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# **FUTURE RESIDENTIAL AND COMMERCIAL ENERGY DEMAND IN THE NORTHEAST**

**John Lee**

**March 1976**

**POLICY ANALYSIS DIVISION  
NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS  
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# FUTURE RESIDENTIAL AND COMMERCIAL ENERGY DEMAND IN THE NORTHEAST

JOHN LEE

March 1976

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## FOREWORD

This report is one of a number of issue papers prepared as part of the Brookhaven National Laboratory Northeast Energy Perspectives Study. The analyses in these papers were performed specifically to assist us in our first integrated study of the energy future of the northeastern United States.

Topics covered by the issue papers include the potential supply of energy to the Northeast from coal, oil, natural gas, liquefied natural gas (LNG), nuclear power, municipal waste, solar energy, and wind power, and the demand for energy in the Northeast from the industrial, transportation, and residential and commercial sectors. In each case a range of estimates of energy supply or demand was constructed to reflect not only a variety of possible policy and technological developments, but also the basic uncertainties of all such future projections. The integrative analysis which relates the supply and demand picture is presented in "A Perspective on the Energy Future of the Northeast United States."

The issue papers prepared for the Northeast Energy Perspectives Study and the summary report will be available from:

National Technical Information Service  
U.S. Department of Commerce  
5285 Port Royal Road  
Springfield, VA 22161

The issue papers and summary report are listed below.

- H. Bronheim, "Future Oil Supply to the Northeast United States," BNL 50557 (June 1976).
- R. J. Goettle, IV, "Alternative Patterns of Industrial Energy Consumption in the Northeast," BNL 50555 (March 1976).
- R. N. Langlois, "Future Natural Gas Supply to the Northeast," BNL 50558 (April 1976).
- J. Lee, "Future Residential and Commercial Energy Demand in the Northeast," BNL 50552 (March 1976).
- P. M. Meier and T. H. McCoy, "Solid Waste as an Energy Source for the Northeast," BNL 50559 (June 1976).
- P. M. Meier, T. H. McCoy, and S. Rahman, "Issues in the Future Supply of Electricity to the Northeast," BNL 50553 (June 1976).
- B. S. Edelston and E. S. Rubin, "Current and Future Use of Coal in the Northeast," BNL 50560 (May 1976), Environmental Studies Institute, Carnegie-Mellon University, Pittsburgh, Penn.
- V. L. Sailor and F. J. Shore, "The Future of Nuclear Power in the Northeast," BNL 50551 (March 1976).
- G. R. Bray, S. K. Julin and J. A. Simmons, "Supply of Liquefied Natural Gas to the Northeast," BNL 50556 (April 1976), Science Applications, Inc., 1651 Old Meadow Road, McLean, Va.
- System Design Concepts, Inc., "Transportation Energy Consumption and Conservation Policy Options in the Northeast," BNL 50554 (April 1976), System Design Concepts, Inc., 9 Rector Street, New York, N.Y. 10006.
- J. Brainard et al., Editors, "A Perspective on the Energy Future of the Northeast United States," BNL 50550 (June 1976).

## ABSTRACT

In 1972 the Northeast consumed 5.02 quadrillion Btu's (quads) or 44% of its energy use in the residential and commercial sectors. Of this total, about two-thirds (3.30 quads) was consumed in residential households and the balance (1.72 quads) in commercial buildings. By end use, space heating is dominant in both sectors, accounting for about 71% of the energy used in the residential sector and 76% in the Commercial sector. In terms of fuel distribution, both sectors are highly dependent on oil, with more than half of their energy supplied from petroleum products.

Based on existing demographic projections and considering different levels of change in technology, government policy, consumer behavior, and related factors, three alternative energy consumption patterns were constructed for 1985 and 2000. The Base Case projections, which assume a continuation of the consumption patterns which have developed since the "energy crisis" of 1973-74, indicate a total residential energy use in the region that remains roughly at the 1972 level until 1985. This consumption is projected to increase at an annually compounded growth rate of 0.6% from 1985 to 2000. The commercial energy demand is projected to grow at an annual rate of 2.7% between 1972 and 1985 and 4.1% between 1985 and 2000.

The conservation scenarios indicate that there is a tremendous potential for energy conservation in the two sectors. Universal application of technology which is currently available at reasonable cost and slight alterations of life style would reduce the average energy growth in the combined residential and commercial sectors from an annual rate of 1.7% to almost zero growth between 1972

and 2000. A more severe conservation case which assumed direct governmental intervention, maximum utilization of current technology, and some public sacrifice of convenience and changes in lifestyle could reduce the energy consumption in 2000 to about the 1972 level.

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## I. SUMMARY

### A. Introduction

The purpose of this report is twofold. First, it presents a range of energy demand projections in the residential and commercial sectors for the Northeast United States. These projections are an integral part of the Northeast Energy Perspectives Study being carried out by the Energy Policy Analysis Division at Brookhaven National Laboratory (BNL) to analyze the major energy issues of the region and the national energy policy issues that require a regional scale of analysis. Second, the projections and their underlying data and analysis provide a framework for assessing the regional impact of possible policy changes, technological innovations, and energy conservation strategies.

The region under study covers the New England States (Region I), New York (Region II), Pennsylvania, New Jersey, Delaware, Maryland, and the District of Columbia (Region III). In most cases, projections were made at the subregional level and then aggregated to the total Northeast. Since 1972 is the most recent year for which fairly complete and consistent data are available, it was chosen as the base year in order to provide a reference point for developing the energy demand forecasts for the years 1985 and 2000. Forecasts of regional economic activities are based on the 1972 OBERS projection.<sup>1</sup> Other primary sources of information are published reports and documents from government agencies, business associations, and private institutions. In the absence of adequate recorded information, data have been estimated or extrapolated. The methods and sources of data used in making such estimates are given later in this report.

The basic methodology employed for projecting future residential and commercial energy demands involved two major steps. First, the determinative factors such as housing stock by type and various categories of commercial floor space were projected for the future reference years. These projections were then combined with projected unit energy demands, saturation rates, and fuel mixes in terms of disaggregated end use to establish the total energy requirements for each demand category (e.g., residential space heating). Detailed discussions of the methodologies and data sources used in deriving values for these factors are presented in Sections II and III.

No single projection of demand can indicate with certainty what will occur in the future. Therefore, in this study several projections were constructed, covering a wide but interesting range of demand possibilities. The three projections included in this report--the base case, a moderate conservation case, and a strong conservation case--were designed to reflect different levels of change in technology, government policy, consumer behavior, and related factors. Section IV describes the detailed assumptions on which these cases were constructed.

Appendix A contains a set of fuel mix tables for each sub-region. These are worksheets that use the factors generated in Sections II and III to establish the demand projections at the subregional level. The disaggregated format of the fuel mix tables is required in order to evaluate technologies or conservation measures that may apply to very specific end uses.

Included in Appendix B are summary tables of energy demand by fuel type, developed by assuming some mode shifts between fuels. These mode shift cases were constructed primarily for use in supply-demand analysis in the Northeast Energy Perspectives Study and are not discussed in detail.

This study represents an initial, exploratory effort to develop a regional model for projecting residential and commercial energy demands. Much of the work described in this report is therefore preliminary and subject to refinement or modification. This study should be expanded to include in-depth analyses of the various policy options available to bring about implementation of the conservation measures considered in this study and the costs and benefits of these measures. A thorough examination in this area is currently under way in the BNL Regional Energy Studies Program, of which the BNL Northeast Energy Perspectives Study is a part.

B. Residential and Commercial Energy Consumption: Base Year, 1972

In 1972 the Northeast United States consumed 5.02 quadrillion, or  $10^{15}$ , Btu (quad) of energy in the residential and commercial sectors. Of this total, about 66% (3.30 quads) was consumed in residential households and 34% (1.72 quads) in commercial buildings. The detailed end use and fuel distribution by region are shown in Tables 1 and 2, from which several significant conclusions can be drawn. The combined residential and commercial sector, with 44% of the total energy use in the Northeast,\* is dominant as compared with industrial, transportation, and electric utility energy consumption. By end use, space heating is dominant in both sectors, accounting for about 71% of the total energy used in the residential sector and 76% in the commercial sector. In terms of fuel distribution, both sectors are highly dependent on oil, with 54% of the combined total energy supplied from petroleum products. The data sources and methodologies used to derive these figures are discussed in detail by Lee.<sup>2</sup>

---

\* Total regional energy consumption, including fuel used by electric utilities, was estimated at  $14.4 \times 10^{15}$  Btu in 1972.

TABLE 1

SUMMARY OF RESIDENTIAL AND COMMERCIAL END USE OF ENERGY, (10<sup>12</sup> Btu) 1972<sup>2</sup>

	Region I*		Region II*		Region III*		Northeast Region	
	Consumption	% of Total	Consumption	% of Total	Consumption	% of Total	Consumption	% of Total
<b>RESIDENTIAL</b>								
Space heating	615.17	75	737.49	69	991.96	70	2,344.62	71
Air conditioning	3.09	1	11.33	1	21.35	2	35.77	1
Water heating	120.28	14	191.69	18	243.32	17	555.79	17
Cooking	22.94	3	44.04	4	54.86	4	121.84	4
Lighting & misc. appliances	51.57	7	83.52	8	107.79	7	242.38	7
Total	813.05	100	1,068.07	100	1,418.78	100	3,300.40	100
<b>COMMERCIAL</b>								
Space heating	321.04	78	446.05	76	537.74	75	1,304.83	76
Air conditioning	7.67	2	16.59	3	22.30	3	46.65	3
Water heating	31.11	8	48.20	8	62.38	8	141.69	8
Lighting & Misc. appliances	48.65	12	76.62	13	97.68	14	222.95	13
Total	408.47	100	587.46	100	720.10	100	1,716.03	100

\*Region I: New England; Region II: New York; Region III: Pennsylvania, New Jersey, Delaware, Maryland and the District of Columbia.

TABLE 2

SUMMARY OF RESIDENTIAL AND COMMERCIAL ENERGY CONSUMPTION (10<sup>12</sup> Btu)  
BY FUEL TYPE, 1972<sup>2</sup>

	Gas	Oil	Coal	Electricity	Total Direct use
<b>RESIDENTIAL</b>					
Region I	177.89	539.49	7.47	88.20	813.05
Region II	377.97	560.64	15.26	114.20	1,068.07
Region III	629.82	546.42	74.79	167.75	1,418.78
Total Northeast	1,185.68	1,646.55	97.52	370.15	3,300.40
<b>COMMERCIAL</b>					
Region I	54.02	294.05	0.41	59.99	408.47
Region II	112.58	366.65	5.07	103.16	587.46
Region III	205.68	380.00	1.74	132.68	720.10
Total Northeast	372.28	1,040.70	7.22	295.83	1,716.03

Note: The number of figures obtained do not represent basic precision but are retained for consistency and calculational purposes.

C. 1985 and 2000 Energy Demand - Base Case

The base case projections (like all others) are conditional forecasts, based on an extension of past and present relationships believed to have future relevance for the regional energy use patterns. The assumptions on which these relationships are formulated in the base case reflect a long-run growth situation without major government policy and economic changes. These assumptions (with no probability of realization attached to them) are described in detail in Section IV.

The residential and commercial base case demands in the region are projected to grow, respectively, from 3.30 quads and 1.72 quads in 1972 to 3.35 quads and 2.41 quads in 1985 and to reach 3.65 quads and 4.41 quads by the year 2000. These projections do not include losses incurred by the power plants in converting primary fuels to electricity and other distribution losses. The projected demand by end use is detailed in Tables 3 and 4.

1. Residential Growth Rate

Total residential energy use in the region is expected to stay at the 1972 level until 1985 and to increase slowly at an annually compounded growth rate of 0.6% from 1985 to 2000. The low rate of growth is due to the slight decline in energy use projected for space heating. Although space heating will continue to be the primary energy user, the average per unit consumption\* is expected to decline 21% by 1985 and 35% by 2000. These reductions offset the effect of household growth projected (19.7% by 1985 and 47.6% by 2000). The major contributors to this decrease in per unit heating demand are summarized below:

\*Calculated as the ratio of total direct energy use for space heating to the number of households in the region. Average per unit demand is estimated at 133 ( $10^6$  Btu/household) in 1972, 105 in 1985, and 86 in 2000. If losses incurred by power plants are included, reduction in per unit energy resource consumption would be 16% by 1985 and 23% by 2000.

TABLE 3

1985 NORTHEAST RESIDENTIAL AND COMMERCIAL ENERGY DEMAND ( $10^{12}$  Btu)

## BASE CASE

	<u>Gas</u>	<u>Oil</u>	<u>Electricity</u>	<u>Total</u>	<u>% of Total</u>
RESIDENTIAL					
Space heating	690	1405	108	2203	66
Air conditioning	-	-	61	61	2
Water heating	286	230	109	625	19
Cooking	97	-	34	131	4
Lighting & misc. appliances	-	-	<u>329</u>	<u>329</u>	<u>19</u>
TOTAL	1173	1635	641	3349	100
COMMERCIAL					
Space heating	255	1414	74	1743	72
Air conditioning	3	-	84	86	4
Water heating	110	-	104	215	9
Lighting & misc. appliances	-	-	<u>366</u>	<u>366</u>	<u>15</u>
TOTAL	368	1414	628	2410	100

TABLE 4

2000 NORTHEAST RESIDENTIAL AND COMMERCIAL ENERGY DEMAND ( $10^{12}$  Btu)

## BASE CASE

	<u>Gas</u>	<u>Oil</u>	<u>Electricity</u>	<u>Total</u>	<u>% of Total</u>
RESIDENTIAL					
Space heating	597	1384	248	2229	61
Air conditioning	-	-	101	101	3
Water heating	279	235	186	680	19
Cooking	90	-	51	142	4
Lighting & misc. appliances	-	-	<u>482</u>	<u>482</u>	<u>13</u>
TOTAL	966	1620	1067	3654	100
COMMERCIAL					
Space heating	255	2664	265	3183	72
Air conditioning	3	-	177	180	4
Water heating	113	-	261	373	8
Lighting & misc. appliances	-	-	<u>671</u>	<u>671</u>	<u>16</u>
TOTAL	370	2664	1374	4407	100

System efficiency: This includes home design efficiency and mechanical efficiency of the heating devices. Under the base assumptions, the average system efficiency will improve significantly for both existing and new housing units (Appendix A). This improvement reflects the impact of retrofit in existing homes, replacement of old heating devices, better standards for new construction, and improved equipment design.

Fuel mix: The increase in penetration of electric heat from 1% to 5% in 1985 and 11% in 2000 would mean a significant reduction in per unit consumption (at point of entry) because of the greater efficiency of electric systems\* (including heat pumps).

Consumer energy ethic: The base case assumes a continuation of the energy ethic developed during the recent energy shortage (e.g., thermostat setback from 72°F to 70°F). This would result in a saving of 7% to 10% in unit consumption over the 1972-2000 period for all households. Since the base case does not assume any major changes in lifestyle or alteration of the consumer's standard of living, the conservation impact is significantly below its full potential.

Housing mix: The present housing stock in the region consists predominantly of single-family homes. Current trends, however, are toward various forms of multifamily housing and mobile homes. This shift toward smaller housing units tends to decrease energy requirements for space heating.

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\* Inclusion of energy losses at power plants (assuming an average efficiency of 33%) would increase the overall annual growth rate to 0.6% between 1972 and 1985 and 1.5% between 1985 and 2000. However, the inclusion of such losses in a demand analysis seems inappropriate because it raises the issue of power plant fuel or efficiency, which properly belongs in a supply analysis.

Despite the low overall growth rate for the projection period, energy use by air conditioning and miscellaneous electric appliances is projected to increase at a fast rate of 2.7% annually between 1972 and 2000, in line with the projected high rates of growth in air-conditioning and appliance saturations.

