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Residential Conservation Measures

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PREFACE

This study was undertaken at the request of Senator James A. McClure, Chairman, Committee on Energy and Natural Resources, United States Senate. The purpose of the study is to examine the potential for achieving energy savings in the residential sector through conservation measures. The report is to be submitted to the General Accounting Office (GAO) to support a major study of the Residential Conservation Service. This study is mandated in S.410, which has been passed by the Senate. Senator McClure requested the GAO to conduct the study though the bill has not yet been enacted.

The first chapter of the report provides an overview of the the study, including the approach taken and a summary of the findings. The second chapter discusses the prevalence and trends in conservation measures in the residential housing stock. The third chapter discusses the potential for upgrading the thermal characteristics of the housing stock in an examination of the distribution of the stock by combinations of conservation measures. This chapter also discusses the problems associated with attempting to estimate possible energy savings that might result from further conservation retrofits to the housing stock.

This report was prepared in the Office of Energy Markets and End Use under the Direction of W. David Montgomery, Director, and the Energy End Use Division, Lynda T. Carlson, Director. The authors of the report are Gerald E. Peabody and Martha M. Johnson.

Table of Contents

Tables

Table of Contents (CONTINUED)

Chapter 1

OVERVIEW OF STUDY

This study was conducted for the General Accounting Office (GAO) at the request of Senator James A. McClure, Chairman of the Senate Committee on Energy and Natural Resources. The study is to provide information for the GAO as part of a large-scale study they are conducting on the Residential Conservation Service (RCS) program. This particular study provides information on the potential for achieving energy savings in the residential sector through conservation measures.

This study, at the outset, had three goals: (1) to examine the trends and current prevalence of conservation measures in the residential housing stock; (2) to examine the potential for conservation upgrades to the stock by categorizing the housing stock by the combinations of housing conservation measures present; and (3) to estimate the potential energy savings from conservation measures that might be instituted. This report presents the findings in these three areas based on analyses of data from the Residential Energy Consumption Survey (RECS) conducted annually from 1978 through 1982 and in 1984 by the Energy Information Administration (EIA).

The next chapter presents data on the individual conservation items, and how their prevalence depends upon the characteristics of the house, its geographical location, and the characteristics of the household residing in the house. The RECS data provide information on conservation items related to the thermal integrity of the housing unit's shell: attic, wall and floor insulation; storm

windows and storm doors; and caulking and weatherstripping. The number of households with each of these items and further information about them is provided by the characteristics mentioned. These data are from the 1984 RECS and provide the most recently available data on energy conservation practices in the residential sector.

The thermal integrity of the housing stock has been increasing over time, both through conservation retrofits in existing houses and from more efficient design and construction of new homes. However, the increase from 1978 to 1984 has been sufficiently small that it could not be detected with any statistical confidence in the RECS data because of limitations due to the sample size of the surveys. At the 95 percent confidence interval, no statistically significant trends in the percentage of homes with individual conservation items, or in the quantity of an item such as inches of attic insulations, was observed in the RECS data. Consequently, no data on trends are presented in Chapter 2.

Since RECS is a sample survey of households, there is a limit to the precision with which a trend could be measured because of the size of the sample. For example, with attic insulation, an increase in the proportion of homes with attic insulation would have to be greater than 5 percent for it to be observed with statistical significance at the 95 percent level in the RECS data. Any increase that did occur in the housing stock as a whole that was smaller than this figure would not be evident with the RECS data base because of the sample size limitations. This study does not conclude that there has been no increase in the percentage of houses with conservation measures, but it does find that any increase that did occur was smaller than can be measured with the RECS data.

The third chapter considers the potential for energy savings through conservation measures by looking at the collection of thermal protection measures available in a given housing unit. Homes are categorized by whether they are essentially fully filled with conservation measures, are lacking in certain important measures, or have a minimum, if any, number of conservation measures. These data provide a good indication of the overall potential for upgrading the thermal integrity of the shells of the housing stock.

It has not been possible at the time of this writing to expand upon these data to provide estimates of the potential energy savings that would result if houses were retrofitted with additional conservation measures. Efforts are underway to determine the potential energy savings that might result from the addition of selected conservation measures. However, to date, no satisfactory data for making the estimates of energy savings have been located. A review of the literature produced such a wide range of estimates of savings that no reliability could be placed on estimates of energy savings based upon these studies. Efforts at the EIA to analytically determine the energy savings have not been completed and will be reported on in a future report should the effort prove fruitful.

Summary of Findings

The most common conservation feature found in single-family homes is attic insulation, and the second most common is caulking or weatherstripping. Floor insulation is next, followed by homes with wall insulation, then houses with 90 percent storm windows and those with 90 percent storm doors.

A number of factors are associated with the presence of each of these items. Homes with more conservation items tend to be larger, recently constructed, and located in colder weather areas. Homeowners are more likely to have various conservation items than are renters. Socioeconomic characteristics of the households associated with the presence of more conservation measures include higher income, middle age, and a higher level of formal education.

The same factors associated with individual conservation measures are also associated with combinations of conservation items. This study found that a minority of housing units, approximately 14 percent [2] in the Nation, and about 20 percent [4] in the Northeast and North Central Census regions--the colder of the four regions--could be considered fully insulated.[1] While a minority of housing units in the colder climate areas have very little insulation, it is not uncommon in the warmer parts of the country for homes to have fewer conservation items.

Participants in the RCS program tend, relative to the general population, to be more affluent, have larger homes which they own, and live in colder climate areas, among other traits. These households also tend to have more conservation items in their homes. For example, around 30 percent [7] of households with incomes over $35,000 in the Northeast and North Central regions had full attic insulation, 90 percent storm window coverage and wall insulation. This figure compares with 20 percent [4] for all households. For individual conservation items, and for combinations of them, households with socioeconomic characteristics that match those of participants in the RCS program are more likely to have conservation features in their homes than are the general population.

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[1] All figures quoted in the text are accompanied by a measure of their statistical significance--1.96*standard error--in brackets.

Chapter 2

PREVALENCE OF RESIDENTIAL CONSERVATION MEASURES

This Chapter contains a discussion of the prevalence of various conservation measures in single-family housing units for the period 1978 through 1984. The discussion is based on data from the 1978, 1980, 1981, 1982 and 1984 Residential Energy Consumption Surveys.[2] Data from the 1979 RECS have been omitted from this report because this survey did not ask about insulation. These surveys, conducted by the EIA, collect detailed data on energy consumption and expenditures from a national sample of households. These surveys also collect data on the types of heating and other energy-using equipment in the housing unit, the characteristics of the housing unit, the types of conservation activities undertaken by the household, the demographic characteristics of the household and other information related to the consumption and expenditures for energy by the household. A single-family housing unit refers to a structure that 1) is either: a) detached, b) attached on one side, or c) attached on two sides; and 2) that provides living space between the basement and attic for only one family or household.

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[2]RECS includes single-family housing units, mobile homes, 2 to 4 unit dwellings and dwelling units in buildings with 5 or more units. RECS doesn't collect conservation measures on multiple-dwelling units. The RCS program includes buildings with 2 to 4 units and these housing unit types are not included in the Tables in this report. The number and percentage of buildings with 2-4 units follows: 1978, 10.7 million (14 percent); 1980, 9.9 million (12 percent); 1981, 8.3 million (11 percent); 1982, 10.1 million (12 percent); 1984, 10.0 million (12 percent). Appendix A contains tables on conservation items found in mobile homes.

The questions asked in the RECS regarding conservation focus on the structural characteristics of the housing shell--such as attic, wall and floor insulation; storm windows and doors; and caulking and stripping. Other items that are included in the RCS audit, such as insulation around water heaters and hot water pipe insulation, are not included in the survey and so are not discussed in this report. The following sections discuss these major conservation features associated with the housing shell.

The South had the largest number of single-family residences in 1978, followed closely by the North Central Region. The Northeast and the West had smaller numbers of these residences. The same pattern was observed in 1984, although the North Central region had a decline in its number of homes over the 1978 through 1984 period, while the other three regions experienced net increases in their numbers. The largest growth in new homes occurred in the South and the West, Table 1.

Conservation Measures 1978-1984

The number of single-family housing units with attic insulation increased from 39.1 million [1.5] in 1978 to 45.2 million [1.1] in 1984, Table 2. As a percentage of the total number of single-family units the change was from 75.6 percent [2.8] to 78.5 percent [3.3]. However, because these estimates are based on a national sample of housing units, there is an uncertainty associated with them. The actual percentages can only be specified within a range for a given level of uncertainty.

Table 1. Distribution of Single-Family Housing Units by Year House Was Built and by Census Region, 1978-1984 (Millions of Households)

Year of Survey; Year House Was Built	United States	Region			
		Northeast	North Central	South	West
1978	51.7	9.5	16.1	17.4	8.6
	[3.1]	[2.0]	[1.2]	[1.8]	[1.0]
Built Before 1975 ...	48.9	9.2	15.1	16.4	8.1
	[2.0]	[2.2]	[1.2]	[1.6]	[0.8]
Built 1975 & After ..	2.8	0.3	0.9	1.1	0.5
	[1.0]	[0.2]	[0.6]	[0.6]	[0.4]
1980	56.3	10.3	15.4	19.7	10.8
	[1.8]	[0.6]	[1.0]	[1.2]	[0.6]
Built Before 1975 ...	49.4	9.5	14.1	16.8	9.0
	[2.0]	[0.6]	[1.0]	[1.2]	[0.8]
Built 1975 & After ..	6.9	0.8	1.3	2.9	1.8
	[1.0]	[0.2]	[0.6]	[0.6]	[0.6]
1981	57.6	10.1	15.5	20.5	11.5
	[1.6]	[0.6]	[1.0]	[1.0]	[0.4]
Built Before 1975 ...	50.6	9.1	14.3	17.8	9.5
	[1.6]	[0.7]	[0.8]	[1.0]	[0.7]
Built 1975 & After ..	6.9	1.1	1.2	2.8	1.9
	[1.0]	[0.4]	[0.2]	[0.6]	[0.5]
1982	57.7	10.6	15.0	20.9	11.2
	[2.2]	[0.2]	[1.2]	[1.4]	[1.2]
Built Before 1975 ...	50.2	9.7	13.2	18.1	9.3
	[2.2]	[0.6]	[1.4]	[1.4]	[1.0]
Built 1975 & After ..	7.4	0.9	1.8	2.8	1.9
	[1.6]	[0.4]	[0.8]	[1.0]	[0.8]
1984	57.6	10.9	14.6	21.8	10.4
	[1.8]	[1.1]	[1.3]	[1.6]	[1.2]
Built Before 1975 ...	49.2	9.7	12.8	18.3	8.5
	[2.4]	[1.2]	[1.4]	[1.6]	[1.1]
Built 1975 & After ..	8.3	1.1	1.8	3.5	1.9
	[1.2]	[0.4]	[0.6]	[0.8]	[0.6]

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. Standard errors for the 1984 figures are preliminary estimates calculated by using the general variance equation for the 1982 data. See Appendix C for further discussion of standard errors for the data of the Residential Energy Consumption Survey.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Surveys 1978, 1980, 1981, 1982, 1984.

Table 2. Attic Insulation by Year of Survey and by Census Region--Single-Family Housing Units, 1978-1984 (Millions of Households)

Year of Survey	United States		Census Region							
			Northeast		North Central		South		West	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
1978	39.1	75.6	7.3	76.6	13.3	82.8	12.4	70.9	6.1	70.3
	[2.9]	[2.8]	[1.6]	[7.0]	[3.6]	[3.6]	[1.6]	[5.2]	[1.1]	[7.9]
1980	43.2	76.8	8.1	78.5	12.7	82.1	14.6	74.1	7.8	72.3
	[1.8]	[1.8]	[0.6]	[3.8]	[0.9]	[2.2]	[1.3]	[4.0]	[0.6]	[3.2]
1981	44.7	77.6	7.8	77.0	13.3	85.7	15.3	74.7	8.3	72.2
	[2.0]	[1.9]	[0.5]	[4.2]	[1.1]	[3.6]	[1.0]	[3.2]	[0.5]	[3.8]
1982	45.5	79.0	8.5	80.1	12.8	85.4	15.9	76.4	8.3	74.1
	[1.9]	[2.1]	[0.7]	[4.3]	[1.1]	[3.0]	[1.2]	[3.7]	[0.8]	[5.4]
1984	45.2	78.5	8.4	77.6	12.4	84.8	16.4	75.2	8.1	77.8
	[2.1]	[3.3]	[1.0]	[4.3]	[1.2]	[3.3]	[1.4]	[3.2]	[1.0]	[4.3]

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below the statistics represents 1.96 of the standard error of the statistic. See Appendix C for further discussion on standard errors.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Surveys 1978, 1980, 1981, 1982, and 1984.

The data in Table 2 provide the size of the confidence intervals for the 95 percent level. The difference between the percentages of households with attic insulation between 1978 and 1984 is not statistically significant at this 95 percent confidence level.[3] As a consequence, it is not possible to say, based on a comparison of the RECS data from 1978 through 1984, whether or not there has been a statistically significant increase in the percentage of homes with attic insulation. An increase of approximately 4.5 percentage points would have to have been observed in the RECS data from 1978 through 1984 before the increase in the proportion of houses with attic insulation would be considered statistically significant at the 95 percent confidence level.

The same finding was observed for the other conservation measures for which data were collected in RECS. While many showed a nominal increase in the percentage of homes that had a particular item, none of the increases were

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[3]To determine whether or not there was a significant change over time the following computation was used.

$$\sqrt{St.dev._A^2 + St.dev._B^2}$$

Where A is the standard deviation of the ratio for year 1 and B is the standard deviation of the ratio for year 2. If 1.96 times the result is greater than the difference between year 1 and year 2 the change is not significant. Consider the following computation. The standard deviation of the proportion of houses with attic insulation in year 1978 is 1.41: for 1984 it is 1.71.

Using the above formula $\sqrt{1.41^2 + 1.71^2} = 2.22$

$2.22 \times 1.96 = 4.34$

The difference between the proportion of homes with attic insulation in 1978 and 1980 is 2.9. Therefore there is not a significant difference between years 1978 and 1984 in the presence of attic insulation.

statistically significant at the 95 percent confidence interval. Also where measures of the quantity of the particular conservation item are available, such as the number of inches of attic insulation or the percent of area insulated, no statistically significant increase was observed. Consequently, from the RECS data it is not possible to determine definitively the amount of increase in conservation measures in single-family housing units.

It is not appropriate to conclude from these findings that there has been no increase in the percentage of homes with conservation measures in the residential sector over the period 1978 through 1984. Indeed, there is substantial evidence that there has been an increase. Each RECS survey has shown that some households (although frequently a relatively small number) have added conservation items to their homes.[4] In addition, a higher percentage of homes constructed since 1978 have conservation features than homes constructed earlier. Thus, there has been some increase overall in the prevalence of conservation features in the residential housing stock.

[4]For survey years 1980, 1981 and 1982, see the Residential Energy Consumption Survey: Housing Characteristics that corresponds to the specific year; for the survey year 1978, see the Residential Energy Consumption Survey: Conservation; for survey year 1984, see the Residential Energy Consumption Survey: Housing Characteristics (in preparation).

However, the effect of these increases has not been large enough that it can be detected with statistical certainty by comparing the housing stock features in RECS for different years. The sample size of the RECS limits the precision with which the increase can be measured. For the conservation items considered in this report, the increase that has occurred in the number of houses with a given item is smaller than the increase that could be reliably measured by comparing RECS for different years.

The data in Table 2 refer to the number of housing units with attic insulation. This number alone does not fully determine the extent of attic insulation in the housing stock. The percent of the attic area that is insulated and the average number of inches of insulation are also important measures of the amount of insulation. Households that have added attic insulation to existing insulation would not show up in Table 2, where only the presence of attic insulation is considered.

The RECS data for 1980 through 1984 provide information on the average number of inches of insulation and the proportion of the attic area that is insulated. These data also do not indicate any substantial trend towards more insulation. There has been little change in the average number of inches of different types of insulation and in the percent of attic insulated for the 1980 through 1984 period.

Trends in Residential Energy Consumption

Over the period 1978 through 1982 the average amount of energy consumed per household in the residential sector declined from 137.9 MBtu [5.8] to 102.9 MBtu [3.5].[5] A statistical analysis of this consumption for the years 1978 through 1981 found that among the various end uses for which energy was consumed, the principal decline was in consumption for space heating.[6] Consumption for the other major end uses considered in the analysis--water heating, air conditioning, and applicances (all other)--was relatively unchanged over the period.

This decline in energy consumed for space heating coupled with the small increase in structural conservation measures noted in the preceding section is an intriguing combination. The decline in space heating consumption is being studied as part of the analysis for this project. However, at the present time, the EIA is not in a position to specify what the major factors were that contributed to the decline in space heating consumption. One important factor that is being explored is that many households have reduced consumption by lowering their thermostat settings.

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[5]Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption and Expenditures, April 1978 through March 1979, DOE/EIA-0207/5 (Washington, D.C., July 1980) and Residential Energy Consumption and Expenditures, April 1982 through March 1983, DOE/EIA-0321/1(82) (Washington, D.C., November 1984).

[6]Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption and Expenditures by End Use for 1978, 1980 and 1981, DOE/EIA-0458 (Washington, D.C., December 1984).

Prevalence of Individual Conservation Items

The remainder of this Chapter presents data on the number and percentages of households that have individual conservation items. All conservation items covered in the RECS survey are considered. Since there is no statistically significant difference in the numbers of households having each item over the 1978 through 1984 period, only data for 1984 are presented.[7] The relationship between the housing unit's characteristics and the socioeconomic characteristics of the household on the one hand, with the presence of conservation measures on the other, are also discussed.

Because of the preliminary nature of the 1984 data, standard errors have not yet been calculated directly using the half-sample procedure that was used for previous RECS reports. (They will be reported in the 1984 RECS publication.) The standard errors for the 1984 data in this report are calculated using the generalized variance equation for the 1982 data, and are adjusted for the effect of clustering. See Appendix C for discussion on the calculation of standard errors and the clustering effect. Because the 1982 and 1984 sample sizes are similar, it is believed that there will not be a significant difference between the preliminary standard errors reported here and the final 1984 standard errors.

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[7] The 1984 RECS data presented here are preliminary. These data have not completed the complete internal review process that provides their official release. However, the review process is sufficiently close to completion that it is unlikely that any of the figures cited in this report will be revised significantly.

In this analysis three types of insulation--1) roof or attic insulation, 2) wall insulation, and 3) floor insulation--are considered along with three types of air infiltration protection--1) the presence of caulking or weatherstripping, 2) the presence of storm windows on 90 percent of the windows, and 3) the presence of storm doors on 90 percent of the doors.

The discussion of attic insulation includes the prevalence of attic insulation, the type of insulation and the amount of insulation. The amount of insulation refers to the proportion of the attic that is insulated and to the average number of inches of attic insulation. In this chapter, the prevalence, the type and the amount of insulation are covered separately. Chapter 3, which includes a discussion of the clustering of conservation measures, combines the prevalence of attic insulation with the amount of insulation in an effort to categorize homes by whether or not they have full attic insulation.

