the walls, and since the thickness is limited by the wall thickness, the recommended values appear either as 0 or as 3.5 inches. The installation of insulating material in existing walls can present difficult problems and further information and recommendations are given in the following sections.

Recommendations for floors over unheated areas are given in the next column designated as Floors. Again, there are options for both floors that have existing insulation and those that have none. It should be noted that this applies only to floors over unheated areas such as basements, crawl space or garage.

Exposed heating ducts are examined next. Glass fiber duct wrap is the only insulation considered here.

The next two columns have recommendations on storm windows and storm doors.

Because these are balanced combinations providing equal return on the dollar investment, the homeowner should follow the recommended values as closely as possible. If the cost of all the combinations is excessive, then he should consider the next line above which provides less overall insulation at a lower cost but still gives a balanced combination. On the other hand, he may also consider that fuel costs are projected to increase further, and he may wish to use a higher level combination which is on the next line below.

Example:

Location - Blacksburg
Type of Heat - Electric Resistance
Air Conditioned - No
Heating Cost - $81.70 electric bill for 3307 kwh.

Solution:

1. From map of Figure 1, house is in Zone III.

2. Energy cost is $81.70 divided by 3307 = $.024/kwh.

3. From Table I, row 3, move horizontally to .02, then vertically up to $0.60 per 100,000 Btu.

4. From item 1 above, Table II is selected.

5. From item 3 above, find $0.60 under column entitled, Energy Prices, which is row d. This row defines the optimum energy conservation methods for the house selected above.

Page 10 shows a step-by-step procedure for determining optimum methods.

PRACTICAL CONSIDERATIONS FOR RETROFITTING

Insulation in Attic Spaces

Two (2) basic forms of attic insulation are considered. The first is preformed glass or mineral fiber blankets; the second is loose fill materials generally made of cellulose or glass fiber. The blankets - or batts - may be more easily installed by the do-it-yourself homeowner since these can be rolled out quickly and minimize the raising of fibers into the air which create an uncomfortable working environment. The loose fill material has an advantage of filling cracks and crevices, particularly around flues and other such obstructions protruding through the attic.

If no previous insulation exists, foil faced vapor barrier batts should be used, with the foil facing downward. This procedure prevents moisture, arising from the room below, from penetrating the insulation. When adding batts over existing insulation, it is preferable to install unfaced batts. These are generally cheaper and prevent moisture from condensing in the existing insulation. If unfaced batts are not available, faced batts can be used if the facing is stripped off or slashed at frequent intervals to allow free passage of moisture.

There is no reason to restrict depth of attic insulation to the height of the ceiling joists if more insulation is warranted. When installing blankets or batts above the joists it may be useful to run the batts perpendicular to the joists to cover the attic more thoroughly.

It is essential that a well insulated attic be well ventilated. Otherwise condensation during the heating months may cause temporary or permanent damage to the insulation and increase the heat flow.

Insulation in Exterior Walls

Applying insulation to existing exterior walls is the most difficult of all the energy conservation methods considered in this study. The homeowner should undertake such a project only after securing the best technical advice available and carefully selecting a firm to do the work. Chose a reliable firm with considerable experience, for it is nearly impossible to check on the quality of work done inside the wall, and doing the job right requires skill and time.

Retrofitting insulation into exterior walls requires that access to the air space be gained through the outside or inside wall. This procedure presents several problems:

1. It is relatively costly.

2. It is difficult to monitor the quality of work done both at the time of insulation and at periodic intervals later in time.

3. A vapor barrier can not be placed between the interior wall and the insulation so that possible water damage from condensation can result. This damage can not be detected until it begins to show through the wall.

4. It may be difficult to restore the wall through which access was made to its original condition.

Loose fill glass or mineral fiber is not considered adequate for such applications because of its low density, and tendency to hang up in the wall, cellulor plastics, such as polyurethane and polystyrene, are no longer being used because of potential fire and gas hazards. Polyurethane also expands with greater pressure than other foams and can cause some problem with bursting walls.