## 2. Commercial Energy Growth

Energy use in the commercial sector is expected to increase at a much faster pace than in the residential sector with a projected annual growth rate of 2.7% between 1972 and 1985 and 4.1% between 1985 and 2000. This is a direct consequence of the implicit assumption in our projection basis\* that the regional economy will become more service oriented. The projection basis and methodology for this sector are discussed in Section III.

From the standpoint of end use, although space heating will continue to be the primary energy use, its relative share in the total is expected to drop somewhat between 1972 and 2000. This is due to the high growth rates of energy use in lighting and appliances and in air conditioning, with annual growth rates of 4.1 and 4.8% respectively from 1972 to the year 2000. The share of energy use by water heating is expected to remain at the present level of 8% of the commercial total.

### D. The Potential for Energy Conservation

The base case projection discussed above quantifies the residential and commercial energy demand by end use and fuel type under the current energy use patterns. In this section, the potential for energy conservation in the residential and commercial sectors is summarized by presenting the energy demands estimated under two different conservation scenarios.

---

\* OBERS projections<sup>1</sup> show the dominance of commercial activities (services, trade, finance, government, etc.) in the growth of the regional economy over the next 25 years.

These scenarios assume different implementation levels of the conservation measures included in the base case (see Section IV). These levels were developed to reflect different degrees of change in government policy and technology without explicit reference to quantitative response functions for energy demand. An analysis of the response of the energy consumer to policy or economic changes is difficult to perform at the regional level and is not the primary intention of this study.

The growth rates shown in Figure 1 indicate that it is possible, with some technological improvements and slight altering of life-style, to reduce energy growth in the combined residential and commercial sectors from an annual rate of 1.72% to almost zero growth between 1972 and 2000 (0.3% in the strong conservation case). Note that zero energy growth does not mean zero economic growth. In this study, OBERS projections of economic growth<sup>1</sup> were used as a basis for all three energy demand scenarios. The 0.3% growth rate in the strong conservation case implies a reduction in total energy demand of 32% from that calculated in the base case. The moderate conservation case would reduce the annual growth to 1.1% and the total energy demand in 2000 by 16% from the base case projection. It might be noted that, on the average, residential and commercial demand in the U.S. has been following a trend since 1973 that is close to the moderate conservation case. Tables 5 to 8 present the energy demand by fuel type for the three cases in the subregions and the entire Northeast.

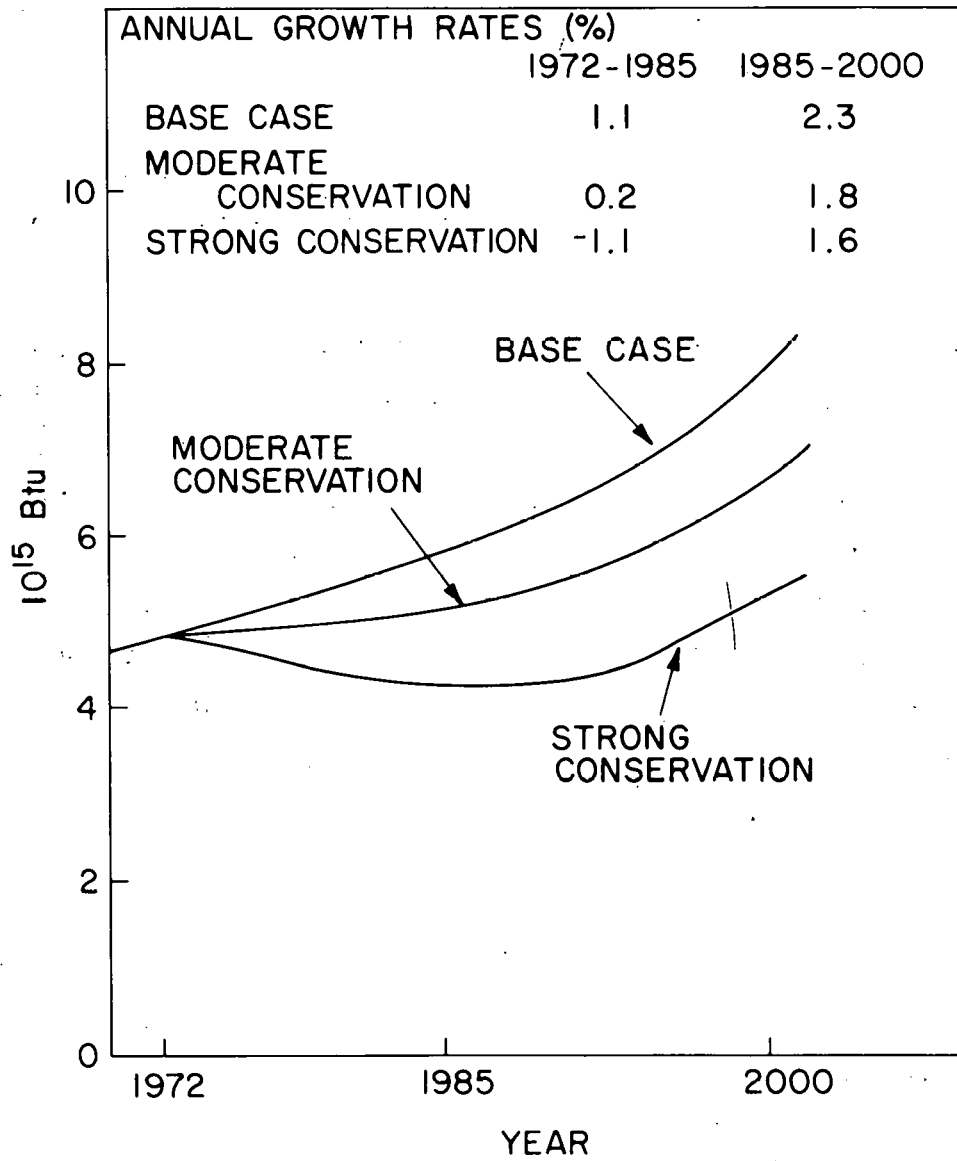


Figure 1. Energy growth in the residential and commercial sector (1972-2000) - base case and conservation scenarios.

TABLE 5

SUMMARY OF NEW ENGLAND RESIDENTIAL AND COMMERCIAL ENERGY DEMANDS (10<sup>12</sup> Btu)  
BY FUEL TYPE, 1985 and 2000

	1985			2000		
	<u>Base Case</u>	<u>Conservation Cases Moderate</u>	<u>Cases Strong</u>	<u>Base Case</u>	<u>Conservation Cases Moderate</u>	<u>Cases Strong</u>
<b>RESIDENTIAL</b>						
Oil	513	477	363	489	424	297
Gas	166	156	124	145	132	98
Electricity	139	133	120	227	197	158
Solar	-	-	6	-	37	79
TOTAL	818	766	613	861	790	582
<b>COMMERCIAL</b>						
Oil	421	348	302	750	550	419
Gas	50	41	36	51	37	29
Electricity	122	101	88	286	185	141
Solar	-	-	-	-	49	80
TOTAL	593	490	426	1087	821	669

TABLE 6

SUMMARY OF NEW YORK RESIDENTIAL AND COMMERCIAL ENERGY DEMANDS (10<sup>12</sup> Btu)  
BY FUEL TYPE, 1985 and 2000

	1985			2000		
	<u>Base Case</u>	<u>Conservation Cases Moderate</u>	<u>Cases Strong</u>	<u>Base Case</u>	<u>Conservation Cases Moderate</u>	<u>Cases Strong</u>
<b>RESIDENTIAL</b>						
Oil	549	514	399	530	454	319
Gas	344	311	248	311	266	196
Electricity	192	181	162	340	297	243
Solar	-	-	9	-	55	87
TOTAL	1085	1006	818	1181	1072	845
<b>COMMERCIAL</b>						
Oil	477	396	344	860	630	461
Gas	99	82	71	109	74	54
Electricity	228	189	164	483	354	259
Solar	-	-	-	-	68	106
TOTAL	804	667	579	1452	1126	880

TABLE 7

\*  
SUMMARY OF REGION III RESIDENTIAL AND COMMERCIAL ENERGY DEMANDS ( $10^{12}$  Btu)  
BY FUEL TYPE, 1985 and 2000

	1985			2000		
	<u>Base Case</u>	<u>Conservation Cases - Moderate</u>	<u>Strong</u>	<u>Base Case</u>	<u>Conservation Cases - Moderate</u>	<u>Strong</u>
<b>RESIDENTIAL</b>						
Oil	591	551	442	601	518	344
Gas	563	526	437	511	443	328
Electricity	310	293	260	500	433	342
Solar	-	-	11	-	71	134
TOTAL	1464	1370	1150	1612	1465	1148
<b>COMMERCIAL</b>						
Oil	546	451	391	1081	791	579
Gas	220	182	157	218	160	117
Electricity	280	231	200	638	467	342
Solar	-	-	-	-	91	142
TOTAL	1046	864	748	1937	1489	1180

\*New Jersey, Pennsylvania, Delaware, Maryland and D.C.

TABLE 8

SUMMARY OF NORTHEAST REGION RESIDENTIAL AND COMMERCIAL ENERGY DEMANDS ( $10^{12}$  Btu)  
BY FUEL TYPE, 1985 and 2000

	1985			2000		
	<u>Base Case</u>	<u>Conservation Cases - Moderate</u>	<u>Strong</u>	<u>Base Case</u>	<u>Conservation Cases - Moderate</u>	<u>Strong</u>
<b>RESIDENTIAL</b>						
Oil	1652	1542	1204	1621	1396	959
Gas	1073	993	809	967	841	622
Electricity	641	607	543	1067	928	743
Solar	-	-	36	-	163	304
TOTAL	3366	3142	2581	3655	3328	2628
<b>COMMERCIAL</b>						
Oil	1443	1194	1037	2691	1971	1459
Gas	368	305	264	370	272	199
Electricity	630	521	452	1374	1006	742
Solar	-	-	-	-	207	438
TOTAL	2441	2020	1753	4435	3456	2838

## II. RESIDENTIAL ENERGY DEMAND PROJECTIONS

### A. Methodology

The residential energy demand projections are determined by the prime energy consuming unit, the household. The number of households for the future reference years is derived from two primary factors: population and family size. Their relationship is given by:

$$\text{Projected households} = \frac{\text{projected population}}{\text{persons per household}}$$

Housing type, saturation of utilizing devices, and unit demand by end use are also included in establishing the energy projections. Housing is classified into single-family detached, low-density, low-rise, and high-rise units, and mobile homes. End-use saturation is categorized by space heating, water heating, air conditioning, cooking, and lighting and miscellaneous appliances. The calculation of annual energy demand involves multiplying the total number of housing units having each end use by the annual unit demand developed in this study. Figure 2 is a schematic representation of the inputs and methodology used in projecting residential energy demand.

### B. Residential Inventory and Projections

1. Base-Year (1972) Inventory The housing inventory for 1972 was escalated from that given in the 1970 Census of Housing<sup>3</sup> by using the average yearly growth rate between 1960 and 1970 given in the 1972 U.S. Statistical Abstract.<sup>4</sup> These data were then categorized into four housing types\* :

\* The 1970 housing mix was assumed in categorizing the 1972 housing types. A fifth type, the mobile home, is introduced in future years as it becomes more significant in number.

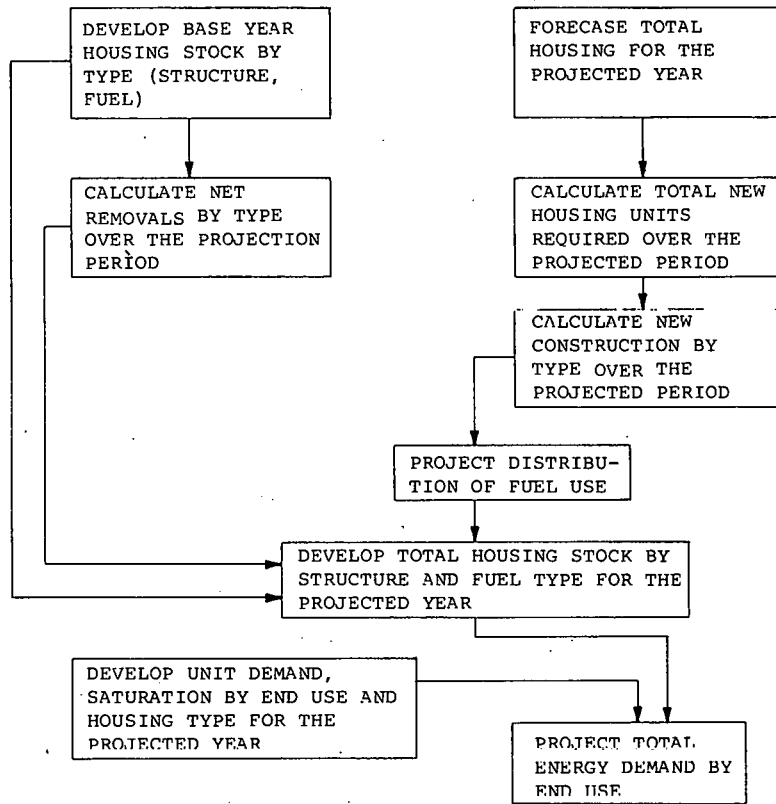


Figure 2. Schematic description of methodology for projecting future residential energy demand.

Single-family	-	one-unit detached structures
Low-density	-	one-unit attached structures and 2 to 4 unit structures
Low-rise	-	structures with 5 to 19 housing units
High-rise	-	structures with 20 or more units

Table 9 presents the base-year housing stock by type and fuel mix by end use.

2. Population and Households. As already stated, projections of the total housing stock are based on the projected population and persons per household. They are therefore long-term housing demand projections and are independent of short-term fluctuations of new housing construction rates. The population figures for 1985 and 2000 were taken from the Bureau of the Census Series E - population projection<sup>1</sup> and are presented in Table 10.

Estimates of the average number of persons per household for the future reference years were based on the historical trend in the three subregions. The significant decline shown for the future is due to the effects of a long-term reduced birth rate. Table 11 shows projected household size by region and the nation as a whole.

3. 1985 and 2000 Inventory. The disaggregation of total projected households into housing units by structure type (indicated by subscript K) is based on

$$HE_K = HB_K + C_K - R_K,$$

where

$HE_K$  = housing stock at end of projection period,

$HB_K$  = housing stock at beginning of projection period

$C_K$  = number of new units constructed during projection period, and

TABLE 9

SUMMARY OF RESIDENTIAL END USE BY HOUSING TYPE AND FUEL, 1972<sup>3</sup>  
(10<sup>3</sup> households)

Region	Housing type	Space heating				Water heating			Cooking			Air conditioning
		Gas	Oil	Electricity	Other	Gas	Oil	Electricity	Gas	Oil	Electricity	Electricity
I	Single-family detached	453	1502	82	20	658	967	432	843	206	1008	555
	Low density	255	846	46	11	371	545	243	476	116	568	313
	Low rise	82	273	15	4	120	176	79	153	37	183	101
	High rise	33	109	6	1	48	70	31	61	15	73	40
II	Single-family detached	875	1351	41	34	990	1128	184	1634	184	483	1013
	Low density	552	853	26	22	625	712	116	1032	116	305	640
	Low rise	299	462	14	12	339	386	63	559	63	165	346
	High rise	575	889	27	23	651	742	121	1075	121	318	666
III	Single-family detached	1891	1815	165	247	2392	990	742	2516	289	1320	2062
	Low density	1109	1061	96	145	1399	579	434	1471	169	772	1206
	Low rise	222	208	38	42	406	168	126	427	49	224	350
	High rise	250	240	22	33	316	131	98	332	38	174	272

TABLE 10  
POPULATION BY REGION<sup>1</sup>  
(Thousands)

Region	1972	1985	2000
I	12,105.0	13,528.3	15,226.3
II	18,367.0	20,132.9	22,438.4
III	24,625.0	27,791.3	31,164.7
Total Northeast	55,097.0	61,452.5	68,829.4

TABLE 11  
NUMBER OF PERSONS PER HOUSEHOLD  
HISTORICAL AND PROJECTED<sup>3</sup>

Region	1950	1960	1970	1972	1985	2000
I	3.56	3.37	3.25	3.23	3.03 <sup>a</sup>	2.80 <sup>a</sup>
II	3.42	3.20	3.09	3.03	2.80 <sup>a</sup>	2.50 <sup>a</sup>
III	3.53	3.39	3.35	3.17	2.96 <sup>a</sup>	2.70 <sup>a</sup>
U.S.	3.37	3.33	3.14	3.06	2.95 <sup>b</sup>	2.68 <sup>b</sup>

<sup>a</sup>Based on the average reduction rate between 1950 and 1970.