Census Region. For the Nation in 1984, the most common conservation item in single family housing units was roof or attic insulation. Approximately 45.2 million [2.1] single family housing units had this item, Table 3. The next most common conservation items were caulking or weatherstripping, about 39.9 million [2.1], followed by floor and wall insulation (33.5 million [1.9] and 30.8 million [1.9] respectively). The least used conservation items were storm windows or doors. Approximately 28.1 million [1.8] households had 90 percent of their windows covered with storm windows, 22.3 million [1.6] used storm doors on 90 percent of their doors. The proportion of homes with these conservation items did not differ significantly over the preceding 6 years. In 1984, more than one-half of the households had insulated their entire attic. This proportion had not significantly changed from 1978.

Table 3. Attic Insulation by Census Region--Single-Family Housing Units, 1984 (Millions of Households)

Type of Thermal Protection	United States	Census Region: Northeast	North Central	South	West
Total Households (millions)	57.6	10.9	14.6	21.8	10.4
	[1.8]	[1.1]	[1.3]	[1.6]	[1.1]
Presence of Attic or Roof Insulation					
Yes	45.2	8.4	12.4	16.4	8.1
	[2.2]	[1.0]	[1.2]	[1.4]	[1.0]
No	8.2	1.9	1.1	3.7	1.5
	[1.0]	[0.5]	[0.3]	[0.7]	[0.4]
Don't know/ not reported	4.1	0.5	1.1	1.7	0.8
	[0.7]	[0.2]	[0.3]	[0.4]	[0.3]
Area of Attic or Roof Insulated					
All insulated	36.5	6.7	10.2	13.2	6.4
	[2.0]	[0.9]	[1.1]	[1.2]	[0.9]
Part insulated	4.8	1.0	1.0	1.8	1.0
	[0.7]	[0.3]	[0.3]	[0.4]	[0.3]
None; very little insulated	0.9	0.2	0.2	0.3	0.1
	[0.3]	[0.1]	[0.1]	[0.2]	[0.1]
Do not know amount/ not reported	3.1	0.6	0.9	1.1	0.6
	[0.6]	[0.2]	[0.3]	[0.3]	[0.2]
Type of Attic or Roof Insulation					
Batt only	21.4	5.6	4.9	7.8	3.0
	[1.5]	[0.8]	[0.8]	[1.0]	[0.6]
Loose fill only	13.2	1.3	3.8	5.0	3.1
	[1.2]	[0.4]	[0.7]	[0.7]	[0.6]
Batt and loose fill only	5.1	0.7	2.1	1.7	0.6
	[0.8]	[0.3]	[0.5]	[0.4]	[0.2]
Other combinations	2.7	0.5	0.8	0.9	0.5
	[0.6]	[0.2]	[0.3]	[0.3]	[0.2]
Don't know/ not reported	2.6	0.3	0.6	0.9	0.8
	[0.5]	[0.2]	[0.2]	[0.3]	[0.3]
No insulation/ don't know/ not reported	12.4	2.4	2.2	5.4	2.3
	[1.2]	[0.5]	[0.5]	[0.8]	[0.5]

Q=Data withheld because of a large variance or because data were unavailable.
Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Although there were statistically significant differences among the types of insulation used, these differences did not vary from year to year. The most popular type of insulation was batt insulation followed by loosefill. A combination of batt and loosefill was the least popular with fewer than one-tenth of the households using this combination.

From 1980 through 1984 the average number of inches of loosefill insulation was somewhat greater than the average number of inches of batt insulation. However, the effectiveness of these two types of insulation as reflected by the R-value is approximately the same. The R-value, a measure of the insulation's resistance to heat flow, is determined by the type, the thickness, and the density of the insulation. Thus, 5 inches of rockwool batt insulation is comparable in effectiveness to 6.5 inches of rockwool loosefill insulation.[8]

The recommended R-value for effective conservation differs by region and by type of main heating fuel. Generally, the minimum recommended R-value for attic insulation ranged from 19 in the warmest regions to 38 in the coldest areas. For the warmest areas these R-values can be translated into approximately 5 to 6.5 inches of batt insulation and 5.5 to 8.5 inches of loosefill. For the coldest regions an R-value of 38 translates to 10.5 to 13 inches of batt and 10.5 to 17 inches of loosefill. In the two coldest weather zones, with 5,500 or more heating degree-days (HDD), 16.9 million [1.4] households in 1984, had attic

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[8]U.S. Department of Energy. "Insulation," Fact Sheet DOE/CS-0912, November 1980.

insulation.[9] These households averaged 5.4 to 6.2 inches of batt insulation and 6.8 to 8.2 inches in loosefill. In the two warmest zones, the households averaged 4.7 inches to 5.3 inches of batt insulation and 5.6 to 6.6 inches of loosefill insulation.

There were significant regional differences in the proportion of homes with conservation items. However, for most items the regional differences were between the northern two regions and the South and West regions. A significantly greater proportion of homes in the North Central region had attic insulation than in the other 3 regions. No differences were found in the prevalence of attic insulation between the Northeast, the South or the West regions.

Batt insulation was the most common type of insulation used in the Northeast region in 1984 with slightly more than one-half of the homes insulating with it, Table 3. It was least used in the West with less than one-third of the homes using it. Although the number of homes using batt insulation was larger in the South, a greater proportion of homes in the North Central region had batt insulation. Loosefill insulation was more common in the North Central region, the South and the West. Approximately one-fourth of the homes in the North Central and the South

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[9]Heating Degree Days are the number of degrees per day the daily average temperature is below 65 degrees Fahrenheit. Heating Degree Days are determined by subtracting the average daily temperature below 65 degrees from the base 65. For example, a day with an average temperature of 50 degrees has 15 heating degree days (65 -50 =15). While one with an average temperature of 65 or higher has none. The average daily temperature is the mean of the maximum and minimum temperature for a 24-hour period.

used only loosefill insulation. In the West, an equal number of households used batt insulation or loosefill insulation.

The pattern of wall insulation usage and floor insulation usage varied by whether or not the homes were located in the North or South, Table 4. More homes in the Northeast and North Central regions had wall and floor insulation than did homes in the South or West regions. Generally, the households that reported the presence of wall insulation reported it for all walls.

Slightly more than one-half of the 57.6 million single family households in 1984 reported using storm windows on three fourths or more of their windows. This did not significantly differ from the preceding RECS surveys. Nationally, the use of storm windows and storm doors followed a U-shaped pattern: the largest number of households had 100 percent coverage of storm windows or doors and a slightly smaller number had no storm windows or doors. A substantially smaller number had partial coverage by storm windows or doors.

This U-shaped pattern was a result of regional variations in the use of these two conservation items. Seventeen million [1.4] households in the combined regions of the Northeast and North Central had all windows covered with storms. 1.5 million [0.4] households in these two regions did not use storm windows. The reverse pattern was evident in the South and the West where the absence of storm windows was more prevalent. A similar regional distribution was also found in the use of storm doors, Table 5.

The use of caulking and weatherstripping was not looked at over time because the survey questions on caulking and stripping were asked differently in 1984 then in 1978 through 1982. In the years 1978 through 1982 the respondents were asked if they had added caulking or weatherstripping in the two years prior to the survey. In 1984, the respondents were asked if they had caulking or

Table 4. Wall and Floor Insulation by Census Region--Single-Family Housing Units, 1984 (Millions of Households)

Type of Thermal Protection	United States	Census Region			
		North-east	North Central	South	West
Total Households (millions)	57.6	10.9	14.6	21.8	10.4
	[1.8]	[1.1]	[1.3]	[1.6]	[1.1]
Presence of Wall Insulation					
Yes	30.8	6.4	9.4	10.6	4.4
	[1.9]	[0.9]	[1.1]	[1.1]	[0.7]
All walls	25.1	5.1	7.8	8.7	3.5
	[1.7]	[0.8]	[1.0]	[1.0]	[0.6]
Some walls	5.7	1.3	1.6	1.9	0.9
	[0.8]	[0.4]	[0.4]	[0.5]	[0.3]
No	15.7	2.8	2.7	6.4	3.7
	[1.4]	[0.6]	[0.6]	[0.9]	[0.7]
Don't know/ not reported	11.1	1.7	2.5	4.7	2.3
	[1.1]	[0.4]	[0.5]	[0.7]	[0.5]
Presence of Floor Insulation					
Has floor insulation or does not need it	33.5	7.0	9.3	11.8	5.4
	[1.9]	[0.9]	[1.0]	[1.2]	[0.8]
No basement	12.3	0.8	1.4	6.7	3.5
	[1.2]	[0.3]	[0.4]	[0.9]	[0.6]
Heated basement	15.7	4.9	6.9	2.6	1.2
	[1.4]	[0.8]	[0.9]	[0.5]	[0.3]
Has floor insulation	5.5	1.2	1.1	2.5	0.7
	[0.8]	[0.4]	[0.3]	[0.5]	[0.3]
All parts insulated	3.8	0.7	0.6	1.9	0.5
	[0.7]	[0.3]	[0.2]	[0.5]	[0.2]
Some parts insulated	1.7	0.5	0.4	0.6	0.2
	[0.4]	[0.2]	[0.2]	[0.2]	[0.1]
Has no floor insulation and needs it					
Unheated basement	29.6	5.1	6.3	12.5	5.7
	[1.8]	[0.8]	[0.9]	[1.2]	[0.8]
No floor insulation	16.0	2.4	3.4	6.9	3.3
	[1.4]	[0.5]	[0.6]	[0.9]	[0.6]
Do not know/not reported	8.1	1.5	1.8	3.1	1.7
	[1.0]	[0.4]	[0.4]	[0.6]	[0.4]

Q=Data withheld because of a large variance or because data were unavailable.
Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Table 5. Storm Windows, Storm Doors, Caulking, and Weatherstripping by Census Region--Single-Family Housing Units, 1984 (Millions of Households)

Type of Thermal Protection	United States	Census Region: Northeast	North Central	South	West
Total Households (millions)	57.6 [1.8]	10.9 [1.1]	14.6 [1.3]	21.8 [1.6]	10.4 [1.1]
Presence of Storm Windows; Percentage of Windows Covered					
Yes	37.9 [2.1]	10.2 [1.0]	13.7 [1.3]	10.7 [1.1]	3.1 [0.6]
100 percent	26.0 [1.7]	7.0 [0.9]	9.9 [1.1]	7.2 [0.9]	1.9 [0.5]
76 to 99 percent	5.5 [0.8]	2.1 [0.5]	1.7 [0.4]	1.4 [0.4]	0.3 [0.2]
51 to 75 percent	3.1 [0.6]	0.5 [0.2]	1.4 [0.4]	0.8 [0.3]	0.3 [0.2]
1 to 50 percent	3.3 [0.6]	0.6 [0.2]	0.7 [0.3]	1.3 [0.4]	0.6 [0.2]
No/no windows	19.7 [1.5]	0.7 [0.3]	0.8 [0.3]	11.0 [1.1]	7.3 [0.9]
Presence of Storm Doors; Percentage of Doors Covered					
Yes	40.2 [2.1]	10.1 [1.1]	13.3 [1.2]	13.7 [1.3]	3.2 [0.6]
100 percent	22.3 [1.6]	6.1 [0.8]	8.5 [1.0]	6.7 [0.9]	1.1 [0.3]
51 to 99 percent	7.9 [1.0]	2.2 [0.5]	2.5 [0.5]	2.5 [0.5]	0.7 [0.3]
1 to 50 percent	10.0 [1.1]	1.8 [0.4]	2.3 [0.5]	4.5 [0.7]	1.4 [0.4]
No/no doors	17.4 [1.4]	0.8 [0.3]	1.3 [0.4]	8.1 [1.0]	7.1 [0.9]
Has Caulking					
Yes	33.8 [1.9]	7.2 [0.9]	9.6 [1.1]	11.7 [1.2]	5.2 [0.8]
No	21.2 [1.6]	3.2 [0.6]	4.4 [0.7]	9.1 [1.0]	4.5 [0.7]
Has Weatherstripping					
Yes	32.6 [1.9]	6.9 [0.9]	8.7 [1.0]	10.9 [1.1]	6.1 [0.8]
No	23.2 [1.6]	3.7 [0.6]	5.6 [0.8]	10.0 [1.1]	3.9 [0.7]
Has Caulking or Weatherstripping	39.9 [2.1]	7.1 [0.9]	9.7 [1.1]	11.9 [1.2]	6.1 [0.8]

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

weatherstripping. Therefore a comparisons of these two items over time would be subject to this change in the questionnaire. Data on the use of caulking or weatherstripping are presented for 1984. The presence of caulking or weatherstripping was the second most common conservation item. Both of these items are relatively inexpensive items, thus not surprising, they are one of the most popular conservation items. Approximately 39.9 million [2.2] single family households had one or both of these items. In all four geographic regions over one-half of the homes had caulking or stripping, Table 5.

The previous section discussed the regional variations in selected conservation items. This section examines the variations in these measures by other characteristics of the housing unit and by selected socioeconomic characteristics of the household.

Conservation Measures and Housing Structure Characteristics

Age of House. The presence of conservation measures varied significantly with the age of the house. There was a steady increase in the proportion of homes with attic, wall and floor insulation as homes decreased in age. The presence of storm windows and storm doors and the age of house showed a different pattern than other conservation measures. Houses with storm windows on 90 percent of the windows showed a U-shaped pattern, with houses constructed before 1939 and after 1980 having significantly more windows covered by storms than houses constructed in the intervening years. In contrast to other conservation measures, slightly more older homes than newer ones had 90 percent of the doors covered with storm doors, Table 6.

Type of House. The presence of conservation measures also varied by the type of housing unit. A greater proportion of split level homes had all types of conservation measures except storm doors than did other types of single-family homes. More older, two story homes had 90 percent storm doors. There was less variation in the prevalence of conservation measures among homes built after 1975, Table 6.

Own/Rent Status. Homeownership was also an important factor affecting the presence of individual conservation measures. In all categories, housing units that were owned by the household occupying it were much more likely to have each type of conservation measures than were renters. In most cases, home owners were more than twice as likely to have a particular conservation measure than were renters, Table 6.

Size of House. The size of the housing unit was again an important influence on the presence of conservation measures. Larger homes for the most part tended to have a higher incidence of each type of conservation measure than did smaller homes. The breaking point in size between homes with lower and homes with higher percentages of conservation measures was in the neighborhood of 1,600 to 2,000 heated square footage. For large homes there was not much variation in the incidence of each measure. However, below the 1,600 - 2,000 cut-off, the incidence of conservation measures generally declined as the size of house declined, Table 6.

Table 6. Insulation and Air-Infiltration Protection by Characteristics of Housing Units--Single-Family Housing Units, 1984 (Millions of Households)

Characteristics of Housing Unit	Total Households (Millions)	Insulation			Air-Infiltration Protection		
		Roof/ Attic	Wall	Floor[1]	Caulking/ Weather-stripping[2]	Storm Windows[3]	Storm Doors[4]
Total Households (millions)	57.6 [1.8]	45.2 [2.1]	30.8 [1.9]	33.5 [1.9]	39.9 [2.1]	28.1 [1.8]	22.3 [1.6]
AIA Weather Zone[5]							
Zone 1	6.2 [1.6]	5.5 [1.5]	4.6 [1.4]	3.8 [1.2]	4.9 [1.4]	4.7 [1.4]	3.3 [1.1]
Zone 2	13.6 [2.3]	11.4 [2.1]	8.4 [1.8]	9.0 [1.9]	10.4 [2.0]	9.5 [2.0]	7.3 [1.7]
Zone 3	15.2 [2.5]	11.8 [2.2]	8.5 [1.9]	8.9 [1.9]	11.1 [2.1]	8.8 [1.9]	7.6 [1.8]
Zone 4	12.9 [2.3]	9.9 [2.0]	5.3 [1.5]	5.7 [1.5]	8.2 [1.8]	3.8 [1.2]	2.9 [1.1]
Zone 5	9.6 [2.0]	6.6 [1.6]	4.0 [1.3]	6.1 [1.6]	5.4 [1.5]	1.4 [0.7]	1.2 [0.7]
Year House Was Built							
1939 or Earlier	17.7 [1.5]	11.2 [1.2]	7.6 [1.0]	7.9 [1.0]	11.4 [1.2]	8.6 [1.1]	7.4 [1.0]
1940 to 1949	5.4 [0.9]	4.0 [0.7]	2.2 [0.5]	2.4 [0.6]	3.6 [0.7]	2.5 [0.6]	2.1 [0.5]
1950 to 1959	10.4 [1.2]	8.5 [1.1]	4.6 [0.8]	5.8 [0.9]	7.1 [1.0]	4.3 [0.8]	4.6 [0.8]
1960 to 1964	5.1 [0.8]	4.4 [0.8]	2.9 [0.6]	3.3 [0.7]	3.6 [0.7]	2.1 [0.5]	1.8 [0.5]
1965 to 1969	5.1 [0.8]	4.7 [0.8]	3.0 [0.6]	3.6 [0.7]	3.8 [0.7]	2.1 [0.5]	1.8 [0.5]
1970 to 1974	5.4 [0.9]	4.8 [0.8]	3.8 [0.7]	3.9 [0.7]	3.9 [0.7]	2.9 [0.6]	1.9 [0.5]
1975 to 1979	5.6 [0.9]	5.1 [0.8]	4.4 [0.8]	4.5 [0.8]	4.3 [0.8]	3.4 [0.7]	1.9 [0.5]
1980 or Later	2.8 [0.6]	2.6 [0.6]	2.3 [0.6]	2.0 [0.5]	2.1 [0.5]	2.1 [0.5]	1.0 [0.3]

See footnotes at end of table.

Table 6. Insulation and Air-Infiltration Protection by Characteristics of Housing Units--Single-Family Housing Units, 1984 (Millions of Households) (Continued)

Characteristics of Housing Unit	Total Households (Millions)	Insulation			Air-Infiltration Protection		
		Roof/ Attic	Wall	Floor[1]	Caulking/ Weather-stripping[2]	Storm Windows[3]	Storm Doors[4]
Vintage and Type							
Built Before 1975							
One Story	30.4 [2.0]	23.2 [1.8]	14.0 [1.4]	15.2 [1.4]	19.9 [1.6]	11.7 [1.3]	10.6 [1.2]
Two Stories	13.9 [1.4]	10.5 [1.2]	7.4 [1.0]	8.7 [1.1]	10.0 [1.2]	8.3 [1.1]	7.1 [1.0]
Three Stories or More	1.1 [0.4]	0.6 [0.3]	0.4 [0.2]	0.7 [0.3]	0.8 [0.3]	0.6 [0.3]	0.4 [0.2]
Split Level	1.4 [0.4]	1.4 [0.4]	1.1 [0.4]	1.1 [0.4]	1.2 [0.4]	0.9 [0.3]	0.5 [0.2]
Other	2.5 [0.6]	1.9 [0.5]	1.2 [0.4]	1.2 [0.4]	1.6 [0.5]	1.1 [0.4]	1.0 [0.4]
Built 1975 or After							
One Story	4.7 [0.8]	4.2 [0.8]	3.6 [0.7]	3.7 [0.7]	3.4 [0.7]	2.6 [0.6]	1.6 [0.4]
Two Stories	2.1 [0.5]	2.0 [0.5]	1.7 [0.5]	1.7 [0.5]	1.7 [0.6]	1.6 [0.5]	0.6 [0.3]
Three Stories or More	0.1 [0.1]	0.1 [0.1]	0.1 [0.1]	0.1 [0.1]	0.1 [0.1]	0.1 [0.1]	Q
Split Level	0.9 [0.3]	0.9 [0.3]	0.8 [0.3]	0.7 [0.3]	0.8 [0.3]	0.8 [0.3]	0.3 [0.2]
Other	0.6 [0.3]	0.6 [0.3]	0.5 [0.2]	0.5 [0.2]	0.5 [0.2]	0.4 [0.2]	0.2 [0.1]

See footnotes at end of table.