Cellulose is frequently used as is urea-formaldehyde, although the latter does emit a formaldehyde odor into the house after installation if not properly vented. Neither have sufficient permeability to be considered as a vapor barrier.

Insulation Under Floors

Insulation under floors is generally overlooked because many homeowners believe that heat flow downward is not a problem. This belief is not correct, however, because heat flows to cold in any direction. When the basement is heated, no insulation in the floor is warranted. Insulation batts are the only practical material to be used under floors. Most insulation manuals show various techniques for installing these batts.

As in the case of attic insulation, when adding preformed batts to existing insulation, it is preferable to use unfaced blankets or batts. When adding new insulation, the facing should be toward the floor.

Insulation of Exposed Ducts

Heating and cooling ducts which run through unconditioned spaces can be a major source of heat loss if not properly taped and insulated. Duct wrap insulation is available in a wide variety of widths. It is generally not available in thicknesses greater than 2 inches. When more than 2 inches are indicated, several layers of duct wrap should be used. Unfaced wrap should be installed beneath the outer layer. A heavy foil face is usually used on the outer layer as a vapor barrier during space cooling operations. Even when a sufficient amount of insulation exists, it may be worthwhile removing this temporarily to check on the condition of the ducts. Escaping air indicates the need for retaping the joists. This repair is especially important if the warm air in a duct is humid, as condensation will result inside the moisture barrier surrounding the insulation.

Storm Windows and Doors

Storm windows and doors vary widely in basic design, durability, and cost. Storm windows having triple track assemblies which include sliding upper and lower windows and a screen are recommended for double hung windows and sliding casement windows. They can be left in place permanently, thereby, encouraging their use during winter heating and summer cooling while allowing windows to be left open for natural ventilation during the mild weather seasons. Their use minimizes wear and tear on the windows and a chance of breakage. Storm doors with interchangeable glass and screen inserts are recommended because such doors can be used for ventilation during the non-heating months when needed. Storm doors over primary doors with substantial windows area are more likely to be cost effective than those over solid doors.

Judgement factors should be used in the application of storm windows and doors. For example, a house that is exposed to high prevailing winds may have a greater need for storm windows and doors than are reflected in this study.

Weather Stripping

In this study, it is assumed that weather stripping is utilized extensively. When properly installed, it can be quite effective in reducing the rate of infiltration through cracks around windows and doors. Good weather stripping will not only cut heat losses, but will reduce uncomfortable drafts as well.