<sup>b</sup>Ford Foundation projection.<sup>5</sup>

$R_K$  = net removals from housing stock during projection period.

The net removal rates were taken from a Project Independence Task Force Report.<sup>6</sup> These rates have been developed by A.D. Little, Inc., from the Northeast regional data on housing inventory change from 1950 to 1960 and 1960 to 1970. The net removal rates have been examined with respect to the implied life of each type of structure and the general age characteristics of the region's housing inventory. These rates were applied to the base-year housing stock to generate the net removals by structure type for the region.

The aggregate new construction in the region over the projection period was obtained by subtracting the base-year inventory (less removals) from the total projected households at the end of the period. Total new construction was distributed among structure types on the basis of the distribution of new units projected in ref. 6. The distribution implies that the construction trend is shifting from single-family structures to various forms of multi-family housing and increasing numbers of mobile homes. The new units by structure type ( $C_K$ ), plus the base-year inventory ( $HB_K$ ), less the removals ( $R_K$ ), equal the projected inventory ( $HE_K$ ). Table 12 presents the housing inventory by type and region based on these calculations.

### C. Unit Demand and Saturation by End Use

In general, unit demands are a function of building type, location, fuel type, and end-use efficiency. For space heating, unit demands for existing housing units (buildings existing in 1972) were derived from the average unit demands in ref. 6 based on values of heating degree day and average house size. Unit demands for new housing units were derived in a BNL report.<sup>7</sup> Unit demands for water heating, air conditioning, and lighting and

TABLE 12  
RESIDENTIAL INVENTORY (10<sup>3</sup> housing units)

	1972 Inventory	New construction (1972-85)	Removals (1972-85)	1975 Inventory	New construction (1975-2000)	Removals (1975-2000)	2000 Inventory
REGION I	3,740	1,440	715	4,465	1,952	979	5,438
Single-family	2,023	670	221	2,472	1,040	316	3,196
Low-density	1,140	344	326	1,158	420	382	1,196
Low-rise	368	192	91	469	232	126	575
High-rise	148	46	37	157	60	42	175
Mobile home	61	188	40	209	200	113	216
REGION II	6,057	2,385	1,252	7,190	3,510	1,725	8,975
Single-family	2,272	753	248	2,777	1,318	350	3,745
Low-density	1,434	432	392	1,474	716	486	1,704
Low-rise	777	406	192	991	532	267	1,256
High-rise	1,497	463	370	1,590	573	429	1,734
Mobile home	77	331	50	358	371	193	536
REGION III	7,781	2,922	1,314	9,389	3,976	1,823	11,542
Single-family	4,053	1,343	443	4,953	2,140	624	6,469
Low-density	2,371	715	483	2,603	830	601	2,832
Low-rise	688	360	169	879	436	237	1,078
High-rise	537	166	133	570	210	154	626
Mobile home	132	338	86	384	360	207	537
NORTHEAST REGION	17,578	6,747	3,281	21,044	9,438	4,527	25,955
Single-family	8,348	2,766	912	10,238	4,498	1,290	13,446
Low-density	4,945	1,491	1,201	5,235	1,966	1,469	5,732
Low-rise	1,033	958	452	2,339	1,200	630	2,909
High-rise	2,182	675	540	2,317	843	625	2,535
Mobile home	270	857	176	951	931	513	1,369

miscellaneous appliances were obtained from refs. 2 and 6. Table 13 shows the average annual unit demand by end use and fuel type for the existing housing units. Unit demands for retrofitted homes and new construction can be found in Appendix A.

Saturation rates for space heating, water heating, and cooking were assumed to be unity for all reference years. The saturation is defined as the fraction of the potential demand for a particular energy use that is actually being fulfilled at a given time. For example, if 95% of all households have refrigerators and the potential demand for refrigerators is taken to be one per house, the saturation is 0.95. For air conditioning and miscellaneous electric appliances, saturation rates were derived from a census of housing<sup>8</sup> and saturation growth rates given in ref. 6. For most appliances, the saturation is expected to increase significantly. However, unit demand for some of these appliances is projected to decrease somewhat because of design improvements. Table 14 summarizes the saturation rates and unit demands for lighting and miscellaneous appliances.

TABLE 13  
ANNUAL UNIT DEMAND (10<sup>6</sup> Btu) FOR RESIDENTIAL END USES, EXCEPT  
LIGHTING AND MISCELLANEOUS APPLIANCES, 1972<sup>2</sup>

End Use	Housing type	Gas			Oil			Electricity		
		Region I	Region II	Region III	Region I	Region II	Region III	Region I	Region II	Region III
Space heating	Single-family detached	176	150	143	209	182	170	83	71	68
	Low density	124	106	101	148	126	120	59	50	48
	Low rise	84	72	68	100	85	81	40	34	32
	High rise	78	67	63	93	80	75	37	31	30
Water heating	Single-family detached	43	43	43	39	39	39	25	25	25
	Low density	32	32	32	29	29	29	18	18	18
	Low rise	27	27	27	25	25	25	16	16	16
	High rise	27	27	27	25	25	25	16	16	16
Cooking	Single-family detached	9.6	9.6	9.6	9.6	9.6	9.6	3.7	3.7	3.7
	Low density	8.2	8.2	8.2	8.2	8.2	8.2	3.1	3.1	3.1
	Low rise	7.2	7.2	7.2	7.2	7.2	7.2	2.8	2.8	2.8
	High rise	7.2	7.2	7.2	7.2	7.2	7.2	2.8	2.8	2.8
Air conditioning	Room							2.8	3.5	3.9
	Central							7.0	8.9	10.0

TABLE 14  
ANNUAL UNIT DEMAND AND SATURATION FOR  
LIGHTING AND MISCELLANEOUS ELECTRIC APPLIANCES<sup>2,6,8</sup>

End-Use Device	Saturation			Unit Demand (10 <sup>6</sup> Btu)		
	1972	1985	2000	1972	1985	2000
Lighting	1.00	1.00	1.00	3.10	3.10	3.10
Dishwasher	0.24	0.70	0.90	1.30	1.15	1.15
Washing machine	0.85	0.90	0.95	0.35	0.35	0.35
Dryer	0.33	0.50	0.70	3.40	3.40	3.40
Color TV	0.43	0.90	1.00	2.10	1.50	1.50
B&W TV	0.82	0.80	0.70	1.20	0.40	0.40
Freezer	0.22	0.35	0.50	4.80	4.50	4.20
Refrigerator	1.00	1.10	1.25	4.50	4.50	4.50
Misc. small appliances	0.60	0.70	0.85	2.50	2.50	2.50
Average	0.60	0.73	0.88			

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### III. COMMERCIAL ENERGY DEMAND PROJECTIONS

#### A. Methodology

The commercial sector as defined in this study is an agglomeration of diverse activities including wholesale and retail trade, finance and insurance, services, schools, hospitals, cultural and recreational establishments, and government institutions. The basic approach used to project the disaggregated energy demand for future reference years is similar to that used in the residential area. First, the floor-space inventories associated with the commercial activities listed above are forecast by building type. The building categories include offices, retail establishments, schools, hospitals, and miscellaneous buildings.\* Then the end-use demand per unit area is developed by building type. The disaggregated energy demands are the product of these two factors. Figure 3 is a schematic representation of the methodology used.

#### B. Commercial Inventory Projections

1. Base-Year Inventory. Since few historical and current regional data have been published on commercial floor space, the 1972 commercial inventory was developed by regionalizing a national inventory developed in ref. 6. The office building inventory was regionalized by using total number of employees in services, finance, insurance, real estate, and government. Regional distribution of retail inventory was based on employment in wholesale and retail trade. School inventory was distributed according to

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\* Miscellaneous buildings include passenger and freight terminal buildings, religious buildings, social and recreational buildings, etc.



school-age population, hospitals by number of hospital beds, and miscellaneous buildings by total population in the region.

2. Commercial Floor Space Projections. Accurate projections of commercial floor space on the regional level are difficult to make since there is little information on future commercial building construction. The method used here to forecast commercial inventory involves four basic steps: (1) Forecast new construction by building type on the national level for the periods 1972-1985 and 1985-2000, (2) regionalize new construction estimated in (1), (3) forecast regional removal rates for the same period, and (4) calculate the total inventory by building type for the future reference years.

In the absence of a regional model, national estimates of commercial floor space were derived on the basis of the regression analysis presented in ref. 6. The net addition of commercial floor-space in one year over a previous year's inventory is

$$N_{n+1} = Y_{n+1} - S_n R_n,$$

where

$Y_{n+1}$  = new construction in year  $n+1$ ,  $S_n$  = total inventory in year  $n$ , and  $R_n$  = demolition rate in year  $n$ . The inventory in year  $n+1$  is  $S_{n+1} = S_n + N_{n+1}$ . Substituting, we have

$$S_{n+1} = S_n + Y_{n+1} - S_n R_n = Y_{n+1} + (1 - R_n) S_n$$

or

$$S_{n+1} = Y_{n+1} + (1 - R_n) Y_n + (1 - R_n)^2 Y_{n-1} + \dots$$

$$(1 - R_1)^n Y_1 + S_0 (1 - R_0)^{n+1},$$

where  $S_0$  is the base-year inventory.

In projecting new construction in the years 1985 and 2000, real personal income values and population from the OBERS projection<sup>1</sup> were used. Yearly new construction between 1972 and future reference years was derived by assuming linear growth in new construction between projection periods. The cumulative total of new floor space by building type is summarized in Table 15.

As with the base-year inventory, new construction was regionalized by apportioning the total according to regional personal income forecasts, earnings in wholesale and retail trade from OBERS projections,<sup>1</sup> and the Bureau of the Census Series E population projection.<sup>1</sup>

TABLE 15  
NEW COMMERCIAL FLOORSPACE CONSTRUCTION  
(10<sup>6</sup> ft<sup>2</sup>) in the U.S.

<u>Building type</u>	<u>1972-1985</u>	<u>1985-2000</u>
Office	3,984	8,740
Retail	5,740	13,205
School	3,234	4,404
Hospital	1,132	1,691
Miscellaneous	4,445	0,687

Forecasting removals from the commercial inventory is difficult because of the lack of data on current and historical removal rates and the age distribution of the buildings. In this report, we have used the regional removal rates estimated in ref. 6, which were assumed to be the same as residential removal rates in the region for the 1960-1970 period.

The base-year inventory and the results of the forecast are summarized in Table 16.

TABLE 16  
COMMERCIAL FLOOR-SPACE INVENTORY  
(10<sup>6</sup> ft<sup>2</sup>)

Region	Building type	1972	New		1985	New		2000
			Construction 1972-85	Removals 1972-85		Construction 1985-2000	Removals 1985-2000	
I	Office	234	247	26	455	538	31	962
	Retail	274	336	30	580	772	35	1317
	School	287	179	32	434	144	36	542
	Hospital	118	65	13	170	97	15	252
	Miscellaneous	465	256	52	669	501	59	1111
II	Office	416	441	46	781	868	53	1596
	Retail	440	485	47	878	1287	57	2108
	School	447	241	49	639	331	58	912
	Hospital	197	97	22	272	144	25	391
	Miscellaneous	705	381	78	1008	739	90	1657
III	Office	484	502	54	932	1091	61	1962
	Retail	579	717	64	1232	1608	69	2771
	School	624	401	69	956	498	80	1374
	Hospital	222	134	25	331	200	28	503
	Miscellaneous	945	527	104	1368	1026	121	2273
Northeast	Office	1134	1160	126	2168	2497	145	4520
	Retail	1293	1538	141	2690	3667	161	6196
	School	1358	821	150	2029	973	174	2828
	Hospital	537	296	60	773	441	68	1146
	Miscellaneous	2115	1164	234	3045	2266	270	5041

C. Unit Demand by End Use

The unit demands (Btu/ft<sup>2</sup>) in this sector were originally derived in ref. 6 for the Northeast and were based on specific assumptions about the building design and energy system characteristics.\* They are probably best regarded as prototypical, not average, values. Projections based on these unit demands are far less certain than those in the residential sector because of the wide variance in energy consumption per square foot between similar buildings with comparable utilizing devices. However, in establishing the 1972 commercial energy consumption in the region, these unit demands have produced results that are in excellent agreement with other independently reported data.<sup>2</sup> This has led to the conclusion that they are representative of the construction and design standard within each region. Table 17 shows the unit demands by end use for 1972 commercial buildings. In forecasting the future energy demand, some of these figures have been reduced to reflect conservation impacts. These reductions, while significant, imply no major changes in technology or lifestyle. Detailed discussions of these points are presented in Section IV.

TABLE 17

1972 COMMERCIAL UNIT DEMAND ( $10^6$  Btu) BY END USE, NORTHEAST REGION<sup>2</sup>

Region	Building type	Space heating				Air conditioning		Lighting and Miscellaneous Appliances
		Gas	Oil	Electricity	Coal	Electricity	Gas	Electricity
I	Office	310	313	165	345	9.6	16.0	31.6
	Retail	172	174	92	191	10.8	17.9	34.0
	School	275	278	146	306	8.5	14.1	27.2
	Hospital	333	336	176	370	12.0	20.0	71.3
	Other	172	174	92	191	10.8	17.9	31.6
II	Office	267	270	142	297	12.2	20.3	31.6
	Retail	148	150	79	165	13.6	22.7	34.0
	School	237	240	126	264	10.7	17.9	27.2
	Hospital	287	290	152	319	15.2	25.4	71.3
	Other	148	150	79	165	13.6	22.7	31.6
III	Office	249	252	133	277	13.7	22.8	31.6
	Retail	138	140	74	154	15.3	25.5	34.0
	School	221	224	118	247	12.0	20.1	27.2
	Hospital	268	271	142	298	17.1	28.6	71.3
	Other	138	140	74	154	15.3	25.5	31.6

\* The values of unit demands were adjusted for the three Northeast subregions on the basis of the average annual heating degree days in each area. Population-weighted annual heating degree days were estimated at 6320 for Region I, 5480 for Region II, and 5090 for Region III.

#### IV. ENERGY IMPACTS OF CONSERVATION MEASURES

Section I demonstrated the significance of conservation measures in reducing the region's energy demand in the residential and commercial sectors. The purpose of this Section is to evaluate the conservation measures included in this study<sup>9</sup> and to provide a detailed description of the three levels of implementation of each measure on which the three scenarios--the base case, the moderate conservation case, and the strong conservation case--were constructed.

##### A. Conservation and Demand Projection

1. Base Case. The energy demands for the base case were calculated under the assumption of no major technological, price, or government policy changes. Some conservation measures were included because current market forces alone are expected to bring about their implementation, although certain market imperfections are assumed to remain. This means that gradual improvements in efficiency can be expected for most elements of the energy system in new construction and some reduction in unit energy demand for existing structures. It is assumed that some existing structures will be retrofitted with better insulation and that their heating units will receive better maintenance. All buildings are assumed to be operated in a less energy intensive fashion; e.g., residences will have their thermostats set back from 72°F to 70°F for heating. The fuel mix for the residential sector was estimated on the basis of the fuel mix in existing housing units and the following assumptions about new housing units:

(a) The number of new gas-heated homes will equal the number of removals from the existing gas-heated housing stock.