Table 6. Insulation and Air-Infiltration Protection by Characteristics of Housing Units--Single-Family Housing Units, 1984 (Millions of Households) (Continued)

Characteristics of Housing Unit	Total Households (Millions)	Insulation			Air-Infiltration Protection		
		Roof/ Attic	Wall	Floor[1]	Caulking/ Weather-stripping[2]	Storm Windows[3]	Storm Doors[4]
Main Heating Fuel							
Natural Gas	32.3 [1.9]	25.3 [1.7]	15.8 [1.4]	18.9 [1.5]	22.6 [1.6]	14.5 [1.3]	12.3 [1.2]
Electricity	7.9 [1.0]	6.9 [0.9]	5.3 [0.8]	5.6 [0.8]	5.5 [0.8]	4.0 [0.7]	2.2 [0.5]
Fuel Oil/Kerosene ..	7.6 [0.9]	5.7 [0.8]	3.9 [0.7]	4.2 [0.7]	5.6 [0.8]	4.9 [0.8]	3.9 [0.7]
LPG	2.6 [0.5]	1.8 [0.4]	1.4 [0.4]	1.3 [0.4]	1.7 [0.4]	1.3 [0.4]	1.2 [0.4]
Wood	5.9 [0.8]	5.0 [0.8]	4.0 [0.7]	2.7 [0.6]	4.2 [0.7]	3.0 [0.6]	2.3 [0.5]
Other	0.8 [0.3]	0.5 [0.2]	0.4 [0.2]	0.4 [0.2]	0.4 [0.2]	0.4 [0.2]	0.4 [0.2]
No Fuel Used	0.4 [0.2]	Q	Q	0.2 [0.1]	Q	Q	Q
Relationship of Housing Unit to Householder							
Owned	47.9 [2.0]	40.7 [2.1]	28.5 [1.8]	29.0 [1.8]	35.5 [2.0]	25.5 [1.7]	20.1 [1.5]
Rented	8.6 [1.0]	3.9 [0.7]	1.8 [0.4]	4.0 [0.7]	3.9 [0.7]	2.2 [0.5]	1.8 [0.4]

See footnotes on following page.

Table 6. Insulation and Air-Infiltration Protection by Characteristics of Housing Units--Single-Family Housing Units, 1984 (Millions of Households) (Continued)

Characteristics of Housing Unit	Total Households (Millions)	Insulation			Air-Infiltration Protection		
		Roof/ Attic	Wall	Floor[1]	Caulking/ Weather-stripping[2]	Storm Windows[3]	Storm Doors[4]
Measured Heated Square Footage of Residence							
Fewer than 600	2.1	0.8	0.4	0.7	0.6	0.4	0.3
	[0.4]	[0.3]	[0.2]	[0.2]	[0.2]	[0.2]	[0.1]
600 to 900	9.1	5.9	3.2	3.4	5.1	3.5	3.3
	[0.9]	[0.7]	[0.5]	[0.6]	[0.7]	[0.6]	[0.6]
1,000 to 1,599	19.0	14.7	9.7	9.1	12.6	8.6	7.3
	[1.3]	[1.2]	[1.0]	[0.9]	[1.1]	[0.9]	[0.8]
1,600 to 1,999	10.5	8.9	6.2	6.8	7.6	5.5	4.2
	[1.0]	[0.9]	[0.8]	[0.8]	[0.9]	[0.7]	[0.6]
2,000 to 2,399	6.9	6.1	4.7	5.3	5.7	4.2	3.1
	[0.8]	[0.7]	[0.7]	[0.7]	[0.7]	[0.6]	[0.5]
2,400 to 2,999	5.4	4.8	3.7	4.2	4.4	3.1	2.4
	[0.7]	[0.6]	[0.6]	[0.6]	[0.6]	[0.5]	[0.5]
3,000 or More	4.7	4.0	3.0	4.0	3.9	2.7	1.7
	[0.7]	[0.6]	[0.5]	[0.6]	[0.6]	[0.5]	[0.4]

[1]Households with floor insulation or that do not need it.
[2]Households with caulking or weatherstripping.
[3]Households with storm windows on at least 90 percent of the windows.
[4]Households with storm doors on at least 90 percent of the doors.
[5]Weather zones, as established by the AIA, are delimited by heating degree-days (HDD) and cooling degree-days (CDD). Zone 1--more than 7,000 HDD and fewer than 2,000 CDD; Zone 2--5,500 to 7,000 HDD and fewer than 2,000 CDD; Zone 3--4,000 to 5,499 HDD and fewer than 2,000 CDD; Zone 4--fewer than 4,000 HDD and fewer than 2,000 CDD; Zone 5--fewer than 4,000 HDD and more than 2,000 CDD. In this table, the CDD and HDD are based on long-term averages.
Q=Data withheld because of a large variance or because data were unavailable.
Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Conservation Measures and Household Socioeconomic Characteristics

This section discusses the associations between the proportions of homes with various conservation measures and the socioeconomic characteristics of the household residing in the unit. It should be noted that there is some relationship between the associations discussed here and those discussed in the previous sections. For example, higher-income families are more likely to live in larger homes. So any association between family income and the incidence of conservation measures may not be solely due to income but also reflect the effects of the larger house. No effort is made here to attempt to determine the relative importances of these co-related factors.

Age of Householder. Age of the householder was an important factor in the presence of wall insulation, caulking or weatherstripping and the use of storm doors. There was not a significant difference between the age of the householder and proportion of homes with attic or floor insulation or the presence of storm windows. More homes with householders under age 45 years had either caulking or weatherstripping or wall insulation. The converse was true for the use of storm doors, Table 7.

Orgin of Householder. White householders were more likely to have most of the conservation measures than were black householders or householders of other races. The differences were quite substantial, ranging from twice as many white householders than black having floor insulation, to

one half as many more white householders than black having ceiling insulation or caulking and weatherstripping, Table 7.

Education of Householder. There was a significant difference in the presence or absence of a conservation measure between the householders that had not completed high school and those with higher formal levels of education. In all of the conservation items, except the presence of storm doors, the proportion of households with a particular item was higher for households where the householder was at least a high school graduate, Table 7.

Family Income. Family income was also an important factor associated with the presence or absence of specific conservation items. For each conservation item (again except for storm doors) there was a direct relationship between income and the presence of the item. There was a steady increase in the percentage of homes with that measure as the family's income increased. Slightly less than one half of households with an income less than $5,000 had roof or attic insulation; over three-fourths of the households with incomes over $35,000 had this item. The differences between low- and high-income families for wall insulation, floor insulation and caulking and stripping was even greater--more than twice the percent of high-income households had these items compared with low-income families, Table 7.

Table 7. Insulation and Air-Infiltration Protection by Socioeconomic Characteristics of Household--Single-Family Housing Units, 1984 (Millions of Households)

Socioeconomic Characteristics	Total Households (Millions)	Insulation			Air-Infiltration Protection		
		Roof/ Attic	Wall	Floor[1]	Caulking/ Weather-stripping[2]	Storm Windows[3]	Storm Doors[4]
Total Households (millions)	57.6	45.2	30.8	33.5	39.9	28.1	22.3
	[1.8]	[2.1]	[1.9]	[1.9]	[2.1]	[1.8]	[1.6]
Age of Householder							
Under 25 Years	2.3	1.6	0.9	1.3	1.2	0.8	0.7
	[0.4]	[0.4]	[0.3]	[0.3]	[0.3]	[0.3]	[0.2]
25 to 34 Years	11.7	9.0	6.4	6.7	8.1	5.6	4.1
	[1.0]	[0.9]	[0.8]	[0.8]	[0.8]	[0.7]	[0.6]
35 to 44 Years	12.6	10.5	7.8	8.2	9.8	6.1	4.4
	[1.1]	[1.0]	[0.8]	[0.9]	[0.9]	[0.7]	[0.6]
45 to 59 Years	13.4	10.7	7.5	8.3	9.5	6.7	5.4
	[1.1]	[1.0]	[0.8]	[0.9]	[0.9]	[0.8]	[0.7]
60 Years and Over	17.7	13.5	8.2	9.0	11.3	8.8	7.8
	[1.2]	[1.1]	[0.9]	[0.9]	[1.0]	[0.9]	[0.8]
Origin of Householder							
White	50.5	41.3	28.5	30.2	36.5	26.1	20.5
	[2.1]	[2.3]	[1.9]	[2.0]	[2.2]	[1.8]	[1.6]
Black	5.8	3.1	1.9	2.7	2.8	1.7	1.7
	[0.9]	[0.6]	[0.5]	[0.6]	[0.6]	[0.5]	[0.5]
Other	1.3	0.8	0.4	0.6	0.7	0.2	0.2
	[0.4]	[0.3]	[0.2]	[0.3]	[0.3]	[0.1]	[0.1]
Family Income							
Less than $5,000	4.2	2.2	1.2	1.4	1.7	1.3	1.3
	[0.6]	[0.3]	[0.3]	[0.3]	[0.4]	[0.3]	[0.3]
$5,000 to $9,999	4.8	3.3	1.9	2.4	2.5	1.9	2.0
	[0.7]	[0.5]	[0.4]	[0.5]	[0.5]	[0.4]	[0.4]
$10,000 to $14,999	8.6	6.4	4.0	4.4	5.2	3.8	3.6
	[0.9]	[0.8]	[0.6]	[0.6]	[0.7]	[0.6]	[0.6]
$15,000 to $19,999	5.7	4.5	2.7	2.7	4.1	2.5	2.1
	[0.7]	[0.6]	[0.5]	[0.5]	[0.6]	[0.5]	[0.4]

See footnotes on following page.

Table 7. Insulation and Air-Infiltration Protection by Socioeconomic Characteristics of Household--Single-Family Housing Units, 1984 (Millions of Households) (Continued)

Socioeconomic Characteristics	Total Households (Millions)	Insulation			Air-Infiltration Protection		
		Roof/ Attic	Wall	Floor[1]	Caulking/ Weather-stripping[2]	Storm Windows[3]	Storm Doors[4]
Family Income (Continued)							
$20,000 to $24,999	5.3	4.4	3.0	3.2	3.8	3.0	2.2
	[0.7]	[0.6]	[0.5]	[0.5]	[0.6]	[0.5]	[0.4]
$25,000 to $34,999	11.5	9.6	7.0	7.2	8.9	6.2	5.0
	[1.0]	[0.9]	[0.8]	[0.8]	[0.9]	[0.7]	[0.7]
$35,000 or More	15.8	13.9	10.5	11.4	12.9	8.7	5.6
	[1.2]	[1.2]	[1.0]	[1.0]	[1.1]	[0.9]	[0.7]
Education of Householder							
Less Than High School	14.7	9.7	6.3	6.9	7.9	6.2	6.0
	[0.7]	[0.5]	[0.4]	[0.5]	[0.5]	[0.4]	[0.4]
High School Graduate	20.9	16.7	11.9	12.3	15.1	11.9	9.0
	[0.8]	[0.7]	[0.6]	[0.6]	[0.7]	[0.6]	[0.5]
Some College	10.9	9.4	5.9	7.0	8.3	5.2	4.2
	[0.6]	[0.5]	[0.4]	[0.5]	[0.5]	[0.4]	[0.4]
College Graduate	6.4	5.2	3.8	4.0	4.5	3.2	1.8
	[0.4]	[0.4]	[0.3]	[0.3]	[0.4]	[0.3]	[0.2]

[1]Households with floor insulation or that do not need it.
[2]Households with caulking or weatherstripping.
[3]Households with storm windows on at least 90 percent of the windows.
[4]Households with storm doors on at least 90 percent of the doors.
Q=Data withheld because of a large variance or because data were unavailable.
Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Chapter 3

THE POTENTIAL FOR RESIDENTIAL CONSERVATION UPGRADES

This Chapter examines the potential for upgrading the thermal integrity of the residential stock of single family dwelling units. It focuses on delineating the number of housing units that could have additional conservation improvements made to them. As part of this study, work was also pursued to obtain estimates of the energy that could be saved if various conservation measures were undertaken. This part of the study proved, as expected, to be quite difficult and has not been completed as this report is being written.[10] Consequently, no energy savings estimates are provided here. A discussion of the effort undertaken to provide estimates of energy savings is given and the current status of the effort is reviewed.

The first step in this analysis is to enumerate and categorize the homes that could benefit from conservation improvements. Since the focus is only on the thermal characteristics of the housing unit shell, the only form of energy consumption significant for this analysis is for space heating. Other forms of residential conservation are not considered. The amount of energy consumed for space heating depends, of course, upon the severity of the winter temperatures. Consequently, the conservation improvements are considered in relation to the climate zone in which the house is located, among other characteristics.

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[10] Work is continuing in an effort to produce estimates of the energy savings from conservation measures. A report will be issued with the results if the work is completed successfully.

Finally, this analysis does not attempt to determine whether or not the conservation improvements considered would be cost effective. The principal goal of this analysis to estimate how many housing units could potentially make conservation retrofit upgrades.

Stock of Housing Units with Conservation Retrofit Potential

The RECS data base provides information on the following types of conservation measures: attic or ceiling insulation, wall insulation, floor insulation, storm windows, storm doors, caulking, and stripping. The sample size of RECS is not large enough to look in detail at the combination of all these conservation measures cross-classified by geographical region, weather zone, and other variables. A subset of these conservation measures has been chosen in an attempt to represent a range of conservation measures from a house that can be considered to be filled fully with conservation measures to one with essentially no conservation features.

Three conservation items were selected to be considered in combination: attic insulation--including area of coverage and number of inches--wall insulation, and storm windows.[11] A house that has a full complement of each of these three can in most cases be considered to have a full complement of conservation measures. (The house may still lack some energy efficiency because of air infiltration or other reasons not easily ascertainable from the RECS file.) On the other hand, houses with few of these items, particularly in colder climates, have substantial room for conservation improvement.

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[11] This selection was made in consultation with the staff of the GAO.

The three items not selected were excluded for reasons beyond the fact that a choice had to be made. Storm doors are relatively expensive, and the evidence that they provide effective thermal protection is less compelling than for the other items. Caulking and stripping can be quite important, but are usually present in those houses that had the full complement of the three items selected. Consequently, their presence does not provide substantial additional information about the degree to which the house had a high degree of thermal integrity. Basement insulation is useful for a minority of houses, and it is difficult from the RECS data to determine whether or not a particular house would benefit from the addition of this form of insulation.[12] As a result, it was not included in the combination selected. A futher discussion of the three conservation measures selected for this study follows.

Attic or ceiling insulation is an important form of insulation and is present in an overwhelming majority of homes, as was seen in the previous chapter. In this Chapter, attention is paid jointly to the percentage of ceiling area covered by the insulation and the number of inches of insulation. Households that had at least 96 percent of the ceiling area covered by insulation and had at least the minimum recommended number of inches of insulation comprise one category considered in the study. The second category consists of housing units that had at least 96 percent of the ceiling area covered but had less than the minimum number of inches. The third category consists of houses that had less than 96 percent area of coverage, did not know the area of coverage, or lacked attics or attic insulation.

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[12]Many styles of houses, for example, houses built on a concrete slab, do not have basements or crawl spaces where insulation could be placed. For these homes, basement insulation is not relevant.

The minimum number of inches of ceiling insulation that are recommended depends upon the winter temperature. The number of inches also depends upon the type of insulation, whether it is batt or fill and the type of material. The RECS data specify whether the insulation is batt or fill or both, but not the type of material. Consequently, an average value for the number of inches of minimum insulation recommended for each weather zone was selected, Table 8. The minimum number of inches recommended for attic insulation ranges from 5 inches in warmer climates with fewer than 4,000 HDD to 10.5 inches houses in areas with 7,000 or more HDD. Since the type of material is not listed on the RECS file, the smallest number of inches from all materials has been selected. This analysis will therefore underestimate to some degree the number of houses that have low levels of insulation.

Table 8. Recommended Insulation Thickness and Nominal R-Value by Weather Zone and Type of Insulation

Weather Zone	Nominal R-Value	Type of Insulation					Minimum No. of Inches Chosen for This Study
		Batt		Fill			
		Glass	Wool	Glass	Wool	Fiber	
More than 7,000 HDD[1]	38	12 - 13	10½ - 12	17	13	10½	10.5
5,500 to 7,000 HDD	30	7½ - 9	6 - 7	10	7½	6	6
4,000 to 5,499 HDD	30	7 - 7½	6 - 7	10	7½	6	6
Fewer than 4,000 HDD	22	6 - 6½	5 - 6	8½	6½	5½	5

[1]Heating degree-days.
Source: U.S. Department of Energy, "Insulation," Fact Sheet DOE/CS-D192, November 1980.

Storm windows are the next major conservation item considered in this study. Three categories of storm window coverage were considered. The first group consists of those housing units that have 90 percent or more of the windows covered with storm windows. The second group has some windows covered but less than 90 percent coverage. The third group has no storm windows.

The third conservation item included in this analysis is wall insulation. Although this form of insulation is expensive to add for housing units without it (and so households without it may be reluctant to retrofit it), it is a very important conservation item when it is present. Households that stated they had some or total wall insulation are included in the category of "having wall insulation" for this study. Households that stated they had no wall insulation, did not know, or did not respond to the question are placed in the category "no wall insulation."

The remainder of this section discusses the number and percent distribution of housing units by the presence of these three conservation items in combination. In the discussion, households are characterized by their geographic location--Census region and weather zone--and within Census regions, by family income, age of house and whether or not they rent.

Census Region. For the Nation about 14 percent [2] of the 57.6 million [1.8] single family housing units in 1984 had full attic insulation, had more than 90 percent of windows covered by storm windows and had wall insulation, Table 9. Another 13 percent [2] had full area coverage of attic insulation but fewer than the recommended minimum number of inches of insulation and also had wall

insulation and full storm windows. Clearly, a minority of housing units in the United States can be considered to be fully weatherized.

There are distinct regional variations in the percentages of housing units that were fully insulated or were only missing some inches of attic insulation. In the Northeast and North Central regions, the percentage of homes in each of these two categories was in the neighborhood of 20 percent [4], Table 9. While in the South and West, the percentages were in the range 6 to 13 percent [2]. Clearly, the colder climate in the two northern regions induced more householders to provide more complete thermal protection for their homes.

A further regional difference is that it is rare to find homes in the Northeast and North Central regions that did not have at least some storm windows and wall insulation. Among households that had the full area of attic insulation, an insignificant number did not have at least some wall insulation or storm windows. Among households that had partial or no attic insulation, only several percent had no storm windows or wall insulation. In the South and West, on the other hand, while it was uncommon for housing units with full attic insulation not to have storm windows and wall insulation, many more households with reduced inches of attic insulation or partial attic insulation had no wall insulation and storm windows.