Maintenance

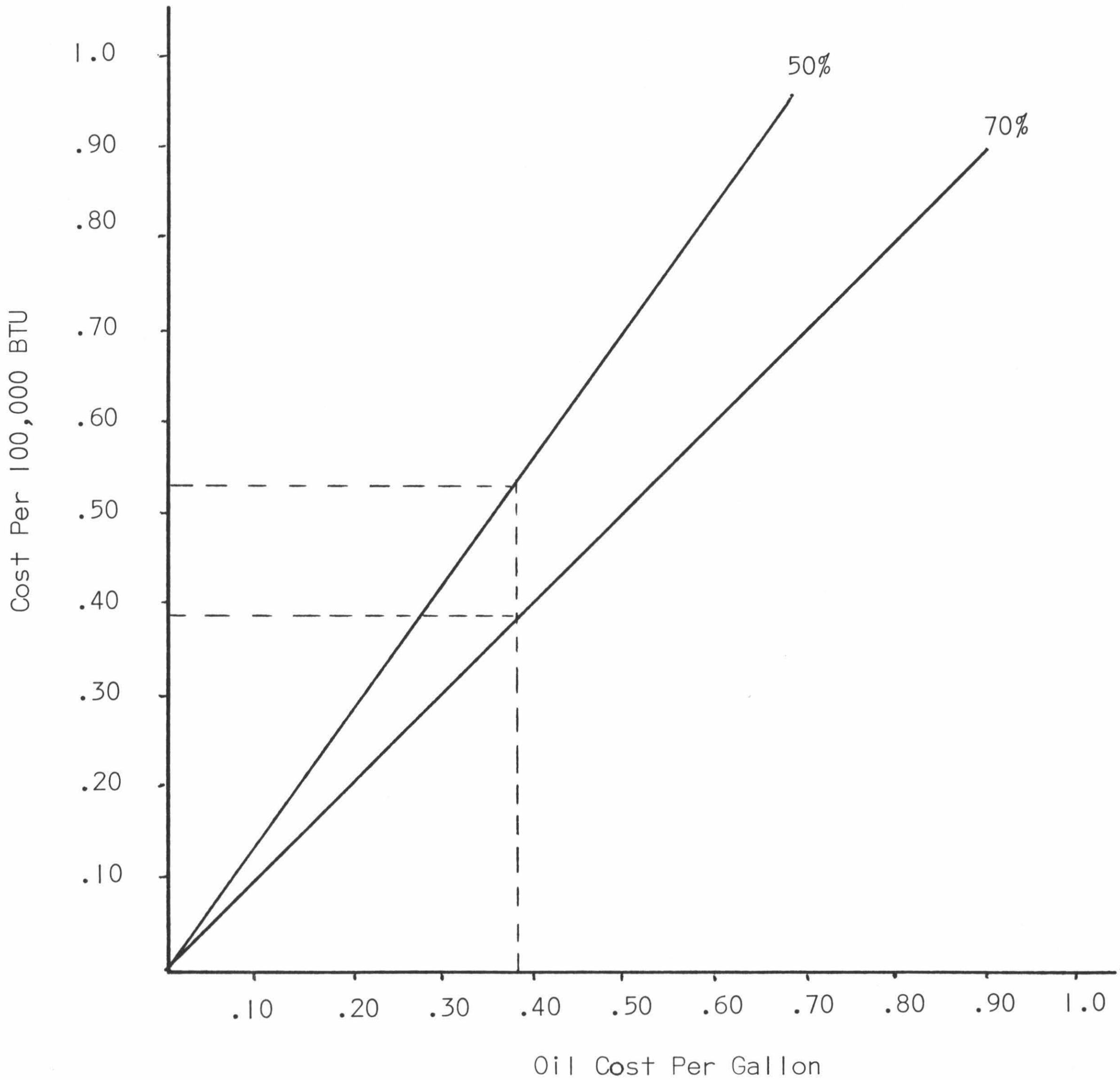
Furnace efficiency can have a tremendous impact on heating costs. For this reason, it is beneficial to assure that the furnace is operating at its most efficient level at all times. Generally, having the furnace checked once a year by a competent service company is adequate. Figure I page 9, shows the difference in energy cost between 50% and 70% efficiencies.

Electric baseboard units should be vacuumed periodically to prevent dust build-up, which reduces efficiency.

Reference Insulation Manuals

"The Why, What and How of Home Insulation"
VPI&SU Extension Publication #656

"Insulation Manual Home Apartments"
NAHB, Research Foundation, Inc.
627 Southlawn Lane
P. O. Box 1627
Rockville, Maryland 20850



FURNACE EFFICIENCY CURVES

Figure 1

PROCEDURES FOR DETERMINING OPTIMUM ENERGY CONSERVATION METHODS FOR HOMES

1. DETERMINE CLIMATIC ZONE FROM FIGURE 2.

2. DETERMINE ENERGY COSTS PER KILOWATT HOUR FOR ELECTRIC HEAT OR HEAT PUMP, PER GALLON FOR FUEL OIL, PER THERM FOR NATURAL GAS, OR PER TON FOR COAL.

3. DETERMINE FUEL COSTS PER 100,000 BTU FROM TABLE I.

4. SELECT PROPER CHART FROM TABLES II THROUGH V BASED ON ZONE AND WHETHER OR NOT HOME IS AIR CONDITIONED.

5. LOCATE COST DERIVED IN STEP 2, IN COLUMN MARKED, "ENERGY PRICES - HEATING". THIS LINE DEFINES THE OPTIMUM ENERGY CONSERVATION COMBINATION FOR THE PARTICULAR APPLICATION.