(b) Thirty percent of the new structures built between 1972 and 1985 will be electrically heated, and 50% thereafter.

(c) The remaining new housing units will be heated by oil.

For the commercial sector, the amount of natural gas used and the relative market share of oil were kept constant at the 1972 levels, the remaining demand being met by electricity. The use of other fuels and solar energy was assumed to be negligible.

2. Moderate Conservation Case. The energy demands for this case were projected under the assumption of a higher implementation level of the conservation measures considered in the base case. It is assumed that government policies to improve the operation of the market system will be implemented. In this case, the public is not generally asked to sacrifice convenience or to change lifestyle.

All the measures are assumed to be in the economic self-interest of the consumer. The fuel mix is altered from that in the base case by the assumption that 25% of the structures built between 1985 and 2000 will receive 50% of their space heat demand from solar devices. For water heating, solar energy is assumed to supply 35% of the demand for these structures. The amount of solar energy used reduces the total demand for oil, gas, and electricity, compared with base case requirements.

3. Strong Conservation Case. For this case, it is assumed that government policies strongly affect conservation measures through direct regulation and alteration of prices. Some public sacrifice of convenience and changes in lifestyle are expected. In the residential sector, all new fossil-fuel heated homes are assumed to be built in accordance with ASHRAE-90 standards. It is assumed that 40% of the new electric homes built between 1972 and 1985 will use heat pumps, and 100% thereafter. Retrofits of existing homes are implemented at 5%/yr. to 1985, compared with 2% in the moderate conservation case and 1% in the base case.

Existing commercial buildings are expected to reduce their unit energy demands by 25 to 35% through advances in technology and changes in operating procedures. For new commercial buildings, reductions are expected to reach 50%.

Table 18 summarizes the levels of implementation and the estimated impacts of each measure under the three scenarios.

#### B. Measures for Reducing Energy Consumption

The assessments and justifications behind some of the conservation measures in Table 18 that have significant impact on regional energy use are discussed below.

Conservation measure: Improved insulation of existing homes through retrofits of insulation, storm windows, and storm doors and through recaulking.

Background: The Federal Power Commission<sup>10</sup> estimates that the addition of ceiling insulation to an existing family home can reduce the annual energy requirements for space heating by 10 to 37%. The specific savings realized in any particular home would depend on the amount of insulation already installed--the better the original insulation, the less effective the additional ceiling insulation. The FPC estimates that further savings, up to another 20%, could be realized by weather-stripping, recaulking, and the addition of storm windows and doors where these do not already exist.

BNL calculations<sup>7</sup> indicate that an average saving of 30% per unit could be achieved in single family homes in the Northeast by retrofitting insulation, storm windows, and storm doors and by recaulking. To be conservative, half this amount (15%) is assumed as the average saving per unit, on the premise that not everyone will perform complete retrofits (some will perform only

TABLE 18

SUMMARY OF CONSERVATION SCENARIOS

CONSERVATION MEASURES	LEVEL OF IMPLEMENTATION		
	BASE	MODERATE	STRONG
<b>RESIDENTIAL - Space Heating</b>			
1. Improved insulation in existing homes - retrofits of insulation, storm windows, storm doors, etc. in existing single-family homes.	12% to 15% savings per unit (depending on housing type) implemented at 1% of housing stock per year to 1985.	Same as base case but implemented at 2% per year to 1985.	Same as base case except implemented at 5% per year to 1985.
2. Improved insulation in new homes - adoption of energy conservation building codes.	ASHRAE 90-standards on 10% of fossil fuel heated homes beginning in 1977. All electric homes built to standards that result in 40% savings over existing units.	ASHRAE 90-standards on 50% of fossil fuel homes beginning in 1977. Electric homes same as base case.	ASHRAE 90-standards on 100% of fossil fuel homes beginning in 1977. Electric homes same as base case.
3. Improved maintenance of existing oil and gas furnaces.	Average efficiency up 5% implemented at 1% of housing stock per year to 1985.	Average efficiency up 5% implemented at 2% per year to 1985.	Average efficiency up 5% implemented at 5% per year to 1985.
4. Improved design of new gas and oil heating systems.	New unit efficiencies up 10% over existing 1972 units.	Same as base case.	Same as base case.
5. Use of electric heat pumps instead of resistance heating.	50% of electric homes built between 1985 and 2000 heated by heat pumps.	20% of electric homes built between 1972 and 1985 heated by heat pumps and 70% of new electric homes from 1985 to 2000.	40% of electric homes built between 1972 and 1985 heated by heat pumps and 100% from 1985 to 2000.
6. Solar space heating in new homes	NONE	25% of homes built between 1985 and 2000 receive 50% of space heat demand from solar devices.	Percentage of homes increased over moderate case to 50%.
7. Lowered thermostats	70°F day and night.	70°F day/68°F night.	68°F day/55°F night.
<b>Air Conditioning</b>			
1. Improved insulation	All factors result in 40% savings for 1985 and 2000.	Savings increase to 56% for 1985 and 61% for 2000.	Savings increase to 61% for 1985 and 71% for 2000.
2. Improved efficiency - new air conditioners			
3. Higher thermostat levels			
<b>- Water Heating</b>			
1. Improved efficiency and insulation of new water heaters.	NONE	5% more efficient in 1985 and 10% in 2000 for gas and oil heaters. 5% improvement in electric heaters in 2000.	10% more efficient in 1985 and 15% in 2000 for gas and oil heaters. Electric heaters same as moderate case.
2. Use of solar energy for water heating	NONE	Supplies 35% of hot water demand for housing built between 1985 and 2000.	Supplies 20% of demand for housing built between 1972 and 1985 and 70% for housing built between 1985 and 2000.
<b>- Cooking</b>			
1. Improved efficiency of ovens - microwave ovens, etc.	NONE	10% savings in 1985 and 2000.	25% savings in 1985 and 2000.
<b>- Lighting and Miscellaneous Electric</b>			
1. Improved efficiency - fluorescent lights, etc.	NONE	5% for 1985 and 2000.	10% for 1985 and 2000.
<b>COMMERCIAL - Space Heating, Cooling and Lighting</b>			
1. Reduced demand in existing buildings - lowered thermostats, improved operating procedures, reduced lighting levels.	15% reduction in average demand of all existing buildings for 1985 and 2000 for heating and 10% for cooling.	20% reduction in demand for 1985 and 2000.	25% reduction in demand for 1985 and 35% reduction for 2000.
2. Improved efficiencies in new buildings - air conditioning, total energy systems, lighting levels, etc.	Same as for existing buildings above.	35% reduction in demand for 1985 and 2000.	50% reduction in demand for 1985 and 2000.
3. Space heating and water heating from solar energy.	NONE	Same criteria as for residential sector	None prior to 1985. After 1985, same criteria as for residential sector.

partial retrofits, neglect to recaulk, etc.) and that imperfect workmanship will deny the homeowner some of the savings that are theoretically possible.

Smaller savings are available in high-rise residential buildings through retrofits of insulation because of their lower surface-to-volume ratios compared with single-family dwellings. For these structures, it is assumed that retrofits of insulation will reduce fuel consumption for space heating by an average of 12%.

Scenarios: 1. Base Case. 1% of the existing residential structures are retrofitted per year through 1985. No further retrofits are performed thereafter. Average savings per unit (i.e., decreases in unit energy demand) are 15% for single-family homes and 12% for high-rise apartment buildings.

2. Moderate Case. 2% of the existing residential structures are retrofitted per year through 1985.

3. Strong Case. 5% of the existing residential structures are retrofitted per year. All houses not demolished are eventually retrofitted.

Conservation measure: Improved insulation in new homes-- adoption of energy-conserving building codes.

Background: The Board of Directors of ASHRAE recently (Aug. 11, 1975) approved the long-debated ASHRAE 90-P (now 90-75) standards for construction.<sup>11</sup> These are model building codes designed to save energy used in home heating. ASHRAE estimates that these standards will "save at least 10-20% of the energy now used in residential structures and possibly twice as much in industrial, commercial, governmental, and institutional buildings."<sup>11</sup>

Scenarios: 1. Base Case. Beginning in 1977, 10% of all new homes are constructed in accordance with ASHRAE 90-75. An average reduction in unit demand of 15% compared with the 1972 level is achieved.

2. Moderate Case. 50% of all new homes are constructed in accordance with ASHRAE 90-75 starting in 1977. This level of implementation will depend on adoption of the code by FHA and some state and local governments in the Northeast (Berg<sup>12</sup> has estimated that FHA standards have a direct effect on ~ 35% of new construction).

3. Strong Case. All new homes are constructed in accordance with ASHRAE 90-75 starting in 1977. This level of implementation will probably depend on national adoption of the code.

Conservation measure: Improved maintenance of existing oil and gas furnaces.

Background: A limited field study<sup>13</sup> indicates that the average efficiency of oil-fired furnaces could be raised by 10 to 15% through improved maintenance. Similar data have not been found for gas-fired furnaces, but research on energy use in a new community in New Jersey<sup>14</sup> has revealed a 25% spread in efficiencies in gas heating in almost identical dwellings. The operation of the less efficient units could probably be improved through better maintenance.

Scenarios: 1. Base Case. Market forces result in better maintenance of space heating furnaces. Average efficiencies in 1985 improve by 5% for gas and oil furnaces, implemented at 1% of existing housing stock per year to 1985.

2. Moderate Case. Federal, state, and local

governments encourage improved maintenance by (a) providing more comprehensive field data on typical installations, (b) developing a set of "approved" maintenance schedules and procedures, and (c) providing information to the public. Under these assumptions, average efficiencies of renting units improve by 5% implemented at 2% per year to 1985.

3. Strong Case. In addition to the above, some state governments require an annual efficiency inspection similar to auto safety inspections. Implementation rate for improved maintenance increases to 5% per year to 1985.

Conservation measure: Improved design of new gas and oil heating systems.

Background: Conventional home heating systems are constructed from components made by different manufacturers which are assembled by the contractor with little or no attempt to obtain an optimized system. A unified system featuring improved burner designs that lose less heat out the flue, burn more of the fuel, include heat storage tanks, more flexible controls, etc., has the potential of improving the overall efficiency of heating systems by an additional 20%.<sup>15</sup>

Scenarios: For all three cases, new unit efficiencies improve by 10% over current efficiencies by 1985. No improvements thereafter.

Conservation measure: Solar energy for space and water heating.

Background: A study by Westinghouse Special Systems<sup>16</sup> shows that solar energy for space and water heating can become competitive in most regions of the country in the 1985-2000 period. The Northeast is identified as a primary market because of its high population density and annual heating requirements. It is economically

impractical, however, to design solar systems to provide 100% of the heating requirements of buildings. The size of a solar collector to absorb, and a storage subsystem to hold, enough energy to carry the building through protracted periods of cloudy days would be so great that the cost would be prohibitive. Solar systems therefore require conventional components such as gas- or oil-burning furnaces as auxiliary systems. It was estimated that solar systems providing 50% of the space heat and 95% of the water heat would be economically feasible for the Northeast region.

Scenarios: 1. Base Case. Solar energy is not used on a significant scale to replace conventional fuel for space and water heating.

2. Moderate Case. 25% of new homes and commercial buildings built between 1985 and 2000 receive 50% of their space heating requirements from solar systems. For water heating, solar energy supplies 35%. This level of implementation calls for technological improvements to reduce solar system equipment costs.

3. Strong case. The percentage of new homes and commercial buildings utilizing solar systems for space heating increases to 50%. For water heating, solar energy supplies 20% of the requirement for homes built between 1972 and 1985 and 70% for homes and commercial buildings built between 1985 and 2000. This level of implementation would require government action to provide incentives such as income tax credits or reductions, low-cost insured loans, or government-guaranteed loans.

Conservation measure: Use of electric heat pumps instead of resistance heating.

Background: A heat pump is basically a modified air-conditioning system in which functions of the evaporator and the condenser can be interchanged to it to heat or cool the desired space. The

coefficient of performance of current heat pumps varies between 2 and 3.<sup>5,17</sup> That is, for every Btu a heat pump consumes in electricity, it produces two or three in heating. It was assumed in this study that a new home with a heat pump would be 2.8 times as efficient as existing resistance-heated homes. If problems of reliability are solved, heat pumps could be highly competitive with electric resistance systems in life-cycle cost effectiveness and minimum energy consumption.

Scenarios: 1. Base Case. 50% of new electric homes built between 1985 and 2000 use heat pumps.

2. Moderate Case. 20% of new electric homes built between 1972 and 1985 and 70% of those built from 1985 to 2000 use heat pumps.

3. 40% of new electric homes built between 1972 and 1985 and 100% of those built from 1985 to 2000 use heat pumps. Significant improvements in heat-pump compressor reliability would occur.

Conservation measure: Reduced heating and cooling levels, improved operating procedures, improved efficiencies in new commercial buildings.

Background: In the commercial sector, the more complicated interrelationships between energy demands and building structures do not permit easy analysis of the effect of the various conservation measures applicable to this sector. A.D. Little<sup>6</sup> estimates that reductions of 15 to 35% in energy requirements of existing commercial buildings and 15 to 50% in new construction can be achieved by employing such energy conservation measures as reduced heating and cooling levels, improved operating procedures, retrofits, and improved design of new buildings and utilizing devices. Improved

design commonly involves reduction in glass area, better insulation, better building orientation, solar shading schemes, and incorporation of heat recovery schemes. Improved operating procedures can be achieved through a periodic maintenance program, minimized partial load operation, and nighttime setbacks.

Scenarios: 1. Base Case. Average demand is reduced by 15% in all commercial buildings in 1985 and 2000 for space heating and 10% for cooling.

2. Moderate Case. 20% reduction in heating demand is achieved in existing buildings and 35% in new buildings for 1985 and 2000; 10% for cooling.

3. Strong case. 25% reduction in heating demand for existing buildings is achieved for 1985 and 35% reduction for 2000; 50% in new buildings for 1985 and 2000. Cooling demand is reduced by 10% for 1985 and 2000 in all commercial buildings.

## APPENDIX A

### FUEL MIX TABLES

Projections of energy demands in this report have been made on a detailed end-use, or disaggregated, basis in order to evaluate technologies or energy policies that may apply to specific end uses. To evaluate the use of heat pumps for space heating, for example, the system efficiency of an electric-resistance heated home may be upgraded and the reduction of fuel demand calculated through this framework. Projections made in this disaggregated manner may underestimate the total energy demand in the future because of unanticipated new uses of energy. However, such additional demands, as they become known, can readily be incorporated into the demand projection by upgrading the unit basic demand of miscellaneous end use in the residential and commercial sectors.

The projections of energy demands and the fuel mix for the reference years are developed in the fuel mix tables included in this appendix. Before describing the methodology used to develop the projections, it is useful to define several parameters:

1. Fuel demand,  $D_i$ , is the quantity of a fuel,  $i$ , actually consumed in a specific demand category, such as residential space heating or commercial air conditioning.

2. Total fuel demand,  $D_s$  is the total fuel required to satisfy the requirements of a specific demand category. Electricity is considered as a fuel in this sense and  $D_s = \sum_i D_i$ .

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\*"Fuel" as used in this sense includes electricity.

3. Relative system efficiency,  $e_i$ , is the relative effectiveness with which fuel,  $i$ , is used in a demand category. This parameter depends on the utilization technology employed. For space heating,  $e_i$  is defined as 1 for existing electrically heated homes. The values of  $e_i$  for other structures are given in the fuel mix tables.

4. Degree of saturation,  $S$ , is the fraction of the potential demand for a particular energy use actually being fulfilled at a given time. For example, if 95% of all households have refrigerators and the potential demand for refrigerators is taken to be one per house,  $S = 0.95$ .