Weather Zone. Another way to view the regional variations in the incidence of conservation measures is by weather zone--geographical areas with similar patterns of average numbers of Heating and Cooling Degree-Days over a long time period. In the coldest region, Zone 1, with more than 7,000 HDD, almost all the

Table 9. Insulation and Air-Infiltration Protection by Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages)

Type of Thermal Protection	United States		Census Region: Northeast		North Central		South		West	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	57.6 [1.8]	100	10.9 [1.1]	100	14.6 [1.3]	100	21.8 [1.6]	100	10.4 [1.1]	100
Insulation:										
Attic--Full[1]	16.3 [1.4]	28.2 [2.2]	3.1 [0.6]	28.4 [4.6]	4.5 [0.7]	30.8 [4.1]	6.2 [0.9]	28.4 [3.3]	2.5 [0.5]	24.0 [4.5]
Wall, and Storm Windows[2]	8.3 [1.0]	14.4 [1.7]	1.9 [0.3]	17.4 [3.8]	2.9 [0.6]	20.1 [3.6]	2.8 [0.6]	12.9 [2.4]	0.7 [0.3]	6.4 [2.3]
Wall, and Some Storm Windows[3]	7.0 [0.9]	12.1 [1.5]	1.1 [0.3]	10.3 [3.0]	1.6 [0.4]	10.9 [2.7]	2.9 [0.6]	13.4 [2.5]	1.4 [0.4]	13.1 [3.4]
None in Wall, No Storm Windows[4]	1.0 [0.3]	1.7 [0.6]	Q	Q	Q	Q	0.5 [0.2]	2.2 [1.0]	0.4 [0.2]	4.2 [2.0]
Attic--Full Area, Fewer Inches[5]	20.2 [1.5]	35.1 [2.5]	3.6 [0.6]	33.0 [4.8]	5.7 [0.8]	39.0 [4.3]	7.0 [0.9]	32.1 [3.4]	4.0 [0.7]	38.5 [5.1]
Wall, and Storm Windows[2]	7.5 [0.9]	13.0 [1.6]	2.0 [0.5]	18.1 [3.8]	3.5 [0.6]	24.3 [3.9]	1.4 [0.4]	6.3 [1.7]	0.6 [0.2]	6.0 [2.4]
Wall, and Some Storm Windows[3]	10.7 [1.1]	18.7 [1.4]	1.6 [0.4]	15.0 [3.6]	2.1 [0.5]	14.6 [3.0]	4.6 [0.7]	21.1 [3.0]	2.3 [0.4]	22.6 [4.4]
None in Wall, No Storm Windows[4]	2.0 [0.5]	3.5 [1.0]	Q	Q	Q	Q	1.0 [0.3]	4.4 [1.4]	1.0 [0.3]	10.0 [3.1]
Attic--Partial or None[6]	21.1 [1.6]	36.6 [2.5]	4.2 [0.7]	38.6 [5.0]	4.4 [0.7]	30.1 [4.1]	1.6 [1.0]	39.4 [3.6]	3.9 [0.7]	37.5 [5.1]
Wall, and Storm Windows[2]	3.0 [0.6]	5.3 [1.0]	1.0 [0.3]	9.3 [2.9]	1.2 [0.4]	8.0 [2.4]	0.7 [0.3]	3.0 [1.1]	0.2 [0.1]	2.1 [1.3]
Wall, and Some Storm Windows[3]	12.7 [1.2]	22.0 [2.1]	2.9 [0.6]	26.6 [4.5]	2.9 [0.6]	19.9 [3.5]	5.0 [0.7]	22.8 [3.1]	1.9 [0.5]	18.5 [4.0]
None in Wall, No Storm Windows[4]	5.4 [0.8]	9.3 [1.3]	0.3 [0.2]	2.9 [1.6]	0.3 [0.1]	2.0 [1.1]	3.0 [0.6]	13.7 [2.5]	1.8 [0.4]	17.1 [3.8]

[1]Households with at least 96 percent of the ceiling area covered and at least the minimum recommended number of inches of insulation.

[2]Households with some or total wall insulation and storm windows on at least 90 percent of the windows.

[3]Households with some wall insulation or storm windows but lacking both wall insulation and storm windows on at least 90 percent of the windows.

[4]Households with no wall insulation or storm windows.

[5]Households with at least 96 percent of the ceiling area covered but with fewer than the minimum recommended number of inches.

[6]Households with less than 96 percent of the ceiling area covered, lacking attics or attic insulation, or not knowing how much ceiling area was covered.

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

houses with full attic insulation also had wall insulation and 90 percent coverage of storm windows, Table 10. Seventy-five percent of the households with full attic insulation also had the other two items.

An interesting feature of Weather Zone 1 is that a low proportion, 15 percent, [9] had at least the recommended minimum number of inches of attic insulation. About 63 percent [12] of the households had the full attic covered with insulation but had fewer than the recommended number of inches. Of these households, slightly more had full storm windows and wall insulation than had some wall insulation or storm windows. Only a small number had no storm windows or wall insulation. An insignificant percent of the households in this weather zone had partial or no attic insulation and also had no storm windows or wall insulation.

In Weather Zone 2, the second coldest zone with 5,500 to 7,000 HDD, about 38 percent [8] of the households had full attic insulation, and about 24 percent [7] also had wall insulation and full storm window coverage. An insignificant fraction had partial or no attic insulation, and no wall insulation or storm windows.

The distribution of households by conservation measures shifted considerably in the warmer climate zones. In Zones 4 and 5, the warmest zones with less than 2,000 HDD and less than 2,000 CDD and more than 2,000 CDD, respectively, very few homes had the full complement of conservation measures. In these two zones, the largest group of households, about 38 percent [9] for Zone 4 and 46 percent

Table 10. Insulation and Air-Infiltration Protection by Weather Zone--Single-Family Housing Units, 1984
(Millions of Households--Percentages)

Type of Thermal Protection	United States		Weather Zone[1]									
			Zone 1		Zone 2		Zone 3		Zone 4		Zone 5	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	57.6 [1.8]	100	6.2 [1.6]	100	13.6 [2.3]	100	15.2 [2.5]	100	12.9 [2.3]	100	9.6 [2.0]	100
Attic--Full[2]	16.3 [1.4]	28.2 [2.2]	0.9 [0.6]	14.7 [8.5]	5.2 [1.4]	38.3 [8.4]	4.2 [1.3]	29.7 [7.1]	3.7 [1.2]	28.5 [7.9]	2.2 [0.9]	23.0 [8.5]
Wall, and Storm Windows[3]	8.3 [1.0]	14.4 [1.7]	0.7 [0.5]	11.0 [7.3]	3.2 [1.1]	23.5 [7.2]	2.4 [1.0]	15.5 [5.9]	1.3 [0.7]	10.5 [5.3]	0.7 [0.5]	7.1 [4.8]
Wall, and Some Storm Windows[4]	7.0 [0.9]	12.1 [1.5]	Q	Q	2.0 [0.9]	14.3 [5.9]	1.8 [0.8]	11.6 [5.0]	1.9 [0.9]	14.9 [6.2]	1.1 [0.6]	11.9 [6.4]
None in Wall, No Storm Windows[5]	1.0 [0.3]	1.7 [0.6]	Q	Q	Q	Q	Q	Q	0.4 [0.4]	3.2 [2.8]	0.4 [0.4]	3.9 [3.4]
Attic--Full[1] Area, Fewer Inches[6]	20.2 [1.5]	35.1 [2.5]	3.9 [1.3]	62.7 [12.3]	4.0 [1.3]	29.6 [7.9]	4.7 [1.4]	31.0 [7.5]	4.3 [1.3]	33.6 [8.4]	2.8 [1.1]	29.3 [9.2]
Wall, and Storm Windows[3]	7.5 [0.9]	13.0 [1.6]	2.5 [1.0]	40.3 [12.1]	2.2 [0.9]	15.8 [6.2]	1.9 [0.9]	12.7 [5.3]	0.7 [0.5]	5.5 [3.8]	Q	Q
Wall, and Some Storm Windows[4]	10.7 [1.1]	18.7 [1.4]	1.4 [0.7]	21.8 [9.8]	1.8 [0.8]	13.5 [5.8]	2.8 [1.1]	18.3 [6.2]	2.6 [1.0]	20.3 [7.0]	2.1 [0.9]	22.3 [8.4]
None in Wall, No Storm Windows[5]	2.0 [0.5]	3.5 [1.0]	Q	Q	Q	Q	Q	Q	1.0 [0.6]	7.9 [4.6]	0.7 [0.5]	7.0 [4.7]
Attic: Partial or None[7]	21.1 [1.6]	36.6 [2.5]	1.4 [0.7]	22.6 [10.2]	4.1 [1.3]	30.1 [8.0]	6.0 [1.6]	39.5 [8.0]	4.6 [1.4]	35.9 [8.5]	4.3 [1.3]	44.5 [10.1]
Wall, and Storm Windows[3]	3.0 [0.6]	5.3 [1.0]	0.5 [0.4]	7.3 [6.3]	1.1 [0.6]	7.9 [4.4]	1.1 [0.6]	7.5 [4.2]	Q	Q	Q	Q
Wall, and Some Storm Windows[4]	12.7 [1.2]	22.0 [2.1]	0.8 [0.3]	13.5 [8.3]	3.0 [1.1]	22.1 [14.2]	4.2 [1.1]	27.5 [7.3]	2.5 [1.0]	19.7 [7.0]	2.1 [0.9]	21.9 [8.3]
None in Wall, No Storm Windows[5]	5.4 [0.8]	9.3 [1.3]	Q	Q	Q	Q	0.7 [0.5]	4.6 [3.2]	2.1 [1.0]	16.2 [6.5]	2.2 [0.9]	22.6 [8.3]

See footnotes on following page.

[1]Delimited by heating degree-days (HDD) and cooling degree-days (CDD). Zone 1--more than 7,000 HDD and fewer than 2,000 CDD; Zone 2--5,500 to 7,000 HDD and fewer than 2,000 CDD; Zone 3--4,000 to 5,499 HDD and fewer than 2,000 CDD; Zone 4--fewer than 4,000 HDD and fewer than 2,000 CDD; Zone 5--fewer than 4,000 HDD and more than 2,000 CDD.

[2]Households with at least 96 percent of the ceiling area covered and at least the minimum recommended number of inches of insulation.

[3]Households with some or total wall insulation and storm windows on at least 90 percent of the windows.

[4]Households with some wall insulation or storm windows but lacking both wall insulation and storm windows on at least 90 percent of the windows.

[5]Households with no wall insulation or storm windows.

[6]Households with at least 96 percent of the ceiling area covered but with fewer than the minimum recommended number of inches.

[7]Households with less than 96 percent of the ceiling area covered, lacking attics or attic insulation, or not knowing how much ceiling area was covered.

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

[10] for Zone 5, had only partial or no attic insulation. Sixteen percent [7] and 23 percent [8], respectively, also had no storm windows or wall insulation.

In considering these variations in the incidence of conservation items by climate zone, it is important to bear in mind that what are prudent conservation practices in one climate may be inappropriate for another. In the colder weather regions, the emphasis is on keeping the housing unit heated during the winters as efficiently as possible. This is accomplished by minimizing air infiltration and reducing the rate of thermal conductivity from the interior to the exterior.

However, in very warm climates, these practices may not be the most efficient when overall space conditioning energy requirements are considered. In areas with very hot summers, space cooling requirements in the summer may approach or even exceed space heating requirements in the winter. In this situation, the best measures for keeping the heat out in the summer--maintaining a cooler temperature inside than the ambient temperature outside--may clash with the requirements for keeping in the heat during the winter months.

Currently, there is a good deal of investigation going on about the most effective conservation practices for warmer climates. Consequently, the reader should put more weight on the data provided here for the colder regions than the warmer regions. A home in the South that has no insulation or storm windows may have very little need for them. Until more is known about the appropriate conservation measures for the warmest climates, the RECS data can not be used to make a full assessment of the conservation situation in the warm climate zones.

Family Income. As with the individual conservation items discussed in the previous chapters, there was a strong association between family income and the presence of combinations of conservation measures in the home. For the Nation, 6 percent [2] of households with incomes less than $15,000 had full attic insulation, wall insulation and 90 percent storm windows, while 23 percent [3] of households with incomes over $35,000 had all three conservation measures, Table 11. For households with full attic insulation, there was a larger percentage of households that had some wall insulation or storm windows at higher income levels.

Among households that had full area attic insulation but less than the minimum recommended number of inches, there was little variation by income group in the various combinations of wall insulation and storm windows. However, for households with partial or no attic insulation, there was again a strong association between income and the presence of other conservation measures. A much higher percentage of low-income households, 17 percent [2] had no wall insulation and storm windows than did higher-income households, 4 percent [1]. More households with low income also had only some storm windows or wall insulation.

For the most part, the patterns of conservation measures associated with income groups observed for the Nation were also observed, with minor changes in the percentages, for the four Census regions. One major difference between the regions noted above was in the incidence of households with full attic insulation, wall insulation and storm windows. These differences were more pronounced within income groups across regions. In the Northeast and North

Table 11. Insulation and Air-Infiltration Protection by Family Income and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages)

Thermal Characteristics	United States							
	Family Income							
	Total Households (millions)		Income Less Than $15,000		Income $15,000 to $34,999		Income $35,000 or More	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	57.6 [1.8]	100	19.3 [1.3]	100	22.4 [1.4]	100	15.8 [1.2]	100
Insulation:								
Attic--Full[1]	16.3 [1.4]	28.2 [2.2]	3.4 [0.5]	17.6 [2.6]	6.5 [0.8]	29.0 [2.9]	6.4 [0.8]	40.5 [3.7]
Wall, and Storm Windows[2]	8.3 [1.0]	14.4 [1.7]	1.2 [0.3]	6.0 [1.6]	3.4 [0.5]	15.4 [2.3]	3.7 [0.6]	23.2 [3.1]
Some Wall or Storm Windows[3]	7.0 [0.9]	12.1 [1.5]	1.8 [0.4]	9.1 [1.9]	2.7 [0.5]	12.1 [2.0]	2.5 [0.5]	15.8 [2.7]
None in Wall, No Storm Windows[4]	1.0 [0.3]	1.7 [0.6]	0.4 [0.2]	2.1 [0.9]	0.4 [0.2]	1.7 [0.7]	0.2 [0.1]	1.3 [0.7]
Attic--Full Area, Fewer Inches[5]	20.2 [1.5]	35.1 [2.5]	6.1 [0.7]	31.6 [3.2]	8.7 [0.9]	38.8 [3.1]	5.4 [0.7]	34.2 [3.5]
Wall, and Storm Windows[2]	7.5 [0.9]	13.0 [1.6]	2.0 [0.4]	10.6 [2.0]	3.3 [0.5]	14.6 [2.2]	2.2 [0.4]	13.8 [2.6]
Some Wall or Storm Windows[3]	10.7 [1.1]	18.7 [1.4]	3.4 [0.5]	17.4 [2.6]	4.7 [0.6]	21.0 [2.6]	2.7 [0.5]	16.9 [2.7]
None in Wall, No Storm Windows[4]	2.0 [0.5]	3.5 [1.0]	0.7 [0.2]	3.9 [1.3]	0.7 [0.2]	3.3 [1.1]	0.5 [0.2]	3.3 [1.2]
Attic--Partial or None[6]	21.1 [1.6]	36.6 [2.5]	9.8 [0.9]	50.8 [3.5]	7.1 [0.8]	31.7 [2.9]	4.1 [0.6]	25.9 [3.3]
Wall, and Storm Windows[2]	3.0 [0.6]	5.3 [1.0]	0.9 [0.3]	4.9 [1.4]	1.2 [0.3]	5.6 [1.4]	0.9 [0.3]	5.4 [1.6]
Some Wall or Storm Windows[3]	12.7 [1.2]	22.0 [2.1]	5.6 [0.7]	28.8 [3.0]	4.5 [0.6]	20.1 [2.5]	2.6 [0.5]	16.5 [1.4]
None in Wall, No Storm Windows[4]	5.4 [0.8]	9.3 [1.3]	3.3 [0.5]	17.3 [2.5]	1.4 [0.3]	6.3 [1.5]	0.6 [0.2]	3.9 [2.7]

See footnotes at end of table.

Table 11. Insulation and Air-Infiltration Protection by Family Income and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	Northeast							
	Family Income							
	Total Households (millions)		Income Less Than $15,000		Income $15,000 to $34,999		Income $35,000 or More	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	10.9 [1.1]	100	2.8 [0.6]	100	4.3 [0.6]	100	3.8 [0.7]	100
Insulation:								
Attic--Full[1]	3.1 [0.6]	28.4 [4.6]	0.3 [0.1]	10.7 [4.6]	1.1 [0.3]	25.6 [5.9]	1.6 [0.4]	42.1 [7.2]
Wall, and Storm Windows[2]	1.9 [0.3]	17.4 [3.8]	0.1 [0.1]	4.7 [3.4]	0.6 [0.2]	15.2 [4.9]	1.1 [0.3]	29.2 [6.5]
Some Wall or Storm Windows[3]	1.1 [0.3]	10.3 [3.0]	0.2 [0.1]	5.5 [4.0]	0.5 [0.2]	11.5 [4.6]	0.5 [0.2]	12.5 [4.4]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	3.6 [0.6]	33.0 [4.8]	1.0 [0.3]	35.7 [7.9]	1.5 [0.4]	34.9 [6.5]	1.1 [0.3]	28.9 [6.5]
Wall, and Storm Windows[2]	2.0 [0.5]	18.1 [3.8]	0.5 [0.2]	18.2 [6.2]	0.9 [0.3]	20.9 [5.4]	0.6 [0.2]	14.9 [4.8]
Some Wall or Storm Windows[3]	1.6 [0.4]	15.0 [3.1]	0.5 [0.2]	19.4 [6.6]	0.6 [0.2]	14.9 [4.8]	0.5 [0.2]	11.9 [4.7]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Partial or None[6]	4.2 [0.7]	38.6 [5.0]	1.4 [0.3]	50.0 [8.4]	1.5 [0.4]	34.9 [6.5]	1.2 [0.3]	31.6 [6.7]
Wall, and Storm Windows[2]	1.0 [0.3]	9.3 [2.9]	0.3 [0.1]	11.5 [5.1]	0.4 [0.2]	9.4 [3.7]	0.3 [0.1]	7.5 [3.4]
Some Wall or Storm Windows[3]	2.9 [0.6]	26.6 [4.5]	0.9 [0.3]	31.1 [8.0]	1.1 [0.3]	25.9 [5.9]	0.9 [0.3]	24.1 [6.1]
None in Wall, No Storm Windows[4]	0.3 [0.2]	2.9 [1.6]	0.2 [0.1]	8.8 [4.7]	Q	Q	Q	Q

See footnotes at end of table.