6. IF A LESS EXPENSIVE COMBINATION IS DESIRED, USE A LOWER ENERGY PRICE IN STEP 5. IF MORE INSULATION IS DESIRED, USE A HIGHER ENERGY PRICE IN STEP 5.

CLIMATIC ZONES

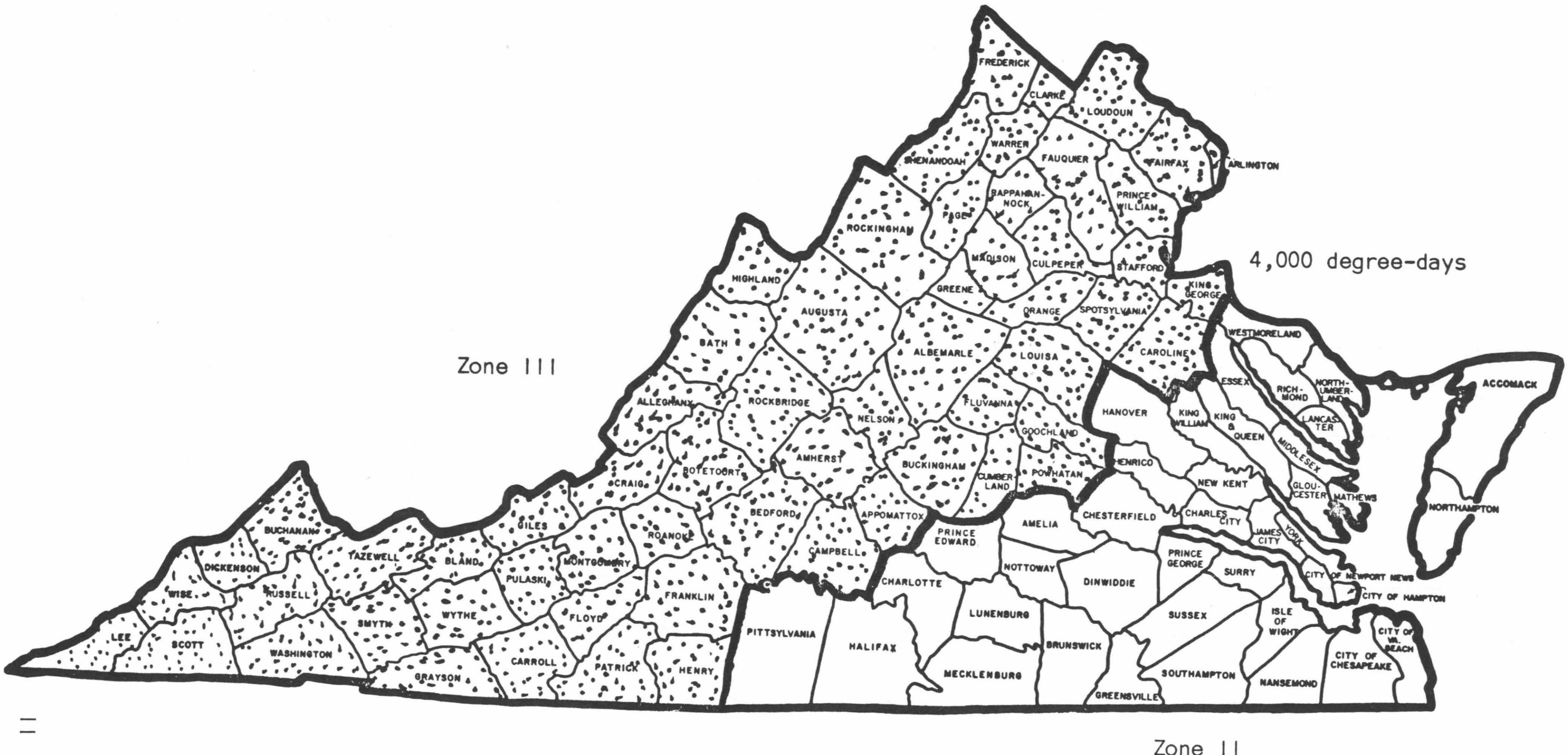


Figure 2

TABLE I

FUEL COSTS NORMALIZED TO 100,000 Btu OUTPUT

A. HEATING

Cost per 100,000 Btu delivered		$0.15	$0.30	$0.45	$0.60	$0.90	$1.20	$1.50
1. Natural gas (100,000 Btu/therm)								
	a. 50% efficiency	.075	.15	.23	.30	.45	-----	-----
$/therm								
	b. 70% efficiency	.105	.21	.32	.42	.63	-----	-----
2. #2 fuel oil (140,000 Btu/gallon)								
	a. 50% efficiency	.105	.21	.32	.42	.63	-----	-----
$/gallon								
	b. 70% efficiency	.15	.30	.44	.59	.89	-----	-----
3. Electric resistance (3413 Btu/kWh)								
$/kWh	100% efficiency	.005	.01	.015	.02	.03	.04	.05
4. Electric heat pump (6826 Btu/kWh)								
$/kWh seasonal COP=2 (EER=6.826)		.01	.02	.03	.04	.06	.08	.10
5. Coal (12,000 Btu/lb.)								
$/ton	55% efficiency	20.00	40.00	60.00	80.00	120.00	160.00	200.00

TABLE II

OPTIMUM ENERGY CONSERVATION COMBINATIONS

Zone III Without Air Conditioning

5000 Degree Days: 0 Cooling Hours

ELEMENT	ATTIC						WALL		FLOOR Over Unheated Area[1]		EXPOSED DUCTS	ENERGY PRICES Dollar Cost per 100,000 Btu's Delivered	ELEMENT	STORM WINDOWS[2] (Triple Track)	STORM DOORS[3]	