5. Unit Energy Demand,  $E_u$ , is the amount of energy per unit that would be required for a specific end use, assuming a relative system efficiency,  $e_i$ , of 100% for each fuel employed. Thus, for a given end use, the actual fuel demand per unit is  $E_u/e_i$ , where  $e_i$  is the actual relative system efficiency.

6. Fuel fraction,  $f_i$ , is the fraction of the total number of energy consuming units (basis) that is satisfied by using the  $i$ -th fuel.

The unit basic demand derived for each end use is independent of  $e_i$  and is projected on the basis outlined in Table 18. By specifying the fuel fraction,  $f_i$ , and relative system efficiency,  $e_i$ , the fuel demands,  $D_i$ , can be derived by the equation:

$$D_i = E_u \times S \times b \times f_i \div e_i$$

The specific assumptions made in each demand category and the basis for the base-case projection are described on the worksheets that follow.

FUEL MIX TABLE A-1

Region: I  
Sector: RESIDENTIAL  
Category: SINGLE FAMILY DETACHED  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.22	0.480	78.25	0.159	0.480	62.53	0.102	0.528	47.15
Retrofitted				0.021	0.585	6.76	0.013	0.514	5.17
New-improved				0.019	0.719	5.78	0.034	0.719	13.37
New-FHA-MPS				0.001	0.922	0.24	0.003	0.922	0.92
FUEL OIL									
Existing	0.73	0.400	311.58	0.466	0.400	219.91	0.300	0.440	166.40
Retrofitted				0.070	0.494	26.75	0.045	0.518	21.20
New-improved				0.142	0.604	51.41	0.235	0.604	110.47
New-FHA-MPS				0.011	0.774	3.11	0.022	0.774	8.04
ELECTRICITY									
Existing	0.04	1.000	6.83	0.029	1.000	5.47	0.019	1.000	4.64
New-improved				0.082	1.392	12.88	0.145	1.392	29.45
Heat pump							0.081	2.800	8.18
OTHER	0.01	0.350	4.88						
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			401.54			394.84			414.99
BASIS, $10^3$ Households			2057			2472			3196
SATURATION, $S$	1.00			1.000			1.000		
UNIT BASIC DEMAND, $E_u$ , $10^6$ Btu/household			Existing 83.00			76.36			76.36
			New			88.46			88.46

REFERENCE TECHNOLOGIES: Fossil fuel burners, electric resistance heat and heat pump.

DATA SOURCES:

$D_i$ ,  $f_i$ ,  $e_i$ , and  $E_u$  for 1972 were obtained from ref. 2.

BASIS OF PROJECTION S:

The basic unit demand for all housing units was reduced by 7% through thermostat setback from 72° F to 70°F. For new housing units estimate of basic unit demand was based on an average house size of 1600 ft.<sup>2</sup> Improved system efficiencies were obtained from ref. 7. It was assumed that 30% of all new houses between 1972-1985 will be electrically heated and 50% thereafter. It was also assumed that 50% of the new electrically heated homes built after 1985 will use heat pumps. Natural gas use was kept at the 1972 consumption level, with the remaining demand met by oil. Coal use and solar energy were assumed to be negligible.

FUEL MIX TABLE A-2

Region: I  
Sector: RESIDENTIAL  
Category: LOW DENSITY  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.22	0.480	31.37	0.137	0.480	17.94	0.064	0.528	0.12
Retrofitted				0.021	0.586	2.25	0.010	0.614	1.06
New-Improved				0.059	0.719	5.64	0.128	0.719	12.64
New-FHA-MPS				0.003	0.922	0.22	0.011	0.922	0.85
FUEL OIL									
Existing	0.73	0.400	124.90	0.449	0.400	70.56	0.235	0.440	34.67
Retrofitted				0.067	0.494	8.52	0.035	0.518	4.39
New-Improved				0.137	0.604	15.59	0.220	0.604	25.86
New-FHA-MPS				0.009	0.774	0.80	0.070	0.774	1.83
ELECTRICITY									
Existing	0.04	1.000	2.74	0.028	1.000	1.76	0.015	1.000	0.97
New-Improved				0.090	1.392	4.06	0.174	1.392	8.88
Heat pump							0.088	2.800	2.23
OTHER	0.01	0.350	1.96						
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			160.97			127.34			93.50
BASIS, 10 <sup>3</sup> households			1160			1158			1196
SATURATION, S	1.00			1.000			1.000		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>6</sup> Btu/household	Existing		59.00			54.28			54.28
	New					59.37			59.37

REFERENCE TECHNOLOGIES: See Table A-1.

DATA SOURCES: See Table A-1.

BASIS OF PROJECTION: Same as in Table A-1 except that average unit size was assumed to be 1100 ft<sup>2</sup>.

FUEL MIX TABLE A-3

Region: I  
Sector: RESIDENTIAL  
Category: LOW RISE  
End use: SPACE HEATING

	1972			1985			2000			
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	
DIRECT FUEL USE										
METHANE										
Existing	0.22	0.480	6.86	0.136	0.480	4.89	0.064	0.528	2.56	
Retrofitted				0.036	0.719	0.86	0.071	0.719	2.09	
New-improved				0.002	0.922	0.04	0.007	0.922	0.16	
New-FHA-MPS										
FUEL OIL										
Existing	0.73	0.400	27.30	0.431	0.400	18.60	0.188	0.440	9.04	
Retrofitted				0.233	0.604	0.66	0.329	0.604	11.53	
New-improved				0.015	0.774	0.34	0.029	0.774	0.79	
New-FHA-MPS										
ELECTRICITY										
Existing	0.04	1.000	0.60	1.000	1.000	0.40	0.010	1.000	0.21	
New-improved				1.392	1.392	1.54	0.201	1.392	3.06	
Heat pump							0.101	2.800	0.76	
OTHER										
	0.01	0.350	0.43							
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			35.19				33.33	30.20		
BASIS 10 <sup>3</sup> households			374				469	575		
SATURATION, S			1.00	1.00			1.00			
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>6</sup> Btu/household			40.00				36.80	36.80		

REFERENCE TECHNOLOGIES:

DATA SOURCES: See Table A-1.

BASIS OF PROJECTION: Same as in Table A-1, except that average unit size was assumed to be 900 ft<sup>2</sup>.

FUEL MIX TABLE A-4

Region: I  
Sector: RESIDENTIAL  
Category: HIGH RISE  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.22	0.480	2.54	0.166	0.480	1.85	0.188	0.528	1.09
Retrofitted					-----	-----		-----	-----
New-improved				0.041	0.719	0.31	0.194	0.719	0.69
New-FHA-MPS				0.003	0.922	0.02	0.017	0.922	0.05
FUEL OIL									
Existing	0.73	0.400	10.13	0.510	0.400	6.81	0.193	0.440	3.79
Retrofitted					-----	-----		-----	-----
New-improved				0.146	0.604	1.29	0.131	0.604	2.40
New-FHA-MPS				0.010	0.774	0.07	0.012	0.774	0.16
ELECTRICITY									
Existing	0.04	1.000	0.22	0.032	1.000	0.17	0.017	1.000	0.10
New-improved				0.089	1.392	0.34	0.164	1.392	0.71
Heat pump							0.084	2.800	0.18
OTHER	0.01	0.350	0.16						
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			13.50			10.86			9.17
BASIS, 10 <sup>3</sup> households			150			157			175
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>6</sup> Btu/household			37.00			34.04			34.04

REFERENCE TECHNOLOGIES:

DATA SOURCES: See Table A-1.

BASIS OF PROJECTION: Same as in Table A-3.

FUEL MIX TABLE A-5

Region: I  
Sector: RESIDENTIAL  
Category: MOBILE HOMES  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing				0.90	0.44	19.24	0.90	0.44	27.24
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY									
Existing				0.10	1.00	0.94	0.10	1.00	1.33
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu						20.18			28.57
BASIS 10 <sup>3</sup> households			Negligible			209			296
SATURATION, S				1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>6</sup> Btu/household						45.00			45.00

REFERENCE TECHNOLOGIES: Fossil fuel burners, electric resistance heat.

DATA SOURCES:  $f_i$ , ref. 6;  $e_i$ , ref. 7.

BASIS OF PROJECTION: Estimates of future  $f_i$ 's were based on current fuel mix..

FUEL MIX TABLE A-6

Region: I  
Sector: RESIDENTIAL  
Category: ALL HOUSING TYPES  
End use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-Improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-Improved									
New-FHA-MPS									
ELECTRICITY									
ROOM	0.18	2.00	2.57	0.36	3.00	4.09	0.54	3.00	7.47
CENTRAL	0.02	2.50	0.52	0.04	3.00	1.04	0.06	3.00	1.89
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			3.09			5.13			9.36
BASIS, 10 <sup>3</sup> households			3740			4465			5438
SATURATION, S	0.20			0.40			0.60		
UNIT BASIC DEMAND, E <sub>u</sub> (10 <sup>6</sup> Btu/household)	Room		7.63			7.63			7.63
	Central		17.38			17.38			17.38

REFERENCE TECHNOLOGIES: Vapor compression cycle operating on electricity.

DATA SOURCES: S for 1972 and E<sub>u</sub> were obtained from ref. 2.

BASIS OF PROJECTION: E<sub>u</sub> for 1985 and 2000 were kept at the same level as in 1972. Saturation were upgraded on the basis of projections given in refs. 2 and 6.

FUEL MIX TABLE

A-7

Region: I  
Sector: RESIDENTIAL  
Category: SINGLE FAMILY DETACHED  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.32	0.57	28.30	0.23	0.57	28.84	0.24	0.57	30.28
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.47	0.63	37.70	0.45	0.63	41.94	0.38	0.63	43.37
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.21	1.00	10.80	0.27	1.00	15.85	0.38	1.00	27.33
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			76.80			86.63			100.98
BASIS, $10^3$ households			2057			2472			3196
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^6$ Btu/household			25.00			23.75			22.50

REFERENCE TECHNOLOGIES: Gas and oil burners, electric resistance heat.

DATA SOURCES:  $f_i$ ,  $e_i$ ,  $D_i$ , and  $E_u$  for 1972 were obtained from ref. 2.

BASIS OF PROJECTION: Unit basic demand was reduced by 5% for 1985 and 10% for 2000 because of the reduction in persons per household. System efficiencies were assumed to be the same as in 1972.  $f_i$ 's for gas and oil were assumed to decrease at the same rate for space heating.

FUEL MIX TABLE

A-8

Region: I  
Sector: RESIDENTIAL  
Category: LOW DENSITY  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.32	0.57	11.87	0.23	0.57	9.73	0.24	0.57	8.16
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.47	0.63	15.80	0.45	0.63	14.14	0.38	0.63	11.69
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.21	1.00	4.38	0.27	1.00	5.35	0.38	1.00	7.36
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			32.05			29.22			27.21
BASIS $10^3$ households			1160			1158			1196
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^6$ Btu/household			18.00			17.10			16.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION: See Table A-7.

FUEL MIX TABLE  
A-9

Region: I  
Sector: RESIDENTIAL  
Category: LOW RISE  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.32	0.57	3.23	0.28	0.57	3.50	0.24	0.57	3.49
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.47	0.63	4.39	0.45	0.63	5.09	0.38	0.63	5.00
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.21	1.00	1.26	0.27	1.00	1.92	0.38	1.00	3.15
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			8.88			10.51			11.64
BASIS 10 <sup>3</sup> households			374			469			575
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			16.00			15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION: See Table A-7.

FUEL MIX TABLE  
A-10

Region: I  
Sector: RESIDENTIAL  
Category: HIGH RISE  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_j$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.32	0.57	1.29	0.28	0.57	1.17	0.24	0.57	1.06
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.47	0.63	1.76	0.45	0.63	1.70	0.38	0.63	1.52
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.21	1.00	0.50	0.27	1.00	0.64	0.38	1.00	0.96
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			3.55			3.51			3.54
BASIS $10^3$ households			150			157			175
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household			16.00			15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION: See Table A-7.

FUEL MIX TABLE

A-11

Region: I  
Sector: RESIDENTIAL  
Category: MOBILE HOME  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY				1.00	1.00	3.18	1.00	1.00	4.26
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu						3.18			4.26
BASIS 10 <sup>3</sup> households			Negligible			209			296
SATURATION, S				1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household						15.20			14.40

REFERENCE TECHNOLOGIES: Electric resistance heating

DATA SOURCES:  $e_i$  was obtained from ref. 2.

BASIS OF PROJECTION: E<sub>u</sub> was assumed to be the same as in Table A-10;  $f_i$  was assumed to be all electric.

FUEL MIX TABLE  
A-12

Region: I  
Sector: RESIDENTIAL  
Category: ALL HOUSING TYPES  
End use: COOKING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.40	0.38	13.44	0.35	0.38	13.82	0.29	0.38	13.94
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.10	0.38	3.29						
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.50	1.00	6.21	0.65	1.00	9.75	0.71	1.00	12.97
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			22.94			23.57			26.91
BASIS 10 <sup>3</sup> households			3740			4465			5438
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household			3.36			3.36			3.36

REFERENCE TECHNOLOGIES: Gas and oil burners, electric resistance heat.

DATA SOURCES:  $f_i$ ,  $e_i$ , and  $E_u$  for 1972 were obtained from ref. 2.

BASIS OF PROJECTION:  $E_u$  and  $e_i$  were assumed to be the same as in 1972.  $f_i$  for gas was assumed to decrease at the same rate as for space heating. Oil cooking was assumed to be negligible by 1985.

FUEL MIX TABLE

A-13

Region: I  
 Sector: RESIDENTIAL  
 Category: ALL HOUSING TYPES  
 End use: LIGHTING and MISC.  
 ELECTRIC APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.60	1.00	51.57	0.73	1.00	69.75	0.88	1.00	100.97
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			51.57			69.75			100.97
BASIS 10 <sup>3</sup> households			3740			4465			5438
SATURATION, S	0.60			0.73			0.88		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			23.05			21.40			21.10

REFERENCE TECHNOLOGIES: Conventional lighting technology, AC induction motor, and other undefined uses of electric energy.

DATA SOURCES: S and E<sub>u</sub> for 1972 were obtained from ref. 2.

BASIS OF PROJECTION: S and E<sub>u</sub> for 1985 and 2000 were developed in Table 14.

FUEL MIX TABLE

A-14

Region: I  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.084	0.531	6.10	0.050	0.531	6.01	0.028	0.531	7.12
FUEL OIL	0.916	0.524	67.49	0.915	0.524	111.43	0.915	0.524	235.60
ELECTRICITY				0.035	1.000	2.23	0.057	1.000	7.69
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			73.59			119.57			250.41
BASIS $10^6$ ft <sup>2</sup>			234			455			962
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			165.00			140.25			140.25

REFERENCE TECHNOLOGIES: Fossil fuel burners, electric resistance heat.

DATA SOURCES:  $S$ ,  $D_i$ ,  $f_i$ ,  $e_i$ , and  $E_u$  for 1972 were derived in ref. 2.

BASIS OF PROJECTIONS: The basic unit demand for all building types was reduced by 15% because of lowered thermostats and improved operating procedures. System efficiencies were kept constant. It was assumed that natural gas demand and the relative market share of oil would not change, with the remaining demand being met by electricity. The use of other fuels and solar energy was assumed to be negligible. Floor space projections were obtained from Table 14.

FUEL MIX TABLE

A-15

Region: I  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.084	0.531	3.99	0.050	0.531	4.27	0.028	0.531	5.43
FUEL OIL	0.916	0.524	44.06	0.915	0.524	79.20	0.915	0.524	179.84
ELECTRICITY				0.035	1.000	1.59	0.057	1.000	5.87
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			48.05			85.06			191.14
BASIS, 10 <sup>6</sup> ft <sup>2</sup>			274			580			1317
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>3</sup> Btu/ft <sup>2</sup>			92.00			78.20			78.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-14.