Table 11. Insulation and Air-Infiltration Protection by Family Income and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	North Central							
	Family Income							
	Total Households (millions)		Income Less Than $15,000		Income $15,000 to $34,999		Income $35,000 or More	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	14.6 [1.3]	100	4.9 [0.7]	100	6.1 [0.7]	100	3.6 [0.6]	100
Insulation:								
Attic--Full[1]	4.5 [0.7]	30.8 [4.1]	0.9 [0.3]	18.4 [4.9]	2.0 [0.4]	32.8 [5.5]	1.6 [0.4]	44.4 [7.4]
Wall, and Storm Windows[2]	2.9 [0.6]	20.1 [3.6]	0.4 [0.2]	8.2 [3.3]	1.4 [0.3]	23.0 [4.8]	1.1 [0.3]	31.7 [7.0]
Some Wall or Storm Windows[3]	1.6 [0.4]	10.9 [2.7]	0.5 [0.2]	9.7 [3.5]	0.6 [0.2]	10.6 [3.5]	0.5 [0.2]	13.1 [4.6]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	5.7 [0.8]	39.0 [4.3]	1.7 [0.4]	34.7 [6.1]	2.5 [0.5]	41.0 [5.9]	1.4 [0.3]	38.9 [7.3]
Wall, and Storm Windows[2]	3.5 [0.6]	24.3 [3.9]	0.9 [0.3]	19.2 [5.1]	1.6 [0.4]	26.7 [5.0]	1.0 [0.3]	27.4 [6.5]
Some Wall or Storm Windows[3]	2.1 [0.5]	14.6 [3.0]	0.8 [0.2]	16.8 [4.7]	0.9 [0.3]	14.7 [4.0]	0.4 [0.2]	11.4 [4.5]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Partial or None[6]	4.4 [0.7]	30.1 [4.1]	2.2 [0.4]	44.9 [6.5]	1.5 [0.4]	24.6 [5.0]	0.6 [0.2]	16.7 [5.3]
Wall, and Storm Windows[2]	1.2 [0.4]	8.0 [2.4]	0.3 [0.1]	6.9 [3.1]	0.5 [0.2]	8.8 [3.2]	0.3 [0.1]	8.2 [3.7]
Some Wall or Storm Windows[3]	2.9 [0.6]	19.9 [3.5]	1.6 [0.4]	33.3 [6.1]	1.0 [0.3]	15.9 [4.3]	0.3 [0.1]	8.1 [3.7]
None in Wall, No Storm Windows[4]	0.3 [0.1]	2.0 [1.1]	0.3 [0.1]	5.6 [2.6]	Q	Q	Q	Q

See footnotes at end of table.

Table 11. Insulation and Air-Infiltration Protection by Family Income and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	South							
	Family Income							
	Total Households (millions)		Income Less Than $15,000		Income $15,000 to $34,999		Income $35,000 or More	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	21.8 [1.6]	100	8.5 [0.9]	100	8.0 [0.8]	100	5.3 [0.7]	100
Insulation:								
Attic--Full[1]	6.2 [0.9]	28.4 [3.3]	1.5 [0.4]	17.6 [3.7]	2.4 [0.5]	30.0 [4.7]	2.4 [0.5]	45.3 [6.2]
Wall, and Storm Windows[2]	2.8 [0.6]	12.9 [2.4]	0.5 [0.2]	5.4 [2.0]	1.2 [0.3]	14.4 [3.4]	1.2 [0.3]	22.3 [5.0]
Some Wall or Storm Windows[3]	2.9 [0.6]	13.4 [2.5]	0.8 [0.2]	9.7 [2.9]	1.0 [0.3]	12.1 [3.2]	1.1 [0.3]	21.2 [5.0]
None in Wall, No Storm Windows[4]	0.5 [0.2]	2.2 [1.0]	0.2 [0.1]	2.8 [1.6]	0.2 [0.1]	2.2 [1.6]	0.1 [0.1]	1.4 [1.0]
Attic--Full Area, Fewer Inches[5]	7.0 [0.9]	32.1 [3.4]	2.3 [0.4]	27.1 [4.4]	3.2 [0.5]	40.0 [5.0]	1.6 [0.4]	30.2 [5.6]
Wall, and Storm Windows[2]	1.4 [0.4]	6.3 [1.7]	0.5 [0.2]	5.7 [2.1]	0.6 [0.2]	6.9 [2.3]	0.3 [0.1]	6.1 [2.8]
Some Wall or Storm Windows[3]	4.7 [0.7]	21.3 [3.0]	1.4 [0.3]	16.5 [3.6]	2.2 [0.4]	27.3 [4.5]	1.1 [0.3]	19.9 [5.0]
None in Wall, No Storm Windows[4]	1.0 [0.3]	4.4 [1.2]	0.4 [0.2]	4.2 [1.2]	0.4 [0.2]	5.4 [2.2]	0.2 [0.1]	3.3 [1.8]
Attic--Partial or None[6]	8.6 [1.0]	39.4 [3.6]	4.7 [0.6]	55.3 [5.1]	2.6 [0.5]	32.5 [4.8]	1.3 [0.3]	24.5 [5.3]
Wall, and Storm Windows[2]	0.7 [0.3]	3.0 [1.1]	0.2 [0.1]	2.7 [1.5]	0.3 [0.1]	3.1 [1.7]	0.2 [0.1]	3.4 [1.9]
Some Wall or Storm Windows[3]	5.0 [0.7]	22.8 [3.1]	2.4 [0.5]	28.5 [4.5]	1.6 [0.4]	20.3 [4.0]	0.9 [0.3]	17.7 [4.4]
None in Wall, No Storm Windows[4]	3.0 [0.6]	13.7 [2.5]	2.1 [0.4]	24.5 [4.4]	0.7 [0.2]	8.4 [2.6]	0.2 [0.1]	4.6 [2.5]

See footnotes at end of table.

Table 11. Insulation and Air-Infiltration Protection by Family Income and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	West							
	Family Income							
	Total Households (millions)		Income Less Than $15,000		Income $15,000 to $34,999		Income $35,000 or More	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	10.4 [1.1]	100	3.1 [0.5]	100	4.1 [0.6]	100	3.2 [0.5]	100
Insulation:								
Attic--Full[1]	2.5 [0.5]	24.0 [4.5]	0.6 [0.2]	19.4 [6.1]	0.9 [0.3]	22.0 [5.7]	0.7 [0.2]	21.9 [6.3]
Wall, and Storm Windows[2]	0.7 [0.3]	6.4 [2.3]	0.2 [0.1]	5.4 [2.9]	0.2 [0.1]	6.1 [3.3]	0.2 [0.1]	7.8 [4.2]
Some Wall or Storm Windows[3]	1.4 [0.4]	13.1 [3.4]	0.3 [0.1]	9.8 [4.4]	0.5 [0.2]	15.2 [4.9]	0.4 [0.2]	13.8 [5.3]
None in Wall, No Storm Windows[4]	0.4 [0.2]	4.2 [2.0]	0.1 [0.1]	4.1 [3.0]	0.2 [0.1]	4.3 [2.3]	0.1 [0.1]	4.0 [2.9]
Attic--Full Area, Fewer Inches[5]	4.0 [0.7]	38.5 [5.1]	1.0 [0.3]	32.3 [7.4]	1.4 [0.3]	34.1 [6.6]	1.4 [0.3]	43.8 [7.8]
Wall, and Storm Windows[2]	0.6 [0.2]	6.0 [2.4]	0.1 [0.1]	3.2 [2.3]	0.2 [0.1]	5.0 [2.7]	0.3 [0.1]	9.9 [4.4]
Some Wall or Storm Windows[3]	2.3 [0.4]	22.6 [4.4]	0.6 [0.2]	19.1 [6.0]	0.9 [0.3]	24.2 [5.8]	0.8 [0.2]	23.9 [6.3]
None in Wall, No Storm Windows[4]	1.0 [0.3]	10.0 [3.1]	0.4 [0.2]	12.3 [4.8]	0.3 [0.1]	7.6 [3.4]	0.3 [0.1]	10.9 [4.9]
Attic--Partial or None[6]	3.9 [0.7]	37.5 [5.1]	1.5 [0.4]	48.4 [8.0]	1.6 [0.4]	39.0 [6.8]	1.0 [0.3]	31.3 [7.2]
Wall, and Storm Windows[2]	0.2 [0.1]	2.1 [1.3]	0.1 [0.1]	1.8 [1.3]	0.1 [0.1]	1.4 [1.0]	0.1 [0.1]	3.2 [2.3]
Some Wall or Storm Windows[3]	1.9 [0.5]	18.5 [4.0]	0.6 [0.2]	20.5 [6.4]	0.8 [0.2]	19.6 [5.5]	0.5 [0.2]	14.8 [5.1]
None in Wall, No Storm Windows[4]	1.8 [0.4]	17.1 [3.8]	0.8 [0.2]	23.9 [6.8]	0.7 [0.2]	16.1 [5.2]	0.4 [0.2]	11.7 [4.5]

See footnotes on following page.

[1]Households with at least 96 percent of the ceiling area covered and at least the minimum recommended number of inches of insulation.

[2]Households with some or total wall insulation and storm windows on at least 90 percent of the windows.

[3]Households with some wall insulation or storm windows. This group does not include households that have both wall insulation and 90 percent storm windows coverage.

[4]Households with no wall insulation or storm windows.

[5]Households with at least 96 percent of the ceiling area covered but with fewer than the minimum recommended number of inches.

[6]Households with less than 96 percent of the ceiling area covered, lacking attics or attic insulation, or not knowing how much ceiling area was covered.

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Central, around 30 percent [7] of households with incomes over $35,000 had all three conservation measures. For households with incomes under $15,000, the percentages with all three measures were much lower, 5 [3] and 8 percent [3], respectively. A similar relationship with income held in the South, although the percentage having all three in the highest income group is lower (22 percent [5]) than in the colder regions. However, in the West, which had a lower percentage of households overall that had all three measures, there was very little variation by income group in the percentages.

There was also a substantial difference between the two colder regions and the two warmer regions in the percentage of low-income households that had partial or no attic insulation as well as no wall insulation and no storm windows. The percentage was 9 percent [5] in the Northeast, 6 percent [3] in the North Central, and around 24 percent in the South [4] and West [7].

Age of House. In the three groups considered for age of house, for the Nation as a whole newer homes were much more likely to have conservation improvements than were older homes. Nineteen percent [3] of homes built before 1950 had full attic insulation, while the corresponding figures for homes built 1950 through 1974 was 31 percent [3] and 44 percent [8] for homes built 1975 or later, Table 12. About three-fourths of the homes built after 1975 that had full attic insulation also had 90 percent storm window coverage and wall insulation. Fourteen percent [2] of the homes built from 1950 to 1975 had the full complement of conservation measures, as did 8 percent [2] of older homes.

Table 12. Insulation and Air-Infiltration Protection by Year House Was Built and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages)

Thermal Characteristics	United States							
	Year House Was Built							
	Total Households (millions)		1949 or Before		1950 to 1974		1975 or After	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	57.6 [1.8]	100	23.2 [1.8]	100	26.1 [1.9]	100	8.4 [1.1]	100
Insulation:								
Attic--Full[1]	16.3 [1.4]	28.2 [2.2]	4.4 [0.8]	19.0 [3.0]	8.1 [1.1]	31.3 [3.4]	3.7 [0.7]	44.4 [7.8]
Wall, and Storm Windows[2]	8.3 [1.0]	14.4 [1.7]	1.7 [0.5]	7.5 [2.0]	3.7 [0.7]	14.4 [2.5]	2.8 [0.6]	33.5 [5.9]
Some Wall or Storm Windows[3]	7.0 [0.9]	12.1 [1.5]	2.3 [0.6]	9.8 [2.2]	3.8 [0.7]	14.7 [2.6]	0.9 [0.3]	10.6 [3.7]
None in Wall, No Storm Windows[4]	1.0 [0.3]	1.7 [0.6]	0.4 [0.2]	1.7 [0.9]	0.6 [0.3]	2.2 [0.9]	Q	Q
Attic--Full Area, Fewer Inches[5]	20.2 [1.5]	35.1 [2.5]	6.5 [0.9]	27.9 [3.4]	10.6 [1.2]	40.5 [3.6]	3.1 [0.6]	38.4 [7.5]
Wall, and Storm Windows[2]	7.5 [0.9]	13.0 [1.6]	2.4 [0.6]	10.3 [2.3]	3.5 [0.7]	13.3 [2.4]	1.6 [0.5]	19.7 [5.0]
Some Wall or Storm Windows[3]	10.7 [1.1]	18.7 [1.4]	3.5 [0.7]	15.2 [2.7]	5.7 [0.9]	21.8 [3.0]	1.5 [0.4]	18.2 [4.8]
None in Wall, No Storm Windows[4]	2.0 [0.5]	3.5 [1.0]	0.6 [0.3]	2.4 [1.1]	1.4 [0.4]	5.4 [1.6]	Q	Q
Attic--Partial or None[6]	21.1 [1.6]	36.6 [2.5]	12.3 [1.3]	52.9 [3.9]	7.4 [1.0]	28.3 [3.3]	1.4 [0.4]	17.1 [5.0]
Wall, and Storm Windows[2]	3.0 [0.6]	5.3 [1.0]	1.8 [0.5]	7.9 [2.0]	0.8 [0.3]	3.1 [1.2]	0.4 [0.2]	4.8 [2.4]
Some Wall or Storm Windows[3]	12.7 [1.2]	22.0 [2.1]	7.2 [1.0]	31.0 [3.6]	4.8 [0.8]	18.3 [2.8]	0.7 [0.3]	8.7 [2.8]
None in Wall, No Storm Windows[4]	5.4 [0.8]	9.3 [1.3]	3.3 [0.7]	14.0 [2.7]	1.8 [0.5]	6.9 [1.8]	0.3 [0.2]	3.6 [2.1]

See footnotes at end of table.

Table 12. Insulation and Air-Infiltration Protection by Year House Was Built and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	Northeast							
	Year House Was Built							
	Total Households (millions)		1949 or Before		1950 to 1974		1975 or After	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	10.9 [1.1]	100	5.5 [0.9]	100	4.2 [0.8]	100	1.1 [0.4]	100
Insulation:								
Attic--Full[1]	3.1 [0.6]	28.4 [4.6]	0.8 [0.3]	15.0 [5.3]	1.6 [0.5]	38.3 [8.3]	0.6 [0.3]	54.2 [15.5]
Wall, and Storm Windows[2]	1.9 [0.3]	17.4 [3.8]	0.4 [0.2]	7.0 [3.5]	1.0 [0.4]	22.8 [7.3]	0.5 [0.2]	47.3 [16.0]
Some Wall or Storm Windows[3]	1.1 [0.3]	10.3 [3.0]	0.4 [0.2]	7.5 [3.7]	0.6 [0.3]	14.9 [6.0]	0.1 [0.1]	6.9 [6.0]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	3.6 [0.6]	33.0 [4.8]	1.7 [0.5]	29.9 [6.8]	1.7 [0.5]	39.1 [8.2]	0.3 [0.2]	26.4 [12.9]
Wall, and Storm Windows[2]	2.0 [0.5]	18.1 [3.8]	0.7 [0.3]	12.2 [6.1]	1.1 [0.4]	25.9 [7.4]	0.2 [0.1]	17.7 [10.9]
Some Wall or Storm Windows[3]	1.6 [0.4]	15.0 [3.6]	1.0 [0.4]	17.7 [5.5]	0.6 [0.3]	13.2 [5.3]	0.1 [0.1]	8.7 [7.4]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic: Partial or None[6]	4.2 [0.7]	38.6 [5.0]	3.0 [0.6]	55.2 [7.8]	1.0 [0.4]	22.6 [6.8]	0.2 [0.1]	19.4 [12.0]
Wall, and Storm Windows[2]	1.0 [0.3]	9.3 [2.9]	0.6 [0.3]	11.2 [4.6]	0.3 [0.2]	6.6 [3.7]	0.1 [0.1]	10.0 [8.7]
Some Wall or Storm Windows[3]	2.9 [0.6]	26.6 [4.5]	2.2 [0.5]	40.9 [7.4]	0.6 [0.3]	14.4 [5.6]	0.1 [0.1]	6.6 [5.7]
None in Wall, No Storm Windows[4]	0.3 [0.2]	2.9 [1.6]	0.2 [0.1]	3.1 [2.1]	0.1 [0.1]	1.6 [1.5]	Q	Q

See footnotes at end of table.

Table 12. Insulation and Air-Infiltration Protection by Year House Was Built and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	North Central							
	Year House Was Built							
	Total Households (millions)		1949 or Before		1950 to 1974		1975 or After	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	14.6 [1.3]	100	7.6 [1.0]	100	5.2 [0.8]	100	1.8 [0.5]	100
Insulation:								
Attic--Full[1]	4.5 [0.7]	30.8 [4.1]	1.9 [0.5]	24.5 [5.5]	1.9 [0.5]	36.7 [7.5]	0.7 [0.3]	42.8 [13.4]
Wall, and Storm Windows[2]	2.9 [0.6]	20.1 [3.6]	1.0 [0.4]	12.8 [4.1]	1.3 [0.4]	25.1 [3.5]	0.6 [0.3]	36.5 [12.7]
Some Wall or Storm Windows[3]	1.6 [0.4]	10.9 [2.7]	0.9 [0.3]	11.6 [4.0]	0.6 [0.3]	11.4 [4.7]	0.1 [0.1]	6.3 [5.6]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	5.7 [0.8]	39.0 [4.3]	2.5 [0.6]	33.2 [6.2]	2.3 [0.6]	43.7 [7.7]	0.9 [0.3]	48.9 [12.3]
Wall, and Storm Windows[2]	3.5 [0.6]	24.3 [3.9]	1.4 [0.4]	18.9 [5.1]	1.4 [0.4]	26.7 [6.8]	0.7 [0.3]	40.3 [12.6]
Some Wall or Storm Windows[3]	2.1 [0.5]	14.6 [3.0]	1.1 [0.4]	14.3 [4.4]	0.9 [0.3]	17.0 [5.6]	0.2 [0.1]	8.6 [7.6]
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Partial or None[6]	4.4 [0.7]	30.1 [4.1]	3.2 [0.7]	42.2 [6.5]	1.0 [0.4]	19.4 [6.0]	0.1 [0.1]	5.6 [5.0]
Wall, and Storm Windows[2]	1.2 [0.4]	8.0 [2.4]	0.8 [0.3]	10.5 [3.8]	0.3 [0.2]	6.4 [3.6]	Q	Q
Some Wall or Storm Windows[3]	2.9 [0.6]	19.9 [3.5]	2.1 [0.5]	27.9 [5.9]	0.7 [0.3]	13.0 [4.9]	0.1 [0.1]	6.0 [5.3]
None in Wall, No Storm Windows[4]	0.3 [0.1]	2.0 [1.1]	0.3 [0.2]	3.8 [2.2]	Q	Q	Q	Q

See footnotes at end of table.

Table 12. Insulation and Air-Infiltration Protection by Year House Was Built and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	South							
	Year House Was Built							
	Total Households (millions)		1949 or Before		1950 to 1974		1975 or After	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	21.8 [1.6]	100	6.9 [1.0]	100	11.3 [1.2]	100	3.6 [0.7]	100
Insulation:								
Attic--Full[1]	6.2 [0.9]	28.4 [3.3]	1.3 [0.4]	18.8 [5.2]	3.3 [0.7]	28.3 [4.8]	1.8 [0.5]	48.0 [8.9]
Wall, and Storm Windows[2]	2.8 [0.6]	12.9 [2.4]	0.3 [0.2]	4.0 [2.3]	1.3 [0.4]	11.2 [3.2]	1.3 [0.4]	35.2 [2.8]
Some Wall or Storm Windows[3]	2.9 [0.6]	13.4 [2.5]	0.8 [0.3]	11.6 [4.2]	1.7 [0.5]	14.7 [3.7]	0.5 [0.2]	12.8 [6.2]
None in Wall, No Storm Windows[4]	0.5 [0.2]	2.2 [1.0]	0.2 [0.1]	3.2 [2.2]	0.3 [0.2]	2.4 [1.4]	Q	Q
Attic--Full Area, Fewer Inches[5]	7.0 [0.9]	32.1 [3.4]	1.3 [0.4]	18.6 [5.2]	4.3 [0.8]	38.4 [5.4]	1.3 [0.4]	37.8 [9.2]
Wall, and Storm Windows[2]	1.4 [0.4]	6.3 [1.7]	0.2 [0.1]	2.6 [1.8]	0.7 [0.3]	6.6 [2.6]	0.4 [0.2]	12.4 [6.0]
Some Wall or Storm Windows[3]	4.7 [0.7]	21.3 [3.0]	1.0 [0.1]	13.9 [4.5]	2.8 [0.6]	24.8 [4.6]	0.9 [0.3]	24.7 [7.7]
None in Wall, No Storm Windows[4]	1.0 [0.3]	4.4 [1.4]	0.1 [0.1]	2.1 [1.9]	0.8 [0.3]	7.0 [2.6]	Q	Q
Attic--Partial or None[6]	8.6 [1.0]	39.4 [3.6]	4.4 [0.8]	62.6 [6.6]	3.8 [0.7]	33.4 [5.1]	0.5 [0.2]	14.3 [6.2]
Wall, and Storm Windows[2]	0.7 [0.3]	3.0 [1.1]	0.4 [0.2]	5.1 [2.9]	0.2 [0.1]	1.4 [1.0]	0.1 [0.1]	4.0 [3.6]
Some Wall or Storm Windows[3]	5.0 [0.7]	22.8 [3.1]	2.1 [0.5]	29.9 [6.2]	2.6 [0.6]	23.2 [4.6]	0.3 [0.2]	8.0 [4.5]
None in Wall, No Storm Windows[4]	3.0 [0.6]	13.7 [2.5]	1.9 [0.5]	27.6 [5.9]	1.0 [0.4]	8.8 [2.8]	0.1 [0.1]	2.3 [2.1]

See footnotes at end of table.