Existing Insulation	None			R-11*			None		None	R-11*	None					
Material Used	A	B	C	A	B	C	B	C	B		D	Heating				
Additional Inches	5"	5"	4"	0	0	0	3.5"	3.5"	4"	0	3"	$.15		3' x 4'	0	a
Years To Pay Back	(7)	(6)	(7)	(0)	(0)	(0)	(5)	(8)	(11)	(0)	(2)		Years To Pay Back	(15)	(0)	
Additional Inches	8"	8"	6"	2"	4"	2"	3.5"	3.5"	5"	2"	5"	$.30		2' x 3'	0	b
Years To Pay Back	(4)	(4)	(4)	(8)	(13)	(8)	(2)	(11)	(6)	(5)	(2)		Years To Pay Back	(8)	(0)	
Additional Inches	10"	10"	7"	6"	5"	4"	3.5"	3.5"	8"	4"	6"	$.45		2' x 2'	0	c
Years To Pay Back	(3)	(3)	(3)	(13)	(9)	(13)	(2)	(7)	(5)	(16)	(1)		Years To Pay Back	(5)	(0)	
Additional Inches	12"	11"	8"	8"	8"	5"	3.5"	3.5"	8"	5"	7"	$.60		2' x 2'	0	d
Years To Pay Back	(3)	(2)	(3)	(10)	(8)	(10)	(1)	(5)	(4)	(10)	(1)		Years To Pay Back	(4)	(0)	
Additional Inches	5"	14"	10"	11"	11"	7"	3.5"	3.5"	10"	6"	8"	$.90		2' x 2'	x/30%	e
Years To Pay Back	(2)	(2)	(2)	(9)	(7)	(9)	(1)	(4)	(3)	(9)	(1)		Years To Pay Back	(3)	(10)	
Additional Inches	8"	17"	11"	13"	14"	8"	3.5"	3.5"	10"	6"	9"	$1.20		2' x 2'	x/10%	f
Years To Pay Back	(2)	(2)	(2)	(8)	(6)	(7)	(1)	(3)	(2)	(6)	(1)		Years To Pay Back	(2)	(10)	
Additional Inches	22"	17"	12"	15"	15"	9"	3.5"	3.5"	10"	6"	10"	$1.50		2' x 2'	x/0%	g
Years To Pay Back	(2)	(2)	(2)	(7)	(5)	(6)	(1)	(2)	(2)	(4)	(1)		Years To Pay Back	(2)	(10)	