FUEL MIX TABLE

A-16

Region: I  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.084	0.531	6.63	0.050	0.531	5.07	0.028	0.531	3.55
FUEL OIL	0.916	0.524	73.25	0.915	0.524	94.05	0.915	0.524	117.45
ELECTRICITY				0.035	1.000	1.89	0.057	1.000	3.83
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			79.88			101.01			124.83
BASIS $10^6$ ft <sup>2</sup>			287			434			542
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			146.00			124.10			124.10

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-14.

FUEL MIX TABLE  
A-17

Region: I  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.084	0.531	3.28	0.050	0.531	2.39	0.028	0.531	1.99
FUEL OIL	0.916	0.524	36.30	0.915	0.524	44.41	0.915	0.524	65.83
ELECTRICITY				0.035	1.000	0.89	0.057	1.000	2.19
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			39.58			47.69			69.97
BASIS $10^6$ ft <sup>2</sup>			118			170			252
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			176.00			149.60			149.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-14.

FUEL MIX TABLE

A-18

Region: I  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.084	0.531	6.77	0.050	0.531	4.93	0.028	0.531	4.58
FUEL OIL	0.916	0.524	74.78	0.915	0.524	91.35	0.915	0.524	151.71
ELECTRICITY				0.035	1.000	1.83	0.057	1.000	4.95
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			81.55			98.11			151.24
BASIS $10^6$ ft <sup>2</sup>			465			669			1111
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			92.00			78.20			78.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-14.

FUEL MIX TABLE

A-19

Region: I  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.30	0.02	1.8	0.29	0.01	1.8	0.29
FUEL OIL									
ELECTRICITY	0.964	3.0	4.89	0.98	3.0	8.40	0.99	3.0	17.35
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			5.19			8.69			17.84
BASIS, $10^6$ ft <sup>2</sup>			416			781			1596
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			36.60			32.94			32.94

REFERENCE TECHNOLOGIES: Vapor compression cycle, gas absorption.

DATA SOURCES:  $D_i$ ,  $e_i$ ,  $f_i$ , and  $E_u$  for 1972 were obtained from ref. 2.

BASIS OF PROJECTIONS: The basic unit demand was reduced by 10% for 1985 and 2000 because of improved efficiency and operating procedures. Natural gas usage was kept at the 1972 level, with the remaining demand supplied by electricity. Saturation, S, was assumed to be unity.

FUEL MIX TABLE  
A-20

Region: I  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.18	0.02	1.8	0.19	0.01	1.8	0.21
FUEL OIL									
ELECTRICITY	0.964	3.0	2.85	0.98	3.0	5.52	0.99	3.0	12.67
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			3.03			5.71			12.88
BASIS, $10^6$ ft <sup>2</sup>			274			580			1317
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			32.40			29.16			29.16

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-19.

FUEL MIX TABLE

A-21

Region: I  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.004	1.8	0.02	0.006	1.8	0.04	0.004	1.8	0.03
FUEL OIL									
ELECTRICITY	0.196	3.0	0.48	0.294	3.0	0.98	0.396	3.0	1.64
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			0.50			1.02			1.67
BASIS, $10^6$ ft <sup>2</sup>			287			434			542
SATURATION, S	0.20			0.30			0.40		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			25.50			22.95			22.95

REFERENCE TECHNOLOGIES:

DATA SOURCES:

See Table A-19.

BASIS OF PROJECTIONS:

Same as in Table A-19, except that saturation, S, was assumed to be 30% by 1985 and 40% by 2000.

FUEL MIX TABLE

A-22

Region: I  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$c_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$c_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.08	0.02	1.8	0.06	0.01	1.8	0.05
FUEL OIL									
ELECTRICITY	0.964	3.0	1.37	0.98	3.0	1.80	0.99	3.0	2.70
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			1.45			1.86			2.75
BASIS, $10^6$ ft <sup>2</sup>			118			170			252
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			36.00			32.40			32.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-19.

FUEL MIX TABLE  
A-23

Region: I  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.004	1.8	0.03	0.006	1.8	0.07	0.004	1.8	
FUEL OIL									
ELECTRICITY	0.196	3.0	0.98	0.294	3.0	1.94	0.396	3.0	
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			1.01			2.01			4.35
BASIS, $10^6$ ft <sup>2</sup>			465			669			1111
SATURATION, S	0.20			0.30			0.40		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			32.40			29.16			29.16

REFERENCE TECHNOLOGIES:

DATA SOURCES:

See Table A-19.

BASIS OF PROJECTIONS:

Same as in Table A-21.

FUEL MIX TABLE

A-24

Region: I  
Sector: COMMERCIAL  
Category: ALL BUILDINGS  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.80	0.70	26.44	0.48	0.70	26.90	0.26	0.26	27.90
FUEL OIL									
ELECTRICITY	0.20	1.00	4.67	0.52	1.00	1.00	0.74	1.00	55.58
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			31.11			47.30			83.48
BASIS, $10^6$ ft <sup>2</sup>			1419			2308			4184
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			17.00			17.00			17.00

REFERENCE TECHNOLOGIES: Gas burners, electric resistance heating.

DATA SOURCES:  $f_i$ ,  $e_i$ ,  $D_i$ , and  $E_u$  were obtained from ref. 2.

BASIS OF PROJECTIONS: Unit basic demand and system efficiencies were held constant for all commercial buildings. Natural gas usage was kept at the 1972 level, with the remaining demand being met by electricity.

FUEL MIX TABLE  
A-25

Region: I  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: LIGHTING AND MISC.  
APPLIANCE

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	7.39	1.00	1.00	14.38	1.00	1.00	30.41
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			7.39			14.38			30.40
BASIS, $10^6$ ft <sup>2</sup>			234			455			962
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			31.60			31.60			31.60

REFERENCE TECHNOLOGIES: Conventional commercial lighting systems, induction motors.

DATA SOURCES:  $e_i$ ,  $f_i$ ,  $D_i$ , and  $E_u$  for 1972 were obtained from ref. 2.

BASIS OF PROJECTIONS: The unit basic demand was held at the 1972 level for all commercial buildings.

FUEL MIX TABLE  
A-26

Region: I  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	9.32	1.00	1.00	19.72	1.00	1.00	44.78
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			9.32			19.72			44.78
BASIS, $10^6$ ft <sup>2</sup>			274			580			1317
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>						34.00			34.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

For reference technologies, data sources, and basis of projections, see Table A-25.

FUEL MIX TABLE  
A-27

Region: I  
Sector: COMMERCIAL  
Category: SCHOOLS  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	f <sub>i</sub>	e <sub>i</sub>	D <sub>i</sub>	f <sub>i</sub>	e <sub>i</sub>	D <sub>i</sub>	f <sub>i</sub>	e <sub>i</sub>	D <sub>i</sub>
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	7.80	1.00	1.00	11.80	1.00	1.00	14.74
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			7.80			11.80			14.74
BASIS, 10 <sup>6</sup> ft <sup>2</sup>			287			4 1/2			542
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>3</sup> Btu/ft <sup>2</sup>			27.20			27.20			27.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-25.

FUEL MIX TABLE  
A-28

Region: I  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: LIGHTING AND MISC.  
APPLIANCE

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	8.41	1.00	1.00	12.12	1.00	1.00	17.97
OTHER									
TOTAL FUEL DEMAND, D, $10^{12} \text{Btu}$			8.41			12.12			17.97
BASIS, $10^6 \text{ft}^2$			118			170			252
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3 \text{Btu/ft}^2$			71.30			71.30			71.30

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-25.

FUEL MIX TABLE  
A-29

Region: I  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	14.70	1.00	1.00	21.14	1.00	1.00	35.11
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			14.70			21.14			35.11
BASIS, $10^6$ ft <sup>2</sup>			465			669			1111
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			31.60			31.60			31.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS: See Table A-25.

FUEL MIX TABLE  
A-30

Region: II  
Sector: RESIDENTIAL  
Category: SINGLE FAMILY DETACHED  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.380	0.480	129.39	0.245	0.480	92.59	0.151	0.528	69.96
Retrofitted				0.036	0.586	11.14	0.022	0.614	8.77
New-improved				0.032	0.719	9.35	0.074	0.719	29.16
New-FHA-MPS				0.002	0.922	0.46	0.007	0.922	2.15
FUEL OIL									
Existing	0.587	0.400	239.85	0.378	0.400	171.42	0.232	0.440	128.98
Retrofitted				0.056	0.494	20.56	0.034	0.518	16.06
New-improved				0.146	0.604	50.79	0.216	0.604	101.34
New-FHA-MPS				0.010	0.774	2.71	0.020	0.774	7.32
ELECTRICITY									
Existing	0.018	1.000	2.94	0.013	1.000	2.36	0.008	1.000	1.96
New-improved				0.082	1.392	10.68	0.148	1.392	30.13
Heat pump							0.088	2.800	8.91
OTHER	0.015	0.350	7.00						
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			379.18			372.06			404.74
BASIS $10^3$ Households			2302			2777			
SATURATION, $S$	1.000			1.000			1.000		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household	Existing		71.00			65.32			65.32
	New					75.67			75.67

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

Note: For all Region II tables for the residential sector, see corresponding Region I tables for reference technologies, data sources and basis of projection.

FUEL MIX TABLE  
A-31

Region: II  
Sector: RESIDENTIAL  
Category: LOW DENSITY  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.380	0.480	57.55	0.238	0.480	33.62	0.111	0.480	16.48
Retrofitted				0.035	0.586	4.05	0.016	0.586	2.04
New-improved				0.095	0.719	9.80	0.180	0.719	21.46
New-FHA-MPS				0.006	0.922	0.48	0.016	0.922	1.49
FUEL OIL									
Existing	0.587	0.400	106.69	0.366	0.400	62.05	0.168	0.440	29.93
Retrofitted				0.054	0.494	7.41	0.025	0.494	3.78
New-improved				0.098	0.604	12.03	0.177	0.604	25.12
New-FHA-MPS				0.006	0.774	0.57	0.015	0.774	1.66
ELECTRICITY									
Existing	0.018	1.000	1.31	0.014	1.000	0.95	0.006	1.000	0.47
New-improved				0.088	1.392	4.29	0.181	1.392	11.15
Heat pump							0.105	2.800	3.21
OTHER (Coal, Steam)	0.015	0.350	3.12						
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			168.67			135.25			116.79
BASIS $10^3$ Households			1454			1474			1704
SATURATION, $S$	1.000			1.000			1.000		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household	Existing		50			46.00			46.00
	New					50.31			50.31

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-32

Region: II  
Sector: RESIDENTIAL  
Category: LOW RISE  
End use: SPACE HEATING

	1972			1985			2000			
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	
DIRECT FUEL USE										
METHANE										
Existing	0.380	0.480	21.18	0.228	0.480	14.72	0.100	0.480	7.44	
Retrofitted				-----	-----	-----	-----	-----	-----	
New-improved				0.070	0.719	3.02	0.128	0.719	6.99	
New-FHA-MPS				0.004	0.922	0.13	0.011	0.922	0.47	
FUEL OIL										
Existing	0.587	0.400	39.27	0.351	0.400	27.20	0.149	0.440	13.30	
Retrofitted				-----	-----	-----	-----	-----	-----	
New-improved				0.210	0.604	10.78	0.273	0.604	17.77	
New-FHA-MPS				0.013	0.774	0.52	0.025	0.774	1.27	
ELECTRICITY										
Existing	0.018	1.000	0.48	0.001	1.000	0.03	0.005	1.000	0.20	
New-improved				0.123	1.392	2.74	0.203	1.392	5.73	
Heat pump							0.106	2.800	1.49	
OTHER (Coal, Steam)										
	0.015	0.350	1.15							
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			62.08				59.23	54.66		
BASIS 10 <sup>3</sup> Households			787				991	1256		
SATURATION, S										
	1.000				1.000				1.000	
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			34				31.28	31.28		

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-33

Region: II  
Sector: RESIDENTIAL  
Category: HIGH RISE  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.380	0.480	37.16	0.274	0.480	25.88	0.157	0.480	14.70
Retrofitted				-----	-----	-----	-----	-----	-----
New-Improved				0.083	0.719	5.23	0.159	0.719	10.94
New-FHA-MPS				0.005	0.922	0.25	0.016	0.922	0.86
FUEL OIL									
Existing	0.587	0.400	68.88	0.422	0.400	47.84	0.238	0.440	26.75
Retrofitted				-----	-----	-----	-----	-----	-----
New-Improved				0.108	0.604	8.11	0.162	0.604	13.26
New-FHA-MPS				0.007	0.774	0.41	0.015	0.774	0.96
ELECTRICITY									
Existing	0.018	1.000	0.84	0.013	1.000	0.59	0.007	1.000	0.35
New-improved				0.088	1.392	2.87	0.163	1.392	5.79
Heat pump							0.083	2.800	1.47
OTHER (Coal, Steam)	0.015	0.350	2.01						
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			108.89			91.18			75.08
BASIS									
$10^3$ Households			1514			1590			1734
SATURATION, $S$	1.000			1.000			1.000		
UNIT BASIC DEMAND, $E_u$ , $10^6$ Btu/household			31			28.52			28.52

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-34

Region: II  
Sector: RESIDENTIAL  
Category: MOBILE HOME  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing				0.90	0.44	29.29	0.90	0.44	43.85
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY									
Existing				0.10	1.00	1.43	0.10	1.00	2.15
New-improved									
Heat Pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu						30.72			46.00
BASIS $10^3$ Households						358			536
SATURATION, $S$									
UNIT BASIC DEMAND, $E_u$ ( $10^6$ Btu/household)				1.00			1.00		
						40.00			40.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-35

Region: II  
Sector: RESIDENTIAL  
Category: SINGLE-FAMILY DETACHED  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.43	0.57	44.76	0.37	0.57	49.20	0.31	0.57	53.50
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.49	0.63	44.76	0.47	0.63	49.20	0.40	0.63	53.50
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.08	1.00	4.60	0.16	1.00	10.55	0.29	1.00	24.44
Existing									
New-Improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			91.91			102.56			123.77
BASIS 10 <sup>3</sup> Households			2302			2777			3745
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> (10 <sup>6</sup> Btu/household)			25.00			23.75			22.50

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-36

Region: II  
Sector: RESIDENTIAL  
Category: LOW DENSITY  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.43	0.57	19.74	0.37	0.57	16.36	0.31	0.57	15.01
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.49	0.63	20.36	0.47	0.63	18.80	0.40	0.63	17.53
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.08	1.00	2.09	0.16	1.00	4.03	0.29	1.00	5.25
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			42.19			39.19			40.54
BASIS $10^3$ Households			1454			1474			1704
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ ( $10^6$ Btu/household)			18.00			17.10			16.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-37

Region: II  
Sector: RESIDENTIAL  
Category: LOW RISE  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.43	0.57	9.50	0.37	0.57	9.78	0.31	0.57	9.84
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.49	0.63	9.80	0.47	0.63	11.24	0.40	0.63	11.48
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.08	1.00	1.01	0.16	1.00	2.41	0.29	1.00	5.25
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			20.31			23.43			26.57
BASIS $10^3$ Households			787			991			1256
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household			16.00			15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-38

Region: II  
Sector: RESIDENTIAL  
Category: HIGH RISE  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.43	0.57	18.27	0.37	0.57	15.69	0.31	0.57	13.58
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.49	0.63	18.84	0.47	0.63	18.03	0.40	0.63	15.85
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.08	1.00	1.94	0.16	1.00	3.87	0.29	1.00	7.24
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			39.05			37.59			36.67
BASIS, $10^3$ households			1514			1590			1734
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^6$ Btu/household			16.00			15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

DATE OF PROJECTION:

FUEL MIX TABLE  
A-39

Region: II  
Sector: RESIDENTIAL  
Category: MOBILE HOME  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY				1.00	1.00	5.44	1.00	1.00	7.72
Existing									
New-improved									
Heat Pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu						5.44			7.72
BASIS 10 <sup>3</sup> Households			Negligible			358			536
SATURATION, S				1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>6</sup> Btu/household						15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-40

Region: II  
Sector: RESIDENTIAL  
Category: ALL HOUSING TYPES  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY									
ROOM	0.29	2.00	9.17	0.58	3.00	14.51	0.80	3.00	24.97
CENTRAL	0.04	2.50	2.16	0.08	3.00	4.27	0.11	3.00	7.34
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			11.33			18.78			32.31
BASIS $10^3$ Households		6057			7100			8975	
SATURATION, $S$	0.33			0.66			0.91		
UNIT BASIC DEMAND, $E_u$									
Room $10^6$ Btu/household	Room		10.44			10.44			10.44
Central $10^6$ Btu/household	Central		22.29			22.29			22.29

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-41

Region: II  
Sector: RESIDENTIAL  
Category: ALL HOUSING TYPES  
End use: COOKING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.70	0.38	35.92	0.62	0.38	37.30	0.45	0.38	33.80
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.09	0.38	4.04						
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.21	1.00	4.08	0.38	1.00	8.57	0.55	1.00	15.70
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			44.04			45.97			49.50
BASIS 10 <sup>3</sup> Households			6057			7190			8975
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			3.18			3.18			3.18

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-42

Region: II  
 Sector: RESIDENTIAL  
 Category: ALL HOUSING TYPES  
 End use: LIGHTING & MISC.  
 ELECTRIC APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.60	1.00	84.10	0.73	1.00	112.32	0.88	1.00	166.65
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			84.10			112.32			166.65
BASIS 10 <sup>3</sup> Households			6057			7190			8975
SATURATION, S	0.60			0.73			0.88		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			23.05			21.40			21.10

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-43

Region: II  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.150	0.531	16.69	0.100	0.531	17.75	0.056	0.531	20.32
FUEL OIL	0.760	0.524	85.68	0.731	0.524	131.51	0.731	0.524	268.74
ELECTRICITY				0.110	1.000	10.37	0.184	1.000	35.45
OTHER (Steam)	0.090	0.655	8.12	0.059	0.655	8.49	0.029	0.655	8.53
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			110.49			168.12			333.04
BASIS, $10^6$ ft <sup>2</sup>			416			781			962
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			142.00			120.70			120.70

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

Note: For all Region II tables for the commercial sector, see corresponding Region I tables for reference technologies, data sources, and basis of projection.

FUEL MIX TABLE

A-44

Region: II  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.150	0.531	9.82	0.100	0.531	11.10	0.056	0.531	14.93
FUEL OIL	0.760	0.524	50.42	0.731	0.524	82.25	0.731	0.524	197.47
ELECTRICITY				0.110	1.000	6.49	0.184	1.000	26.05
OTHER (steam)	0.090	0.655	4.78	0.059	0.655	5.31	0.029	0.655	6.27
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			65.02			105.15			244.72
BASIS, $10^6$ ft <sup>2</sup>			440			878			1317
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			79.00			67.15			67.15

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-45

Region: II  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.150	0.531	8.44	0.100	0.531	12.88	0.056	0.531	10.30
FUEL OIL	0.760	0.524	43.31	0.731	0.524	95.47	0.731	0.524	136.26
ELECTRICITY				0.110	1.000	7.53	0.184	1.000	17.97
OTHER (Steam)	0.090	0.655	4.10	0.059	0.655	6.16	0.029	0.655	4.32
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			55.85			122.04			168.85
BASIS, $10^6$ ft <sup>2</sup>			237			639			912
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			126.00			107.10			107.10

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-46

Region: II  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.150	0.531	8.46	0.100	0.531	6.62	0.056	0.531	5.33
FUEL OIL	0.760	0.524	43.43	0.731	0.524	49.02	0.731	0.524	70.47
ELECTRICITY				0.110	1.000	3.87	0.184	1.000	9.30
OTHER (Steam)	0.090	0.655	4.11	0.059	0.655	3.17	0.029	0.655	2.24
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			56.00			62.68			87.34
BASIS, $10^6$ ft <sup>2</sup>			197			272			391
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Dtu/ft <sup>2</sup>			152.00			129.20			129.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-47

Region: II  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.150	0.531	15.73	0.100	0.531	12.75	0.056	0.531	11.74
FUEL OIL	0.760	0.524	80.78	0.731	0.524	94.43	0.731	0.524	155.22
ELECTRICITY				0.110	1.000	7.45	0.184	1.000	20.47
OTHER (Steam)	0.090	0.655	7.65	0.059	0.655	6.10	0.029	0.655	6.63
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			104.16			120.73			194.06
BASIS $10^6$ ft <sup>2</sup>			705			1008			1657
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			79.00			67.15			67.15

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-48

Region: II  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.30	0.02	1.8	0.29	0.01	1.8	0.29
FUEL OIL									
ELECTRICITY	0.964	3.0	4.89	0.98	3.0	8.40	0.99	3.0	17.35
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			5.19			8.69			17.84
BASIS $10^6$ ft <sup>2</sup>		416			781			1596	
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			36.60			32.94			32.94

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-49

Region: II  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.36	0.02	1.8	0.39	0.01	1.8	0.43
FUEL OIL									
ELECTRICITY	0.964	3.0	5.77	0.98	3.0	10.53	0.99	3.0	25.54
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			6.13			10.92			25.97
BASIS $10^6$ ft <sup>2</sup>			440			878			2108
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			40.80			36.72			36.72

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-50

Region: II  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.004	1.8	0.03	0.006	1.8	1.8	0.004	1.8	0.06
FUEL OIL									
ELECTRICITY	0.196	3.0	0.94	0.294	3.0	3.0	0.396	3.0	3.48
OTHER									
TOTAL FUEL DEMAND, D, $10^{12} \text{Btu}$			0.97			1.87			3.54
BASIS $10^6 \text{ft}^2$			447			639			912
SATURATION, S	0.20			0.30			0.40		
UNIT BASIC DEMAND, $E_u$ , $10^3 \text{Btu/ft}^2$			32.10			28.89			28.89

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-51

Region: II  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.18	0.02	1.8	0.13	0.01	1.8	0.09
FUEL OIL									
ELECTRICITY	0.964	3.0	2.89	0.98	3.0	3.65	0.99	3.0	5.30
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			3.07			3.78			5.39
BASIS $10^6$ ft <sup>2</sup>			197			272			391
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			45.60			41.04			41.04

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-52

Region: II  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.004	1.8	0.06	0.006	1.8	0.13	0.004	1.8	0.14
FUEL OIL									
ELECTRICITY	0.196	3.0	1.88	0.294	3.0	3.63	0.396	3.0	8.03
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			1.94			3.76			8.17
BASIS $10^6$ ft <sup>2</sup>			705			1668			1657
SATURATION, S	0.20			0.30			0.40		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			40.80			36.72			36.72

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-53

Region: II  
Sector: COMMERCIAL  
Category: ALL BUILDINGS  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.68	0.70	36.15	0.42	0.70	36.50	0.40	0.26	46.84
FUEL OIL									
ELECTRICITY	0.32	1.00	12.05	0.58	1.00	35.28	0.60	1.00	49.15
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			48.20			71.78			95.99
BASIS $\cdot 10^6$ ft <sup>2</sup>			2206			3578			6664
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			17.00			17.00			17.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-54

Region: II  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	13.15	1.00	1.00	24.68	1.00	1.00	50.43
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			13.15			24.68			50.43
BASIS $10^6$ ft <sup>2</sup>			416			781			1596
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			31.60			31.60			31.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-55

Region: II  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	14.96	1.00	1.00	29.85	1.00	1.00	71.67
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			14.96			29.85			71.67
BASIS $10^6$ ft <sup>2</sup>			440			878			2108
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			34.00			34.00			34.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-56

Region: II  
 Sector: COMMERCIAL  
 Category: SCHOOL  
 End-use: LIGHTING AND MISC.  
 APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	12.16	1.00	1.00	17.38	1.00	1.00	24.81
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			12.16			17.38			24.81
BASIS $10^6$ ft <sup>2</sup>			447			639			912
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			27.20			27.20			27.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-57

Region: II  
 Sector: COMMERCIAL  
 Category: HOSPITAL  
 End-use: LIGHTING AND MISC.  
 APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	14.05	1.00	1.00	19.39	1.00	1.00	27.88
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			14.05			19.39			27.88
BASIS $10^6$ ft <sup>2</sup>			197			272			391
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			71.30			71.30			71.30

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-58

Region: II  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	22.28	1.00	1.00	31.85	1.00	1.00	52.36
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			22.28			31.85			52.36
BASIS $10^6$ ft <sup>2</sup>			705			1008			1657
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			31.60			31.60			31.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-59

Region: III  
Sector: RESIDENTIAL  
Category: SINGLE FAMILY DETACHED  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.46	0.480	268.75	0.296	0.480	191.08	0.188	0.528	144.10
Retrofitted				0.044	0.586	23.27	0.028	0.614	18.46
New-improved				0.039	0.719	19.47	0.064	0.719	41.74
New-FHA-MPS				0.002	0.922	0.78	0.006	0.922	3.05
FUEL OIL									
Existing	0.44	0.400	308.48	0.312	0.400	241.69	0.198	0.440	182.12
Retrofitted				0.047	0.494	29.48	0.030	0.518	23.44
New-improved				0.103	0.604	61.32	0.193	0.604	149.82
New-FHA-MPS				0.007	0.774	3.25	0.017	0.774	10.30
ELECTRICITY									
Existing	0.04	1.000	11.22	0.030	1.000	9.30	0.019	1.000	7.69
New-improved				0.120	1.392	26.71	0.174	1.392	58.61
Heat pump							0.083	2.800	13.90
OTHER (Coal)	0.06	0.350	48.07						
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			636.52			606.75			653.23
BASIS, 10 <sup>3</sup> Households			4124			4953			6469
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			Existing 68.00			62.56			62.56
			New			72.48			72.48

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

Note: For all Region III tables for the residential sector, see corresponding Region I tables for reference technologies, data sources, and basis of projection.

FUEL MIX TABLE  
A-60

Region: III  
Sector: RESIDENTIAL  
Category: LOW DENSITY  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.46	0.480	110.95	0.296	0.480	70.88	0.185	0.528	43.82
Retrofitted				0.044	0.586	8.63	0.028	0.586	5.70
New-improved				0.080	0.719	13.99	0.101	0.719	30.63
New-FHA-MPS				0.005	0.922	0.68	0.015	0.922	2.22
FUEL OIL									
Existing	0.44	0.400	127.35	0.309	0.400	88.80	0.193	0.440	54.86
Retrofitted				0.040	0.494	10.70	0.029	0.494	7.00
New-improved				0.075	0.604	15.61	0.112	0.604	25.36
New-FHA-MPS				0.005	0.774	0.81	0.010	0.774	1.77
ELECTRICITY									
Existing	0.04	1.000	4.63	0.029	1.000	3.33	0.019	1.000	2.38
New-improved				0.111	1.392	9.17	0.175	1.392	17.20
Heat pump							0.073	2.800	3.57
OTHER	0.06	0.350	19.85						
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			262.78			222.60			194.51
BASIS $10^3$ Households			2417			2603			2832
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household	Existing		48.00			44.16			44.16
	New					48.30			48.30

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-61

Region: III  
Sector: RESIDENTIAL  
Category: LOW RISE  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.46	0.480	21.47	0.289	0.480	15.58	0.133	0.480	7.99
Retrofitted				-----	-----	-----	-----	-----	-----
New-improved				0.084	0.719	3.02	0.158	0.719	6.97
New-FHA-MPS				0.005	0.922	0.13	0.014	0.922	0.48
FUEL OIL									
Existing	0.44	0.400	24.64	0.276	0.400	17.86	0.114	0.440	8.22
Retrofitted				-----	-----	-----	-----	-----	-----
New-improved				0.170	0.604	7.28	0.233	0.604	12.24
New-FHA-MPS				0.011	0.774	0.37	0.020	0.774	0.82
ELECTRICITY									
Existing	0.04	1.000	0.90	0.025	1.000	0.65	0.012	1.000	0.38
New-improved				0.140	1.392	2.60	0.181	1.392	4.13
Heat pump							0.135	2.800	1.53
OTHER	0.06	0.350	3.84						
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			50.85			47.49			42.76
BASIS $10^3$ Households			700			879			1078
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ $10^6$ Btu/household			32.00			29.44			29.44

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-62

Region: III  
Sector: RESIDENTIAL  
Category: HIGH RISE  
End use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing	0.46	0.480	15.67	0.331	0.480	10.85	0.188	0.480	6.15
Retrofitted				-----	-----	-----	-----	-----	-----
New-improved				0.100	0.719	2.19	0.194	0.719	4.66
New-FHA-MPS				0.007	0.922	0.11	0.017	0.922	0.33
FUEL OIL									
Existing	0.44	0.400	17.99	0.347	0.400	13.65	0.193	0.440	7.58
Retrofitted				-----	-----	-----	-----	-----	-----
New-improved				0.091	0.604	2.37	0.131	0.604	3.75
New-FHA-MPS				0.006	0.774	0.12	0.012	0.774	0.27
ELECTRICITY									
Existing	0.04	1.000	0.65	0.030	1.000	0.47	0.017	1.000	0.30
New-improved				0.088	1.392	1.00	0.164	1.392	2.04
Heat pump							0.084	2.800	0.52
OTHER (Coal)	0.06	0.350							
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			34.31			30.10			25.59
BASIS 10 <sup>3</sup> Households			545			570			626
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, F <sub>U</sub> 10 <sup>6</sup> Btu/household			30.00			27.60			27.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-63

Region: III  
 Sector: RESIDENTIAL  
 Category: MOBILE HOME  
 End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing				0.90	0.44	27.49	0.90	0.44	38.44
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY									
Existing				0.10	1.00	1.35	0.10	1.00	1.88
New-improved									
Heat Pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu						28.84			40.32
BASIS , 10 <sup>3</sup> Households						384			537
SATURATION, S				1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household						35.00			35.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-64

Region: III  
Sector: RESIDENTIAL  
Category: ALL HOUSING TYPES  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY									
ROOM	0.32	2.00	14.57	0.61	3.00	22.36	0.73	3.00	32.86
CENTRAL	0.10	2.50	7.78	0.19	3.00	14.88	0.27	3.00	25.97
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			21.35			37.24			58.83
BASIS 10 <sup>3</sup> Households			7781		9389			11542	
SATURATION, UNIT BASIC DEMAND, E <sub>u</sub>	0.42			0.80			1.00		
Room			11.70			11.70			11.70
10 <sup>6</sup> Btu/household Central			25.00			25.00			25.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION.