Table 12. Insulation and Air-Infiltration Protection by Year House Was Built and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	West							
	Year House Was Built							
	Total Households (millions)		1949 or Before		1950 to 1974		1975 or After	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	10.4 [1.1]	100	3.2 [0.7]	100	5.3 [0.8]	100	1.9 [0.5]	100
Insulation:								
Attic--Full[1]	2.5 [0.5]	24.0 [4.5]	0.4 [0.2]	13.3 [6.4]	1.4 [0.4]	26.4 [6.7]	0.6 [0.3]	33.6 [12.0]
Wall, and Storm Windows[2]	0.7 [0.3]	6.4 [2.3]	0.1 [0.1]	3.4 [3.1]	0.2 [0.1]	3.6 [2.4]	0.4 [0.2]	19.3 [8.8]
Some Wall or Storm Windows[3]	1.4 [0.4]	13.1 [3.4]	0.2 [0.1]	5.5 [3.7]	0.9 [0.3]	17.8 [5.7]	0.2 [0.1]	12.9 [8.4]
None in Wall, No Storm Windows[4]	0.4 [0.2]	4.2 [2.0]	0.1 [0.1]	4.4 [4.0]	0.3 [0.2]	5.0 [2.8]	Q	Q
Attic--Full Area, Fewer Inches[5]	4.0 [0.7]	38.5 [5.1]	1.0 [0.4]	32.2 [9.2]	2.2 [0.5]	43.0 [8.0]	0.7 [0.3]	36.8 [11.7]
Wall, and Storm Windows[2]	0.6 [0.2]	6.0 [2.4]	0.1 [0.1]	3.2 [2.9]	0.2 [0.1]	4.3 [2.9]	0.3 [0.2]	15.3 [8.3]
Some Wall or Storm Windows[3]	2.3 [0.4]	22.6 [4.4]	0.5 [0.2]	16.2 [7.0]	1.4 [0.4]	27.1 [6.6]	0.4 [0.2]	20.6 [9.4]
None in Wall, No Storm Windows[4]	1.0 [0.3]	10.0 [3.1]	0.4 [0.2]	12.8 [6.2]	0.6 [0.3]	11.6 [4.7]	Q	Q
Attic--Partial or None[6]	3.9 [0.7]	37.5 [5.1]	1.7 [0.5]	54.6 [10.2]	1.5 [0.4]	30.5 [7.4]	0.5 [0.2]	29.7 [11.8]
Wall, and Storm Windows[2]	0.2 [0.1]	2.1 [1.3]	Q	Q	Q	Q	0.1 [0.1]	5.8 [5.1]
Some Wall or Storm Windows[3]	1.9 [0.5]	18.5 [4.0]	0.8 [0.3]	24.1 [7.9]	0.8 [0.3]	16.0 [5.5]	0.3 [0.2]	16.3 [8.7]
None in Wall, No Storm Windows[4]	1.8 [0.4]	17.1 [3.8]	0.9 [0.3]	27.9 [8.5]	0.7 [0.3]	14.1 [5.2]	0.1 [0.1]	7.6 [6.8]

See footnotes on following page.

[1]Households with at least 96 percent of the ceiling area covered and at least the minimum recommended number of inches of insulation.

[2]Households with some or total wall insulation and storm windows on at least 90 percent of the windows.

[3]Households with some wall insulation or storm windows. This group does not include households that have both wall insulation and 90 percent storm window coverage.

[4]Households with no wall insulation or storm windows.

[5]Households with at least 96 percent of the ceiling area covered but with fewer than the minimum recommended number of inches.

[6]Households with less than 96 percent of the ceiling area covered, lacking attics or attic insulation, or not knowing how much ceiling area was covered.

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Homes in the newest age group also had the lowest proportion of homes with partial or no attic insulation as well as no storm windows and no wall insulation--around four percent [2]. The corresponding figure for the homes built from 1950 to 1974 was closer to 7 percent [2], while for the oldest age group it was 14 percent [3]. Among homes with full area of attic insulation but less than the minimum recommended number of inches, new homes also had a higher percentage with 90 percent storm windows and wall insulation.

The regional differences discussed above are also observed when housing units are distinguished by the year they were built. Within specific age groups, houses in the two colder regions, the Northeast and North Central, were more likely to have more conservation items, particularly storm windows and wall insulation. However, the differences between the regions within specific age groups, were not as large as the overall regional differences. Indeed, for the homes built in the South in 1975 or later, the distribution of homes by attic insulation and the other two items were not dramatically different than for the northern regions. Homes built in the West after 1975 were still less likely than the homes in other regions to have sizeable amounts of conservation measures, but again the difference was not as large as between the regions as a whole.

One factor that influences the comparison of regions in conjunction with the year the house was built is the substantial regional variation in the distribution of the housing stock by age. In the Northeast and North Central regions, slightly more than one-half of the houses were built before 1950 and only about 11 percent [3] to 12 percent [3] were built in 1975 or later. By way

of contrast, slightly over one-half the houses in the South and West were built in the period 1950 to 1974 and 16 percent [3] to 18 percent [4] were built in 1975 or after.

Own/Rent Status. In the discussion in the previous chapter of individual conservation items, it was found that homeowners were much more likely to have a item than were renters. The same situation holds for the combination of conservation items considered in this Chapter. Across the Nation, 32 percent [2] of the homeowners had full attic insulation and about one-half of these also had wall insulation and full storm window coverage. Among renters or households that had free rent, only 8 percent [3] had full attic insulation. The majority of these households had only some wall insulation and storm window coverage. A higher percentage of owners than renters lived in housing units with full area coverage of attic insulation but low inches. A higher percentage of owners among this group also had full storm window coverage and wall insulation.

The same pattern holds in all the regions. Homeowners were more likely to have fully insulated homes or higher levels of conservation measures than were renters or householders with free rent, Table 13.

Energy Savings from Conservation Retrofits

One goal of this study was to provide estimates of the energy that might be saved under different assumptions about the kinds of conservation upgrades that households might make to their houses. It was recognized at the start of the

Table 13. Insulation and Air-Infiltration Protection by Home Ownership and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages)

Thermal Characteristics	United States: Total Households (Millions) No.	Total Households (Millions) Per.	Home Ownership: Owned No.	Owned Per.	Rented No.	Rented Per.	Rent-Free No.	Rent-Free Per.
Total Households (millions)	57.6 [1.8]	100	47.9 [2.0]	100	8.6 [1.0]	100	1.1 [0.3]	100
Insulation:								
Attic--Full[1]	16.3 [1.4]	28.2 [2.2]	15.5 [1.3]	32.3 [2.4]	0.7 [0.3]	8.1 [2.9]	Q	Q
Wall, and Storm Windows[2]	8.3 [1.0]	14.4 [1.7]	8.1 [1.0]	16.9 [1.6]	0.2 [0.1]	1.9 [1.6]	Q	Q
Some Wall or Storm Windows[3]	7.0 [0.9]	12.1 [1.5]	6.5 [0.9]	13.7 [1.7]	0.4 [0.2]	4.6 [2.1]	Q	Q
None in Wall, No Storm Windows[4]	1.0 [0.3]	1.7 [0.6]	0.8 [0.3]	1.8 [0.6]	0.1 [0.1]	1.6 [1.3]	Q	Q
Attic--Full Area, Fewer Inches[5]	20.2 [1.5]	35.1 [2.5]	17.9 [1.4]	37.4 [2.5]	2.1 [0.5]	23.9 [4.7]	0.3 [0.2]	25.4 [11.3]
Wall, and Storm Windows[2]	7.5 [0.9]	13.0 [1.6]	7.1 [0.9]	14.8 [1.8]	0.4 [0.2]	4.2 [1.9]	Q	Q
Some Wall or Storm Windows[3]	10.7 [1.1]	18.7 [1.4]	9.1 [1.0]	19.1 [5.1]	1.4 [0.4]	15.8 [4.0]	Q	Q
None in Wall, No Storm Windows[4]	2.0 [0.5]	3.5 [1.0]	1.7 [0.4]	3.5 [1.3]	0.3 [0.2]	3.9 [2.0]	0.3 [0.2]	23.5 [10.4]
Attic--Partial or None[6]	21.1 [1.6]	36.6 [2.5]	14.5 [1.3]	30.2 [2.4]	5.9 [0.8]	68.1 [5.2]	0.7 [0.3]	67.5 [14.4]
Wall, and Storm Windows[2]	3.0 [0.6]	5.3 [1.0]	2.7 [0.5]	5.7 [3.6]	0.2 [0.1]	2.7 [1.7]	Q	Q
Some Wall or Storm Windows[3]	12.7 [1.2]	22.0 [2.1]	8.6 [0.9]	17.9 [3.0]	3.7 [0.6]	42.6 [5.5]	0.4 [0.2]	40.1 [14.7]
None in Wall, No Storm Windows[4]	5.4 [0.8]	9.3 [1.3]	3.2 [0.6]	6.6 [1.5]	2.0 [0.5]	22.7 [4.5]	0.2 [0.1]	20.2 [11.3]

See footnotes at end of table.

Table 13. Insulation and Air-Infiltration Protection by Home Ownership and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	Northeast							
	Home Ownership							
	Total Households (Millions)		Owned		Rented		Rent-Free	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	10.9 [1.1]	100	9.9 [1.0]	100	0.9 [0.3]	100	Q	Q
Insulation:								
Attic--Full[1]	3.1 [0.6]	28.4 [4.6]	3.0 [0.6]	30.4 [4.9]	Q	Q	Q	Q
Wall, and Storm Windows[2]	1.9 [0.3]	17.4 [3.8]	1.9 [0.5]	19.0 [4.1]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	1.1 [0.3]	10.3 [3.0]	1.1 [0.3]	11.2 [3.2]	Q	Q	Q	Q
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	3.6 [0.6]	33.0 [4.8]	3.3 [0.6]	33.6 [4.5]	0.2 [0.1]	24.5 [13.3]	Q	Q
Wall, and Storm Windows[2]	2.0 [0.5]	18.1 [3.8]	1.9 [0.5]	19.2 [4.0]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	1.6 [0.4]	15.0 [3.6]	1.4 [0.4]	14.4 [3.6]	0.2 [0.1]	17.6 [13.5]	Q	Q
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Partial or None[6]	4.2 [0.7]	38.6 [5.0]	3.6 [0.6]	36.0 [5.1]	0.6 [0.2]	69.6 [15.4]	Q	Q
Wall, and Storm Windows[2]	1.0 [0.3]	9.3 [2.9]	1.0 [0.3]	9.8 [2.9]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	2.9 [0.6]	26.6 [4.5]	2.5 [0.5]	25.2 [4.5]	0.4 [0.2]	44.3 [14.2]	Q	Q
None in Wall, No Storm Windows[4]	0.3 [0.2]	2.9 [1.6]	0.1 [0.1]	1.1 [0.9]	0.2 [0.1]	23.4 [12.4]	Q	Q

See footnotes at end of table.

Table 13. Insulation and Air-Infiltration Protection by Home Ownership and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	North Central							
	Home Ownership							
	Total Households (millions)		Owned		Rented		Rent-Free	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	14.6 [1.3]	100	12.6 [1.2]	100	1.7 [0.4]	100	0.2 [0.1]	100
Insulation:								
Attic--Full[1]	4.5 [0.7]	30.8 [4.1]	4.3 [0.7]	34.0 [4.4]	0.2 [0.1]	12.9 [7.6]	Q	Q
Wall, and Storm Windows[2]	2.9 [0.6]	20.1 [3.6]	2.9 [0.6]	22.7 [3.9]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	1.6 [0.4]	10.9 [2.7]	1.4 [0.4]	11.2 [4.0]	0.2 [0.1]	9.9 [5.8]	Q	Q
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	5.7 [0.8]	39.0 [4.3]	5.2 [0.8]	41.0 [4.6]	0.5 [0.2]	28.6 [10.1]	Q	Q
Wall, and Storm Windows[2]	3.5 [0.6]	24.3 [3.9]	3.4 [0.6]	26.9 [4.1]	0.2 [0.1]	8.8 [7.1]	Q	Q
Some Wall or Storm Windows[3]	2.1 [0.5]	14.6 [3.0]	1.8 [0.4]	14.1 [3.2]	0.3 [0.2]	19.8 [9.4]	Q	Q
None in Wall, No Storm Windows[4]	Q	Q	Q	Q	Q	Q	Q	Q
Attic--Partial or None[6]	4.4 [0.7]	30.1 [4.1]	3.1 [0.6]	25.0 [4.1]	1.0 [0.3]	58.4 [11.4]	Q	Q
Wall, and Storm Windows[2]	1.2 [0.4]	8.0 [2.4]	1.1 [0.3]	8.4 [2.4]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	2.9 [0.6]	19.9 [3.5]	1.8 [0.4]	14.6 [3.5]	0.9 [0.3]	51.5 [11.3]	Q	Q
None in Wall, No Storm Windows[4]	0.3 [0.1]	2.0 [1.1]	0.2 [0.1]	1.9 [1.2]	Q	Q	Q	Q

See footnotes at end of table.

Table 13. Insulation and Air-Infiltration Protection by Home Ownership and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	South							
	Home Ownership							
	Total Households (millions)		Owned		Rented		Rent-Free	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	21.8 [1.6]	100	17.0 [1.4]	100	4.1 [0.7]	100	0.7 [0.3]	100
Insulation:								
Attic--Full[1]	6.2 [0.9]	28.4 [3.3]	5.9 [0.8]	34.6 [3.8]	0.3 [0.2]	6.9 [3.5]	Q	Q
Wall, and Storm Windows[2]	2.8 [0.6]	12.9 [2.4]	2.7 [0.5]	16.0 [3.8]	0.1 [0.1]	1.8 [1.5]	Q	Q
Some Wall or Storm Windows[3]	2.9 [0.6]	13.4 [2.5]	2.8 [0.6]	16.3 [2.9]	0.1 [0.1]	2.7 [2.2]	Q	Q
None in Wall, No Storm Windows[4]	0.5 [0.2]	2.2 [1.0]	0.4 [0.2]	2.3 [1.1]	0.1 [0.1]	2.7 [2.2]	Q	Q
Attic--Full Area, Fewer Inches[5]	7.0 [0.9]	32.1 [3.4]	5.9 [0.7]	34.6 [3.8]	0.8 [0.3]	20.4 [6.3]	0.2 [0.1]	29.0 [15.0]
Wall, and Storm Windows[2]	1.4 [0.4]	6.3 [1.7]	1.2 [0.4]	7.2 [2.0]	0.1 [0.1]	3.1 [2.6]	Q	Q
Some Wall or Storm Windows[3]	4.7 [0.7]	21.3 [3.0]	3.9 [0.7]	23.1 [3.4]	0.5 [0.2]	13.0 [5.2]	0.2 [0.1]	26.0 [13.4]
None in Wall, No Storm Windows[4]	1.0 [0.3]	4.4 [1.4]	0.8 [0.3]	4.6 [1.6]	0.2 [0.1]	4.4 [3.6]	Q	Q
Attic--Partial or None[6]	8.6 [1.0]	39.4 [3.6]	5.2 [0.8]	30.5 [3.8]	3.0 [0.6]	72.7 [7.2]	0.5 [0.2]	64.4 [14.2]
Wall, and Storm Windows[2]	0.7 [0.3]	3.0 [1.1]	0.5 [0.2]	2.9 [1.2]	0.1 [0.1]	3.6 [3.0]	Q	Q
Some Wall or Storm Windows[3]	5.0 [0.7]	22.8 [3.1]	3.0 [0.6]	17.5 [3.0]	1.8 [0.4]	43.7 [7.7]	0.2 [0.2]	30.2 [15.6]
None in Wall, No Storm Windows[4]	3.0 [0.6]	13.7 [2.5]	1.7 [0.4]	10.2 [2.4]	1.0 [0.3]	25.5 [21.1]	0.2 [0.2]	30.5 [15.7]

See footnotes at end of table.

Table 13. Insulation and Air-Infiltration Protection by Home Ownership and Census Region--Single-Family Housing Units, 1984 (Millions of Households--Percentages) (Continued)

Thermal Characteristics	West							
	Home Ownership							
	Total Households (millions)		Owned		Rented		Rent-Free	
	No.	Per.	No.	Per.	No.	Per.	No.	Per.
Total Households (millions)	10.4 [1.1]	100	8.3 [1.0]	100	2.0 [0.5]	100	Q	Q
Insulation:								
Attic--Full[1]	2.5 [0.5]	24.0 [4.5]	2.3 [0.5]	27.7 [5.1]	0.1 [0.1]	7.3 [5.9]	Q	Q
Wall, and Storm Windows[2]	0.7 [0.3]	6.4 [2.3]	0.6 [0.2]	7.7 [2.9]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	1.4 [0.4]	13.1 [3.4]	1.3 [0.4]	15.1 [4.1]	0.1 [0.1]	5.0 [4.0]	Q	Q
None in Wall, No Storm Windows[4]	0.4 [0.2]	4.2 [2.0]	0.4 [0.2]	4.9 [2.3]	Q	Q	Q	Q
Attic--Full Area, Fewer Inches[5]	4.0 [0.7]	38.5 [5.1]	3.5 [0.6]	41.5 [5.6]	0.5 [0.2]	26.6 [9.7]	Q	Q
Wall, and Storm Windows[2]	0.6 [0.2]	6.0 [2.4]	0.6 [0.2]	7.0 [2.7]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	2.3 [0.4]	22.6 [4.4]	2.0 [0.5]	23.9 [4.8]	0.3 [0.2]	17.2 [8.3]	Q	Q
None in Wall, No Storm Windows[4]	1.0 [0.3]	10.0 [3.1]	0.9 [0.3]	10.6 [3.3]	0.2 [0.1]	7.9 [6.4]	Q	Q
Attic--Partial or None[6]	3.9 [0.7]	37.5 [5.1]	2.6 [0.5]	30.8 [5.2]	1.3 [0.4]	66.1 [10.7]	Q	Q
Wall, and Storm Windows[2]	0.2 [0.1]	2.1 [1.3]	0.2 [0.1]	2.6 [1.6]	Q	Q	Q	Q
Some Wall or Storm Windows[3]	1.9 [0.5]	18.5 [4.0]	1.2 [0.4]	15.0 [4.0]	0.6 [0.2]	32.1 [10.4]	Q	Q
None in Wall, No Storm Windows[4]	1.8 [0.4]	17.1 [3.8]	1.1 [0.3]	13.2 [3.7]	0.7 [0.3]	34.0 [10.0]	Q	Q

See footnotes on following page.