*Equivalent to 3 1/2" of Glass Fiber Batt/Blanket Insulation
A - Loose Fill Glass Fiber (R-2.2 per inch)
B - Glass Fiber Batt/Blanket (R-3.1 per inch) (not applicable to finished walls)
C - Loose Fill Cellulose Fiber (R-3.7 per inch in attic/R-3.3 per inch in walls)
D - Glass Fiber Duct Wrap (R-4 per inch)

1. Floor Over Unheated Basement, Crawlspace or Garage
2. Minimum Economical Size Payback for 3' x 5' Storm Window
3. Refers to Minimum Glass Composition of Primary Door That Makes Storm Door Economical (10 year life)

TABLE III

OPTIMUM ENERGY CONSERVATION COMBINATIONS

Zone III With Air Conditioning

5000 Degree Days: 750 Cooling Hours

ELEMENT	ATTIC						WALL		FLOOR Over Unheated Area[1]		EXPOSED DUCTS	ENERGY PRICES Dollar Cost per 100,000 Btu's Delivered	ELEMENT	STORM WINDOWS[2] (Triple Track)	STORM DOORS[3]	
Existing Insulation	None			R-11*			None		None	R-11*	None					
Material Used	A	B	C	A	B	C	A	B	B		D	Heating				
Additional Inches	7"	6"	5"	0"	4"	2"	3.5"	3.5"	4"	0"	3"	$.15		3' x 4'	0	a
Years To Pay Back	(5)	(4)	(5)	(0)	(16)	(20)	(4)	(15)	(11)	(0)	(2)		Years To Pay Back	(13)	(0)	
Additional Inches	10"	10"	6"	5"	5"	3"	3.5"	3.5"	5"	2"	5"	$.30		2' x 3'	0	b
Years To Pay Back	(4)	(3)	(3)	(14)	(11)	(14)	(2)	(9)	(6)	(9)	(2)		Years To Pay Back	(7)	(0)	
Additional Inches	12"	11"	8"	7"	6"	5"	3.5"	3.5"	8"	4"	6"	$.45		2' x 2'	0	c
Years To Pay Back	(3)	(3)	(3)	(11)	(8)	(11)	(2)	(6)	(5)	(16)	(1)		Years To Pay Back	(5)	(0)	
Additional Inches	13"	12"	9"	8"	8"	6"	3.5"	3.5"	8"	5"	7"	$.60		2' x 2'	0	d
Years To Pay Back	(3)	(2)	(3)	(10)	(8)	(10)	(1)	(5)	(4)	(12)	(1)		Years To Pay Back	(4)	(0)	
Additional Inches	16"	14"	11"	12"	11"	8"	3.5"	3.5"	10"	6"	8"	$.90		2' x 2'	x/30%	e
Years To Pay Back	(2)	(2)	(2)	(8)	(6)	(8)	(1)	(3)	(3)	(9)	(1)		Years To Pay Back	(3)	(10)	
Additional Inches	19"	17"	12"	15"	14"	9"	3.5"	3.5"	10"	6"	9"	$1.20		2' x 2'	x/10%	f
Years To Pay Back	(2)	(2)	(2)	(7)	(5)	(6)	(1)	(2)	(2)	(6)	(1)		Years To Pay Back	(2)	(10)	
Additional Inches	22"	20"	14"	16"	17"	11"	3.5"	3.5"	10"	6"	10"	$1.50		2' x 2'	x/0%	g
Years To Pay Back	(2)	(2)	(2)	(6)	(5)	(6)	(1)	(2)	(2)	(5)	(1)		Years To Pay Back	(2)	(10)	