FUEL MIX TABLE

A-65

Region: III

Sector: RESIDENTIAL

Category: SINGLE FAMILY DETACHED

End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.58	0.57	104.91	0.49	0.57	101.12	0.40	0.57	102.14
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.24	0.63	39.28	0.24	0.63	44.81	0.22	0.63	50.83
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.18	1.00	18.56	0.27	1.00	31.76	0.38	1.00	55.31
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			162.75			177.69			208.28
BASIS 10 <sup>3</sup> Households			4124			4953			6469
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			25.00			23.75			22.50

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-66

Region: III  
Sector: RESIDENTIAL  
Category: LOW DENSITY  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE:									
METHANE	0.58	0.57	44.18	0.49	0.57	38.26	0.40	0.57	32.20
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.24	0.63	16.54	0.24	0.63	16.96	0.22	0.63	16.02
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.18	1.00	7.81	0.27	1.00	12.02	0.38	1.00	17.43
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			68.53			67.24			65.65
BASIS, $10^3$ Households			2412			2603			2832
SATURATION, $S$	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^6$ Btu/household			18.00			17.10			16.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-67

Region: III  
Sector: RESIDENTIAL  
Category: LOW RISE  
End-Use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.58	0.57	11.40	0.49	0.57	11.49	0.40	0.57	10.89
Existing									
Retrofitted									
New-Improved									
New-FHA-MPS									
FUEL OIL	0.24	0.63	4.27	0.24	0.63	5.09	0.22	0.63	5.42
Existing									
Retrofitted									
New-Improved									
New-FHA-MPS									
ELECTRICITY	0.18	1.00	2.02	0.27	1.00	3.61	0.38	1.00	5.90
Existing									
New-Improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			17.69			20.19			22.21
BASIS 10 <sup>3</sup> Households			700			879			1078
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			16.00			15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-68

Region: III  
Sector: RESIDENTIAL  
Category: HIGH RISE  
End-Use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.58	0.57	8.87	0.49	0.57	7.45	0.40	0.57	6.33
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.24	0.63	3.32	0.24	0.63	3.30	0.22	0.63	3.15
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.18	1.00	1.57	0.27	1.00	2.34	0.38	1.00	3.43
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			13.76			13.09			12.91
BASIS 10 <sup>3</sup> Households			545			570			626
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			16.00			15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-69

Region: III  
Sector: RESIDENTIAL  
Category: MOBILE HOME  
End use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY				1.00	1.00	5.84	1.00	1.00	7.73
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu						5.84			7.73
BASIS 10 <sup>3</sup> Households			Negligible			384			537
SATURATION, S				1.00			1.00		
UNIT BASIC DEMAND, E <sub>i</sub> , 10 <sup>6</sup> Btu/household						15.20			14.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE  
A-70

Region: III  
Sector: RESIDENTIAL  
Category: ALL HOUSING TYPES  
End-use: COOKING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.60	0.38	41.69	0.52	0.38	45.56	0.42	0.38	42.74
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
FUEL OIL	0.09	0.38	4.78						
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.32	1.00	8.39	0.48	1.00	15.98	0.58	1.00	22.43
Existing									
New-improved									
Heat Pump									
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			54.86			61.54			65.17
BASIS 10 <sup>3</sup> Households									
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> 10 <sup>6</sup> Btu/household			3.35			3.35			3.35

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-71

Region: III  
 Sector: RESIDENTIAL  
 Category: ALL HOUSING TYPES  
 End-Use: LIGHTING AND MISC.  
 ELECTRIC APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
Existing									
Retrofitted									
New-improved									
New-FH'-MPS									
FUEL OIL									
Existing									
Retrofitted									
New-improved									
New-FHA-MPS									
ELECTRICITY	0.60	1.00	107.29	0.73	1.00	146.67	0.88	1.00	214.31
Existing									
New-improved									
Heat pump									
OTHER									
TOTAL FUEL DEMAND, $D$ , 10 <sup>12</sup> Btu			107.29			146.67			214.31
BASIS 10 <sup>3</sup> Households			7781			9389			11542
SATURATION, $S$	0.60			0.73			0.88		
UNIT BASIC DEMAND, $E_u$ 10 <sup>6</sup> Btu/household			23.05			21.40			21.10

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTION:

FUEL MIX TABLE

A-72

Region: III  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.290	0.531	35.16	0.225	0.531	44.65	0.122	0.531	50.96
FUEL OIL	0.710	0.524	87.22	0.700	0.524	140.75	0.700	0.524	296.30
ELECTRICITY				0.075	1.000	7.90	0.178	1.000	39.48
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			122.38			193.30			386.74
BASIS, $10^6$ ft <sup>2</sup>			484			932			1962
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			133.00			113.05			113.05

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

Note: For all Region III tables for the commercial sector, see corresponding Region I tables for reference technologies, data sources, and basis of projection.

FUEL MIX TABLE  
A-73

Region: III  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.290	0.531	16.69	0.225	0.531	32.84	0.122	0.531	40.05
FUEL OIL	0.710	0.524	58.05	0.700	0.524	103.52	0.700	0.524	232.84
ELECTRICITY				0.075	1.000	5.81	0.178	1.000	31.02
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			77.74			142.17			303.91
BASIS, $10^6$ ft <sup>2</sup>			579			1232			2771
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			74.00			62.90			62.90

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-74

Region: III  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.290	0.531	40.21	0.225	0.531	40.63	0.122	0.531	31.66
FUEL OIL	0.710	0.524	99.77	0.700	0.524	128.09	0.700	0.524	184.10
ELECTRICITY				0.075	1.000	7.19	0.178	1.000	24.53
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			139.98			175.91			240.29
BASIS, $10^6$ ft <sup>2</sup>			624			956			1374
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			118.00			100.30			100.30

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-75

Region: III  
 Sector: COMMERCIAL  
 Category: HOSPITAL  
 End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.290	0.531	14.49	0.225	0.531	16.93	0.122	0.531	13.95
FUEL OIL	0.710	0.524	42.71	0.700	0.524	53.37	0.700	0.524	81.10
ELECTRICITY				0.075	1.000	2.93	0.178	1.000	10.81
OTHER									
TOTAL FUEL DEMAND, D, 10 <sup>12</sup> Btu			57.20			73.23			105.86
BASIS, 10 <sup>6</sup> ft <sup>2</sup>			222			331			503
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , 10 <sup>3</sup> Btu/ft <sup>2</sup>			142.00			120.70			120.70

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-76

Region: III  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: SPACE HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.290	0.531	38.19	0.225	0.531	36.46	0.122	0.531	32.85
FUEL OIL	0.710	0.524	94.75	0.700	0.524	114.95	0.700	0.524	191.00
ELECTRICITY				0.075	1.000	6.45	0.178	1.000	25.45
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			132.94			157.86			249.30
BASIS, $10^6$ ft <sup>2</sup>			945			1368			2273
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			74.00			62.90			62.90

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-77

Region: III  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.40	0.02	1.8	0.38	0.01	1.8	0.40
FUEL OIL									
ELECTRICITY	0.964	3.0	6.39	0.98	3.0	11.26	0.99	3.0	23.95
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			6.79			11.64			24.35
BASIS, $10^6$ ft <sup>2</sup>			484			932			1962
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			41.10			36.99			36.99

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-78

Region: III  
Sector: COMMERCIAL  
Category: RETAIL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.53	0.02	1.8	0.57	0.01	1.8	0.64
FUEL OIL									
ELECTRICITY	0.964	3.0	8.54	0.98	3.0	16.63	0.99	3.0	37.78
OTHER									
TOTAL FUEL DEMAND, $D$ , $10^{12}$ Btu			9.07			17.20			38.42
BASIS $10^6$ ft <sup>2</sup>			579			878			2771
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			45.90			41.31			41.31

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-79

Region: III  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.004	1.8	0.05	0.006	1.8	0.10	0.004	1.8	0.10
FUEL OIL									
ELECTRICITY	0.196	3.0	1.47	0.294	3.0	3.0	0.396	3.0	5.88
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			1.52			3.14			5.98
BASIS $10^6$ ft <sup>2</sup>			624			956			1374
SATURATION, S	0.20			0.30			0.40		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			36.00			32.40			32.40

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-80

Region: III  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.036	1.8	0.23	0.02	1.8	0.17	0.01	1.0	0.13
FUEL OIL									
ELECTRICITY	0.964	3.0	3.66	0.98	3.0	4.99	0.99	3.0	7.66
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			3.89			5.16			7.79
BASIS $10^6$ ft <sup>2</sup>			222			331			503
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			51.30			46.17			46.17

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-81

Region: III  
Sector: COMMERCIAL  
Category: MISCELLANEOUS  
End-use: AIR CONDITIONING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.004	1.8	0.10	0.006	1.8	0.19	0.004	1.8	0.21
FUEL OIL									
ELECTRICITY	0.196	3.0	2.83	0.294	3.0	5.54	0.396	3.0	12.40
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			2.93			5.73			12.61
BASIS, $10^6$ ft <sup>2</sup>			945			1368			2273
SATURATION, S	0.20			0.30			0.40		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			45.90			41.31			41.31

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-82

Region: III  
Sector: COMMERCIAL  
Category: ALL BUILDINGS  
End-use: WATER HEATING

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE	0.68	0.70	46.79	0.40	0.70	46.81	0.22	0.26	47.46
FUEL OIL									
ELECTRICITY	0.32	1.00	15.59	0.60	1.00	49.15	0.78	1.00	117.79
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			62.38			95.96			165.25
BASIS, $10^6$ ft <sup>2</sup>			2855			4819			8883
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			17.00			17.00			17.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-83

Region: III  
Sector: COMMERCIAL  
Category: OFFICE  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	15.29	1.00	1.00	29.45	1.00	1.00	62.00
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			15.29			29.45			62.00
BASIS, $10^6$ ft <sup>2</sup>			484			932			1962
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			31.60			31.60			31.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-84

Region: III  
 Sector: COMMERCIAL  
 Category: RETAIL  
 End-use: LIGHTING AND MISC.  
 APPLIANCE

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	19.69	1.00	1.00	41.89	1.00	1.00	94.22
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			19.69			41.89			94.22
BASIS, $10^6$ ft <sup>2</sup>			579			1232			2771
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			34.00			34.00			34.00

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-85

Region: III  
Sector: COMMERCIAL  
Category: SCHOOL  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	16.97	1.00	1.00	26.00	1.00	1.00	37.37
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			16.97			26.00			37.37
BASIS, $10^6$ ft <sup>2</sup>		624			956			1374	
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $E_u$ , $10^3$ Btu/ft <sup>2</sup>			27.20			27.20			27.20

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE  
A-86

Region: III  
Sector: COMMERCIAL  
Category: HOSPITAL  
End-use: LIGHTING AND MISC.  
APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	15.83	1.00	1.00	23.60	1.00	1.00	35.86
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			15.83			23.60			35.86
BASIC, $10^6$ ft <sup>2</sup>			222			331			503
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, $F_u$ , $10^3$ Rtu/ft <sup>2</sup>			71.30			71.30			71.30

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

FUEL MIX TABLE

A-87

Region: III  
 Sector: COMMERCIAL  
 Category: MISCELLANEOUS  
 End-use: LIGHTING AND MISC.  
 APPLIANCES

	1972			1985			2000		
	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$	$f_i$	$e_i$	$D_i$
DIRECT FUEL USE									
METHANE									
FUEL OIL									
ELECTRICITY	1.00	1.00	29.86	1.00	1.00	43.23	1.00	1.00	71.83
OTHER									
TOTAL FUEL DEMAND, D, $10^{12}$ Btu			29.86			43.23			71.83
BASIS, $10^6$ ft <sup>2</sup>		945			1368			2273	
SATURATION, S	1.00			1.00			1.00		
UNIT BASIC DEMAND, E <sub>u</sub> , $10^3$ Btu/ft <sup>2</sup>			31.60			31.60			31.60

REFERENCE TECHNOLOGIES:

DATA SOURCES:

BASIS OF PROJECTIONS:

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## APPENDIX B

### MODE SHIFT ANALYSIS

In addition to the projections based on assumptions described in Section IV, projections exploring the possibilities for shifts between energy forms were made for use in supply-demand analysis in the Northeast Energy Perspectives Study. Such mode shifts may indicate a decrease in total energy demand of several percent; however, such reductions must be interpreted judiciously. A shift to electricity may reduce end-demand energy requirements but increase thermal energy input requirements in a supply sector. The principal advantage of a mode shift lies in the resulting change in demand for specific fuels, not in the change in total demand.

#### Mode Shift to Electricity

For each of the three cases developed in Section IV, a corresponding case was constructed with a mode shift to electricity. For these cases, it is assumed that a larger portion of new homes are electrically heated because of restrictions on gas and oil supplies. In this mode shift, 50% of the homes built between 1972 and 1985 and 75% of those built thereafter are assumed to be electrically heated. Furthermore, it is assumed that half of the existing stock of warm air furnaces that must be replaced within the projection period are replaced with electric units. In the commercial sector, it is assumed that electricity is used for heating in twice as many units as in the non-mode shift case. The amounts of oil and natural gas replaced by electricity are assumed to be proportional to the relative market share of each fuel in the non-mode shift case. The result is shown in Table B-1.

TABLE B-1

NORTHEAST RESIDENTIAL AND COMMERCIAL ENERGY  
DEMAND ( $10^{12}$  Btu) MODE SHIFT TO  
ELECTRICITY

<u>Fuel type</u>	<u>1985</u>			<u>2000</u>		
	<u>Base</u>	<u>Moderate</u>	<u>Strong</u>	<u>Base</u>	<u>Moderate</u>	<u>Strong</u>
Oil	2816	2513	2061	3567	2838	2027
Gas	1403	1261	1043	1280	1066	791
Electricity	1398	1227	1070	2812	2191	1667
Solar	-	-	25	-	370	631

Mode Shift to Electricity and Gas

The rationale for this mode shift was a desire to see to what extent a shift to electricity and gas, supported by production of low Btu gas, could alleviate the high oil demands. For each of the original three cases (Section IV) an alternative has been constructed in which gas retains its 1972 market share for space heating and electricity use is projected on the same basis as in the mode shift to electricity cases. Solar energy, if used, remains at its original levels and oil is used for the remaining demand.

Mode Shift to Oil and Gas

In this case, the possibility was explored that a high relative cost of electricity would reduce its use for heating in new buildings to half the level projected in the original reference case. The remaining demands for space heat are met with gas and oil in proportion to their use in the reference case.

TABLE B-2

NORTHEAST RESIDENTIAL AND COMMERCIAL ENERGY DEMAND-  
 (10<sup>12</sup> Btu) MODE SHIFT TO ELECTRICITY AND GAS

<u>Fuel type</u>	<u>1985</u>			<u>2000</u>		
	<u>Base</u>	<u>Moderate</u>	<u>Strong</u>	<u>Base</u>	<u>Moderate</u>	<u>Strong</u>
Oil	2517	2255	1851	2954	2177	1562
Gas	1739	1555	1290	2147	1745	1287
Electricity	1398	1227	1070	2812	2191	1667
Solar	-	-	25	-	370	631

TABLE B-3

NORTHEAST RESIDENTIAL AND COMMERCIAL ENERGY DEMAND-  
 (10<sup>12</sup> Btu) MODE SHIFT TO OIL AND GAS

<u>Fuel type</u>	<u>1985</u>			<u>2000</u>		
	<u>Base</u>	<u>Moderate</u>	<u>Strong</u>	<u>Base</u>	<u>Moderate</u>	<u>Strong</u>
Oil	3164	2807	2299	4552	2568	2529
Gas	1460	1318	1089	1397	1163	849
Electricity	1231	1091	968	2330	1851	1447
Solar	-	-	25	-	370	631

All the above cases attest to the region's very great dependence on oil for its energy source. Only in the case in which strong conservation is coupled with a mode shift to electricity and gas does the level of oil demand remain fairly constant over time.

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## **THE BROOKHAVEN NATIONAL LABORATORY REGIONAL ENERGY STUDIES PROGRAM**

**The Brookhaven National Laboratory Regional Energy Studies Program is part of a national effort supported by the U.S. Energy Research and Development Administration (ERDA) to create an energy assessment capability which is sensitive to regional conditions, perceptions, and impacts. Within ERDA, this program is supported by the Division of Biomedical and Environmental Research and includes, in addition to a concern for health and environmental impacts of energy systems, analysis of the complex trade-offs between economics, environmental quality, technical considerations, national security, social impacts, and institutional questions. The Brookhaven Program focuses on the Northeast, including the New England states, New York, Pennsylvania, New Jersey, Maryland, Delaware, and the District of Columbia. The content of the program is determined through an identification of the major energy planning issues of the region and in consultation with state and regional agencies. A major component of the program in 1976 is the Northeast Energy Perspectives Study which examines the implications of alternative energy supply-demand possibilities for the region.**