[1]Households with at least 96 percent of the ceiling area covered and at least the minimum recommended number of inches of insulation.

[2]Households with some or total wall insulation and storm windows on at least 90 percent of the windows.

[3]Households with some wall insulation or storm windows. This group does not include households that have both wall insulation and 90 percent storm window coverage.

[4]Households with no wall insulation or storm windows.

[5]Households with at least 96 percent of the ceiling area covered but with fewer than the minimum recommended number of inches.

[6]Households with less than 96 percent of the ceiling area covered, lacking attics or attic insulation, or not knowing how much ceiling area was covered.

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

project that such estimates would be difficult to obtain, particularly under the tight time frame under which this work was to be conducted. At the time this report is being written, the EIA has not been able to obtain or produce estimates of energy savings that are of high enough quality to be included in this report. Work is continuing on this subject and will be presented in a future report if data of sufficient quality are obtained.

Two approaches were followed to explore the energy savings obtainable from conservation measures. The first was a review of the literature on studies of energy savings from various types of conservation programs such as the Weatherization Program and the Residential Conservation Service. The highlights of this review are discussed in the next section. The basic conclusion of the review is that the findings from the different studies are so varied that the studies do not provide a sufficiently reliable source for estimating the effectiveness of conservation measures.

The second approach was an attempt to estimate the effectiveness of conservation measures directly using multiple regression techniques directly on the RECS data. It was anticipated that this approach would be difficult and time consuming--and such turned out to be the case. The methods followed in this statistical analysis are described below. But at the time of this writing, the research has not provided results that were considered reliable enough to incorporate into this study.

It might also be the case that the problem posed is simply intractable. There may be so much variation in the quality, materials, behavior patterns of the

householders and other features of houses that affect their energy use that the effectiveness of a particular conservation measure, or a group of them, may be unique to each house. There may be a very wide variation in the effectiveness of a particular measure or group of measures, because of the wide variations in the characteristics of the housing stock.

In such a case, the best that could be done to estimate the energy savings obtainable from a wide scale thermal upgrading of the housing stock would be to take a "best guess" of the average energy savings to be obtained, and apply this savings to the average energy consumption for the entire group of households for which the conservation measures are assumed to be made. The savings could be dependent upon region to reflect variations in energy consumption for space heating.

No estimates of this type are provided in this report because the EIA is not able to provide any estimate of the standard error that might be associated with such a "best guess" estimate of energy savings. There is such a wide variation in the energy savings observed in the various studies that is not possible to estimate the reliablity of the estimates of the energy savings.

Review of Literature. This section provides a brief review of the findings of studies investigating the energy savings obtained from various conservation measures. This review will give an idea of the range of estimates of possible savings from conducting selected conservation measures. However, it should be emphasized that these estimates are quite rough. The various studies do not provide a consistent pattern of findings, and even within a particular study, there is a wide range of variation in energy savings from one house to another.

There are three basic types of studies that have been conducted to evaluate the conservation savings from conservation improvements: evaluations of the Weatherization Program for low-income households, evaluations of the effectiveness of the RCS program; and other studies of the effects of conservation measures. There are also many engineering studies on individual and collections of homes, but these findings have not been drawn upon for this study. Generally, when field measures of the energy savings from a conservation retrofit measure are compared with engineering estimates, the results are not in agreement.

A major overview of the effectiveness of a variety of conservation programs has been given by Goldman and Wagner.[13] This report draws upon the data base accumulated through the Building Energy Use Compilation and Analysis (BECA) project at Lawrence Berkeley Laboratory, University of California. This data base includes data from several hundred studies of residential (and other types of) buildings, both new homes and older homes with conservation retrofits. The data on retrofitted homes, BECA-B, comes from a wide range of evaluation studies of conservation programs and demonstration projects. The estimates of energy savings from the conservation improvements have attempted to correct for changes in weather, but other factors that may affect consumption, such as changes in life style or in the number of household members, were not accounted for. Data were derived from evaluations of Weatherization Programs directed at low-income single family houses, of utility sponsored conservation programs and of research studies and demonstration programs. Some of the studies covered retrofit

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[13] Goldman, C. A. and B.S. Wagner "Saving Energy in Occupied Buildings: Results from the Berkeley Laboratory Residential Data Bases," Presented at the Working Conference on Families and Energy - Coping with Uncertainty, Michigan State University, 1983.

measures that have not been included in this study, such as automatic timers or set-back thermostats and modification or replacement of heating system equipment.

The studies surveyed in the report by Goldman and Wagner had a wide range of estimated energy savings resulting from the conservation retrofit measures. For electrically heated homes, the percentage savings in electricity consumption for space heating ranged from a high of 54 percent to a low of 17 percent, with an average savings of 29 percent for the 13 studies listed. For homes heated with natural gas the savings ranged from 47 percent to 3 percent with an average of 24 percent for the 33 studies. Each of the studies incorporated different sets of conservation measures and there was no clear-cut relationship between the number and types of conservation measures and the resulting energy savings.

The study found that participants in utility-sponsored conservation programs saved 38.5 million Btu of their annual space heating consumption, while savings for low-income households were 35.9 MBtu respectively.

From the data presented in the report it is not possible to assess how much energy savings are attributable to specific conservation measures. Nor is it known whether attic insulation or any other measure is being added to some already there or is being installed for the first time. Further the studies cover a wide range of climate conditions in a number of parts of the country, so the effects of these variables will affect the results.

One particularly interesting set of studies included in the BECA-B data base is the CSA/NBS Optimal Weatherization Demonstration Program. Data are presented for studies in 12 different cities where space heating energy savings of 31 percent were achieved. Homes that received retrofit measures designed to reduce building shell condition and infiltration heat loss saved 23.1 MBtu per year, while homes that had heating system retrofits installed reduced annual consumption by 63 MBtu. Twenty-one percent of space heating consumption was saved in homes that had only retrofits for the shell.

An evaluation of several RCS programs has been conducted by Eric Hirst and his colleagues at the Oak Ridge National Laboratory. In an article summarizing the findings from several of these studies, Hirst found that the typical savings from the 6 RCS programs evaluated ranged from 3 to 9 MBtu, with typical savings in the range 4 to 5 MBtu.[14] These findings are from studies that relied on actual fuel consumption data.

These savings, needless to say, are substanially lower than those cited above from the BECA-B data base. One reason for the difference is that the RCS data reviewed by Hirst are for households that participated in the RCS program, but they may not have taken advantage of the energy audit by installing any of the recommended conservation measures.

In some RCS programs the audit was accompanied by a low- or zero-interest rate loans. Hirst cites two programs where it was possible to compare the savings for those households that received both the audit and the loan with those that

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[14]Hirst, Eric "Improving Energy Efficiency of Existing Homes: The Residential Conservation Service," State Energy Policy: Current Issues, Future Directions, Westview Press, 1985.

just received the audit. In Minnesota, natural gas bills showed a net savings of 4 MBtu per year for RCS participants, 4 percent of the pre-program use. However, for households that received both the audit and the loan, and, therefore, presumably installed many of the recommended conservation features, the savings were 23 MBtu per year (14 percent of consumption before the audit). Similar findings were obtained in other states where loans were available in addition to the energy audits.

Hirst and others have conducted an extensive evaluation of the Bonneville Power Administration's Residential Weatherization Pilot Program.[15] Households that received both an energy audit and zero-interest loan saved an average of 15 MBtu per year, a 15 percent net savings, while the net savings for audit only households was 6 MBtu per year. In the BPA program, about 80 percent of the homes had ceiling insulation and storm windows installed. Over 60 percent installed storm doors, basement/crawl space insulation, and caulking/weatherstripping.

A large scale evaluation of the Weatherization Program for low-income households was carried out as an adjunct to the Residential Energy Consumption Survey.[16] The evaluation used a questionnaire very similar to the RECS questionnaire on a specially drawn sample of households that had participated in the Weatherization Program. The sample drawn was designed to be representative of all households participating in the Program.

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[15]Hirst, Eric, Dennis White, and Richard Goeltz, "Comparison of Actual Electricity Savings with Audit Predictions in the BPA Residential Weatherization Pilot Program," Oak Ridge National Laboratory, ORNL/CON-142, November, 1983.

[16]Energy Information Administration, "Weatherization Program Evaluation," SR-EEUD-84-1, August 20, 1984.

Data on fuel consumption was obtained from the relevant utility companies for annual periods before and after the conservation measures were installed through the program. The savings resulting from the program were determined by comparing consumption before and after the installation, after adjusting the consumption to account for changes in HDD and in the number household members living in the housing unit.

The evaluation found that the average savings per household were 13.9 MBtu per year. This amount was about 13 percent of energy consumed for space heating, 10 percent of the consumption of the main heating fuel, and about 9 percent of total energy consumption. For households that had attic insulation installed, along with storm windows and/or doors and usually caulking and weatherstripping, the savings averaged 17.8 MBtu. This savings was about 18 percent of space heating consumption and 12 percent of total energy consumption. For households that had attic installed insulation but not storm windows or doors, savings averaged 12.8 MBtu, about 13 percent of space heating consumption. Households that did not have any insulation installed, but had some other measure taken, saved about 7.2 MBtu, about 7 percent of space heating consumption.

Statistical Analysis of Energy Savings. The second approach taken in this study to determine the energy saved by conservation measures involved a detailed analysis of the RECS data. Multiple regression analytical techniques were used to explore correlations between energy consumption and housing characteristics, conservation features in particular.

There were two steps in this analysis. First, an analytical procedure was used to estimate how much of the energy consumed by the households was used for space heating, the principal end-use affected by the conservation measures considered in this study.[17] The second stage was a statistical analysis of the relationship between energy consumption for space heating and the characteristics of the house, weather conditions, and any conservation measures incorporated in the house.

Two approaches were used to determine the amount of energy used for space heating. One was developed at the EIA using multivariate statistical regression techniques to estimate how much of a fuel is used for each end use that the fuel is used for.[18] Each household in the RECS file may use one or several fuels, and each fuel may be used for a number of end used.

The amount of energy used for space heating was estimated by specifying an equation for the fuel used for space heating that included terms related to all the purposes for which the fuel is used. The space heating component, for example, contains variables such as heating degree days, size of house, age of house, conservation measures, number of household members, that are related to space heating. If a household used natural gas for space heating, water heating and cooking, the regression equation would consist of a series of terms, one for

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[17] The RECS data base contains data obtained from the utility or other fuel supplier on the amount of energy consumed. The household supplies information on how these fuels are used. When a fuel is used for several purposes, the RECS data only gives the total consumpton for all uses of the fuel.

[18] Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey: Regression Analysis of Energy Consumption by End Use, DOE/EIA-0431 (Washington, D.C., October 1983) and Residential Energy Consumption and Expenditures by End Use for 1978, 1980, and 1981, DOE/EIA-0458 (Washington, D.C., December 1984).

each of these end uses. By estimating these equations over the entire set of households that use natural gas--not each of which uses gas for the same end uses--it is possible to estimate the amount of fuel used for each end use.

The second procedure used in this study for estimating the energy used for space heating was developed at Princeton University and is called the Princeton Score-Keeping Model (PRISM).[19] This approach depends upon the fact that for those households that maintain a consistent use pattern for energy for space heating over the winter, the amount of energy consumed for space heating will be proportional to the difference between the average outdoor temperature and a reference temperature which depends upon the thermostat setting and the thermal tightness of the housing structure. For households that don't change their habits for heating their house over the winter (by going on vacation for a month and turning down the thermostat, for example) monthly data on temperature and fuel consumption can be used to obtain a fairly good estimate of the amount of energy consumed for space heating.

In the work for this project, the PRISM model was applied to the 1982 RECS households that heated with natural gas. No efforts were made to apply the approach to households that heated with other fuels because the analysis of households heating with natural gas was not completed successfully.

The second stage of the analysis of the effectiveness of conservation measures was to determine how the energy consumed for space heating depended upon the characteristics of the housing unit, including conservation measures. For this

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[19] Fels, Margaret, et al., Monitoring Consumption and Electricity Heated House (Methodology Development: Phase I), Center for Energy and Environmental Studies, PU/CEES Report No. 160, April 1984.

analysis, multiple regression methods were used in an effort to determine statistically the influence of various characteristics of the housing structure on energy consumed for space heating. In this approach, space heating consumption is the dependent variable, and it is assumed to be a function of the physical characteristics of the house (including the conservation measures), factors associated with the use patterns of the way the household uses energy for space heating, and weather conditions (HDD).

The successful application of this method requires a stable, definable relationship between the variables in question that is reasonably consistent from house to house. If there are important factors, such as air infiltration, construction methods, wind exposure, and the like, that have a large influence on space heating consumption and are not included in the RECS data set, it might not be possible to use statistical methods to measure the influence on space heating of the features of the house that are known.

As this report is being written, attempts to specify and estimate a fully satisfactory regression equation have not been successful. Work is continuing on this issue, but the relationship between housing characteristics and space heating consumption may be so complex and variable among housing units that statistical methods may not be a viable means for estimating the effectiveness of conservation measures.

APPENDIX A

Prevelance of Conservation Measures in Mobile Homes - 1984

In 1984 there were 5.1 million [1.0] mobile homes in the United States as measured by the RECS survey. The pattern of conservation measures in mobile homes followed the pattern in single family homes. The proportion of mobile homes that had either 100 percent storm window and door coverage, or no storm window and door coverage was greater than the proportion of homes with limited coverage. Over half of the mobile homes had attic insulation and/or wall insulation. The majority of the homes with attic and wall insulation had insulated all walls and the entire attic, Table 14.

Table 14. Distribution of Insulation and Air-Infiltration Protection--Mobile Homes, 1984 (Millions of Households)

Type of Thermal Protection	Total Households (Millions)
Total Households (millions)	5.1 [1.0]
Presence of Roof/Attic Insulation, Area Covered	
Yes	3.6 [0.8]
All insulated	3.2 [0.7]
Part insulated, none, very little	Q
None, very little insulated	Q
Don't know amount/not reported	0.3 [0.2]
No	0.4 [0.2]
Don't know/not reported	1.2 [0.4]
Type of Roof or Attic Insulation	
Batt only	2.2 [0.6]
Loose fill only	Q
Batt and loose fill only	Q
Other/Combination	0.4 [0.2]
Don't know/not reported	0.9 [0.4]
No insulation, don't know/ not reported	1.6 [0.5]
Presence of Wall Insulation, Area Covered	
Yes	3.6 [0.8]
All insulated	3.3 [0.7]
Part insulated	0.3 [0.2]
No	0.5 [0.3]
Don't know/not reported	1.0 [0.4]

See footnotes on following page.

Table 14. Distribution of Insulation and Air-Infiltration Protection--Mobile Homes, 1984 (Millions of Households) (Continued)

Type of Thermal Protection	Total Households (Millions)
Presence of Storm Windows, Percentage of Windows Covered	
Yes	2.9 [0.7]
100 percent	2.3 [0.6]
76-99 percent	0.4 [0.2]
51-75 percent	Q
1-50 percent	0.2 [0.2]
No/no windows	2.2 [0.6]
Presence of Storm Doors, Percentage of Doors Covered	
Yes	2.6 [0.7]
100 percent	0.9 [0.4]
51-99 percent	Q
1-50 percent	1.7 [0.5]
No	2.5 [0.6]

Q=Data withheld because of a large variance or because data were unavailable.
Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

Housing Characteristics and Socioeconomic Characteristics of Energy-Audited Households - 1982

The 1982 RECS survey included several questions on energy audits which were not included in on the 1984 survey. Householders in 1982 were asked if a representative from their electric or gas company had performed a detailed energy audit of their home within 12 months prior to the survey. Approximately 2.1 million households [0.5] of the 57.7 million single-family housing units had received an energy audit within the 12 months prior to the RECS interview. More households in the Northeast and the West had had an audit than did households in the North Central and South regions.

The households that had an energy audit were looked at by selected housing characteristics and socioeconomic characteristics. Although these figures should be interpreted cautiously because of the small sample size, they can provide a broad description of the types of households that are likely to have energy audits. Generally, the households that participated in an energy audit were young, white homeowners. Audited householders tended to have more years of schooling. They lived in larger homes for longer periods of time. The largest group of audited householders were in the middle income category of $15,000 to $35,000. The majority of the households were in one of three temperature zones: 1) areas with less than 2,000 cooling degree-days and betweeen 5,500 and 7,000 heating degree-days; 2) areas with less than 2,000 cooling degree-days and between 4,000 and 5,499 heating degree-days and 3) less than 2,000 cooling degree-days and less than 4,000 heating degree-days. Table 15. The socio-economic characteristics of the RECS householders that had an energy audit were similar to other evaluations of households that had an energy audit.

Table 15. Distribution of Energy-Audited Households by Selected Housing Characteristics and Socioeconomic Characteristics--Single-Family Housing Units, 1982 (Millions of Households)

Socioeconomic Characteristics of Household	Total Households (Millions)
Total Households (millions)	2.1 [0.5]
Age of House	
Built Before 1975	1.8 [0.4]
Built 1975 and After	0.3 [0.2]
Heated Square Footage	
Less than 1,600	0.9 [0.3]
1,600 or More	1.2 [0.3]
2,000 or More	1.0 [0.3]
AIA Weather Zone[1]	
Zone 1	0.3 [0.2]
Zone 2	0.5 [0.2]
Zone 3	0.5 [0.2]
Zone 4	0.6 [0.2]
Zone 5	0.2 [0.1]
Relationship of Housing Unit to Householder	
Owned	1.9 [0.4]
Rented	0.2 [0.1]
Age of Householder	
45 Years or Less	1.2 [0.3]
Over 45 Years	1.0 [0.4]

See footnotes on following page.

Table 15. Distribution of Energy-Audited Households by Selected Housing Characteristics and Socioeconomic Characteristics--Single-Family Housing Units, 1982 (Millions of Households)

Socioeconomic Characteristics of Household	Total Households (Millions)
Origin of Householder	
White	1.9
	[50.4]
Black	0.1
	[0.1]
Other	0.1
	[0.1]
Education of Householder	
12 Years or Less	0.9
	[0.3]
Some College	0.6
	[0.2]
College Graduate	0.7
	[0.2]
Number of Years' Residence of Household in House	
3 Years or Less	0.5
	[0.2]
More than 3 Years	1.6
	[0.4]
Family Income	
Less than 15,000	0.5
	[0.2]
15,000 to 35,000	0.9
	[0.3]
35,000 or More	0.7
	[0.2]

[1]Delimited by heating degree-days (HDD) and cooling degree-days (CDD). Zone 1--more than 7,000 HDD and fewer than 2,000 CDD; Zone 2--5,500 to 7,000 HDD and fewer than 2,000 CDD; Zone 3--4,000 to 5,499 HDD and fewer than 2,000 CDD; Zone 4--fewer than 4,000 HDD and fewer than 2,000 CDD; Zone 5--fewer than 4,000 HDD and more than 2,000 CDD.