***Equivalent to 3 1/2" of Glass Fiber Batt/Blanket Insulation**
A - Loose Fill Glass Fiber (R-2.2 per inch)
B - Glass Fiber Batt/Blanket (R-3.1 per inch) (not applicable to finished walls)
C - Loose Fill Cellulose Fiber (R-3.7 per inch in attic/R-3.3 per inch in walls)
D - Glass Fiber Duct Wrap (R-4 per inch)

1. Floor Over Unheated Basement, Crawlspace or Garage
2. Minimum Economical Size Payback for 3' x 5' Storm Window
3. Refers to Minimum Glass Composition of Primary Door That Makes Storm Door Economical (10 year life)

TABLE IV

OPTIMUM ENERGY CONSERVATION COMBINATIONS

Zone II Without Air Conditioning

4000 Degree Days: 0 Cooling Hours

ELEMENT	ATTIC						WALL		FLOOR Over Unheated Area[1]		EXPOSED DUCTS	ENERGY PRICES Dollar Cost per 100,000 Btu's Delivered	ELEMENT	STORM WINDOWS[2] (Triple Track)	STORM DOORS[3]	
Existing Insulation	None			R-11*			None		None	R-11*	None					
Material Used	A	B	C	A	B	C	B	C	B		D	Heating				
Additional Inches	5"	4"	3"	0	0	0	3"	0"	4"	0"	3"	$.15		4' x 5'	0	a
Years To Pay Back	(8)	(6)	(8)	(0)	(0)	(0)	(6)	(0)	(14)	(0)	(2)		Years To Pay Back	(23)	(0)	
Additional Inches	7"	6"	5"	0"	4"	0"	3.5"	3.5"	4"	0"	4"	$.30		3' x 3'	0	b
Years To Pay Back	(5)	(4)	(5)	(0)	(17)	(0)	(3)	(13)	(7)	(0)	(2)		Years To Pay Back	(12)	(0)	
Additional Inches	9"	10"	6"	4"	4"	3"	3.5"	3.5"	6"	4"	5"	$.45		2' x 3'	0	c
Years To Pay Back	(4)	(4)	(4)	(15)	(10)	(15)	(2)	(9)	(6)	(20)	(1)		Years To Pay Back	(8)	(0)	
Additional Inches	11"	10"	7"	6"	6"	4"	3.5"	3.5"	6"	4"	6"	$.60		2' x 3'	0	d
Years To Pay Back	(4)	(3)	(4)	(13)	(10)	(12)	(2)	(7)	(4)	(15)	(1)		Years To Pay Back	(6)	(0)	
Additional Inches	13"	12"	9"	9"	10"	6"	3.5"	3.5"	10"	6"	7"	$.90		2' x 2'	0	e
Years To Pay Back	(3)	(2)	(3)	(10)	(8)	(10)	(1)	(5)	(4)	(11)	(1)		Years To Pay Back	(4)	(0)	
Additional Inches	16"	16"	10"	11"	12"	7"	3.5"	3.5"	10"	6"	8"	$1.20		2' x 2'	x/40%	f
Years To Pay Back	(3)	(2)	(2)	(9)	(7)	(8)	(1)	(4)	(3)	(8)	(1)		Years To Pay Back	(3)	(10)	
Additional Inches	13"	16"	11"	13"	12"	8"	3.5"	3.5"	10"	6"	9"	$1.50		2' x 2'	x/20%	g
Years To Pay Back	(2)	(2)	(2)	(8)	(6)	(7)	(1)	(3)	(3)	(7)	(1)		Years To Pay Back	(3)	(10)	

*Equivalent to 3 1/2" of Glass Fiber Batt/Blanket Insulation
A - Loose Fill Glass Fiber (R-2.2 per inch)
B - Glass Fiber Batt/Blanket (R-3.1 per inch) (not applicable to finished walls)
C - Loose Fill Cellulose Fiber (R-3.7 per inch in attic/R-3.3 per inch in walls)
D - Glass Fiber Duct Wrap (R-4 per inch)