Q=Data withheld because of a large variance or because data were unavailable.

Note: Because of rounding, data may not add up to totals. Percentages are calculated on unrounded numbers. The value in brackets below each statistic represents 1.96 of the standard error of the statistic. See Appendix C for further discussion of standard error.

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1984.

APPENDIX B

How The Residential Energy Consumption Survey Was Conducted

The Residential Energy Consumption Surveys have been designed by the Energy Information Administration to provide information concerning energy consumption within the residential sector. Information concerning the housing unit is collected through personal interviews with a representative national sample of households. Data concerning actual energy consumption data are obtained from fuel records maintained by the household's fuel suppliers. An inventory of motor vehicles used by the household residents is also obtained at the time of the personal interview.

Data Collection. The fieldwork for these surveys was conducted by a contractor, Response Analysis Corporation of Princeton, New Jersey. Personal interviews were conducted with adult residents at the eligible units. Subsequently, mail questionnaires were sent to households that had not participated in personal interviews.

Interviewer contacts at sample households were begun in late September of the specific year of the survey and continued through January of the following year. More than 90 percent of the personal interviews were completed in October and November. Most of the completed mail questionnaires were received in January and February, with a few additional questionnaires received in March. November was regarded as the rough midpoint for data collection activity. Thus, November was the date for determining the independent estimates of the size of the universe of households used in the ratio estimation of survey results, Table 16.

Table 16. Response Rate for Residential Energy Consumption Surveys, 1978-1984

Survey Date	Sample Size	Period for Consumption and Expenditures	Response Rate
November 1978	4,081	April 1978 through March 1979	90.5
November 1979	4,033	April 1979 through March 1980	90.6
November 1980	6,051	April 1980 through March 1981	91.2
November 1981	6,269	April 1982 through March 1982	91.6
November 1982	4,724	April 1982 through March 1983	89.6
November 1984	5,683	April 1982 through March 1983	84.2

Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Surveys 1978, 1980, 1981, 1982, and 1984.

The average personal interview which included measurements of the housing unit lasted 52 minutes. The interview with the householder (or his or her spouse) generally covered structural features of the house related to energy, such as insulation, doors, and windows; the heating and cooling systems, with the fuels used in these systems; use of wood, energy conservation improvements and the reasons for making the improvements; household appliances; household vehicles; receipt of government assistance for the cost of heating; and demographic data on household members.

At the end of the interview, respondents, were asked to sign a waiver authorizing the contractor to obtain records of energy consumption from the housing unit's energy supplier(s). Beginning in 1980, the interviewer also measured the dimensions of certain housing units, using a retractable 50-foot metal tape measure, and recorded the dimensions on a rough-drawn diagram of the floor plan.

Data are not collected for the following two types of housing units:

- Vacant housing units. These units may have minimal heating for protection from the weather and lighting for security. They also may not be vacant all year long.

- Second homes for the owner's use.

These two types of units are not included primarily because of the difficulty in acquiring data and limitations in the availability of funds. The RECS data are

collected by interviewing someone who knows the housing unit and who may sign an authorization form for the release of fuel records from the fuel supplier. That type of person does not usually live at the units excluded from the survey.

Sample Design and Survey Estimates. The sample households were selected using a multiple-stage area-probability sampling design. The universe for this sample design includes all housing units occupied as the primary residence in the 50 states and the District of Columbia. The 1978 and 1979 RECS did not include households in Alaska or Hawaii. The survey estimates were developed to project sample results to the universe. Weights were calculated for each sample household. The household weight reflected the probability of selection for that household and additional adjustments to correct for potential biases arising from the failure to contact all sampling housing units and the failure to list all housing units in the area.

The adjustment for these noninterviews was designed to spread the effects of noninterviews over the interviewed sample of households in the final cluster. The noninterview weight is equal to the number of households in the ultimate cluster (interviews plus noninterviews) divided by the number of interviews. When the weight computed in this way was greater than 2.0, however, that part of the noninterview adjustment that exceed 2.0 was spread over the remaining ultimate clusters in the Primary Sampling Unit.

The failure to list all housing units in the field-listing task is a common problem in surveys of this type. The result is an undercount of housing units in the sample area and, hence, an underestimating of the number of households in

the universe. The undercount in RECS surveys is in the range of 7 to 9 percent. This problem is treated in two ways in the RECS. One treatment occurs during the interviewing process and the second in the estimation process. During the interviewing stage, unlisted housing units or households are discovered by querying the household where interviews are conducted to determine if other households are present in the unit. In addition, the interviewer is instructed to conduct an interview at all housing units contained in the geographical area between the interviewed household and the next listed address. This tactic reduces the number of missed households but does not completely eliminate the noncoverage problem. The noncoverage problem is also treated by using ratio estimation to adjust selected estimates of households to official population values.

Minimizing Nonresponse. In an effort to maximize the validity of the survey data, a multiwave, multicontact approach was employed. Before the initial contacts, a letter was sent to each household from the Administrator of the EIA, briefly describing the purposes and stressing the importance of the survey. Beginning in September of the year of the specific survey, interviewers made up to seven or more callbacks at different times of the day throughout the week in an effort to minimize the number of uncontacted households. The interviewers also queried neighbors regarding the most opportune times to contact the prospective respondent.

A second wave was initiated in an effort to contact households that were not available during the first wave and to attempt to convince selected first-wave refusals to reconsider. A new set of letters preceded the renewed effort and,

in most cases, the sampled housing units were assigned to a different interviewer. Again, up to seven or more attempts were made to contact the prospective respondents. A third wave was initiated in an effort to reach nonrespondents in a number of locations that had low completion rates. In a final attempt to reduce nonresponse, an abbreviated version of the questionnaire (adapted for self-administration) was mailed to most of the remaining nonrespondents.

Item nonresponse occurs when respondents do not know the answer or refuse to answer a question or when an interviewer does not ask a question or does not record an answer. Imputations were made for nonresponse to most items that were to be used for making national estimates and items that had less than 10-percent nonresponse. Items for which national estimates are made but for which imputations were not made include questions on the presence, type, and amount of attic and floor insulation; the presence of wall insulation. For these items, the number of missing cases was considered large enough that the imputations would have introduced too much additional error.

The most frequently used imputation procedure was hot-deck. This procedure requires sorting the file of households by variables related to the missing item. A household is then selected that has the same value of the related variables, and this "donor" household supplies the value for the variable that is missing in the "donee" household.

Less frequently used imputation methods included random selection from the distribution of the know values of a variable, regression estimates, and user of modal values. Regression procedures were used to impute the total square

footage of the housing unit when actual measurements were missing. The random selection procedure was used only to assign dates (month and/or year) when those response were missing. A few variable were imputed by assigning modal values; this was done when the distribution of available data showed a highly skewed distribution.

The mailed questionnaires had considerable missing data since the mailed questionnaire was a small subset of questions from the household interview. For the mailed questionnaire, a modified hot-deck imputation method was used. A hot-deck matrix was created for both mailed-questionnaire and personal-interview households using Census region, type of housing unit structure, space heating fuel, hot water fuel, and presence and fuel of air conditioning. For each mailed questionnaire household, a donor personal interview household was chosen from the same cell of the hot-deck matrix whenever possible. for approximately 95 percent of the mailed questionnaires, donors matched on all hot-deck variables.

Since each cell of the matrix usually contained several possible donors, a donor was chosen from the cell based on how closely it matched the mailed questionnaire household on a number of additional variables. These variables were: income, number of household members, number of household vehicles, age of householder, tenure, number of rooms, model year of newest vehicle, and household structure (married couple, other). Except for information on household vehicles, which was taken directly from the mailed questionnaire, the entire set of responses from the donor houseold was imputed to the mailed questionnaire households. This means that all responses for mailed questionnaire households are imputed except weather data, fuel consumption data

acquired from the household's fuel suppliers, the geographic location of the mailed questionnaire household, information on household vehicles, and those items in the hot-deck imputation process for which an exact match was obtained.

Interviewers mailed completed questionnaires to the contractor, where they were carefully reviewed. The first step in the review process was to verify the accuracy of the basic identifying information. Next, the questionnaires were manually reviewed by two editors to ensure completeness and the logical consistency of selected patterns of responses and to prepare the questionnaires for translation into machine-readable form. Keypunching of important items was fully verified. Overall, approximately 25 percent of the keypunching work was fully verified. Finally, the data were machine edited to further ensure completeness, logical consistency, and the legitimacy of coded values. The computer editing utilized a proprietary software package called EDITOR II.

The contractor attempted to resolve inconsistencies or ambiguities in the data internally, by reference to other parts of the questionnaire. When these efforts failed to resolve an important problem, particularly those involving heating fuels or heating equipment and/or relationships between questionnaire responses and data on fuel consumption, the contractor made telephone contact with a member of the household in question. Telephone contacts of this type were completed with approximately 10 percent of households during the course of data editing for this survey.

Comparisons were made between rental agent and household respondent reports on main heating fuel, main heating equipment, supplemental heating fuel, water-heating fuel, and air-conditioning fuel. Each discrepancy was

individually examined. Changes were made in the household record whenever it was judged that the rental agent was more knowledgeable than the household respondent on specific fuels and/or equipment.

Editors followed the guideline that the rental agent was the more knowledeable person when the landlord paid for the fuel and the fuel was used as the main home heating, water-heating, or air-conditioning fuel. The rental agent's view generally prevailed also in the case in which the rental agent paid for the main heating fuel and the rental agent's description of the main heating equipment differed from that of the household respondent.

Since a supplement heating fuel was more likely to be under the household's control, even in a multiunit dwelling, the respondent's definition of supplemental heating fuel was generally accepted. For a more detailed discussion on how the surveys were conducted for each specific survey, see Appendix A in the 1978, 1980, 1981, 1982 RECS: Housing Characteristics, or RECS: Consumption and Expenditure Reports, and the 1984 RECS: Housing Characteristics, (in preparation).

APPENDIX C

Sampling Error Methodology

Data from the RECS are subject to many sources of sampling errors, nonsampling error, and bias. Sampling error is a measure of the variability in the data because a sample of households was surveyed rather than the entire population. Because the survey used probability sampling techniques, sampling errors of the survey estimates can be estimated and used as a guide in making inferences from the sample estimates to the total population.

Nonsampling error and bias are measures of variability due to the conduct of the survey. They can include population undercoverage during sampling, response bias and variance, interviewer error, coding and/or keypunching error, and nonresponse bias. The wording and format of survey questionnaires, the procedures used to select and train interviewers, and the quality control built into the data collection, receipt, and processing operations were all designed to minimize these sources of error. In addition, response adjustments and ratio estimations were incorporated into the survey estimator to help reduce both sampling and nonsampling error.

The form of the sampling error that is presented in this report is 1.96 the standard error.

The estimates of sampling error were obtained by using a balanced half-sample replication technique. Estimates of sampling error for 1978 were calculated directly from the variations of those statistics over the half-samples. Estimates of sampling error for the 1980 through 1982 surveys were produced from

generalized equations that relate the standard errors of a statistic to the number of households over which the statistics applies. The standard errors for the 1984 have not at the time of this report been calculated directly using the half-sample procedure. The 1984 standard error presented in this report are calculated using the following generalized variance equation for the 1982 RECS household counts:

$$\text{Log(RSE)} = 1.244 - 0.450 \times \text{Log(NHSLD)} - 0.027 \times [(\text{Log(NHSLD)})^2]$$

This generalized variance equation was obtained using a least square regression. The RSE's used as input data in the regression procedure were obtained using a half-sample variance estimating procedure.

The household count statistic is an estimate of a number of households that belong to a certain subset of all households in the country. The subset is defined by restrictions on certain characteristics. Therefore a value in a particular cell depends partly on the amount of homogeneity, the characteristics used in defining the cell. In calculating the standard error of a household count the degree of homogeniety, or the clustering factor, of that particular count must be considered. Standard errors for the 1984 statistics are multiplied by the clustering factors presented in Table 17. The value of the clustering factor is greater than one when a particular characteristic is highly clustered. If the characteristic is widely spread out the value of the clustering factor is less than one. For example, one possible characteristic is heating and cooling degree days. People who live close to each other experience the same weather conditions; consequently, the value of the clustering factor

for heating and cooling degree-days is greater than one. Conversely, although there is some clustering of households headed by people of the same age group, this tendency is less pronounced than for other characteristics. As a result, the value for the clustering factor for age of householder is less than one.

Table 17. Clustering Factors for Calculation of Standard Errors for 1984 Data[1]

Cell Definition	Value
Heating and Cooling Degree-Days	1.86
Housing Structure	1.20
Year House Was Built	1.08
Origin (Race)	1.07
Owned/Rented	0.98
Conservation Item	0.945
Number of Heated Square Feet	0.90
Age of Householder	0.87
Family Income	0.87

[1]Clustering factors are based on 1982 data.
Source: Energy Information Administration, Office of Energy Markets and End Use, Energy End Use Division, Residential Energy Consumption Survey 1982.

Further details on how the sampling error estimates were determined can be found in the following RECS publications.

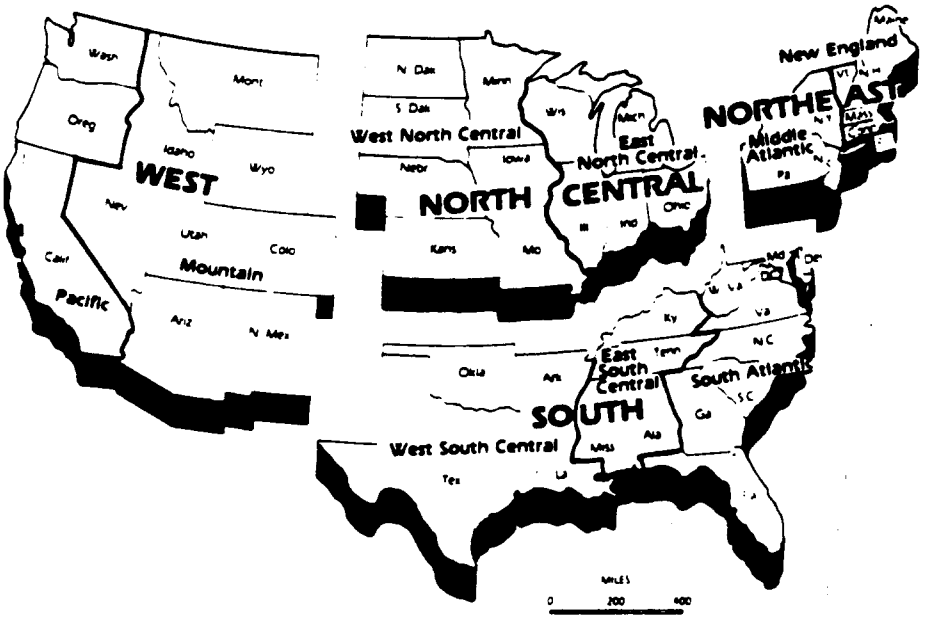
1980 RECS
Consumption and Expenditures--April 1980 through March 1981 (DOE/EIA-0321/2), Part 2 Regional Data, June 1983, p.253.

1981 RECS
Consumption and Expenditures--April 1981 through March 1982 (DOE/EIA-0321/1 (81)), Part 1 National Data, September 1983, p. 125.
(DOE/EIA-0321/2 (81)), Part 2 Regional Data, November 1983, p.260.

1982 RECS
Consumption and Expenditures--April 1982 through March 1983 (DOE/EIA-0321/1 (82)), Part 1, National Data, November 1984, p.126.
(DOE/EIA-0321/2 (82)), Part 2, Regional Data, December 1984, p.276.

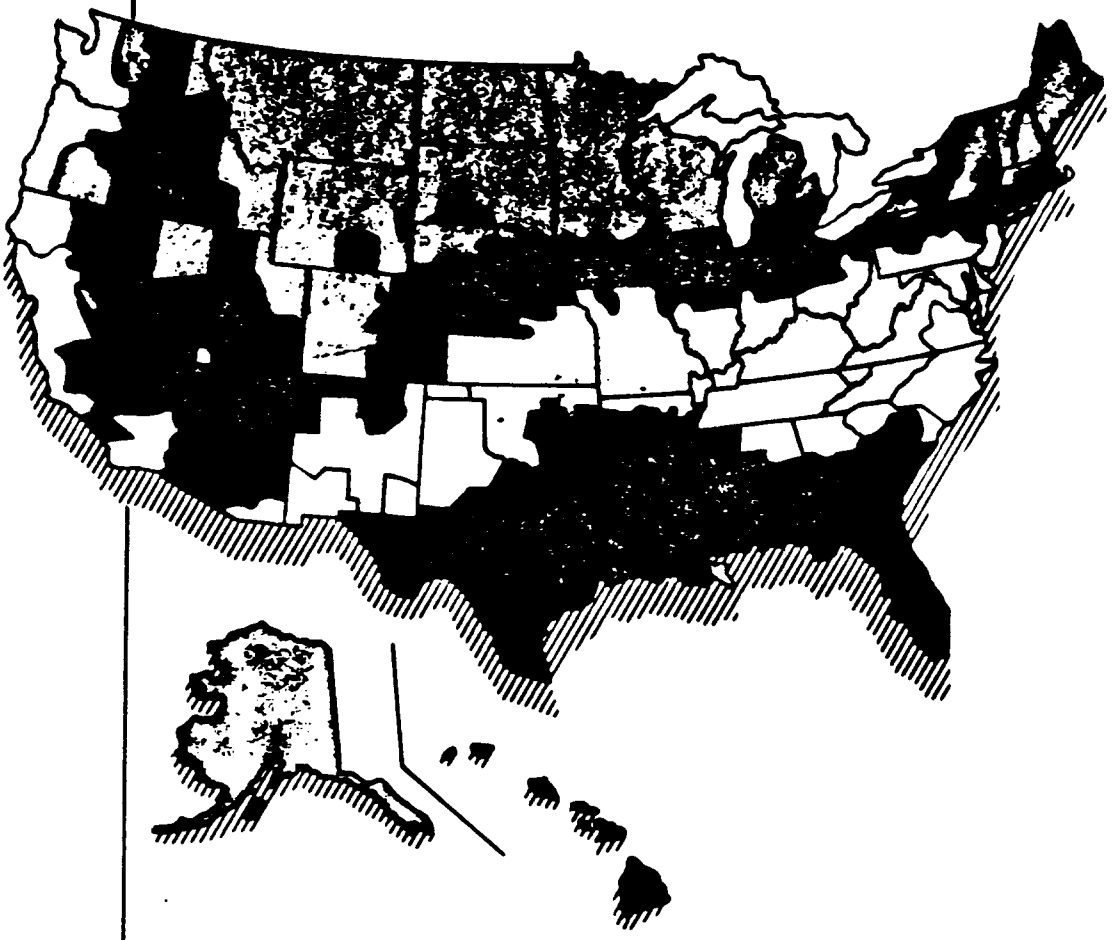
Appendix D

U.S. Census Regions and Divisions



Appendix E

U.S. Weather Zone Map of Heating Degree-Days (HDD) and Cooling Degree-Days (CDD)



Weather Zones

- Zone 1 is less than 2,000 CDD and greater than 7,000 HDD.
- Zone 2 is less than 2,000 CDD and 5,500-7,000 HDD.
- Zone 3 is less than 2,000 CDD and 4,000-5,499 HDD.
- Zone 4 is less than 2,000 CDD and less than 4,000 HDD.
- Zone 5 is greater than 2,000 CDD and less than 4,000 HDD.

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