1. Floor Over Unheated Basement, Crawlspace or Garage
2. Minimum Economical Size Payback for 3' x 5' Storm Window
3. Refers to Minimum Glass Composition of Primary Door That Makes Storm Door Economical (10 year life)

TABLE V

OPTIMUM ENERGY CONSERVATION COMBINATIONS

Zone II With Air Conditioning

4000 Degree Days: 1000 Cooling Hours

ELEMENT	ATTIC						WALL		FLOOR Over Unheated Area[1]		EXPOSED DUCTS	ENERGY PRICES Dollar Cost per 100,000 Btu's Delivered	ELEMENT	STORM WINDOWS[2] (Triple Track)	STORM DOORS[3]	
Existing Insulation	None			R-11*			None		None	R-11*	None					
Material Used	A	B	C	A	B	C	B	C	B	B	D	Heating				
Additional Inches	7"	6"	5"	0"	4"	2"	3.5"	3.5"	4"	0"	3"	$.15		3' x 4'	0	a
Years To Pay Back	(5)	(4)	(5)	(0)	(16)	(20)	(4)	(16)	(14)	(0)	(2)		Years To Pay Back	(16)	(0)	
Additional Inches	9"	10"	6"	4"	4"	3"	3.5"	3.5"	4"	0"	4"	$.30		3' x 3'	0	b
Years To Pay Back	(4)	(4)	(4)	(15)	(10)	(15)	(3)	(10)	(7)	(0)	(1)		Years To Pay Back	(10)	(0)	
Additional Inches	11"	10"	7"	6"	6"	4"	3.5"	3.5"	6"	4"	5"	$.45		2' x 3'	0	c
Years To Pay Back	(4)	(3)	(3)	(13)	(9)	(12)	(2)	(7)	(6)	(20)	(1)		Years To Pay Back	(7)	(0)	
Additional Inches	12"	12"	8"	7"	6"	5"	3.5"	3.5"	6"	4"	6"	$.60		2' x 2'	0	d
Years To Pay Back	(3)	(3)	(3)	(11)	(8)	(11)	(2)	(6)	(4)	(15)	(1)		Years To Pay Back	(5)	(0)	
Additional Inches	15"	12"	10"	10"	10"	7"	3.5"	3.5"	10"	6"	8"	$.90		2' x 2'	0	e
Years To Pay Back	(3)	(2)	(3)	(9)	(6)	(9)	(1)	(4)	(4)	(11)	(1)		Years To Pay Back	(3)	(0)	
Additional Inches	18"	16"	11"	13"	12"	8"	3.5"	3.5"	10"	6"	9"	$1.20		2' x 2'	x/40%	f
Years To Pay Back	(2)	(2)	(2)	(8)	(6)	(7)	(1)	(3)	(3)	(8)	(1)		Years To Pay Back	(3)	(10)	
Additional Inches	20"	18"	12"	15"	16"	10"	3.5"	3.5"	10"	6"	10"	$1.50		2' x 2'	x/20%	g
Years To Pay Back	(2)	(2)	(2)	(7)	(6)	(7)	(1)	(3)	(3)	(7)	(1)		Years To Pay Back	(2)	(10)	

*Equivalent to 3 1/2" of Glass Fiber Batt/Blanket Insulation
A - Loose Fill Glass Fiber (R-2.2 per inch)
B - Glass Fiber Batt/Blanket (R-3.1 per inch) (not applicable to finished walls)
C - Loose Fill Cellulose Fiber (R-3.7 per inch in attic/R-3.3 per inch in walls)
D - Glass Fiber Duct Wrap (R-4 per inch)

1. Floor Over Unheated Basement, Crawlspace or Garage
2. Minimum Economical Size Payback for 3' x 5' Storm Window
3. Refers to Minimum Glass Composition of Primary Door That Makes Storm Door Economical (10 year life)